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REPORT No. 9.

U. S. DEPARTMENT OF AGRICULTURE.

FIBER INVESTIGATIONS.

A DESCRIPTIVE CATALOGUE

OF

USEFUL FIBER PLANTS OF THE WORLD,

INCLUDING

THE STRUCTURAL AND ECONOMIC CLASSIFICATIONS OF FIBERS.

BY

CHAS. RICHARDS DODGE,
Special Agent.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1897.

LETTER OF TRANSMITTAL.

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF FIBER INVESTIGATIONS,
Washington, D. C., January 2, 1897.

SIR: I have the honor to submit herewith the manuscript of a descriptive catalogue of 1,018 species of useful fibers of the world. No similar work has previously been published in this country, and no work has appeared in any country with so full descriptive lists of the commercial and native fibers of the people of the globe, the compilation embodying notes, observation, and research by the author during a period of over twenty-five years. During the preparation of the work for publication the author has had the assistance of fiber experts, botanists, and others, in many lands, and it is thought the volume will prove a valuable contribution not only to the literature of economic industries but to ethno-botany as well.

The demand made upon the Department for information regarding every phase of the fiber industry shows the extent of the industrial interest in fibers and their manufacture, while the popular interest in this subject is evinced by the constant applications received by the Department from teachers in our colleges and schools for fiber specimens and literature. To these two classes especially the work will prove most useful, and at the same time it is hoped that it may be of assistance to those writers upon industrial topics who from lack of authoritative information regarding new fibers have sometimes been led into error and misstatement. The alphabetical arrangement of the titles, which include both the common and botanical names of the fiber plants described, affords a ready means of referring to any desired species.

In the portions relating to the study and uses of fibers and on fiber identification the technology of fiber work is presented in the hope that more attention may be given to this work by American students, as it opens up a broad field of practical research.

I am, respectfully,

CHAS. RICHARDS DODGE,
Special Agent, in Charge of Fiber Investigations.

HON. J. STERLING MORTON,
Secretary.

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PREFACE.

A little over twenty years ago at the Philadelphia International Exhibition of 1876, while the writer was acting for the United States Department of Agriculture, but under the direction of the late Prof. Spencer F. Baird, the foundation of this work was laid. The exhibition of 1876 brought to this country many superb collections illustrating the arts and industries of the world, none of these being more interesting or complete than the collections of textiles and textile manufacture. Prominent among the collections of raw fibers were those contributed by the Australian colonies, including the magnificent series of New Zealand flax and flax products. These, with many other collections, in different fields, were presented to the United States Government at the close of the exhibition, the agricultural products coming to the Department of Agriculture, while the animal and mineral collections went to the National Museum.

Next to the Australian collections of fibers, those from the several South American Republics which were represented in the exhibition were particularly instructive, and it was mainly through the interest developed by the superb collections of these two regions of the globe that the descriptive list of fibers which appeared in the annual report of this Department for 1879 was prepared by the writer. The Australian exhibit was particularly interesting and valuable, as it illustrated a series of experiments in economic fiber investigation conducted by Dr. Guilfoyle, director of the Melbourne Botanic Gardens, the specimens being properly and systematically labeled and accompanied by valuable notes and descriptive matter.

It was this collection, with its carefully prepared notes, that laid the foundation of the present work, in which has been embodied the notes of collections from every important international exhibition since that of 1876, and which has been largely augmented by the results of personal study, observation, and investigation during many years, as well as through the more recent examination of all available publications relating to the subject.

The result has been the enumeration of 1,018 species of useful fiber plants, the more important of which are fully described and treated from the botanical, agricultural, and industrial standpoints; being described or referred to under their scientific, commercial, common, and native names (as far as the latter could be obtained and properly verified); the kind of fiber produced, the part of the plant producing it, as well as the position of the species in the vegetable kingdom, being indicated, and in some instances the name of museum or museums stated where specimens of the fiber are preserved. The first pages were definitely prepared for publication about three years ago, after the close of the World's Columbian Exposition, and the work has been pushed, with only brief interruptions, from that time until the date of its completion.

The object of the work has been to bring together in one volume, arranged for ready reference, a descriptive list of such useful fibers of the world as are known to be or that have been employed commercially, or those prepared by the natives in the countries where they abound, or that have been the subject of experiment, and shown at prominent industrial exhibitions. Naturally the simple list of commercial species would make an insignificant showing; the experimental list would be much larger, the greater number of species therefore coming into the category of "native" fibers, of which the Indian hemp (*Apocynum cannabinum*), the plant that supplies several North American Indian tribes with material for their cordage, fish lines, and nets, is an example.

The fiber economists find a most interesting study in these native forms. The native or aboriginal American fibers have never before been brought together in any way approaching a complete list, and in this particular especially it is hoped that the work will prove a valuable contribution to the literature of the economic botany of our country.

In like manner, with the aid of Mexican and South American botanists and observers, the Central and South American lists have been greatly augmented. The Australian list is very full, and with the list of fibers of India, which have been so carefully worked up by Dr. George Watt in the Dictionary of the Economic Products of India, and the lists of the more commonly known species from other portions of the globe, the work in its entirety presents a more complete catalogue of the world's useful fibers than doubtless has before been brought together.

The more than 1,000 species of fibers that are enumerated have been described under the names by which they are known to botanists rather than under their common names, the scientific designation more clearly indicating the precise plant that is meant, while showing at the same time its exact position in the vegetable kingdom. The common and native names of the different species, however, as far as known, have been given place in the alphabetical arrangement, with the name of the country making use of such common or native names, and followed by a reference to the botanical species. The descriptive matter, therefore, may be readily referred to under any name by which the species may be known, provided it is known to this work.

In the scientific nomenclature, the Index Kewensis has been generally followed, exceptions being made in the case of some American species, which are referred to under names that are in most common use by American botanists.

The common and native names comprise three classes: (1) The common English names or the recognized commercial names, which in some instances have been derived from native appellations; (2) the native names which are universally recognized as the common names of the plants in the countries where grown; (3) the tribal, vernacular, or local names, which, in some instances, are unknown even in the countries to which the plant is native in localities remote from the districts where it grows. The vernacular names of the plants of India are legion, nearly every district or province having several, which may be either widely or only slightly different, from the names of the same plants growing in a neighboring province. It would be undesirable, therefore, if not impossible, to reproduce a considerable number of these local or vernacular names; and another trouble with such names is the liability of error through their orthography. Many of them doubtless have been spelled phonetically by the different authorities, and the difference between *chiti* and *jiti*, as an example, is sufficiently great to suggest two different plants, when the same thing is meant by both spellings. No doubt vernacular names have been multiplied in this manner, resulting in more or less confusion.

Another source of confusion has been the use of names generically that have been applied to a particular species, or vice versa. "Mahoe" and "silk grass" as English common names and "*pita*" and "*keratto*" as native names are examples. The *keratto* of Jamaica is *Agave Morrisii;* the *keratto* of the Leeward Islands is *Agave polyantha*, but a dozen other species of Agave may be known as *keratto* in other places, or *keratto* may stand for the whole group of Agaves. Silk grass means anything from coarse Agave fiber to the delicate filament drawn from pineapple leaves. It will be seen, therefore, with the indiscriminate use of such familiar common names, how difficult it may be to avoid falling into error, and when we consider vernacular or tribal names, error is almost unavoidable. Regarding this point the author and compiler begs to state that while the native names used in this work have been the subject of most careful investigation, with valuable assistance rendered by botanists in the countries from which they were derived, errors no doubt have crept into the work. Many of the fibers collected at the expositions, particularly those from Central and South American countries, have borne on their labels only the native common or, in some instances, the narrowly localized "country" names, and frequently it has been utterly impossible to trace such names.

The roots of many of these native names are words common to the vocabulary of the country, and when used in combinations form a compound appellation, such as *Embira preta*, or the black embira, the root of *embira* signifying something resistant. This might be equivalent in English to such a name as the "black tough." In unfamiliar South American Spanish it at least affords something that may stand for a name, slender as the clue may be toward the identification of the plant from which derived. Many of the East Indian vernacular names are simply compounds of adjectives with such nouns in everyday use as "tree," "root," "vine," etc. Some of these are equivalent in value, therefore, to similar names employed in this country, as "blood-root," "gum-tree," and others.

That many common names have been omitted from this work is not the fault of the author. It is to be regretted that the example of Hillebrand, in the Flora of Hawaii, where a few brief lines of small type are given to matters of general economic interest, such as the native names and the native utility of the species, is not universally followed. Such a practice would greatly enhance the value of botanical publications both for the student and specialist. The admirable work of Dr. J. W. Fewkes, Dr. Edw. Palmer, and others in this direction is to be heartily commended.

Acknowledgments are due for valuable aid rendered in the preparation of the work to Dr. D. Morris, assistant director of the Royal Kew Gardens; Dr. A. Ernst, director of the National Museum of Caracas; Prof. José Ramirez, botanical department, Instituto Medico Nacional, Mexico; Mr. F. V. Coville, Botanist of the United States Department of Agriculture, and Dr. V. Havard, U. S. A.; also to Dr. W. R. Guilfoyle, director of the Botanic Gardens, Victoria; Mr. K. Tawara, agricultural bureau, Tokyo, Japan; Mr. J. H. Hart, director of the botanic gardens of Trinidad; Mr. William Fawcett, director of the public gardens of Jamaica; Mr. Romulo Escobar (Mexican court, W. C. E., 1893), Jaurez, Mexico; Mr. A. Dorca, of Lima, Peru; Mr. Herbert Putnam, librarian of the Boston Public Library; Mr. Gustav Niederlein, of the Philadelphia Commercial Museum; Dr. George L. Goodale, Harvard University Botanical Museum; Dr. L. M. Underwood, department of botany, Columbia University, New York; Mr. J. R. Dodge, formerly statistician of the Department of Agriculture; Prof. William H. Seaman, United States Patent Office; Dr. Thomas Wilson, Dr. J. W. Fewkes, Dr. Otis T. Mason, and Mr. Walter Hough, United States National Museum; and Messrs. Lyster H. Dewey and E. S. Steele, assistants, botanical division of the Department of Agriculture, for their kind offices in the collection of material for the work and for assistance in other ways. And I recall the name of one whose friendly encouragement in all my endeavors will ever be held in grateful remembrance, the late Dr. George Brown Goode.

To the many friends who have aided in the work and whose names only appear in the list of contributors, on another page, I also desire to express my thanks for interesting notes of species, which have added greatly to the value and completeness of the publication in its entirety.

For the photographs of palms from which fig. 2, Pl. VI, and the figures on Pl. IX were reproduced, I am indebted to Mr. W. S. Gavey, of Brooklyn, N. Y.; for the print of California hemp, to Mr. Sidney E. Meltzer, Bakersfield, Cal.; for the photograph of *Agave decipiens* to Mr. Alfred Monroe, Concord, Mass., and to Prof. William Trealease, of the Missouri Botanic Garden, for the original of fig. 2, Pl. XII. The frontispiece and Pl. XI are from negatives in possession of the Department. All other plate illustrations are from negatives made by the author.

C. R. D.

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USEFUL FIBER PLANTS OF THE WORLD.

DEFINITION OF FIBERS.

The tissue of plants when viewed under the microscope is seen to be made up of cells which are compacted together as they are formed during the growth of the plant, thus slowly building up roots, stems, and leaves. The walls of these cells inclose the life germ, or protoplasm, and the substance of which they are composed is known as cellulose, which chemically is very similar to starch.

Regarding the size ot the cells of which common plants are made up, Dr. Gray states that their ordinary diameter in vegetable tissue is between one three-hundredth and one five-hundredth of an inch. The smaller of these sizes would allow as many as 125,000,000 cells in the compass of a cubic inch. "All soft cellular tissue, as leaves, pith, and green bark, is called parenchyma, while fibrous and woody plants are composed of prosenchyma, that is, of peculiarly formed strengthening cells." We are also told that those cells that lengthen and at the same time thicken their walls form the proper woody fiber, or wood cells; those of larger size and thinner walls, which are thickened only in certain parts so as to have peculiar markings, and which often are seen to be made up of a row of cylindrical cells, with the partitions between absorbed or broken away, are called ducts, or sometimes vessels. There are all gradations between wood cells and ducts, and between both these and common cells. But in most plants the three kinds are fairly distinct. Wood cells, or WOODY fibers, consist of tubes, commonly between one and two thousandths of an inch in diameter. A highly magnified group of these cells from Buttonwood (after Gray) illustrates the manner in which wood cells are put together, their ends pointed and overlapping, thus strengthening the whole. (See fig. 1.)

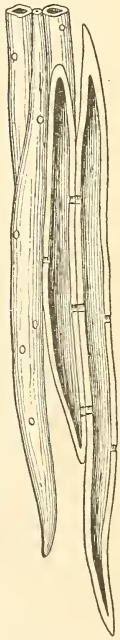

FIG. 1.—Woody cells of Buttonwood.

Wood cells also occur in the bark, though they are longer, finer, and tougher than those found in the wood. They form the principal part of fibrous bark, or the bast layer, and are called BAST cells. These give toughness and flexibility to the structure, and the extracted bundles of these cells form the filamentous product known economically as fiber, such as flax, hemp, and jute, derived from Dicotyledonous plants. "In Monocotyledons the fibrous cells are found built up with vessels into a composite structure known as fibro-vascular bundle." (Dr. Morris.) Such fiber occurs in the palms, and in the fleshy-leaved Agaves, like the century plant, the fibro-vascular bundles being found, not in the outside covering of the trunk, as in bark, but throughout the stem, or leaf, forming what may be termed (in an Agave leaf, for example) the supporting structure, or that which gives rigidity and toughness to the leaf. These filaments or bundles of elongated, thickened cells, pressed firmly together, when extracted or separated from the soft cell mass by which they are surrounded, may be known as STRUCTURAL Fiber, of which the fiber of Sisal hemp is an example. (See fig. 2.)

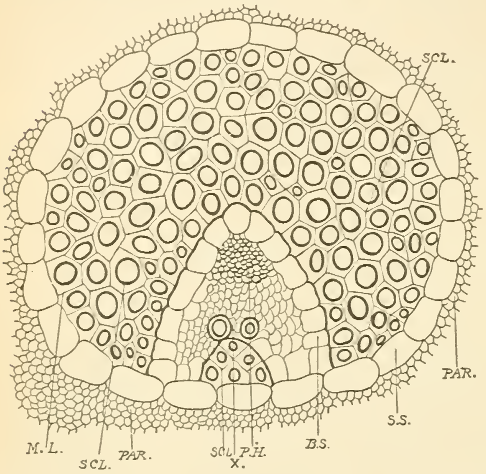

FIG. 2.—Sisal hemp (*Agave rigida* var. *sisalana*). Transverse section through a fibro-vascular bundle embedded in (PAR) the cellular parenchyma: S. S. starch layer, forming a ring round the sclerenchyma (SCL.), with the fiber cells closely packed together; M. L., middle lamella; B. S., bundle sheath; X., xylem, or wood cells; P. H., phloëm, or bast cells, × 300.

The simple cells already described, when single or agglutinated and produced on the surfaces of the leaves, stems, and seeds of plants as hairs, form a fibrous material also valuable, to which the name SURFACE Fiber has been given. Such hairs are found enveloping the seeds of plants, and when they are produced in the bolls or capsules of species of Gossypium form the cotton of commerce.

The fiber bundles, therefore, whether occurring as bast fiber or structural fiber, or whether in the form of simple cells, as surface fiber, may be regarded as the spinning units, and a flax thread is but an aggregation of bundles of bast cells purified and cleansed of all extraneous matter and simply twisted together. In the perfecting of processes, therefore, for separating, cleansing, and purifying the bundles of cell structure known as fibers a knowledge of their physical structure is absolutely essential. The rotting of a fiber is simply the breaking down of the cellular structure or complete separation of the individual cells, by which means the filament is resolved into its smallest parts, each part being measured by the length to which the original cell attains during the period of its growth.

THE ANCIENT USES OF FIBERS.

It has already been noted as an interesting fact, though in no wise a remarkable one, that the most valuable commercial fibers of to-day were the prominent fibers of ancient times, illustrating, in a word, the survival of the fittest. Flax, cotton, hemp, the liliaceous fibers, many of the palms, reeds, and grasses were known and valued in past ages on both hemispheres, being employed in connection with the common animal fibers, as wool, hair, and silk. When or how vegetable fibers first came to be used will never be known, but it is possible that they were first employed in aiding man to secure his food, as the natives of every country from the burning tropics to the frigid north have drawn largely upon the resources of the vegetable kingdom for their fish lines and nets. And it might further be conjectured that the rude knotting of the twisted filaments of fiber in the form of nets may have first suggested weaving and the substitution of vegetable clothing for the skins of animals.

Flax has a greater antiquity than any of the fibers of which we have knowledge, for its cultivation goes back to the Stone Age in Europe. It is known to have been manufactured by the Swiss Lake Dwellers, a people contemporaneous with the long-extinct mammoth and other great mammals of the Quaternary Epoch, as specimens of the straw, fiber, fabrics, etc., prepared by them are preserved in the museums. It is supposed that the species cultivated at that remote period of the world's history, concerning which no written records remain, was *Linum angustifolium*, while at a later period, though still remote by four or five thousand years, the Egyptians cultivated the species known to-day as commercial flax (*Linum usitatissimum*).

Before the books of Genesis and Exodus were written the Egyptians were skilled in spinning and weaving flax, for both the culture and the manufacture of this textile are pictorially carved upon the bas-reliefs and upon the walls of palaces, temples, and tombs. Egyptian fabrics of linen 4,500 years old and preserved in the museums and among the mummy cloths—fabrics from the most delicate tissues to linen-like sailcloth—have been found, and as many as 300 yards were sometimes used to enwrap one body. The linens were both white and dyed in colors—yellow, red, and purple—and they were handsomely embroidered. Spinning and weaving in Bible times were household industries, as we are assured by many references to women and flax. The Phœnicians did much to extend the culture of flax and the art of weaving linen, as their ships plowed the Atlantic more than three thousand years ago, even journeying to Britain, for they were a nation of traders, and there is every reason to believe that the Chaldeans excelled in spinning and weaving flax, while the Babylonians centuries before Christ were noted for their luxury and the high state of development of their textile art, flax, cotton, and wool being manufactured by them.

Wool was more grown in ancient Greece than flax, though the latter textile was produced in certain favorable districts and imported in large quantities for manufacture. There was a distinct linen industry, slaves being the operatives, as well as a household industry, for whether in the cottage or the palace, if possible, a special room was set apart for the occupation of weaving. In Homeric times not only were maids and ladies of high degree familiar with weaving, but with spinning and embroidery, and the distaff and spindle were often made of ivory or of gold. As in Greece, so in Rome there were regular linen establishments, and at the same time a domestic manufacture practiced by maids and matrons. Woolen was earlier used for clothing by the Romans; then linen was employed, first for domestic uses, then as a dress material, the women adopting it before the men.

Regarding the early use of linen in our own country, the time when American history began to be made is so recent that the word ancient does not apply. It has been stated that both flax and hemp were known to the ancient Mexicans or Aztecs, though I can refer to no records which relate to their use.

While it has been shown that cotton was the ancient national textile of India, its cultivation and use were by no means confined to that country. Flax was the aristocratic textile of Egypt, and was generally cultivated, but cotton was grown in the southern part of the country. Cotton and linen were sometimes woven together (flax warp and cotton woof), just as mixed "tow linen" is made in the mountains of Virginia and North Carolina to-day. These Egyptian mixed fabrics, as well as pure cotton cloths, were largely used in upholstery as the coverings of chairs and couches, and probably also as drapery hangings. The cottons of India were famous, and Hindoo muslins were formerly produced that were so fine that when laid upon the grass and wet with dew they became invisible. The marvelous fabrics of Cos and Tarentum, by some said to have been made from cotton, were more likely silk, as they are described as floating like mist around the female form, disclosing the contour like a gauze veil. There is also the record of a muslin turban 30 English yards in length, contained in a cocoanut set with jewels, which was so exquisitely fine that it could scarcely be felt by the touch. It is impossible to say how far back into the ages cotton was first used in India, and though it is referred to 800 B. C., we may be sure that the industry was old at that time. Cotton was a late introduction into Greece, though it was known 200 B. C., and even linen was an introduced textile, which came slowly into favor at a time when wool was almost universally used.

Turning to the Western World and to the aboriginal civilization of the Incas, we find the ancient Peruvians, with their simple handlooms, were enabled to produce fabrics that were marvels of design and exquisite in color and finish. Both cotton and wool were used in the different articles of dress of these people with other fibers. The Aztecs, or ancient Mexicans, were familiar with cotton, as well as several other vegetable fibers. With cotton and feathers we are told they produced a soft and beautiful fabric, which was used for mantles and blankets, and examples of their plain cotton fabrics are said to have been as fine as some of the imported linens of the present age. Regarding the early use of cotton on this continent, there are abundant records to show that it has been cultivated more or less generally for four or five centuries. How long it has been known to the early ancestors of some of the native Indian tribes of our own country will never be known, although from the fact that its use is required in religious ceremonials, as in the Hopi Indian tribe, for example, we may be sure that such use is no modern innovation.

Among the ancient fibers of India, we have early allusions, in the Institutes of Menú, to several prominent fibers, particularly where the material of the sacrificial thread is prescribed. Cotton, *sana*, and woolen thread are mentioned. *Sana* has been supposed to refer to Sunn hemp, one of the commercial fibers of the present time (*Crotalaria juncea*). Dr. Watt says the possible *sana* fibers of the Sanscrit authors were Sunn, above mentioned, *sanpat*, or *Hibiscus cannabinus*, and common hemp (*Cannabis sativa*). On the whole, the evidence is in favor of Sunn. Hemp grows wild throughout India, just as it is found in a wild state in many parts of our own country, but is regarded as the source of the drug known as bhang, or hasheesh, rather than as a fiber plant. We know that the use of hemp among the ancients was very limited. It has no mention in the Scriptures, and it is rarely referred to by the heathen writers of antiquity. It was used by the Scythians at least five hundred years before the Christian era, and some writers attribute to its cultivation an antiquity more remote by a thousand years; and it was known to the Chinese at a period quite as remote. The Romans were familiar with the use of hemp for sails and cordage, though not until after the dawn of the Christian era.

The China grass fiber, more popularly known as ramie, has been grown in the Orient from time immemorial, and modern writers have attempted to prove that it was contemporaneous with flax several thousand years ago in Egypt, if, indeed, it was not used for mummy cloth. Dr. Watt also advances a suggestion regarding ramie which would give it a great antiquity in India. He states that frequent reference is made in the Ramagana to a garment called the *kshauma*, and goes on to say that while *kshauma* is generally regarded as a name for linen, the word strongly resembles the Chinese name of the grass-cloth plant, or ramie, which is *Chu-ma*, *schou-ma*, or, as now most commonly written, *tchou-ma*. The use of ramie fiber is undoubtedly old, but how ancient, history does not inform us.

The date palm, as we know, afforded a valuable material for cordage in Egypt in very early times, as the modern excavations have revealed to us, and the fiber is valued quite as highly by the present inhabitants of the country; and the ancient Chaldeans, or Babylonians, are said to have used this palm for everything—food, clothing, wine, and the timber for their habitations. There is plenty of evidence that palm fiber was employed throughout this entire region of the ancient world.

Pliny tells us that even the papyrus (*Cyperus papyrus*) was used for cordage in Egypt, as well as for matting, curtains, and sails, and Warden says that small boats were sometimes made from the plant. Ancient vessels of bulrushes are mentioned by Isaiah, and Lucan alludes to the manner of binding and sewing them with papyrus. The use of papyrus for paper is even more interesting. (See description of the mode of preparation under the title *Cyperus papyrus* in the catalogue.) In the realm of rank aquatic vegetation we may note a reed known as *Arundo donax*, which has been regarded as the "reed" of the Scriptures: "A bruised reed shall he not break, and the smoking flax shall he not quench." (The Hebrews employed flax for their lamp wicks.) Dr. Moore tells us that the heroes of Homer made their arrows of the *Arundo* (Iliad XI), and that the tent of Achilles was thatched with its leaves. A coarse grass (*Spartium junceum*) has been used in Italy as a fiber plant from ancient times, its Italian name being *Ginestra de Spagna*. It is mentioned by Pliny. It was also largely used by the Greeks and Romans for many purposes. Another ancient Egyptian fiber grass is known as Teff (*Poa abyssinica*), said to have been the "straw" that was used by the ancient Egyptians in brickmaking. The ancients were also familiar with the use of flexible twigs for tying material, the name *viburna* being used for such substances. Twigs of *Viburnum cassinoides* are used for such purposes in the present age.

In the Western Hemisphere the fiber of two species at least of Agave were employed by the ancient Mexicans or Aztecs, together with palm fiber and very coarse cotton, as clothing for the poorer classes. Cloth from the Agave was called *nequen*, and to-day the Yucatan name of the commercial sisal hemp, or *Agave rigida*, is *henequen*. This may have been one of the ancient Mexican species, but as the history of their civilization was grotesquely recorded by the use of ideographic paintings, and not by means of written language upon books or scrolls, such fine distinctions as botanical species are not possible. Agave fiber was also used to a limited extent by the ancient Peruvians, though wool and cotton were held in first esteem. In the burial mounds of the southwestern United States the remains of fibers are frequently found, Agave and Yucca fiber being common. Remains of bast fibers are also found, but they have not been identified.

The subject is interesting, but it is not possible, on these pages, to give more than an outline, chiefly for the purpose of showing that the most valued of the commercial fibers of to-day were among the useful fiber species of the ancient world.

PRINCIPAL FIBERS USED COMMERCIALLY IN THE UNITED STATES, AND THEIR IMPORTS.

Of the two dozen species of commercial fibers used in the United States, 20 figure in the list of imported raw products. Taking into account, also, the imported manufactures from fibrous substances and some of the rougher manufactures from fibers or fibrous substances produced at home, the complete list of American commercial fibers may be swelled to 30 species, many of these being unimportant.

There are six bast fibers, as follows: Flax, *Linum usitatissimum*; China grass, *Boehmeria nivea* (including Rhea, *B. tenacissima*); hemp, *Cannabis sativa;* jute, *Corchorus capsularis* and *C. olitorius;* Sunn hemp, *Crotalaria juncea*, and Cuba bast, *Hibiscus tiliaceus;* all excepting the last being spinning fibers, the Cuba bast finding employment in millinery. There are two surface fibers: Cotton, *Gossypium* spp., and Raffia, *Raphia ruffia.* The list of structural fibers numbers 15, representing Agaves, palms, and grasses, as follows: Sisal hemp, *Agave rigida* (varieties); Manila hemp, *Musa textilis;* Mauritius, *Furcræa gigantea*, and New Zealand flax, *Phormium tenax*, cordage fibers; Tampico, or Istle, *Agave heteracantha;* Bahia piassaba, *Attalea funifera;* Para piassaba, *Leopoldinia piassaba;* Mexican whisk, or Broom root, *Epicampes macroura*, and Cabbage palmetto, *Sabal palmetto*, brush fibers; Crin végetal, *Chamærops humilis*; Spanish moss, *Tillandsia usneoides;* Saw palmetto, *Serenoa serrulata;* Cocoanut fiber, *Cocos nucifera*, upholstery and matting fibers; Esparto grass, *Stipa tenacissima*, for paper manufacture; and Vegetable sponge, *Luffa ægyptica*, as substitute for bath sponges. The two species of palmetto and the Spanish moss for vegetable hair are wholly produced in this country.

As to the sources of supply of these fibers, flax is imported chiefly from Belgium, Russia, Holland, Italy, the United Kingdom of Great Britain and Ireland, and from Canada. China grass or ramie comes from China (in very small quantities). Hemp is derived from Russia, France, Belgium, Germany, Austria-Hungary, Italy, the Netherlands, and British East Indies (the latter in trifling quantity); jute from India, and Cuba bast from the West Indies. The imports of cotton are chiefly produced in Egypt and Peru, though small quantities may be derived from other countries. Raffia, used as agricultural tie bands, comes from Africa.

The sisal hemp supply is produced in Yucatan, small quantities being produced in Cuba and the Bahamas. Manila hemp is a product of the Philippine Islands, cebu hemp being a trade variety. Mauritius or aloe fiber comes from Africa, and the source of supply of New Zealand flax is indicated by its name. Tampico, or Istle, is a Mexican product, and the Bahia and Para piassabas, or "bass" fibers, are collected from Brazilian palms. There are other species of bass (see Bass in catalogue) derived from African palms, which formerly never came to the United

States, and now, if at all, only in trifling quantities. Broom root is a Mexican product, the root of a tall, wiry grass. The two palmetto fibers are produced from uncultivated species of Florida palms, while the Crin végetal is derived from an allied palm, growing in Algeria. The vegetable hair from Spanish moss is prepared in South Carolina and other Gulf States, while cocoanut fiber comes from the East Indies. Esparto grass is produced in Algeria, Spain, and Portugal, and vegetable sponge comes largely from Japan.

Other commercial species that might be enumerated are imported in a partially prepared state or as manufactures. Such fibrous substances appear in the form of straw plait from Italy, Japan, and China, chiefly, the eastern floor mattings, and basketry from various substances. In this account, however, only the raw fibers are noted.

The fibers produced in this country in commercial quantity are cotton, hemp, flax, palmetto fiber, and vegetable hair from Spanish moss. Hemp and flax production should be largely extended; jute production and the growth of sisal hemp, pineapple, and bowstring hemp are possible. Cane fiber can be produced in large quantities, and there are doubtless other kinds that might form the basis of local fiber industries.

The paper materials other than Esparto are not considered in this category. The native fibrous substances that might be employed in lieu of cellulose from our forest trees, for paper pulp, would make a long list, at the head of which might be placed the waste fiber from a million acres of flax produced only for seed. A day is surely coming when the question of securing new pulp materials will present itself, and it is to be hoped that from the long list of native species of fibrous plants enumerated in this work something will be found that will supply at low cost a better paper material for common use than wood pulp, which has nothing to recommend it but availability of raw material and cheapness.

The following table of quantities and values of vegetable fibers imported into the United States for the year ended June 30, 1896, has been made up from figures supplied by the Bureau of Statistics of the Treasury Department.

Imports of vegetable fibers into the United States for year ending June 30, 1896.

Fiber.	Quantity.	Value.	Value per ton.
	Tons.	*Dollars.*	*Dollars.*
Broom root	222	39, 884	179
China grass, or ramie [1]			
Cocoanut fiber [1]			
Cotton	27, 675	6, 578, 212	
Crin végetal	1, 348	213, 818	17
Cuba bast [1]			
Esparto grass [1]			
Flax straw	32	926	28
Flax, not hackled	3, 788	909, 658	240
Flax, dressed line [1]	1, 322	639, 368	483
Flax, tow of	1, 711	261, 082	152

[1] Included in all other.

Imports of vegetable fibers into the United States, etc.—Continued.

Fiber.	Quantity.	Value.	Value per ton.
	Tons.	*Dollars.*	*Dollars.*
Hemp, not hackled	8,306	1,030,547	124
Hemp, dressed line[1]	93	22,847	243
Hemp, tow of	244	27,265	111
Istle, or Tampico fiber	12,205	717,585	58
Jute	23,393	957,054	40
Jute butts	65,599	1,044,152	15
Kittul[2]			
Kapok[2]			
Manila hemp	49,433	3,594,901	72
Mauritius hemp[2]			
New Zealand flax	103	5,548	53
Palmyra[2]			
Piassaba and Bass fiber[2]			
Rattan and Bamboo[2]			
Sisal grass	20,616	3,372,346	163
Vegetable sponge[2]			
All other, and waste	4,405	183,768	41
Total	221,495	19,604,961	

[1] Flax, dressed line, is dutiable at $33.60 per ton; dressed line of hemp at $22.40 per ton; all others, free.
[2] Included in all other.

The $19,000,000 to $20,000,000 represented by the imports of raw fibers, in the above table, must not be taken as the value of the fiber industry to this country. It should be remembered that considerably larger quantities of many of these fibers are manufactured in other countries for export to the United States, and that the total value of our imports of "raw and manufactured" is equal to three or four times the value represented in the table. Our raw and dressed flax imports amount to perhaps $1,750,000, while the imports of flax manufactures have reached $12,000,000. Even Mexican manufactures from sisal grass, such as hammocks, etc., are sold in the United States, and the imports of cordage and yarns from various fibers is considerable. Where $20,000,000 worth of fibers are now manufactured in this country it might be possible to manufacture $40,000,000 worth, and thus double the home fiber industries; and it might easily be possible to produce home grown fibers to the extent of half of the supply needed in the manufactures that these industries represent.

ECONOMIC INVESTIGATION.

While 30 of 40 species of plants supply the world's demand for commercial fibers, hundreds of fibrous plants could readily be enumerated, the simple fiber substance in many of which to outward appearance is just as good as the fiber of some of the commercial species widely cultivated, and for which they would be the substitutes. This country imports millions of dollars' worth of jute annually, yet some of the plants recognized as native weeds in the United States contain stronger and better fiber. That many of them are capable of producing a good quality of fiber has been known for years, yet they are not utilized. But they are interesting and are the subject of constant inquiry, as the masses of their filaments, disintegrated and semibleached on the parent stalk by the winter storms, attract attention; and often the observer, regarding his discovery as new and considering it the source of a valuable, undeveloped industry, writes to learn the name and history of the species, how far the plant is susceptible of cultivation, and what price the fiber will bring in the market. In considering such a plant the first question is not, can we grow the species, but what will be its uses in manufacture, or, in other words, what commercial fiber will it either replace or become a substitute for. In most instances the inquiry need not be carried further, for the present commercial fibers represent in a sense those that have stood the test of experience, and until these are crowded out by new conditions, or through what might be termed evolution in the economic arts, they will have no chance. The only opportunity that may be afforded these secondary forms is in the creation of special uses to which they may be peculiarly adapted, for which the standard forms known to the market price current are not so well fitted.

Should a fiber be considered "promising," it would need to be subjected to chemical and microscopic study to determine the length of the ultimate fiber cell, the proportion of cellulose, and any other elements which would give it its rating among textiles. By such technical study we are enabled to obtain direct knowledge of the species and in a measure to avoid long and costly economic experimentation.

Experiments for the development or extension of vegetable fiber industries under governmental auspices or direction have been instituted at different times in many countries, and such experiments date back nearly one hundred years. In some instances these have been confined to testing the strengths of native fibrous substances for comparison with similar tests of commercial fibers, as the almost exhaustive experiments of Roxburgh in India early in the present century. Another direction for Government experimentation has been the testing of machines to supersede costly hand labor in the preparation of the raw material for market, or in the development of chemical processes for the further preparation of the fibers for manufacture, or in microscopic and chemical investigation. The broadest field of experiment, however, has been the cultivation of the plants, either to introduce new industries as sources of national wealth or to economically develop those which require to be fostered. The introduction of ramie culture is an example of the first instance, the fostering of the almost extinct flax industry of our grandfathers' days an illustration of the second.

The United States Government has conducted experiments or instituted inquiries in the fiber interest at various times in the last fifty years, but it is only since 1890 that an office of practical experiment and inquiry has been established by the Department of Agriculture, that has been continued through a term of years. This is known as the Office of Fiber Investigations.

The work of this branch of the Department of Agriculture has been mainly directed toward the development or introduction of those fibers which we do not produce commercially, but which are capable of cultivation in the United States, and which will add to our national resources. This work has been prosecuted by the importation and distribution of the seeds of fiber plants, by encouraging and directing field experiments, by testing fiber machines, and by affording information, both through personal correspondence and through a series of publications.[1]

CHEMICAL INVESTIGATION.

In presenting this phase of the study of fibers I can but refer to the valuable work that has been accomplished in England in the field of chemical research by Messrs. Cross, Bevan, and King, and I will refer particularly to the Report on Indian Fibers[2] and the work on Cellulose,[3] the latter being a recent publication. The methods adopted in the chemical study of fibers and the processes essential to proper determinations are as follows:

Moisture.—All the celluloses hold in their ordinary state a certain proportion of moisture, which, within the limits of variation (one-half of 1 per cent) due to atmospheric changes, is definite and characteristic of each fiber. It is noteworthy that the proportion of hygroscopic moisture is an index of susceptibility of attack by hydrolytic agents; it is certainly true that the textile fibers of the highest class are distinguished by their relatively low moisture. It is scarcely necessary to say that the moisture is determined by drying a weighed quantity of the fiber. It is necessary to raise the temperature to 110° to drive off the whole of the water; at 100° a fiber will often retain 1 per cent of its weight. Owing to the variations in this constituent, it is expedient to express all the results of analysis as percentages of the dry fiber.

Mineral constituents.—The ash left on incinerating the fiber is determined in the usual way. The proportion is low in the ligno-celluloses, higher in the pecto-celluloses, especially when the proportion of noncellulose is high. Cellular tissue further contains a higher proportion

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[1] The special reports issued previous to this work are:

1. A Report on Flax, Hemp, Ramie, and Jute, Illust., pp. 104, 1890.
2. Recent Progress in the Ramie Industry in America, pp. 16, 1891.
3. A Report on Sisal Hemp Culture in the United States, pp. 59, Illust., 1891.
4. A Report on Flax Culture for Fiber in the United States (and Europe), pp. 93, Illust., 1892.
5. A Report on the Leaf Fibers of the United States, pp. 73, Illust., 1893.
6. A Report on the Uncultivated Bast Fibers in the United States, pp. 54, Illust., 1894.
7. A Report on the Cultivation of Ramie in the United States, pp. 63, Illust., 1895.
8. A Report on the Culture of Hemp and Jute in the United States, pp. 43, Illust., 1896.

Five Annual Reports have been issued, which will be found in the Yearbook, or Annual Reports of the Department of Agriculture, 1890 to 1895; also Farmers' Bulletin No. 27, Flax for Seed and Fiber, pp. 16, 1895.

[2] See Cross, Bevan, and King, list of authorities.

[3] See Cross and Bevan.

of mineral constituents than the fibers, and an admixture of the former therefore raises the percentage.

Hydrolysis.—There are two classes of reagents which intensify that resolving action of water upon organic bodies known as hydrolysis; they are the acids and alkalis. The destructive action of acids has not been included in the scheme of analysis. The action of boiling dilute alkalis, however, effecting a simpler resolution and involving very important points in the practical applications of the fibers, gives results which form a necessary part of their diagnosis.

Example of treatment: The fiber is boiled (*a*) for five minutes in a solution of caustic soda (1 per cent Na_2O), washed, dried, and weighed—the loss of weight presents the proportion of the fiber which yields to the solvent action of the alkali; (*b*) in a second portion the boiling is continued for one hour—the loss of weight is an indication of the "degrading" action of the alkali. In many of the pecto-celluloses the hydrolytic action of the prolonged boiling is such that the noncellulose is almost completely dissolved away. The power of resistance of a fiber to the action of bleaching processes, as well as the resisting of "wear" of the manufactured fabric in subsequent washings (laundering), where strong alkaline soaps or even chemicals are used, is shown.

Cellulose.—Celluloses, although similar in external characteristics, are of widely different chemical constitution, and vary considerably in their power of resisting the further action of oxidizing and hydrolytic action. A determination of the value and composition of cellulose is made as follows: A fresh specimen having been boiled in the dilute alkali (1 per cent Na_2O), is well washed and exposed for one hour, at the ordinary temperature, to an atmosphere of chlorine gas. It is then removed, washed, and treated with a solution of sodium sulphite, which is slowly raised to the boiling point. After two or three minutes' boiling, it is washed, on a filter when necessary, though in most cases it may be so placed in a funnel as to act as its own filter. Lastly, it is treated with dilute acetic acid, washed, dried, and weighed. The percentage yield on the raw fiber is the most important criterion of its composition and value.

Mercerizing.—This refers to the action of concentrated solutions of the alkalis upon vegetable fibers, particularly the compound fibers or those which are made up of a number of fibrils aggregated into a bundle, the larger portion of fiber consisting of such bundles. The action of the alkali often causes a very profound change in structure, not only dissecting the bundles, but altering the contour of the fibrils. The treatment takes its name from Mercer, whose original studies were for the determination of the structural modification which cotton undergoes when treated with strong alkalis.

Nitration.—When a fiber is exposed for one hour to a nitrating acid, such as a mixture of equal volumes of concentrated nitric and sulphuric acids, one of the most important results which follow is an increase in weight. An external characteristic which should also be noted is color. A great deal of information regarding the constitution of a fiber is ascertained by this process.

Carbon percentages from combustion.—This process consists in burning the substance with chromic anhydride in presence of sulphuric acid and leading over the gaseous products (CO and CO_2) into an apparatus in which their volume can be exactly measured. The two oxides of carbon having the same volume, the quantity of carbon in unit volume is independent of the composition of the gas, which therefore only requires to be measured. The carbon in the typical (cotton) cellulose is 44.4 per cent; the compound celluloses, on the other hand, range themselves for the most part into two groups—(1) of lower carbon percentage (40–43), (2) of higher (45–50), in the former the pecto-celluloses are included, the ligno-celluloses in the latter. This is considered a prominent chemical constant of the fiber substance.

Acid purification.—The object of this treatment is to clean the fiber and remove accidental impurities, while occasioning the minimum loss of weight and therefore alteration in composition. For this purpose acetic acid (20 per cent) is chosen, the fiber being heated with the acid to the boiling point, then removed and washed first with alcohol and lastly with water, dried, and weighed. The loss in weight sustained is thus determined. It is in the fiber thus purified that the carbon percentages are determined.

In a report on the miscellaneous fibers in the Colonial and London Exhibition of 1886, by C. F. Cross, the scheme of analysis is thus briefly stated in tabular form:

Separate portion taken for each determimation. Results calculated in percentage of dry substance.	Moisture	Hygroscopic water, or water of condition.
	Ash	Total residue left on ignition.
	Hydrolysis (*a*)	Loss of weight on boiling raw fiber five minutes in 1 per cent solution of caustic soda.
	Hydrolysis (*b*)	Loss of weight on continuing to boil one hour.
	Cellulose	White or bleached residue from following treatment: (1) Boil in 1 per cent NaOH five minutes; (2) exposure to chlorine gas one hour; (3) boil in basic sodium sulphite.
	Mercerizing	Loss on treating one hour with 33 per cent solution caustic potash, cold.
	Nitration	Weight of nitrated product obtained by treatment with mixture equal volumes of nitric and sulphuric acids one hour, in the cold.
	Acid purification	Raw fiber boiled one minute with acetic acid (20 per cent), washed with water and alcohol, and dried.
	Carbon percentage	The carbon in the fiber from above, determined by combustion.

THE MICRO-CHEMICAL STUDY OF FIBERS.

The microscope is a valuable adjunct to the study of fibers, not only for the purpose of determining the dimensions of the ultimate cell, the thickness of the cell walls, the arrangement of the different kinds of cells in the plant tissue, and the relative abundance of the fiber cells, but all these taken together, with the employment also of certain chemical reagents, giving a ready means of determining the identity of the species of fiber where doubt exists as to the kind of fiber that has been employed in the particular manufacture under investigation. The methods to be pursued in this kind of fiber analysis should be fully understood by the textile student, as well as the industrialist and all others who handle fibers and fabrics commercially.

Among the text-books that may be consulted no better can be suggested than the valuable work of M. Vétillart, of Paris, who has given many years of study to the subject. As the publication is in French, it is not readily available to English students. An abstract of the methods pursued by M. Vétillart appears, however, in Appendix B in the valuable paper "On the identification of fibers," which has been specially prepared for this work by Prof. William H. Seaman.

The identification of fibers involves both chemical and microscopic study, in many instances microscopic determination only being possible with the employment of the resources of the chemist, and the use of both systems, therefore, is essential. As the work of Professor Seaman covers the ground most thoroughly, a further consideration of the subject here is unnecessary.

THE CLASSIFICATION OF FIBERS, BASED ON USES AND STRUCTURE.

Among the many wants of man there are two which in all ages and in every clime have been regarded as necessities—food and the covering of the body. The first is an absolute essential to life; the second, an adjunct either to comfort or appearance. In supplying the second necessity man has used the bark, stems, leaves, and roots of trees, shrubs, vines, grasses, and the fibrous growth often provided by nature to protect their fruits during the period of development; he has employed the skins of animals, their shorn hair or wool, and, lastly, the cocoons of the silkworm.

At first vegetable substances could scarcely have been employed, for primitive man was satisfied with the skin of an animal girded about his loins; but in time, with the dawn of creative intelligence, the filaments of bark and wool and hair were rudely twisted into threads and coarsely woven. These fibers twisted again into larger threads, as fish lines, when knotted together formed fish nets, with which he was enabled to secure food, or a number of these threads wrought together made him cordage. His wants increasing as his inventive faculties were more and more developed and he became more intelligent, he felt the need of various utensils in the domestic economy, and pottery, trays, and baskets were fashioned from clay, from twigs of bushes or trees, from rushes and the leaves of palms and similar plants. And when caves or overhanging cliffs and rock shelters ceased to be his protection from the elements he learned to build huts and to thatch them with palms and grasses. Having now entered upon a domiciliary existence and new wants being created, mats and screens were woven from reeds and sedges or from strips of palm, and primitive man had entered upon a kind of barbaric civilization.

Aboriginal man is primitive in all ages, and the age of his particular race and his environment fixes the scale of his civilization. If, in the early Stone Age, he threw across his shoulders or girded about his loins the skin of an animal slaughtered for food, it was because such rude dress satisfied his simple wants in this direction. And there are native tribes in Africa and Australia at the present time with no higher desires as to their raiment and who still dress in skins, and African tribes who still adhere to Adam's costume—not fig leaves, but a girdle of evergreens and creepers or a leafy branch, as in the Obbo tribe.

But the economic uses of plants were bound to be learned by savage man in time, and skill was early acquired in preparing them for use. We find, therefore, among the uncivilized races all over the world that many species of fiber plants have become most useful for utensils, cords, and clothing which civilized man with all his intelligence and inventive genius can not afford to employ commercially. It is true that the recognized commercial fibers represent those best adapted for use, and that many of them, like flax, hemp, and cotton, must be classed with the fibers of antiquity. They have established their places because they have been proved to be the best for the purposes for which they are employed, and the others can only be considered as their substitutes or as simple "native" fibers. We have therefore two natural groups of fibers—the commercial species with their substitutes, which are soon enumerated, and the vast group of the so-called native fibers, many of which might fitly be termed emergency fibers, because they are extracted and used at the moment when needed. These so-called native fibers are all interesting, however, and through our knowledge of some of them, or when a species finds its way to the outside world, a new commercial fiber now and then is brought to light. They are legion when taken collectively, and therefore in enumerating the many species found in the countries of the globe it is very easy to secure a list that can only be stated in four figures.

STRUCTURAL CLASSIFICATION.

We have seen that different forms of cellular structure compose the fibers derived from dicotyledonous and monocotyledonous plants, as well as the seed hairs, or other hairs, from certain species of both divisions of the vegetable kingdom. In general terms, therefore, fiber is composed of bundles of bast or fibro-vascular tissue in the form of long, flexible filaments, such as flax, hemp, or manila, or of hairs, such as cotton, capable of being twisted or spun into threads or yarns, to be subsequently manufactured into cordage or fabrics.

In the economic employment of fibrous vegetable material it is often the case that the fiber bundles are not separated or subdivided into such delicate filaments as compose the cleaned fibers of flax and hemp, but are used in a conglomerated mass, or even in a more primary form, as the whole stems of reeds or grasses, as in matting manufacture, where both fibrous substance and the cellular tissue and woody waste is used without further preparation than drying. Or, a still broader differentiation is found in the employment of palm leaves torn into strips or the woody stems of such plants as the willow and sumac, which are coarsely woven or plaited into baskets and similar objects.

These fibrous substances, however, are not always utilized by subjecting them to the operations of twisting, spinning, plaiting, or weaving, but are employed in a mass, as upholstery material for the stuffing of cushions, mattresses, and the like. Beginning with true fibrous material, such as tow or the waste from scutching flax, hemp, etc., and the seed hairs of the many plants known as cotton and silk cotton, and coming down through the list we discover the use of mosses, leaves, and even finely subdivided wood shavings, or "excelsior," as forms of stuffing or packing material. The last named are not fiber, though on account of their economic employment they are regarded as the substitutes of fibrous substances.

Therefore, in considering the many species of plants which are employed for so many different uses in the industrial economy, one species ofttimes being utilized as a cheaper substitute for another, in order to show their relations, both botanically and economically, a division into classes is necessary, that the place and value of each form of fiber may be readily recognized. Several classifications will be found in the works relating to this subject, but after reviewing the 1,000 or more species of vegetable fibers and fibrous substances comprised in this catalogue a new scheme of classification, considered chiefly from the economic standpoint, has been devised, and is presented as both simple and natural.

In this arrangement I have separated the fibrous substances derived from plants into five groups, according to their use in the plant economy, as well as in relation to part of the plant employed. The first and third groups follow the natural division of the two great vegetable kingdoms into exogenous and endogenous plants; the second group confined wholly to the first division, but only fibrous in a sense; the fourth group pertaining to both, but more largely confined to the first division, while the fifth group is comprised of low orders of plants that are not fibrous at all, but which are chiefly used as cheap substitutes of better packing materials. The classification is as follows:

A. Fibro-vascular structure.

1. *Bast fibers.*

Derived from the inner fibrous bark of dicotyledonous plants or exogens, or outside growers. They are composed of bast cells, the ends of which overlap each other so as to form in mass a filament. They occupy the phloëm portion of the fibro-vascular bundles, and their utility in nature is to give strength and flexibility to the tissue.

2. *Woody fibers.*

(*a*) The stems and twigs of exogenous plants, simply stripped of their bark and used entire, or separated into withes, for weaving or plaiting into basketry.

(*b*) The entire or subdivided roots of exogenous plants, to be employed for the same purpose, or as tie material, or as very coarse thread for stitching or binding.

(*c*) The wood of exogenous trees easily divisible into layers or splints for the same purposes, or more finely subdivided into threadlike shavings for packing material.

(*d*) The wood of certain soft species of exogenous trees, after grinding and converting by chemical means into wood pulp, which is simple cellulose, and similar woods more carefully prepared for the manufacture of artificial silk.

3. *Structural fibers.*

(*a*) Derived from the structural system of the stalks, leaf stems, and leaves, or other parts of monocotyledonous plants, or inside growers, occurring as isolated fibro-vascular bundles, and surrounded by a pithy, spongy, corky, or often a soft, succulent, cellular mass covered with a thick epidermis. They give to the plant rigidity and toughness, thus enabling it to resist injury from the elements, and they also serve as water vessels.

(*b*) The whole stems, or roots, or leaves, or split and shredded leaves of monocotyledonous plants.

(*c*) The fibrous portion of the leaves or fruits of certain exogenous plants when deprived of their epidermis and soft cellular tissue.

B. Simple cellular structure.

4. *Surface fibers.*

(*a*) The down or hairs surrounding the seeds, or seed envelopes, of exogenous plants, which are usually contained in a husk, pod, or capsule.

(*b*) Hairlike growths, or tomentum, found on the surfaces of the stems and leaves or on the leaf buds of both divisions of plants.

(*c*) Fibrous material produced in the form of epidermal strips from the leaves of certain endogenous species, as the palms.

5. *Pseudo-fibers, or false fibrous material.*

(*a*) Certain of the mosses, as the species of Sphagnum, for packing material.

(*b*) Certain leaves and marine weeds, the dried substance of which forms a more delicate packing material.

(*c*) Seaweeds wrought into lines or cordage.

(*d*) Fungous growths, or the mycelium of certain fungi that may be applied to economic uses, for which some of the true fibers are employed.

The bast fibers, derived from the bark of exogenous plants, such as trees, shrubs, the climbing vines, herbaceous vegetation generally, are clearly defined, and the fibers of all species of such plants, when simply stripped, are similar in form as to outward appearance, differing chiefly in color, fineness, and strength. An example of a fine bast fiber is the ribbons or filaments of hemp, and of a coarser form, the bast from the linden or the cedar. In fig. 3 are shown highly magnified filaments of flax. A variation in form should be noted in the lace barks and the paper barks, where the bundles of fibers which interlace may be peeled off in the form of thin, flat strips. The woody fibers are only fibrous in a broad sense, as their cellulose is broken down and all extraneous matter removed by chemical means, as for the manufacture of paper pulp or of artificial silk. The greater number are merely wood in the form of flexible slender twigs or osiers that are useful for making baskets; or the larger branches may be split or subdivided into strips, withes, or flat ribbons of wood, for making coarser baskets. The softer

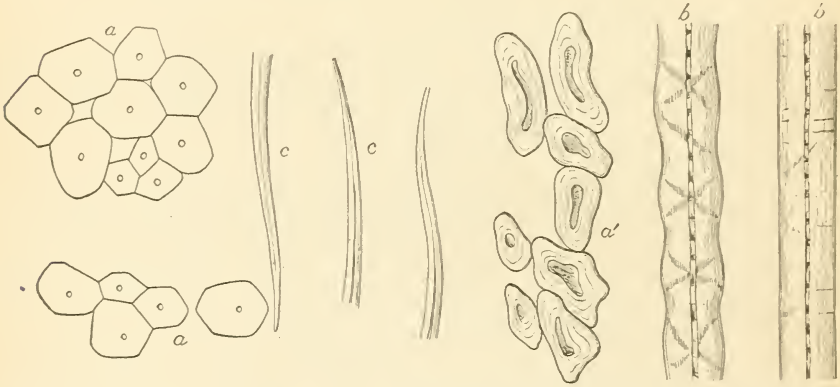

FIG. 3.—Flax fibers: *a*, *a'*, transverse sections of fibers; *b*, fibers viewed in length; *c*, points or ends of fibers. Example of a bast fiber.

woods still further subdivided give the product known as excelsior, which can only claim a place in a list of fiber plants because it is a substitute for upholstery or packing material.

Structural fibers are found in many forms, some of which may be enumerated as follows: The stiff, white, or yellowish fibers forming the structure of all fleshy-leaved or aloe-like plants, as the century plant, the Yuccas, Agave, and pineapple, or the fleshy trunk of the banana; as an example, sisal hemp of commerce; the coarser bundles of stiff, fibrous substance which gives strength to the trunks, leaf, stems (mid-ribs and veins), and even the leaves of palms, a good example being Piassaba, derived from the dilated margins of the petioles of a palm, where they clasp the stem; these are made into thin strips which afterwards split into smooth, cylindrical fibers. Another example is the stiff fibers extracted by maceration from the "boots" or bases of the leaf stems of the cabbage palmetto, or the shredded leaves of the African fan palm, known as Crin végétal. Other familiar examples may be noted in strips of rattan, the fibrous material derived from bamboo, from the cornstalk, the flower stems of broom corn, and from reeds, sedges, and the true grasses. Still another form is the fibrous mass surrounding the fruit of the coacoanut, known as coir, and as a curious example may be noted the fiber from pine needles; a notable exception of a structural fiber derived from an exogenous plant, the fibrous mass filling the sponge cucumber being another.

The surface fibers are still more varied in form. They may be the elongated hairs surrounding the individual pods which contain the single seeds of the thistle, familiarly known as thistledown, or they may be the hairy growths covering the clusters of seeds contained within large pods, as the cotton boll, the pod of the milkweed, or the seed envelop of species of Bombax found in tropical countries. See fig. 4, a highly magnified example of the fiber of cotton. In this

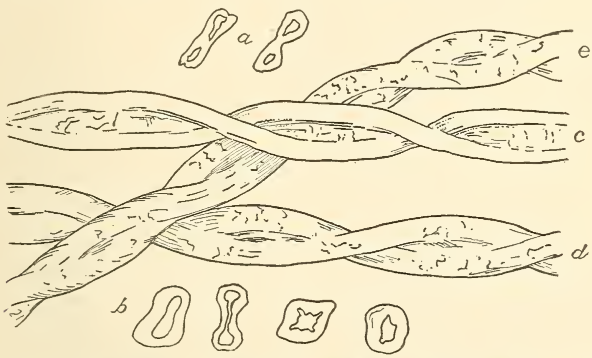

FIG. 4.—Cotton fibers: *a*, half ripe fibers of cotton, transverse section; *b*, mature fibers; *c*, half ripe fibers with thin cell wall; *d* and *e*, mature fiber with definite cell wall. × 325. (After Bowman.) Surface fiber.

group also is placed the leaf scales or tomentum found on the under surfaces of leaves, etc., or on the leaf buds of both endogenous and exogenous plants, which can only be used for upholstery, or as tinder. Epidermal strips of palm leaves, raffia being an example, are also included with the surface fibers.

The pseudo-fibers are not fibers, but substances used as their substitutes. However, they are so clearly defined in the scheme of classification it will not be necessary to describe them further or to give examples. Fig. 5 represents sphagnum moss, used as a packing material.

ECONOMIC CLASSIFICATION.

The highest use for which a fiber may be employed is in the manufacture of cloth or woven fabric. As these fabrics vary greatly in texture from the fineness of delicate linen cambric to the coarseness of jute bagging, it would seem that a large number of fibers might be considered spinnable forms and capable of manufacture. In point of fact, however, a comparatively small number are actually spun and woven as commercial articles, these having proved their superior adaptability for the special purposes for which they are employed, and the form and appearance of the different manufactures from them having become in a measure so fixed that change could not be made without serious result. And, besides, it should be recognized that such change might necessitate complete change in an entire system of textile machinery employed in a special industry. Examples of the fabric fibers of the first rank are China grass (bast fiber), pineapple (structural fiber), and cotton (surface fiber); of the second rank, jute (bast fiber) and coir or cocoanut (structural fiber). The FABRIC fibers, therefore, are easily disposed of, and we come to the next of the higher uses in which fibers are employed, the manufacture of threads, twines, cords, and ropes, or, reduced to a term, CORDAGE. The fibers employed for this group of manufactures include all the spinning and weaving fibers, which for the most part are employed in the manufacture of thread and fine twines, and a larger number of coarser fibers, which also have their substitutes, for the manufacture of which ordinary systems of cordage machinery are generally adapted. In this group, also, must be included a still larger number of "native" fibers, or those which are extracted, prepared, and rudely spun or wrought into ropes by hand by the natives of the countries where they are produced, the finer kinds being used for sewing thread, fish lines, nets, and hammocks. Even the group of "native fibers" used for cordage is capable of subdivision into *prepared* fibrous material, for spinning and twisting, and *unprepared* bark, or the whole stems or leaves of plants or bundles of unprepared bast, simply twisted together to form a very rough rope or cable. Such cordage has been largely used in South America and in India in the construction of rope bridges. Examples

FIG. 5.—Sphagnum moss.

of the cordage fibers are: Commercial—for threads, flax (bast fiber); for twines, common hemp (bast fiber), and for ropes, manila and sisal hemps (structural fiber); native—for fine twines, fish lines, etc., Indian hemp (or *Apocynum*) (bast fiber); for ropes, the Yuccas (structural fiber); for binding and rough sewing material, spruce roots (woody fiber); and for fish lines, kelp or seaweed, used in Alaska and other high northern latitudes (pseudo-fiber).

The third use is the preparation of certain tree basts that are extracted from the bark in layers or sheets, and which, by pounding, are made into rough SUBSTITUTES FOR CLOTH. Such cloth has long been used by the natives of the Pacific islands, and is known as *Tappa* or *Kapa*. Other forms, such as the *Damajagua*, of Ecuador, are used in South America as cloth, while similar fibrous bast is employed in India in its primary form, for sacks, etc. In this group are also included the more delicate tree basts that are extracted in thin lacelike layers and known as lace barks, as well as other forms of which the cigarette bast, or Cuban bast, is an example. Certain close-textured fibrous growths from palm trees, when they may be secured in thin sheets, likewise come into this category.

A fourth use is in the manufacture of BRUSHES AND BROOMS, for which a different class of fibers are employed than either the fabric or cordage fibers. The first essentials of a brush fiber are toughness and stiffness, qualities found in many of the fibers from Endogens, and the brush fibers, therefore, especially the commercial species, are largely derived from palms. Grasses and grass roots are also used, while the best substitute for animal bristles is a species of Agave, the fibro-vascular bundles of which are large, smooth, rigid, and cylindrical. The most important commercial brush fibers derived from palms are noted as Piassaba, or Bass, of which there are several forms from as many different species. An American example of palm brush fiber is found in the finished product from crushed and softened palmetto leaf stems. Coarser brush material consists of twigs or small stems of woody plants, or even of splints of wood, while the aboriginies and "natives" use anything that has the requisite stiffness, from a bunch of grass to the small branches of bushes tied together. Examples of commercial brush fibers are Tampico, from *Agave heteracantha*, Piassaba, or Bass, from *Attalea funifera*, a palm, and Broom root, from the roots of *Epicampes macroura*, a Mexican grass.

The fifth group of uses comprises PLAITED OR COARSELY WOVEN MANUFACTURES of articles employed in the domestic economy, some of which are of commercial importance, while the greater number are "native" productions. The materials used are the whole stems of reeds, rushes, or grasses, palm leaves, coarse tree basts, etc., wrought or plaited together in the simplest manner possible. Some of these articles may be enumerated as follows: Mats and mattings, screens, wallets, bags, saddle cloths, sandals, hats, toys, chair seats, and basketry in endless form. Examples of the commercial manufactures are the Japanese mattings from the mat rush (*Juncus effusus*), the Russian mattings from the bast of the linden tree, the finely subdivided leaves of *Carludovica palmata* for Panama hats, and the split stems or straw of wheat, rye, barley, and rice, for braids or straw plait, all of which are structural fibers, save the Russian bast. Examples of "native" or aboriginal manufactures are the sleeping mats from various sedges or grasses, the East Indian *tatties* and screens from the fragrant roots of the Khus-Khus; the split leaves of Yucca, used for making sandals, and the rain coats of China and Japan.

The use of fibers or fibrous substances in the coarse weaving or plaiting of basketry is an industry that belongs to all civilized countries and that is practiced by the native tribes of the world, and a catalogue of the varied forms would be too long for enumeration on these pages. By reason of the similarity of construction and materials used, we must also include in this class a considerable number of articles that resemble baskets, known as willow ware, such as hampers and infants' carriages; and even chairs, that are produced from willow withes; and chair bottoms are also included. While the commercial basket material is confined chiefly to the osiers, or willows, to certain forms of wood splints, and to a few species of rushes and the grain straws, the native and Indian basket fibers are legion, for they include a range of vegetable substances from the stipes of delicate ferns, and the smaller grasses, through the sedges, reeds, the bamboos, the palms, and liliaceous plants, to the stems and twigs of shrubs, and even the splints from the wood of trees, or their subdivided woody roots. A few examples of this class of manufactures are the sweet-scented grass baskets made by the New England Indians from the holy grass; the delicate fern baskets of the Sandwich Islanders, the Yucca coil baskets, and others by the Hopi Indians of Arizona, the sumac and willow trays, and the spruce-root baskets of Northern tribes, palm-leaf baskets, and those from bamboos, sedges, and reeds. Among commercial forms are the Italian straw-plait baskets, the Buscola baskets from certain sedges, the osier manufactures from Italy, and the ash and white-oak splint baskets made in our own country, together with chair bottoms plaited in rattan or rushes.

A sixth form of utility is the employment of fibers or fibrous substances in mass as FILLING MATERIAL, for stuffing pillows, cushions, mattresses, furniture, etc., or as packing substances. The surface fibers for the most part compose this class, as the bast fibers are too valuable, while the structural fibers are too stiff for such purposes, exceptions being the shredded leaves of palms, the commercially prepared Spanish moss (*Tillandsia usneoides*), known as vegetable hair, and the familiar corn "shucks." The pseudo-fibers embraced in group 5 are also largely used as packing material, though a notable exception should be made of certain leaves, as well as species of fungi, and Alaskan seaweed, the last being twisted into fish lines, the fungi used for making caps, table mats, etc., or employed as tinder. Mycelium has also been employed as a substitute for fabric.

A seventh and most important use is in the manufacture of PAPER. With this brief enumeration of some of the ways in which fibers are employed by man the following economic classification, relating to the utility of fiber and fibrous substances, is presented:

A. SPINNING FIBERS.

1. *Fabric fibers.*

(*a*) Fibers of the first rank, for spinning and weaving into fine and coarse textures for wearing apparel, domestic use, or house furnishing and decoration, and for awnings, sails, etc. (The commercial forms are cotton, flax, ramie, hemp, pineapple, and New Zealand flax.)

(*b*) Fibers of the second rank, used for burlap or gunny, cotton bagging, woven mattings and floor coverings, and other coarse uses. (Commercial examples are jute and coir.)

2. *Netting fibers.*

(*a*) Lace fibers, which are cotton, flax, ramie, agave, etc.

(*b*) Coarse netting fibers, for all forms of nets, and for hammocks. (Commercial forms: Cotton, flax, ramie, New Zealand flax, agave, etc.) The native netting fibers are legion, and include the fibers derived from tree basts, palms, etc.

3. *Cordage fibers.*

(*a*) Fine spun threads and yarns other than for weaving; cords, lines, and twines (all of the commercial fabric fibers, sunn, Mauritius, and bow-string hemps, New Zealand flax, and the so-called commercial hard fibers, coir, manila and sisal hemps, and other forms); the fish lines made from seaweed.

(*b*) Ropes and cables. (Chiefly common hemp, sisal and manila hemps, when produced commercially. In native manufactures made from palm fiber, yuccas, and many other plants.)

B. TIE MATERIAL (*rough twisted*).

Very coarse material, such as stripped palm leaves, the peeled bark of trees, and other coarse growths used without preparation, and employed in the construction of huts, fences, as emergency cordage, and sometimes as cables for "rope bridges," with other native uses too numerous to mention.

C. NATURAL TEXTURES.

1. *Tree basts, with tough interlacing fibers.*

(*a*) Substitutes for cloth, prepared by simple stripping and pounding. (Examples: The *Tappa* or *Kapa* cloth of the Pacific islands; the *Damajuhato* of South American tribes.)

(*b*) Lace barks. (The best example is the bast from *Lagetta lintearia*, of Jamaica, which has been used for cravats, frills, ruffles, etc., and likewise as thongs and whips.)

2. *The ribbon or layer basts*, extracted in thin, smooth-surfaced, flexible strips or sheets. (Examples: The Cuba bast that is employed commercially as a millinery material, plain and dyed in colors; cigarette basts for wrappers.)

3. *Interlacing structural fiber or sheaths.*

(*a*) Pertaining to leaves and leaf stems of palms, such as the fibrous sheaths found at the bases of the leaf stalks of the cocoanut.

(*b*) Pertaining to flower buds. The natural caps or hats derived from several species of palms.

NOTE.—The separated filaments of these cloth substitutes, sheet or ribbon basts, etc., are also employed, by twisting, as cordage.

D. Brush fibers.
1. *Brushes manufactured from prepared fiber.*
(*a*) For soft brushes. (Substitutes for animal bristles, such as Tampico.)
(*b*) For hard brushes. (Examples: Palmetto fiber, palmyra, kittul, etc.)
2. *Brooms and whisks.*
(*a*) Grasslike fibers. (Examples: Broom root, broom corn, etc.)
(*b*) Bass fibers; also for coarse brushes and sweepers. (Monkey bass, Piassaba, etc.)
3. *Very coarse brushes and brooms.*
Materials used in street sweeping, etc. Usually twigs and splints.

E. Plaiting and rough weaving fibers.
1. *Used in articles for attire, as hats, sandals, etc.*
(*a*) Straw plaits. From wheat, rye, barley, and rice straw. (Examples: The commercial Tuscan and Japanese braids.)
(*b*) Plaits from split leaves, chiefly palms and allied forms of vegetation. (Example: The celebrated Panama hats, from the finely divided leaves of *Carludorica palmata*.
(*c*) Plaits from various materials used entire and without preparation. (Example: Basts and thin woods used in millinery trimmings, etc.; Chinese sandals from rushes.)
2. *Mats and mattings; also thatch materials.*
(*a*) The commercial mattings, from eastern countries.
(*b*) Sleeping mats and other forms of mats or mattings, screens, etc., made by "natives" for their own use.
(*c*) Thatch or other covering or protection from the elements, made of tree basts, palm leaves, grasses, etc.
3. *Basketry.*
(*a*) Manufactures from woody fiber. (Commercial examples: Osier and splint baskets; the same forms produced by Indians, and including also manufactures from sumac and other twigs, roots of spruce, etc.)
(*b*) From the whole or split leaves or stems of endogens, or from any rigid fibrous material, including also the culms of grasses. (Chiefly Indian or native manufactures, from yucca leaves, palm leaves, reeds, grasses, etc., used individually or in combinations.)
4. *Miscellaneous manufactures.*
Willow ware in various forms, chair bottoms from splints or rushes, etc.

F. Various forms of filling.
1. *Stuffing or upholstery.*
(*a*) Wadding, batting, etc., usually commercially prepared lint cotton.
(*b*) Feather substitutes. For filling cushions, pillows, etc., cotton; seed hairs or silk cottons, such as kapok, Asclepias down, etc.; tomentum, from the surfaces of stems, leaves, and leaf buds of plants; other similar soft fibrous material.
(*c*) Mattrass and furniture filling. The tow or waste of prepared fiber; unprepared bast; straw and grasses; substitutes for curled hair, as spanish moss, crin végétal, maize husks, etc.
2. *Caulking.*
(*a*) Filling the seams in vessels, etc., oakum from various fibers.
(*b*) Filling the seams in casks, barrels, etc., leaves of reeds and giant grasses.
3. *Stiffening.*
In the manufacture of "staff" for building purposes, and as substitutes for cow's hair in plaster. New Zealand flax; palmetto fiber.

4. *Packing.*
   (*a*) In bulkheads, etc. (as in armored vessels). Examples: Coir, cellulose of corn pith, etc. In machinery, as the valves of steam engines, various soft fibers.
   (*b*) For protection, usually in transportation; various fibers and soft grasses; marine weeds, excelsior; also stuffing and upholstery materials generally.

G. Paper material.

1. *Textile papers.*
   (*a*) The spinning fibers in the raw state. The secondary qualities, or the waste, from spinning mills, which may be used for paper stock, including tow, jute butts, manila rope, etc.
   (*b*) Cotton or flax fiber that has already been spun and woven, but which as rags find use as a paper material.
2. *Bast papers.*
   This includes Japanese papers from soft basts, such as the paper mulberry (*Broussonetia*), or species of the genus *Edgeworthia*.
3. *Palm papers.*
   From the fibrous material of palms and similar monocotyledonous plants. Example: Palmetto and Yucca papers.
4. *Bamboo and grass papers.*
   This includes all paper material from gramineous plants, including the bamboos, esparto, maize, and the true grasses.
5. *Wood pulp, or cellulose.*
   The wood of spruce, poplar, and similar "paper pulp" woods, prepared by various chemical and mechanical processes.

It should be noted that an absolute economic classification of uses with relation to species is impossible, as the same fiber may be used in several ways. Manila hemp is manufactured into rope, and old manila rope into manila paper. Cotton is used for fabrics, as a netting fiber, for cordage, in upholstery, and in paper. In fact, there are very few fibers which may not be made into paper, the amount of cellulose they contain and the cost of the process by which they are converted being the main considerations. The same plant may also yield two kinds of fibers, as lint cotton covering the seed, and cotton bast, stripped from the stalk.

DESCRIPTIVE CATALOGUE OF WORLD'S FIBERS.

[ABBREVIATIONS.—*Countries*.—Afr., Africa; Alg., Algeria; Andam. Is., Andaman Islands; Arab., Arabia; Arg., Argentina; Aus., Austria; Austr., Australia; Bomb., Bombay; Braz., Brazil; Br. Guian., British Guiana; Burm., Burma; Can., Canada; Cent. Am., Central America; Ceyl., Ceylon; Fr., France; Fr. Guian., French Guiana; Ger., Germany; Gt. Brit., Great Britain; Guat., Guatemala; Hind., Hindostan; Holl., Holland; Hond., Honduras; Ind., India; It., Italy; Jam., Jamaica; Jap., Japan; Maurit., Mauritius; Mex., Mexico; N. S. W., New South Wales; N. W. Prov. Ind., North West Provinces of India; New Zea., New Zealand; Panj., Panjab; Phil. Is., Philippine Islands; S. Am., South America; Sp., Spain; Span., Spanish speaking countries; Tasm., Tasmania; Trin., Trinidad; Turk., Turkey; Venez., Venezuela; Vict., Victoria; W. Ind., West Indies; Yuc., Yucatan.

Museums and exhibitions.—Bot. Mus. Harv. Univ., Botanical Museum of Harvard University, Cambridge; C. S. I. Exp., 1895, Cotton States and International Exhibition, 1895, Atlanta; Field Col. Mus., Field Columbian Museum of Chicago; Herb. Col. Univ., N. Y., Herbarium of Columbia University, New York City; Phil. Com. Mus., Philadelphia Commercial Museum; Phil. Int. Exh., 1876, Philadelphia International Exhibition, 1876; Kew Mus., Museum Royal Kew Gardens, England; Mus. U. S. Dept. Ag., Museum of the United States Department of Agriculture; Paris Exp. Univ., 1889, Paris Exposition Universelle, 1889; U. S. Nat. Herb., United States National Herbarium; U. S. Nat. Mus., United States National Museum; W. C. E., 1893, World's Columbian Exposition, 1893, Chicago.

An asterisk before the word * Specimen denotes that the author has examined the fiber. All descriptive matter is invariably given under the botanical name of the species, this name always being found after a common or native name as a reference.]

Aainunnas (Pers. and Arab.). See *Ananas sativa.*

Abaca (Phil. Is.). See *Musa textilis.*

Abelmoschus (see *Hibiscus*).

Abroma augusta. DEVIL'S COTTON.

Exogen. *Sterculiaceæ.* Perennial. A small tree.

NATIVE NAMES.—*Abrome* (Fr.); *Oelta-kamal* and *Ulatkamball* (Ind.).

Wild, and cultivated throughout the hotter parts of India, and grows in Mauritius. The plant yields three crops a year, and is said to be more easily cultivated than jute or sunn hemp.

BAST FIBER.—Derived from the bark of the twigs; is strong, white, and clean, and much valued for local uses. "Might be employed as a substitute for silk.' (*Watt.*) "A cord of its fiber bore 74 pounds, when sunn hemp broke with 68 pounds." (*Royle.*) Chiefly employed for cordage, etc., by the natives in the districts where grown.

* *Specimen*.—Herb. Col. Univ., N. Y.

Abroma mollis is found in the Isles of Sunda, Molucca, and the Spice Islands; the fiber also derived from the bark.

Abrus precatorius. INDIAN LICORICE. ROSARY PLANT.

Exogen. *Leguminosæ.* A twining shrub.

Native of India, but found in the West Indies, Mauritius, and other tropical regions. The bark or bast is twisted into rough cordage.

Abutilon avicennæ. INDIAN MALLOW.

Exogen. *Malvaceæ.* Herbaceous annual.

NATIVE NAMES.—*Cañapiña* (Arg. Rep.); *Ch'ing Ma* (China).

See *A. indicum* for Indian names of *Abutilon*, spp.

Widely distributed, north and south, east of the Rocky Mountains, and is found in the State of Washington. Although it has been considered an indigenous species, Gray states that it was introduced from India, and when found growing wild has escaped from cultivation. Also distributed to northern Asia and westward to southern Europe. Grows in northwestern India (Sind and Kashmir). Said to be found in South America; cultivated experimentally in United States and India, commercially in China, from whence the fiber is exported as China jute. In the United States the plant grows so freely upon any rich soil, even thrusting itself in and growing spontaneously, that it has come to be considered a farm pest in many portions of the country. It grows luxuriantly throughout the West and North, the line of States from Ohio to Missouri producing vast quantities of the bast, which rots and goes to waste upon the stalks every year. (See fig. 6.)

The revised name of this species is *Abutilon abutilon.*

BAST FIBER.—A jute substitute, which may be manufactured into twine, rope, and common cordage. Fiber white and glossy, and shows good strength. Has been manufactured into paper in Illinois, the ligneous body of the plant giving more cellulose for paper stock than other species. Early experimenters stated that fiber extracted from plants that had not reached their maturity would be fine enough to work into yarns for carpet fillings and even fabrics. It takes dyes readily, and an advantage is claimed in this respect over India jute, which is antagonistic to cheap bleaching and dyeing. The fiber was once classified in value between Italian and manila hemp, but it will not grade so high, coming nearer to jute, as is proved by its being sold as a variety of jute. The seed of the plant is so hardy that it is not affected by the severest winter, which enables the plant to perpetuate its species in any locality where introduced. It is claimed that an acre of ground will produce 5 tons of Abutilon stalks, giving about 20 per cent of fiber. Of doubtful economic value, considering that we have other and better fibers which are already in cultivation.

CULTIVATION.—Experiments with cultivation in the United States date back to about 1870, when the plant attracted considerable attention in the West, particularly in Illinois, through the endeavors of Mr. J. H. McConnell to establish the industry, and the fiber was given a flattering promise of utility. The plants are stated to grow 9 to 14 feet high; the seed should be sown 12 to 16 quarts per acre, in corn-planting time, in the same manner as hemp; it is cut with a reaper, shocked like hemp till cured, then water retted like hemp; a volunteer crop will spring up the last of July, which can be dew retted. The cost of cutting is given at 75 cents per acre; water retting, $10; dew retting, $5; hand cleaning, $12; and half as much by machinery, making the total cost, not including rent of land, $19 to $31. Messrs. McConnell offered $100 per ton for all water retted that could be furnished and $75 for the dew-retted. The crop is not exhausting to the soil if the refuse is restored to it.

Seven or eight years later the plant was the subject of special investigation and experiment in the State of New Jersey, through the endeavors of Mr. Samuel C. Brown, secretary of the bureau of labor, statistics, and industries of that State. A circular was issued in 1878 for the twofold purpose of awakening an interest in the subject of fiber cultivation and to ascertain what portions of the State were best adapted to its cultivation. While the promoters of these experiments were satisfied that no difficulty existed in the cultivation of the fiber, the enterprise failed completely, notwithstanding the fact that a bounty was offered for the production of the fiber. It was demonstrated at the time of these experiments that the plant would thrive in any rich soil suitable for corn and potatoes.

PREPARATION.—The fiber can be disintegrated and separated from the stalks by steeping in water, like flax, hemp, or jute (as practiced in India), but such practice should be avoided in this country if possible. At the time of the New Jersey experiments it was thought that the question of economically cleaning the fiber had been

FIG. 6.—The Indian mallow (*Abutilon avicennæ*.

settled by the invention of a "combined chemical and mechanical process." There is no doubt that a combined mechanical and chemical process must be employed in extracting all jute-like fibers, but the process must give straight fiber, uninjured as to strength, and with the natural color preserved. This means a machine that will strip the bark at economical cost and an after-process that will remove the gums without weakening the fiber. Steeping the ribbons in water for the requisite number of days is the simplest form of accomplishing the result, but this is primitive.

Nevertheless, machine stripping and water retting of jute has been practiced in this country in Texas in a small way. An economical machine for extracting this class of bast fibers is yet a desideratum. See Machinery, Appendix A.

* *Specimens.*—Field Col. Mus.; U. S. Nat. Mus.; Mus. U. S. Dept. Ag.

Abutilon bedfordianum.

Native of Brazil. Tall rank shrub. Introduced into Victoria, Australia, where its growth is rapid.

Bast Fiber.—Almost white, the filaments fine and regular. "The bark yields a fiber of superior quality, suitable for whipcord, fine matting, paper, and perhaps textile fabrics." (*Guilfoyle.*) A beautiful example of the fiber was shown in the Victorian collection, Phil. Int. Exh., 1876. *A. album* is another Victorian species. See Ann. Rept. U. S. Dept. Ag., 1879.

* *Specimen.*—Mus. U. S. Dept. Ag.

Abutilon incanum.

Native Mexican name.—*Tronadora.*

The species is found in Mexico, acquiring greatest perfection on the rich bottom lands. It reaches a height of about 8 feet.

Bast Fiber.—Extracted from the bark. The Zotlahnacar Indians, who live 40 miles south of Manzanillo, are said by Dr. Palmer to utilize the fiber in making hammocks, ropes, and carrying nets, which are so durable that they last from seven to ten years in constant use.

Native preparation.—When the plant is mature, the lateral branches are cut away and the stems are buried in the mud at the edge of Lake Alcuzagua (Lake of the Devil). Three or four days afterwards the plants are removed and washed, and are then ready for the stripping of the inner bark or fiber. This is done in the following manner: The workman, standing upright, with the stem, which rests firmly upon the ground, in his left hand, presses the right thumb firmly upon the stick, and taking the fiber between the fingers, he pulls steadily, bending gradually to the work until he falls upon his knees. When the fiber is removed, the stem rebounds and flies over the shoulder of the operator, stripped of half its bark. This seems a very slow process, but jute was formerly cleaned as slowly, and it was only after many and repeated trials that machinery was perfected to perform this tedious work. Probably if this, like jute, is allowed to die before cutting, it would become brittle and fit only for paper manufacture; therefore, in more northern latitudes, it may be best to cut the plants before frost. Experiments will be necessary to ascertain the proper time for cutting, the length of time it should be immersed, if water will accomplish the same result as mud, rendering the bark soft and pliable. (*Dr. Edw. Palmer,* Contr. U. S. Nat. Herb., Vol. I.)

Abutilon indicum. Country Mallow.

Native names.—*Kanghi* (Hind.); *Potári* (Beng.); *Deishar* (Arab.); *Darakhte-shanah* (Pers.); *Uram* (Malay); *Anoda-gaha* (Ceyl.).

A small annual shrub, common to India and Burma, but cultivated in Mauritius; found in south Africa.

Bast Fiber.—Very similar to that of *A. avicennæ,* which see. "The stems contain good fiber suitable for cordage." (*Watt.*) A fine sample of the fiber was exhibited in the Indian Court, Forestry, W. C. E., 1893. The leaves, seed, and bark of this species and *A. asiaticum* are used as a medicine in India. The last-named species also yields a good cordage fiber.

There are 10 or 12 Indian species of Abutilon, among which may be also named *A. graveolens,* *A. muticum,* and *A. polyandrum,* all of which are fiber plants. The latter is said to yield a long silky fiber resembling hemp.

Abutilon molle. LANTERN FLOWER.

Native of Brazil. Introduced into Australia, where it is considered worthy of cultivation.

BAST FIBER.—"Very strong and suitable for matting, paper, etc." (*Guilfoyle.*) The sample of fiber shown in the Victorian collection, Phil. Int. Exh., 1876, was poorly prepared and lacked in strength. The sample was accompanied by fiber from two other Brazilian species introduced into Australia, *A. venosum* and *A. oxycarpum.* Of the first Dr. Guilfoyle says: "Fiber of fine quality, suitable for fishing lines, textile fabrics, etc." The fiber of the latter was well prepared, white, soft, and lustrous, and was produced in Queensland. *A. giganteum* is another South American species, noted for withstanding cold. Fiber has been extracted from the bark.

**Specimen* of *A. molle*, Mus. U. S. Dept. Ag.

Abutilon periplocifolium. MAHOLTINE.

The species thrives in tropical America.

Live plants, stalks, and fiber of this species were received from Trinidad through T. J. St. Hill in 1890. The stalks reach a height of 12 feet. The plant grows wild, but can be easily cultivated, and large crops assured. Seed was obtained and sent to several points in Florida for experiment, but the Department was unable to secure from the experimenters any reports of the results.

BAST FIBER.—When the bark is green, it can be peeled its entire length with no other preparation than steeping the stalks in pools of water from five to eight days. The color of the fiber is a creamy yellow, and some of the samples received measured 11 feet 10 inches in length. Samples of the fibers submitted to London brokers were favorably reported upon and valued at £17 to £20 per ton.

A true bast fiber of good quality. The stems strip well and readily and the bark "rets" out, leaving a fine fiber of a type to compete with jute. A very large crop of this fiber can be grown per acre, but as no regular cultivation exists only an approximate estimate can be given. It is estimated that as much as 10,000 pounds of stripped bark can be obtained from an acre, and that from 25 to 40 per cent of cleaned fiber could be obtained from this. It promises best of all the newer fibers. (*J. H. Hart.*)

Mr. St. Hill states that it thrives magnificently in barren and rocky soil; the land is prepared simply by burning, when the seeds are thrown broadcast over the plain, about the beginning of the month of May, and the stalks are ready to be converted into fiber one year after. No attention is required to be paid to the plants while growing, and wild weeds, etc., do not affect them in the least. Plants growing very near to each other will produce very tall stems, say from 10 to 12 feet high and straight, but those that happen to grow far apart will shoot out branches and make bad growth, and the ribbons will be very irregular.

* *Specimens.*—Mus. U. S. Dept. Ag.; U. S. Nat. Mus.; Field Col. Mus.

Abutilon striatum. STREAKED LANTERN FLOWER.

Native of Brazil. Widely distributed as a flowering plant in greenhouses and gardens. Common in United States. Introduced into Victoria.

FIBER.—It has only been produced experimentally in Victoria. "Its bark, which peels readily, furnishes a fiber of fine texture." Is worthy of experiment in the United States.

* *Specimen.*—Mus. U. S. Dept. Ag.

Acacia leucophlœa. PANICLED ACACIA.

Exogen. *Leguminosæ.* A tree.

NATIVE NAMES.—*Safed-kikar* (Hind.); *Safed-babúl* (Burm.), and many others.

Wild in many districts of India, Ceylon, and Burma. Plains of Panjab to South India.

BAST FIBER.—"A coarse, tough fiber is prepared from the bark, much valued (locally) for fishing nets and ropes." (*Dr. George Watt.*) *A. modesta* is mentioned by Liotard as a possible paper plant in India; known as *Phulahi.*

Acanthorhiza warscewiczii.

A magnificent palm found in the forests of Chiriqui. "Employed by the natives for making brushes of very fine quality, carpets, tapestries, etc." (Manual Hoepli). Cultivated in greenhouses. (See fig. 7.)

Achúal, or Agúash (Peru). See *Mauritia flexuosa.*

Acrocomia lasiospatha. GREAT MACAW PALM.

Endogen. *Palmæ.*

NATIVE NAME, *Mucuja* (Braz). Cuban name of the fiber, *Pita de corojo.*

This species is common in the neighborhood of Para, where its nearly globular crown of drooping feathery leaves is very ornamental. The fruit, though oily and bitter, is very much esteemed and is eagerly sought after. It grows on dry soil about Para and the Lower Amazon, but it is quite unknown in the interior. The stem is about forty feet high, strong, smooth, and ringed. The leaves are rather large, terminal, and drooping. The leaflets are long and narrow, and spread irregularly from the midrib, every part of which is very spiny. The sheathing bases of the leafstalks are persistent on the upper part of the stem, and in young trees clothe it down to the ground. The spadices grow from among the leaves erect or somewhat drooping, and are simply branched. The spathes are woody, persistent, and clothed with spines. The fruit is the size of an apricot, globular, and of a greenish-olive color, and has a thin layer of firm edible pulp of an orange color covering the seed. (*Wallace.*)

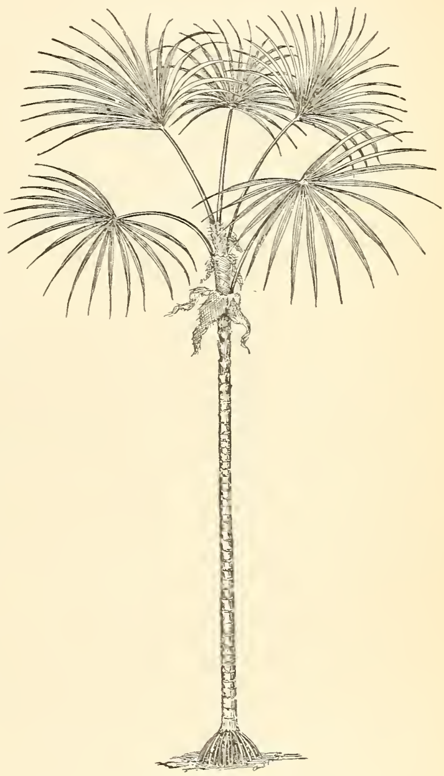

FIG. 7.—Plant of *Acanthorhiza warscewiczii.*

STRUCTURAL FIBER.—"The strands of fiber present a ribbon-like appearance somewhat resembling Raffia, but firmer and not so papery. Extremely strong and capable of being divided into very tough filaments." (*Morris.*)

Specimens of the fiber were received by the Department from Cuba so long ago as the early seventies. The ribbons are very white. By rolling between the hands it breaks up into innumerable filaments, some of great fineness. It might prove a valuable fiber for cordage, though a drawback (in the specimen examined) is the presence of little spines, doubtless those mentioned by Squier, which are as sharp as needles, and half an inch in length. They are not readily seen, but by grasping a handful of the fiber in the hand they make their presence known with painful surety. Two varieties of *Corojo* are given in the catalogue of M. Bernardin, the "*Corojo de la tena*" from the West Indies, stated to be *Cocos crispa*, and the *Corojo, Corozo,* or *Cocoyal* from Central America, without name. Squier states that the *Corosal, Coyal*, or *Corojo palm* abounds in dry and rocky locations in Central America and Cuba and some other portions of tropical America. It is described as a tree 20 feet high, producing a large cluster of nuts, with a hard shell, which yields an oil similar to that of the cocoanut. The trunk and leaves of the coyal are armed with long, narrow, hard spines. "The leaves are lined with a long and excellent fiber called *Pita de corojo*, from which ropes and cords are manufactured. The fibers are equal to those of Henequen, from which they can hardly be distinguished." Among Brazilian palm fibers the handbook of Para (W. C. E., 1893) mentions the *mucuja* as this species.

FIG. 8.—The Mucuja, or Gru gru Palm, *Acrocomia lasiospatha*.

A fine sample of *Corojo* fiber from Cuba was contributed, by Messrs. Ide & Christie, to Kew in 1890. At the time it was impossible to trace its origin. A careful examination showed that the fiber was formed of the epidermal layer of a palm leaf and probably derived from a species of *Bactris* or *Acrocomia* armed with prickles. In March, 1895, a further inquiry elicited the fact that the fiber was obtained from the unopened leaflets of the "*Gru-gru* palm of the West Indies (*A. lasiospatha*)." The Kew Mus. contains a cap and a strainer made from the spathe, the latter used as a strainer for cassava. Dr. Morris says: "It is a remarkable fiber, and in point of tensile strength it surpasses even the oil palm fiber, *Elais guineensis*." For further details refer to Ann. Rept. U. S. Dep. Ag., 1879, p. 551; Cantor Lectures on Commercial Fibers, by Dr. D. Morris, p. 31.

**Specimens.*—Mus. U. S. Dept. Ag.

Acrocomia sclerocarpa. MACAW TREE. GRU GRU.

Endogen. A palm.

NATIVE NAMES.—*Macaúba* (Braz.); *groo groo* (W.Ind.), of Fawcett.

The tree grows from 20 to 30 feet high; found in Jamaica, Granada, Trinidad, Guiana, and Brazil. (See fig. 8.)

FIBER.—Derived from the leaves, valued for local uses. "Distinguished from other fibers of this class by remarkable fineness and softness." (*Cross.*) *A. totai* appeared in the collection of Argentina. "The leaves of this species give a good textile fiber." (*Niederlein.*) *A. totai* is known as the *Mbocaya*. See notes on the State of Para, Exposition Handbook, Brazil, W. C. E., 1893.

**Specimens.*—W. C. E., exhibits of Brazil and Argentina.

Adam's needle. See *Yucca.*

Adansonia digitata. BAOBAB TREE. MONKEY BREAD TREE OF AFRICA.

Exogen. *Malvaceæ.* One of the largest trees in the world.

NATIVE NAMES.—*Gorakha-amli* (Bomb.); *Hujed* (Arab.); *Mowana* (Afr.), and many others.

Native of Africa (west and interior). "This is one of the largest and longest-lived trees in the world." (*Watt.*) Abounds Senegal to Abyssinia. Found in India, where it has been cultivated experimentally. Introduced into the West Indies.

FIBER.—Derived from the bark; strong and much valued for cordage; can be woven into cloth. The commercial fiber from Africa quoted in London market at £9 to £15 per ton.

"The hard, outer bark is first chopped away, and the inner bark stripped off in large sheets. These are beaten to remove pithy matter, sun dried, and baled. Africans use the fiber for rope, twine, and sacking. In India elephant saddles are made from it." (Spon.) "Cultivation deserves to be extended." (*Watt.*)

This fiber has been mentioned as a raw material for paper makers in this country. Ide and Christie, the London fiber brokers, inform me that the bark of this species has never been imported into Great Britain from either Senegal or Abyssinia. It has never been a large trade and has invariably come from St. Paul de Loando and perhaps some adjacent port in Portuguese west Africa, to either Liverpool or Hull. The fiber was held in some esteem by makers of strong light-colored wrapping papers called in the trade "small hands," and ten or twenty years ago good parcels ranged in value from £8 to £10 per ton. It formerly came to Liverpool and Hull from the west coast, both direct and by way of Portugal, but no direct shipments have been made since 1892. The importations have fallen off from 190 tons in 1887 to 2 tons in 1896.

Adki (Ind.). See *Areca catechu.*

Adiantum spp. MAIDEN-HAIR FERNS.

A large genus of polypodiaceous ferns, the representatives of which are found in many parts of the world, but more particularly in the Tropics. They all have black shining stipes, and in structure are unlike any other ferns.

STRUCTURAL FIBER.—*A. pedatum* is a beautiful specimen found in this country. It affords "an elegant material for the woof of the nicer caps and baskets of the Hoopa and Klamath Indians." (*Dr. V. Havard.*)

The black glossy stalks of *A. capillus-veneris*, as well as of *Pteris decipiens*, are worked by native women (of Hawaii) into ornamental baskets and mats (*Hillebrand*). Native Hawaiian name, *Iwaiwa.*

Æschynomene aspera.

Exogen. *Leguminosæ.* A small subfloating bush.

NATIVE NAMES.—*Sola* or *Shola* (Beng.); *Paukpan* (Burm.).

Frequents marshes, growing in Bengal, Burma, Assam, and South India during the inundation period.

FIBER.—Derived from the bark (in Burma). The pith is used for floats by fishermen, and the same is used by Europeans for making hats, which are very light and perfect protectors from the sun's heat. See Dic. Ec. Prod. Ind., Vol. I, p. 125.

African Button Flower. *Dais cotinifolia.*

African Millet. *Eleusine coracana.*

Agave spp.

A very large genus of fleshy-leaved plants belonging to the *Amaryllidaceæ*, chiefly found in Mexico, and Central and South America, a few species creeping up to and crossing the southern boundaries of the United States. Some of the species, as the familiar Century plant (*A. americana*), are cultivated in our conservatories as ornamental plants. They flower but once, sending up a flower stalk or "mast" sometimes the height of 20 feet, upon which the flowers appear. Two or three species furnish valuable commercial fibers, while others not known to commerce might be utilized in like manner. Several of the species in Mexico yield the distilled liquor known as *mescal*, as well as the fermented *pulque*, both of which are national beverages. A few of the more interesting of the Agaves that are used for fiber are described at length in the pages which follow, and some others that I have treated for fiber are briefly referred to here. Among the Agaves used by the Indians of the United States may be mentioned *A. heteracantha*, which is treated at length on another page. Dr. Havard names *A. palmeri* and *A. parryi* as the *mescal* plants of the Apaches and other Indians. They also yield useful fibers, scraped from the edible portions of the baked leaves.

In June, 1891, the leaves of some 20 species of Agave were collected at the United States Botanical Gardens, Washington, and run through a Van Buren machine. Small museum specimens only were secured, and the quality of the fiber was found to be as follows: *A. americana*, fiber as strong as *A. sisalana* from greenhouse plants, but quite inferior to the Florida-grown fiber. This species is fully described below. *A. brauniana*, a weak fiber, resembling *A. jacquiniana*. *A. caribæa*, fiber similar to *A. variegata* in color and general appearance, but finer, and showing less strength than *A. americana*. *A. corderoyi*, fiber straight, fine, white, of average strength. *A. coccinea*, three varieties, worthless. *A. flaccida* gave a very fine fiber; not straight, approaching in strength that of *A. sisalana*. *A. decipiens*, worthless. *A. inghami*, a coarse, harsh fiber, the filaments smooth and polished, and of such stiffness that the material would make a superior brush fiber, possibly rivaling the tampico of commerce derived from *A. heteracantha*. Under repeated tests three filaments stood an average strain of 10 pounds. *A. jacquiniana*, a very fine, white fiber, but possessing no strength. *A. pruinosa*, worthless. *A. kerchovei*, a harsher fiber than that obtained from the *rigida* group below, but apparently having less strength; somewhat resembles tampico. *A. rigida* var. *elongata*, similar to the preceding, the fiber not distinguishable from it in appearance or strength. *A. rigida* var. *longifolia*, gave fiber that was much finer than that from *A. sisalana* (above), but quite deficient in strength. In appearance it resembles the fiber from *A. americana* rather than *A. sisalana*, though differing from either. *A. rigida* var. *sisalana* (greenhouse plants), the fiber appeared to be finer than that from Florida plants, and not quite so strong. *A. salmiana*, almost as fine as the fiber from *A. americana*; not straight; very little strength. *A. vivipara*, similar to *A. inghami*, though not so coarse, but of sufficient stiffness to produce a good brush fiber. The fiber if washed when extracted would have come out very white. Three filaments bore an average strain of 7 pounds. These two species yielded about 5 per cent of pure bristle fiber. *A. variegata*, fiber very white, crinkly, and elastic, stronger than *A. americana*, but inferior to good sisal hemp.

Out of 16 species other than *A. rigida* (varieties) but 2 species can take rank with *A. rigida* var. *sisalana* in strength, *A. inghami* and *A. vivipara*. In the next grade I would place *A. flaccida*, *A. americana*, *A. kerchovei*, and possibly *A. corderoyi*, while the other species are either not half the strength of *A. sisalana* or are worthless. *A. latevirens* went to pieces in the machine, coming out in short, pulpy fragments. It would be interesting to secure fiber from these species as grown in the open air of the Tropics. No doubt several of the better species would give fiber of fair strength, though inferior to sisal hemp grown under the same conditions.

A. Isabel Mulford, in the Seventh Report of the Missouri Botanical Garden, names, as the Agaves of the United States, *A. virginica*, *A. virginica* var. *tigrina*, *A. variegata*, *A. maculata*, *A. schottii*, *A. schottii* var. *serrulata*, *A. parviflora*, *A. lecheguilla*, *A. utahensis*, *A. deserti*, *A. applanata*, with varieties *parryi* and *huachucensis*, *A. shawii*, *A. palmeri*, *A. asperrima*, *A. americana*, *A. rigida* var. *sisalana*, *A. decipiens*, and two species which remain unidentified, one of these being the immense Agave figured by the author on page 38 of Rept. 5, Fib. Inv. series.

The commercial Agaves are described on the pages which follow.

Agave americana. CENTURY PLANT. AMERICAN ALOE.

Endogen. *Amaryllidaceæ.* Aloe-like leaf cluster.

NATIVE NAMES.—*Maguey,* the plant; *Pita,* the fiber (Mex.); *Pite, aloes* (Fr.); *Bans-keora* (Hind.); *Jungli* (Beng.); *Cutthalay-nar* (Ind. of Royle); *Seubbara* (Arab.).

A native of tropical America, but now distributed over both hemispheres. Employed in the United States as an ornamental plant; in Mexico, for its fiber; in India (Madras), as a hedge plant along railways; in Spain and Sicily, for cordage and mats; in the West Indies, for cordage, hammocks, and fishing lines; in South America, for various uses. Fig. 1, Pl. I, is a century plant in the grounds of the Alcazar Hotel, St. Augustine, Fla.

STRUCTURAL FIBER.—Three to 7 feet, derived from the leaves. "Commercial fiber is white to straw color. Its main faults are the stiffness, shortness, and thinness of wall of the individual fibers, and a liability to rot." (Spon.) "Composed of large filaments, white, brilliant, and readily separated by friction; it takes color freely and easily. It is light, and contracts under water rapidly." (*Watt.*) Commercial quotation, London, £35 to £40 per ton. A number of samples in the Government fiber exhibit (W. C. E., 1893), including not only those prepared by myself, but samples extracted by Mr. T. Albee Smith, of Baltimore, show a fine, soft, white fiber, of more or less brilliancy, a distinctive characteristic being a wavy or crinkled appearance which prevents the bundles of fibers in mass from lying closely parallel, as is the case with sisal hemp and similar straight fibers. Another marked peculiarity is great elasticity.

Dr. Forbes Royle states that the India *pita* has been found superior in strength to either coir, jute, or sunn hemp. In a trial of strength near Calcutta, the tests were made with ropes 1 fathom long and 3 inches in circumference, with the following results: The Agave or *pita* broke in a strain of 2,519½ pounds; coir, 2,175 pounds; jute, 2,456½ pounds, and sunn hemp, 2,269½ pounds. In an experiment with Russian hemp and *pita,* the first named broke with 160 pounds' weight, and the latter with 270 pounds. These experiments show the great strength of the fiber, which is worthy of more extended cultivation and employment in the arts.

Among the interesting uses of this fiber is the manufacture of lace by the peasant women of Fayal. At one time the Mus. U. S. Dept. Ag. contained a valuable series of manufactures of this delicate and beautiful lace, which at that time was largely sold in Paris at very high prices. It was said by the donor of the series that there were but 25 women on the island capable of producing this lace, the art requiring practice from childhood.

CULTIVATION AND PREPARATION.—The plant is cultivated in Mexico, in the south of Europe, in India, Mauritius, etc. The best account of the method of cultivation is given in the Dic. Ec. Prod. Ind., Vol. I, p. 137.

No attempt has been made in the United States either to cultivate the species or to use the leaves of growing plants for fiber. R. W. Paton, representing a California industrial company, corresponded with the Department of Agriculture a few years ago relative to cultivation in southern California, and proposed to utilize the fiber in commerce. The want of a good machine, however, was the principal obstacle met with in the endeavor to start the industry. A quantity of leaves were at that time sent to Mr. Van Buren, of Jacksonville, Fla., to be extracted by his machine, but this inventor found the leaves too thick and wide for the machine as at that time constructed. T. Albee Smith, has cleaned the leaves successfully on a machine described in Rept. 3, Fib. Inv., Dept. Ag., p. 39. A powerful machine employed for extracting the fiber is also described in Spon's Enc., pt. 3, p. 913.

"The plant requires about three years to come to perfection, but it is exceedingly hardy, easy of propagation, very prolific, and grows in arid wastes where scarcely any other plant can live. It perishes after inflorescence, and then sends up numerous shoots. In Mexico 5,000 to 6,000 plants may be found on an acre. The average number of leaves is 40, each measuring 8 to 10 feet long and 1 foot wide, and yielding 6 to 10 per cent by weight of fiber. The culture of the plant is being extended in America, but not in the proportion which its value deserves. In India it is all but neglected." (Spon.)

A. americana is not found in Florida, save in conservatories or gardens, though an allied form was met with at various localities. Some magnificent cultivated examples were observed in Fernandina, and others were noticed in St. Augustine, their leaves so large and fleshy that no ordinary machine could work them without first cutting them into strips. Though the plants come to maturity in three years, they do not flower before eight, and sometimes not before twenty years.

UTILITY.—Twines and rope; fishing lines, nets, and hammocks; imitation horsehair cloth, and other coarse fabrics; Fayal lace, and paper. For further details refer to Rept. U. S. Dept. Ag., 1879, p. 545; Fib. Inv. Rept. 5, p. 34; Kew Bull., 1889, p. 301; Dic. Ec. Prod. Ind., Vol. I, p. 134; Spon Enc., pt. 3, p. 912.

**Specimens.*—W. C. E., United States Government exhibit; from Mexico, Costa Rica, and India; U. S. Nat. Mus.; Field Col. Mus.; Mus. U. S. Dept. Ag.

Agave aurea.

Lower California and Sonora, Mexico. Recently described by Brandegee. The plant is recognized by the natives as a form of *lechuguilla;* wild, and cultivated in gardens.

Specimens of the leaves of this plant were recently received by the Department from Louis F. Kwiat Kowski, of Los Angeles, Cal., who states that the native name of the plant is *lechuguilla mescal.* "There is also a *lechuguilla maguey*, and a *lechuguilla blanca.* It is claimed that *lechuguilla blanca* gives the best mescal, while *lechuguilla maguey* is the most cultivated for the purpose." One of the largest leaves sent weighed, when freshly cut, 2½ pounds. Its length was about 20 inches not including spine, and its greatest width fully 6 inches.

STRUCTURAL FIBER.—This correspondent evidently confuses *A. aurea* with *A. heteracantha*, the *lechuguilla* which supplies the major part of the tampico or istle fiber of commerce. He says: "The *lechuguilla mescal*, leaves of which I send the Department, gives the istle fiber." In the mail with these specimens a leaf of the same species was received from T. Albee Smith, of Baltimore, and probably received by him from the above source, as the leaves are identical. Mr. Smith, who is thoroughly familiar with the commercial fiber Agaves of Mexico, says: "I send you a sample leaf and fiber of an Agave I received last Friday from Lower California. They are the first I have ever seen, of the size and description, with such fiber. I have seen a great many Agave plants having leaves of about this size, but the fiber was worthless and obtained in very small quantities. My correspondent writes that he has several million plants that are now available, and he proposes to extract the fiber on a large scale; he has forwarded samples to dealers with good results. I have also forwarded several samples that he has sent me and have received good reports therefrom, but I was under the impression that the samples sent me came from the regular *lechuguilla* until I received the sample leaf."

This species is an interesting addition to our list of fiber plants that may be employed commercially. The fiber compares well with tampico of commerce, and as the leaf is several times larger it can be more economically extracted. Its cultivation would mean a new and profitable industry, as the tampico of commerce is secured only from wild plants. See *Agave heteracantha.*

**Specimens.*—Leaves and fibers, Mus. U. S. Dept. Ag.; U. S. Nat. Herb.

Agave decipiens. THE FALSE SISAL HEMP OF FLORIDA.

Found wild along the coasts and keys of the Florida peninsula. Species described by Dr. Baker from material obtained in the fiber investigations of the Department of Agriculture in Florida. Fig. 2, Pl. II, is a large false sisal plant photographed at the Government experimental factory on Biscayne Bay.

STRUCTURAL FIBER.—From the leaves; 2 to 3 feet, Biscayne Bay and keys; 3 to 4 feet, Lake Worth region. In color very white, fine, soft; about half as strong as sisal hemp, from which it is readily distinguished by its lighter color. An inferior fiber.

ECONOMIC CONSIDERATIONS.—The importance of this plant in the list of vegetable fibers is due to the fact that it has so long been confounded with the true sisal hemp of Florida, both by the people of Florida and by Bahamians who have purchased, or otherwise obtained, plants for cultivation in the Bahamas. The two forms, the false and the true sisal, differ so greatly in habit and general appearance that there should be no mistaking them when their peculiarities are known. *A. decipiens* throws out its mass of leaves from the top of a footstalk, sometimes 6 feet high, the leaves seeming to radiate like a many-pointed star, while the color is always in strong contrast to the surrounding vegetation. The true sisal plant, on the contrary, sends up its mass of leaves from the surface of the ground, though sometimes with a very short footstalk, this difference alone rendering identification easy, for before the lower leaves of *sisalana* have been cut, as in cultivation, the plant never shows this habit. Other marked differences are: The shorter, narrower leaf in *decipiens* nearly always (on the keys) rolled in at the sides so that a cross section appears like the letter U. In color it is a brighter, more livid green. Its spines, which are very thickly set along the edges, are strongly curved, and so sharp that it is impossible to go about among the plants without lacerating the flesh or tearing the clothing. Even the young plants which have not acquired their footstalks differ so greatly from the young plants of *sisalana* that no one should mistake them after having had the differences once pointed out. The young *sisalana* grows very erect, the leaves being flatter and of a dark green, and without spines. The *decipiens* throws out its leaves with a more spreading habit, the lower series usually bent (recumbent) to the ground, the leaves themselves being short, stocky, and with the edges more or less turned up. The color, even in the young plants, is a brighter green than *sisalana*,

FIG. 9.—An old plant of *Agave decipiens*.

the tout ensemble presenting a particularly marked form of plant. In their manner of poling we find the only similarity between the two, and this doubtless has caused the expensive mistake so often made by those collecting sisal plants, and through which ship loads have been taken from Florida to the Bahamas in past time. Dr. Baker even says: "I can not make out any material difference between the flowers of the two species." The poling is not only similar, but the young pole plants are similar, though I soon learned to detect a difference in the stockier appearance of the *decipiens*. But when once fixed in the soil the identity of the species is soon brought out in a marked manner. Fig. 9 is an old plant growing at Lake Worth, Florida.

Coming to the fiber, we find the strongest mark of difference between the two forms of fiber plants. In *decipiens* it is whiter, finer, softer, and greatly deficient in strength, though it approaches nearer the appearance of the true sisal fiber than that of any of the allied Agaves not varieties of the *A. rigida* known commercially.

A. decipiens is always most abundant in the wilds, as on uninhabited keys, where *A. sisalana* is never found. It is a singular fact, however, that in the Lake Worth region it changes its form somewhat, the leaves being longer and often flattened (sometimes perfectly flat), but always provided with the footstalks and armed with the terrible spines. For further accounts see Fib. Inv. Rept. 5, p. 28; Kew Bull., 1892, p. 183.

**Specimens.*—W. C. E., United States Government exhibit; Mus. U. S. Dept. Ag.; Field Col. Mus., Chicago.

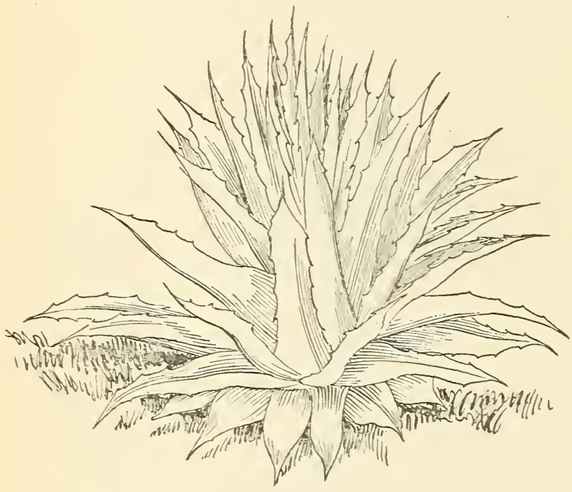

FIG. 10.—Plant of *Agave deserti.*

Agave deserti.

This species, discovered by Lieutenant Emory in 1846, is found at the base of the coast range in San Diego County, Cal., extending into the adjoining desert. (See fig. 10.)

STRUCTURAL FIBER.—"This species has very fibrous leaves; is used for ropes, mats, nets, etc., and even for sewing thread." (*Dr. V. Havard.*)

* *Specimens* of the fiber, and rope made from it by the California Indians, collected by Dr. Edward Palmer, are in the U. S. Nat. Mus. The fiber is very harsh, but strong and durable.

Agave heteracantha. LECHUGUILLA. MEXICAN FIBER.

Endogen. *Amaryllidaceæ.* Low aloe-like leaf cluster.

NATIVE NAMES.—*Istle* or *Ixtle* (Mex.); Tampico hemp, the commercial name.

Found in Mexico, southwestern Texas, and southern California. "The various plants from which istle is extracted are found at present chiefly on the plains and rugged mountain slopes of the States of Coahuila, Tamaulipas, Nuevo Leon, and San Luis Potosi. The central towns for the trade in the several States are: In Coahuila, Saltillo; in Nuevo Leon, Monterey; in Tamaulipas, Jaumava, Tula, Tampico, and formerly Matamoras; in San Luis Potosi, San Luis Potosi." (Kew Bull., Oct., 1890.) Fig. 2, Pl. I, represents a plant of this species growing in the United States Botanic Garden.

STRUCTURAL FIBER.—Derived from the leaves; stiff, harsh, but pliant, bristle-like.

Employed as a substitute for animal bristles and for the manufacture of cheap brushes; length, 18 inches to 2 feet. "The best known fiber plant of northern Mexico and southwestern Texas. In extracting the fiber the parenchyma or pith squeezed out (40 per cent of the leaf) is a valuable substitute for soap, possessing remarkable cleaning and detergent qualities." (*Dr. V. Havard.*)

ECONOMIC CONSIDERATIONS.—Until recently there has been considerable doubt as to the identity of the species of Agave from which the istle of commerce is produced. The common name of the plant is *lechuguilla* (or "*lechigilla*"), and the writers upon the subject usually refer to it under this name. In the report of the Mexican Boundary Survey the name *Agave lecheguilla* appears as the botanical designation of a plant producing a coarse fiber employed in the manufacture of cordage and bagging. Specimens of this fiber, and brushes made from it, were sent to the Kew Mus. fourteen years ago by the late Dr. C. C. Parry, formerly botanist of this Department, and from this and other material the identity of the plant, or plants, producing "tampico hemp" has been established. In Appendix XXI, Report of the Chief of Ordnance for 1883, there is a report on brush material and the manufacture of brushes, by Capt. A. L. Varney, in which appears an account of this fiber, with rude figures. This writer, misled by Squier in his work on Tropical Fibers, makes istle the product of *Bromelia sylvestris.* He also produces a letter from Hon. J. McLeod Murphy to the Department of Agriculture, who states that the average length of the leaf is 6 feet. This would indicate that Mr. Murphy has also been mistaken in the identity of the plant, and doubtless, likewise, has referred it to *Bromelia sylvestris.* The confusion is complicated by Spon (Enc., pt. 3, p. 985), who refers it to *Nidularium Karatas,* "Silk grass," *Bromelia sylvestris* being cited as an alternative name. Specimens of the plant furnishing the true istle have been examined by the writer from different sources in the past two years. The leaves have also been examined at T. Albee Smith's establishment in Baltimore, and they have never averaged over 18 inches in length. Mr. Smith has also produced the fiber in quantity in Mexico and is familiar with the plant. At the same time there is no doubt that several other allied species of Agave (having harsh, bristle-like fiber) are also employed in obtaining the commercial supply of istle. Mr. Smith states, however, that fully 90 per cent of the fiber made in Mexico is from the species represented by the leaves of *A. heteracantha.* For further accounts, see Fib. Inv. Rept. 5, p. 38; Kew Bull., Dec., 1887, p. 5; Idem, Oct., 1890, p. 220. See also *Agave aurea,* this catalogue.

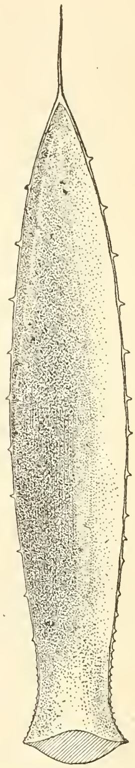

FIG. 11.—A leaf of *Agave heteracantha.*

* *Specimens.*—W. C. E., United States Government exhibit (manufactures also shown); Mexican exhibit, from various localities; Mus. U. S. Dept. Ag.

Agave mexicana.

This species is also called the *maguey,* and is said to be one of the Agaves allied to *A. americana* which produces the liquor called *pulque* and the spirit known as *mescal.* As its fiber bears a close resemblance to that of the century plant, no special mention is necessary, and reference is made to that species. The plant referred to in Rept. 5, Fib. Inv. series, as *A. mexicana* is *A. decipiens.*

Agave morrisii. THE KERATTO OF JAMAICA.

FIBER.—"Fiber of little strength and undesirable; value £12 to £14 per ton; it is not an even fiber." (*Ide & Christie.*)

ECONOMIC CONSIDERATIONS.—Has been referred to, in West Indian sisal hemp literature, as "the worthless *keratto*." An attempt was recently made to start a fiber industry in the Virgin Islands, east of Puerto Rico, with this species, but with unsatisfactory results.

"*Keratto* is a term widely used in the West Indies in connection with Agave plants. It is used generically for the whole tribe of American aloes. The *keratto* of Jamaica is *A. morrisii* of Baker. The *keratto* of the Leeward Islands is *A. polyantha;* what the *keratto* of the other islands is we can not say. In any case we can not define any species by the name. It only means generically an Agave of some kind." (*Dr. Morris.*)

Agave potatorum.

This species is possibly *A. scolymus.*

The species, which is much smaller than *A. salmiana*, is employed in the region of Tehuacan for making the brandy called *mescal* or *mezcal*, and for this reason Zuccarini has given to it the name *A. potatorum.* Many other species of maguey are likewise employed in the manufacture of *mescal*, but this species does not generally produce textile fiber. (*Dr. Weber.*) See A. *salmiana.*

Agave rigida elongata. SISAL HEMP OF YUCATAN. THE SACQUI OR SACCI OF DR. PERRINE.

Agave rigida sisalana. SISAL HEMP OF FLORIDA AND THE BAHAMAS. THE YASHQUI OR YAXCI OF DR. PERRINE.

Endogen. *Amaryllidaceæ.* Aloe-like leaf cluster.

NATIVE NAMES.—*Henequen* or *Jenequen* (Yuc.); *Sosquil* (Mex.); *Cabulla* or *Cabuya* (Cent. Am.).

Natives of Yucatan, but found in other portions of Mexico, Honduras, Central America, and distributed to the West Indies and to the islands of the Caribbean Sea. "Recommended for culture in Victoria" (Spon). The variety *sisalana* was introduced into Florida by Dr. Perrine in 1836. Introduced into the Bahamas by C. Nesbit in 1845. Large importations of Florida plants into the Bahamas in recent years. Fig. 1, Pl. II, represents a sisal thicket, with plants in "pole," on Indian Key.

STRUCTURAL FIBER.—Yellowish white, straight, smooth, clean. A valuable cordage fiber, second only to manila in strength. Does not require retting, and dries white from the machine when well cleaned, without washing. The Yucatan fiber (of commerce), a little coarser than the Florida fiber. As freshly imported sometimes shows a greenish tinge, due to careless manipulation. "The *yaxci* (or *yashqui*), with shorter leaf of bright velvety green, produces less fiber, but excels in softness, flexibility, and luster, and brings a higher price in the market." (*Dr. Schott.*)

CLIMATE AND SOIL.—The plants will not stand frost. Northerly limit of safe cultivation in Florida the line of 27° north latitude running across the State. Possibly may be grown a little higher in the interior with safety. Fully matured plants will stand one or two degrees of frost without injury.

The majority of writers agree that arid, rocky land is suited to the growth of the plant. The soil of Yucatan best suited to this culture is of a gravelly, stony, and in some places of a rocky character, the plants thriving best and yielding the largest amount of fiber in comparatively arid districts only a few feet above the level of the sea. On the other hand, moist or rich land is considered unsuited because of the lesser yield of the fiber which results. The plants thrive upon the Florida keys, Indian Key especially, upon the almost naked coral rock, with a luxuriant growth, and similar conditions prevail in the Bahamas where plantations have been established.

CULTIVATION.—The first consideration is the preparation of the land. If hummock growth, the timber is simply cleared. In other situations, and especially where palmetto scrub occurs, the soil must be cleared of these roots, there being about 20 cords of roots to the acre. Dr. Washburn, of Fort Myers, estimates the expense of clearing the land in this manner at $25 (see statements upon this subject, in Fib. Inv. Rept. No. 3, U. S. Dept. Ag.). As sisal plants will not thrive when even slightly shaded, all other growth should be cleared away.

Plantations are established by setting either suckers or "pole plants." Suckers are the shoots which spring from the roots of old plants. Pole plants form on the blossom stalk of old plants that have flowered. (See fig. 13.) When the old plant flowers, it sends up a stalk, or "pole," as it is called, to the height of 15 or sometimes 20 feet. After the tulip-shaped blossoms which appear have begun to wither, there starts forth from the point of contact with the flower stalk a bud, which develops into a tiny plant, which, when grown to the length of several inches, becomes detached and falls to the ground. Such pole plants as come in contact with the soil take root, and in a very short time are large enough to transplant. In the Bahamas these flower-stalk plants are largely utilized in establishing sisal fields, and with as good results as where the suckers alone are used. Precisely the same course must be pursued in Florida. Such plants should first be set out in the nursery. It should be remembered that the smaller the plants used in establishing a plantation the longer the time that must elapse before leaves are sufficiently mature to cut for fiber.

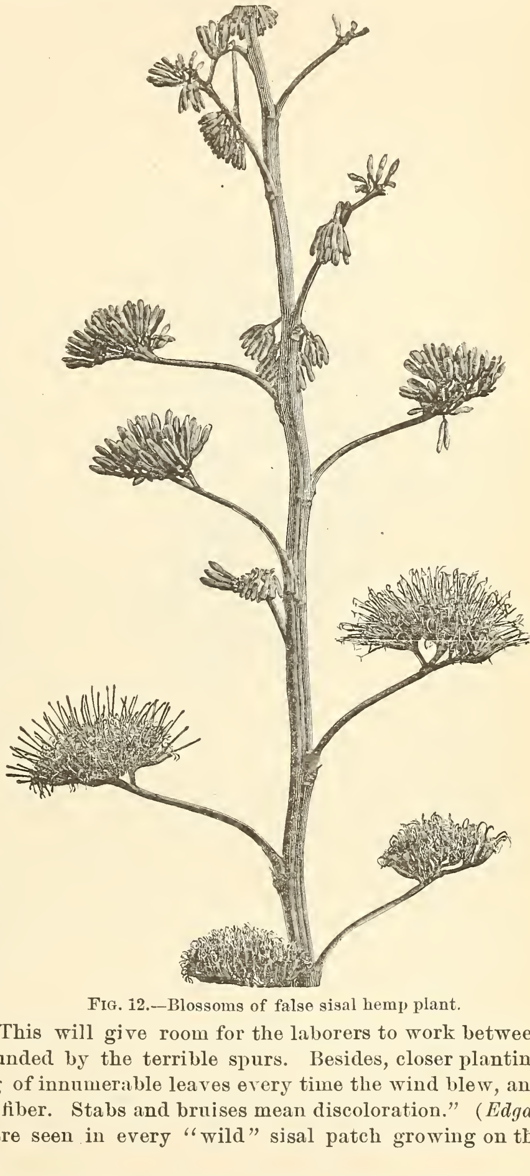

FIG. 12.—Blossoms of false sisal hemp plant.

In setting out plants in Florida, we must be guided by the experience of other countries. In the Bahamas 650 plants are set to the acre in rows 11 feet by 6 feet distant from each other. "This will give room for the laborers to work between the rows without being wounded by the terrible spurs. Besides, closer planting would result in the piercing of innumerable leaves every time the wind blew, and the consequent destruction of fiber. Stabs and bruises mean discoloration." (*Edgar Bacon.*) Evidences of this are seen in every "wild" sisal patch growing on the Florida keys.

The number of plants usually set out in an acre in Yucatan is 650. Rows 11 to 12 feet apart and 6 feet apart in the row; some old fields 9 feet between the rows and 4 feet in the row, the plants set with considerable regularity. The plants receive two dressings the first year and one every year afterwards.

The size of the cultivations on the estates range from 250 to 3,500 acres. They are laid out in fields or sections of 50 to 200 acres, and contain from 600 to 900 plants to the acre. When preparing the fields, the land is cut during the dry season, is then allowed to spring up, after which it is "sprig weeded," and burned after the first fall of rain. The stumps are cut close to the ground, so as to be out of the way of the leaves of the plants and to facilitate the running of the line for planting and getting the rows straight. When planting, the laborers have a small line with the distances at which the plants are to be set out knotted on it and a pole cut to the length that the rows are to be apart. A man and a boy are employed at each line. The boy drops the plants along the row at the distance marked on the line, and then removes the line to the next row, dropping the plants as before. The man does the planting, and is responsible for the rows being straight. When coming to a rock the planter does not turn aside, but goes on and places the plant in the row a little beyond. (*Stuart's Report.*)

FIG. 13.—Pole plants or slips, *Agave sisalana.*

Mr. Stuart states that the hemp plantations in Yucatan vary from 500 to 28,000 acres in extent, with a total number of 105,000 acres under cultivation, employing 12,000 Indian laborers. The largest and best estates are on the rocky, gravelly lands, and they are valued from $100,000 to $500,000 each. Each estate is managed by three principal men—the attorney, the manager, and assistant manager. The largest estates employ locomotives for hauling in the crop from the fields, others using tramway trucks or carts drawn by mules or oxen. Estates with less than 800 acres under cultivation erect one Raspador (see fig. 16) for every 100 acres. Those of 1,000 acres use the large automatic machines.

Regarding the rate of growth in Florida, a plant set out at 18 inches high, from the nursery, will produce leaves fit for cutting in three years.

"In June, 1887, I set out plants around my house; these were from 6 to 8 inches high. At the end of the first year small plants began to appear around the base, which I used for propagation. At two years the leaves of the large plants were 2 feet 8 inches long at the same time the longest leaves were 3 feet 2 inches long and were fit to commence cutting. The result of one plant here of two and one-half years' growth is an average of 17 young plants and 10 leaves sufficiently long to harvest. The same plant in its fourth year will give a still larger result, increasing in usefulness each year until it flowers in its eleventh to its thirteenth year, which ends the life of the plant." (*Robert Ranson.*)

Mr. Cleminson, of Jupiter, states that the average length of the leaf from a 4-year-old plant as grown in Florida is 3 feet 3 inches when cut, and for three years afterwards 6 inches longer each year. Thrifty plants 7 years old will produce leaves 5 feet in length.

"The length of time required for the production of the first cutting of leaves may, I think, safely be regarded as 4 years from the time of planting. A great deal depends upon the size of the plants when transplanted, but if they be of a suitable size, say from 12 to 15 inches, without doubt the leaves will attain a length of from 4 to 5 feet and be fit to cut well within the period named. I have seen thousands of plants with leaves from 2 to 3 feet long that had been growing only two years; I have also seen plants that, I was told, were 3 years old, from which leaves had been already cut." (*Rae's Report.*)

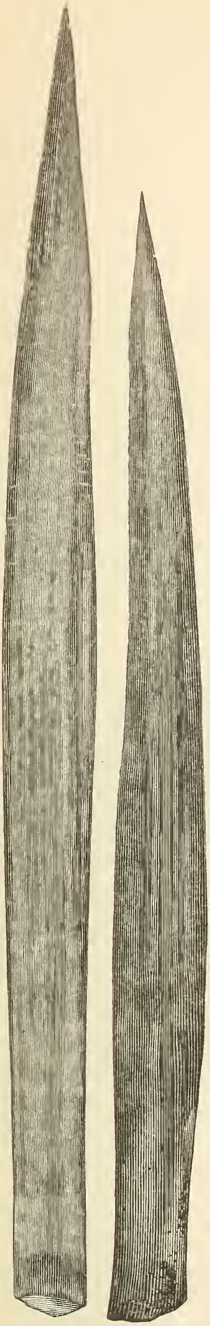

Fig. 14.—Leaves of the true sisal hemp plant.

The life of a plant when undisturbed is six or seven years, after which it sends up its blossom stalk and then perishes. In Yucatan cutting extends the life of the plant fifteen to twenty years; T. Albee Smith says twenty-five years. No special cultivation is needed further than to see that the land is kept clean and the suckers kept down. These are valuable for starting new plantations.

Yield of Fiber.—The annual yield of fiber in Yucatan is from 1,000 to 1,470 pounds per acre; 50 to 70 pounds of fiber is derived from 1,000 leaves. Calculating 33 leaves to the plant as the annual cuttings from the 650 plants on an acre, the 21,450 leaves may be said to yield 1,287 pounds of clean fiber.

T. Albee Smith states that the plants are set out in Yucatan at the rate varying from 96 to 140 plants per mecate (one-tenth of an acre). The latter is thought to bring the best yield and longest fiber—say 1,400 plants per acre. The producer pays a tax to the State of 3 cents per arroba (25 pounds), which equals $2.40 per ton of 2,000 pounds. He has seen 90 leaves cleaned in five minutes on one wheel with two feeders, but says that this speed can not be continued. One thousand leaves of henequen weigh in the rainy season 160 to 200 arrobas, in the dry season, 100 to 160 arrobas. One thousand leaves average a yield of 55 pounds of fiber.

The average weight of a leaf of the Mexican form of plant is 1 pound, 10 ounces, according to reliable authorities. A calculation based on the above figures places the yield of dried fiber from 2,240 pounds of leaves at 82 pounds and a fraction. The actual product of a long ton of Indian Key (Florida) leaves from the *sisalana* form as determined by the Department's Florida experiments is about 79 pounds. The machine made a very considerable waste, which, after being carefully washed and dried, gave a weight of 22½ pounds from the ton of leaves. This gives a total of very nearly 102 pounds of straight fiber and waste from a ton of leaves. Regarding the waste made by the Raspador in Mexico no statements can be made. The average yield of 2,000 pounds of sisal leaves in the Bahamas is 75 pounds, equivalent to 83 pounds to the

Fig. 15.—Leaves of the false sisal hemp plant.

long ton. Wastage not stated. Dr. Morris reduces these yields to equivalents, in Kew Bull., 1893, p. 207. "Highest possible yield (waste accounted for), 4.6 per cent; yield in Yucatan with the Raspador, 3.6 per cent; in Florida (Van Buren machine), 3.5 per cent; in Bahamas (supposed to be Van Buren machine, C. R. D.), 3.7 per cent." Percentage with the automatic machines in present use in the Bahamas, unknown. (See figs. 14 and 15, leaves of true and false sisal hemp.)

HARVESTING AND PREPARATION.—Little can be said on these points from actual experience in our own country. The machinery used in the Government experiments in southern Florida was too small and too slow to give a basis for estimating cost of production. (See fig. 17, the Van Buren machine.)

The cutting of the leaves is done in Yucatan by Indians, using a heavy-bladed, saber-like knife called a machete. The task is 2,000 to 2,500 leaves per day. The spine at the leaf end is cut off and the leaves bundled for removal to the machines. On large plantations the leaves are transported by steam power over tramways running from different portions of the estate.

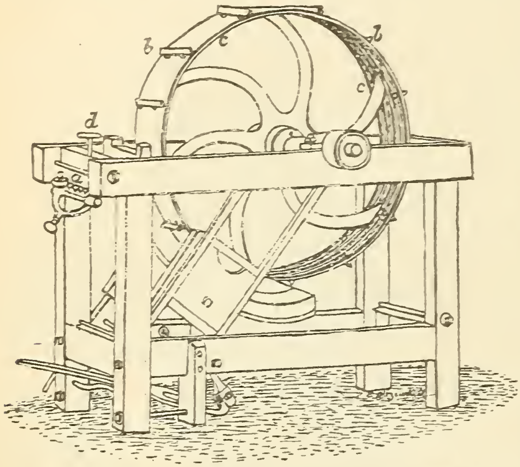

FIG. 16.—Raspador or Patruillo machine used in Mexico.

*Specimens.—Complete series illustrating the Government experiments in Florida, Field Col. Mus.; Mus. U. S. Dept. Ag.; U. S. Nat. Mus.

Agave salmiana. THE MAGUEY BLANDO OF MEXICO.

FIBER.—Specimens shown in the Mexican exhibit at the Paris Exposition closely resembled the fiber of *A. americana;* white, wavy, of medium strength. Fiber from a plant of *A. salmiana* growing in the United States Botanic Garden, extracted by the Department, was coarse, harsh, and wiry, without any of the characteristics of Mexican samples.

Dr. Weber, of Paris, informs me that the *maguey*, or *metl*, which is cultivated on the plains of Apam for the production of *pulque*, bears in Mexico the name *maguey manso fino*, and is the *A. salmiana; A. potatorum*, reported by Antonio G. Cubas, being an error. See *A. potatorum*.

*Specimens.—U. S. Nat. Mus.; Mus. U. S. Dept. Ag.

Agave tuberosa. CABULLA OF COSTA RICA. See *Furcræa*.

Agave vivipara. BASTARD ALOE.

Endogen. *Amaryllidaceæ.* Aloe-like leaf cluster.

Native Mexican name, *Theo-metl; Chouca* of the Antilles.

Flourishes in Southern United States; tropical America; northwest provinces of India. Closely resembles *A. virginica*, also growing in the United States.

STRUCTURAL FIBER.—Said to be strong and useful. Known as Bombay aloe fiber. "In the jails a good fiber is made from its leaves." (*India Oudh Gazetteer.*) Used for cordage and twine in India.

*Specimen.—Bot. Mus. Harv. Univ.

Agave ———

A species of Agave which has not yet been identified was found in many portions of southern Florida. Fine specimens of the leaves have been sent from the Indian River region by Mr. McCarthy, who states that the plant is common in that section. I have myself seen it growing at Jupiter, at Lake Worth, and at other points on the mainland to the southward as far as the Perrine grant, but do not recall a specimen on any of the keys. The mature leaves measure 5 feet or more in length, 8 to 10 inches in breadth, and will weigh 8 pounds or more. The serrations on the edges are very fine and close set, the terminal spine being present. The color of the leaf is a light bluish green. (See fig. 18).

Fig. 1, Pl. III, shows several young plants of this species found on Addison's place, Perrine grant, in southern Florida.

A quantity of small leaves of this species were run through the machine at Cocoanut Grove, but owing to the thickness of the butts it was necessary to split each

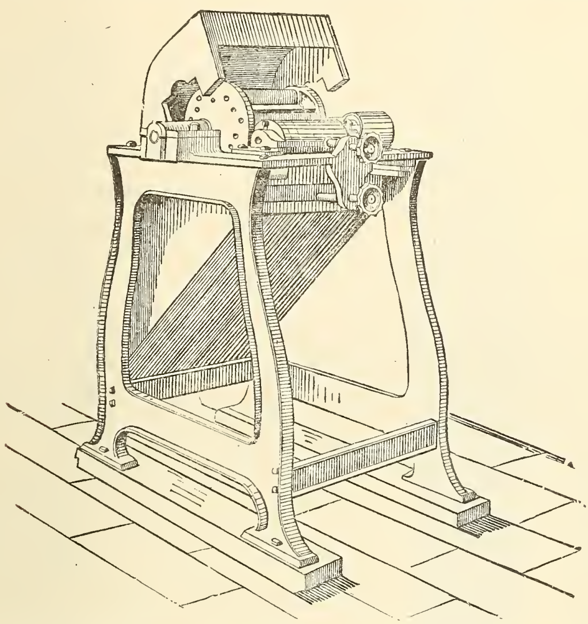

FIG. 17.—The Van Buren machine, used in the experiments of the Department in Florida.

leaf into four pieces and crush the butts with a mallet. The fiber is similar to that of *A. americana* in every respect, crinkly, elastic, and very white. A sufficient quantity of the fiber was secured for exhition purposes, but not enough for test in manufacture. See The Agaves of the United States, by A. Isabel Mulford, St. Louis, 1896, and Rept. No. 5, Fib. Inv. series, p. 38.

* *Specimens.*—Field Col. Mus.; Mus. U. S. Dept. Ag.

Agbari-ettu (Afr.). See *Alafia.*

Aguaje (Peru). See *Mauritia flexuosa.*

Agust, Agusta, Agasti. East Indian names of *Sesbania grandiflora.*

Agotai (Phil. Is.). See *Musa textilis.*

Akaroa (New Zea.). *Plagianthus betulinus.*

Ake-iri (Yorubaland). See *Urena lobata.*

Akia (Hawaii). *Wikstroemia viridiflora.*

Akpako (Yorubaland). *Raphia vinifera.*

Alfa (Alg.). See *Stipa tenacissima.*

Alafia sp.

This creeper grows wild, Yorubaland, west Africa, where it is called *Agbari-ettu;* species not identified.

BAST FIBER.—The stems are used to make a coarse rope for tying rafters, in house construction. (Kew Bull., 1891, p. 208.)

Albardine (Alg.). See *Lygeum spartum.*

Algæ. See SEAWEEDS.

Albero (It.) = Tree.

—— *del pane, Artocarpus incisa;* —— *della seta, Asclepias fruticosa* (now *Gomphocarpus fruticosus*).

Algodon (Sp.). See *Gossypium.*

Ali (Ind.). See *Linum usitatissimum.*

Allæanthus zeylanicus.

Exogen. *Urticaceæ.* A tree.

Native of Ceylon, 1,000 to 2,000 feet elevation, where the plant is known as *Allandoo-gas.*

FIBER.—The inner bark furnishes a very tough fiber, employed in many native uses.

Allandoo-gas. See *Allæanthus zeylanicus.*

Aln kabel (Ceyl.). See *Musa sapientum.*

Alnus nitida.

Exogen. *Betulaceæ.* A large tree.

NATIVE INDIAN NAMES.—*Shral, sarali,* etc.

Found in the Himalayas, 1,000 to 9,000 feet elevation; principal value for dyeing and tanning.

FIBER.—The natives employ the young twigs in rope bridges and for tying loads, etc.; also used for making baskets. (Dic. Ec. Prod. Ind., Vol. I, p. 177.)

Alocasia macrorrhiza. See *Arum.*

Aloe.

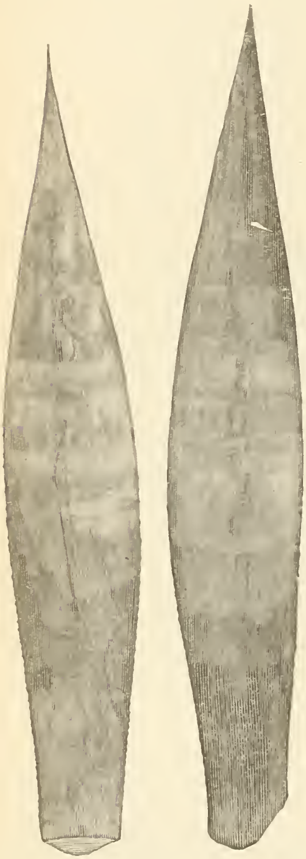

FIG. 18.—Leaves of Florida *Agave* (species unidentified).

The American ——, *Agave americana;* —— lace, the Lace of Fayal made from this species; the Bastard ——, or False ——, *A. vivipera;* —— leaved Adam's needle, *Yucca aloifolia.* Savorgnan gives —— *boemica* as a common Italian name of *A. americana.* See also *Aloe vera.*

Aloes.

The name is usually applied to the bitter extract from the leaves of certain species of Aloe, valued in pharmacy. Barbados and Indian ——, *Aloe vera.* Also applied to fiber plants ——, *vert, Furcræa gigantea;* the word is used by the French to designate *Agave americana,* though Bernardin states that it is a French generic term applied to the Agaves generally.

Aloe vera. BARBADOS ALOES. INDIAN ALOES.

Endogen. *Liliaceæ.* Rosette of thick leaves with central flower stalk.

NATIVE INDIAN NAMES.—*Ghi-kavar, Ghirta-kumari,* and many others.

The plant is said to be a native of northern Africa, Canary Isles, and southern Spain, and its many varieties have been introduced into all tropical countries. Cultivated in the West Indies, Barbados, and Antigua. Grows generally in India, and in south India has escaped from cultivation.

STRUCTURAL FIBER.—While the plant is grown for its medicinal qualities, the leaves contain a good fiber which could be utilized, as the leaves are of no further use after the juice has been extracted. This fiber should not be confounded with the Aloe fiber of commerce derived from *Agave americana.*

*Specimens of fiber from *A. indica* were exhibited in the Indian department at the W. C. E., 1893, Chicago.

Alsi (Hind.). *Linum usitatissimum.*

Althæa cannabina.

Exogen. *Malvaceæ* A shrub.

This species is found in southern Europe—Spain and Italy—and is also indigenous to southern Russia, Hungary, and the Caucasus. In Italy it is known as *Canapa salvatica,* or wild hemp.

FIBER.—The bast is said by Savorgnan to yield a fiber in Spain that is employed "for very fine cloth." Enumerated in Bernardin's catalogue as a fiber plant.

Althæa rosea. THE HOLLYHOCK.

This species of Malvaceæ, which is the origin of the common hollyhock, grows wild in China and also southern Europe. It is similar to the common marsh mallow, *A. officinalis.*

BAST FIBER.—A sample of its fiber of good length, experimentally prepared by Henry Koenig, a Missouri correspondent, was recently sent to the Department. The fiber is bright in color, a light straw, but exhibits only medium strength; would be a poor jute substitute.

* *Specimen.*—Mus. U. S. Dept. Ag.

Alva marina. See *Zostera.*

Ambada (Ind.). See *Hibiscus cannabinus.*

American Aloe. *Agave americana.*

Amole (U. S.). *Chlorogalum pomeridianum* and other plants used for soap.

Ambari hemp (Ind.). See *Hibiscus cannabinus.*

Ambrosia trifida. TALL RAGWEED.

Exogen. *Compositæ.* A coarse annual weed.

The species of this genus are found in North and South America, tropical India, and Africa, growing in waste places.

BAST FIBER.—Dr. Havard states that the fiber of the tall, stout stems of the ragweed were formerly utilized by Indians to make strings and ropes.

Ammophila arenaria. BEACH GRASS.

Syn. *Psamma arenaria, Ammophila arundinacea.*

Endogen. *Gramineæ.* A sea reed or grass.

COMMON NAMES.—*Marram, marum,* sea reed, sea matweed, beach grass, bent grass, etc.

Habitat: Temperate North America, Europe, northern Africa, and introduced into

Australia. *A. arenaria* is native along the Atlantic coast of the United States and also on the coasts of western Europe. It was introduced into Australia from Holland, and its Dutch name "*Marram* grass" was taken with it. It is known in this country and in most places in England as "beach grass" and sea-sand grass. It is one of the most valuable of the grasses adapted to binding the drifting sands of our coasts, and has been cultivated for this purpose in this as well as in other countries. The action of this grass in holding the drifting sands is like that of brush or bushes cut and laid upon the ground in accummulating snow when drifted by the wind. The sand collects around the clumps of grass, and as it accumulates the grass grows up and overtops it, and will so continue to grow, no matter how high the sand hill may rise. A plant will, by gradual up-growth, finally form stems and roots sanded in to the depth of fully 100 feet. Many years ago it was as customary to warn the inhabitants of Truro and some other towns on Cape Cod to turn out to plant marram grass as it was in the inland towns to turn out and mend the roads. This was required by law, with suitable penalties for its neglect, and took place in April. Marram grass is best propagated by transplanting, the grass being pulled by hand and set in a hole about a foot deep and the sand pressed about it. (*Scribner.*) It is also used in Eastern countries and in Holland for binding the sands upon the coast and preserving them from the inroads of the sea. (See fig. 19).

FIG. 19.—Marram grass, *Ammophila arenaria.*

STRUCTURAL FIBER.—In the north of England the grass is said to be used for table mats and basket work. Spon says that its fiber is used for paper making, matting, and agricultural tie bands; also employed as thatch material. Its fiber is not used in the United States.

Specimens.—U. S. Nat. Herb.

Amomum magnificum.

Endogen. *Zingiberaceæ.* Herb.

A genus of aromatic herbs. The species is found in Mauritius "From the very fine fiber of the leaves textures de luxe are made" (Manual Hoepli).

Ampelodesma tenax. DISS.

Endogen. *Gramineæ.*

The plant grows wild on the Algerian coast, and is said to produce 84 per cent of fiber, with an average length of 5 feet. One of the plants often confounded with *Stipa tenacissima,* as it grows wild in the regions where the true esparto abounds. In the Kew Mus. are shown examples of rope from the *diss* made in Genoa. Has been imported into Sicily for paper making. Nets from *Ampelodesma tenax* have been used on the Tuscan coast in the tunney fishery. The nets are very durable if kept in water and protected from the action of the sun." (Off. Guide Kew Mus.)

Amsonia tabernæmontana.

Exogen. *Apocynaceæ.* Herb.

A genus of *Apocynaceæ* with five species, natives of North America. The species named has been received from Mr. S. S. Boyce, of Rolling Fork, Miss., who regards it as a promising fiber plant.

Anadendrum sp.

Endogen. *Araceæ*.

NATIVE NAME.—Andaman Islands, *Yolba*.

FIBER.—From the bark; used for bowstrings and netted reticules carried by the women.

Ananas sativa. PINEAPPLE.

Endogen. *Bromeliaceæ*. Aloe-like leaf cluster.

NATIVE NAMES.—*Ananas* (Fr.); *Piña* (Eastern Archipelago); *Anannas* (Beng.); *Aainunnas* (Arab. and Pers.); *Po-lo-Ma* (China).

Native of tropical America, probably Brazil, and distributed over southern Europe, and tropical Asia and Africa. In the United States chiefly cultivated for its fruit in subtropical Florida. Dr. Morris informs me that the *Crowia* of British Guiana, a plant of which is growing at Kew, has been determined to be a wild form of the common pineapple. The term silk grass, sometimes applied to its fiber, is meaningless and a misnomer. See *Crowia* in the alphabetical arrangement. Fig. 2, Pl. III, shows the pineapple plant in cultivation.

STRUCTURAL FIBER.—"Both the wild and cultivated pineapple yield fibers which, when spun, surpass in strength, fineness, and luster those obtained from flax; can be employed as a substitute for silk, and as a material for mixing with wool or cotton." (*Watt.*) Useful for cordage, textile fabrics, sewing silk or twist, laces, etc. In China fabrics for clothing of agriculturists. In request in India as material for stringing necklaces. Produces the celebrated *piña* cloth of the Philippine Islands. "It is remarkably durable, and unaffected by immersion in water; and is white, soft, silky, flexible, and long in staple." (Spon.) Samples cleaned, without washing, in the Government experiments in Florida, 1892, when twisted to the size of binding twine, showed a breakage strain of 150 pounds. Dr. Taylor subdivided a specimen of this fiber to one ten-thousandth of an inch.

ECONOMIC CONSIDERATIONS.—Pineapple culture, for its fruit, in Florida is a comparatively recent industry, the first plantings having been made on the keys about 1886, though the first plantation of commercial importance was not established until fifteen years later, on the Indian River. The value of the fiber has long been known, however, and in 1891 the fiber expert of the United States Department of Agriculture began a series of investigations into the practicability of utilizing the Florida leaves for fiber after the fruit has been gathered, as their utilization would give to the United States a new industry. In the experiments of 1892 it was shown that the yield of fiber from freshly cut pineapple leaves ranges from 45 to 60 pounds per ton of 2,240 pounds of leaves. An important point to be noted is the fact that selected leaves, as to size, do not give as high a yield of fiber as average leaves. Lot No. 1 was 820 pounds of average leaves and 202 pounds of selected. While the total 1,022 pounds of leaves gave 25 pounds of fiber, the 820 pounds gave 21 pounds of fiber against a yield of 4 pounds from 202 pounds of leaves. Reduced to equivalents, the average leaves yielded at the rate of 57½ pounds to the ton, while the selected leaves yielded less than 44½ pounds of fiber to the ton.

Lot No. 5 was from Fuzzard's plantation, near the Perrine grant, 1,000 pounds of leaves, tips cut off. The leaves averaged 10 to the pound. Dry fiber from this 1,000 pounds weighed 18 pounds, 2 ounces, or a little over 40 pounds to the ton of leaves. It should also be noted that there was an excessive waste of fiber in the process of cleaning.

Special Agent Monroe, who attended to the details of the experimental work of 1892 in Florida, stated that the practice has been to allow the leaves to decay under the plant and afford possible nourishment to the young suckers. The general opinion on this point is in favor of cutting the leaves, but experiments covering several seasons will be necessary to properly decide this point. Owing to the practice on the keys of planting very close, it was found that a large proportion of the leaves were injured by chafing one on another, and also from being crushed under foot in weeding and cutting the fruit. This condition seems to be almost entirely obviated by spacing the plants at least 2 feet, as has been done on the mainland. Another defect was found in the withered condition of several inches of the tip or end, not noticeable in the younger leaves. This, however, may have been due to the excessive drought of the season. It does not occasion much loss of fiber, but adds to the cost of extraction, the decayed parts having to be cut off. The approximate acreage in pineapples in 1892 on keys Metacomba, Largo, and Elliott's was 930, and the number of apples shipped (1892) about 1,916,400, which did not include many thousands marketed after the close of the season.

The average yield of good leaves from the Red Spanish was about 10 out of the average 25 of each plant, and the weight 1 pound, making the total for fruited plants, in round numbers, 958 tons. Adding the leaves to be secured after the close of the season and from abandoned fields, the quantity might be raised to 1,000 or 1,100 tons. This refers, of course, to extreme southern Florida, no account having been taken of the large acreage on Indian River and elsewhere.

As to the value of the fiber, a London quotation for a lot of well cleaned from an Asiatic source was $150 per ton. There is no doubt that if the fiber could be produced in quantity at an economical cost, manufacturers would soon find a use for it and would know what price they could afford to pay for it. The market price would then be fixed by the demand and supply. The machine question enters largely into the problem, however, and as the leaves are small a quantity would need to be cleaned at one feeding of the machine to make it pay. Estimating 10 leaves to the pound, there would be over 22,000 leaves to the ton, which, as we have seen, would produce from 50 to 60 pounds of fiber.

The machine used in the Department experiments produced a fine product, but in too small quantity to be employed commercially. There is no doubt that a modified sisal hemp machine (automatic) would do the work, although a machine has recently been constructed for all small-leaved plants that may be adapted to use in extracting this fiber. See Appendix A.

The Chinese extract the fiber by hand. "The first step is the removal of the fleshy sides of the leaf. A man sitting astride a narrow stool extends on it in front of him a single leaf, one end of which is held beneath him. He then, with a kind of two-handled bamboo plane, removes the succulent matter. Another man receives the leaves as they are planed, and with his thumb nail loosens the fibers about the middle of the leaf, gathers them in his hand, and by one effort detaches them from the outer skin. The fibers are next steeped in water, washed, and laid out to dry and bleach on rude frames of split bamboo. The processes of steeping, washing, and exposing to the sun are repeated until the fibers are considered properly bleached. In the Philippines the blunt end of a potsherd is used and the fiber is carefully combed and sorted into four classes." (Spon.)

The Chinese fiber is manufactured into a strong, coarse fabric resembling the coarser kinds of grass cloth. In Formosa its chief use is for the inner garments of the agricultural class. The fabric is called *Huang-li-Pu*. *Piña* is considered to be more delicate in texture than any other known to the vegetable kingdom. It is woven from the untwisted fibers of the pineapple leaf after reducing them to extreme fineness and after the ends have been glued together to form a continuous thread. There is another delicate fabric, used for ladies' dresses, which is said to be manufactured from pineapple fiber woven with silk, the latter forming lustrous stripes in soft colors or shades.

The pineapple cloth of the Philippines is produced by the common pineapple also, i. e., *Ananas sativa*. The plants have become almost wild in Singapore and the Philippines, with leaves 5 to 6 feet long. The fruit is small, but the leaves appear to yield better fiber than the cultivated plants. (*Dr. Morris.*)

Further accounts of the fiber will be found in the Ann. Rept. U. S. Dept. Ag., 1879, p. 542; Fib. Inv. Rept. No. 5, p. 44; Kew Bull., 1887, p. 8; Jan., 1889, p. 27; Oct., Nov., 1891, p. 251; Spon. Enc., pt. 3, p. 917; Dic. Ec. Prod. Ind., Vol. I, p. 236; Royle, Fib. Pl. of Ind., p. 38.

**Specimens.*—Fiber, U. S. Nat. Mus.; Mus. U. S. Dept. Ag.; Field Col, Mus.; cloth, Bot. Mus. Harv. Univ.

Ananas bracteatus.

Syn. *Bromelia sagenaria.*

A South American species, from which a good fiber has been extracted, called *Grawatha* by Savorgnan; though Bernardin states that *Grawatha* is *Bromelia medicalis.*

Ancient fibers. See Introduction.

Andromachia igniaria. See *Liabum igniarium.*

Andropogon gryllus. See *Chrysopogon.*

Andropogon schœnanthus. Rusa or Ginger Grass of India.

This species yields an oil which is used in European Turkey to adulterate attar of roses. It abounds in tropical and subtropical Asia and Africa.

Structural Fiber.—Specimens of this grass are preserved in the Mus. U. S. Dept. Ag. It is described in India as a tall grass, too coarse to stack, but used for thatching and for screens.

Andropogon sorghum vulgaris. Broom Corn.

Endogen. *Gramineæ.* A giant grass.

Cultivated in many parts of the world. *Andropogon sorghum* includes many varieties, a number of which have been recognized by some authors as distinct botanical species under the genus *Sorghum;* others, including Hackel, have referred them all to the genus *Andropogon.* The same name has been applied to different varieties, and the same variety has often been designated under various names. All the forms are of Eastern origin, and have arisen probably from a common stock through ages of cultivation. From varieties of this species are obtained grain, which furnishes nutritious food for man and domestic animals, particularly poultry; sirup and sugar in commercial quantities are obtained from the saccharine varieties. The variety *saccharatus,* or Chinese sugar grass, yields about 13 per cent of sugar, and all furnish fodder of more or less value for farm stock. In Africa alcoholic drinks are prepared from the grains, and useful coloring pigments are contained in the fruiting glumes.

While this is not, strickly speaking, a fiber plant, it yields a brush material and is therefore included in this list. The statements which follow are extracted from Circular No. 28, Office of Experiment Stations, United States Department Agriculture:

Broom corn, as is well known, resembles sorghum in appearance, both plants being varieties of the same species. Broom corn usually grows 8 to 12 feet high, though the dwarf variety attains only half that height. The chief economic difference between broom corn and other varieties of sorghum consists in the greater length, strength, and straightness of the fine stems composing the head, or panicle, and supporting the seeds. The longer, straighter, and tougher these stems or straws and the greener their color after curing, the higher the price the product commands. The different varieties of broom corn afford dissimlar products. The dwarf variety produces the short brush used in the manufacture of small brooms and whisks. It is somewhat difficult to harvest and is cultivated only to a limited extent. Of the large varieties the Evergreen, known also as the Missouri or Tennessee Evergreen, has given general satisfaction. The Mohawk is regarded as earlier, but as affording a smaller yield. There is some advantage in planting more than one variety and at several different dates so as to extend through a long season the time of harvesting.

Culture.—A climate suitable for Indian corn is also adapted to the growth of the broom-corn plant. Dry weather at harvesting time is a favorable climatic condition. A well-drained, rich, sandy or gravelly loam soil such as will produce a heavy yield of Indian corn, and is as free as possible from weeds, is best for broom corn. If the soil is not fertile, it should be liberally manured. The seed can be planted almost as early as corn. Only mature seed should be used, and it may be planted in hills or drills, although drill culture is generally recommended. The rows should be 3 to 4 feet apart, and sufficient seed should be planted to insure three to five stalks every 15 or 18 inches in the row; or the seed may be drilled thinly so as to leave one stalk every 3 or 4 inches. The cultivation of broom corn is similar to that given to corn or sorghum. The early growth of the plant is slow, hence the need of prompt and frequent shallow cultivation to keep the weeds in subjection and to maintain a thin layer of loose soil on the surface.

Harvesting.—The chief difficulty encountered by the novice in broom-corn culture is in determining when to harvest the brush. Even experienced growers are not unanimous on this point, some cutting the heads while in blossom, and others harvesting later so as to obtain better developed seeds possessing considerable nutritive value. The time generally preferred is just after the fall of the so-called "blossom" (anthers). A common custom with tall varieties at time of harvesting is to bend down the stalks of two rows diagonally toward each other in such manner that the bent parts support each other in a nearly horizontal position. The stalks of one row cross diagonally those of the other and form a platform or "table." The break, or rather the sharp bend, in the stalk is made about 2½ or 3 feet above the ground. The brush borne on one row projects over and beyond the other row in a position convenient for the cutter, who follows immediately. The heads with 5 inches of stalk are laid on the table, or platform, until they can be removed to a drying shed. Cutting while the plants are wet with dew or rain should be avoided. The brush of the dwarf variety is pulled out, not cut. If the season is dry as the corn approaches maturity the brush remains straight, but if the weather is hot and damp at this period the straws are likely to bend and to form crooked brush. In harvesting and in curing great pains are taken to keep the brush straight. Crooked or tangled brush is carefully sorted out. From the field the brush is taken to the scrapers, which remove the seed. Large growers of broom corn employ special scraping machines, consisting of one or two cylinders provided with iron teeth and usually driven by horsepower. The most complete scrapers are provided with an automatic feeding arrangement. With cheaper machines the operator holds the seed end of a handful of brush against the cylinders until the seeds are removed. It is stated that the ordinary threshing machine, with concave removed, has been used in a similar manner. For small quantities of brush a long-toothed currycomb, or a wooden comb made by sawing teeth in a plank has been used. The brush should be cured in the shade, as exposure to sun or moisture injures its color and strength. Free circulation of air is necessary in this process. Hence, when large quantities are to be cured special curing houses thoroughly ventilated and provided with racks made of narrow planks and laths are constructed. On these racks layers of brush 3 inches thick are laid. Curing is continued until the brush will not heat when bulked or baled. When curing the brush is pressed into bales, usually 46 by 30 by 24 inches and weighing about 300 pounds. The butts are placed evenly at the ends of the bale, and the pieces of "brush" lap in the middle.

Foreign uses.—The Venetian whisks of Italy are made from this species, which is employed in all civilized countries for similar use, and for the manufacture of brooms and brushes.

Andropogon squarrosus. The Cuscus, Khus Khus, or Koosa.

Endogen. *Gramineæ.* Perennial grass, 8 to 10 feet.

Common and native names.—*Vetivert, Kush-kush, Bene; Khas* (Hind. and Pers.); *Usir* (Arab.); *Miyamore* (Burm.), etc.

Native of India. Very common in many portions of India, growing in low, moist, rich soil, usually along the water courses, but found on the plains of northwest

India. Also found in the West Indies and Brazil, growing on river banks and in the marshes. It was introduced into Louisiana many years ago, and is now spontaneous in some of the lower parts of that State. Cultivated successfully at Knoxville, Tenn., where the fragrance of the rhizomes and roots was developed to a marked degree, but the plants did not bloom.

Structural Fiber.—This species is interesting as supplying the material for the sweet-scented, fibrous fans from India, which proved one of the novelties of the Chicago Exposition of 1893. These fans are made from the roots, which are also employed for making the fragrant screens known as tatties, which when wet are hung before the open windows and doors of houses to cool the atmosphere. The Kew Mus. collection contains a series of specimens of fans, baskets, and hand screens made from these roots. "Also used for awnings and as covers for palanquins and fans, and brushes used by weavers in arranging the thread of the web are made from either the roots or the whole plant. The roots laid among clothing impart a pleasing fragrance to the garments and are said to keep them free from insects. The roots are an article of commerce sold by druggists. In European drug stores the roots are known as *Radix anatheri* or *Radix vetiveriæ*, a stimulant or antiseptic. They yield a perfume known as *vetivert*, or, in India, *itar*." (*F. Lamson-Scribner.*) This grass is used as thatching material in India.

A. involutus, another Indian species, was formerly supposed to produce the "*Bhabar*" grass, which, however, is the product of an *Ischæmum*. *A. nardus* is the Citronella of India, the stems of which have been proposed as a useful paper product. Dic. Ec. Prod. Ind. *A. condensatus* is an Argentine species, noted as useful for its fiber. Other fiber species are *A. tenuis* and *A. sericeus*, in South Australia. The natives of Kavirondo, British Central Africa, make use of the material of a species of *Andropogon* for grass ropes with which their cattle are tethered. There are a number of species of the genus in the United States, but none has been reported as a fiber material other than cultivated broom corn.

**Specimens* of fans, W. C. E., 1893, Indian section; grass and fiber, U. S. Nat. Herb. and Mus. U. S. Dept. Ag.

Anjan (Hind.). See *Hardwickia.*

Anoda-gaha (Ceyl.). *Abutilon indicum.*

Anodendron paniculatum.

Exogen. *Apocynaceæ.* A giant climber.

An Indian species of plant also found in Ceylon. The stems are said to yield a very strong, fine fiber much esteemed in Ceylon for native uses, known as *dul.*

Anoer (Malay). *Cocos nucifera.*

Anona squamosa. Sour-sop.

Exogen. *Anonaceæ.* Small trees or shrubs.

There are several species of the genus, found in America, Africa, and Asia. They are chiefly prized for their fruit, though a fibrous substance is yielded by the bark, which has been utilized in some countries. Savorgnan states that in Guadaloupe the fiber has been employed for cordage. *A. reticulata*, the true custard apple of the West Indies, a fiber said to have been extracted from the young twigs which is better than that from the above species. *A. palustris*, Brazil, which is known as *araticucortica*, supplies the natives of Para with a useful fiber. Species of *Anona* of Venezuela, known locally as *anoncillo* and *manirito*, find a place in the list of useful fibers of that country. Several of the species named above are found in India, *A. reticulata* being prized as yielding dye and tanning material, fiber, food, medicine, and timber. See Dict. Ec. Prod. Ind., Vol. I, p. 258, and Cat. Venez. Expos., 1883, by Dr. Ernst, The State of Para, Braz. Com. W. C. E., 1893.

**Specimens* of *A. muricata.*—Herb. Col. Univ., N. Y.

Anoncillo (Venez.). *Anona* spp.

Anthistiria arundinacea.

Endogen. *Gramineæ.* A grass.

This species is found in northern India, where, according to Watt, the culms yield a fiber used for cordage and for the sacrificial strings used by the Hindoos. The leaves are also employed as a thatching material. Another species, the kangaroo grass of Australia (*A. australis*), is given in Bernardin's list of fiber-producing plants.

Anthurium acaule.

Belongs to the *Arum* family. Native of tropical America. "The small, broad leaves are used as a thatch material by the Indians of British Guiana, strung together many on a stick" (*E. F. im Thurn*).

Antiaris toxicaria. THE UPAS TREE.

Exogen. *Moraceæ.* Large evergreen tree.

By some authors *A. toxicaria* and *A. innoxia* (syn. *A. saccidora*), the Travancore sacking trees, are regarded as one species. Both abound in portions of India, the former on the Western Ghats and in Ceylon, the latter in Burma. The stripped bark is soaked in water and beaten, producing a white fibrous cloth, employed by the natives. The fiber is also used for native cordage, matting, and sacking. Both clothing and natural sacks are formed from the bark. An account of this rude manufacture is given in Dic. Ec. Prod. Ind., Vol. I, p. 268, as follows: "Small branches are made into legs of trousers and arms of coats, the larger ones forming the bodies of the garments. * * * In making sacks, sometimes a disk of the wood is left attached to the fiber to form the bottom of the sack. At other times the bark is peeled off, and after being beaten in water and dried the top and bottom are sewed up, forming the sack."

**Specimens.*—Bot. Mus. Harv. Univ.

Antidesma alexiteria.

A species of *Euphorbiaceæ*, found in India, the leaves of which are an antidote for snake bites. Its fruits are edible, and cords are made from the fiber of the bark.

Antirrhinum majus. COMMON SNAPDRAGON.

The species of this genus of *Scrophulariaceæ* are found in southern Europe and in California. *A. majus* is common in Italy, where it is known as *Lino dei Muri*, *Bocca de leone*, etc. It grows in walls and is cultivated in gardens. "The fiber of the stem is tenacious and can be used as a textile" (Manual Hoepli).

Apeiba tibourbou.

Exogen. *Tiliaceæ.* A tree.

This species abounds in many South American countries, the fiber being in the form of a thin ribbon of coarse bast, similar to that produced from the *Tilias*, and capable of rude weaving into mats and similar manufactures. Not an important fiber, though given by Dr. Ernst in the list of Venezuelan fibers. Known in Venezuela as *Erizo*. Bernardin mentions *A. ulmifolia* as one of the fiber trees of Trinidad. *A. petoumo*, known as *Cortega* in Panama, is used for cordage, its fiber being white, tough, and strong. Savorgnan mentions *A. glabra* as a fiber species found in Guiana. Bernardin catalogues two other species as fiber producing, *A. aspera* and *A. ulmifolia*.

Apocynum cannabinum. INDIAN HEMP.

Exogen. *Apocynaceæ.* A perennial herb.

Abounds throughout the western portion of the United States. Specimens of fiber have been received from Minnesota, Nebraska, Utah, Nevada, and Arizona.

BAST FIBER.—Easily separated from the stalk, and when cleaned is quite fine, long, and tenacious. In color it is light cinnamon as usually seen, though finely prepared specimens are creamy white and remarkably fine and soft; will rank with Asclepias for strength, and is readily obtained, as the stems are long, straight, smooth, and slender. Although paper has not been made of it, it could doubtless be utilized for the purpose. It is principally employed by the North American Indians, who manufacture from it in rude fashion bags, mats, small ornamental baskets, belts, twine, and other cordage, fishing lines, and nets. Among fine specimens received is a fish line, such as is used by the Pai Utes at the Walker River Reservation in Nevada.

FIG. 20.—The Indian hemp plant, *Apocynum cannabinum.*

The plant belongs to the Dogbane family, having upright branching stems 4 or 5 feet in length with opposite leaves, and a tough, reddish bark. Spon mentions the species, but gives it the common name "Colorado hemp," which does not apply to this species, but to *Sesbania macrocarpa.* He states that "it yields a fine, white, strong fiber." The naturally prepared fiber of the specimens of *A. cannabinum* that have come under the notice of the author are always a dark cinnamon color and not white, and it is probable that the two species have been confounded. (Fig. 20.)

In the Russian exhibit at the Columbian Exhibition of 1893 was shown a beautiful example of *Apocynum* fiber, about 2½ feet in length, and dark salmon in color, which it was claimed is used commercially in Russia to a limited extent. Bernardin places *A. cannabinum* in his list as produced in Virginia, and states that the fiber is adapted to cordage and fabrics. "*A. canadense*" the same author designates as "Canadian hemp."

There are several foreign species, as *A. syriacum* (Spon's Enc.), *A. venetum*, etc., which abound in southern Siberia, Turkestan, Transcaucasus, and on the Adriatic, and that produce fiber employed for cordage, fishing nets, lines, and other uses. Spon states that in some districts where the fiber is more carefully prepared it is manufactured into textiles. "It is separated by a short retting, is strong and elastic, easily divisible, bleaches and dyes well, and has a length of 6 to 12 feet." *A. venetum* is difficult of extraction. *A. androsæmifolium* probably affords as good a fiber as *A. cannabinum*, but is not so available on account of the more spreading or branching habit of the plant.

**Specimens* of *A. cannabinum*.—U. S. Nat. Mus.; Field Col. Mus.; and Mus. U. S. Dept. Ag.

Aralia papyrifera. RICE PAPER PLANT. See *Fatsia papyrifera*.

Araticu cortica (Braz.). See *Anona*.

Arbol del Pan (Peru). *Artocarpus incisa*.

Arcidiavolo (It.). *Celtis australis*.

Araujia sericifera.

An asclepiadaceous plant of Brazil growing in uncultivated fields, blooming in the winter months. It is known as *Paina de campo*, and also *Cipo Sapo*. Löfgren states that it is found in Sao Paulo, where its cotton is used in the same manner as that from species of *Bombax*.

Arctium lappa. THE COMMON BURDOCK.

Exogen. *Compositæ*. Coarse herb.

This familiar plant and troublesome weed, which is said to be of no utility in the vegetable economy, was several years ago the subject of experiment by Mr. W. W. Ball, of Lasalle, Ill., who hoped to produce at low cost a fiber material suitable for binding twine. It was claimed that the plants could be produced in quantity in new or waste land, and could be cut, crushed with a cane mill, and the bast steeped in pools of water at small cost, the fiber to be stripped by children, and a lengthy correspondence followed.

FIBER.—Upon examination of the many specimens of stalks and samples of the "fiber," submitted both straight and in the form of "tow," the filaments were found to be harsh and wiry, very brittle, and possessing little strength. A small sample, extra treated, yellowish in color, very soft and pliant to the touch, and absolutely worthless as to strength, it was suggested could be employed as paper stock, but the entire series showed no possibilities in the textile economy.

Fibrous plants of this class have no value in the industrial economy, the fibrous material contained in their bast being too inferior ever to be used in manufacture where so many other better fibers are obtainable that may be produced possibly at less cost.

**Specimens*.—Field Col. Mus.; Mus. U. S. Dept. Ag.

Arctium minus.

This is a European species, but has been reported from Sao Paulo, Brazil. Brazilian name, *Carapicho do grande*.

This plant could certainly be utilized industrially, having an excellent fiber beneath the bark which often attains a length of 1 meter without a break. It grows in the suburbs of towns, and flowers in the summer months. (*Alberto Löfgren.*)

Areca catechu. BETEL-NUT PALM.

Endogen. *Palmæ.* Palm, 80 feet.

Native of Cochin China, Malayan Peninsula, etc. Cultivated throughout tropical India, growing near the seashore and not above 3,000 feet elevation.

FIBER.—While grown chiefly for its nuts, "the flower sheath is made into skull

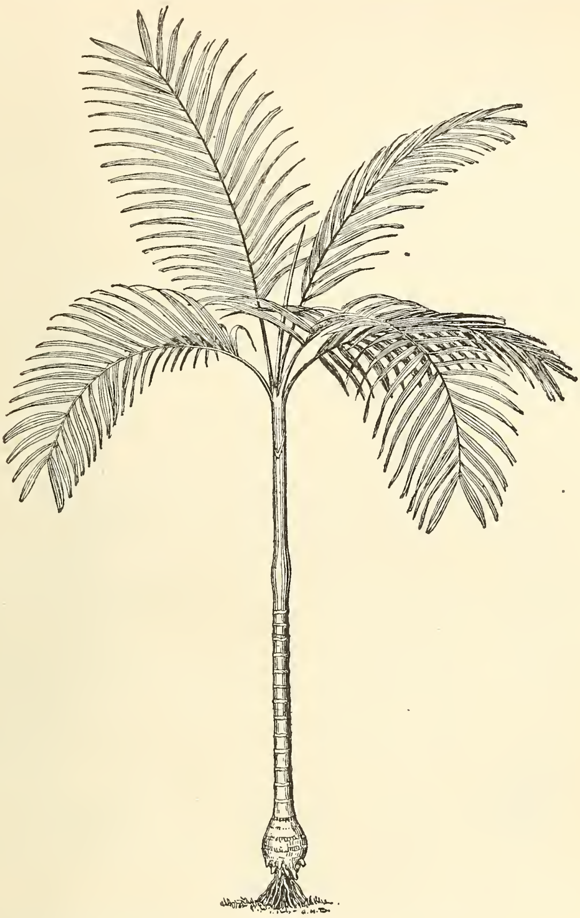

FIG. 21.—Young Betel-nut palm, *Areca catechu.*

caps, small umbrellas, and dishes; and the coarser leaf sheath is made into cups, plates, and bags for holding plantains, sweetmeats, and fish" (Bombay Gazetteer). The flower spathe and the fibrous pericarp from the nut is adapted to paper making. In some parts of Ceylon the chief vessels used for carrying water are made from the leaves of this graceful palm, which, being of leather-like consistency, are easily converted into strong and durable water buckets, in the making of which the natives show great ingenuity. Fig. 21 is a greenhouse plant of this species.

Arenga saccharifera. SAGO PALM OF MALACCA.

Endogen. *Palmæ.* Palm, upward of 40 feet.

Malayan name, *Gomuti;* known in Burma as *toung-ong.* This is also a Malayan species, generally cultivated in India, the Asiatic islands, Java, Sulu Archipelago, and Celebes. (See fig. 22.)

STRUCTURAL FIBER.—The gomuti fiber, *Ejoo* or *Eju* of the Malays. The product is a horse-hair like substance found at the base of the leaves, which is useful for the manufacture of cables, ropes, brush making, and upholstery. "Within the sheaths is found a layer of reticulated fibers, which is said to be in great demand in China, being applied, like oakum, in calking the seams of ships" (*Watt*). Roxburgh states that the black fibers of the leaf stalks are adapted for cables and ropes intended to long resist wet. Simmonds regards the *Ejoo* fiber as superior in durability, quality, and cheapness to cocoanut fiber, on account of its resistance to the action of water. The fiber placed in the bottom of a vessel is useful for filtering water of its mechanical impurities. Royle states that a coarse line of *Ejoo*, tested for its strength, stood a strain of 85 pounds, while a similar line of coir broke with 75 pounds. The same author states that the bow anchor of a merchant ship, buried in the sands of the Hoogly, was raised by means of an *Ejoo* cable after three Russian cables had given way in previous attempts. The fiber is equally elastic with coir, floats on the water, and is more serviceable than coir. Sandals are made from the leaf sheath.

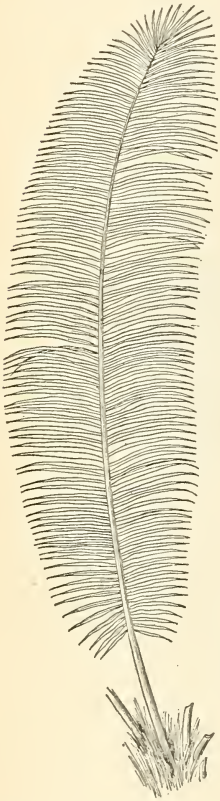

FIG. 22.—Leaf of the Sago Palm of Malacca, *Arenga saccharifera.*

Aristida adscensionis. BROOMSTICK GRASS.

Endogen. *Gramineæ.* A broom grass.

From the root fibers of this grass, which is common in northwest India, a material is obtained for the manufacture of weavers' brushes. Fine specimens of the product were shown in the Indian Court at Chicago, W. C. E., 1893, though little information could be secured concerning them. "The Telinga paper makers construct their frames from the culms; it also serves to make brooms" (*Watt*). Used for tatties, or hot-weather screens, in India in the same manner as the Cuscus roots (*Andropogon*) are employed. The material is spread thinly over bamboo frames. See Dic. Ec. Prod. Ind., Vol. I, p. 312. The Indian Agriculturist for February 25, 1893, contains a full account of this grass and the manner of collecting it for use in making weavers' brushes. The Bot. Mus. Harv. Univ. shows Mexican brooms made from the rigid culms of *A. appressa.*

Aristotelia macqui.

Exogen. *Tiliaceæ.* A shrub or small tree.

Native of Chile. The wood of this tree is considered to be the most sonorous of all in the vegetable kingdom; elegant and resonant guitars are made from it, and from the bark are constructed strings for the same. The acid berries of this plant are used in China as a remedy for malignant fever. In Chile they are used to make a sort of wine. (Manual Hoepli.) I can find no other reference to the use of this plant for fiber.

Arnotto or **Annato plant.** See *Bixa orellana.*

Aromatic sumac. *Rhus trilobata.*

Aroosha or Arusha (Ind.). See *Callicarpa cana.*

Arrowroot plant (see *Maranta*).

Artabotrys spp.

Exogens. *Anonaceæ.*

Natives of India and Indian Archipelago; shrubs or climbing plants. Savorgnan mentions *A. zeylanicus,* the fiber of which—the color of iron rust—is used in tackle for marine purposes, and *A. suaveolens,* the twigs of which are used by the natives of the Malaysian Archipelago for cords. The species is cultivated in greenhouses. *A. odoratissimus* is a scandent shrub, cultivated in India and eastern countries. It is not mentioned as a fiber plant by Dr. Watt, but is included in list of fibers, Rept. Flax and Hemp Com., 1863. The fiber is said to be of good length.

Artemisia moxa.

Exogen. *Compositæ.* Small shrubs.

The wormwoods are widely distributed over the temperate regions of the two hemispheres. In Texas, New Mexico, and other regions of the "great West" entire tracts are covered by species of *Artemisia. A. absinthium* is of well-known economic value.

FIBER.—On the authority of Savorgnan the down or cottony substance produced, as a surface fiber, by *A. moxa,* is used as an absorbent by Chinese and Japanese physicians. He also mentions *A. vulgaris,* found in stony places and among the gravelly soil of water courses (presumably in Italy), known as *Canapaccia,* the bark of which is filamentous and gives a material similar to hemp. A common species of temperate Europe.

Artificial Silk.

One of the interesting exhibits in Machinery Hall, at the Paris Exposition of 1889, was that illustrating the process of drawing out the filmy thread of artificial silk and reeling it into skeins of wonderful brilliancy and finish, this process being the invention of Count M. de Chardonnet. The process is intended to produce from pure cellulose, as a starting point, an artificial substance resembling as far as possible in form, appearance, and in adaptability to the uses of manufacture, the animal substance spun from the cocoons of *Bombyx mori* (or other species) and known as silk. The various kinds of cellulose can be employed to produce the substance out of which the silk is drawn, on condition that they are pure and not liable to alteration by reagents. The inventor in his own experiments has given his attention principally to cotton and the pulp of soft woods sulphureted.

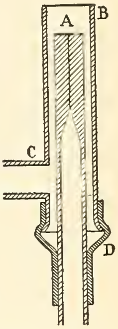

FIG. 23.—Device for the manufacture of artificial silk.

With these materials there is formed a pure octonitric cellulose, dissolved in the proportion of 6.5 per 100 in a mixiure of 38 parts ether and 42 parts alcohol. This collodion is inclosed in a reservoir of tinned copper where an air pump keeps a pressure of several atmospheres, which is held down by a ramp, upon which are fixed glass tubes terminating in a capillary section A. A second tube, B, envelops each of the first and receives an excess of water by the tubulure C. This water, held by an india-rubber pipe, D, falls again around B. The collodion driven through the orifice A is immediately solidified at the surface in contact with the water, and falls with this water in thread form around B, and there pincers, which move automatically, take up the thread and carry it over the reels, which are turning above. The threads coming from the neighboring jets are united, forming a combined thread like raw silk. Each jet is furnished with a device for regulating the size of the thread. In manufacturing this thread the jets and bobbins are inclosed in a glass case to prevent the loss of the dissolvent, and in which an even quantity of air circulates, being constantly reheated at the entrance of the machine (to dry the threads) and cooled again at the exit (to collect the vapor). The skeins are formed like those from the silk cocoons. (*Count de Chardonnet.*)

Starting with paper pulp, which is pure cellulose, this is nitrated, as has been shown, transforming it into pyroxyline or gun cotton. It is this collodion that is spun, and the "silk" is naturally inflammable to a high degree, and consequently in this form would be a decidedly undesirable form of fabric to use for any purpose. It is necessary to denitrify the silk, therefore, before the processes of spinning and subsequent manufacture. The various pyroxylines reduced in tepid baths lose their nitric acid. Pure water is also effective, though the reaction is even more complete in diluted nitric acid. The nitric acid of the cellulose is removed by a dissolution which takes place more or less quickly in proportion as the bath is warm and concentrated; but it can be pushed further in proportion as the bath is cooler and more diluted. The elasticity of the artificial silk is claimed to be equal to the natural silk of animal origin. The elongation before rupture is from 15 to 25 per cent. "The real elasticity is about 4 to 5 per cent." A square millimeter of artificial silk will stand a breaking strain of 25 to 35 kilograms. Raw silk will break at 30 to 45 kilograms. In density, artificial silk rates at about 1.49, coming between that of natural raw silk at 1.66 and natural boiled silk at (about) 1.43. In luster and brilliancy it is said to surpass the natural article. Examined under the microscope in section, the filament of artificial silk has the appearance of a grooved cylinder. It is claimed that this silk can be produced for 15 to 20 francs per kilogram, or about $1.40 to $1.80 per pound, natural silk costing from three to four times as much. The Textile World, Boston Mass., for June 1897, publishes recent interesting statements on this subject.

Artocarpus incisa. BREADFRUIT TREE.

Exogen. *Moraceæ.*

This species is the well-known breadfruit tree of the South Sea Islands. A caoutchouc is derived from the tree which is used as a glue and for calking the canoes of the islanders. Known in Peru as the *Arbol del Pan*, which means breadfruit tree. The species of this genus are found in India and the East Indies, New Guinea, Polynesia, New Zealand, and the Pacific islands.

FIBER.—"The bark yields a fiber used by the Indians of Loreto for making clothing" (*A. Dorca*). "The bark of the young branches is utilized for clothing in the more southern islands of Malaysia" (*Savorgnan*). *A. integrifolia*, the jackfruit tree, yields a fiber, samples of which were sent to the Paris Exposition from India. The timber is much used for making furniture and resembles mahogany. *A. lakoocha* also yields a fiber, said to be employed for cordage.

Arum spp.

A genus of *Araceæ*, the species of which are found in many parts of the world.

FIBER.—I have never seen the fiber of any species, but Bernardin states that fiber has been extracted from *A. macrorrhizon* (now *Alocasia macrorrhiza*) and from *A. funiculaceum* (species not in the Index Kewensis). Both are included in the Flax and Hemp Commission list, the first-named fiber measuring 19 feet, and the second, "aerial root, 10½ to 14½ feet; petiole, 2 feet 6 inches."

Arundinaria falcata. HIMALAYAN BAMBOO.

Endogen. *Gramineæ.* Cane-like grass, 6 to 10 feet.

Western Himalayas, above 4,000 feet elevation, but descending to the plains in the eastern. "The leaves are used for roofing and baskets" (*Watt*). The Kew Mus. exhibits a rough mat made from the split stems in India. See also *Bambusa* and *Dendrocalamus* for other forms of bamboos. The Harvard University botanical collection contains some examples of Japanese fans from *A. japonica.*

Arundinaria gigantea. Cane.

Endogen. *Gramineæ.* Perennial, 10 to 30 feet.

Cane of the Southern swamps. (See fig. 24.)

"A valuable supplement to the winter pastures. Thousands of animals have almost no other food. The fodder furnished, however, does little more than sustain life, and is of no value for fattening or for milch cows. Attempts made to cultivate this grass have not been successful. The plant blooms but once, and when the seeds mature the cane dies. The canes are used for many purposes, such as fishing rods, scaffolds for drying cotton, splints for baskets, mats, etc." (*F. Lamson-Scribner.*)

Two species are recognized—the above, or large cane, and *A. tecta*, the small cane, which is the more important as a fiber plant. See the next title.

Arundinaria tecta. Lesser Cane.

"This is regarded by some as only a variety of the cane mentioned above, but it is of smaller growth, rarely exceeding 10 feet in height; it extends as far north as Maryland. Its woody stems and perennial leafage are like those of *A. gigantea*, affording similar fodder to cattle upon the winter ranges." (*F. Lamson-Scribner.*)

Fig. 24.—Cane, *Arundinaria gigantea.*

Structural Fiber.—Coarse, but very strong, the length depending upon the distance between the joints of the cane. As prepared, it is a yellowish ochre in color. Is suitable for coarse cordage, such as binding twine, and for paper manufacture.

Economic Considerations.—The employment of southern cane as a fiber substance dates back to about 1870, when an effort was made to produce a paper material from the canes by a process known as "steam blowing." In reducing the cane to this fibrous state, tightly compressed bundles of the "bamboo" were placed in steam cylinders or guns 24 feet long and 12 inches in diameter, and there subjected to the action of steam at a pressure of about 170 pounds to the square inch for about ten minutes. The gums and glutinous matters which held the fibers together were thereby dissolved or softened, and while in that state the cane was blown into the air by the force of the steam in the gun, and the fibers separated by the expansion of steam among them. The papers manufactured from the steam-blown fiber were different grades of wrapping paper, book, and "news," some of the samples being quite white and of good quality. The industry never became permanent, however. See Ann. Rept. U. S. Dep. Ag., 1879, p. 563.

Recently another form of cane fiber has been produced from this species, which promises to become an industry, as the fiber is prepared at such low cost that it will be able to compete with the better fibers for certain purposes. Beautiful samples of the straight and tangled fiber were exhibited with the canes in the collection of the Office of Fiber Investigations in the United States Government exhibit at Chicago. Tests of the fiber made by the author show that it will stand a breaking strain about equal to sisal hemp and approaching to that of manila hemp. The process is patented.

Dr. Havard makes the statement that the cane of the Southern States furnishes the principal basket material of the remnants of the Cherokees, Choctaws, Creeks, Chickasaws, and Seminoles. The Choctaws especially excel in its use, and their little baskets, variously colored, are offered for sale in several Southern cities.

* *Specimens.*—Field Col. Mus.; Mus. U. S. Dept. Ag.

Arundo donax.

Endogen. *Gramineæ.* Tall grass or reed.

A widely distributed species, supposed to be the scriptural "reed." The plant grows to a height of 10 feet in England, though much taller in the south of Europe.

USES.—The canes being long, straight, and light, make admirable fishing rods and excellent arrows; the latter quality being of great importance to the warlike Jews after they began to practice archery with effect. See also *Phragmites communis*, an allied species. *A. karka* is mentioned by Liotard as one of the fiber-producing plants of the Province of Sindh, in India. See page 14, Introduction.

Arvore de Paina (Braz.). See *Chorisia speciosa.*

Asa (Jap.). See *Cannabis sativa.*

Asclepias syriaca. COMMON MILKWEED, OR SILKWEED, OF THE UNITED STATES.

Syn. *A. cornuti.*

Exogen. *Asclepiadaceæ.* Perennial shrub.

Abounds in Canada, grows over a wide section of our own country, and is well known in portions of South America and in the Old World. The culture of the plant is said to be attended with little difficulty, as it generally thrives on poor soil and is a perennial. It grows from either the roots or seed, so would be easily propagated if desirable to cultivate it. Probably the commonest and best known species of milkweed or "silkweed" growing in the United States.

FIBER.—The only portion of the plant of which practical use can be made is the *bast*, which furnishes quite a fine, long, glossy fiber that is strong and durable. Early authorities have given it a place between flax and hemp, and the yield has been claimed about equal to the latter. Dr. Schaeffer, as far back as the fifties, made comparisons of the two fibers in Kentucky, and his conclusions were most favorable to the *Asclepias* fiber. The native fiber was taken in winter from the decayed stalks as they stood in the ground where they grew without culture, while the hemp had not only been cultivated but treated afterwards with the usual care. The fiber of the milkweed was nearly, if not quite, as strong as that of the hemp, but apparently finer and more glossy, while the quantity from a single stalk of each was nearly the same.

Among specimens of the fiber shown in the Mus. U. S. Dept. Ag. are some fine examples from Brazil, which have been most carefully prepared, showing that the value of the plant has been recognized in that country, though there are no records of its use in manufacture. According to one of the old authorities, "an early knowledge of the fiber of silkweed caused its introduction into Europe, where it has fully become a cultivated plant, while in its own country but little is known of its true value." Dr. Masters, an European authority, states that "its excellent fiber is woven into muslin, and in some parts of India is made into paper." From the Flax and Hemp Commission of 1863 the Department received small pieces of *Asclepias* cloth mixed with one-third cotton. The bast forms a good paper material.

SURFACE FIBER.—While the stalks yield a good fiber, the pods or seed vessels produce a mass of silk-like filaments, adhering to the seed, resembling thistle down, and frequently called vegetable silk. Experiments in this country have shown that the substance has no value beyond a mere upholstery material, or for use as wadding, and for stuffing pillows. Spon makes the statement that the material is used for stuffing beds in this country, and reference is made to the manufacture of fabrics from it in Russia and France. A French firm has used it by mixing 20 per cent of the "down" with 80 per cent of wool, the fabric being called "silver cloth." The substance could not be used alone, as the cells are so smooth that they have no felting property, and therefore will not hold together and can not be spun. They possess little strength, and can only be considered as silky hairs, and not as fiber.

In my notes made at Kew I find reference to samples of muslin made from a species of *Asclepias* from Syria. There was also a very beautiful and delicate fabric in colors. *A. syriaca* is referred to by Royle, who states that it is a native of Syria and cultivated as far north as Upper Silesia. "The plants thrive luxuriantly in light soil, but flourish on any poor land. The fibers of the stem, prepared in the same manner as those of hemp, furnish a very long fine thread of glossy whiteness." The Syrian species, doubtless introduced from the New World, is the common milkweed of the United States. John Robinson, Museum, Peabody Academy of Science, Salem, informs me that as early as 1862 Miss Margaret Gerrish, of that city, spun and wrought from the fiber of *A. syriaca* purses, workbags, socks, and skeins of thread, which were dyed in many colors.

**Specimens*—Mus. U. S. Dept. Ag.

Asclepias curassavica. WILD IPECACUANHA.

This species is found in the southern United States, Mexico, West Indies, and portions of South America, as Venezuela. Common in Yucatan, *cuchilixiu* being the Maya name. The plant is also found in India, having been introduced from South America, though it is not mentioned in any list of Indian fiber plants.

SURFACE FIBER.—While the stalks produce a bast, the only mention of the plant as a textile is in regard to its yielding "silk cotton." Dr. Havard states that the seed hairs of this species are claimed to be stronger than those of other species that have been considered. The Kew Mus. has a collar made from the fiber. The economic value of the plant in the West Indies is its employment in pharmacy.

Asclepias fruticosa.

The down of this species is used in Italy to a small extent as wadding. The plants only thrive in favorable situations. The plant is known as *Albero della seta*, or silk tree.

Asclepias incarnata. THE SWAMP MILKWEED.

This species, according to Gray, abounds from Maine to Minnesota and southward to Louisiana, being found as far south as the Carolinas on the Atlantic coast. A variety, *pulchra*, having hairy stems, has almost as wide a northerly distribution, and is also found in North Carolina.

BAST FIBER.—Light gray to white in color, according to preparation, specimens from the old stalks in the field resembling dew-retted flax in appearance. The fiber is finer than hemp as usually prepared, soft and glossy, possessing greater strength than the majority of bast fibers of wild growth in the United States. Useful for all purposes to which hemp may be applied. "Binder twine from this species stood a breaking test of 95 to 125 pounds" (*R. J. Hall*).

ECONOMIC CONSIDERATIONS.—In 1890 this plant attracted attention in Minnesota as worthy of cultivation, and a quantity of the fiber from wild plants was secured and manufactured into binding twine for examination and experiment. While no better than common hemp, it might pay to cultivate the plant for its fiber, but as hemp culture is an established thing, and hemp is also found growing wild (escaped from cultivation) in many localities where *A. incarnata* abounds, there would be no special advantage in its cultivation.

"It can be produced on overflowed land where no other cultivated plants will grow and yield double the fiber that flax will produce. Such lands may be described as bottom lands subject to overflow, of which Minnesota has thousands of acres. The use of such tracts would avoid drawing upon our grain lands. The plant will produce as much fiber as a crop of hemp and with less labor. It grows as far north as the forty-sixth parallel, and I incline to the opinion that cultivation will carry it up to the British line and perhaps beyond. It blossoms in August, and the fiber does not fully develop until nearly or quite ripe, in September." (*A. E. Ball.*)

"*A. incarnata* flourishes in low, moist grounds and by slow running streams, growing annually from a perennial root some 5 to 7 feet high. It grows in clumps or stools, starting as soon as frosts leave, and seems to assert its position successfully with other shrubbery and weeds. In many respects the plant seems to resemble the ramie; the fiber is soft and silky until the plant is quite mature, and rather difficult of handling by any present known process, but from experiments already made it promises to equal the ramie in fineness and value. The plant may be propagated by seed, but the root may be divided into from five to ten separate plant hills and produce stalks the same season. It should have an abundance of water to draw from, although plants 4 feet high have been noticed growing upon uplands, but unless set thickly together the plant is shorter and more bushy." (*S. S. Boyce.*) (See fig. 25.)

FIG. 25.—The Swamp milkweed, *Asclepias incarnata.*

Undoubtedly *A. incarnata* promises better results than any of the indigenous species of bast fibers in the United States that have been considered. If it will thrive upon waste lands where no other crops will grow, it has to that extent an advantage over hemp, considering the strength of the fiber as fully equal to hemp. Recent cultural experiments under the direction of the Department of Agriculture seem to show that the plant does not thrive on upland, nor do as well in cultivation as in the uncultivated state. See Rept. Fib. Inv. series, U. S. Dept. Ag., No. 6.

**Specimens.*—Mus. U. S. Dept. Ag.; Field Col. Mus.

Asclepias verticillata.

Abounds in New Mexico, Arizona, Nevada, and contiguous territory, and as far eastward as the Mississippi Valley.

"The fiber is grayish white, very strong, and is used by the Indians of the Southwest for sewing together the skins for 'rabbit robes,' and also as a tying material in the construction of their habitations" (*C. W. Irish*). The soil thrown up to form the banks of irrigating ditches is soon covered with this *Asclepias.*

Ash (for basket splints). See *Fraxinus nigra.*

Asimina triloba. THE PAPAW OF TEMPERATE UNITED STATES.

Exogen. *Anonaceæ.* A tree.

Abounds in eastern middle United States from Michigan to the Gulf.

FIBER.—Derived from the inner bark, but now scarcely employed for any purpose. "The inner bark stripped from the branches in the early spring is still used by fishermen on the Ohio and other Western rivers for stringing fish; formerly employed in making fish nets" (*C. S. Sargent*). Dr. Havard states that the inner bark has a tough fibrous texture, and in former times was commonly used by the Indians for withes, strings, nets, etc. Savorgnan states that the bast from the inner bark of young sprouts is very strong and lustrous.

Assai Palm, of Para. (Braz.). *Euterpe oleracea.*

Astelia banksii.

Endogen. *Liliaceæ.* A rush.

This species belongs to a genus of rush-like plants found in the islands of the southern ocean. The plant is a native of New Zealand, and grows to a height of 4 feet. "It is rich in fiber suitable for ropes, paper," etc. The fiber is of a dirty yellow color, the "filaments" exceedingly coarse and wiry; rather brittle when bent sharply, but of considerable strength when tested with a lateral strain. The specimen in the collection of the Department of Agriculture was prepared by Dr. Guilfoyle. The leaves of *A. alpina* which grow on the sand hills of the coast of Tasmania are edible.

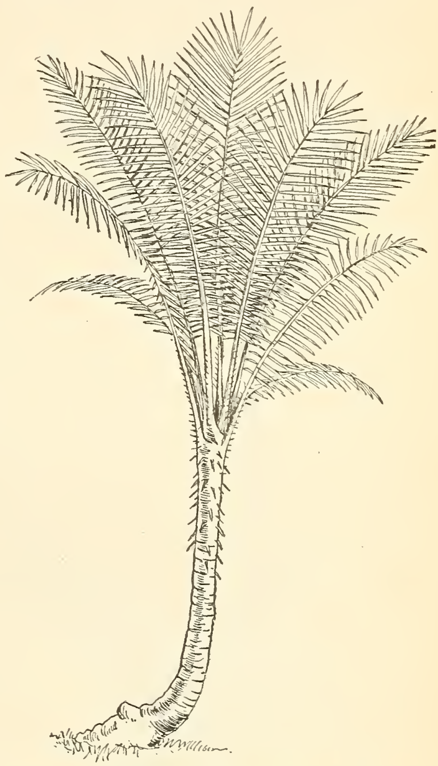

FIG. 26.—The Murumurú palm, *Astrocaryum murumurú.*

Astrocaryum acaule. THE IÚ PALM.

Endogen. *Palmæ.* A palm, 8 to 10 feet.

"This palm never has any stem, the leaves springing at once from the ground. They are 8 or 10 feet long, slender and pinnate. The leaflets are very narrow and drooping, and are disposed in groups of three or four, at intervals along the midrib, the separate leaflets standing out in all directions." (*Wallace.*)

It is stated that this palm grows in the dry Catinga forests of the upper Rio Negro, Brazil. The rind of the leafstalks is used by the Indians for making baskets. *A. ayri,* another Brazilian species, is used in the manufacture of coarse articles. The fiber is derived from the leaves.

Astrocaryum murumurú. THE MURUMURÚ PALM.

This is another South American species of palm. It grows "on the tide lands of the lower Amazon, and on the margins of the rivers and gapós of the upper Amazon, though it is possible that the two may be distinct species." Fig. 26 grows in Para.

The stem is from 8 to 12 feet high, irregularly ringed, and armed with long, scattered black spines. The leaves are terminal and of moderate size, regularly pinnate, the leaflets spreading out uniformly in one plane, elongate, acute, with the terminal pair shorter and broader. The petioles and sheathing bases are thickly covered with long black spines generally directed downward, and often 8 inches long. The spadices grow from among the leaves and are simply branched and spiny, erect when in flower, but drooping with the fruit. The spathes are elongate, splitting open and deciduous. The fruit is of a moderate size, oval, of a yellowish color, and with a small quantity of rather juicy eatable pulp covering the seed. (*A. R. Wallace.*)

This author also states that the cattle of the upper Amazon eat the fruit, which is hard and stony, wandering about for days in the forest to procure it. There is scant reference to its fiber. It is called the *Múrúrúni* in a pamphlet distributed by the Brazilian commission, W. C. E., 1893, where it is stated that its fruit serves for food for cattle and the stems of its new leaves for braiding hats and making baskets. It is also mentioned by Orton.

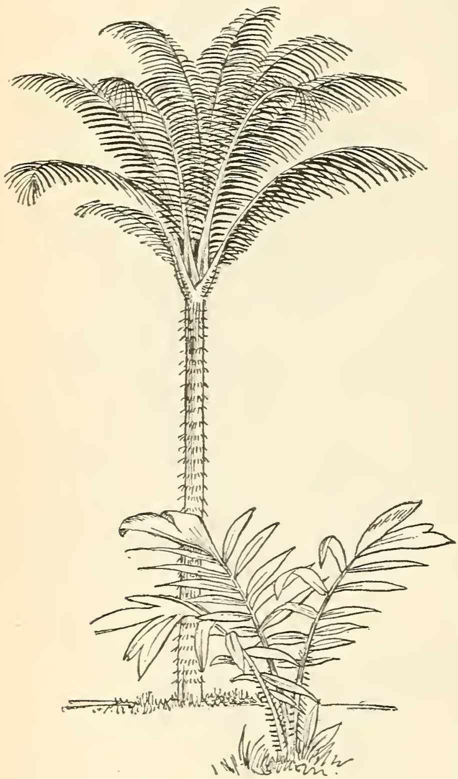

Fig. 27.—The Tecuma palm, *Astrocaryum tucuma.*

Astrocaryum tucuma. THE TECUMA PALM.

In the list of Brazilian fibers published by the Brazilian commission, W. C. E., 1893, the *Jauary* (*A. jauari*) and the *tucum* (*A. tucuma*) are mentioned as valuable fiber-producing plants. From *A. tucuma* "the fiber is extracted for manufacture into hats, baskets, ropes, and other useful articles." In Bernardin's list the *Tucum* palm is given as *Astrocaryum vulgare* (which see), found in Guayaquil, Guiana, and Trinidad. In the Official Guide of the Kew Mus. the *Tecuma* palm is given as *A. tucuma*, the *Tucum* palm being *A. vulgare*.

STRUCTURAL FIBER.—Samples of the fiber of *A. tucuma* were exhibited in the Brazilian collection, Phil. Int. Exh., 1876, and presented to the United Sates Department of Agriculture.

It was stated that the fiber is obtained from the young leaves and is readily secured, as it lies just under the epidermis of the leaf, which is so exceedingly thin that it is easily rubbed off, leaving the fiber white and clean. Its strength was claimed to be equal to flax. The filaments are so fine that it has received the name of vegetable wool. In the specimens received by the Department the fiber had not been cleaned, yet in some portions the bundles of filaments were clear and white, showing the fiber to the best advantage. This was sufficiently strong for fine weaving, and from the ease with which it is separated might be obtained very cheaply. "Its use in Brazil is for the manufacture of nets, fish lines, and hammocks." Fig. 27 shows a young and an old tree.

While authorities agree that *Tucum* is an *Astrocaryum*, *Bactris setosa* is mentioned as the *Tucum* in a volume on the resources of Brazil distributed at the Philadelphia exhibition of 1876, and *Astrocaryum* is called the *Tucuman*. In Bernardin's list *Bactris* is called *Tecun*. The Kew Mus. Guide names *A. aculeatum* as the *Gri Gri*.

* *Specimens.*—Mus. U. S. Dept. Ag.

Astrocaryum vulgare. THE TUCUM PALM.

This species grows on the dry forest land of the Amazon and Rio Negro. Cultivated by the Indians when not met with in a wild state. (See fig. 28).

STRUCTURAL FIBER.—"Tucum thread," derived from the unopened leaves, "is used chiefly for bowstrings and fishing nets; employed also for hammocks, which fetch a high figure in Rio Janeiro." By the native method of extraction only about 2 ounces of fiber can be extracted in a day, even by an expert manipulator. Savorgnan states that the leaves yield a fiber of great strength, which is made into cordage, and also furnish material for hats known commonly as *Accora*.

The only part used is the young unexpanded leaves, the cuticle of which, when twisted, furnishes cordage of extreme fineness, combined with great strength and durability. Some of the tribes on the upper Amazon are said to make all their hammocks of this fiber. Wallace, in his Palm Trees of the Amazon, says: The Brazilians of the Rio Negro and upper Amazon make very beautiful hammocks of fine '*tucúm*' thread, knitted by hand into a compact web of so fine a texture as to occupy two persons three or four months in their completion. They then sell at about £3 each, and when ornamented with the feather-work borders, at double that sum. Most of them are sent as presents to Rio de Janeiro.

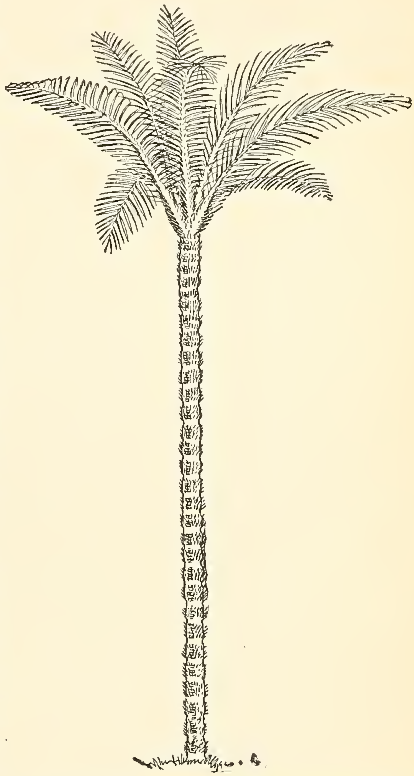

FIG. 28.—The Tucum palm *Astrocaryum vulgare*.

The fiber is fine, resistant, and durable, and the natives employ it in making ropes, coarse linen, nets, horse blankets, and especially hammocks and strong fish nets, for which it is much esteemed. The fiber is yellowish white and very elastic. A small cord of scarcely 2 millimeters in thickness will sustain a weight of 3 kilos. And at the end of six hours it will have extended in length from 800 millimeters to 809 millimeters, which is equal to 1.125 per cent. It is capable of absorbing a great quantity of water; a rope weighing 72 grams after having been submerged in water something more than one hour showing an increase of 27.7 per cent.

**Specimens* are preserved in the Bot. Mus. Harv. Univ.

Atabula (Ind.). *Sida rhombifolia.*

Atiraukawa (New Zea.). *Phormium tenax.*

Attalea funifera. BAHIA PIASSABA, or PIASSAVA.

Endogen. *Palmæ.* A palm tree, 30 to 40 feet. (See fig. 29.)

Widely distributed in the lowlands of Brazil; common throughout the Province of Bahia parallel to the coast from latitude 13° to 18°. A very full account of the fiber and methods of gathering it for market appears in the Kew Bulletin for 1889, from which the following statements have been largely compiled:

STRUCTURAL FIBER.—Obtained from the dilated base of the leaf stalks, which separates into a long, coarse fringe, which is collected by the natives by cutting with a small ax. The fiber is stiff, wiry, and a bright chocolate in color, and is employed in the manufacture of brushes; largely used on street-sweeping machines, particularly in London. The natives twist these fibers into coarse cables, which are light and durable, and which will float on the water.

Fiber from young undeveloped plants, called *Bananeiras*, is bright colored and more flexible. The fiber from the fully matured plants, called *Cogueiras*, is separated into three qualities—

(1) Ordinary fiber, which is found wound up among the broken leaves and the upper part of the trunk.

(2) Balloon, formed by the elder fiber which has fallen to the ground round the base of the trunk.

(3) *Piassava d'olho*, or "eye piassava," which is the latest growth, and is in all respects similar to that yielded by the *Bananeiras*. The latter, on account of its flexibility and color, is chiefly used in tying the bales. Its yield is small.

COLLECTION AND PREPARATION.—The palm grows in the neighborhood of rivers and on land that is always in a half swampy condition. The trees bear fiber fit to pull or cut at the of age 6 to 9 years. The mean temperature of the piassava district is 77°. "Crops" are discovered by exploration, as a tract of scattered trees can not be advantageously worked over. After a suitable location is discovered the camp is stocked with mules and food for both men and animals, and the work begins. The average cut of one man is 3 arrobas per day (1 arroba = $32\frac{1}{2}$ pounds) of the loose fiber, though the fiber is only weighed after putting into bundles, into which stones and pieces of palm are often smuggled to add to the weight. After weighing the fiber it is transported to the fazenda of the proprietor, where it is baled (both by hand and by press), ready for shipment to Bahia. Including cutting, expenses of transportation, with wages of muleteers and hire of animals, and then food, packing, labor, commission, etc., amount to 2.468 milreis, or, approximately, $1.38. Very little of the fiber is used locally, almost the entire product being exported. Of the annual export of 7,000 tons, Great Britain takes about half, Germany very nearly a quarter, the remainder going to Belgium, France, Portugal, and the southern Republics.

In the monthly circular of Messrs. Ide & Christie, the London fiber brokers, all the harsher commercial brush fibers are classed under "*Piassava*," the following forms being recognized: Brazilian, Bahia (*Attalea funifera*) and Para (*Leopoldinia piassaba*); *Kitool*, from Ceylon, etc. (*Caryota urens*); *Palmyra*, also from Ceylon (*Borassus flabellifer*); West Africa, *Raphia vinifera*, and Madagascar, *Dictyosperma fibrosum*. Bahia *piassaba* ranges in price from 18s. to 58s. per hundredweight in London.

A. funifera finds a place in Dr. Ernst's Venezuelan list, known as *Chiquechique*. Its fiber is an article of export from Venezuela as well as Brazil, some 90,000 pounds having been exported in a single year. "The fiber is employed for brooms, brushes, ropes, and cables. The last are very strong, durable, and so light that they float on water. Recently there have been experiments made in the United States to transform these fibers into an article similar to horsehair for making mattresses." (*Dr. Ernst.*) Principally used in the United States as a brush fiber.

A. spectabilis, the *Curua* palm, found on the Rio Negro, Brazil, furnishes in its leaves a thatch material. In Peru it is known as *Shacapa*, and "the fiber is used for ropes." James Orton, in The Andes and the Amazon, mentions also *A. humboltiana*, the *Yagua* of the Indians. Dorca gives *Catirina* as the Peruvian name of *Attalea*.

**Specimens* of fiber and ropes, Mus. U. S. Dept. Ag.

Attalea speciosa. UAUASSÚ PALM.

This species grows on the dry forest lands of the upper Amazon. It is a noble palm, with a stem 50 or 60 feet high, straight, cylindrical, and nearly smooth. The leaves are very large, terminal, and regularly pinnate. The leaflets are elongate, rigid, closely set together, and spreading out flat on each side of the midrib. The sheathing bases of the petioles are persistent for a greater or less distance down the stem, and in young trees down to the ground, as in the *Œnocarpus batava*. The spadices grow from among the leaves and are large and simply branched. The fruit is of large size compared with most American palms, being about 3 inches long, and from this circumstance it derives its native name "*Uauassú*," signifying "large fruit."

On the lower Amazon and in the neighborhood of Para *A. excelsa* is not uncommon. It is a handsome, lofty species which grows on lands flooded at high tides, and is called by the natives *Urucurí*. The fruit of this tree is burnt, and the smoke is used to black the newly made india rubber. Martius says that the fruit of the *A. speciosa* is used for this purpose, but that species is not found in the principal rubber districts, while *A. excelsa* is abundant there. (*Wallace*, Palms of the Amazon).

Structural Fiber.—The foliage of this tree is very extensively used for thatching. The young plants produce very large leaves before the stem is formed, and it is in this state that they are generally used. The unopened leaves from the center are preferred, as, though they require some preparation, they produce a more uniform thatch. The leaf is shaken till it falls partially open, and then each leaflet is torn at the base so as to remain hanging by its midrib only, which is, however, quite sufficient to secure it firmly. They thus hang all at right angles to the midrib of the leaf, which admits of their being laid in a very regular manner on the rafters. They are generally known as "palha branca" or "white thatch," from the pale yellow color of the unopened leaves, and are considered the best covering for houses in places where *Bussú* can not be obtained. (*Wallace*, Palms of the Amazon.)

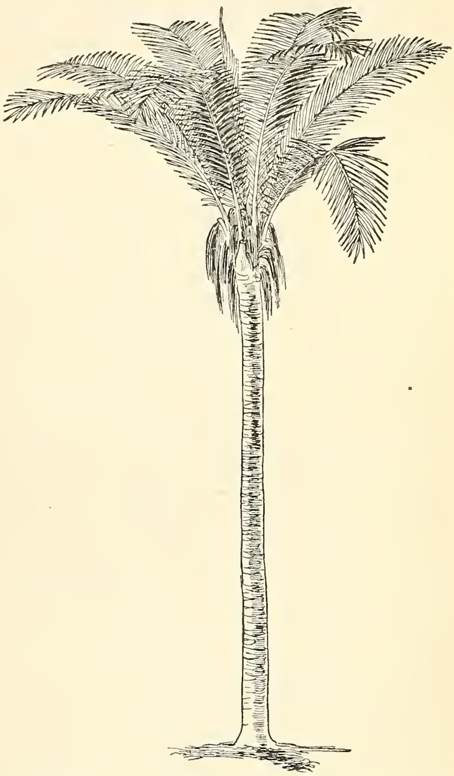

Fig. 29.—The Bahia Piassaba palm, *Attalea funifera*.

Athryxia phylicoides.

This species, known in Natal as *i-Tshanyela*, is said by J. Medley Wood, in the Report of the Colonial Herbarium (Durban, 1894), to be employed as a material for brooms.

Australian mallow. See *Lavatera plebeia*.

Aya-mushiro matting (Jap.). See *Cyperus unitans*.

Baboi and Babui (Beng.). See *Ischæmum*.

Bacaba (Braz.). See *Œnocarpus bacaba.*

Bacona and **Vacona** (Maurit). *Pandanus utilis.*

Bactris setosa.

Endogen. *Palmæ.* A slender palm.

This genus of palms is found in the West Indies, Brazil, and other tropical regions of South America.

Structural Fiber.—The fiber of the leaves, known as *Tecun* (or *Tecum*) both in Peru and Brazil, is very strong, and is used "for fishing nets and lines" (*Savorgnan*), and "for hats, ropes, hammocks, etc." (*Dorca*).

The species appears in Bernardin's Catalogue with the common name *Tecum*, the fiber of which is "employed for hammocks and fillets." See also *Astrocaryum tucuma* and *A. vulgare*. *B. maraja* is another Brazilian species mentioned in Notes on the State of Para, W. C. E., 1893, as supplying a useful fiber.

Fig. 30.—*Bactris integrifoli*

Bactris integrifolia.

A Brazilian species found on the upper Rio Negro. The stem is hardly so thick as the little finger, and 9 or 10 feet high, smooth and distinctly jointed. The leaves are four or five in number, terminal, entire, three or four times as long as they are wide, and not very deeply bifid at the end. The petioles and their sheathing bases are thickly set with long, flat black spines. The spadices are very small, erect, and two-branched, growing from among the persistent sheathing bases below the leaves. The spathes are small, erect, and persistent, clothed with adpressed brown spines. The fruit is small and globular and of a black color. (*Wallace.*) Not particularly interesting as a fiber plant, but serves to illustrate the group. (See fig. 30.) Refer to *Guilielma speciosa*.

Bagasse.

The refuse of sugar cane after roller crushing, before the diffusion process had been adopted. The following is from a report by the author issued in 1879:

"Among other fibrous products named in reply to the circular sent to manufacturers were samples of the bagasse of sugar cane and a series of the products derived from it for paper manufacture. The raw product is obtained at the mills (Louisiana sugar plantation) at about $15 per ton, or three-fourths of a cent per pound. The bagasse from Louisiana cane is considered superior to that from the West Indies, from the fact that it never reaches its real state of maturity, while the latter is not used until quite ripe. The matured fiber is coarser and less flexible and strong."

"Megasse, or Bagasse, the refuse of the sugar cane after passing through the rollers of the sugar mill for the expression of the juice. It is generally used in the Tropics as fuel, but latterly an attempt has been made to use it for paper making. Samples of paper made from it are shown." (Off. Guide Kew Mus.)

Bagolaro (It.). *Celtis australis.*

Bahia piassaba (Braz.). See *Attalea funifera.*

Bakrabadi jute (Ind.). See *Corchorus.*

Balizier (Trin.). See *Heliconia.*

Balsa or Balso (S. Am.). See *Ochroma lagopus*, etc.

Bambagia (see *Bombax malabaricum*).

Bamboo (see *Arundinaria*, *Bambusa*, and *Dendrocalamus*).

Bambusa arundinacea. THE BAMBOO.

Endogen. *Gramineæ.* A cane, 70 to 80 feet.

NATIVE NAMES.—*Quasb* (Arab.); *Nai* (Pers.); *Mandgay* (Bomb.); *Bans* (Beng.); *Kattu-una* (Ceyl.).

"The spiny bamboo of central and southwest India."

The genus *Bambusa* embraces many species of "giant grass" found in the Tropics of both hemispheres, but *B. arundinacea* may be generally accepted as the one commonly known as bamboo. The largest and best canes are produced from this species, though other cultivated species are sometimes mistaken for it. Dr. Morris says that *B. vulgaris* is generally cultivated in British gardens.

STRUCTURAL FIBER.—This is derived from the shoots, which are reduced to fibrous material to form paper stock. For other manufactures the canes are split or shredded, to be afterwards wrought into various forms.

CULTIVATION.—The method of planting it most commonly adopted by the natives of India is by shoots, or the lower part of the halm with a portion of the rhizome, set out during the rains, but heavy and constant rain for some time afterwards is essential. In Algeria propagation by stem cuttings is found to succeed admirably. Cultivation from seed is, perhaps, the most certain plan; but it is open to the serious disadvantage that the plant then requires ten to fifteen years to attain a growth sufficient to admit of cropping. The plant will not grow in poor or waste soils, but prefers the rich land on the banks of streams. Abundance of moisture, supplied either naturally or by irrigation, is absolutely essential. Thousands of acres of wild bamboo jungle exist in the Tropics, but very little of this is available for the purposes of the paper manufacturer, as experience has shown that shoots of the year are the only ones which can be used. This fact, coupled with the equally important one that an abundance of bamboo is essential to the very existence of the native races of the East Indies, renders it certain that for industrial undertakings the plant would have to be systematically cultivated. (Spon.)

UTILITY.—The variety of purposes to which the bamboo is applied is almost endless. The Chinese use it in one way or another for nearly everything they require. The sails of their ships as well as their masts and rigging consist chiefly of bamboo, manufactured in different ways. Almost every article of furniture in their houses, including mats, screens, chairs, tables, bedsteads and bedding, and utensils generally employed in the domestic economy, and even coarse underclothing, are made of this material, which is similarly used in Japan, Java, and Sumatra.

"Employed in shipbuilding and in the construction of bridges. Buckets, pitchers, flasks, and cups, are made from sections of the stems. Baskets, boxes, fans, hats, and jackets are made from the split bamboo. Ropes and Chinese paper are made from these grasses. A Chinese umbrella consists of bamboo paper, with a bamboo handle and split bamboo for a frame. The leaves are used for packing, filling beds, etc., and occasionally serve as fodder for stock. The young shoots serve as a vegetable. Tabashir, or bamboo manna, a siliceous and crystalline substance which occurs in the hollow stems of some bamboos, is regarded as possessing medicinal properties. Good drinking water collects in quantities in the hollows of the internodes of many of the larger bamboos. All sorts of agricultural implements, appliances for spinning cotton and wool or for reeling silk are often constructed entirely from bamboo. Very many articles of household use or decoration made from bamboo have become articles of commerce in Europe and in this country. So many and varied are the uses of the several species of bamboo that it is possible to mention here only a part of them." (*F. Lamson-Scribner.*)

For making paper stock the Chinese employ the shoots 1 and 2 years old. The material is macerated in water for a week or more, after which the pieces—some 5 feet in length—are washed and placed in a dry ditch and covered with slacked lime for a number of days, when they are again washed, cut into filaments, and dried or bleached in the sun. In this state they are boiled in large kettles and subsequently reduced to pulp in wood mortars by means of heavy pestles. A glutinous substance is then mixed with the pulp, and upon this mixture the quality of the paper depends. Another account is given in An Index to Economic Products of Jamaica, 1891, under *Bambusa vulgaris*, as follows:

"In China, it is the principal, if not the only, material for paper making. The Chinese use the native bamboo, which they split into lengths of 3 or 4 feet, and place in a layer in a tank. This is covered with lime, and alternate layers of bamboo and lime are so placed until the tank is full. Water is run in to cover the whole, and left for three or four months, when the bamboo has become rotten. The soft bamboo is pounded in a mortar into a pulp, mixed with water, and then poured on square, sieve-like molds. The sheets are allowed to dry on the mold, then placed against a hot wall, and finally exposed to the sun. Mr. Routledge advocated the use of young shoots, but one difficulty is that cutting them weakens the stock; in fact, if all the young shoots are cut for three successive years the stock dies. At Lacovia, bamboo is crushed, and exported in short lengths as packing for cylinders. The young shoots, freed from the sheaths, are used in India in curries, pickles, and preserves. The very young shoots are not unlike asparagus." (*Fawcett.*)

While articles of bamboo are common in this country, being largely imported brush making from bamboo splints is a considerable industry.

Bamiyá (Arab.). *Hibiscus esculentus.*

Banana (see *Musa sapientum*).

Ban-bway (Burm.). See *Careya arborea.*

Bandaká (Ceyl.). See *Hibiscus esculentus.*

Bandala. See *Musa textilis.*

Bandura-wel (Ceyl.). See *Nepenthes.*

Bang (Pers.). *Cannabis sativa.*

Bankas and **Bankush** (N. W. Prov. Ind.). See *Ischæmum.*

Banraj and **Banraji** (Beng.). *Bauhinia racemosa.*

Ban-rhea (Ind.). See *Villebrunea.*

Bans and **Behúr-bans** (Beng.). *Bambusa arundinacea.*

Bans-keora (Ind.). See *Agave americana.*

Banyan Fiber (see *Ficus benghalensis*).

Baobab Tree. Monkey Bread of Africa. See *Adansonia digitata.*

Barbone (It.). *Chrysopogon gryllus.*

Barbari (Ind.). See *Beaumontia.*

Barley straw. Employed in straw plait. See *Hordeum.*

Barrigon (S. Am.). See *Ceiba.*

Barriguda (Braz.). *Iriartea ventricosa.*

Bashofu (cloth, of Jap.). See *Musa basjoo.*

Basket manufacture.

Baskets are made from grasses and sedges, from the lance-like leaves of *Yucca* and similar plants, from palm leaves, and from the twigs of various dicotyledonous plants, such as the willows, etc. See *Salix viminalis, S. triandra, S. lasiandra,* etc.; *Rhus trilobata, Yucca brevifolia, Scirpus lacustris, Epicampes rigens, Lygeum spartum,* etc. Also made from splints of ash, pine, hickory, and other woods. See *Fraxinus.*

Bass fiber. Monkey ——— or Para *piassaba* (see *Leopoldinia piassaba*); West African ——— (see *Raphia vinifera*).

Bass-like fibers (see *Attalea funifera, Borassus flabellifer,* and *Dictyospermum fibrosum*).

Bassia longifolia.

An India species of *Sapotaceæ* mentioned by Liotard in his work on India paper materials.

Bassine. Same as Palmyra. See *Borassus.*

Basswood or **Linden.** See *Tilia.*

Bast Fiber, Description of. See Introduction, page 25.

Bastard Aloe. *Agave vivipara.*

Bastard cedar (Jam.). See *Guazuma.*

Batatas paniculata. CAFFIR COTTON. See *Ipomœa.*

Bauhinia coccinea.

Exogen. *Leguminosæ.* Small tree.

A plant of Cochin China, the bark of which, according to the Manual Hoepli, yields a very strong fiber; the uses are not stated.

Bauhinia racemosa. MALOO CLIMBER.

The *Bauhinias* are a genus of arborescent or climbing plants belonging to the *Leguminosæ,* and are found in tropical countries.

FIBER.—The inner bark of this Indian species yields a bast fiber that can be made into rude cordage, but which soon rots in water. It is reddish in color, very tough and strong, and on account of this quality has been employed in India in the construction of bridges across the Jumna. The stems are usually cut in July or August, the outer bark being stripped off and thrown away, while the inner layers are used for rope as wanted, being previously soaked in water, and are twisted wet.

Other Indian species yielding fiber are *B. macrostachya, B. tomentosa, B. purpurea, B. anguina* (the snake climber), and *B. vahlii* (the gigantic climber). (See fig. 31.)

The uses of *B. racemosa* are, perhaps, more numerous than those of any other forest plant; the strong cordage prepared from its bark is an important article with the hill tribes. Specimens of this fiber were exhibited at the London Exhibition of 1851 under the name of *Patwa* or *Mawal*. A large collection of strong red ropes from it were also displayed at the Calcutta International Exhibition. Captain Huddleston in his Report on Hemp in Garhwál, in 1840, gives the following facts: "The '*maloo*' is a large creeper, 40 or 50 yards in length, and of considerable thickness, from the bark of which a very strong rope is made. The natives chiefly use it for tying up their cattle and sewing their straw mats with the fresh bark; it also makes capital matches for guns, and muzzles for oxen and calves." It is "cut generally in July or August, though it may be cut all seasons, and the outer bark, being stripped off, is thrown away, the inner coating being used for ropes, as wanted, by being previously soaked in water and twisted when wet. A large creeper will produce a maund of fiber, called '*seloo*.' The bark before being used is boiled and beaten with mallets, which renders it soft and pliable for being made into ropes and string for charpoys." (*Watt.*) See Spon, Enc., Div. 3, p. 921; Dic. Ec. Prod. Ind., Vol. I, p. 422; Ann. Rept. U. S. Dept. Ag., 1879, p. 528.

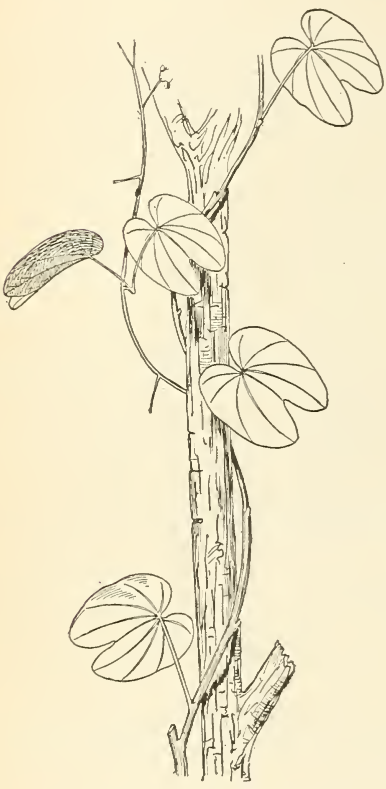

FIG. 31.—Leaves of *Bauhinia vahlii*.

Bauhinia splendens. THE CHAIN CREEPER.

NATIVE NAME.—*Bejuco de Cadena* (Venez.). *Bejuco* (Cent. Am.).

Grows wild in Brazil, Venezuela, and South America generally. Samples of the fibrous bark from the countries named were received from the Phil. Int. Exh., 1876. "Found in hot, damp forests. The stems are extremely flexible and tough so that they can be used as cords, being more durable than iron nails, which in the damp atmosphere rust very soon and give way." (*Ernst.*)

Specimens of heavy cordage from this species exhibited in the museum of the Department were made by twisting together the unprepared strips of bark as peeled from the plant. The ribbon-like strip is very dark, almost black, and the cordage is of the coarsest description. The cables are about 1¼ inches in diameter. In the handbook of Para, *Bauhinia* is referred to as the *muraró*, which produces strong fibers for ropes. Also found in Costa Rica.

Beach grass (see *Ammophila*).

Bear grass (see *Yucca* and *Dasylirion*).

Beaumontia grandiflora.

Exogen. *Apocynaceæ*. Evergreen climber.

India, east and north Bengal. From Nepal eastward to Sikkim, Sylhet, and Chittagong, ascending to 4,000 feet elevation.

SURFACE FIBER.—"It furnishes the best seed hairs yet known, though least utilized. The fiber is said to be not only the most lustrous and most purely white of all the so-called 'vegetable silks,' but possesses besides a remarkable degree of strength. Moreover, the hairs are very easily separated from the seeds. The dimensions of the fibers are, 1.181 to 1.771 inches long, and 0.001287 to 0.00195 inch in diameter." (Spon.) A fiber is also prepared from the young twigs. (*Watt.*)

Bédanjir (Pers.). See *Ricinus communis.*

Bedolee sutta (Ind.). See *Pæderia.*

Bejuco, or **Bejuco de Cadena** (S. Am.). See *Bauhinia splendens.*

Beligobel (Ceyl.). *Hibiscus tiliaceus.*

Belli pattá (Bomb. and Ceyl.). See *Hibiscus tiliaceus.*

Bene. *Andropogon squarrosus.*

Bengi (Panj.). *Cannabis sativa.*

Bent grass (see *Ammophila arenaria*).

Bermuda palm. *Sabal blackburnianum.*

Bertholletia excelsa. BRAZIL NUT TREE.

Exogen. *Lecythidaceæ.* Tree, 100 to 150 feet.

Native of British Guiana, Venezuela, and Brazil. The fruit is the well-known Brazil nut. The tree is one of the most majestic in the South American forests, attaining a height of 100 or 150 feet, with a smooth cylindrical trunk, about 3 or 4 feet in diameter, and seldom having any branches till near the top. (*A. Smith.*)

FIBER.—Samples of the bark of this tree were exhibited at the Philadelphia Exhibition with the fiber produced from it. "Used as a substitute for oakum for calking vessels" (*De Gama*).

Betel-nut palm (see *Areca*).

Betina-da (Ind.). The fiber. See *Melochia arborea.*

Betula bhojpattra. INDIAN PAPER BIRCH.

Exogen. *Betulaceæ.* A tree.

An Indian species, found in the higher ranges of the Himalayas, in India. "The bark is well known as the material upon which the ancient Sanskrit manuscripts of northern India are written."

FIBER.—The bark, in sheets, used as a substitute for paper. "The young branches are plaited into twig bridges" (*Watt*). It is also used as wrapping paper and in the manufacture of the flexible pipe stems used by hookah smokers. Has been used for umbrellas and for clothing by Hindu pilgrims in Kashmir.

Betula papyrifera. PAPER BIRCH. CANOE BIRCH.

North America. Northwestern and northeastern in United States; northward in British America. It reaches a higher latitude than most other North American trees; grows to a height of 60 feet. "The wood is extensively employed in the manufacture of spools, shoe lasts, and all kinds of turnery; lately much employed for paper pulp" (*B. E. Fernow*).

The thick bark of this tree, which can be readily removed from a long clean trunk in spring, is the one employed by the Indians for making their bark canoes. The bark is also used in the manufacture of small ornaments, such as napkin rings, baskets, pincushions, etc. (*G. B. Sudworth.*)

Bhabur grass (see *Ischæmum*).

Bhánga (Sanscrit). *Cannabis sativa.*

Bhátiál jute (Ind.). See *Corchorus.*

Bhat niggi (Ind.). See *Wikstrœmia.*

Bhendi
Bhindi } (Ind.). *Thespesia populnea* and *Hibiscus esculentus.*

Various forms of the word are used in different provinces, and for both species.

Bible, Fibers of the. See Ancient Fibers, in Introduction, page 11.

Biboci (Bolivia). See *Couratari.*

Bichu (Ind.). *Urtica dioica.*

Bignonia viminalis. LIANE Á CORDES, of the French colonies.

Exogen. *Bignoniaceæ.* Climber.

Many species of the genus are found in North and South America. They are scandent, tendrilled plants, often climbing to the tops of the highest trees. *B. viminalis* is mentioned in Bernardin's Catalogue as a cordage substitute. "The natives of French Guiana use the tough, flexible stems of *B. kerere* as a substitute for ropes, and from strips of them weave various kinds of baskets and broad-brimmed hats" (*A. Smith*). *B. æquinoctialis* is a Brazilian species. "From the young branches the natives make baskets and fishing-tackle" (*Savorgnan*). See *Tecoma.*

Bingo-i. Japanese matting rush. See *Juncus.*

Bira-bira (Arg.). See *Daphnopsis leguizamonis.*

Bissus. The ancient Greek name of flax. *Linum.*

Birch. See *Betula.*

Bixa orellana. ARNATTO. THE ROCOU.

Exogen. *Bixaceæ.* Small tree, to 30 feet.

NATIVE NAMES.—*Uruca* (Braz.); *Kougkuombi* (Beng.).

Tropical America. Escaped from cultivation in India. This species supplies the well-known Arnatto dye.

FIBER.—"The bark yields a good cordage" (*Watt*). Enumerated in the State of Para (W. C. E., 1893) among the species that yield fibers for rope making.

Black Ash. *Fraxinus nigra.*

Black Bunch grass. *Hilaria jamesii.*

Black Fiber (Ceyl.). *Caryota mitis.*

Black Grama. *Muhlenbergia pungens.*

Black Reed (Vict.). See *Ghania.*

Black Run Palm (Afr.). See *Borassus.*

Black sage. See *Cordia.*

Blood wood. See *Croton gossypiifolius.*

Blue grass. *Poa pratensis.*

Blue mahoe. *Hibiscus elatus.*

Blue moor grass (Gt. Brit.). *Molinia cœrulea.*

Bocca di Leone (It.). See *Antirrhinum majus.*

Bockara (of Bernardin), or **Bokhara clover.** See *Melilotus.*

Boehmeria spp. STINGLESS NETTLES.

This genus of *Urticaceæ* comprises 40 or more species found in both hemispheres, and is closely allied to the genus *Urtica*, the plants of which have stinging hairs. They are herbs or shrubs producing slender stalks, clothed with large, obovate leaves. There is but one American representative of the genus, *Boehmeria cylindrica* (the false nettle), an annual plant found in waste lands from Ontario, Canada, to Minnesota and southward from Florida to Kansas. It has no value as a fiber plant. *B. caudata* is a Brazilian species used only medicinally, and *B. stipularis* is found in the Sandwich Islands, its bark having been used to a slight extent for making "kapa," or native beaten cloth. An allied species, *Pipturus gaudichaudianus*, formerly included in the genus *Boehmeria*, is also used in this manner by the natives of these islands. Other Indian species are *B. polystachya*, *B. sidæfolia*, *B. didymogynæ*, etc.

Among the species native to India, of which there are nearly a score, are found some better fiber plants, though not worthy of special mention. I may note, however, *B. macrophylla*, which abounds from Kumaon to the Khásia hills, and which yields a beautiful fiber much prized by the natives for fishing nets. *B. platyphylla* is a south Indian species which produces a strong cordage bast, and *B. malabarica* is found in the tropical forests of India, Burma, and Ceylon. This species yields a very tenacious fiber which has found use in Ceylon for fishing lines.

The commercially important species of *Boehmeria* are *B. nivea* and *B. tenacissima*, full descriptions of which are to be found below. See fig. 1, Pl. VIII, the upper portion of a stalk of *B. nivea*, showing form of leaves.

Regarding the identity of these two species, particularly in relation to their common names, so much confusion has existed that Dr. Morris, of the Royal Gardens, Kew, has proposed the following economic classification, which has been adopted:

Series A—*Boehmeria nivea.*

1. China grass. The commercial fiber, hand cleaned in China.
2. China grass. Stripped bast or ribbons (hand or machine).
3. China grass Fiber prepared (hand or machine).

Series B—*Boehmeria tenacissima.*

4. Ramie or Rhea. Ribbons or stripped bast (hand or machine cleaned).
5. Ramie or Rhea. Fiber prepared (either hand or machine).

It should be further noted that *B. nivea* is the temperate and subtropical species, while *B. tenacissima* thrives best in subtropical and tropical climes.

There are several allied species which produce superior fiber, among which may be mentioned *Maoutia puya*, found in India. See also *Touchardia latifolia*, which produces the *Olona* fiber of the Sandwich Islands, a textile that should be better known.

Boehmeria nivea. CHINA GRASS.

Exogen. *Urticaceæ*. Shrub 5 to 8 feet as cultivated.

NATIVE NAMES.—The following names have been used indiscriminately to designate the two commercial species of *Boehmeria* (see economic classification under *Boehmeria*): China grass, *Rhea*, *Ramie* (Eng.); *Ramio* and *Ramie* (Span.); *Ortie Blanche sans dards de Chine* (Fr.); *Ramie*, *Rameh* (Java); *Tsjo*, *Mao*, and others (Jap.); *Tchou-ma* and others (China); *Klooi*, *Caloee*, etc. (Siam); *Kankhúra* (Beng.); *Poah* (Nepal); *Goun* (Burm.), and many others.

Indigenous in India, and probably also in China, Japan, and the Indian Archipelago, but introduced by cultivation into the warmer parts of Europe and North and South America.

The China grass (*B. nivea*) is a shrubby plant with the habit of the common nettle, but without stinging hairs. There are numerous straight shoots that arise from the perennial rootstock to a height of 4 to 8 feet. The leaves are on long petioles, broadly heart-shaped, with serrated edges and white, downy beneath. The seeds are small, and produced somewhat sparingly. This is the original China grass plant so long cultivated by the Chinese under the name of *Tchou Ma*. There are two forms of this plant. One is the China grass mentioned above, *Boehmeria nivea*, a temperate, and the other, ramie or rhea, a tropical, plant, known as *B. nivea*, var. *tenacissima*. It would be well to preserve these distinctions in regard to the fiber also. The term ramie, or rhea, should only be applied to the variety *tenacissima*. This differs from the type by its more robust habit and larger leaves, which are green on both sides. This character easily distinguishes it from China grass, which has leaves white-felted beneath. The distinction here suggested is an important one. Ramie or rhea is a native of Assam and the Malay Islands. It thrives only in tropical countries, and it is useless to cultivate it elsewhere. At Kew it has been found that while ramie or rhea (*B. nivea* var. *tenacissima*) can not be grown in the open air, the China grass (*B. nivea*) remains in the ground all the winter, and furnishes a crop of shoots, but only once in the year. The value of the ramie or rhea fiber, as compared with China grass, has not been carefully and fully investigated. Ramie from India has, however, not proved so valuable, so far, as the China grass. In the large mass of literature on China grass there is considerable confusion between it and ramie or rhea, and the results in consequence lose their value. (*Dr. D. Morris.*)

FIG. 32.—A properly grown stalk of ramie.

BAST FIBER.—The fiber of China grass is strong and durable, is of all fibers least affected by moisture, and from these characteristics must take first rank in value as a textile substance. It has three times the strength of Russian hemp, while its filaments can be separated almost to the fineness of silk. In manufacture it has been spun on various forms of textile machinery, also used in connection with cotton, wool, and silk, and can be employed as a substitute in certain forms of manufacture for all of these textiles, and for flax also, where elasticity is not essential. It likewise produces superior paper, the fineness and close texture of its pulp making it a most valuable bank-note paper. The fiber can be dyed in all desirable shades or colors, some examples having the luster and brilliancy of silk. In China and Japan it is extracted by hand labor; it is not only manufactured into cordage, fish lines, nets, and similar coarse manufactures, but woven into the finest and most beautiful of fabrics.

The specific gravity of ramie[1] yarn is less than that of linen yarn in the ratio of 6 to 10, so that 1 kilogram linen yarn No. 10 measures 6,000 meters, while the same weight of ramie yarn measures 10,000 meters. This peculiarity lessens the apparent difference in the price of the two yarns. On the other hand, ramie yarn is heavier than cotton in the ratio of 6 to 5. Ramie yarn is easily distinguished from other yarns by its high luster and silky appearance, in which it excels linen and cotton. Ramie fibers are distinguished from all other fibers by their great length, usually from 10 to 15 centimeters (often 25 to 40 centimeters or more), by a certain straightness and stiffness, and by the considerable breadth

[1] The term *ramie*, used in this statement, as well as in those which follow, refers to the fiber from either species of *Boehmeria*, Ramie proper being *B. nivea* var. *tenacissima*, while China grass is *B. nivea*.

of from 0.04 to 0.06 millimeter (flax, 0.016; cotton, 0.014 to 0.024; silk, 0.009 to 0.029). (*Dr. Hassack.*)

HISTORY.—The active interest in China grass, ramie, and rhea began in 1869, when a reward of £5,000 was offered by the Government of India for the best machine with which to decorticate the geeen stalks. The first exhibition and trial of machines took place in 1872, resulting in utter failure. The reward was again offered, and in 1879 a second official trial was held, at which ten machines competed, though none filled the requirements, and subsequently the offer was withdrawn. The immediate result was to stimulate invention in many countries, and from 1869 to the present time inventors have been untiring in their efforts to produce a successful machine.

The first records of Chinese shipments of fiber to European markets show that in 1872 200 or 300 tons of the fiber were sent to London, valued at £80 per ton, or about $400. India also sent small shipments, but there was a light demand and prices fell to £30 to £40 per ton for Chinese and £19 to £30 for the India product. In a letter from Messrs. Ide & Christie, the London fiber brokers, discussing the point of demand and supply, received in 1890, it was stated that ramie ribbons had at no time been shipped to Europe from any country in large quantity. Three hundred or 400 tons during the preceding five years would represent the maximum quantity brought from China, while India and other producing countries had sent little more than sample lots and trial parcels. The largest lot of ramie ever received at any one time was in October, 1888, when 120 to 130 tons of ribbons were offered in the London market. There was nothing like competition for it, and it was sold for £8 to £9, less than half what it cost in China.

Experiments in manufacture in England date back to the sixties. There were difficulties, however, in the way of preparing the fiber and in adapting machinery for spinning it that made these processes too costly, and after fortunes had been wasted the effort was abandoned.

Ramie seed is said by Favier to have been first introduced into France in 1836, and in 1844 plants were brought from China by the surgeon of the war ship *Favorite*, which were grown in the acclimating gardens. While one writer claims that the plant was first brought to the gardens of Europe in 1733, Favier states that Dr. Fras cultivated the plant in the botanical gardens of Munich in 1850, and that it was grown in Belgium in 1860.

Introduction into the United States dates back to 1855, but the records seem to show that it did not obtain a foothold in Mexico until 1867, the year in which the first American ramie machine was brought to public attention. It is interesting to note that the first shipment of plants into France in considerable number was from America, 10,000 plants having been imported for distribution in France and Algiers in 1868.

The first French official trials took place in 1888, followed by the trials of 1889, in Paris, at which the writer was present, and which are recorded in Report No. 1 of the Fiber Investigations series. Another trial was held in 1891, and in the same year the first official trials in America took place, in the State of Vera Cruz, in Mexico, followed the next year by the first official trials of American machines in the United States; these being followed by the trials of 1894. The history of the experiments in cultivation in the United States are recorded or referred to in the reports issued by the Office of Fiber Investigations of the United States Department of Agriculture, notably Nos. 1, 2, and 7, to which reference should be made for more detailed statements than are here presented.

CULTIVATION.—In general terms it may be said that the ramie plant requires a hot, moist climate, with no extremes of temperature, and a naturally rich, damp, but never a wet, soil, the necessary moisture to be supplied by frequent rains or by irrigation; in other words, such a climate and soil that, when the growing season has commenced, the growth will be rapid and continuous. In the United States the best localities, so far as experiment has determined, are portions of Florida, Mississippi, Louisiana, and Texas on the Gulf, and central California on the Pacific

Coast. The other Gulf States, doubtless, will prove equally favorable to this culture when more extensive experiments have been undertaken than are now recorded. Regarding the northern limit of commercial culture it is difficult to make positive statements. The plant thrives in South Carolina, and it is fair to suppose that two annual crops are possible, though the quality and yield of the fiber can only be ascertained to a certainty by careful tests of the product of both crops. North of this State commercial culture is hardly possible. Intelligently conducted experiments in Missouri have demonstrated that but a single crop of fiber, of doubtful value, can be secured in a season in that latitude, while attempted culture in the State of New Jersey, with the aid of a State bounty, resulted in nothing. In China the commercial crop is produced between latitudes which in this country form very nearly the northern and southern boundaries of Louisiana. Fig. 30 is a properly grown stalk of ramie, which matured seed in ten weeks in Louisiana. (See also fig. 32). Fig. 31 is a stalk of ramie, which grew through an entire season on the grounds of the Department of Agriculture in Washington without even blossoming, while the plants branched to such an extent that the stalks were totally ruined for fiber. In no country are the stalks cut for fiber until mature, for if cut before proper maturity the portion of the stalk which is still growing and green and succulent can not produce fiber. These facts disprove, in toto, the idea that ramie can be cultivated for its fiber as a paying industry in any section where straight, properly-matured stalks, free from branches, can not be grown, and produce at least two annual crops.

FIG. 33.—An improperly grown stalk of ramie.

In the Gulf States ramie has been grown experimentally in a great variety of soils, from the light sandy uplands to the rich black lands of the Louisiana bottoms, though light, sandy, alluvial soils have always given the best results. In California deep alluvial, sandy, or loamy lands which, when well prepared, will hold their moisture through the growing season, or that can be irrigated, are most commonly selected. Dr. Hilgard, director of the California Agricultural Experiment Station, says only strong soils can be expected to produce in one season one crop of 10 tons of stalks of any kind, and that few can continue to produce such crops for many years without substantial returns to the land, no matter how fertile originally. Among the strongest soils in the State are those containing more or less of "alkali," and, as these are mostly valley lands, the question of their adaptation to ramie culture is important. He considers that the plant will stand alkali provided it is not of the black kind, viz, carbonate of soda.

In all countries where ramie has been grown commercially or experimentally the necessity for heavily enriching the soil by the application of the farm manures or chemical fertilizers is emphasized, for successful ramie culture is an impossibility on impoverished land. Where it is difficult to obtain sufficient quantities of manure it is recommended to collect and burn all refuse of decortication and return the ashes to the soil. The proportion of mineral constituents found in the fiber which is taken away is very small. The French writers attach great importance to the use of leaves as fertilizing material, and as these amount to almost half of the green weight of the crop, the advantage of such a practice will be readily appreciated. Well-decomposed stable manures and well-ground chemical fertilizers, guano, and oil cake are all used with success upon French ramie plantations. The practice is to spread these upon the land, the rains or irrigation carrying the nutritive elements to the roots of the plants. About 7,000 pounds of stable manure, or 525 to 615 pounds of chemical fertilizers or oil cake are used per acre. Allison recommends 300 pounds of cotton-seed meal and 300 pounds of kainit per acre.

The plant is propagated by seeds, by cuttings, or by layers, and by division of the roots. When produced from seed, open-air planting can hardly be relied upon, plants started in the hotbed giving the best results. After planting, the seeds are covered thinly with sifted earth and kept shaded from the sun until the young plants are 2 or 3 inches high. In five or six weeks they will be strong enough to transplant to the field. The most practical method is propagation by a division of the roots of old or fully matured plants. (See fig. 35.)

In preparing the land for a plantation, thorough tilth—that is, deep plowing and cross harrowing—is essential, which should be done in the fall. The ground is frequently broken to a depth of 15 inches or more, but never less than a depth of 12 inches, to secure good results, and lumpy land is rolled. Before planting, the ground is again cross plowed, harrowed, and rolled, about the 1st of February being a good time for the work. The roots are usually set in rows 4 to 5 feet apart, and 1 foot to 15 inches in the row, although practice differs in different sections.

Fig. 34.—Clusters of flower racemes of ramie.

The estimated cost of establishing a ramie plantation in the United States per acre is about $60, including purchase of 8,000 roots at $35, and about $10 for fertilizers. The crop is ready to cut when the leaves can be readily detached by passing the hand down the stems and when the base of the stalks begins to turn brown. In France the first crop is cut from June to July, and the second from September to October. See chapter on culture, in different countries, in Report 7, Fiber Investigations series, published by the United States Department of Agriculture.

Yield.—The yield per acre of green stalks with leaves has been placed at 8 to 10 tons, or say 25 tons for two cuttings under the most favorable circumstances. A calculation based on the above figures places the yield of dry fiber per acre at about 1,000 pounds for two annual cuttings, provided that the crop has been properly grown. Mr. Charles Rivière (director of the botanic garden at Algiers) states that 1,000 kilograms (2,200 pounds) of stalks and leaves will yield 520 kilograms (1,144 pounds) of stripped stalks; the 520 kilograms of stripped stalks will give 104 kilograms (228.8 pounds) of dry stalks, and these will yield 20.8 kilograms (45.7 pounds) of decorticated product (a little less than 20 per cent), and this weight will give 11.2 kilograms (24.6 pounds) of degummed filasse. "This is a yield which I have proven in all my experiments" (*De Landtsheer*). This means that a long ton of green ramie stalks with leaves will yield 46½ pounds of decorticated fiber, which will give 25 pounds of degummed fiber, the figures forming a ready basis of calculation when the total weight of an acre of stalks is known.

Extraction of the Fiber.—There are but three ways in which the fiber of China grass and ramie may be extracted: By hand stripping, as practiced in China; by boiling the stalks in water or solutions, which also requires a certain amount of hand manipulation; and by machinery. The stripping by hand can only be made to pay where wages are down to the level of these paid in China, and almost the same may be said of boiling processes, on account of the after handling necessary to separate trash from fiber when the bark separation has been accomplished. As far as the Department has knowledge of new machines, this phase of the ramie question is still unsettled, though progress is being made from year to year, as old machines are improved and new ones are devised. For further considerations of this subject, see Appendix A.

Degumming of the Raw Fiber.—Before the fiber can be combed, it is subjected to a chemical treatment called degumming. Through the researches of the late M. Frémy, member of the French Institute, it has been shown that the gums and cements holding together the filaments of ramie are essentially composed of pectose, cutose, and vasculose, while the fiber itself is composed of fibrose, cellulose, and its derivatives. The theory of degumming, therefore, is to dissolve and wash out the gums without attacking the cellulose. In order to eliminate the vasculose and cutose it is necessary to employ alkaline oleates or caustic alkalies, employed under pressure, and even bisulphates and hydrochlorates. The gums being dissolved, the epidermis is detached and can be mechanically separated from the layers of fiber by washing. The larger number of degumming processes in present use embody these general principles.

French experimenters have shown that it costs no more to degum the China grass that will fill a kier or tank of certain dimensions than the charge of simple stripped ribbons that will fill the same tank. Yet the weight of China grass that will fill this kier will be almost double that of the stripped bark, and while the kier of China grass will show a shrinkage (waste) of only 30 per cent, let us say, the loss from the stripped bark may be 66 per cent. To state this differently, a half-ton charge (1,120 pounds, French) of China grass may give 775 pounds of degummed fiber, the expense of degumming (at $20 per charge, let us say) being about 2⅗ cents per pound. Now the same kier, when charged with simple stripped bark, will hold only 660 pounds and give but 264 pounds of degummed filasse. But, as the cost of degumming the contents of the tank will be the same in both instances, the last operation has cost 7½ cents per pound of pure fiber turned out. The commercial value of the degummed fiber is stated according to French figures at about 13½ cents per pound.

Fig. 35.—Ramie roots before subdivision.

Manufacture.—It is not important to go into the details of manufacture here. This branch of the industry has passed the stage of experiment and is an established fact. At the present time there are two filatures or spinning mills in France, two in Germany, one in Austria, one in Switzerland, and two English companies, one of which—the Boyle Fiber Syndicate—operates at Long Eaton. Probably the most successful spinning mills are those operated at Emmendingen, Baden, Germany.

Uses of the Fiber.—As to the possibilities of ramie manufacture there seems to be no limit. Stuff goods for men's wear, upholstery, curtains, laces and embroideries, plushes and velvets, stockings, underclothing, table damask, napkins, handkerchiefs, shirtings, sheetings, sail duck, carpets, cordage, fishing nets, and yarns and threads for various uses not enumerated, bank-note paper, etc. Regarding these various uses of ramie fiber in manufacture, however, M. Roux says we should not conclude that this textile is destined to be employed so largely. The cost of its preparation will always prevent its common use as a substitute for the textiles that can be more cheaply grown and prepared. He concludes that while it has brilliancy it has not the elasticity of wool and silk, nor the flexibility of cotton; but it will always be preferred for making articles requiring the strength to resist the wear and tear of washing or exposure to weather. This facility to imitate all other textiles is one of the principal causes which has kept back the development of the ramie industry; and if, instead of launching out into a series of experiments, attention had been concentrated upon the exclusive manufacture of those articles to which the properties of the plant were peculiarly and naturally adapted, this industry would probably be in a more advanced condition than it is at present. The Department of Agriculture has held to this position since its work in this field was begun. The folly of building up a ramie manufacturing industry on a false basis, that is, employing the textile as a substitute for something else, is to be deprecated. The fiber should be used in those articles of economic necessity which would appear on the market as ramie, that any distinctive merit the textile may possess will become known, not only to the ramie trade, but to consumers of the product.

AUTHORITIES.—The publications upon this subject are legion. A few principal English references are therefore given, viz: Report on Rhea Fiber (*Watson.*), London, 1875; various articles in Bull. Royal Kew Gardens (*Morris.*); Dic. Ec. Prod. Ind. (*Watt.*); Spon's Enc., pt. 3; Reports 1, 2, and 7, Fiber Investigations series, U. S. Dept. Ag. (*Dodge.*); Bulletin of the Experiment Station of Louisiana, No. 32 (*Stubbs.*), and of the California Experiment Station, Nos. 90 and 94. (*Hilgard.*) See also the French publications of Favier, De Landtsheer, Michotte, Roux, and of the Ministry of Agriculture.

Boehmeria tenacissima. RAMIE, OR RHEA.

Tropical variety of *B. nivea*. Dr. Morris states that the term ramie, or rhea, should only be applied to *tenacissima*, which may be known by its robust habit and larger leaves, which are green on both surfaces, and which do not show the silvery white under surface characterizing *B. nivea*, or the plant belonging to a temperate climate. For general statements as to cultivation, etc., see the preceding species.

Bog Moss (See *Sphagnum cymbifolium*).

Bois (Fr.).=wood.

——— *ceip, Ocotea sieberi;* ——— *dentelle, Lagetta lintearia;* ——— *l'ome, Guazuma ulmifolia;* ——— *sang,* see *Croton.*

Bola (Beng.). See *Hibiscus tiliaceus.*

Bolobolo (W. Afr.). See *Honckenya.*

Bombax ceiba. GOD-TREE. YAXCHE.

Exogen. *Malvaceæ.* A large tree.

This species of *Bombax*, or silk cotton tree, was considered by A. Smith, in the Treasury of Botany, to be the same as *Eriodendron anfractuosum.* Examples of silk cotton labeled *Ceiba* were received from the Mexican exhibit at the World's Columbian Exhibition of 1893. On the authority of Dr. Ernst, of the National Museum of Carácas, "*Ceiba*" fiber is stated to be the product of *Bombax ceiba*, and is applied to the same uses as the silk cottons from allied species. The Peruvian name is *Huimbaquiro-ceibo.*

SURFACE FIBER.—Distinguished by its yellowish color and lustrous silky appearance. Like other seed hairs, it can not be spun unless mixed with other fibers. "Used in the manufacture of mattresses, cushions, etc., and the bark is useful for cordage" (*Dorca*). See *Ceiba, Bombax malabaricum,* and *Eriodendron anfractuosum,* in the alphabetical arrangement.

Bombax malabaricum. RED SILK COTTON.

Syn., *Salmalia malabarica.*

The Simal Tree of India. Abounds throughout the hotter forests of India and Burma; distributed to Java and Sumatra.

The fruit of the various species of Bombax is a woody capsule with divisions containing numerous seeds, each seed surrounded by a mass of silky hairs, which, when collected after the opening of the pod, produce the "silk cotton."

SURFACE FIBER.—The silk-like down, or seed hairs, described above and known as Simal cotton may be used as upholstery material, for stuffing pillows, etc. The "cotton" is similar, though inferior, to the kapok of commerce derived from *Eriodendron anfractuosum*, which see.

Fiber too short and soft to be spun. The smoothness of the cotton prevents cohesion or felting, and hence in the textile industries could only be used to mix with others, imparting a silky gloss to the fabric. It has also been talked of as a paper fiber. The inner bark of the tree yields a good fiber suitable for cordage. (*Watt.*)

* *Specimens.*—Herb. Col. Univ., N. Y.; Bast fiber, Bot. Mus. Harv. Univ.

Bombax mungaba. SILK COTTON OF BRAZIL.

A tree, 80 to 100 feet, common along the banks of the Amazon and Rio Negro. Its fruit is about 8 inches long by 4 wide, and of a clear brick color. The silk cotton surrounding the seeds is light brown in color. It has found limited use as a material for stuffing cushions. In a catalogue of the products of Brazilian forests, by Jose Saldanha da Gama (Phil. Int. Exh., 1876), it is stated that this tree furnishes in its bark fibrous material for coarse rope, as well as vegetable silk in its pods. He also mentions *Eriodendron samauma* as "the largest tree of the Amazon, the fruit containing a silk much sought for mattresses."

A species of *Bombax* silk-cotton was received from the Venezuelan Department, W. C. E., 1893, named *Sibucara* wool, and another example was labeled "*Lana del Tambor*, the silky wool which envelops the seeds of *Bombax cumanense*. It can not be spun, but is used for making pillows." (*Ernst.*)

Bombax pubescens. THE EMBIRA-GUASSÚ.

This is also called the *Embir-ussú* in Brazil. It is found in the province of Minas Geraes, and attains a height of 25 to 30 feet.

BAST FIBER.—This species has a tough, fibrous bark, which yields quite a strong fiber, resembling jute in color, and very useful for making ropes and cordage. A surface fiber is also obtained from its seed capsules, much employed in Sao Paulo for filling bolsters and mattresses. The tree is found in secluded places and blossoms in the winter.

Löfgren mentions another species (*B. gracilipes*), which is found in brambly localities along the river banks, and which also supplies fiber.

Bombay Aloe (see *Agave vivipara*).

Bombonaje (S. Am.). See *Carludovica palmata.*

Booba Palm (Braz.). See *Iriartea exorrhiza.*

Borassus flabellifer. PALMYRA PALM.

Endogen. *Palmæ.* Tall palm.

NATIVE NAMES.—*Tal, Tari,* etc. (Hind.); *Tal-gas* (Ceyl.); *Tan, htan,* (Burm.), and others. In west Africa known as the Black Run Palm.

Found in Ceylon and the Indian Archipelago; throughout tropical India, in Bengal, and Northwest Provinces. Cultivated in Ceylon. Also found in tropical west Africa.

STRUCTURAL FIBER.—This is obtained from the base of the petioles, or the sheathing leafstalks. It is stiff, harsh, wiry, and resembles the bass and *piassaba* fibers of commerce, particularly the Brazilian forms. A trade name is bassine.

It came into notice as a commercial article in 1891, when the high prices of *piassaba* induced the introduction of substitutes. At that time even split rattan, stained black, was requisitioned as a brush fiber. Palmyra fiber has steadily increased in quantity, and, contrary to what was at first anticipated, it has also risen in value.

Palmyra now has practically taken the place of west African bass. The latter on the 16th of September, 1895, was "dull, business small, £14 to £23 per ton." Palmyra fiber on the other hand was: "Good, £26 to £34; medium, £22 to £25; common, £15 to £19 per ton" (*Dr. D. Morris*).

The fiber extracted from the leafstalks is used for rope and twine making, and may also be used for paper. This fiber is strong and wiry, and is about 2 feet long. In Ceylon it is extracted and the ropes and string largely used for cattle yokes and other agricultural purposes are made of it. In Madras it is also made into rope and twine. In Bengal the trees are too scattered to admit of an extended trade in this fiber. The long cord-like and dark-colored fibrovascular bundles are carefully extracted, however, while preparing dugouts, etc. By the fishermen these are made into invisible fish traps. (*Watt.*) Employed in the United States as a brush material, and imported in bundles of prepared fiber.

Every part of the plant is employed in one way or another, some 800 uses having been enumerated. Further accounts in the Dic. Ec. Prod. Ind.; Cantor Lectures, London, 1895.

**Specimens* of the fibers were received from the Ceylon court, W. C. E., 1893.

Bowstring hemp (see *Sansevieria*).

Brachystegia, spp. UGANDA BARK CLOTH TREES.

Exogens. *Leguminosæ*. Trees, 20–50 feet.

NATIVE NAMES: The several species are known variously as *Mecomba, Matondo, Motondo, M'Chenga*, and others.

Found in the Uganda country, Africa, several species being referred to in the Bulletin of the Royal Kew Gardens for 1892, from which this account is reproduced. The trees produce a bark cloth.

BAST FIBER. Messrs. Speke and Grant, in their expedition to the sources of the Nile, 1860–1863, made some interesting notes on the preparation and uses of cloth from this source. They say of *Brachystegia spicæformis* Benth., that it is a light, graceful tree of 20 to 40 feet high, common in rich forests, and is known in the Robeho Mountains, Zanzibar, under the name of "*M'chenga*" or "*M'nenga*," the bark of which is made into kilts, cloths, bandboxes, huge grain stores, matches, roofing for camp huts, etc.; they also add that a blood-red juice exudes on cutting the bark. These same explorers collected slight herbarium material at Keegwah, in lat. 5° 5′ S., of what is so far determined as *Brachystegia tamarindoides* Welw. var.? With the following note: "Native name '*Mecombo*,' a first-class tree, as it has so many uses. Tree 50 feet high; long, naked trunk 9 feet in circumference. Foliage deep green. The wood is considered good for building. Its bark, after being boiled and prepared, is made into white sheets of cloths worn by the natives at 10° S. They also make canoes, boxes, matches, and ropes from it. Its honey is considered very superior in flavor and whiteness. First met with 30 miles from the sea; afterwards in the interior it was frequent. It is so plentiful at 6° S. lat. that our temporary huts were roofed with its bark, and my plants were protected by planks of its bark, which answered admirably, being light and stiff." During Livingston's Zambesi expedition, in 1860, Sir John Kirk collected specimens of *Brachystegia appendiculata* Benth., a tree of 20 to 40 feet high in the highlands of the Batoka country, where it is known by the name of "*Motondo*" (*Setoka*), the seeds being eaten by the natives; he also collected the same species near Muata Manja, 14° 19′ S. lat., and states that the fibrous bark is made into cloth by being beaten out. According to Dr. Meller, this tree is known as "*Chenga*" near Zomba. The herbarium contains a specimen of *Brachystegia longifolia* Benth., collected by Mr. J. Buchanan in the Shire highlands, and bears the following label: "*Njombo*. Bark-cloth tree, wood very soft." Another herbarium specimen collected by Sir John Kirk near Kusuma, on the river Shire, is labeled *Brachystegia*, sp. nov., and is described as being a good-sized tree with a fibrous bark, which is used for cloth.

Brecco (Tuscan). See *Chrysopogon gryllus.*

Bricks, Ancient Clay. Made with stems of *Poa abyssinica.*

Brazil-nut Tree (see *Bertholletia*).

Broad-leaved flax lily (Tasm.). *Dianella latifolia.*

Brome (Fr.). *Abroma augusta.*

Bromelia spp.

A genus of plants having very short stems and densely packed, rigid, lance-shaped leaves, the margins of which are armed with sharp spines. They are natives of tropical America, though they have been distributed to the East Indies, Africa, and other countries, several species being cultivated as greenhouse plants.

While many species are known to produce fiber, three or four are regarded valuable as fiber plants, among them *B. pinguin* being the best known, while all are interesting. "*B. fastuosa*, commonly cultivated in greenhouses in England, yields fiber in New Granada" (*Dr. Morris*), and Spon states that *B. sagenaria*,[1] known in Brazil as the *Curratow*, is worthy of cultivation for its fiber. In portions of Mexico a *Bromelia*, cultivated as a textile plant, yields a fiber which is described as very fine, from 6 to 8 feet in length, and from its fineness and toughness commonly used in belt-making works. It also finds application in the manufacture of many articles, such as bagging for baling cotton, wagon sheets, carpets, etc., besides forming a valuable material for making cordage, nets, hammocks, and similar articles of common use. Beautiful examples of *Bromelia* fiber were brought back from Santo Domingo in 1871 by Dr. C. C. Parry, and at the W. C. E. many unnamed fibers of great length and fineness were shown which doubtless were derived from species of this genus. There is great confusion regarding the species of *Bromelia* yielding fiber, which can only be cleared up by studying the plants where they grow and extracting the fiber from the different species.

Bromelia argentina. CARAGUATÁ.

Endogen. *Bromeliaceæ.* Aloe-like leaf cluster.

Allied to the wild pineapple, *Bromelia pinguin.* Abounds in Paraguay and in northwestern Argentina. "Very abundant in the Gran Chaco and Missiones territories, Corrientes, and Santa Fé. Two forms are recognized, *Caraguata ibira* and the *Caraguatá de agua.*" (*Niederlein.*)

STRUCTURAL FIBER.—Soft and silky, obtained in lengths of 4 to 6 feet, medium strength, resembles pineapple fiber. The production is limited to native uses, such as for rude cordage, sacks, etc. There is no doubt that with proper machinery the preparation of this fiber might become a commercial industry in the countries where grown. I have met with it in South American exhibits at international expositions, and the samples secured were remarkably fine, particularly those from Argentina, where two species of *Bromelia* are thus employed. See also *Bromelia serra*, or the *chaguar*.

In the year 1870 Messrs. Branlio Artecona and Louis L. Lenguas made experiments with machinery that they established in the department of Arroyos y Esterios, Paraguayan Republic, having obtained from the Government a concession for the working of this product freely for the space of fifteen years in all fiscal lands, and to export the same when manufactured free of duty. This industry did not give satisfactory results, owing to the inexperience of those in charge and to the imperfection of the machinery. After several fruitless attempts they retired and their concession lapsed. In 1889–90 Mr. Artecona again organized the same industry with modern machinery, and took a contract from the company 'Tejidora,' of Buenos Ayres, for all he could remit. He remitted altogether 400 tons, and the result of the sale might have been

[1] *B. sagenaria* is now referred to *Ananas bracteatus.*

remunerative if he had not committed the fault of employing inexpert hands; he spent his capital in useless experiments, and again suspended operations. (Kew Bull., September, 1892).

Bromelia karatas (see *Karatas plumieri*).

Bromelia pinguin. THE WILD PINEAPPLE. PINGUIN.

Abounds in the West Indies and Central America, British Guiana, and Venezuela. Common in Yucatan; known as *Chom.* The species is common on the rocky hills of the West Indies, and particularly in Jamaica, where the plants are used for hedges and fences. It is abundant in Trinidad, where it grows on the poorer soils, the leaves often reaching a length of 5 or 6 feet.

In the literature of the fiber-producing species of *Bromelia* in tropical America the greatest confusion exists, and particularly in relation to the fiber of this species and *B. sylvestris.* I have myself been led into error regading *B. sylvestris,* basing my published statements on the literature of the subject of thirty or forty years ago, including the communications which appear in the earlier publications of the Department of Agriculture, and upon the records accompanying the specimens themselves received through the Smithsonian Institution, and from early correspondents of the Department, together with documents and specimens received at a comparatively recent period. Becoming convinced of the confusion regarding *B. sylvestris,* a communication on the subject was addressed to Dr. Morris, of Kew, who says in reply:

"I am afraid the investigation of the fiber-yielding members of the *Bromeliaceæ* is a very difficult question. We know really very little of the species yielding fibers in tropical America beyond two or three of the most common of them. *B. sylvestris* has been confounded by many writers as a form of the common pineapple. Hence, fiber labeled *B. sylvestris* may after all be nothing but pineapple fiber. The true *B. sylvestris* Willd, figured in the Bot. Mag., t. 2392, as the 'narrow-leafed wild pineapple,' probably does yield fiber, but it is impossible to say without careful study of the plant itself whether it is the form of the common pineapple or true *B. sylvestris.* The wild pineapple fiber of British Honduras, which is mentioned in my book as *Bromelia pita* is probably *Karatas plumieri* yielding silk grass. The former must be dropped. It has no meaning except as a synonym of the latter."

B. pinguin is everywhere common in the West Indies, yet only one or two specimens from the West Indies in the Department collection are labeled *pinguin,* while many are named *sylvestris.* A recent specimen from Trinidad, marked *B. sylvestris,* and which also bears the name *pinquine,* is probably from this species. See further remarks under *B. sylvestris.*

BOTANICAL DESCRIPTION.—*B. pinguin* Linn., Sp. Plant., 408 (Dill. Elth., t. 240, fig. 311; Trew Ehret., t. 51); Red. Lil., t. 396. *Agallostachys pinguin* Beer. *Karatas penguin* Miller. *Ananas pinguin* Gaert. *Karatas plumieri* Devan, non Morren—Acaulescent. Leaves 100 or more in a rosette, ensiform, stiffly erect in the lower half, reaching a length of 5 to 6 feet, 1½ to 2 inches broad at the middle, tapering gradually to the point, green and glabrous on the face, thinly white-lepidote on the back, armed with very large-toothed pungent brown prickles. Peduncle stout, stiffly erect, about a foot long, its leaves often bright red. Panicle dense, stiffly erect, 1 to 2 feet long; axis and branches densely mealy; branch-bracts oblong, pale, lower with a rigid spine-edged cusp; lower branches 3 to 4 inches long, bearing 6 to 8 sessile flowers; flower-bracts, minute, ovate. Ovary cylindrical, very pubescent, about an inch long; sepals nearly as long, with a densely matted tip. Petals reddish, densely matted at the tip with white tomentum, about 1¼ inches longer than the calyx. Berry ovoid, yellowish brown, 1 inch diameter. (*Dr. Baker.*)

STRUCTURAL FIBER.—In the Kew Bulletin for April, 1887, page 8, the fiber of this species is thus referred to: The fiber of the Jamaica *pinquin* (*Bromelia pinguin* L.) would appear not to be of high value. The plant covers hundreds of acres in the plains and lowlands of Jamaica, and an effort was made some time ago to prepare the fiber for commercial purposes. The report of the brokers upon a sample of 90 pounds was as follows: "A long, towzeled, weak fiber, of bad color, coarse, no strength, and only fit for breaking up. Similar to St. Helena hemp tow, but not so good. We should think £12 to £10 per ton the utmost value." Several samples of this pinguin fiber, from Jamaica and elsewhere, cleaned both by hand and by machine, are to be seen in the Kew Mus., No. 2.

* *Specimens* of the fiber were secured from the exhibit of British Guiana, W. C. E., 1893. "Used for commercial purposes only to a slight extent. Probably used for cordage by natives employed in making cables and large ropes for use on the rivers." (*Quelch.*) The Kew Bulletin for September, 1892, states that the fiber of the *pinguin* was carefully investigated by the botanical department in Jamaica in 1884. The plant covers hundreds of acres in the island, and it would readily support a large industry. Great difficulty was, however, experienced in extracting the fiber by machinery, without maceration, and the results were by no means satisfactory. Several samples were forwarded to London and to New York for the opinion of brokers, and the London reports were as follows: "Poor, dull fiber, gummy, fair strength, value about £20. Almost unsalable in the form sent, not well dressed, not good color, and in some parts rather tender. If this was better dressed it might have a sale, but in the present form, when so gummy, it is difficult to form an estimate of it."

Spon refers to the fiber "yielded by the leaves of *B. pigna* (*pinguin*), a native of the Philippine Islands, being woven into a most delicate textile fabric, known as *pigna* cloth, from which the celebrated manila handkerchiefs are made;" and M. Perroutel is said to have considered the pineapple cloth of the Philippines the product of a distinct species, which he called *B. pigna*, but this has been determined to be the cultivated pineapple, *Ananas sativa*, in a semiwild state. Specimens of "*guamara*" fiber were secured from the Mexican exhibit, W. C. E., 1893. Dr. Ernst refers *guamara* to *B. pinguin*, though the name has also been given to *Karatas plumieri*.

Bromelia serra. CHAGUAR.

This species abounds in the northwestern portions of Argentina. The fiber is chiefly used by the Indians, who manufacture it into cords, hammocks, sacks, etc., known as *chaguar*. In the Kew Mus. is shown a cuirass of *chaguar* fiber made by the Mataeo Indians of Argentina. "When worn by these people it is padded before and behind with cotton from the fruit of the Yachan, *Chorisia insignis*. By rolling themselves in water, the fiber swells and the whole becomes arrow proof." (Off. Guide Kew Mus.)

Bromelia sylvestris.

A form of "wild pineapple" found in the West Indies and Central America. While many examples of its fiber have been sent to the Department from time to time, specifically named *B. sylvestris*, I have serious doubts as to the correctness of the labeling in a majority of instances, for they not only differ widely when compared, but the statements concerning them give evidence of error and confusion.

BOTANICAL DESCRIPTION.—*B. sylvestris* Willd.; Sims in Bot. Mag., t. 2392. *Agallostachys sylvestris* Beer.—Acaulescent. Leaves ensiform, rigid, 3 to 4 feet long, 1½ inches broad low down, narrowed gradually to the point, bright green on the face, thinly albo-lepidote on the back, armed with strong hooked prickles. Peduncle a foot or more long, its leaves reflexing, the upper bright red. Inflorescence a narrow panicle with short spaced-out corymbose branches, all subtended by bright-red bracts, the lower with rigid spine-edged tips. Ovary pubescent, cylindrical-trigonous, about an inch long; sepals nearly as long as the ovary. Petals reddish, not matted at the tip, protruding one-fourth of an inch from the calyx. (*Dr. Baker.*)

STRUCTURAL FIBER.—Occurs in various forms, the age of the plant making a difference in the appearance and quality of the fiber. Dr. Morris states that "there are several samples of a wild pineapple (*Bromelia sylvestris* Willd.) from the West Indies and Central America at Kew, but there is no record of their commercial value." A sample sent to Kew from Trinidad in 1887, supposed to be from this species, was reported upon as follows: "Not in commercial use, but destined, we think, to a successful future; fine, soft, supple fiber, strong and good color, ample length, (worth) say £30 per ton and upwards."

A beautiful sample of fiber secured by me from the Mexican exhibit at the Paris Exposition of 1889, and labeled *B. sylvestris*, was very long, creamy white, fine, soft, and silky. A memorandum secured with the sample reads as follows: "Grows wild in a zone extending from Tustepec in the State of Oaxaca to Acayucan in Vera Cruz. Employed in making hunting bags or game pouches and fine woven textures. Formerly it was used for the fine sewing of shoes." This sample is finer, softer, and of a better color than any other samples labeled *B. sylvestris* in the Department collection. Regarding the correctness of the identification, however, nothing authoritative can be stated.

The name "silk grass," and "silk grass of Honduras" has been given to this species (in the books), though "silk grass" has also been given to other species, and even to the fiber of Agaves. Dr. Morris writes me that a wild form of the common pineapple, *Ananas sativa*, growing at Kew, yields a fiber called "silk-grass fiber" by the English. This plant is the "*Crowia*" of British Guiana (see also *Krowa* in this catalogue). He further states that the name silk grass is applied indiscriminately to the fiber of the common pineapple, of a *Bromelia*, a *Karatas*, and also of *Furcræa cubensis*. The name silk grass therefore serves no purpose of identification in connection with the fiber of *B. sylvestris*.

ECONOMIC LITERATURE.—In the monthly report of the United States Department of Agriculture for 1869, pages 232–233, there is a communication from Hon. J. McLeod Murphy, which, when sent to the Department, was "accompanied with three skeins of the istle fiber, *Bromelia sylvestris*," etc., and also with a package of the hackled fiber and small samples of fishing-tackle. In this communication the leaf is described as "being shaped like a sword, its edges armed with prickles similar, in fact, to the weapon formed from itzli, or obsidian, used by the Aztecs; hence the term." It was said to grow almost exclusively on the southern shore of the Mexican Gulf, between Alvarado and Tabasco, extending as far inland as the northern slopes of the dividing ridge which separates the Atlantic from the Pacific. The leaves were 5 to 6 feet in length. In the monthly report of the Department for August and September, 1870, page 354, there is another communication from the same source which was sent to the Department with a package of dried leaves "sun dried by Squier," and a hank of the fiber. These specimens are still in the collection of the Department; the leaves are without spines, though these may have been cut off.

In Squier's Tropical Fibers (New York, 1861) there is an account of the "*Bromelia sylvestris*, or wild pineapple, the istle of Mexico, but known as pita and *pinuella* in Central America and Panama, and in the West Indies as *Bromelia pinguin or penguin*, (which) can hardly be said to rank second to the *henequens* in economic importance." This is reproduced in the report of the Flax and Hemp Commission of 1863. Squier also quotes Major Barnard, U. S. A., in a report on the Isthmus of Tehuantepec, who, speaking of the "*istle*," says: "Among the spontaneous products of the Isthmus is the *Bromelia pita* or *ixtle*, which differs in some regard from the *Agave americana* of Europe," etc. Further he quotes from a paper read by Chief Justice Temple, of Belize, or British Honduras, in the year 1857, which appeared in the journal of the Royal Society of Arts, Vol. V, p. 125. An extract is here reproduced:

"Among other objects of interest he exhibited a quantity of the fiber of the plant under notice as well as of the *Agave sisalana*." Of the former, or *Bromelia sylvestris*, he said: "The plant called *Bromelia pita*, *istle* by the Mexicans, and silk grass by the creoles of British Honduras, grows spontaneously in the greatest abundance. The leaves are of a soft, dark green, from 5 to 15 feet long and from 1½ to 4 inches wide.

Along the edge of the leaf, about 6 inches apart, are short, sharp, curved thorns. When the plant is cultivated these gradually disappear."

Capt. A. L. Varney, in a paper on bristle fibers (Report of the Chief of Ordnance, 1883, p. 161), refers to the statements of Squier and others, and, commenting on the confusion that exists as to the names of the fibers of the Agaves and Bromelias, says: "Most writers, however, refer to the '*istle*,' '*ixtle*,' or '*itzle*' as the fiber of *Bromelia sylvestris*," which he regards as the source of Tampico. He then gives a plate illustration of "*Bromelia sylvestris* or *penquin* (sic.), the wild Pineapple."

The writer also fell into error in his "Report on vegetable fibers," in Annual Report of the Department of Agriculture for 1879, the statements being reproduced in No. 6, New Commercial Plants and Drugs, by Thos. Christy (London, 1882). And the confusion is still further added to in the writer's treatment of *B. sylvestris* in No. 5, Fiber Investigations series, A Report on the Leaf Fibers of the United States (1893). In Bernardin's Catalogue the species is treated thus: "*Iztle*, Mexique; *pita*, *piñuella*, Am. cent.: *Penguin*, Ind. oc.; Silk grass, Honduras Brittanique. *Bromelia Karatas en paraît une variété*." In the Manual Hoepli *B. sylvestris* is stated to be found in Brazil and Guiana. "The fiber is white, lustrous, and fine, from which is manufactured exclusively articles de luxe." (*Savorgnan.*)

See *Istle* and *Agave heteracantha*, in this catalogue, and also refer to *Bromelia pinguin*, above, and to the note by Dr. Morris on *Bromelia pita*, under *B. pinguin;* see *Karatas plumieri*.

Broom (see *Cytisus scoparius*).

Broom corn (see *Andropogon sorghum vulgaris*).

Broom hemp (see *Crotalaria*).

Broom palm (see *Attalea* and *Thrinax*).

Broom root (Mex.). See *Epicampes*.

Broom, Spanish (see *Spartium*).

Broomstick grass (see *Aristida setacea*).

Broussonetia papyrifera. PAPER MULBERRY.

Exogen. *Moraceæ*. A small tree.

NATIVE NAMES.—*Kodzu* and *kozo* (Jap.); *hoa-ko-chu* (China); *kendang* (Java); *ma-lo* (Fiji Is.). The fabric made from its bark, by beating, is known on the Pacific Islands as *tappa*, *tapa*, and *kapa*.

Native of China, Japan, Siam, Polynesian Islands, and Burma. Introduced into other countries. (See fig. 36.)

FIBER.—The fibrous substance of the bark pulps readily, and is therefore esteemed in Japan as paper stock. In Burma iti s used for *papier mâché*. "The fiber is strong and fine, and has the great merit of requiring little bleach" (*Watt*). Beautiful specimens of the fiber were received from the Japanese court, W. C. E., 1893, and are now in the collection of this Department.

It is said that the finest and whitest cloth and mantles worn by Sandwich Islanders and "the principal people of Otaheite," are made from the bast of this tree. It dyes readily, particnlarly in red, and takes a good color. Tapa cloth is also printed, a large sheet from the Fiji Islands, in possession of the Department, being stamped or rudely printed in black, in large checks or squares, resembling the patchwork of a quilt. The manner in which the fiber is beaten out by the native women of Otaheite is very curious. The cleansed fibers are spread out on plantain leaves to the length of about 11 or 12 yards; these are placed on a regular or even surface of about a foot in breadth. Two or three layers are thus placed one upon the other, much attention being paid to making the cloth of uniform thickness; if thinner in one place than another a thicker piece is laid over this place, when the next layer is laid down. The cloth is left to dry during the night, and a part of the moisture being evaporated, the several layers are found to adhere together so that the whole mass may be lifted from the ground in one piece. It is then laid on a long smooth plank of wood prepared for the purpose, and beaten with a wooden instrument about a foot long and 3 inches square. Each of the four sides has longitudinal grooves of different degrees of fineness, the depth and width of those on one side being sufficient to receive a small pack thread, the other sides being finer in a regular gradation, so that the grooves of the last would scarcely admit anything coarser than sewing silk. A long handle is attached, and the cloth is first beaten with its coarser side, and spreads very fast under the strokes; it is then beaten with the other sides successively, and is then considered fit for use. Sometimes, however, it is made still thinner by beating, after it has been several times doubled, with the finest side of

FIG. 36.—Leaf of *Broussonetia papyrifera*.

the mallet, and it can thus be attenuated until it becomes as fine as muslin. Should the cloth break under this process, it is easily repaired by laying on a piece of bark, which is made to adhere by means of a glutinous substance made from the arrow-root, and this is done with such nicety that the break can hardly be detected. The King of the Friendly Islands had a piece made which was 120 feet wide and 2 miles long, a part of which is now in the Kew Mus.

W. D. Alexander makes statements regarding the manufacture and uses of the Kapa cloth of the Hawaiian Islanders as follows: "This was made of the bark of the paper mulberry or *wauke* (*Broussonetia papyrifera*) and of the *mamake* (*Pipturus albidus*), which were cultivated with much care. Its manufacture was left entirely to the women, who peeled off strips of the bark and scraped off the outer coat with shells. After being soaked a while in water each strip was laid upon a smooth log and beaten with a square-grooved mallet of hard wood until it resembled thick, flexible paper. The strips were united by overlaying the edges and beating them together. There were several qualities of kapa, some so fine as to resemble muslin, and other kinds very thick and tough, which appeared like wash leather. It was bleached white or stained with vegetable or mineral dyes, impressed with bamboo stamps in a great variety of patterns and colors, and glazed with a kind of gum or resin. Nothing like a loom was known in Polynesia. The dress of the women consisted of the *pa-ú*, a wrapper composed of five thicknesses of kapa, about 4 yards long and 3 or feet wide, passed several times around the waist and extending below the knee, while that of the men was the *malo* or girdle, which was about a foot wide and 3 or 4 yards long. The *kihei* or mantle, about 6 feet square, was occasionally worn by both sexes. It was worn by the men by tying two corners of the same side together so that the knot rested on one shoulder, and by the women as a long shawl. In general, this paper cloth would not bear washing and lasted only a few weeks. The *kapa moe* or sleeping *kapa* was made of five layers of common *kapa*, 3 or 4 yards square. The outside piece (*kilohana*) was stained or painted with vegetable dyes."

In Japan a kind of cloth is made from paper derived from this tree. It is cut into thin strips, which are twisted together and spooled, to be used in the woof of the fabric, while the warp is composed of silk or hemp. About 250 pieces only are manufactured at the principal manufacturing place. The paper mulberry grows everywhere in Japan, and is a valuable tree as furnishing the bast from which a large portion of the Japanese paper is made. The plants are reproduced in quantity by subdividing the roots, and in two or three years are ready to be cut. This work is done in November, and the branches (7 to 10 feet long) are made up into bundles 3 or 4 feet in length, and steamed, so that the bark is loosened and can be more readily stripped off. This is washed, dried, and then again soaked in water and scraped with a knife to remove the outer skin, which is used for inferior kinds of paper. The bast when cleaned is washed, repeatedly kneaded in clean water, and rinsed. It is then bleached in the sun until sufficiently white, after which it is boiled in a lye, chiefly of buckwheat ashes, to remove all gummy matters. The fibers are now readily separated, and are transformed into pulp by beating with wooden mallets. The pulp is mixed in vats with the necessary quantity of water, to which is added a milky substance prepared from rice flour and the gummy infusion of the bark of *Hydrangea paniculata*, or the root of *Hibiscus manihot*. The couches on which the paper sheets are produced are made of bamboo, split into very thin sticks, and united in paralleled lines by silk or hemp threads, so as to form a kind of mat. This is laid upon a wooden frame and the apparatus dipped into the vat, raised, and shaken so as to spread the pulp evenly, after which the cover is first removed, then the bamboo couch with the sheet of paper, and in returning the operative lays the sheet upon the others. When a number of sheets have thus been prepared they are pressed to exclude the water, and afterwards spread out with a brush upon boards and allowed to dry. The sheets are only about 2 feet in length, but sometimes sheets 10 feet long are produced. (From a report by the Japanese commissioners to the Phil. Int. Exh., 1876.)

The topographical features fit for the plant is a sloping place facing southeast, so as to receive the full light of the sun and protected from high wind. The suitable soil is gravel loam, or vegetable mold or yellow loam with some gravel. The propagation is done either by planting divisions of old roots, layerings, cuttings, or seeds; but the most common method is the first mentioned. This is performed in March, digging off young shoots from the old stubble, which is well manured, once in the previous winter and again early in the spring, and the land is hand hoed at the same time. The young shoots, with some rootlets, are cut to the length of about 1 foot and planted in rows of about 2½ feet wide, at an interval of about 3 inches, leaving the top about 2 inches above the ground, manured with some liquid manure, and covered with straw to prevent burning by the sun. And when the buds come out at the beginning of June the covering of straw is taken off and watering is repeated several times according to need. Weak branches, which come out in abundance, are taken off, leaving at last only one vigorous shoot. The young plants are carefully dug out after the leaves have fallen and heeled in temporarily in some place till the time for transplanting. No particular preparation of the soil is necessary where they are to be replanted besides digging holes to receive the young plants, which are usually transplanted at any time from the end of November to the beginning of January, or beginning of February to the end of March. At the time of transplanting, the holes previously dug are partly filled with farmyard manure or with some oil cake, covered slightly with earth, over which the seed plants are set one by one. the remaining open part of the holes is filled up with earth lightly trodden in around the plants. The seed plants required for an acre vary very much; but usually range between 1,500 and 4,500. Manures used after transplanting are commonly farmyard manure, grasses, tree leaves, night soil, dried fish, etc., and they are placed around the plants in spring. Weeding should be done many times, especially, in the first year, and weak shoots pruned from time to time. The yield from one acre varies according to the time of transplanting, but the average of five years is estimated at 300 to 600 kilograms of raw bark. As the plants are cut, they are steamed and the bark is stripped off before cooling and dried by hanging on bamboo frames under the roof. The dried bark is now steeped in water and when softened rubbed violently in order to remove the exterior coarse and woody part which is again cleaned off by means of a small knife, then well dried, and is now ready for market. (Desc. Cat. Ag. Prod. Jap., W. C. E., 1893.)

Brown Hemp (Ind.). *Crotalaria juncea.*

Buazé (So. Afr.). See *Securidaca longepedunculata.*

Bullrush (or **Bulrush**). *Scirpus lacustris.*

Also *Typha latifolia,* the cat-tail flag. Lesser ———. *Typha angustifolia;* ——— of the Nile, *Cyperus papyrus.*

Bun ochra (Ind.). See *Urena lobata* and *Triumfetta rhomboidea.*

Bun-pat or **Bhunji-pat.** (Beng.) *Corchorus olitorius.*

Buphane disticha.

An amaryllid found in south Africa, remarkable in producing a bulb as large as a man's head, supporting 100 or more flowers. This bulb yields a fiber, examples of which are shown in the Kew Botanical Museum.

Burdock, Common (see *Arctium lappa*).

Burity (see *Mauritia*).

Burn-nose Bark (Jam.). *Daphnopsis tinifolia.*

Buscola, or **Bruscola Baskets,** of Italy; made from the "*Giunco marino.*" See *Juncus acutus* and *Lygeum spartum.*

Bussú (see *Manicaria saccifera*).

Butea frondosa. BUTEA GUM.

Exogen. *Leguminosæ* A tree.

Found throughout India and Burma. Yields the gum known as Bengal *kino.* The flowers furnish the *tésú* dye.

BAST FIBER.—"It yields a tough fiber said to be useful for paper making and for cordage; also the young roots yield a strong fiber known as *chhoel.* This is made into ropes in Chutia Nagpur, Central Provinces, Oudh, Rajputana, and Bombay hill tracts, etc.; it is also used in some parts of India for making native sandals. The roots and young branches of *B. superba,* another Indian species (also mentioned by

Savorgnan), affords a strong and useful fiber prepared in Chutia Nagpur, the Central Provinces, and Rajputana." (*Watt.*)

Cabbage palm, of the West Indies, *Oreodoxa oleracea;* of Australia, *Livistona australis.*

Cabbage palmetto (Fla). *Sabal palmetto.*

Cabo negro. *Caryota unusta*, or *Arenga saccharifera.*

Cabouja, or **Cabuja** (W. Ind.). See *Furcræa.*

Cabulla (Cent. Am.). *Agave rigida sisalana;* of Costa Rica, *Furcræa tuberosa.*

Cabuya (Cent. Am.). *Agave rigida.*

Cactus. See *Opuntia.*

The sisal hemp plant has sometimes been called cactus erroneously. See *Agave.*

Cadhi (Arab.). See *Pandanus.*

Cadillo (Venez.). *Urena lobata.*

Cadillo negro. *Triumfetta.*

Cæsar weed (Fla.). *Urena lobata.*

Caffir cotton (Afr.). See *Ipomœa digitata.*

Cajun (Cent. Am.). *Furcræa cubensis.*

Caladium giganteum.

A genus of the *Araceæ.* This species, now *Colocasia indica*, is found in Guiana. Savorgnan mentions that the fiber from the stems is adapted for paper stock. Dorca mentions in his textile list a Peruvian species, *C. pertusum*, known as *Chuncu*, but does not state how it is used.

Calamus rotang. The Rattan Cane.

Endogen. *Palmæ.* A scandent palm.

Known in Ceylon as the *ela-wéwel.*

Nearly 200 species of this genus inhabit tropical and subtropical Asia, Africa, and Australia. *C. rotang* is found in India, Burma, and Ceylon, and yields the best rattan canes of commerce. Split into strips, it is woven or plaited into chairs and furniture, baskets, etc. "It is made into ropes, or is stretched, entire, across rivers as the main supports of cane suspension bridges."

Good examples of these may be seen in the Khásia and northern Cachar hills. On the march from Silchar to Manipur, for example, three have to be crossed, namely, over the Muku, the Barak, and the Irang rivers. Within the past few years, owing to heavy traffic, these have been strengthened by one or two wire ropes, but cane bridges are by no means unfrequent in the mountainous tracts of the eastern side of India, and cane ladders are not uncommon in the south on the Animalis. Carefully selected canes, 300 or 400 feet long, constitute the chains, and the bridges of that length are often thrown across rocky valleys 50 feet above the water. This height is necessary in order to be above the water level in the sudden rising of the rivers which takes place during the rains.

Ropes are regularly made in China by splitting the rattan and twisting the long fibers thus prepared into cordage of any desired thickness. In the Kew Mus. specimens of cuffs, and an undershirt, are shown from China, made of the split stems of this or allied species. *C. rotang* also supplies the material for Malacca canes. "They are imported in large quantities from Siak, and are valued according to the length of their internodes, the longest being used for walking sticks and the shorter ones for the handles of chimney-sweepers' brushes, etc." (Off. Guide Kew Mus.)

The European uses of canes are even more varied than the Asiatic. They are valued on account of their lightness, flexibility, and strength. They are extensively used as walking sticks, umbrella handles, and even as a substitute for whalebone for umbrella and parasol ribs, each set of such ribs costing only from 1d. to 2½d. instead of 2s. 6d. to 3s. for whalebone. Cane is also extensively employed in saddlery and harness, and a wickerwork of rattan is now used in the construction of the German military helmet, which is said to make it sword proof. But the chief purpose to which cane is put in Europe is in furniture and basket making.

In the United States rattan is used in a great variety of manufactures, among which may be enumerated chairs and other articles of furniture, chair seating, baby carriage bodies, baskets, floor mattings, brooms, corset stays, whips, and other uses of minor importance.

Calamus rudentum. THE MA-WÉWEL.

Several species of rattan palms abound in Ceylon. Among the most common are *C. rudentum*, *C. pachystemonus*, and *C. radiatus* (the *kukul-wel*).

These palms are common throughout the damp forests of the island up to 3,500 feet altitude. In some districts they occur in great abundance, affording a conspicuous feature in the forests, their tall feathery heads overhanging the highest trees, while their powerful stems, often 200 feet in length, appear like green cables coiling about the ground in curious contortions and disorder. The first two species named are very largely used for a variety of purposes, such as the manufacture of baskets, chairs, crates, and the hoods of carts; while, split into strips and twisted, they become most powerful ropes. A very large trade is done in making tables and chairs of these canes, of which the most familiar is probably the well-known "deck chair," to be found on every passenger ship in eastern waters. The two smaller canes, *C. pachystemonus* and *C. radiatus*, the stems of which only attain the thickness of a pencil, are used in vast quantities for the manufacture of baskets for Ceylon tea gardens, for receiving the tea leaves as they are plucked from the bushes; in fact, so great is the quantity consumed in this way that if the canes used in these baskets were put end to end they would extend for some thousands of miles. In addition to its use in basket making, *C. radiatus* supplies the material for making the bottoms of chairs, for which purpose it is first split into long thin strips to render it elastic and pliable. Twisted, the *kukul-wel* supplies rope for towing purposes, as its tenacity is prodigious. Finally, the thin strips cut from this cane are used for making frames for hats used by some of the laboring classes in Ceylon. (Official Cat. and Handbook, Ceylon Courts, W. C. E., 1893.)

C. equestris is a scandent palm found in the Moluccas, or Spice Islands, and the Philippines, and also cultivated in conservatories. "On account of the flexibility and elasticity of its delicate branches it is much sought for making harness, the reins of bridles," etc.

Calathea zebrina. ZEBRA PLANT.

A representative species of a genus of *Marantaceæ* inhabiting the West Indies and South America. Bernardin mentions this Jamaica species as producing a fiber. "The species are natives of tropical America, and some of them are in cultivation for the sake of their handsome foliage, especially *C. zebrina*, the leaves of which have alternate dark-colored and green stripes. The leaves of some of the South American kinds are used for making baskets." (*Dr. Masters.*)

Caldera bush (see *Pandanus*).

Calla-wel (Ceyl.). See *Derris scandens.*

Callicarpa cana. ARUSHA.

An India shrub (3 to 4 feet) belonging to the *Verbenaceæ*, common along the roadsides. Forbes Royle states that fiber has been extracted from the plant, "but it does not appear of much value in a country where so many others abound." Tested with Russian hemp of a given size, the *aroosha* broke at 127 pounds, while the hemp stood a strain of 400 pounds. "It possesses all the free and kindly nature of flax, and even swells like flax" (*Captain Thompson.*)

Calmelia (It.). See *Daphne mezereum.*

Caloee (Siam). See *Boehmeria.*

Calotropis gigantea. GIANT ASCLEPIAS. MADÁR; MUDÁR.

Exogen. *Asclepiadaceæ*. Perennial shrub.

Abounds in India, Malay Islands, and south China. "It is not very common in Burma, and as represented by the doubtfully distinct species, *C. procera*, it is distributed to Persia and tropical Africa" (*Watt*).

BAST FIBER.—The species yields a fine fiber in the bast, while the seeds are enveloped in a silk cotton known as *madár* floss. In the Javanese exhibit at the Chicago World's Fair two fibrous productions were shown, one a bast fiber of good color and great strength, the other a substance resembling cotton, but of a creamy color. The bast fiber was derived from the Giant Asclepias (*C. gigantea*). It is of considerable value in Indian pharmacy, growing wild upon arid wastes, and producing a fiber of superior quality. It resembles flax somewhat in appearance, and is quite strong. It is not cultivated in India, though its fiber is regarded in Madras, where the plant grows wild, as the best and strongest material for bowstrings and tiger traps. The plant is known under a variety of names, as *Ashur* in Arabic, *Mudár* and *Ak-Muddar* in Hindoo; in Madras it goes by the name of *Yercum*. As it thrives upon soils where nothing else will grow, needing neither culture nor water, it has been considered an advisable plant for bringing waste land under tillage and for reclaiming drifting sands.

An acre of ground stocked with plants 4 feet apart each way will yield 10 tons of green stems and 582 pounds of fiber per acre, as prepared by native methods, which waste 25 per cent. The fiber is said to possess many of the qualities of flax (*Linum usitatissimum*), though it is somewhat finer. Its fineness, tenacity, luster, and softness fit it for many industrial purposes. It is said to be better adapted for textiles than for cordage, and that it may readily be mixed with silk; yet it shows a high degree of resistance to moisture. "Samples exposed for two hours to steam at two atmospheres, boiled in water for three hours, and again steamed for four hours, lost only 5.47 per cent by weight, as compared with flax, 3.50; manila hemp, 6.07; hemp, 6.18–8.44; coir, 8.13" (Spon).

The mode of separating the fiber as practiced by the natives is exceedingly tedious and would prevent the material from becoming an article of commerce unless some more speedy and less trifling way for preparing it could be discovered. In short, no water is used, and everything is done by hand manipulation, assisted by the teeth. Flax machinery might facilitate the matter if it was desired to cultivate extensively for fiber. As to its cultivation, "it is difficult to conceive anything less productive than dry sand, yet the *mudár* thrives in it, requiring no culture and no water." Dr. Wight tested samples of the fiber from Madras, where it is much employed for fish lines, and found that it bore a strain of 552 pounds when sunn hemp bore 404 pounds. Royle's experiments gave 160 for Russian hemp and 190 pounds each for Jubbulpore hemp (*Crotalaria*) and the *mudár* or *Calotropis gigantea.*

In the autumn of 1884, while testing different machines in their power of extracting the fibers of various fiber-yielding plants, I devoted attention to the *ákunda* or *madár* amongst other plants. I had already studied this shrub previously, to a certain extent, and had formed a hopeful idea of it. But the trials just alluded to have induced me to alter considerably my previous opinion. I can now confidently state that the hopes expressed by previous writers and by myself that the *madár* would be one of the best fiber producers of this country will never be realized. Its fiber is certainly fine, strong, white, and silky, and could doubtless be extracted in a merchantable condition (though none of the machines tested by me produced any good results with it), but the obstacles to its profitable utilization on a large scale outweigh its natural good qualities: (1) The very small proportion of the fiber to weight of the stems, the proportion being only 1.56 per cent; and (2) the shortness of the fibers, extending as they usually do from joint to joint, the joints being from 3 to 8 inches apart. These two chief obstacles are sufficient to justify a withdrawal of the *madár* from the list of hopeful fiber-bearing plants of India. (L. Liotard, in Dic. Ec. Prod. Ind.).

SURFACE FIBER.—The cotton-like substance derived from the pods is similar to the silky hairs of the common milkweed, though coarser and less silky. The substance shown in the Javanese exhibit was erroneously stated to have been derived from this species. The Javanese name of the fiber was *kapok*, and the *kapok* of Java is the product *Eriodendron anfractuosum.* The cottony fiber of *C. gigantea* is said to have been manufactured into shawls and handkerchiefs, but it hardly possesses sufficient strength to be spun alone. I am aware, however, that a soft kind of a cloth has been made from the "down" of this tree. Dr. Walker, prison superintendent, Agra, sent to the London Exhibition of 1862 three specimens of this cloth, as follows: Made entirely of *mudár* floss; made of one part cotton and one part floss; and made of three parts cotton and one part floss. A rug made of the floss was also exhibited. It has also been used in the manufacture of paper. There are several other species of plants belonging to the *Asclepiadaceæ*, that are known to the vegetable economy as fiber producers, and found chiefly in the Old World.

The *madár* is not alone a fiber plant, as it produces gutta-percha, varnish, dye, medicine, and a liquor, and besides it is useful in the domestic economy.

Savorgnan mentions *C. procera*, the fiber of which presents some of the characteristics of the above.

Camelina sativa.

Exogen. *Cruciferæ.* Annual herb, 2 feet.

"Cultivated in middle and southern Europe and in temperate Asia for its fiber, but especially for its oil" (Spon). There are several European and North American species of this genus. "The stems of *C. sativa* contain a considerable proportion of fiber, and are commonly used for making brooms in many parts of Europe" (*A. Smith*). It is sometimes known as false flax and is a bad weed in some places. It produces a bast fiber.

Camelote, or **Gamelote** (Venez.). *Panicum myurus.*

Camona (Peru). *Iriartea deltoidea.* See also *Mastinazia.*

Canamo (Peru). *Cannabis sativa.*

Canapa (It.). See *Cannabis sativa.*

Canapaccia (It.). See *Artemisia vulgaris.*

Cañapiña (S. Am.). See *Abutilon avicennæ.*

Candee rush (Vict.). See *Juncus effusus.*

Cane, The Rattan (see *Calamus rotang*, and *Calamus rudentum*).

Cane fiber (U. S.). See *Arundinaria tecta.*

Canna (It.).

"*Canna da stuoje,*" etc., cane for mats. "Common generic name for a great many plants of the *Gramineæ*, more or less marshy in their growing localities, especially the *Arundo donax,* with the stems of which are braided mats and matting, fishing baskets," etc. (*Savorgnan*). This should not be confounded with the ornamental plant known as *Canna,* or Indian shot.

Cannabis sativa. COMMON HEMP.

Exogen. *Urticaceæ.* Annual shrub, 6 to 15 feet.

COMMON AND NATIVE NAMES.—Hemp (Eng.); *Chanvre* (Fr.); *Hanf* (Ger.); *Canapa* (It.); *Konapli* (Rus.); *Bang* (Pers.); *Ghanga* (Beng.); *Asa* (Jap.); *Chu-ts-ao* (China). The Sanskrit name of the plant is *Bhanga;* in Hindostan it is called *Ganja;* the Arab name is *Kinnub, Kanab,* or *Kannab,* from which, doubtless, its Latin name, *Cannabis,* is derived.

Its native home is India and Persia, but it is in general cultivation in many parts of the world, both in temperate and more tropical climes. Its cultivation is an established industry in the United States, Kentucky, Missouri, and Illinois being the chief sources of supply, though the culture has extended as far north as Minnesota and as far south as the Mississippi Delta, while California has recently become interested in its growth. Fig. 3, Pl. V, shows a growth of hemp in Kern County, Cal., where it reaches a height of 12 to 15 feet. This hemp is of remarkably fine quality, and it brings an extra price in the New York market.

Several varieties are recognized in cultivation in this country, that cultivated in Kentucky, and having a hollow stem, being the most common. China hemp, with slender stems, growing very erect, has a wide range of culture. Smyrna hemp is adapted to cultivation over a still wider range, and a variety is beginning to be cultivated in California known as Japanese hemp, but which is doubtless indentical with China hemp. In Europe five varieties are cultivated, which are enumerated as follows: The common hemp, grown largely in France, and generally in Europe outside of Italy, growing to a height of 5 to 7 feet. Bologne hemp, known in France as Piedmontese hemp, or Great hemp, an Italian variety averaging 12 feet in height. Chinese hemp, known in Europe since 1846, and said to have been imported by Signor Itier. It is stated that in Algiers this hemp has been grown to a height of 20 feet, and that its fiber is remarkably fine and wonderfully elastic. The *Canapa piccola,* or small hemp of Italy, is another variety, with a reddish stalk, which is found in the valley of the Arno and around Tuscany. The fifth variety is the Arabian hemp known as *Takrousi,* a short species cultivated for its resinous principle from which hasheesh is derived.

BAST FIBER.—In the literature of fiber-producing plants of the world the word hemp appears frequently, applied oftentimes to fibers that are widely distinct from each other. The word is usually employed with a prefix, even when the true hemp is meant, as manila hemp, sisal hemp, Russian hemp, etc. The hemp plant proper, the *C. sativa* of the botanists, has been so generally cultivated the world over as a cordage fiber that the value of all other fibers as to the strength and durability is estimated by it, and in many of the experiments of Roxburgh and others we find "Russian hemp" or "best English hemp" taken as standards of comparison. The fiber is produced for export chiefly in Russia and Poland, much of it being dark in color and low in grade. It approaches nearer to American hemp than any other. French or Breton hemp is fine, white, and lustrous; but little, if any, is exported, as the home demand equals the supply. Italian hemp is the highest grade which comes to our market, 2,500 tons having been received in 1894-95, out of a total import of about 6,000 tons.

A sample of Persian hemp in the Department collection is the simple stripped bast. It is light in color and very strong. A sample of Siamese-hemp bast also shown is so rough that it appears like another fiber. Hemp grows in all parts of India, and in many districts flourishes in a wild state. It is but little cultivated for its fiber, although Bombay-grown hemp at one time "was proved to be superior to the Russian." In portions of India, as well as other hot countries, it is cultivated for its narcotic products, the great value of which makes the India cultivators indifferent about the fiber. The raw hemp produced in Japan is usually sold in the form of ribbons, thin as paper, but as smooth and glossy as satin, a light straw color, the frayed ends showing a fiber of exceeding fineness. Beautiful samples of this hemp were secured by the Department at the World's Columbian Exposition, together with many samples of manufactures. The fiber is largely grown in Japan for the manufacture of cloth and the industry is very old, as prior to the introduction of silk weaving it was the only textile fabric of the country.

USES.—Largely employed in the United States for small twines and cordage, binding twines, etc. Formerly large areas were devoted to the cultivation of the plant in the United States, and thirty-five years ago nearly 40,000 tons of hemp was produced in Kentucky alone, while now hardly more than a fourth of this quantity is produced in the whole country. There are several reasons for the decline in production in the United States, but it dates back, primarily, to the decline in American shipbuilding and to the introduction of the Philippine Island hemp (*Musa textilis*), the manila hemp of commerce, and later to the large importation of jute. Quite recently there has been a further falling off in production, and it is worthy of note that this is largely due to the overproduction of this same hemp of Manila, brought about by the high prices of the latter fiber in 1890-91, a direct result of the manipulation of the fiber market by certain binding-twine manufacturers. In past years the hemp of Kentucky was not only used for the rigging of vessels, and in twines or yarns, and bagging, but it was spun and woven into cloth, just as to-day it is manufactured into fabrics in portions of Brittany.

FIG. 37.—The Hemp plant, *Cannabis sativa*.

CULTURE.—As in Breton France, so in Kentucky, limestone soils, or the alluvial soils, such as are found in the river bottoms, are best adapted to this plant. The culture, therefore, is quite general along the smaller streams of Brittany, where the climate is mild and the atmosphere humid; and in Kentucky the best lands only are chosen for hemp, and the most favorable results being obtained where there is an underlying bed of blue limestone. As a general rule, light or dry soils or heavy, tenacious soils are most unfavorable.

Hemp is not considered a very exhaustive crop. It is stated by a successful Kentucky grower that virgin soil sown to hemp can be followed with this crop for fifteen to twenty years successively; alternating then with small grain or clover, it can be grown every third year, without fertilizers, almost indefinitely. In France a rotation of crops is practiced, hemp alternating with grain crops, although competent authorities state that it may also be allowed to grow continuously upon the same land, but not without fertilizers. Regarding this mode of cultivation, they consider that it is not contrary to the law of rotation, as by deep plowing and the annual use of an abundance of fertilizer the ground is kept sufficiently enriched for the demands which are made upon it. If the soil is not sufficiently rich in phosphates or the salts of potassium, these must be supplied by the use of lime, marl, ground bones, animal charcoal, or ashes mixed with prepared animal compost. Even hemp cake, the leaves of the plant, and the "shive," or "boon," may be returned to the land with benefit. This high fertilizing is necessary, as the hemp absorbs the equivalent of 1,500 kilos of fertilizers per every hundred kilos of fiber obtained. In Japan, where most excellent hemp is produced, the ground is given a heavy dressing of barnyard manure before it is plowed in November. After the soil has been well pulverized and reduced to fine tilth, the seed is drilled and the land given a top dressing composed of one part fish guano, two parts wood ashes, and four parts animal manure. The proportions and the quantities used differ, of course, upon different soils. In New York, where hemp was formerly grown, barnyard manures or standard fertilizers were used, as it was considered essential to put the soil in good fertility to make a successful crop. A Kentucky practice is to burn the refuse and spread the ashes over the land.

As in flax culture, a careful and thorough preparation of the seed bed is important, for the finer and more mellow the ground the better will be the fiber. Soil preparation in the blue-grass region of Kentucky consists in a fall or early spring plowing, and a short time before seeding, which, in general terms, is about corn-planting time, the ground is thoroughly pulverized by means of an improved harrow, such as the disk harrow, after which it is made smooth. The date of planting varies according to whether the soil is wet or dry and may range from the last week in March to the last week in April, or even the 1st of May. In Shelby County, Ky., the ordinary grain drill is used for broadcast seeding. The rubber pipes are removed from the drill, and a board is attached directly beneath the hopper. The seed falling upon the board is scattered in front of the drill hoes, which do the covering. A light drag passed over the field levels and evens the surface, after which nothing is done until the hemp is ready for the harvest.

The quantity of seed sown to the acre varies in different practice from 33 pounds to 1 to 1¼ bushels. In New York 1 to 3 bushels have been sown, 1 bushel giving better results than a larger quantity. In Illinois it varies from 1 to 2½ bushels. In France a difference is made regarding the use to which the fiber will be put, a third more seed being sown for spinning fiber than for cordage fiber. On a farm in Sarthe, visited by the writer, a little less than 3 bushels to the acre was the usual quantity sown, but as high as 4 bushels are sown on some farms. There will be little trouble with weeds if the first crop is well destroyed by the spring plowing, for hemp generally occupies all the ground, giving weeds but little chance to intrude. For this reason the plant is an admirable weed killer, and in flax-growing countries is sometimes employed as a crop, in rotation, to precede flax, because it puts the soil in good condition.

In Kentucky the hemp stalks are considered ready to cut in one hundred days, or when the first ripe seed is found in the heads. The cutting is usually done with a hooked implement, or knife bent at right angles about 24 inches from the hand. In recent years, however, the work is sometimes done by machines adapted to the purpose, and particularly when the stalks are slender. The foreign practices relating to the harvesting differ materially from those usually followed in this country. They are fully described, however, in Report No. 8 of the Fiber Investigations series issued by the Department, to which the reader is referred.

In this country when the stalks are cut they are laid in rows, even at the butts, and are allowed to remain on the ground not over a week to dry—only long enough, as one correspondent expresses it, to get a rain on the leaves, so that they will drop off readily. When the rain is too long deferred, however, the hemp should be put in shocks, or small stacks, having been first made into bundles of convenient size for easy handling. Hemp is usually dew retted—that is, spread evenly over the ground to undergo the action of the elements which dissolve or rot out the gums holding the filaments together. Formerly pool, or water, retting was practiced in a very small way in Kentucky and to a slight extent later in Illinois. The hemp is allowed to remain in stack until November or December, or about two months, when it is spread over the ground until retted. No rule can be given regarding the proper length of time that the hemp should lie, as this varies according to the weather, sudden freezing, followed by thaws, hastening the operation. It is usually allowed to lie until the bast separates readily from the woody portion of the stalk. When there is a large crop there may be an advantage in spreading the hemp earlier than November, in order that the breaking may be done in the winter months. Winter-retted hemp is brighter, however, than that retted in October. It is usually stacked and spread upon the same ground upon which it is grown, and when sufficiently retted, as can be determined by breaking out a little, it is again put into shocks. If the hemp be dry, the shocks should be tied around the top tightly with a band of hemp to keep out the rain. The shocks are made firm by tying with a band the first armful or two, raising it up and beating it well against the ground. The remainder of the hemp is set up around this central support. By flaring at the bottom, and tying well, a firm shock can be made that will stand firmly without danger of being blown over by the wind.

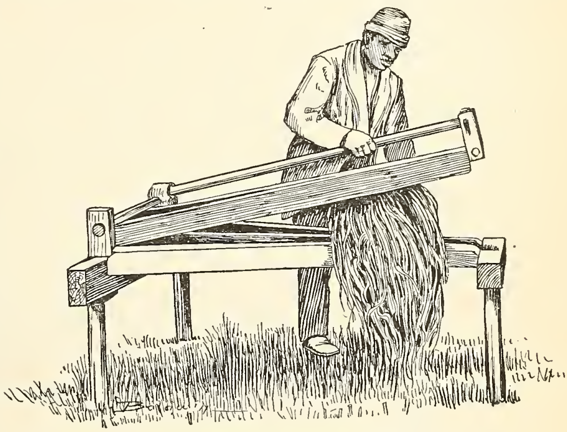

FIG. 38.—Kentucky hemp brake.

As the best hemp which comes to our market is that grown in Italy, a few words on the Italian practice will not be out of place. Several varieties are cultivated in Italy, the soil chosen being a soft, deep, sedimentary formation, and this is twice plowed in November, fifteen days intervening between the two plowings. The quantity of seed sown varies according to the soil, climate, and variety of hemp, but in Lombardy the average quantity is 200 liters per hectare, or about 2½ bushels per acre. The crop is well fertilized, but not excessively, and regard is had to economy of cost. In addition to other fertilizers, in Bologna, Professor Marconi names the following: First, manure and olive husks (after the last pressing); second, manure and excrement from hens (little used but very efficacious); third; manure and chrysalides of worms, i. e., silk worms; fourth, manure and olive husks with one or more of the others. The guide for harvesting the crop is the state of maturity of the tops, which become yellow, and the white appearance at the foot of the stalks. First, the male plants are harvested and twenty or twenty-four days later the female plants. These two operations are never retarded nor precipitated. After cutting, the stalks are removed to a shady place and the tops inclined over a sort of trestle to dry. Ten or twelve handfuls of stalks form a bundle of equal length stems for the operation of macerating.

In favorable soils Italian hemp averages a yield of 1,700 to 2,200 pounds of dry stalks per acre, which produce from 450 to 530 pounds of fiber. "In general, 100 kilos of raw hemp furnish 25 kilos of raw filasse, and 100 kilos of ordinary filasse (fiber) give 65 kilos combed filasse and 32 kilos of tow; 100 kilos of seed furnish 27 kilos of oil." (*Savorgnan.*) A kilo is 2.2 pounds.

The stalks are retted in water and either dried in the open air, in furnaces, or in trenches, the last practice being rarely followed. Drying in the open air has advantages over any other method; first, less expensive; second, a superior bleaching of the fiber. In the ovens the operation is hastened, and many times this is a very desirable system. In a perfectly dry atmosphere three to six days suffice for drying thoroughly. The stalks are again put into bundles and placed in dry locations, safe from rodents. The drying by artificial heat is done in common bread ovens, but the temperature should be very moderate; usually the hemp is introduced one hour or one hour and a half after the removal of the bread from the oven. The hemp stalks are decorticated in various ways, by hand processes of beating, or by machinery. The French brake, which is somewhat similar to the Kentucky brake, is little used, though a machine quite as primitive is largely employed. In this device the stalks are first crushed, then cleaned by beating. The hemp is not ready for market when it comes from this machine, but is further cleaned, and the bits of wood, etc., which adhere to the fibers are carefully removed. See Hemp Machinery in Appendix A. Fig. 38 is a Kentucky hemp brake.

The market prices for American rough hemp at the present time may be stated at $70 to $80 per ton for Missouri and $125 per ton for Kentucky. No recent figures are at hand showing cost of production, but in 1890, counting a man and a team worth $3.50 per day, the cost of producing an acre of hemp in Kentucky was shown to be about $24. The average yield is about 1,000 pounds per acre, but this is frequently exceeded by several hundred pounds.

*Specimens.—Field Col. Mus.; U. S. Nat. Mus.; Mus. U. S. Dept. Ag.

Fig. 39.—*Carex paniculata.*

Canoe birch (see *Betula papyrifera*).

Capas, or **Kapas**. *Gossypium.*

Capo di bue (It.). See *Antirrhinum.*

Caraguatá (Arg.). See *Bromelia argentina.*

Caraúa.

Orton gives this as the Brazilian name of a fine glossy fiber from a species of *Bromelia*, from which ropes are made.

Carex brizoides, et sp. div.

Endogen. *Cyperaceæ.* A sedge.

This and the two species of *Carex*, which follow, are mentioned in the Manual Hoepli, and are presumably Italian species. They are sedges or rushes. *C. brizoides* can be employed as a substitute for *Esparto* in brush making, and is woven. The species appears in Bernardin's list as *Alpengrass*, from Holland. *C. pendula* is employed for chair seating, its Italian name being *Sala per seggiole*. *C. paludosa* supplies similar material and is known by the simple name *Sala*.

Other species of *Carex* are mentioned in the Official Guide Kew Mus., as follows: *C. tereticaulis* is an Australian species, that has been employed by the Murray River native tribe for net making. Guilfoyle names the species as paper stock. *C. leporina* is employed in Switzerland for stuffing furniture. The culms of *C. rhynchophysa* are used for making table mats in Japan, and *C. paniculata*, in England, is employed for hassocks and brooms. The species is also mentioned by Guilfoyle as a good paper stock. See Fig. 39.

Carex vulpinoidea (?). Slough Grass.

A species of *Carex* or sedge supposed to be *C. vulpinoidea* has been used to some extent in the manufacture in Iowa, under the Lowry patents, of a grass binding twine. Samples of this twine in the Department collection show a strand composed of the grass leaves, held together by means of a thread or fine twine which winds spirally about the mass, forming a continuous "twine," or tying substance, of considerable strength.

C. vulpinoidea is a very common sedge in this State (Iowa) in rather low places. I am not familiar with the manufacture of this twine, but am of the opinion that this may not have been the only species that was used. There are several species which have tough, fibrous stems. Professor Budd informs me that this sedge was largely used in tying sacks, and that it is of excellent quality. (*Prof. L. H. Pammel.*)

Mr. Lowry, the patentee, makes the following statements regarding the manufacture of this twine:

The grass for twine should be cut the latter part of July or early in August; if cut earlier it is pulpy and has no strength; if allowed to grow longer the slender tops wither off and the stalk becomes brittle. It is cut with a reaper, which delivers from the platform straight and in gavels; the following day the gavels are bound and "stooked" or "shocked" on the butt ends, as is done with grain, and allowed to dry or "cure" for about three days, when it is stacked or baled for shipment. The yield is from 1½ to 2 tons per acre. In baling, it is necessary, for twine, that it should be kept straight. The first process is putting it through the combing machine to remove the short grass and any weeds there may be among it. The machines as made at present have each a capacity of 7,500 yards per hour. The machine takes the grass from the hopper, twists it, puts the thread around it, and bales it. The labor of combing the grass and feeding the machine is light work and could be done by boys or girls. One ton of grass yields about 1,850 pounds of twine and 250 pounds of hay. For binder twine it requires no treatment of any kind, but it should not be subjected to excessive moisture or artificial heat.

* *Specimens.*—Field Col. Mus.; Mus. U. S. Dept. Ag.

Careya arborea.

A deciduous tree, found in India, which yields a gum, tan bark, dye, medicine, fruit, and fiber. "The bark yields a good fiber for coarse cordage, and a stuff suitable for brown paper of good quality. Silk worms feed on the leaves. The fibrous bark is used in Mysor as a slow match to ignite gunpowder, and in many parts of India as fusees for matchlocks." (Dic. Ec. Prod. Ind.).

Carica papaya. The Papaw of the Tropics.

While celebrated for its fruit, it yields a fiber that may be obtained 5 feet long, and is mentioned in the lists of Bernardin and the Flax and Hemp Commission and alluded to by Dr. Watt. Of questionable utility.

Carludovica palmata.

Endogen. *Cyclanthaceæ.*

The plants of this genus are found in tropical South America and in Central America. *C. palmata* is a stemless species, "common in shady places all over Panama and along the coast of New Granada [United States of Columbia] and Ecuador."

The leaves, which are plaited like a fan, "are borne on three-cornered stalks from 6 to 14 feet high. They are about 4 feet in diameter and deeply cut into four or five divisions, each of which is again cut. The leaves are cut while young, and the stiff parallel veins removed, after which they are slit into shreds, but not separated at the stalk end, and immersed in boiling water for a short time and then bleached in the sun." (*A. Smith.*)

Specimens of the prepared leaves, in bundles, were obtained from the several

Central and South American collections at the W. C. E., 1893, and are preserved in the National Museum and the Museum of the Department of Agriculture. These always have the appearance of a bundle of straws. The leaf is split in narrow strips, which are dried in the sun. Under the action of the heat they roll up into this straw-like form, and it only remains to bleach and weave them.

USES.—The leaves are plaited into many useful objects, the best known being the celebrated Panama hats, which have been sold as high a $150 apiece. It is said that the hats of superior quality are plaited from a single leaf without any joinings. Cigar cases, small bags, and similar objects are also made from these leaves.

Specimens.—Mus. U. S. Dept. Ag. U. S. Nat. Mus. Phil. Com. Mus.

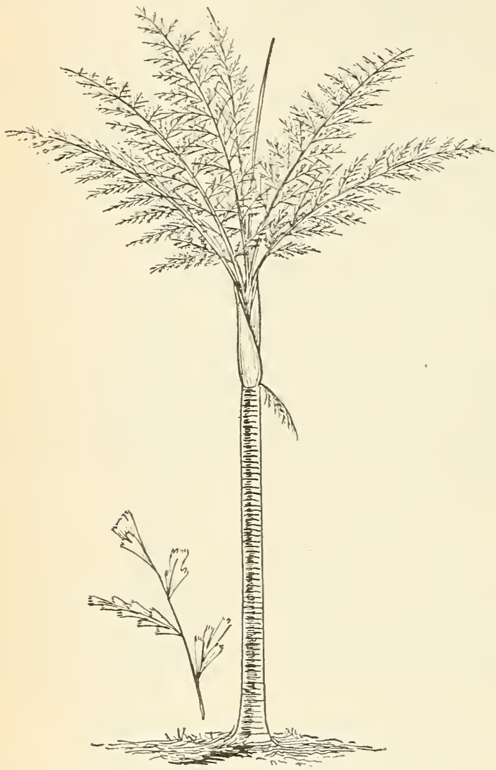

FIG. 40—The Kittool palm, *Caryota urens.*

Carnauba palm (Braz.). See *Copernicia.*

Carnestolendas (Venez.). *Cochlospermum gossypium.*

Carolinea fastuosa (Mex.). See *Pachira.*

Carya. See *Hicoria.*

Caryota urens. KITTOOL PALM. JAGGERY PALM.

Endogen. *Palmæ.* Palm tree, 60 feet. See fig. 40.

Common in the eastern and western moist zone of India and has long been known to the native inhabitants of Ceylon. "In places it has been introduced by the natives into their gardens, as it yields so much that enters into the economy of their daily life, while affording a remarkable commodity in the form of jaggery or native sugar." (Handbook of Ceylon, W. C. E., 1893.)

STRUCTURAL FIBER.—Brownish black, the filaments straight, smooth, and glossy It exhibits considerable tenacity and will bear twisting, as the fiber is somewhat elastic. Some of the filaments resemble horsehair very closely, and, drawn between the thumb and nail of the forefinger, curl as readily as coir. Samples of fiber from this palm as well as tow prepared from it were received from the Philippine Islands and from Victoria, the latter prepared by Dr. Guilfoyle. It is indigenous in northern Australia. In Malabar it is called *Shunda-pana,* in Burma *Minbaw,* and the Singalese name is *Kittúl* or *Kittool.* It is a beautiful tree, growing to a height of 60 feet, and surmounted by an elegant crown of graceful curved leaves. The tree is a foot in diameter. The fiber, which is black and very coarse, is useful for making ropes, brushes, brooms, baskets, etc.; and a woolly substance or scurf scraped from the leaf-stalks is used for calking boats. It is also extensively used in machine brushes for polishing linen and cotton yarns, for cleaning flax fiber after it is scutched, for brushing velvets, and other similar purposes. In Ceylon the black fiber is manufactured into ropes of great strength and durability, which are used for tying elephants. It is both regular and compact, and its manufacture exhibits considerable skill. In Australia, Dr. Guilfoyle says, it is used for making paper. As high as $16,000 worth of this fiber has been exported from Ceylon in a single year; it enters largely into the manufacture of brushes, and there is a considerable demand. "The fiber, as it is called, forms at the base of the leaves of the palm, in a strong sort of bracing, that tends to hold the leaf against the stem as it appears on both sides of the blade of the leafstalk. This is removed with a knife from the fallen leaves, and then cleaned, to free it from extraneous matter, and finally put up into bobbins, in shape not unlike a torpedo, when it is ready for sale. Ropes, and even fishing lines, are made from kitul fiber, as it is easily twisted into fine cord, and is strong and durable." (Handbook of Ceylon.)

When first imported the finer fibers were used for mixing with horsehair for stuffing cushions. As the fiber is imported it is of a dusky-brown color, but after it arrives here it is cleaned, combed, and arranged in long, straight fibers, after which it is steeped in linseed oil to make it more pliable; this, also, has the effect of darkening it, and it becomes, indeed, almost black. It is softer and more pliable than *piassaba,* and can consequently be used either alone or mixed with bristles in making soft, long-handled brooms, which are extremely durable, and can be sold at about a third the price of ordinary hair brooms. The use of *Kittool* fiber is said to be spreading not only in this country but also on the Continent. During 1895 *Kittool* fiber has not been much in demand. (Cantor Lectures, *Morris.*) Its chief use in the United States is for the manufacture of brewer's brushes.

* *Specimens.*—Field. Col. Mus.; Mus. U. S. Dept. Ag. Phil. Com. Mus.

Caryota spp.

C. mitis is mentioned by Savorgnan as another species found in Ceylon, from the leaves of which a kind of *Crin végétal* is manufactured called Black fiber. Bernardin also mentions *C. onusta* from the Philippine Islands, called *Cabo Negro.* *C. onusta* is *Arenga sacharifera.*

Cáscara (Peru.) See *Couratari legalis.*

Cascara also means a husk, as, *Cascara de coco,* husk of the cocoanut.

Cassia auriculata. TANNER'S CASSIA.

Exogen. *Leguminosæ.*

The species of this genus are more important from the medical standpoint as producing "Senna," besides gums, tans, and dyes. *C. auriculata* is merely mentioned as yielding fiber in its bast. "Specimens of the bark were sent to the Calcutta Exhibition from Cuddapah, Madras, as a tanning material, but an excellent fiber was prepared from a surplus of this bark and made into rope. The fibrous property of the plant does not appear to have been investigated. The caterpillar of a large species of silkworm feeds on the leaves of this plant." (*Watt.*)

Cassytha melantha. COMMON SCRUB VINE OF AUSTRALIA.

Mentioned by Dr. Guilfoyle as a fiber-producing species. These scrub vines sometimes form impenetrable thickets. The plant belongs to a common genus of semiparasitical leafless, thread-like plants. Their habit is to twine around other trees, with which they come in contact, with their wire-like branches. They are sometimes called Dodder laurels. *C. filiformis* is found in India.

Castilloa elastica.

Exogen. *Moraceæ.* A tree.

This species abounds in Mexico and Central America. It has male and female flowers alternating one with the other on the same branch. The male flowers have several stamens inserted into a hemispherical perianth, consisting of several united scales. The female flowers consist of numerous ovaries in a similar cup. The tree contains a milky juice, yielding caoutchouc.

Bast Fiber. The Costa Rican exhibit, W. C. E., 1893, contained an interesting collection of the tough, cloth-like bast from this tree, some of the examples measuring 10 to 12 feet in length and 15 inches wide. The sheets of bast are similar to the Damajagua bast from Peru and applicable to the same uses.

Specimens: Phila. Com. Mus.

Casuarina stricta. The Drooping She Oak.

Exogen. *Casuarinaceæ.*

These singular trees are met with most abundantly in tropical Australia and New Caledonia, where, according to Dr. Bennett, they are called oaks. "They have very much the appearance of gigantic horse tails (*Equisetaceæ*), being trees with thread-like jointed furrowed pendant branches. Their sombre appearance causes them to be planted in cemeteries, where their branches give out a mournful sighing sound as the breezes pass over them, waving at the same time their gloomy hearse-like plumes." *C. stricta* is common on the coast as well as the inland tracts of South Australia, Victoria, Tasmania, and New South Wales.

Fiber.—The stringy foliage formed by the cylindrical concrescence of the branchlets with the leaves can be converted into an excellent pulp for packing, and even printing paper and millboard. The mechanical contrivances for preparing the pulp are of particular ease. (*Ferd. von Mueller*).

C. suberosa, the Erect She Oak, is restricted to Victoria and New South Wales. The foliage in its use is akin to that of the former species. Different *Casuarinæ* occur in the other Australian colonies, in south Asia and the Pacific Islands, but none of the species has been employed before for paper manufacture, and consequently the investigations instituted in Victoria may be found even of value in a country so anciently industrial as China. (*Ferd. von Mueller*).

C. muricata is a native of southern India, and *C. equisetifolia* is found in the South Sea Islands. The trees of these two species are valuable for many economic uses, but are not particularly mentioned as fibrous.

Catirina (Peru). See *Attalea.*

Cat-tail flag (see *Typha*).

Cavanillesia plantanifolia. Volandero.

Exogen. *Leguminosæ.*

Found in Panama and New Carthagena. "The inner bark affords a fiber much resembling Cuba bast. It bleaches readily and makes a strong, white, opaque paper." (Spon.)

Cebu hemp (Phil. Is.). *Musa textilis.*

Cecropia peltata. Trumpet Tree.

Exogen. *Moraceæ.* Tree, 50 feet.

Native name.—*Embauba* or *umbauba.*

Native of West Indies and tropical South America.

Fiber.—Produced from the inner bark of the young branches; said to be very tough. Bernardin says the fiber is used in Brazil for sacks. In notes on the State of Para, W. C. E., 1893, the fiber is claimed to be used for strong ropes and cordage.

The Uaupé Indians, who inhabit the Rio Uaupés, a tributary of the Rio Negro, convert the hollow stems of this tree into a very curious kind of musical instrument, a species of drum, called by them *Amboobas.* They select a trunk 4 or 5 inches in diameter, and cut off a piece about 4 feet long, removing the partitions and rendering the inside smooth by means of fire; they then close up the lower end with leaves beaten down into a hard mass with a pestle, and cut two holes toward the top end so as to form a handle. These rude instruments are commonly used in the native dances, the performer, holding by the handle, beats the lower end upon the ground, and moves his feet in unison with the sounds thus produced. (Treas. Botany.)

Cedar, Gigantic Red, of the Pacific Coast. *Thuja gigantea.*

Ceiba (Mex.). See *Bombax ceiba.*

The following nomenclature is given in Bernardin's List of 550 Textiles Fibers, under the title "*Duret Brun*" (brown downs or silk cottons): Silk cotton, Dominique; *Soie de la Havane, Kawo-kawo,* Malais; *Suffed-simul,* Hind.; Cotton, *kapok,* S. M.; *Guana,* Cuba; *Poor,* Tel.; *Pania, Paniala,* Mal. (*Eriodendron anfractuosum*). *Duret de Bimba,* Peru; (*Bombax* sp.) *Duret de Ceiba,* Cent. Am.; *Comaca,* Demarara; *Pullom,* Cote d'Afrique, (*Bombax ceiba*) *Duret de Lanero,* Cuba; *patte de lievre édredon végétal,* Antilles; *Balsa,* Cent. Am. (*Ochroma lagopus*).

The Venezuelan flora possesses the following species: *Bombax ceiba, B. cumanense, B. septenatum, Eriodendron anfractuosum.* These are called in common parlance *ceiba;* but we prefer, with Andres Bello, the form *ceibo,* according to the analogy with other species, as *balso ó lano, Ochroma lagopus.* (*Dr. Ernst.*)

The Bot. Mus. Harv. Univ. has fine* specimens of the fiber of *C. lucia,* from Costa Rica.

Ceiba pentandra.

This is *Eriodendron anfractuosum,* or "*Pochote,*" which see.

In Millspaugh's Contributions to the Flora of Yucatan (Field Col. Mus. Pub., No. 4, Bot. series), I find *C. pentandra* with notes as follows: "*Pochote,*" "*Peem,*" *Bombax pentandrum* Linn., *B. ceiba* Linn., *Eriodendron anfractuosum* DC. Plentiful throughout the peninsula. Under the general head *Bombax,* a few lines above, occurs: *Bombax ceiba,* "*ceiba,*" *Yaxché,* a tree 80 to 100 feet. Dr. Ernst, who was associated with me in making the awards in group 9, W. C. E., 1893, refers "*pochote*" to *Eriodendron anfractuosum.*

Celastrus scandens. CLIMBING BITTER SWEET.

Exogen. *Celastraceæ.* A vine.

Common in eastern United States, its showy red berries making the species particularly marked. It has the habit of twining about other woody plants and eventually embedding itself in their bark so deeply that the spiral form is preserved after cutting for canes, etc.

FIBER.—The bark yields a good fiber, which many years ago was prepared experimentally by Mr. Phippen, of Salem, and exhibited at the meeting of the Essex Institute.

Cellulose.

The cellular structure of plants reduced by chemical means and purified; as an example, wood pulp. See Classification, p. 25, group 2, woody fibers, sub group *d.* See also page 20; Corn-pith Cellulose, see *Zea mays*; Cotton and Wood Cellulose, see under Artificial Silk.

Celmisia coriacea. LEATHER PLANT. "TEKAPU."

Exogen. *Compositæ.*

Hills of South Island, New Zealand. Samples of the thick, leathery leaves of this species were received from the Phil. Int. Exh., 1876. "Used for the manufacture of garments." My only authority for this species is the exhibition label which accompanied the specimen, and notes made at Kew: "Leaves resemble corn husks, but with a silky gloss. The garments are made by weaving together in longitudinal layers."

* *Specimens.*—Mus. U. S. Dept. Ag.

Celosia cristata.

Exogen. *Amarantaceæ.* A shrub.

India. Cultivated as an ornamental plant.

FIBER.—"It yields a strong, flexible bast fiber, so highly esteemed that rope made of it sells at five times the price of jute rope." Confirmation of this fact is much required, and also samples of the plant from which the fiber has been extracted. It is known in Bengali as *Lál-múrga,* but Roxburgh makes no mention of the fiber; indeed, with the exception of the notice in Spon's Encyclopædia quoted above, no author, as far as the writer can discover, alludes to the fiber. (*Watt.*)

Celtis australis.

Exogen. *Ulmaceæ.* A shrub or small tree.

An Italian species known by the names *Arcidiavolo, Bagato, Bagolaro, Bucerata, Fragiracolo, Legno da racchette, Loto, Perlaro, Spaccasassi.* The bark yields a fiber for cordage. (Manual Hoepli.)

Celtis caucasica. NETTLE TREE.

An Indian species supposed to be a variety of the European nettle tree, *C. australis.* Baden Powell mentions that the bark is made into cordage.

Celtis orientalis.

Now *Trema orientalis;* formerly referred to *Sponia.* A very common Indian species of nettle tree. "The nether bark consists of numerous reticulated fibers, which some of the tribes of Assam convert into coarse textile fabrics. *C. philippinensis,* in the Philippines, and *C.* [now *Trema*] *aspera* and *C. sinensis,* in Japan, also afford useful fibers." (Spon.) See *Trema.*

Century plant (see *Agave americana*).

Cerbera odollam.

Exogen. *Apocynaceæ.*

A genus of trees natives of tropical Asia, and said to be very poisonous, the seeds being particularly so. "The inner shell of the drupe is fibrous, partly divided, when ripe, into two divisions, and when seen in the dried state resembles a ball of string." (Treas. Botany.)

BAST FIBER.—Watt states that fiber prepared from the bark was sent by the forestry department of Madras to the Amsterdam Exhibition of 1883.

SURFACE FIBER.—*C. oppositifolia* is a Cochin China species held in high esteem in pharmacy. From the silky down of the fruit is obtained a substance for wadding.

Ceroxylon.

A species of palm found in Peru, which, on the authority of A. Dorca, supplies material for cordage and coarse textures. Known locally as *Palma de la cera.*

Chaguar (Arg.). See *Bromelia serra.*

Chain creeper (Braz.). See *Bauhinia.*

Chain fern (U. S.). *Woodwardia radicans.*

Chándla (Ind.). See *Antiaris.*

Chat (Hind.).=root.

Chamærops humilis.

Endogen. *Palmæ.* A dwarf palm.

This species abounds in Algeria, and is cultivated in southern Europe. It is the source of the upholstery material imported into the United States from Algeria under the names African fiber and *Crin végétal*. It is a species of palmetto, and is allied to the saw or scrub palmetto of Florida and the Southern States.

Structural Fiber.—Samples of the fiber were received from the Algerian section, W. C. E., 1893, and included the twisted ropes of raw fiber, both black and white, as imported, with specimens of cordage, vegetable curled hair, etc. The leaves of the plant are shredded, and the twisting into strands crinkles the fiber so that it forms a substitute for curled hair proper. 1,000 to 2,000 tons a year are imported into this country, in the form of "rope," worth not over $25 per ton, though when "picked" or opened, the consumer pays double this price; used as a mattrass fiber. See *Serenoa serrulata*, the allied American species.

* *Specimens.*—Field Col. Mus.; U. S. Nat. Mus.; Mus. U. S. Dept. Ag.

Chanvre (Fr.). *Cannabis sativa.*

Charcoal tree (Ind.). See *Trema orientalis.*

Cheirostemon platanoides.

A Mexican tree belonging to the *Sterculiaceæ;* found also in Guatemala and tropical South America. Its ancient Mexican name is *Macpalxochitlquahuitl*, and its Peruvian name *Huampo*. "The fiber, from the bark, is used by the Indians for garments" (*A. Dorca*).

Chenga. (Afr.). See *Brachystegia.*

Chiendent (Fr.). See *Epicampes macroura.*

Chikti (Hind.). *Triumfetta rhomboidea.*

Chikun (Beng.). See *Trema orientalis.*

Chilima (Peru).

This is the native name of a species of *Bombax*, the bark of which is said by Dorca to yield a very strong fiber.

China grass (see *Boehmeria nivea*).

China jute (see *Abutilon avicennæ*).

Chinbaune (Burm.). See *Hibiscus sabdariffa.*

Chinela (Peru). See *Caladium.*

Ch'ing Ma. China Jute. *Abutilon avicennæ.*

Chin pat (Ind.). See *Crotalaria juncea.*

Chip.

The trade name of thin strips or shavings of willow and poplar used, when braided, as millinery trimmings, or material for hats.

Chiquechique (Venez.). See *Attalea funifera.*

Chitrang (Ind.). See *Trema orientalis.*

Chlorogalum pomeridianum. Soap Plant.

Endogen *Liliaceæ*

California, in the valleys and foothills from the upper Sacramento to Monterey and Santa Barbara. The bulb is 1 to 4 inches in diameter, covered with a thick coat of coarse dark or brownish fibers resembling the coir of the cocoanut. Recommended for culture in Victoria.

Structural Fiber.—"These fibers are light, elastic, of good strength, and durable. They have been separated from the bulbs, especially by the Chinese, and used as hair to fill cushions, mattresses, etc., constituting, in places, quite an article of commerce." (Am. Jour. Ph., Dec., 1890.) Also noted in the Botany of California, and in Spon's Encyclopædia.

Chom (Yuc.). See *Bromelia pinguin.*

Chonta (Peru). See *Mastinazia.*

Chorda filum. See under *Macrocystis.*

Chorisia insignis. SAMOHÚ OF ARGENTINA.

Exogen. *Sterculiaceæ.* Small tree.

The genus includes a number of South American species, allied to *Bombax* or the silk cottons. Like other better-known producers of vegetable silk or "downs," they also yield in their bark a good fiber. The bast of this species is employed in Argentina. It is known in Peru as *Huimbaquiro ceibo,* both the down or surface fiber and the bast being employed, the latter for cordage. See also note on the species under *Bromelia serra.*

Chorisia speciosa.

This Brazilian species is mentioned in a brochure entitled Notes on Textile Plants of Brazil, distributed at the Phil. Int. Exh., 1876. The down or vegetable silk is stated to be excellent for winter mattresses and pillows. The tree is known in Brazil as *Arrore de Paina.* The species is mentioned by Spon. "This plant yields a fiber of which textures are made which are so much like silk in their luster, fineness, and pliableness to be scarcely distinguished from it" (*Savorgnan*). The tough bark of *C. crispiflora* is also used in Brazil for making native cordage.

Chouca (Antilles). See *Agave vivipara.*

Chrysopogon gryllus.

Endogen. *Gramineæ.* A grass.

Abounds in southern France and northern Italy. Known in Italy as *Barbone* and *Pollinia.* From the fibrous roots horse brushes and other coarse brushes, mats, etc., are said to be made; also used for thatch material. Classed as a structural fiber.

Chumese (Ind.). See *Crotalaria juncea.*

Chuncu (Peru). *Caladium giganteum.*

Churu, or **Choró** (Braz.). *Couratari.*

Chusan palm (Ind.). *Trachycarpus fortunei.*

Chu-ts-ao (China). *Cannabis sativa.*

Chrysopsis graminifolia.

Exogen. *Compositæ.* Perennial herb.

A Southern species found abundantly in the piney woods, particularly in Washington and Tangipahoa parishes of Louisiana. Attention was called to its value as a fiber plant by Mr. J. T. Blackwell, who wrote that the blade or leaf was the source of fiber. He cultivated the plants in his garden and secured a growth of three feet. Estimated yield of fiber, 150 pounds to the acre, which would not pay for cultivation, while the fiber itself is of doubtful value.

Cibotium barometz.
menziesii. TREE FERNS.

Syn. *Dicksonia barometz* and *D. menziesii.*

A small genus ranging over Mexico and Central America, the Hawaiian and Philippine Islands, Sumatra, southern China, and India.

SURFACE FIBER.—"The base of the leafstalks is densely covered with a soft and glossy yellowish wool, used for stuffing mattresses and pillows, and which, under the name of *pulu*, forms a regular article of export to California from Hawaii. The wool of *C. barometz*, from tropical Asia, and of *Dicksonia culcita*, from the Atlantic islands, serves for similar purposes and has also found a limited employment in surgery for stanching bleeding from ulcers or wounds. The hairs consist of a single series of flat thin-walled cells which break readily at the joints, the cells being shortest in *C. chamissoi* and longest in *C. menziesii*. *C. glaucum* is a rare species, though found in most of the Hawaiian Islands. The pulu, as to gloss and curl, is intermediate between *menziesii* and *chamissoi*. (*Hillebrand.*)

Spon mentions *C. barometz*, but ignores the other species, or confounds the four as one, stating that each plant yields about 2 to 3 ounces of the fiber, which occupies about four years in production. The gathering is a very slow and tedious operation. When picked the fiber is wet, and has to be laid out on the rocks or on mats to dry. In favorable weather this may be effected in a day or two; but in the habitat of the plant rains prevail, so that the fiber is often brought in a wet state to market, even after several weeks' "drying." "The application of the fiber is as a substitute for feathers and horsehair for stuffing purposes. The exports from Honolulu in 1878 were 212,740 pounds, of which Australia and New Zealand took 181,070 pounds and the Pacific ports of the United States 31,670 pounds." (Spon.)

C. menziesii produces the best fiber. On Hawaii this species, with *chamissoi* and *glaucum*, formed extensive thickets, which have, however, been nearly cleared away by the *pulu* gatherers, who sacrifice whole trees to get at the fiber without difficulty. The fallen trunks send out lateral shoots, but full-grown trees are now rare. Native names, *Hapui Ili* and *Heii*. The "golden moss" of the Chinese is produced by *C. chamissoi, glaucum*, and *Dicksonia culcita*. In Salvador and Costa Rica the natives make use of the vegetable wool of a species of *Cibotium*, common to all Central America.

Cigarette bast (see *Lecythis ollaria*).

Cipó imbe of Bernardin (Braz.). See *Philodendron*.

Cipó means a tropical climber, though sometimes root; frequently used.

Civil (Mex.). See *Malvaviscus*.

Clematis dioica. TRAVELER'S JOY.

Exogen. *Ranunculaceæ*. Climber.

"Native of West Indies and tropical America. This Jamaican clematis is a climber with ternate leaves, greenish-white flowers, and the numerous seed vessels terminating in a long, feathery tail. A decoction of the root in sea water mixed with wine is said to act as a powerful purge in hydropic cases. Stems used as withes for tying." (*Fawcett.*)

Clematis triloba.

India, mountains of the Deccan and West Konkan. Watt recognizes seven species of *Clematis* in the Dic. Ec. Prod. of Ind. Under this species he says: "The above species of *Clematis* yield fibers which are regularly used for agricultural purposes, and although authors allude to the medicinal properties of only one or two species, they are all more or less used by the natives of the hill districts."

Clinogyne dichotoma (see *Maranta*).

Coast Sword Rush (Austr.). *Lepidosperma gladiatum*.

Cochlospermum gossypium. WHITE SILK COTTON TREE.

Exogen. *Bixaceæ*. A small tree.

This genus is represented in tropical India, Africa, America, and northern Australia. *C. gossypium* is an Indian species, yielding gum, oil, fiber, and medicine.

SURFACE FIBER.—The seeds possess a short but very soft and elastic floss, from which fact the plant has received its specific name. This floss is much too short to be of any service as a textile, but, with the flosses of *Bombax malabaricum*, *Eriodendron anfractuosum*, and *Calotropis gigantea*, it has been classed as a "silk cotton." In some parts of India the floss of this tree is collected and used for stuffing pillows, for which purpose it would seem better suited than the floss from *Bombax malabaricum*, as it is not so liable to get matted. It might be found serviceable as a gun cotton. (*Watt.*)

Among South American species yielding silk cotton may be mentioned *C. hibiscoides*, in Venezuela "called *carnestolendas*, i. e., Lent, the large yellow flowers unclosing about that time" (*Ernst*). *C. insigne* is a native of Brazil.

Cochlospermum tinctorium.

Native of Yorubaland, west Africa, where it is known as *Fe-ru* or *Rawaye*. "Bark makes good rope, largely used as such by Yorubas and Houssas; plentiful; sufficient supply for export; not cultivated." (Kew Bull., Aug., 1891).

Cocoa, or Chocolate tree. (See *Theobroma cacao.*)

Cocoanut fiber (see *Cocos nucifera*).

Coco (see *Cocos nucifera*).

Coco de mer (Seychelles). See *Lodoicea callipyge.*

Coco de mono (Venez). See *Lecythis.*

Cocos butyracea.

Endogen. *Palmæ.*

This is a United States of Columbia and Peruvian species, chiefly useful as yielding a toddy. Dorca states that a fiber is extracted from its leaves fit for ropes and coarse textures. *C. oleracea* gives a similar fiber.

Cocos crispa.

A Cuban palm, which appears to have been more or less confounded with *Acrocomia lasiospatha* by past writers on West Indian fiber-producing plants. Squier describes the *Corosol, Coyol,* or *Corojo* palm of Cuba, while Bernardin mentions the *Corojo de la tena*, Cuba, as *Cocos urispa*, doubtless a misprint for *crispa*. Dr. Ernst refers *Corozo* to *Elæis melanococca.* In my list, published in the Ann. Rept. U. S. Dept. Ag., 1879, p. 551, the fiber referred to under the name *C. crispa* has since been determined as the product of *Acrocomia lasiospatha.*

Cocos datil.

A palm found in Argentina and particularly in Entre Rios. According to Niederlein, the fiber is "used by the natives for the fabrication of baskets, hats, etc.," the leaves being employed for this purpose. The Brazilian palm, known in common parlance as *datil*, is another species.

Cocos nucifera. COCOANUT.

NATIVE NAMES.—The fiber is known to commerce as coir, kair, and cocoa fiber. The names of the plant are as various as the countries in which it grows. Among the 100 or more appellations that have been used to designate it, the following may be given as representative: In the Malay Archipelago it is called *Anoer; Djai soi*, in Borneo; *Kelpo*, etc., Java; *Jouze-hindie*, Arab.; *Narkol*, *Nasil*, etc., Beng.; *Oteri*, New Guinea; *Sinlo-Kawa*, Jap.; *Nadi*, *Nali* or *Nari*, *Kera*, Sanskrit, etc. See *Narel* in Catalogue.

There is hardly a tropical country on the face of the globe where the cocoa palm does not flourish, and it is impossible to ascertain its native country, though it is thought to be indigenous in some parts of Asia, perhaps southern India. In the Coromandel and Malabar districts, and in the adjacent islands, it grows in the greatest luxuriance, preferring the sandy and rocky seashores to the higher country, though it is often found some distance inland. It is common in Africa, and abounds in America and the West India Islands. Dr. Parry found it plentiful on the island of Santo Domingo, where it forms groves on the sandy beaches at the outlet of mountain streams, and bears fruit abundantly. It is found in southern Florida, 20,000 trees having been planted on Long, Lignum-vitæ, and Sands keys alone, while examples 80 feet high and 50 years old are found at the mouth of the Miami River. Grows to 100 feet. Fig. 1, Pl. IV, is from a photograph of a tree about 7 years old, growing on Long Key.

Its extensive geographical distribution is accounted for by the fact that the tree growing in such close proximity to the sea the fruits falling on the beach are washed away by the waves and afterwards cast upon some far distant shore, where they readily vegetate. It is in this way that the coral islands in the Indian Ocean have been covered with these palms.

FIG. 41.—Cocoanut tree, Cape Florida.

STRUCTURAL FIBER.—Coir fiber appears in the form of large, stiff, and very elastic filaments, each individual of which is round, smooth, very clean, resembling horsehair. It posesses a remarkable tenacity and curls easily. Its color is a cinnamon brown. These filaments are bundles of fibers, which, when treated with the alkaline bath and ground in a mortar, are with difficulty separated by the needles for microscopic examination.

The individual fibers are short and stiff, their walls very thick, notwithstanding which this thickness does not equal the size of the interior canal. The surface does not appear smooth; it is often sinuous and the profile appears dentated. The diameter is not very regular. The points terminate suddenly and are not sharp. The walls appear broken in places as if they were pierced with fibers, corresponding with the fissures of the sections.

ECONOMIC CONSIDERATIONS.—The fiber of the cocoa palm is contained in the husk of the nut, fig. 42, which is composed of a mass of coir, as the separated fiber is called. The husks are removed by forcing the nuts upon sharp iron or wooden spikes fixed in the ground, one man being able to remove the husks from 1,000 nuts daily. The proper time for cutting the fruit is in the tenth month, as the fruit must not be allowed to get thoroughly ripe, for the fiber becomes coarser and more difficult to twist, and must remain longer in the soaking pits, which is a disadvantage, as the fiber is rendered darker. These pits in some of the islands are merely holes in the sand, and the nuts lie under the influence of salt water a year, kept from floating away by large stones placed over them. Sometimes the nuts are soaked in freshwater tanks, and, as the water is not changed, it becomes in time very foul and dark colored, which affects the color of the coir. After soaking, the fiber is readily extracted by beating. Fresh water is said to weaken the fiber, and, in fact, too long soaking will produce this result in any event. The coir from the islands of Kadamat, Kelton, and Chetlat, in the Laccadives, is said to be of the best description, and the manufacture into cordage is done entirely by women. After it is taken from the pit and sufficiently beaten, the extraneous matter is separated from the fibrous portion by rubbing between the hands. After it is thoroughly cleaned, it is arranged into a loose roving preparatory to being twisted, which is done in a very ingenious manner between the palms of the hands, so that it produces a yarn of two strands at once. According to the old, native system of treatment, the nuts sometimes remained in the pits eighteen months. The best commercial coir of to-day is obtained by better methods, and the soaking is accomplished in tanks of stone, brick, iron, or wood, the water being warmed by steam, which shortens the duration of the treatment very materially. "Where machinery is used (in the after processes), the husks, when sufficiently soaked, are passed through a crushing mill, which flattens and crushes them ready for the extractor, or breaking-down machine. In the latter the fibers are completely disintegrated, and are then passed through a 'willowing' machine, to free them from dust and refuse. It is calculated that when treated in England 10,000 husks will produce 45 to 50 cwt. of spinning fiber and 9 to 13 cwt. of brush fiber. In the process of separating the fiber, the following commercial qualities are produced: The mat, or long fibers used for spinning purposes; the shorter, or more stubborn fibers (bristles), for brooms or brushes; the tow or curled fiber for stuffing cushions, and the dust or refuse for gardening purposes. When dyed black, the tow has been used as a substitute for horsehair. A singular use was proposed a short time ago for cocoanut dust or refuse. Taken before it is quite dry, and subjected to great pressure, it is capable of forming plates of varying thickness, like millboard, only much more brittle. These boards, if used as backing for steel plates of ironclads, swell up on being punctured below the water line and soon close the orifice. If really effective, such plates could be produced at a trifling cost, for thousands of tons of cocoanut refuse float away annually down the rivers in India and elsewhere." (*Dr. Morris.*) See also Corn-pith Cellulose for this purpose, under *Zea mays.*

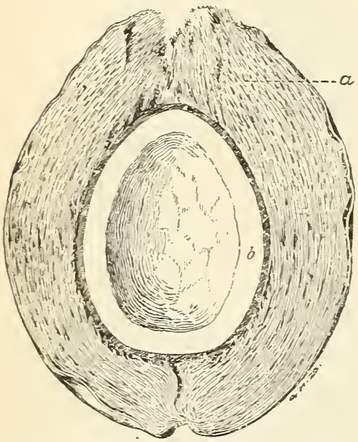

Fig. 42.—Section of a cocoanut. *a*, the husk containing the fiber; *b*, the fruit, or edible portion.

Three large coast cocoanuts will yield 1 pound of coir, measuring about 130 feet, whereas 10 small inland nuts are required for 1 pound, but it will give over 200 feet. Two pounds of such yarn, averaging from 70 to 75 fathoms, are made up into sooties, of which there are 14 in a bundle, averaging about a maund (28 pounds). A Mangalore candy (560 pounds) will thus be the produce of 5,600 nuts, and should contain 20,000 fathoms (120,000 feet) of yarn.

Coir fiber is used by the Spaniards of the South Seas instead of oakum for calking their vessels, and it is claimed that it will never rot. Coarse cloth is sometimes made from the fiber which is used for sails. The principal use of coir, however, in the commercial world is for cordage and matting. "The character of coir has long been established in the East, and is now in Europe, as one of the best materials for cables, on account of its lightness as well as elasticity." Ships furnished with coir cables have been known to ride out a storm in security while the stronger made, but less elastic, ropes of the other vessels snapped like pack thread. Coir cables were used extensively in the Indian seas until chain cables were introduced. It is rougher to handle and not so neat looking as hemp rigging, but it is well suited to running rigging where lightness and elasticity are desired, as for the more lofty sheets; it, however, is too elastic for standing rigging. In vessels of 600 tons it is generally used for lower rigging.

Tests of coir cordage by Dr. Wright gave the following results: *Hibiscus cannabinus* broke with 190 pounds strain, coir broke with 224 pounds, but bowstring hemp (*Sanseviera zeylanica*) required a strain of 316 pounds to break it. In another series of experiments, made at the office of the marine board of Calcutta, plain coir stood a strain of 823 pounds, when a remarkably fine specimen of European hemp stood 1,967 pounds. In this test the coir stood No. 12 in strength and No. 1 in elasticity, stretching 32 inches against 9½ inches for the hemp. Unfortunately the length of rope was not given, though its size was 1½ inches in circumference.

Economic uses of the cocoa palm.—The cocoa palm has other uses than for fiber which are of sufficient interest, in connection with its textile uses, to briefly mention. The cocoanuts are sometimes used for illuminating purposes, to light roads, and an excellent charcoal is yielded by the burnt shells. These in their entire state are manufactured into a great variety of vessels for household use. The tree itself is used in the manufacture of small boats, frames for houses, rafters, spear handles, furniture, and fancy articles of different kinds. It is exported under the name of porcupine wood. "The Cingalese split the fronds in halves and plait the leaves so nicely as to make excellent baskets, and they form the usual covering of their huts, as well as the bungalows of the Europeans." These dried fronds also furnish fuel and are used for torches, or they are made into brooms by tying the midribs together. The leaves furnish mats, baskets, and screens, and combs are made of the midribs of the leaflets in the Friendly Isles. Mats are also made of the cocoanut leaf cut out of the heart of the tree, which are described of fine quality and used in the Laccadive Islands as sails for their boats. A downy fiber is also taken from the plant which is used to stanch the blood in wounds after the manner of lint.

Cocoanut oil is one of the best-known products of the palm, especially as it is employed in the manufacture of stearine candles. In the East it is employed as lamp oil, and also for anointing the body. Fifteen cocoanuts produce about 2 quarts of oil. The drink known as toddy, or palm wine, is derived from the flower spathes before they have expanded. It is also distilled and produces an intoxicating liquor, or arrack. It is also made into vinegar, or, if it is not allowed to ferment, may be made to yield jaggery, or sugar, which is brown and coarse.

The collection of the Department contains a full series of coir in the various stages of preparation, as the husk, the loose fiber, yarn, rope, matting, brushes, and coir, or "curled hair," used for upholstering. It is much esteemed in India for stuffing mattresses and cushions for couches and saddles. Very little raw fiber is now imported into the United States. An interesting fiber specimen is a network of fibers taken from the petiole of the leaf. As seen upon the tree at the bases of the young fronds, it is beautifully white and transparent, but at maturity it becomes tough and coarse and of the same color as coir. It may be stripped off in large pieces, and the fibers are so straight and cross each other so regularly that they are used to strain cocoanut oil or palm wine.

It is doubtful if the production of native coir fiber will ever become an American industry, although I am informed by T. Albee Smith, of Baltimore, that machinery for extracting the fiber is already available. The palms grow well in southern Florida, and while already producing nuts the cocoanut industry has assumed no importance, though a single company in Massachusetts, extracts the fiber from imported nuts.

References.—Probably the best account of this useful plant, with a treatise upon its cultivation, uses in the domestic and industrial economy, etc., will be found in Vol. II, Dic. Ec. Prod. Ind.

**Specimens* can be seen in the Mus. U. S. Dept. Ag.

Cocos urispa.

I include this species on the authority of M. Bernardin. Two varieties of *Corojo* are given in Bernardin's Catalogue, the "*Corojo de la tena*" from Cuba stated to be "*Cocos urispa*," and the *Corojo, Corozo*, or *Cocoyal* from Central America, without name. See *C. crispa*.

Cocotero (Mex.). See *Cocos nucifera*.

Cocoyal (Cent. Am.). See *Acrocomia*.

Cocuiza (Venez.). *Furcræa gigantea*.

Cocuy (Venez.). See *Agave americana*.

Coir. Fiber of *Cocos nucifera*.

Cokerite palm (Braz.). See *Maximiliana regia*.

Colocasia antiquorum.

A genus of *Araceæ*, allied to *Caladium*. The species named is cultivated in most tropical countries as a food plant, both its leaves and tubers being eaten. It furnishes the "*Poi*" of the Sandwich Islands. Is only interesting here from the fact that fiber prepared from the plant in Mauritius was sent to the Vienna Exposition of 1873, similar specimens being exhibited in the Kew Mus.

Colorado River hemp (U. S.). See *Sesbania macrocarpa*.

Commersonia fraseri. TIE PLANT OF AUSTRALIA.

Exogen. *Sterculiaceæ*. A small tree.

A Victoria species known in some sections as Blackfellow's hemp. It is a tall shrub or small tree, and abounds on the banks of rivers and creeks. The bark is used extensively by the settlers as a tying material. It yields a fine fiber suitable for matting and cordage, and a good quality of paper could doubtless be made from it.

BAST FIBER.—The museum specimen was obtained from the Victorian collection, Phil. Int. Exh., 1876, and was prepared by Dr. Guilfoyle. The fiber is quite dark, due probably to insufficient bleaching, but is strong and not very brittle, and although the filaments are stiff, they exhibit under the magnifying glass a very fibrous nature, some of them being fine and lustrous; is inferior to *Hibiscus* fiber. It measures between 2 and 5 feet in length.

Commersonia echinata.

A sample of this bast fiber was secured from the New South Wales Exhibit, Phil. Int. Exh., 1876, labeled "Brown *Kurrijong*," by which name it is said to be known to the colonists. The name has been applied by other authorities to *C. platyphylla*. "The fiber of *C. echinata* is of a very tenacious nature, and is preferred to all others by the aborigines for making nets." The fiber is quite dark and does not appear to be quite as strong as that from *C. fraseri*.

Copernicia cerifera. *Carnauba palm.*

ENDOGEN. *Palmæ*. Height, 40 feet.

The genus includes six species of palms inhabiting tropical America. The Carnauba or wax palm is a Brazilian species about 40 feet high, with a trunk 8 inches thick. "It has been recommended for culture in Victoria. It resists drought to a remarkable degree and thrives on a somewhat saline soil." (Spon.)

STRUCTURAL FIBER.—The leaves are utilized in a variety of native manufactures. The museum series includes the leaf, plaited into hats, mats, etc.; the leaf reduced to filaments and made into rope and small cordage; small baskets and other brica-brac made from dark-brown piassaba-like fibers probably from the leaf spathe, and other objects, including fence material from the leaf stems. The leaves are also used as a thatching material.

OTHER USES.—The young leaves are coated with a yellow wax, which is readily collected by jarring or shaking and used for candles. A farina and a starch are also prepared from the bulbous root, while the rootlets produce a medicine. The seeds are a substitute for coffee. A beverage is also yielded by this palm, and the young branches are food for cattle and sheep.

* *Specimens.*—Complete economic series, Mus. U. S. Dept. Ag.

Coquilla palm (Braz.). *Attalea funifera.*

Coquito palm (Chili). See *Jubæa.*

Corchorus spp.

This genus of *Tiliaceæ* numbers between 40 and 50 species of herbaceous plants that are found in both hemispheres, growing in subtropical and tropical climes. The genus is particularly interesting on account of two India species that supply commercial fibers to the extent of milions of dollars annually, *C. capsularis* and *C. olitorius.* Other species indigenous or growing in India that are mentioned by Dr. Watt are *C. acutangulus,* fiber coarse; *C. antichorus,* fiber indifferent; *C. fascicularis,* fiber has been employed for ropes; *C. tridens,* locally used for rough cordage; and *C. trilocularis,* said to furnish a fair cordage fiber.

The only species worthy of mention that are found in the Western Hemisphere are *C. siliquosus,* which see, and *C. æstuans,* which Savorgan, quoting Miraglia, states "is cultivated in equatorial America on an equality with flax and hemp for its fine fiber." The author does not know that this species is considered as a fiber plant; it is not found in the United States. The commercial species are described below.

Corchorus capsularis. }
olitorius. } JUTE, JEW'S MALLOW.

Exogens. *Tiliaceæ.* Tall shrubs, 8 to 15 feet.

Found wild or in cultivation throughout the hotter parts of India, in which country the two species are supposed to be indigenous. Cultivated by the Malays, and by the Chinese to a limited extent, and have been introduced into the United States. *C. olitorius* has been naturalized in all parts of the tropics as far north as the shores of the Mediterranean. It is also grown in Egypt and Syria as a pot herb, hence the name Jew's mallow. It should be noted, however, that the commercial fiber known as China jute is not jute at all, but is derived from *Abutilon avicennæ,* a plant known as a common American weed. (See.) The commercial species of *Corchorus* were introduced into the United States by the Department of Agriculture about 1870, and the plants were found to thrive in cultivation all along the line of Gulf States and in South Carolina and Florida, though they have not yet been grown to a commercial extent. Passing by the vast literature of the two species as recorded in the Report on the Cultivation of Jute in Bengal, 1874, by Mr. Kerr, in the Dict. Ec. Prod. Ind., in the Kew Bulletin, and other British publications, the two plants will only be considered here from an economic standpoint, and will be treated together as supplying the jute of commerce.

Jute doubtless takes its name from the Sanskrit, as the words "*jhout,*" "*jhot,*" and "*jhat*" are all derived from the Sanskrit "*jhat,*" meaning "to be entangled." One form of the root is *jat,* and from it are produced *jata* and *juta,* both meaning "matted hair." The name "*jute*" was first used by Dr. Roxburgh. The Bengal name of the plant is "*pat*" or "*paat;*" the fiber, "jute;" the cloth, "*tat chotee*" and "*megila.*" The Malays call the plant "*rami tsjina,*" and the Chinese name is "*oi-moa.*" The native names, however, are legion, almost half a hundred names being recognized in different districts of India, where the plants are cultivated.

Botanical considerations.—*Corchorus capsularis* is an annual plant, growing from 5 to 10 feet high, with a cylindrical stalk as thick as a man's finger, and seldom branching except near the top. The leaves, which are of a light-green color, are about 4 to 5 inches long by $1\frac{1}{2}$ inches broad toward the base, but tapering upward into a long sharp point with edges cut into saw-like teeth, the two teeth next the stalk being prolonged into bristle-like points. The flowers are small and of a whitish-yellow color, coming out in clusters of two or three together opposite the leaves. The seed pods are short and globular, rough and wrinkled. The second species, the *C. olitorius*, is precisely similar to the last in general appearance, shape of leaves, color of flower, and habits of growth; but it differs entirely in the formation of the seed pod, which, in this species, is elongated (about 2 inches long), almost cylindrical, and about the thickness of a quill. See Pl. V, fig. 1. See also figs. 43 and 44.

Different kinds of jute.—Hem Chunder Kerr, in the Report on the Cultivation of and Trade in Jute in Bengal, 1874, states that among the many varieties of jute the most common are known by the names (*a*) *Uttariya*, (*b*) *Deswal*, (*c*) *Desi*, (*d*) *Deora*, (*e*) *Narainganji*, (*f*) *Bakrabadi*, (*g*) *Bhatial*, (*h*) *Karimganji*, (*i*) *Mirganji*, (*j*) *Jangipuri*. These are described by Mr. Kerr as follows:

Fig. 43.—Seed vessels of *Corchorus capsularis*.

(*a*) The first variety is by far the best. It is called *Uttariya*, or northern jute, because it comes from the districts to the north of Serajgungee. The districts are Rungpore, Goalparah Bogra, parts of Mymensing, Cooch Behar, and Julpigoori. This jute recommends itself to the trade by its possessing to the greatest extent those properties which are essentially necessary in fiber intended for spinning, namely, length, color, and strength. It is sometimes, however, found to be weak, and it is never equal to the *Desi* and *Deswal* descriptions in softness. A superior quality of jute is produced, chiefly for domestic use, by the Hajung and Koch tribes of hill people. It comes into the market so late as November.

(*b*) Next in commercial value is the *Deswal* jute. It goes down fairly with the trade on account of fineness, softness, bright color, and strength. It is stated, however, to have deteriorated to a certain extent within the last two or three years from the inefficient system of drainage in the new fields where it is grown. The fiber has become shorter and more rooty, and lately weaker also. Its name implies that it is the native jute of Serajgungee and its neighborhood. Such of it as is grown on beels is called Bilan, and what is raised in churs is known by the name of Charua; but in Calcutta they pass under the generic name of *Deswal*. It first comes into the market in Sravana, that is, about the latter end of July or beginning of August.

(*c*) The *Desi* jute is the produce of Hooghly, Burdwan, Jessore, and 24-Pergunnahs. It is of a long, fine, and soft fiber. If its defects, which are stated to be fuzziness and bad color, were removed, it is believed by men experienced in the trade that its market value would be very much improved.

(*d*) The staple known under the name of *Deora* comes from Furreedpore and Backergunge. Its name is due to a village in Furreedpore, where formerly there was a large mart. The village has dwindled down to insignificance now, but all the produce of the district, as also of the neighboring district of Backergunge, is known by its name. The bulk of the fiber of this class is strong, coarse, black, and rooty, and much overspread with runners. This fiber is used for the manufacture of rope. Its value would rise if the dealers would refrain from pouring water on the prepared fiber, which they are said to do in order to increase the weight of their consignments. Occasionally small batches of this jute are met with of a very superior quality.

(*e*) The *Naraingan ji* jute, which is brought from Aralia, Kurimgunge, and other jute centers, locally called Mokams, of the Naraingunge mart, is mostly the produce of the district of Dacca. It is very good for spinning, being strong, soft, and long; but from some neglect in steeping, the fiber, by the time it reaches Calcutta, changes its original color into a brown or foxy tint, which detracts from its value.

(*f*) The finest description of *Dacca* jute is the *Bakrabadi* fiber, which is raised on the churs of the river Megna. It excels particularly in color and softness.

(*g*) The *Bhatial* jute is also the produce of the district of Dacca, and comes to Calcutta from Naraingunge. It is grown on churs, and is called *Bhatial* because it is imported to Naraingunge from the south or tidal side (Bhati) of that place. It is very coarse, but strong, and is to a certain extent in demand in the British markets for the manufacture of rope.

(*h*) *Karimganji*, in the Mymensing district, gives its name to a very fine description of jute which is grown there. It is usually long, very strong. and of good color, partaking to some extent of the nature of the Naraingunge of Decca jute.

(*i*) The produce of Rungpore, though large, is generally of medium quality, and the worst kind of it comes from Mirgunge, on the Teesta, whence its name *Mirgánji*.

(*j*) The produce of a portion of the Pubna district is known by the name of *Jangipuri*, so called from a small village of that name. It is of short fiber, weak, and of a foxy color, most objectionable for spinning.

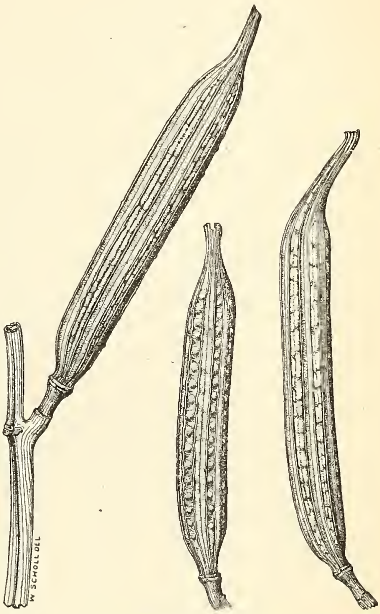

FIG. 44.—Seed vessels of *Corchorus olitorius*.

HISTORICAL.—Jute has been known and cultivated since remote times in India, particularly in the lower provinces, but its employment as a textile by the nations of the earth is an industry that belongs to the present century. It was first recognized under a separate head in the custom-house records of the Indian Government in 1828, though the fiber had been sent to the European market in trifling quantities during the two or three previous decades. In 1793 the East India Company sent to England 100 tons of the fiber under the name "pat." In the warehouse committee's report on this shipment it was stated that "some of the most eminent dealers declare that it is not hemp, but a species of flax, superior in quality to any known to the trade." The first exports as jute, in the year named above, amounted to but 18 tons. In 1850–51 the total exports, including jute rope, had reached 30,000 tons, and in 1871–72, 310,000 tons. At this time 35 districts of India were cultivating 800,000 acres in jute, more than one-half of this area lying in nine districts of northern Bengal.

Up to this date hemp and flax had been used to bale the cotton crop of the United States, and jute as an article of import occupied a very small place. The year 1872, however, saw the native fibers superseded by the India product, particularly in the West, resulting in the almost total destruction of the industries they represented. As already shown, the present imports of the fiber into this country are enormous, while the exports of raw fiber to all countries from India amounted in 1894-95 to nearly 649,000 tons, the exports of manufactures also showing large figures. The interest in jute cultivation in this country had its beginning just prior to the time that the fiber began to be largely imported. The Department of Agriculture directed attention to the culture as early as 1869, and in 1869–70 procured from France and India a quantity of the seed for distribution. As a result, hundreds of small cultural experiments were conducted in the South from the Carolinas to Texas, and ample proof was secured that the plant was well adapted to growth in the United States.

Bast Fiber.—Were it not for its fineness, silkiness, and adaptibility for spinning, with the easy cultivation of the plant, jute would not to-day hold the position it has secured in the industrial economy, for, compared with the other textiles, it is very inferior. Several American plants that are classed as weeds produce better and stronger fiber, but their cultivation and preparation are yet matters of experiment. One defect of jute is the difficulty to spin it into the higher numbers. Its durability is also against it, as the fiber can not stand dampness, and under the best conditions rapidly deteriorates. The bleached fiber also loses its whiteness and in time oxidizes until it presents a dingy, yellowish-brown color. Its strength is inferior to most fibers, though it is amply strong for the coarse uses to which it is commonly put, such as the manufacture of gunny sacks, cotton bagging, etc., where durability is of less consequence than primary cheapness.

Fig. 45.—Plant of jute, *Corchorus capsularis.*

Samples of the fiber exposed for two hours to steam at 2 atmospheres, followed by boiling in water for three hours, and again steamed for four hours, lost 21.39 per cent by weight, being about three times as great a loss as that suffered by hemp, manila hemp, phormium, or coir. A similar test of jute with flax, hemp, ramie, and other fibers showed as great a loss, while flax lost less than 4 per cent and ramie a small fraction under 1 per cent.

Specimens of jute grown in this country experimentally have been found for the most part superior to the imported fiber, and with the more careful cultivation and preparation that would be given it would no doubt command a better market price and be employed in higher manufactures.

Uses of the Jute Fiber.—This is employed in three forms of manufacture—weaving into fine and coarse fabrics, in the making of fine twines and cordage, and in paper manufacture; the latter chiefly from "jute butts and rejections." In Europe the fiber enters into a great variety of fabrics or cloths, such as curtains and upholstery, carpets, etc., and even sheetings and imitations of silk fabrics. It has been applied extensively as a substitute for hemp. For this purpose the fibers are rendered soft and flexible by being sprinkled with water and oil, in the proportion of 20 tons of water and 2½ tons of train oil to 100 tons of jute. Sprinkled with this the jute is left for twenty-four to forty-eight hours, when, after being squeezed by rollers and hackled, the fibers become beautifully soft and minutely isolated, and thereby suited for a number of purposes unknown a few years ago. Its perishable nature is fatal to its obtaining a position much higher than it has already attained, and probably admixture of jute in certain articles, such as sailcloths, must sooner or later be viewed as a criminal offense.

In coarser woven goods it appears as webbing, burlap, and cotton-bagging stuff. Its use in fine and coarse twines, binding twine, sash cord, etc., is very large, while it is also used extensively in the smaller sizes of rope. Because of its fineness and luster, coupled with its cheapness, it is frequently used to adulterate the manufactures from better fibers, and on account of the tendency to rapid deterioration already noted such use is plainly fraud. When employed in hemp twines in this manner, it is artificially given the dark color of hemp, its natural color being a light-salmon. Binding twine is sometimes made of this fiber, colored to resemble hemp, and sold at a good price under a fancy trade name.

CULTIVATION.—The largest areas in India are found in Bengal, where there is a wide diversity in soil and climate, and where high lands, low lands, recent alluvial formations along rivers (known in India as "churs"—mud banks and islands), dry lands, humid lands, and even cleared bamboo jungle have been all more or less cultivated in jute. These lands are classified in India under two general heads—first, "Suna," high land, which is generally reserved for the cultivation of fruit trees, pulses, vegetables, tobacco, sugar cane, and early rice; and, second, "Sáli," or the lowlands upon which the late rice crop is produced.

The great bulk of jute that comes from the central and some of the eastern districts is grown on "churs" and on inferior soil, but in the "desi," or the littoral districts, a larger proportion is grown inland than on the banks of the rivers. In the early days of this cultivation, however, when jute was raised for home consumption only, it used to be grown only on raised lands close to the grower's homestead. On the whole, the balance of evidence is decidedly in favor of high or "súná" lands as the best for jute, provided all the other conditions necessary for its healthy growth be attainable, but that low lands and "churs" are not unsuited, "churs" ranking midway between the two. (*Hem Chunder Kerr.*)

In the district of Burdwan the plant is grown on soil composed of rich clay and sand in equal proportions. In Mymensing it grows on "soil consisting of a mixture of clay and sand, or sand combined with alluvial deposit;" in Backergunge, "on loam mixed with a little sand;" in Cooch Behar, "on soil with a certain admixture of sand;" in Tipperah, "on loamy and sandy soil;" in Pubna, "on land which is neither inundated nor dry, the soil being loam, i. e., half clay and half sand." On the other hand, the jute plant appears not to be averse to clayey soil. It grows in the Barripore subdivision of the Twenty-Four Pergunnahs "on mátiál or clayey soil;" in Hooghly, according to the district officer and Baboo Joykissen Mookerjee, "on clayey soil," which, in their opinion, is "best suited for jute cultivation;" in Moorshedabad, also on "clayey soil," which is considered there, too, to be "best adapted for jute;" in Noakhally, "on high land, the soil of which is called attáliá," i. e., stiff and sticky; and in Cuttack, "on high land, rich and clayey." It also thrives in ferruginous soil, as in Bhowal, in the district of Dacca, where jute is pretty largely cultivat d; and the fiber produced there is considered to be among the best kinds which find their way to the markets of Dacca and Naraingunge. As a summary, it may be said that in India rich alluvial lands give the best results, particularly in connection with a hot, damp atmosphere and heavy rainfall. A light, sandy soil, however, is not suited to the plant. Dr. George Watt states, briefly, that "a hot, damp climate, in which there is not too much actual rain, especially in the early part of the season, is the most advantageous." The most congenial conditions are alternate sunshine and rain, and even excessive rain after the plant has reached a height of several feet is not injurious if water does not lodge at the roots. The effect of such lodgment, or from the plants standing in water, is the growth of suckers, which causes defective fiber. Drought stunts the plant and also injures the fiber. In the preparation of the soil much depends upon its constituents, heavy or clayey lands requiring more plowings than the lighter, sandy, or alluvial lands. The soil is thoroughly broken up and finely pulverized, and with heavy soils much is accomplished in this direction by the action of the elements—the sun particularly. The preparation therefore commences in November or December, some authorities say September, though it may be put off until February and March, and even as late as June. Four to twelve plowings are usually given, and at the last plowing all weeds and other trash are collected, dried, and burned. Due allowance should be made, however, for the rude and primitive implements that are called plows in many parts of India. The ground is also harrowed, or the clods broken with a mattock. The soil for early sown jute is sometimes laid with manure, but this is never the case with the later sown crops. In the Hooghly district fresh earth and cow dung are used for manure, but the poor soils are treated to oil cake. In localities where the ryot is too poor to own a plow and cattle the land is turned with a hoe. As a rule, the oftener and more thoroughly the land is plowed the larger is the yield. Soil exhaustion is remedied by manuring, rotation of crops, and fallows. The manures ordinarily used are crow dung, ashes, house sweepings, oil cake, the ashes of burnt jute roots, the stubble of rice crops. All refuse from the plant should be returned to the soil. Rotation of crops is practiced in almost every district where jute is extensively grown, and is well understood by the cultivators, though no universal rules are curent. The crops most frequently selected are mustard, rice, and pulses. Leaving the land fallow for two to three years is resorted to whenever found necessary.

A study of the practice in India points to the choice in the United States of alluvial lands, such as the second bottoms, so called, along rivers or other bodies of water, and even lowlands that are not flooded. The experience of those who made trials of the culture in the early seventies indicates that while the plants will grow on a great variety of soils, the best results are secured where there is plenty of moisture, or, when the moisture is not found in the soil, where it can be applied artificially, as by irrigation. In the experiments in Florida in 1872 cultivation in a bay head, composed of muck several feet deep, cleared off and lined, produced stalks to the height of 12 feet or more. On Florida cotton lands which are not uplands the plant did well. In Georgia, in the same year, culture upon "stiff clay lands" produced stalks 15 feet tall. A South Carolina farmer utilized rice lands, securing stalks 7 to 10 feet tall. In Louisiana several experiments were conducted the same year upon river lands 1 foot and 3 feet above Gulf tide. Notwithstanding that the season was very dry, stalks 10 to 13 feet tall were produced, and the experiment was considered in every way a success. In North Carolina moist bottom lands were chosen with good results.

The following, from Felix Fremerey, gives a practice that has produced good results near Galveston, Tex.:

"In February the soil is plowed to a depth of 7 inches and exposed to the influences of sun and air. By the middle of April, when the soil has gotten fairly warm, and by no means before, it is harrowed twice in order to thoroughly pulverize it. Furrows at a distance of 8 inches are drawn by means of a drill; they should be about 2½ to 3 inches deep, and cotton-seed meal at the rate of a quarter to half a ton per acre is thrown in them. The seeds are dropped in these furrows at the rate of 15 to 16 pounds per acre and then covered with earth in any convenient manner. At this time of the year the soil contains much moisture, which, combined with the atmospheric warmth, brings the seeds to germination in a few days; the young plants will appear about the fourth or fifth day after sowing, when they will rapidly advance in growing, requiring no care whatever. As long as there is sufficient moisture in the soil the plant should be let alone, but as soon as the ground begins to be dry irrigation should be resorted to. In order to insure a most regular and effective soaking of the soil, I would advise to draw furrows in both directions about 4 inches wide, and as deep, at regular distances of 10 or 12 feet. If the soil is naturally rich no fertilizing in connection with irrigation is required; in the case, however, of the soil being poor, or humus being insufficiently represented in it, additional fertilizing should be given, and for this purpose I would advise to put in cotton-seed meal, mixed with water a few days before its use; the meal will rot and the irrigation water will carry it where it will become available for the young plants. A jute plantation must be kept moist, avoiding an excess of irrigation in order to keep the ground as far as possible in a temperate warmth. If the plant has attained the age of four weeks its rank growth will prevent the sunbeams from penetrating to the soil, so it will for a long time preserve the needed moisture and consequently keep the soil soft and mellow, allowing the roots to absorb the needed chemical constituents, and permitting organic and mineral plant food to decompose so as to render them fit to be drunk by the plants. In case of broadcast sowing, 22 to 25 pounds of seed should be used, waiting if possible until after a rain; or if natural precipitation is lacking, after a soaking of the soil by irrigation. The manure in this case should be spread as uniformly as possible before harrowing, and after sowing the soil should be smoothed by a common field roller in order to press the seeds in the ground, granting them in this way every chance of germination."

The quantity of seed sown per acre varies greatly in the different districts of Bengal, ranging from 1 seer per bega in Hooghly to 6½ seers in Burdwan. A seer is 1 pound 13 ounces. This would give in English equivalents 5½ pounds to 11¾ pounds per acre. Twelve to 15 pounds to the acre are generally accepted as the average, though Spon states that 22 to 28 pounds are required. The yield of seed per acre in India is about 4½ maunds, or nearly 400 pounds. The season for putting the seed into the ground extends from February to June, though March and April are the months usually selected. As in the case of plowing, so in the period of sowing, there are marked differences; but the mode of sowing is with one exception alike everywhere. The seeds are sown broadcast on a clear, sunny day, and covered with a thin crust of earth, either by the hand or by a "binda," or harrow, or a "moi," or ladder, or, as in Bhaugulpore and Julpigoree, by beams of wood drawn over the field by oxen. Little or no after cultivation is given, and no care further than to thin out the weaker plants where a field is overcrowded. Ordinarily, the space left between plants is 6 inches, though in some localities more space is left, sometimes 8 to 10 inches. The plants mature in about three months, so that the harvest of a crop sown in March or April will come in June and July, the May and June sowings maturing in September and October.

Extraction of the Fiber.—Machinery has never been used for this purpose in India, and the fiber is separated from the stalks by retting or steeping for a week or more in water. In Mr. Kerr's report it is stated that the almost universal practice is to ret in stagnant water, "especially such as contains a large proportion of decomposing vegetation," which expedites the retting process. It is stated, further, that the ryots go down into the pools and, standing waist deep, thrash the water with handfuls of the retted stalks to facilitate the separation of the fiber. In referring to the India practice the author does not recommend it, as few American farm laborers North or South could be found who would adopt it any more than European laborers will pull flax by hand after becoming residents of the United States, if they can avoid it. Plainly, then, successful jute culture in the United States can only be brought about by the use of machinery for extracting the fiber. See Appendix A.

But the machine alone does not prepare the fiber in marketable form. The decorticated ribbons have yet to be retted to remove the gums, wood, and other waste matters, and give a spinnable product. The best combined process so far available is to strip the stalks by machine and ret the fiber in tanks of water. Mr. Fremerey, who has had a large experience in this work, recommends the use of wooden vats filled with water and kept as near a temperature of 95° to 100° F. as possible; or holes may be dug in the ground, as for flax retting, measuring, say, 10 feet long by 4 wide and 4 feet deep. The stripped ribbons are tied loosely in bundles of about 50 pounds, for ease in handling, and placed in the vats or pools in such a manner as to insure their being completely submerged until the dissolution of the gums and waste matters has been accomplished. In the absence of the vats or pools, the India practice of retting in pools or waterways must be followed, though it is not essential that the farmer shall follow the Indian ryot's example, by taking a warm bath in water fouled by decomposing vegetable matters almost to the point of putrification.

Yield and value of the crop.—Warden, in his work on the linen trade, 1867, places the yield of jute fiber per acre in India at 400 to 700 pounds. George Watt states in the report of the revenue and agricultural department of India (1888–89) that an average crop of fiber is 15 maunds, though the range is from 3 to 36 maunds per acre—a maund is $87\frac{2}{7}$ pounds. He also cites the experiments performed at the Saidapet farm in Madras, where the yield was 599 pounds of fiber if cut close to the ground, and 703 pounds when pulled, but adds that is less than half of the average yield in Bengal. Undoubtedly the American yield, on proper soil, will be considerably higher then the yield in India and it would be perfectly safe, then, to count upon crops of 3,000 pounds per acre, since this yield is exceeded in India under the best conditions of growth.

Regarding the value of the crop, a perusal of the past literature of the subject published in this country reveals promises of large remuneration to those who will embark in the industry. Tables showing cost of production and profits of culture have appeared that, however honestly they may have been stated at the time they were prepared, are now misleading, for the reason that the prices of fibers of all kinds were never lower than at the present time (1896).

The following table showing the values of India jute on December 31, for three years, from monthly statements of H. H. Crocker & Co., New York City, January 1, 1896, is interesting:

Year.	Jute fiber.		Butts and rejections.	
	Spot.	Shipment.	Spot.	Shipment.
	Cents.	*Cents.*	*Cents.*	*Cents.*
1893	$3\frac{1}{4}$ @ $4\frac{1}{2}$	$3\frac{1}{4}$ @ $4\frac{1}{2}$	$1\frac{5}{8}$ @ $2\frac{3}{4}$	1.7 @ $2\frac{7}{8}$
1894	$2\frac{1}{4}$ @ $3\frac{1}{8}$	2 @ $3\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{1}{16}$ @ $1\frac{3}{4}$
1895	$2\frac{3}{8}$ @ $3\frac{1}{4}$	$2\frac{1}{4}$ @ $3\frac{3}{8}$	$1\frac{1}{8}$	$1\frac{1}{16}$ @ $1\frac{3}{4}$

The Report on the Foreign Commerce and Navigation of the United States for the year ending June 30, 1895, shows that the fiber was imported in the following quantities:

Year.	Jute fiber.		Butts and rejections.	
	Tons.	Value.	Tons.	Value.
1894	18,154	$935,537	31,845	$780,821
1895	41,787	1,573,690	68,885	1,181,439
Total	59,941	2,509,227	100,730	1,962,260

These figures show that over 100,000 tons of the cheaper fiber (selling at an average of less than $1\frac{1}{2}$ cents per pound) are used in this country annually, against about

60,000 tons of the fiber, bringing at highest market prices 3⅝ cents a pound. It is extremely doubtful if the demand for cheap jute could be met by the Southern farmers at present prices, even if the cotton crop should continue to be baled with jute bagging, and the new inventions for compressed bales covered with iron suggest a contingency worth considering. The Southern jute planter, then, could only endeavor to fill the demand for the higher-priced fiber at the best prices he would be able to realize in competition with the Indian product. That he would be able to secure the full price of the foreign commodity, judging from samples of American jute I have examined, there is little doubt; and were he to grow a superior product, which he would be able to do with better practices in culture than are followed in India, he can fill a limited demand for fiber at higher prices than the Indian product, for use in superior grades of jute manufactures. In time, special uses in manufacture might be created that would be filled exclusively by American jute, but this can not be assured.

* *Specimens*, in series, Mus. U. Dept. Ag.

Corchorus siliquosus.

This small shrub is a well-known tropical American species, said to be indigenous in the West Indies and southward. It is a herbaceous plant only 2 or 3 feet high, its leaves differing from those of the two commercial species "in not having bristles or the two bottom teeth, and there is usually a line of minute hairs along the stem." It is not regarded for its fiber, its only economic uses being the making of besoms by the negroes, while the inhabitants of Panama employ the leaves in an infusion which is a substitute for tea.

Cord grass, Fresh water (see *Spartina*).

Cordia cylindristachya. BLACK SAGE.

This genus of *Borraginaceæ* contains almost two hundred species of plants found in tropical and subtropical regions of the world. They are trees or shrubs; the fruits of some species are eaten, and also used in pharmacy, and some of them are valued as timber trees.

C. cylindristachya is a Trinidad species, said to be "a common wayside weed, the fiber of which is seldom seen except in museums and at exhibitions" (*Hart*). Its fiber is fit for coarse forms of cordage. Samples of the fiber of *C. macrophylla* (the Manjack), of *C. gerascanthus* (the Spanish elm), and of *C. sebestena* all tropical American species, were received from the Smithsonian Institution in 1869, without data. A good *specimen of *C. colococca* appears in the Herb. Col. Univ. N. Y., which shows that it is unimportant economically.

Cordia myxa.

An Indian species (western, central, and south India). Wild in the Himalayas, cultivated on the plains.

FIBER.—The bark is made into ropes, and the fiber is used for caulking boats; fuses are also made from it. "From the inner bark is obtained a fiber, from which the coiled match of the native firearms is made" (*James*).

My notes on this species, in Ann. Rept. Dept. Ag., 1879, are as follows: *Cordia angustifolia*, called by the natives of Mysore *narwuli*, is used in the manufacture of rope. The bark is extracted in ribbon-like layers, and then twisted into cordage. It is possible some of the species might yield a useful fiber for textile purposes, though the examples in the museum are very inferior. In its lace-bark appearance the bast resembles *Sterculia*; it is white in color, soft, and of inferior tenacity.

* *Specimens*.—Mus. U. S. Dept. Ag.

Cordia rothii.

The *C. angustifolia* of Spon. A small tree of northwest and central and south India. The liber or inner bark yields a coarse, gray bast fiber, which is used by the natives for cordage. It is a small tree, 12 to 15 feet, found in Mysore, Bombay, and the Deccan. A fiber prepared from the bark is made into ropes, used in Malabar for dragging timber from the forests. It is very strong, and samples are said to have supported more than 600 pounds. *C. latifolia* affords similar fiber; used for rope, coarse cloth, twine, and netting.

Cordyline australis. FORSTER'S PALM LILY.

This genus of erect-stemmed, shrubby, palm-like *Liliaceæ* are found in tropical Africa, in Madagascar and the Mascarene Islands, in the Malayan Archipelago and Australia.

Guilfoyle enumerates nine species in his Australasian list from which he has extracted fiber, as follows: *C. australis*, *C. australis* var. *lineata*, *C. banksii*, *C. baueri*, *C. cookii*, *C. indivisa*, *C. stricta*, *C. terminalis*, and *C. veitchii*.

The most common in the botanical and other gardens of Melbourne is "Forster's Palm Lily" (*C. australis*), one of the New Zealand species. Under favorable circumstances it grows to a height of 30 to 40 feet, and the leaves afford a large percentage of excellent, strong fiber. With proper attention this plant will yield a good crop of leafage in its fourth or fifth year; and, as it will grow vigorously in land subject to partial inundation, it can be utilized in places otherwise comparatively useless. It seeds freely, and can therefore be extensively propagated, so that a young plantation may be always coming on to supersede the old one when the latter becomes unprofitable. (*Guilfoyle.*) Fig. 1, Pl. VI, shows this species. From a small plant growing in the United States Botanical Garden.

Cordyline banksii.

C. pumila (error for *pumilio*) of my report, in Ann. Rept. U. S. Dept. Ag., 1879, this name having been attached to the label accompanying the specimen of fiber obtained from the Phil. Int. Exh., 1876. Habitat: New Zealand. The fiber from this plant is another of Dr. Guilfoyle's preparations. The native name is *Ti-rauriki*. "The leaves of this interesting species of *Cordyline* grow to a great length and yield an abundance of fiber of long staple, suitable for ropes, mats," etc. It is also convertible into a good quality of paper. The fiber is from 2½ to 3 feet in length, straight, white, and glossy, but very stiff, resembling fiber of Yucca or Agave, and seems to have been extracted in coarse bundles of filaments, which must be hackled to be reduced to anything like fineness. It is fully as strong as Yucca fiber, and would make excellent rope of great tenacity.

C. banksii, Sir Joseph Banks's Palm Lily, attains a height of about 10 feet, and throws out leaves of 3 or 4 feet in length. The fiber is long in staple and of great strength. Like the first-named species, the seeds are produced in great abundance, and, especially on irrigated land, it will grow rapidly in this colony, as under these conditions two or even three strippings of the outer leaves might be made in a year. (*Guilfoyle.*)

* *Specimens.*—Mus. U. S. Dept. Ag.

Cordyline indivisa. THE TALL PALM LILY.

Fiber and tow of this species were also received from the Victorian collection, Phil. Int. Exh., 1876, prepared by Dr. Guilfoyle. They are not as fine as the preceding, however, though possessing considerable strength. A very rudely manufactured rope from the last-named species accompanies the collection. This fiber, however, is darker colored, and possesses little of the beauty of the preceding example, which has been carefully prepared. Neither Royle nor Vétillart makes mention of this fiber, though it is named in Bernardin's Catalogue.

The leaves attain a length of 4 feet, and a breadth of 4 to 5 inches, and contain an abundance of fiber, which diverges from the center to the edge and top of the leaf. It is therefore shorter than the leaf, and not of the same strength throughout; but it is prepared with greater care than the New Zealand flax (*Phormium tenax*), and is better for cordage purposes, as it does not contract in water. The natives use it in the manufacture of rough mats, employed as a cape to keep off the rain, it being more durable than *Phormium* fiber. Though the fiber is coarse, it seems well adapted for ropes and paper making. (Spon.)

C. terminalis is a Hawaiian and Asiatic species (see *Dracæna*), and *C. reflexa*, and *C. fragrans* are African species. *C. nutans* is found in China, India, and South Sea Islands. Bernardin records *C. heliconia* from Jamaica. According to the Official Guide Kew Mus., garments have been made from species of *Cordyline* in New Zealand and colored with native dyes.

* *Specimens.—C. indivisa,* Mus. U. S. Dept. Ag.

Cork-wood Tree. *Ochroma lagopus.*

Corn. (Maize.)

Various fibers from leaves and husks of corn, and cellulose from cornstalks. See *Zea mays.*

Coronilla emerus.

Exogen. *Leguminosæ.* A bush, 5 feet.

A Mediterranean plant sometimes cultivated in gardens of southern Europe and commonly known as the *Scorpion senna.* The leaves yield a dye and have medicinal properties.

Bast Fiber.—Savorgnan mentions this species as one of the plants that has been given the name *Ginestra,* which is applied to several distinct species of plants yielding fiber and particularly to *Spartium.* It is the *Ginestra di bosco,* and is of little value as a textile.

Corosal (Cent. Am.). See note from Squier under *Acrocomia.*

Corozo (see *Cocos crispa*).

May be the same as *Corojo* (Cuba). See *Acrocomia lasiospatha.* In Venezuela *Corozo* is *Elæis melanococca.* "*Corozo* is a collective name for several species of palms with fruits having a hard kernel" (*Dr. Ernst*).

Cortega (Panama). See *Apeiba.*

Corteza (Sp.)=bark.

Corylus californica. Hazelnut Trees.

The hazels are too well known to need description here. They are small trees or large shrubs. "The usual form of the hazel, in its wild state, is a straggling bush consisting of a number of long, flexible stems from the same root" (Treas. Botany).

Woody Fiber.—"The young flexible twigs of the California hazelnut (*C. rostrata* var. *californica*) are almost in as great demand by the Indians of California and Oregon as the branches of *Salix sessilifolia;* these two plants making up most of the warp of their basket work. Hazelnut twigs are also much used in binding fish dams" (*Dr. V. Havard*).

Corypha gebanga. Gebang Palm.

Endogen. *Palmæ.*

A Javanese species of palm, from the trunk of which a kind of sago is obtained. The Kew Mus. exhibits a kadu, or sleeping mat, made from the leaves on the island of Ceram; also a hat made from the leaves in Java, and strips of the unexpanded leaves used in Borneo for sewing. The leaves are also plaited into baskets.

Corypha umbraculifera. Talipot Palm.

Native of Ceylon and Malabar coast. Straight cylindrical trunk, marked by rings and surmounted by a crown of gigantic fan-like leaves; height, 60 to 70 feet. See fig. 1, Pl. IX.

STRUCTURAL FIBER.—The leaves are made into fans, mats, and umbrellas, and are used for writing on. They are also largely employed for thatching. Roxburgh remarks that the leaves "are used to tie the rafters" of native houses, as they are "said to be strong and durable." It seems probable that after removing the edible pulp from the interior of the stem the long fibrovascular cords might be used as a substitute for kittul, similar to the fibers extracted from the stem of *Caryota urens*. These fibers are reported to be softer and more pliable than those found at the bases of the leaves. (*Watt.*)

Specimens of the fiber obtained from the Ceylon exhibit, W. C. E., 1893. Principally used as a thatch or covering for tea houses. In the Official Handbook of Ceylon (W. C. E., 1893) it is stated that this palm is never now found in the forests, as it is a cultivated species. "This last palm is one of the glories of our flora, reaching, when fully grown and in flower, to 100 feet in height, of which some 20 feet are occupied by the great pyramidal flower head. It belongs to that group of palms which flower but once; in this case after about forty-five to fifty years' growth, and die after ripening the seed."

Spon mentions *C. australis* as the Australian cabbage palm, but this is the same as *Livistona*. The leaves, which are of great size, yield a fiber by simply splitting them longitudinally. This is employed in "the manufacture of hats, baskets, netting, clothing, etc."

* *Specimens.*—U. S. Nat. Mus.; Mus. U. S. Dept. Ag.

Cos (Ceyl.). See *Artocarpus*. See also *Cos*, p. 12.

Coscinium fenestratum. WENI-WEL OF CEYLON.

Exogen. *Menispermaceæ.* Climber.

This strong, woody, scandent species is found in great abundance in the moist districts of Ceylon between sea level and 3,500 feet altitude. In the Dic. Ec. Prod. Ind. there is mention of the plant as yielding a yellow dye and medicine, but of no other economic use. In the Handbook of Ceylon (W. C. E., 1893) it is stated that the freshly cut stems or vines are made into a strong rope by twisting, and largely used by the natives for tying cattle. The species is included in Bernardin's list.

Costus afer.

Credited to Africa. Many of the species of *Costus* are ornamental greenhouse plants. Fiber, 3 feet 6 inches in length. Mentioned in lists of Bernardin and the Flax and Hemp Commission of 1863.

Cotton. Species, cultivation, etc. See *Gossypium.*

Cotton grass. *Eriophorum latifolium.*

Cotton, Silk, or **Vegetable silk.** Species of.

This substance is produced in the seed pods of many species of plants in different parts of the world. They are variously named and in past time much confusion has existed in regard to their nomenclature. As they are treated in this catalogue under their botanical names, the following list of principal species should be referred to for detailed description:

Asclepias syriaca and *incarnata*, milk weed, silk weed, etc. Temperate North America.

Asclepias curassavica. Platanillo, Venezuela and India.

Bombax ceiba. Tropical America.

Bombax cumanensis. Lana del tambor. Venezuela.

Bombax malabaricum. India and Burma.

Bombax munguba. South America.

Bombax pubescens. South America.

Bombax villosum. Mexico.

Calotropis gigantea. Tropical Africa, Persia, India, and Ceylon.

Chorisia insignis and *speciosa.* Argentina and Brazil.

Cochlospermum gossypinum. India.

Eriodendron anfractuosum. The commercial kapok. West Indies, South America, tropical Africa, Java, India, and Ceylon.

Eriodendron samauma. Brazil.

Epilobium angustifolium. Temperate North America.

Ochroma lagopus. Balso. South America.

See *Cibotium menziesii, Pulu* of the Hawaiian Islands. This is not a "silk cotton," but it resembles this substance and is employed for the same uses. See also *Typha.*

Cotton-stalk fiber. See Bast Fiber, under *Gossypium.*

Cottonwood. *Populus deltoides.*

Country mallow (see *Abutilon indicum*).

Couratari spp.

The genus *Couratari,* belonging to the *Myrtaceæ,* embraces a dozen species or more of South American trees, the superb examples occurring in Brazil, along the Amazon and its tributaries, and in countries to the northward, Peru and Guiana especially. The flowers are large and white, mixed with purple in color, arranged in axillary spikes. The fruit is a woody capsule, oblong in form, covered by an operculum which extends in a central axis to the base of the capsule, where the seeds are inserted. The species of the genus *Couratari* and of *Lecythis* are very nearly related, differing especially in their fruit, which in the latter is hard and bulky, serving the natives for cups and vases. A traveler in Guiana states that one of the species of that region blossoms about the time that its leaves fall, and that it is covered with thousands of rose-colored blossoms like the peach tree. The timber of these trees is prized for many uses, and the bark of several species has long been known to the South American Indians as yielding a valuable fiber.

The trees of this genus are particularly interesting as yielding a bark fiber known as *Corteza del Damajuhato,* from which the natives produce a kind of cloth for the rough clothing of the country. While authorities do not agree upon any one particular species supplying this fiber, at least three are mentioned, and it is probable that all are employed to a greater or less extent economically. Prof. James Orton, in The Andes and the Amazon, states that "the natives make a bark cloth from the *Tururi* or *Curatari legalis,* called *Cascaria* up the Madeira, and from the *Llanchama* on the Marañon (Napo and Huallága). The latter tree is 20 inches in diameter and has a white bark. From the *Tururi* garments 4 yards long are made of a single piece, resembling a coarse woolen stuff, with two layers of wavy fiber. In the manuscript notes received from A. Dorca of Lima, Peru, the species is stated to be "*Couratari guianensis, Llanchâma, Damajuhato, Tatuiari;* Indians make cloth from the bark." In a recent work on this subject "*Corteza del Damajuhato,*" by Dr. Alberto L. Gadea, Lima, 1894, the above species are mentioned, together with *C. tauari, C. estrellensis,* and *C. domestica,* all fiber producing. The common names given by this author to the *Couratari* bark cloth will be found under *C. tauari* below, where, also, the descriptions of the fiber of *Damajuhato,* as well as that from allied species of *Couratari* is described.

Couratari tauari. THE TAUARY OF BRAZIL.

Exogen. *Myrtaceæ.* A forest tree.

NATIVE NAMES.—See descriptive matter below.

C. tauari grows to a height of 50 or 60 feet. Its wood and fiber were shown in the Brazilian exhibit, W. C. E., 1893, from the River Amazon, though examples were not secured by me.

BAST FIBER.—The interior bark is extracted in thin layers, appearing somewhat like paper, and in this form has been used for wrapping cigarettes and cigars. It is also used for cordage, for rough clothing, and bedding by the natives of many South American countries. In the recently published pamphlet by Dr. Gadea on the subject of the employment by natives of South America of "*Damajuhato*" fiber from species of *Couratari*, the following account is given of the manner in which the bast is secured.

By means of a knife or other sharp instrument they make two cuts in the bark of the tree at different heights, surrounding the entire tree, and then another cut longitudinal to the first. They then tear or strip off these sections of the bark, pound it and wash it to separate the parenchyma from the fiber, thus obtaining a textile substance of the quality we have described in this report. In other cases they loosen the bark by continued blows or beating. At the present time in the forest region many tribes use garments of bark. Some of the blankets appear as if made from soft pliable leather, others look like cotton. We see, therefore, that the savages use the *Llanchama, Damajuhato, Tahuari*, etc., for bed blankets, for garments, for cordage, and the more civilized use it for carpets, mats, and to take the place of paper in wrapping cigarettes.

According to this authority the fiber is known among the natives of Peru as *Damajuhato* in Gaen, *Llanchama* in Marañon and Loreto, and *Tahuari* in Loreto. In Bolivia and portions of Peru, the fiber is called *Cáscara* above the Madeira, and *Biboci* in Beni, Mamoré, Abuna, and Madre de Dios. In Brazil, *Tauari* on the Amazon, and *Jequitiba* in Matto Grosso, and *Irabirussu* in Bahia. In Colombia it is *Tataja*, and in French Guiana it bears the name *Ingipipa, Couratari*, and *Oulemari*, the latter name being used by the Galibis Indians. In Venezuela it is *Courimari*. In the geography of Peru a species of *Couratari* found in the Province of Jaen is mentioned, which is called *Damajuhato*, "the bark of which is a ductile fiber that serves for making cloth or blankets." One of these blankets is described as being two yards long and three yards wide. Professor Raimondi, in his work on Peru, describing the people of the Iquitos, mentions the Llanchama, "a species of cloth made from the bark of a tree, which serves them for beds and many other uses."

The women of the tribe of the Churruyes, of Colombia, use the bark of the *Tataja* in the fashioning of a sort of garment called *furquina*, which is secured to the shoulders by strands of palm fiber, probably an *Astrocaryum*. "The fiber is separated by blows and jerks into sheets, resembling cloth, which, when rubbed, washed, and exposed to the sun and dew, becomes light in color and flexible." The garment is sometimes dyed red. Some of the Indians of Peru and Bolivia make shirts of the fiber (*Biboci*); these being dyed in red and other colors. In many other works of travel, relating to the regions where species of *Couratari* are found, references to the fiber are frequently made under one or another of the native names already recorded.

C. guianensis is also called *Tauari* in Guiana, and produces a textile fiber used for many purposes. *C. estrellensis* furnishes a wood used in naval construction "and produces a coarse hemp." *C. legalis*, also prized for its timber, yields a fiber. This tree is known in Brazil as *jequitiba*.

Courimari (see *Couratari*).

Cowania mexicana.

Exogen. *Rosaceæ*. A small shrub.

The plants of the genus are found in Mexico and Peru, and the species named also occurs in southwestern United States. It is an interesting shrub about 2 feet high when mature, with alternate small narrow leaves, the edges turned down; covered with glands on the upper surface, and on the lower, white with fine down. The flowers are numerous and of a yellow color.

BAST FIBER.—This tree, before the advent of Europeans, was the great source from which the Nevada and Utah Indians obtained the materials for their dress goods.

The outer bark is rough, but the inner is soft, silky, and pliable, and of a brownish color. It is removed in long strips, varying in width, a desirable quality in a bark that is used in the manufacture of clothing, sandals, and ropes. These articles were formerly made by braiding strips of bark together, or woven with the hand loom. Females made skirts from strips of this bark by braiding a belt, to which they suspended many strips of the same material, hanging down to the knees like a long fringe; the rest of the person was naked in summer. Mats were also made from this bark, which were used as beds. (*Dr. E. Palmer.*)

* *Specimens* of fiber, Bot. Mus. Harv. Univ. Little better than cypress bast.

Cow Pea (U. S.). See *Vigna catjang.*

Coyal (S. Am.). See *Cocos crispa.*

Crin végétal (Alg.). See *Chamærops humilis.*

Crotalaria juncea. THE SUNN HEMP OF INDIA.

Exogen. *Leguminosæ.* A tall shrub.

NATIVE NAMES.—*Chin-pat* and *Chumese* (Ind.); Sanskrit name, *Sana.*

The fiber is known as Sunn, *Taag*, or Conkanee hemp, Indian hemp, Brown hemp, and Madras hemp.

Abounds in southern Asia and tropical Australasia. In the Northwest Provinces of India it has been cultivated to the extent of 50,000 acres annually. See fig. 2, Pl. V.

BAST FIBER.—Takes the place of jute in portions of India; a better fiber than jute, lighter in color, with a tensile strength that adapts it to cordage manufacture. According to experiments by Roxburgh a dry line of jute broke with a weight of 143 pounds, and when wet, with 146; a similar sunn line sustained 160 and 209 pounds. Royle has shown that a cord 8 inches in size of best Petersburg hemp broke with 14 tons 8 hundredweight and 1 quarter, while a similar rope of sunn only gave way with 15 tons 7 hundredweight and 1 quarter. He further demonstrated the slight deterioration of sunn hemp as follows: A rope made in 1803 broke with a weight of 6 tons 0 hundredweight 3 quarters, whereas, when kept till 1806, it gave way with 5 tons 17 hundredweight.

In Dr. Wight's experiments with sunn, cotton rope, hemp, and coir, they were found to stand a strain of 407, 346, 290, and 224 pounds, respectively. The fiber is used principally for ropes and cables, though in India it is manufactured into cordage, nets, sackcloth, twine, and paper. The finely dressed and most carefully prepared fiber is made into canvas of great durability.

Sunn hemp is "probably one of the earliest of the distinctly named fibers, as we find, in the Hindoo 'Institutes of Menú,' that the sacrificial thread of the Cshatriya, or Rajpoot, is directed to be made of *sana.*" The plant producing this fiber is a shrub growing from 8 to 12 feet high, with branching stem marked with longitudinal furrows. When cultivated it is sown quite close, at the beginning of the rainy season, in order that the plants may grow tall and thickly together—the natives say the thicker the better, so as to prevent the air passing through it—80 to 100 pounds of seed being used to the acre, and some even sow a larger quantity. In some portions of India two kinds are cultivated, one sown in May and June, when the first showers fall, and the other in October, though in quality they are the same. "That sown in June is cut in August and September, and the other about April."

Early in 1893 this Department imported a small quantity of the seed for test in the South. The seed was distributed to 15 localities. While the plant grew well, the stalks seemed deficient in fiber save in extreme southern Florida, a fine sample having been sent from Fort Lauderdale. The experiment is worthy of a second trial in this country, particularly in southern Florida.

CULTIVATION.—In the Dictionary of the Economic Products of India there is a full account of the treatment of the plant in cultivation, from which extracts are reproduced:

In Kolaba it is sown in November, after the rice is harvested, and the stalks are uprooted in March. In Kolhapur it is sown in August and harvested in December, by being cut when the plants are full grown. In Poona it is sown in July and ripens in October. In the central provinces and the northwestern provinces it is a kharif crop, being sown with the advent of the rains, but in Bengal it is sown a little earlier, namely, from 15th of April to 15th of June. In Madras the sowings take place still earlier. In the experiments performed at the Saidapet farm, Madras, sunn was sown on the 2d of February. In the Ain-i-Akbari the plant is described as bearing its yellow flowers in spring, a fact at which Mr. Kerr (writing of Bengal) expresses some astonishment, since "it now flowers in the rainy and cold seasons." Roxburgh says it is sown in Bengal in May and June and flowers by August—that is to say, toward the end of the rainy season. In the last agricultural report of Bengal it is stated that the crop is harvested from 15th of August to 15th of September.

FIG. 46.—Leaf and blossom of *Crotalaria juncea*.

It requires a light, but not necessarily rich, soil, and it can not be grown on clay. It is therefore sown on the high sandy lands, less suited for the more important crops. Wisset remarks that clay soils are injurious, but that on a rich soil the fiber is of a coarser quality than that grown on dry, high situations.

The opinion prevails all over India that high cultivation is not necessary for sunn hemp. Of Kolaba it is said: "The soil is roughly plowed twice and the seed sown broadcast." In Bengal "the seeds are sown broadcast. It is necessary to have the plants grown thick, otherwise they become bushy and coarse and give very inferior fibers." "There is nothing more required after sowing till harvest time." In the Northwest Provinces "two plowings at most are given, and the seed is sown broadcast and plowed in. It germinates quicker than any other crop, the seedlings showing above ground within twenty-four hours after being sown. Irrigation, even when necessary, is rarely given, and no weeding is required." In the experiments made in Madras, to which reference has already been made, it was apparently sown in drills. "The land was prepared for an ordinary crop by plowing and harrowing until it was reduced to a proper state, and the seed was then sown with the drill in rows 9 inches apart at the rate of 12 pounds per acre," but in the Northwestern Provinces about 1 maund (or 80 pounds) to the acre in general. In Bengal 20 seers (40 pounds) to the bigha (three-fourths of an acre) is the customary amount of seed. Roxburgh states that from 80 to 100 pounds weight to the acre were used in his time. The plant should not be more than 2½ to 3 inches apart each way, and hence thick sowing is desirable.

In most cases the plants are pulled up by the roots; in others the stems are cut with a sickle close to the ground. Of the Poona district, Bombay, it is stated that the crop is "left standing for about a month after it is ripe, that the leaves, which are excellent manure, may fall on the land." It is not clear whether the crop is left on its roots—that is to say, not reaped—or whether it is cut and stacked on the fields; the latter more probably. The greatest difference of opinion prevails as to whether the cut crop should be dried before being steeped, or, like jute, be carried at once to the retting tanks. But even with jute some cultivators dry the plants sufficiently to allow of the leaves being rapidly stripped, since these are supposed to injure the color of the fiber if allowed to rot in the water of the tank. With regard to sunn hemp, the general rule may be almost safely laid down that in moist regions, like Bengal, rapid submersion is preferred, and in dry regions, like Madras, stacking the crop is practiced. Roxburgh, from actual experiments, arrived at the opinion that "steeping immediately after the plant is pulled is the best, at least in Bengal during the rains, for then it is very difficult to dry it, and the fiber becomes weakened and the color injured."

The average yield of fiber is about 640 pounds per acre. In preparing the fiber in the Lucknow district the stalk is cut near the root when the plant begins to flower, "tied in large bundles, and immersed in water, the natives putting small weights upon it (generally mud) to prevent it being carried away. After remaining in water from four to eight days it is withdrawn, taken by handfuls, beaten on a piece of wood or stone, and washed till quite clean, and the cuticle and leaves entirely removed." The woody portion is separated by further beating and shaking when perfectly dry. At Commercolly the plants are pulled, tied in bundles, and are then left standing in water, on their roots, to the depth of several inches. This allows the fiber to obtain the right degree of firmness without becoming parched and dried by the sun. Oversteeping causes the bark to separate very easily, but weakens the fiber. Dr. Roxburgh found "no advantage, but the reverse, by drying the plant after maceration and before the bark is removed," which is the mode practiced in regard to flax and hemp. After the fiber has been separated it is thoroughly washed by repeatedly squeezing and wringing the water out of it, after which it is hung upon lines. When dry the fiber is separated a little, or combed with the fingers, and then bundled for market.

In another account it is stated that small pools of clear water, well exposed to the sun's beams, seem best suited for the steeping, because heat hastens maceration and consequently preserves the strength of the fibers, while clean water preserves their color.

Having discovered that the necessary degree of retting has been attained, the cultivator, standing in the water up to his knees, takes a bundle of the stems in his hand and threshes the water with them until the tissue gives way and the long, clean fibers separate from the central canes. According to some writers, the retted stems, after being partially washed, are taken out of the water and placed in the sun to dry for some hours before being beaten out in the way described. This practice, while it is followed in some parts of the country, is condemned in others as injurious, or at least as a useless delay.

The drying is usually accomplished by hanging the fiber over bamboos to be dried and bleached by the sun. Naturally, in this country, such primitive processes as are described above would never be resorted to. They are interesting, however, and some valuable points may be gained from the experience.

When the plant first began to attract attention among Europeans it was believed the Hindo method of treatment could be improved upon with favorable results, but much opposition was raised by the natives, who declined strenuously going out of the beaten track of their fathers. It was found to be a much more delicate plant than hemp, and consequently could not be prepared after the European methods without a modification of the processes.

OTHER SPECIES.—The Jubbulpore hemp (*Crotalaria tenuifolia*) has been considered by some authors to be a variety of *C. juncea*, and is said to be superior to Russian hemp (*Cannabis sativa*), breaking approximately at a strain of 95 pounds for the first named to 80 pounds for the latter. It is 4 to 5 feet in length, and resembles best Petersburg hemp, compared with which Royle considers it equal, if not superior. Although its cultivation is limited, it is regularly grown for its fiber, which is used for the same purpose as sunn. The fiber of *C. retusa* is sold in India as a form of sunn hemp. *C. sericea* is another species which yields fiber, while *C. striata* is grown for fiber "by the Santals in Chutia Nagpur."

Croton gossypiifolius. BOIS SANG.

A species of *Euphorbiaceæ* found in Trinidad. The plants of this genus are chiefly valuable in pharmacy, but J. H. Hart states that the above species yields a coarse fiber.

Crowia (Br. Guian.). *Ananas sativa.*

E. F. im Thurn states, in his work Among the Indians of Guiana, that *Crowia* is derived from a *Bromelia*. Sometimes written *Krowa*. See note under *Ananas*.

Cryptostegia grandiflora.

Exogen. *Asclepiadaceæ*. Climbing shrub.

Two species of the genus are recorded, from India and Madagascar. The plants of this genus abound in milky juice, which, when exposed for a short time to the sun, is converted into pure caoutchouc.

BAST FIBER.—The only mention of the plants as producing fiber is a note in Spon to the effect that *C. grandiflora* yields a fine, strong fiber, resembling flax, which may be spun into the finest yarn.

Cuba bast (see *Hibiscus elatus*).

Cübi (Hopi Indian). *Rhus trilobata.*

Cuchilixiu (Yuc.). *Asclepias curassavica.*

Culcitium canescens.

An interesting species belonging to the *Compositæ*, the generic name having been derived from *Culcita*, a cushion. The plants of the genus are woolly herbs or small bushes found in the Andes of Peru and Colombia, near the snow limit. Peruvian name, *Huira-huira*.

SURFACE FIBER.—The Treasury of Botany states that all parts of the plants of this genus, except the upper surface of the leaves of a few, are covered with dense white or rusty colored woolly hairs, which serve as beds for those travelers who may be forced to spend the night in the open air at this great elevation. The manner of making the bed is, by first amassing a quantity of the plants, and, after taking the soft woolly pappus from the flowers, laying the branches, with the leaves attached, on the ground. On this first layer the soft warm pappus hairs are scattered, then a third layer is placed of leaves only, and, lastly, another layer of pappus hairs. On this couch the traveler reposes after the toils of the day without fear of frozen limbs. Dorca states that the fiber of *C. canescens* is used in Peru for torches. The genus *Espeletia* (which see) also belongs to this family and, growing on the high Andes, bears much resemblance to this in the woolly clothing of the leaves and stems, but the present is easily distinguished from it, the florets being all tubular, while in *Espeletia* there is an outer row of strap-shaped florets in the flower head.

Cumare (Venez.). See *Astrocaryum tucuma.*

Curculigo latifolia.

The species of this genus of *Amaryllidaceæ* are found in South Africa, New Holland, and India. The species named is found in Borneo, where its "leaves are soaked in water and beaten, which loosens the fiber, which is afterwards prepared and woven into a very close cloth, known as Lamba" (Off. Guide Kew Mus.).

Curcuma longa.

Belongs to the *Zingiberaceæ*. The source of turmeric, which enters into the composition of curry powder. Savorgnan states that a fiber is extracted from the midrib of the leaf.

Curratow (Braz.). *Ananas bracteatus.*

Currijong, or Kurrijong (Austr.). See *Sterculia.* Brown *Kurrijong* (see *Commersonia echinata*).

Curuá palm (Braz.). See *Attalea spectabilis.*

Curujujul (Venez.). *Karatas plumieri.*

Cus-cus (Ind.). See *Andropogon squarrosus.*

Custard apple (W. Ind.). See *Anona.*

Cutthalay-nar, of Royle (Ind.). See *Agave americana.*

Cutting grass (Vict.). See *Gahnia radula.*

Cycas rumphii.

Exogen. *Cycadaceæ.* Small trees.

The species of this genus are natives of Asia, Australia, and Polynesia. They are popularly but erroneously called sago palms; they furnish a kind of sago, but it is not known commercially. The plants are said to be intermediate between palms and ferns. *C. rumphii* is found in India and *C. revoluta* in Japan.

Surface Fiber.—This is somewhat similar to *pulu*, being in the form of soft down from the foliage. The entire leaves also serve as thatch material (structural fiber), while from the leaf stems, according to Savorgnan, a fiber is obtained.

Cynosurus cristatus. Crested Dog's Tail Grass.

From this common British species mats and baskets are sometimes made by the peasantry in county Wexford, Ireland.

Cyperus corymbosus.

Endogen. *Cyperaceæ.* Reed-like grass or sedge.

A genus of plants belonging to the sedge family, being widely distributed over the warmer parts of the earth. When used for textile purposes they are chiefly woven into mats and the like, or pulped into paper. *C. corymbosus* is found in India and Ceylon—more commonly in wet places.

Structural Fiber.—This is "the *C. pangorie*, referred to by many writers as one of the chief sources of the *Mádur*, or so-called Calcutta grass mats. Dr. Bidie writes that several species of sedge appear to be used for mat making, but the one from which the finest sorts of mats are manufactured at Tinnevelly and Pálghát is *C. pangorie.* Tinnevelly mats of the first quality are generally uncolored or with one or two simple bands of red and black at each end, and they may be made so fine that a mat sufficient for a man to lie on can be rolled up and packed into the interior of a moderate-sized walking stick. The strips of the split sedge used in the Pálghát matting are not so fine as those employed in Tinnevelly, and the article is therefore heavier, coarser in texture, and not so flexible." (*Watt.*)

C. esculentus, exaltatus, and *iria* are also used in India for mat making, and sleeping mats are made in Madagascar from the flattened culms of *C. alternifolius.*

Cyperus lævigatus.

This species abounds, in or near brackish water, in the Hawaiian Islands. "A common plant in many tropical countries of the New and Old World, extending also to the Cape of Good Hope and the Mediterranean region. Hawaiian name, *Ehuawa*. The fine and highly prized Niihau mats are made of this plant." (*Hillebrand.*)

C. longa and *C. elegans* (W. Ind.) are named in the Flax and Hemp Commission Report of 1863.

Cyperus lucidus. SHINING GALINGALE RUSH.

Included in Dr. Guilfoyle's Australian list as a paper stock.

Cyperus papyrus. THE PAPYRUS OF THE ANCIENTS.

Syn. *Papyrus antiquorum*, which was doubtless one of the bulrushes mentioned in Scripture.

Grows on the marshy banks of rivers in Abyssinia, Sicily, and Palestine. It formerly abounded on the Nile, but is now almost extinct in Egypt (Spon). Various portions of the plant were used in Egypt in the construction of boats, mats, baskets, and even rough woven fabrics. Its chief use, however, was in the preparation of writing paper, which was made from the inner bark of the stem.

The liber or bark is composed of thin laminæ or plates, and these unrolled and placed together formed a sheet. The plates obtained near the center were the best, and each cut diminished in value in proportion as it was distant from that part of the stem. When carefully peeled from the plant and dressed at the sides, that these might join evenly, these plates were laid close together on a hard, flat table, and then other pieces similarly cut were laid across them at right angles. They thus formed a sheet of many pieces, and, to promote their adhesion, the whole was moistened with the water of the Nile, and, while wet, pressure was applied. The glutinous matter inherent in the bark promoted adhesion. They were afterwards dried in the sun. Bruce, the traveler, who frequently made the paper in the manner thus described, ascertained that the saccharine juice contained in the plant and dissolved and diffused in the water causes the immediate adhesion of the parts. In some cases, where the plants themselves did not contain sufficient juice, or when the water did not dissolve the juice properly, the strips of bark were joined together with paste made of fine flour mixed with hot water and a little vinegar. After being dried and again pressed the paper was smoothed and flattened by beating it with a wooden mallet. The ancient Egyptians made their sheets of prodigious length, though narrow. One of those purchased by the Earl of Pelmore, and unrolled by his lordship, was 14 feet long by 1 foot broad. Belzoni had a papyrus 23 feet long by 1½ feet broad. The quantity of the papyrus used by the Egyptians in their funeral operations alone must have been very great. Those papyri now found in the ancient tombs and about the mummy caves in Egypt are yet in a wonderful state of preservation. The rolls are always compressed. Sometimes their exterior is ornamented with gilding, in which case they are looked upon as of superior value. They are generally thrust into the breast or between the knees of the mummy, and occasionally they are inclosed in small wooden boxes or purses. In the museum of Naples there are not less than 1,700 to 1,800 manuscript papyri which have been dug from the ruins of Herculaneum, and yet only a very small portion of this ancient city has been dug out of the mass of lava by which it was overwhelmed. (*Rhind.*) See Ancient Fibers, in the Introduction.

C. syriacus is mentioned by Bernardin as the papyrus of Sicily.

Cyperus tegetiformis. SEASIDE GRASS. CHINESE MAT RUSH.

Examples of cuffs and shoes made from this rush in China are shown in the U. S. Nat. Mus. Plain and colored mattings from the culms of this species are shown in the Kew Mus. made at Ningpo, and "very largely used at the present time for floor coverings in this country" (Great Britain). A set of tools as used by the the native mat makers is also exhibited, together with samples of hats made from the same material. These were formerly imported into Great Britain and Europe in enormous quantities and sold for a few pence each. The same material is used in Korea for mat making.

Cyperus tegetum. CALCUTTA MAT RUSH.

Common in portions of India; said to be found in Egypt and Abyssinia.

FIBER.—The Calcutta mats are chiefly made of this species. The culms are split into two or three and then woven into mats upon a warp of threads previously stretched across the floor of a room. The mat maker passes the culms with the hand alternately over and under the successive threads of the warp and presses them home. In different districts of India it is believed that two or three allied species are used for this purpose. (*Watt.*) According to Hooker's Flo. Brit. India, cultivated in Mauritius.

Cyperus textilis.

According to Spon this species is widely dispersed over the Australian Continent, not including Tasmania and New Zealand. The *C. textilis* of Von Mueller referred to by Spon is *C. vaginatus,* which see below. The true *C. textilis* belongs to South Africa.

Cyperus unitans. MAT RUSH OF JAPAN.

This is the *Shichito-i* of Japan, from which the cheaper, rougher quality of mats are made for the common people, in the manner that *Bingo-i* or *Juncus effusus* is employed for the mats used by the higher classes. The mats exported to foreign countries from Japan are also made of these two species, and have been exported in a single year to the value of 650,000 yen, or over $400,000. The *Shichito-i* mats are chiefly produced in the Oita prefecture. Beautiful examples of both forms of these mats, with the raw material, were secured from the Japanese exhibit at the W. C. E., 1893, at Chicago, together with interesting information concerning them.

The *Shichito-i* (*C. unitans*) is cultivated both in upland or "*Hata*" and rice field or "*Ta*" (the irrigated lands). If it is grown in upland, soil of a moist nature is preferable, while in paddy field, too much water is undesirable. *Shichito-i* is propagated from roots, and for this purpose the bundles of three or four plants separated from the mother stubbles are transplanted in well-cultivated and manured nursery ground, in rows of 5 *sun*, or 6 inches, apart at a distance of same length between the bundles. The plants raised in 20 "*Tsubo*" of such nursery ground are sufficient for transplanting in a "*Tan*" of the field (300 *tsubo*=1 *tan*; 10 *tan*=1 *cho*, and 1 *cho*=2 acres). For transplanting *Shichito-i* in the paddy field, or "*Ta*," the land is deeply cultivated soon after the harvesting of rape or wheat crops, and well pulverized and manured with rape cake or "*Shōchū-kasu*," the quantity of which depends greatly upon the character of soil, and then the land is irrigated. Two or three root plants together are transplanted in the rows of 5 *sun* apart at a distance of 3 *sun* between the plants. Ten days after transplanting the water is withdrawn and the land is dried to a certain degree, and weeds are eradicated, and again the land is watered. These processes of drying, weeding, and watering the land are repeated two or three times during the summer months, and the second manuring is also given in the month of July. *Shichito-i* is ready for harvesting at eighty to one hundred days after transplanting, in fact, the reaping of the plants takes place from the end of August to the middle of September. For harvesting the rushes, the weather must be very fine. The rushes are torn lengthwise into two parts with special tools and dried on sandy ground or grass land.

The varieties of mats from this species represented in the collection are as follows: Kikaiori Hana-mushiro, Damask Hana-mushiro, common Hana-mushiro, two forms; Seidaka Hana-mushiro, manufactured at Bungo.

**Specimens,* Mus. U. S. Dept. Ag.

Cyperus vaginatus. SHEATHED GALINGALE.

One of the most widely and most copiously distributed of the rush-like plants of all Australia. Its fiber is extraordinarily tough, and accordingly can be formed into a very tenacious paper, which, moreover, proves one of great excellence. The raw material is available by thousands of tons on periodically flooded river flats, swampy depressions, and other moist localities where a continued harvest of the plant can not possibly exhaust the soil. (*Dr. Ferd. von Mueller*).

Of this plant (under the name of *C. textilis*) Spon says: "It is the best indigenous fiber plant in Australia, and is likewise notable as being with ease converted into pulp for good writing paper."

Cypress, of North Carolina. *Taxodium distichum.*

Cytisus scoparius. BROOM.

A leguminous species of shrub better known as yielding a dyestuff. Has been recommended as a paper stock. The statement that it was formerly employed in Italy and south France in textile fabrics is doubted, though Savorgnan includes it in his work under the name *Ginestra da Granate*, the bark of which yields an indifferent fiber. Probably has been confused with the *Ginestra di Spagna*, or *Spartium junceum*, which has been used for fabrics for ages.

Dab grass (see *Eragrostis cynosuroides*).

Dædalia quercina (see under *Fomes*).

Dæmia extensa.

Exogen. *Asclepiadaceæ.* Shrubby climber.

Hotter parts of India. Distributed to Afghanistan. Malay Peninsula. A common weed in the Deccan.

BAST FIBER.—The stems supply a fine and strong fibrous material, which has been recommended as a substitute for flax. "A very pretty fiber, sometimes used for fishing lines" (*Watt*). Said to have been awarded a medal at the Madras Exhibition, 1895.

Dagassa (Ind.). *Eleusine coracana.*

Dagger plant. *Yucca* spp.

Daguilla (Span.). See *Lagetta.*

Dais cotinifolia. AFRICAN BUTTON FLOWER.

Exogen. *Thymelæaceæ.* A large tree.

Cape of Good Hope. Cultivated in Australia. "The bark is very tough. A valuable yellow dye has been extracted from the bark at the Melbourne Botanic Gardens." Other plants of the genus are found in the subtropical portions of Asia. This species is referred to by Dr. Guilfoyle, who states that it produces a fiber of fine quality.

Damajagua (Ecuad.). See *Hibiscus tiliaceus.* Also written *Huamaga*, *Damagua*, and *Emajagua.*

Damajuhato (Peru). See *Couratari tauari.*

Daphne cannabina. THE NEPAL PAPER PLANT.

Syn. *Daphne papyracea.*

Exogen. *Thymelæaceæ.* Shrub, or small tree.

An India species, native of the Himalayas, which is said to supply the raw material of the well-known Nepal paper. Said to thrive only near the oak.

BAST FIBER.—The inner bark, when prepared like hemp, affords a very superior paper, particularly adapted to cartridge manufacture. "The process of making paper from this plant is thus described in the Asiatic Researches: After scraping the outer surface of the bark, what remains is boiled in water with a small quantity of oak ashes. After the boiling it is washed and beaten to a pulp on a stone. It is then spread on molds or frames made of bamboo mats. The Setburosa, or paper shrub, says the author in the above journal, is found on the most exposed parts of the mountains, and those the most elevated and covered with snow throughout the province of Kumáon. It is invariably used all over Kumáon, and is in great request in many parts of the plains for the purpose of writing *misub-namahs* or genealogical records, deeds, etc., from its extraordinary durability. The paper is generally made about one yard square, and of three different qualities. The best sort is retailed at the rate of 40 sheets for a rupee, and at wholesale 80 sheets. The second is retailed at the rate of 50 sheets for a rupee, and 100 at wholesale. The third, of a much smaller size, is retailed at 140 sheets, and wholesale 160 sheets to 170 for a rupee." A very complete account of the plant occurs in the Dic. Ec. Prod. Ind., Vol. III.

Daphne spp.

D. gnidium is reported in southern Italy, where it abounds on stony slopes and is used in the same manner as the Indian species. *D. laureola* is mentioned in Bernardin's list as another Italian fiber species. This author also lists *D. sinensis* (*odora*) from China, and *D. laureola* is reported by Spon as abundant in Spain, where its fiber is somewhat employed.

Daphnopsis leguizamonis. BIRA-BIRA.

A genus of South American *Thymelæaceæ*. The species named was represented in the collection of Argentina, W. C. E., 1893. The fiber was produced from the bast.

A beautiful example of the delicate, white, lace-like fiber of *D. tinifolia*, known as burn-nose bark, has been sent me by William Fawcett, of the Jamaica Botanic Garden. Löfgren also mentions *D. brasiliensis*, the *Embira branca*.

Darakhte-shanah (Pers.). *Abutilon indicum*.

Dasylirion graminifolium. BEAR GRASS OF TEXAS.

Endogen. *Liliaceæ*. Aloe-like leaf cluster.

The species of this genus are chiefly Mexican plants, although the one named is found in Texas. The plants have short stems and densely crowded linear leaves (which furnish the fiber), drooping gracefully, and generally having a little brush-like tuft of fibers at the point. From amidst these leaves the flower stalks rise to a considerable height, the upper portion being crowded with a dense panicle of flowers. Fig. 2, Pl. IV, is a *Dasylirion* grown in the United States Botanical Garden.

STRUCTURAL FIBER.—The old museum collection of the Department contained a sample of this fiber, without data other than the name. It resembles Istle, is about 2 feet in length, fully equal to it in strength, though in color it is darker, due very likely to improper mode of preparation. A peculiarity of this sample is that the filaments are filled with kinks, as though the fiber had been folded upon itself a number of times. These do not impair the strength, however, the breaking point coming oftener between than on the "joints," as these kinks appear to be, for the filament has no stiffness at this point. This should not be confounded with the bear grass of the Southern States, *Yucca filamentosa*, an inferior fiber.

D. texanum and *D. wheeleri* of the Southwest have thick clusters of long, slender leaves which can be split into fibers. I doubt whether these are textile, or good for anything finer than mats and basketry. (*Dr. V. Havard.*) *D. glaucophyllum* is a Mexican species that has been introduced into Australia (Guilfoyle's List).

* *Specimen.*—Mus. U. S. Dept. Ag.

Date palm (Ind.). See *Phœnix dactylifera*.

Datil (see *Cocos datil*).

Datilera (Peru). See *Phœnix dactylifera*.

Dealibanni (Guian.). *Geonoma baculifera*.

Debregeasia hypoleuca.

Exogen. *Urticaceæ.* A large shrub.

Abounds in the western temperate Himalayas; distributed to Afghanistan and Abyssinia. Watt states that the different species of *Debregeasia* yield strong and useful fibers, which are more or less extracted by the hill tribes of India. The fiber of the species named is valued in the Panjab for net ropes on account of its resistance to the action of water. It is not steeped, but merely dried, and when brittle is beaten, the fiber separating readily. The fiber is chiefly used by the natives for ropes with which to tether their cattle.

Debregeasia velutina.

Another Indian species, which is found in the Himalayas from 2,000 to 2,500 feet elevation, and at 7,000 on the Nilgiri hills.

In the Madras Manual of Administration (Vol. I, 313) it is mentioned as one of the chief fiber plants of the Presidency. The manager of the Glen Rock Fiber Company, Wynaad, is reported to have sent a consignment, presumably of this fiber, to London. It was valued at £70 per ton. Of the Madras Presidency it is commonly stated that it is much used both by the natives generally and the managers of coffee estates. Mr. J. Cameron, superintendent of the Botanic Gardens, Bangalore, states that "this is one of the commonest and most conspicuous plants in the Wynaad and Nilgiri sholas. Its fiber is used for bowstrings, and it would only appear to require to be better known to be much appreciated."

D. wallichiana, Indian, also yields a fiber fit for cordage, and *D. edulis* is a Japanese species that has been recommended for cultivation in Victoria.

Deckanne or **Deccan hemp** (Ind.). See *Hibiscus cannabinus.*

Deishar (Arab.). *Abutilon indicum.*

Dendrocalamus strictus.

An Indian species of bamboo, the crushed stems of which have been an article of export for paper making. See *Bambusa.*

Deora jute (see *Corchorus*).

Derris scandens.

A handsome climbing shrub belonging to the *Leguminosæ,* met with in the eastern Himalayas and western Ghats of India, the bark of which affords a coarse cordage fiber.

Desi jute (see *Corchorus*).

Desmodium molle.

Exogen. *Leguminosæ.* An annual shrub.

A species of forage plant which abounds in Georgia and Florida, and which a Georgia writer considers as good, for the locality, as clover.

Specimens of the canes were submitted to the Department as of possible utility in fiber production. The fiber is, however, of doubtful utility for any purpose, with the disadvantage of a small yield. A stem free from branches and 6 feet high can easily be grown in sandy soil if the seed is sown thickly.

Desmodium tiliæfolium.

This is an Indian species that is extensively employed for rope making and is also used for paper manufacture in the Himalayas. It is said that the fiber is exported to Tibet from Kumáon for paper stock. *D. latifolium,* India and Ceylon, is used for the same purpose.

Desmoncus macroacanthus. The Jacitára.

This species grows in the Catinga forests of the Upper Rio Negro and on the margins of small streams, climbing over trees and hanging in festoons between them, throwing out its armed leaves on every side to catch the unwary traveler. The stem of this palm is very slender, weak, and flexible, often sixty or seventy feet long, and climbing over bushes and trees or trailing along the ground. It is armed with scattered tubercular prickles. The leaves grow alternately along the stem; they are pinnate, with from three to five pairs of leaflets, beyond which the midrib is produced and armed with several pairs of strong spines directed backward, and with numerous smaller prickles. The leaflets are ovate, with the edges waved or curled. The bases of the petioles are expanded into long membranous sheaths. The spadices grow on long stalks from the axils of the leaves and are simply branched. The spathes are ventricose, erect, persistent, and prickly, and the fruit is globular, of a red color, and not eatable. The rind or bark of this species is much used for making the "tipitis" or elastic plaited cylinders used for squeezing the juice out of the grated mandioca root in the manufacture of farina. These cylinders are sometimes made of the rind of certain water plants and of the petioles of several palms, but those constructed of "*Jacitára*" are said to outlast two or three of the others, and though they are much more difficult to make, are most generally used among the Indian tribes. (*Wallace.*)

Fig. 47.—A plant of *Desmoncus macroacanthus.*

This Brazilian palm is mentioned in the Handbook of the State of Para, W. C. E., 1893, as producing a useful fiber. It is there known as the *jacitára.*

Deswal jute (see *Corchorus*).

Devil's cotton (see *Abroma augusta*).

Devil's nettle (see *Laportea*).

Dhak (Ind.). *Butea frondosa.*

Dháman and **Dhamru** (Ind.). *Grewia asiatica.*

Dhunchi (Ind.). See *Sesbania.*

Dianella tasmanica. Broad-leaved Flax Lily.

A genus of *Liliaceæ* found in Australia and southern Asia. They have fibrous roots and grass-like leaves.

Fiber.—This species was secured at the Phila. Int. Exh., 1876, under the name *D. latifolia.* It was prepared by Dr. Guilfoyle, who stated on the label accompanying the specimen that the plant grows on the banks of creeks and fern gullies in elevated situations, where its leaves sometimes attain a length of 6 feet. He considered the fiber good, and excellent for paper stock. The specimen preserved much of its grass-like form, having been prepared experimentally in a simple manner. Some of the filaments were white and brilliant, quite strong; a few fibers twisted together required quite an effort to break them. Its name does not appear in the list of useful textile fibers, from which it is to be inferred it has not hitherto been known as a fiber-producing plant of any value.

In Dr. Guilfoyle's recently published brochure, Fibers from Plants, Indigenous and Introduced, four other species are mentioned: *D. cœrulea*, *D. elegans*, *D. lævis*, and *D. revoluta*.

**Specimen.*—Mus. U. S. Dept. Ag.

Fig. 48.—Tree fern, *Dicksonia*.

Dichelachne crinata. Horsetail Grass.

A tough grass, universally diffused over extra-tropical Australia, and occurring also in New Zealand.

According to Dr. Ferd. von Mueller, this species yields a tenacious paper, especially fit to be used for thin wrapping or packing paper. It is not unlikely to make fair printing and the less costly kinds of writing and tissue paper.

Dicksonia culcita.

This species is mentioned by Hillebrand in the Flora of Hawaii. See under *Cibotium*, where several allied species of tree ferns, supplying the Pulu of commerce, are described. Fig. 48 is a species of *Dicksonia* in the U. S. Botanical Gardens.

Dictyosperma fibrosum. MADAGASCAR PIASSABA.

Endogen. *Palmæ.*

A species of palm, known as *Vonitra,* inhabiting the island of Madagascar, the trunk of which is densely covered with brownish fibers about 18 inches long, formed from the inner sheaths and the edges of the petioles.

STRUCTURAL FIBER.—Individual fibers finer and more flexible than Brazilian *piassaba* and slightly shorter; in other respects resemble it closely. The quantity produced was never very large, and in the early stages of the enterprise the fiber was shipped in a very rough, uncombed state. Latterly the quality has much improved, and during the period when this class of fiber commanded specially high prices the shipments were probably remunerative. Owing, however, to the discovery of west Africa *piassaba,* or "bass fiber," obtained from *Raphia vinifera,* the prices obtained for Madagascar *piassaba* have apparently fallen almost as low as the cost of production; and little has appeared lately in the London market. (Kew Bull., Oct., 1894.)

Well-combed, straight, and clean fiber is worth in England £30 to £46 per ton. Has almost entirely disappeared from the market.

Diplothemium littorale. YATAY-PONY.

A species of palm found in Argentina (Corrientes and Misiones), from the leaves of which a good fiber is produced (*Niederlein*).

Dirca palustris. MOOSEWOOD.

Exogen. *Thymelæaceæ.* A shrub.

This species is found in the northern portions of the United States and Canada. It does not yield fiber in any sense, though its flexible twigs, which can be readily tied in knots, are employed as thongs. Also called leatherwood and wicopy. The Department collection contains specimens of the leathery twigs.

D. occidentalis is a California species. Dr. Havard writes that its strong, tough, fibrous bark was formerly much used by the Indians for ropes, nets, and baskets.

* *Specimen.*—Mus. U. S. Dept. Ag.

Dishcloth plant (see *Luffa*).

Diss (Alg.). See *Ampelodesma tenax.*

Djai-soi (Borneo). *Cocos nucifera.*

Dodo cloth (see *Apocynum*).

Dolichandrone falcata.

Family *Bignoniaceæ.* A small tree of central and southern India, used for timber, and also in pharmacy, a decoction being made from its fruits.

BAST FIBER.—Both *D. falcata* and *D. rheedii* yield blackish, coarse bark fibers. Specimens of the first named were sent to the Amsterdam Exhibition.

Dolichos trilobus.

Exogen. *Leguminosæ.* A bush.

The genus has representatives throughout the temperate and tropical regions of America, Asia, and Africa. They are herbaceous or shrubby plants, or beans, many having twining stems. While chiefly valuable as food plants, some species are valued for their fiber. "*D. trilobus* is a very important fiber plant in China, textiles made from it being termed grass cloth, like those from nettle fiber. It has been utilized from earliest times, and the manufacture is extensive." (Spon.) Several species of *Dolichos* grown in India are described in full by Dr. George Watt, but no mention is made of their yielding fiber. See *Pachyrhizus angulatus,* the revised name of the plant, *D. trilobus* having been used in this instance as Spon's name.

Dombeya acutangula et sp. div.

Exogens. *Sterculiaceæ*. Shrubs or small trees.

The species of *Dombeya* are African shrubs abounding in Madagascar and Mauritius, extending as far north as Abyssinia. The plants are often seen in hothouses.

This species is cultivated in the Island of Bourbon, where it is said to be held in esteem for its fiber. A variety, *D. angulata*, according to Savorgnan, "is cultivated in the Island of Réunion for its textile fiber, from which cordage is made." This author also mentions *D. ferruginea*, Isle of France, as yielding a strong fiber fit for cordage. Spon states that the fibrous bark of another Madagascan species, *D. cannabina* (*D. viscosa*), is made into strong ropes. The bark of *D. platanifolia*, according to A. A. Black, is also used in Madagascar for the manufacture of ropes, twines, etc. *D. wallichii* is mentioned by Bernardin, and in the Flax and Hemp Commission list.

Dombeya natalensis.

Fiber of the above species, which is a native of Natal, was received from the Victorian collection of Dr. Gulfoyle, Phil. Int. Exh., 1876. In Victoria the plant forms a most beautiful flowering shrub or small tree and is of quick growth. Its fiber is suitable for cordage or for paper stock. Like all the species belonging to this family, the fiber is brownish in color, though lighter than "*Kurrijong*," and, judging from the museum samples, is a little stronger. It is at best, however, a very coarse fiber and is not to be compared with mallow fiber of the commonest description, neither is it as fibrous in texture as *Commersonia*.

**Specimen*.—Mus. U. S. Dept. Ag.

Doryanthes excelsa. SPEAR LILY.

Endogen. *Amaryllidaceæ*. Aloe-like leaf cluster.

HABITAT.—East Australia.

The plant is "a tall straight stem, 20 feet high, springing from an aloe-like tuft of broadly ensiform-spreading basal leaves, the stem itself clothed with much smaller appressed ones." The stem terminates in a bulky flower head composed of crimson flowers. It is sometimes met with in cultivation.

STRUCTURAL FIBER.—Specimens were secured from the New South Wales and Victorian collections received with the Australian exhibit, Phil. Int. Exh., 1876. According to Dr. Guilfoyle, who has prepared its fibers experimentally, the leaves are a complete mass of fiber of great strength, fit for strong ropes, matting, cordage, etc. It can also be employed in paper making with good results. It is of moderately quick growth in Victoria. The specimen has not been thoroughly prepared, as some of the filaments are quite white, while the majority are a rust red. They are stiff but fine, the white fibers being smooth and glossy. In strength the sample examined is considerably below the average of fibers in this family.

In a recent publication Dr. Guilfoyle mentions *D. palmeri*, and *D. guilfoylei*, the Giant Queensland Lily, as fiber producing.

**Specimens*.—Mus. U. S. Dept. Ag.

Dowaniya (Ceyl.). See *Grewia*.

Doum palm. *Hyphæne thebaica*.

Dracæna draco. DRAGON'S BLOOD TREE.

Endogen. *Liliaceæ*.

HABITAT.—Teneriffe, Canary Islands. Cultivated in Australia. See fig. 49.

D. draco "has a tree-like stem, simple or divided at the top, and often, when old, becoming much branched, each branch terminated by a crowded head of lanceolate, linear, entire leaves of a glaucous-green color, which embrace the stem by their base." The tree derives its name from a resinous secretion or exudation known to commerce as dragoon's blood, which at one time formed an article of considerable export from the Canaries. Some of the plants are gigantic in size, "the colossal dragon tree at the town of Orotovia, in Teneriffe, being 75 feet high and 48 feet in circumference, with an antiquity which must at least be greater than the pyramids."

STRUCTURAL FIBER.--Specimens received with the Victorian collection from the Melbourne Botanic Garden, where it is thoroughly established. Dr. Guilfoyle states that "the fiber is strong and flexible, but the tree is of very slow growth." It is prepared

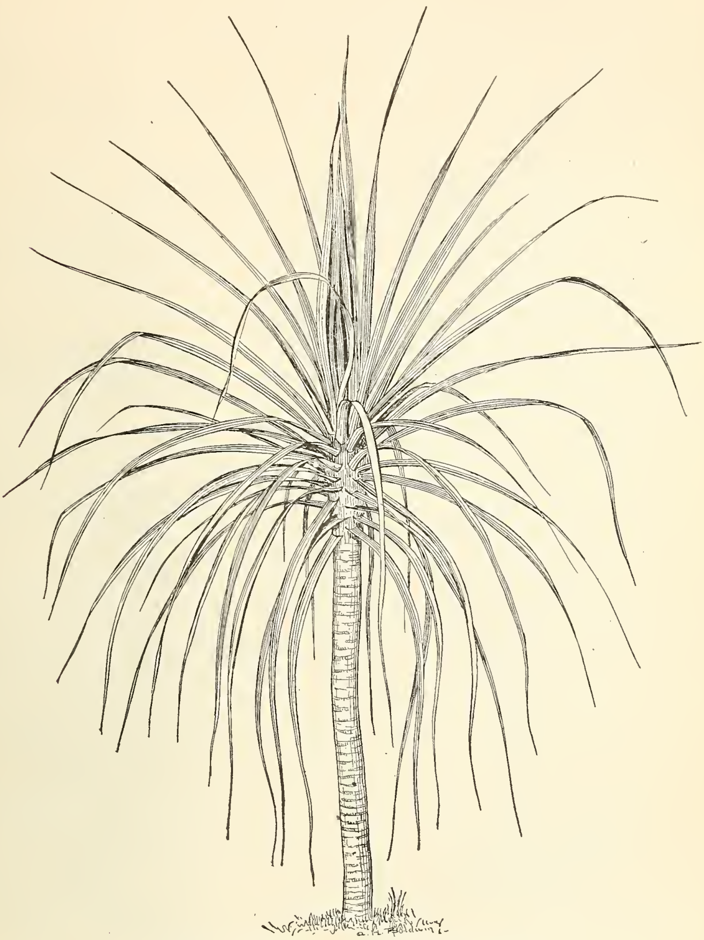

FIG. 49.—Greenhouse plant of *Dracæna draco.*

from the leaves, and is white, fine, and lustrous, and between 18 inches and 2 feet in length. It is not as strong, however, as the *Cordyline* fibers, though much softer.

Bernardin mentions four species: *D. draco, D. mauritiana, D. marginata,* from Mauritius, and *D. terminalis,* Sandwich Islands, known as *Ti.* Hillebrand refers this species, however, to *Cordyline,* and states that the leaves are used in Hawaii as wrappers for food, or for plates. *Ti* is the Tahitian name of the tree.

**Specimens.*—Mus. U. S. Dept. Ag.; Bot. Mus. Harv. Univ.

Dragon's blood tree (see *Dracæna*).

Dregea volubilis.

Exogen. *Asclepiadaceæ.* Tall climbing shrub.

An Indian species, found in Bengal, Assam, the Deccan, and Ceylon. Contains a strong fiber used by the natives. In Bombay the creeper is used as a cordage substitute in binding bundles of wood.

Dúl }
Dun } (Ceyl.). See *Anodendron.*

Dunchee (Ind.). See *Sesbania aculeata.*

Dwabote (Burm.). See *Kydia.*

Edgeworthia gardneri.

Exogen. *Thymelæaceæ.* A large bush.

Found in the Himalayas between 4,000 and 9,000 feet elevation.

BAST FIBER.—The strong, tough fiber obtained from the long, straight, sparsely branched twigs of this bush must, sooner or later, become one of the most valuable of Indian fibers. The finest qualities of Nepal paper are made from this plant, which produces a whiter paper than that obtained from *Daphne cannabina.* (*Watt.*)

Edgeworthia papyrifera. MITSUMATA OF JAPAN.

One of the three species of plants employed in the paper industries of Japan. The fibers of *Mitsumata* (*E. papyrifera*) and *Ganpi* (*Wikstrœmia canescens*) are not considered strong enough to use singly for paper making, yet they are used extensively with other coarse raw materials "in order to give tenderness, smoothness, and luster to paper of low quality."

FIBER.—The specimens in the Department collection from Japan are in the form of raw stripped bast, and the same bleached and cleaned of epidermis and woody matter. The strips are 6 to 8 feet in length, very clean, and yellowish white in color. There is also a sample of pulp, and different forms of paper.

ECONOMIC CONSIDERATIONS.—Soil fit for the *Mitsumata* is about the same as that for the paper mulberry plant, but the topographical conditions suitable show quite a contrary result, the paper mulberry flourishing in exposed situations, while the *Mitsumata* succeeds in shaded places, but free from stagnant water, and consequently the best situation for the *Mitsumata* culture is the slope of mountains or hill sides, the soil, gravel loam, belonging to the paleozoic or mesozoic geological formation.

It can be propagated either by seed, layering, or by cuttings; but the most extensive and practical method is raising plants from the seed. The seed is sown between the rows of barley or wheat or any other places where they are not exposed to sunlight. When the land is poor, some liquid manure is given to the row before the seed is sown. In March of the next year the young shoots are dug out and transplanted at the rate of 5,000 per *tau*[1] on hilly places or 6,000 per *tau* on level land. In planting out it is considered that a close plantation is rather better than an open one. Plowing should be done two or three times a year, manuring at the same time either with Chochin cake (by-product of rice spirit brewing), oil cake, or rice bran, or sometimes with green manure.

It yields the first crop in the second year, and afterward every other year. It is harvested from November to March of the next spring, the yield commonly ranging at about 300 kilograms per acre, though there are some cases of a product of over 1,000 kilograms of raw bark. The process of bleaching is quite the same as employed for paper mulberry bark, *Broussonetia papyrifera.*

Edrédon végétal (see *Ochroma lagopus*).

Ehuawa (Hawaii). *Cyperus lævigatus.*

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[1] *Tau.* See under *Cyperus unitans.*

Ejoo or **Eju** (Malay). See *Arenga*.

Elæis guineensis. OIL PALM.

Endogen. *Palmæ.* Palm, 20 to 30 feet.

This genus includes the oil palm of west Africa, which has been introduced into the West Indies, and several mostly South American and West Indian species.

STRUCTURAL FIBER.—This is obtained from the inner leaflets of the plant, and is described as being almost as fine and tenacious as human hair. It is extensively used by the natives for fishing lines and other purposes where great strength is required.

In the preparation of this fiber a considerable amount of skill is shown. The pinnæ of the young leaves which have not been hardened by exposure are the only ones that can be made use of. If too old, the fiber can not be separated from the tissue, and if gathered before the leaves have opened it has not sufficient strength to stand the rough handling which it has to undergo while in process of manufacture. If gathered at the right age the stripping of the fiber offers no difficulties, although the process is both tedious and wasteful. So far as can be ascertained, the only use to which this fiber is put is the making of fishing lines and fine cords. It would appear to be too costly for native cloth, net, or bag making. The following results of actual experiments will serve to show the tedious and expensive nature of the process which has just been described: A day's hard work is counted well spent on the production of 6 ounces of fiber from 36 pounds of the raw material. Estimating the value of labor to the native at not more than 3*d.* a day, and leaving out of consideration the time expended in collecting and sorting the leaves in the forest, the actual cost of this material to the producer can not be calculated at less than £75 a ton. It is therefore clear that it would be impossible to develop an export trade in this article at the present rate of European prices. (Kew Bull., March, 1892.)

FIG. 50.—The oil palm, *Elæis guineensis.*

Spon mentions the species and says of the fiber that "it has not received the attention it seems to merit. The filaments are fine, clean, and regular, like bundles of horsehair; and are supple and very strong." *E. melanococca*, the "*Corozo*," is named in Dr. Ernst's list of Venezuelan fiber palms.

Ela-wéwel (Ceyl.). See *Calamus rotang*.

Eleocharis acuta. SLENDER SPIKE RUSH.

A genus of cyperaceous plants having a wide range from the torrid zone almost to the arctic. This species is common in Australia in moist situations, and is allied to the creeping spike rush of middle Europe. It is named by Dr. Ferd. von Mueller, of Melbourne, as a good paper stock. "The local experiments here show this and many other cyperaceous plants exquisitely adapted for good printing and tissue paper, and a by no means very inferior writing paper. Better appliances will necessarily improve the quality of the paper." (*Dr. Ferd. von Mueller.*)

The stout spike rush, *E. sphacelata*, a swamp land species of southeast Australia and Tasmania, is said by the same authority to be applicable to similar uses. *E. plantaginea* and *E. fistulosa* are Ceylon species, from the culms of which sleeping mats are made, and examples of these are preserved in the Kew Mus.

Eleocharis palustris.

Syn. *Scirpus palustris.*

A sedge common in America, Europe, northern Asia, and southern Africa. Used in the same manner as the common bulrush, *Scirpus lacustris*, which see. Savorgnan states that *E. palustris* is especially valued in Holland for making beautiful matting.

Elephant Grass. *Typha latifolia.*

Eleusine coracana. RAGI MILLET.

Endogen. *Gramineæ.* An erect annual grass, 2 to 4 feet.

COMMON NAMES.—African Millet; Ragi Millet. Indian names, *Dagassa*, *Korakan*, and *Mandua.*

"Cultivated in India, southern China, Japan, and in many parts of Africa for the grain, which is used as food. It forms the principal food of many African tribes. In spite of the bitter taste of the flour, a kind of bread or unleavened cake is made of it. Beer is brewed from the grain in Abyssinia. Said to yield good crops even on very poor soil, and may be cultivated in the same way and for the same purposes as millet." (*F. Lamson-Scribner.*)

Savorgnan states that fiber has been extracted from this species which is useful for rough cordage. *E. indica*, which has been distributed throughout the warmer countries of the globe, is particularly abundant in the Southern States, growing in cultivated grounds about dwellings, etc. It has somewhat wiry, flattened stems, many springing from a single root, and rather thick leaves. It might be useful as a paper plant; known as wire grass, crab grass, etc.

Elionurus hirsutus.

Endogen. *Gramineæ.* A perennial grass, 1 to 2 feet.

India. Watt mentions that the roots are claimed to yield a fiber for use in weaver's brushes.

Elm (see *Ulmus*).

Elodea canadensis. WATER WEED.

Bernardin gives *E. canadensis* as a paper material. Of doubtful utility.

Elymus arenarius. SEA LYME GRASS.

This species, allied to the common barley, is known as a common sand-binding grass along the shores of Great Britain, but is found also in other parts of Europe and in America, particularly on "our North Atlantic coast and on our western shores from Santa Cruz, Cal., northward to within the arctic zone. The seeds are used for food by the Digger Indians of the Northwest, and as the grass springs up around their deserted lodges it is called by the settlers 'Rancheria' grass. This lyme grass is usually regarded as possessing little or no forage value, but in very moist climates or under certain favorable conditions it may yield a valuable fodder, for when young the grass is tender and nutritious." (*F. Lamson-Scribner.*) See fig. 51.

Structural Fiber.—This species has been employed in Labrador in the manufacture of table mats and baskets, and it might be worthy of consideration as a paper stock. *E. arenarius* is one of the most useful basket grasses of the Aleutian islanders, though *E. mollis* and *E. sibiricus* are also employed. Dr. O. T. Mason states that the material is employed not only when macerated and treated as hemp, but as a straw plait, which is described as follows:

The ornamentation on the outside of the mats and baskets is formed by embroidering on the surface with strips of the straw instead of the macerated fiber, which forms the body of the fabric. The embroidery stitches in these, as in most savage basketry, does not always pass through the fabric, but are more frequently whipped on, the stitches passing always between the two woof strands, as in aresene embroidery, showing only on the outside. There is no Chinese or Japanese basket in the National Museum showing this plaited weft. The grass of these Aleutian wallets is exceedingly fine, the plaiting done with exquisite care, the stitches being often as fine as 20 to the inch, and frequently bits of colored worsted are embroidered around the upper portion, giving a pleasing effect. (*Dr. O. T. Mason.*)

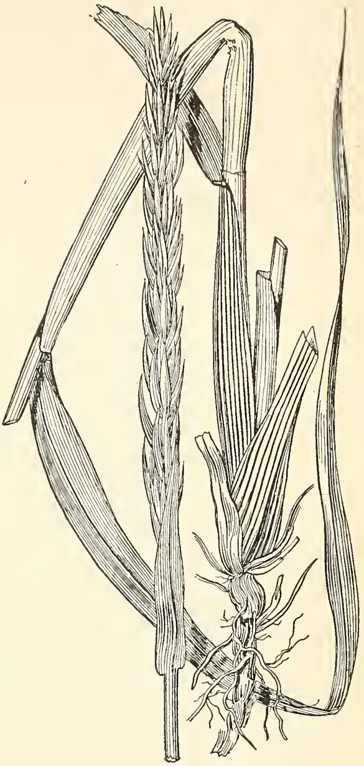

Fig. 51.—*Elymus arenarius.*

Emajagua (Peru). See *Hibiscus tiliaceus.*

Embauba (Braz.). See *Cecropia peltata.*

Embira (Braz.). See *Xylopia sericea.*

The term has likewise been used in the sense of bark, usually with an affix, as *Embira-ocu* (see *Lecythis*). Sometimes written *Envira.* ——— *preta* means the black embira. ——— *branca, Xylopia grandiflora*, and *Daphnopsis brasiliensis.*

Embirama. Same as the above, *Xylopia.*

Embirussú (Braz.). See *Bombax pubescens.*

Enea (Venez.). *Typha angustifolia.*

Enhalus koenigii.

A genus of *Hydrocharitaceæ*, this species being found in the Island of Celebes, where "it is highly valued for its fruit and for its fiber" (*Savorgnan*).

Entada scandens. *Leguminosæ.*

A species of climbing plant native to the Tropics of both hemispheres, the tough bark of which is claimed to be used in Ceylon for ropes.

The pods of this species often measure 6 or 8 feet in length. The seeds are about 2 inches across by ½ an inch thick, and have a hard, woody, and beautiful polished shell, of a dark brown or purplish color. In the Tropics the natives convert these seeds into snuffboxes, scent bottles, spoons, etc., and in the Indian bazaars they are used as weights. (*A. Smith.*)

Entelea arborescens.

Exogen. *Tiliaceæ.* A small tree, 5 to 10 feet.

Found in New Zealand, where the light wood of the tree is used by the natives as floats for their nets.

Bast Fiber.—"From the cortical fiber are made ropes, cords, and fishing nets" (*Savorgnan*). *E. palmata* is a New Holland species, also included in the Manual Hoepli.

Fig. 52—The Mexican broom root, *Epicampes macroura.*

Envira.

This word, with an affix, occurs many times in a catalogue of woods exhibited by the State of Amazon, Brazil, at the W. C. E., 1893, Chicago, as a common name for certain trees that yield fiber. Examples are: ——— *de anta,* "furnishes a resistant fiber, though little used;" ——— *preta* (or the black envira), "the twigs of young plants serve for fishing poles, also has a fiber of resistant quality;" ——— *pixuna* and ——— *surucucú,* the same; ——— *taia,* or *Queimoza,* "thick fibrous bark;" ——— *de igapo,* "inner bark holds the best known fiber for cords." See *Embira.*

Epicampes macroura. Broom Root.

Endogen. *Gramineæ.* A grass, 6 to 7 feet. (See fig. 52.)

Common and native names.—Broom root, Mexican whisk. *Raiz de Zacaton* (Mex.); *Chiendent* (Fr.).

Broom root, or zacaton, is a wild plant which grows in profusion on the high plains included in Huamantla, San Andres, Chalchicomula, Perote, and San Felipe del Obraza, and other localities of Mexico having a cold climate. It not only was not cultivated, but until its export made it of commercial importance proprietors of plantations were at considerable expense to rid their fields of the weed. In 1884 it was exported exclusively from Vera Cruz, and in five years its exportation amounted to 1,763,680 pounds. In 1889 it was stated by M. Chas. Baur that a Frenchman was producing zacaton on a plantation upon the slopes of the Popocatapetl and the Yxtaeihuatl, with a pay roll of 500 workmen.

Structural Fiber.—This is the roots of the grass, which "are about 9 inches to a foot long, possessing a wavy character, and about one-sixteenth of an inch in diameter." When cleansed they are a pale yellow." The Department specimens were secured at the Paris Exp. Univ., 1889, the W. C. E., 1893, and at the C. S. I. Exp., 1895, Atlanta, besides commercial samples from H. H. Crocker & Co., New York City.

Uses.—It is used by the Germans and French to mix with Venetian whisk, derived from the roots of *Chrysopogon gryllus,* for the manufacture of dandy brushes, clothes brushes, carpet brushes, and velvet brushes, which are shipped to this country at exceedingly low prices. The broom root therefore appears to be a cheap substitute for Venetian whisk, and it is said that when made into brushes and thoroughly dry it is apt to become brittle and break off. For this reason it has never found much favor in England. (Kew Bull., Dec., 1887.) Employed in the United States.

Epicampes rigens. WOOD REED GRASS.

This species is found in California, Mexico, and eastward in New Mexico to western Texas. It is a tall-growing rigid grass, pale yellowish green in color, growing in tufts in the alkaline regions. It is used by the Indians in basket manufacture. See account under *Salix lasiandra*.

Epilobium angustifolium. WILLOW HERB. FIREWEED.

Exogen. *Onagraceæ*. Perennial herb.

The species of *Epilobium* are mostly perennial herbaceous plants from 2 to 7 feet high, bearing pod-like vessels, which are filled with cottony seeds.

SURFACE FIBER.—Samples of *Epilobium* down, or silk cotton, were received from Utica, N. Y., by the Flax and Hemp Commission in 1863, as specimens of a fiber that might be used as a substitute for cotton for textile purposes. The fiber was accompanied by home-made samples of "thread," rope, and a piece of quilting to illustrate the value of the fiber as a substitute for cotton batting. The fibers are not half the length of upland cotton, or not more than three-eighths of an inch, and consequently could not be spun; and, even mixed with other fibers, would fly off in the process of manufacture; the fiber is soft, has a silky luster, and is of a creamy white color. Examined microscopically, the filaments consist, like most seed hairs, of single cells. Their walls are very thin, make sharp bends, and seem to be brittle, without the least wind or twist, and, while resembling the down of *Asclepias*, are of less length, with a rather strong longitudinal marking. The specimens are only interesting in the light of experiment, and from the fact of their having been presented by the Flax and Hemp Commission.

BAST FIBER.—The stalks yield a bast which, according to R. H. Ballinger, of Port Townsend, Wash., is used by the Indians of the Northwest for fiber. The fiber is doubtless extracted in the green state, for the bast stripped from the dry stalks was a most unpromising source of fiber material.

Spon mentions fireweed under the name *Erechthites hieracifolia*, and says that the plant springs up as a weed on recently cleared land in America. "Its seed pods yield a fiber much resembling cotton, but the seeds are smaller and require no ginning to separate them from the boll. This fiber may be spun and woven, and wicks, ropes, yarn, and paper are said to have been made from it. The application to paper making was especially successful, the product comparing well with the silk-made papers of China and Japan." I can find no reference to such use of this plant in America under the name fireweed.

Eragrostis cynosuroides. DAB GRASS.

Endogen. *Gramineæ*. Perennial grass.

Northwestern Provinces of India.

FIBER.—It produces a fairly strong structural fiber used for making ropes. In the Karnāl Settlement Report it is stated that the fiber is used for the ropes of Persian wheels, and they are said to last for three months or more. Stewart remarks that the upper part of the stem is in some places used for making the seives employed in paper manufacture.

Erba bianca (It.). See *Artemisia vulgaris*.

Erica spp. THE HEATHWORTS.

E. scoparia and *E. vulgaris* (now *Calluna vulgaris*) are stated by Savorgnan to be manufactured into brooms, the stems being used.

Eriko (Yorubaland). *Raphia vinifera.*

Erinocarpus nimmonii.

Exogen. *Tiliaceæ.* A tree.

Found in the Deccan and Bombay Presidency, India. Watt states that the bark is said to yield an excellent fiber for ropes.

Eriodendron anfractuosum. WHITE COTTON TREE.

Exogen. *Malvaceæ.* Tree, 50 to 60 feet.

NATIVE AND COMMON NAMES.—The White Cotton Tree (Ind.); Kapok floss tree (Java); *Imbul* (Ceyl.); *Thinbawle* (Burm.); *Safed-semal* (Hind.); *Shwet simul* (Beng.); *Ceiba* and *pochote* (Mex. and Cent. Am.); *Pemm* (Maya of Yucatan).

According to the Flora of British India this species occurs in the forests of the hotter parts of India and Ceylon, and has found its way to South America, the West Indies, and tropical Africa.


FIG. 53.—Cotton grass, *Eriophorum angustifolium.*

SURFACE FIBER.—The commercial kapok of Java. Beautiful examples of this substance, the most valuable of all the silk cottons, seed hairs, or downs, from the commercial standpoint, were secured from the Holland exhibit, W. C. E., 1893, though erroneously stated to be the product of *Calotropis gigantea.* Kapok, or the floss from the seeds of this *Eriodendron,* "is, according to the present demand, a fiber of great merit. The modern trade in it was created by the Dutch merchants, their supply being drawn from Java. It is used in upholstery, being too short a staple to be spun, and, indeed, too brittle and elastic. But these are the very properties that commend the floss to the upholsterer. In cushions, mattresses, etc., its elasticity and harshness prevent its becoming matted as in the case with *simal* floss from *Bombax malabaricum,* and it is therefore considerably superior to that fiber. Indeed, it is probable that the even still shorter staple of *Cochlosperum* would in time command a better price than that of the *simal.* Like kapok it is very elastic, the fiber springing up to its former position the moment the weight is removed from the cushion. With *simal,* on the other hand, a very short time suffices to make a mattress assume permanently a compressed condition, in which it occupies, perhaps, less than half its original bulk, and at the same time becomes knotted. This necessitates the removal of the stuffing to be teased or rudely carded." (*Watt.*) While this species of silk cotton is well known in tropical America, it does not seem to have reached commercial importance, as the only records regarding its utility refer to household uses by the natives or country people in the localities where produced. The Mexican specimens in the Department collection came from the State of Oaxaca, and are bright, soft, and lustrous with good elasticity. One of the native Mexican uses for this substance is for candle wicks. See also Cottons (Silk Cottons) in alphabetical arrangement.

Since the Chicago Exposition kapok has come into use commercially in this country, being employed as an upholstery fiber.

* *Specimens.*—Mus. U. S. Dept. Ag.

Eriodendron samauma.

Flourishes along the river banks of portions of Brazil, particularly the Rio Negro. "It is the tallest and most flourishing tree of the Amazon forests, attaining over 120 feet in height, with a diameter difficult to be calculated in consequence of the number of hard roots that in the form of a star proceed from the base of the trunk. When young the tree has thorns that disappear when it attains its full growth. These thorns are used as ornaments among some of the Indian tribes. The Indians of the upper Purus weave and make mats of the fiber." (From a Catalogue of Forest Products of Brazil, W. C. E., 1893.) "Silky, satin-like, and of an exceeding tenuity and beauty are the cottons which involve the seeds of the capsular fruits of *monguba* and *samauma*—*Bombax munguba*, Mart; and *Eriodendron samauma*. Raw material of great abundance, and already utilized in Brazil for the manufacture of costly threads and twists, it contains an invaluable substitute for beaver for velvety and luxurious felts." (Notes on the State of Para.)

This fiber was also met with at the Phil. Int. Exh., 1876. The tree was stated to be the largest in the Amazon region, "the fruit containing a silk much sought after for mattresses" (*De Gama*).

Eriolæna hookeriana.

It is said that the bast of this Indian species of *Sterculiaceæ* yields a good fiber, examples of which were sent to the Paris Exposition, 1878, and to the Colonial and Indian Exhibition, 1886.

Eriophorum comosum. Cotton Grass.

Endogen. *Cyperaceæ*. Sedge-like perennial herb.

Common in India, allied species abound in Europe.

Structural Fiber.—A silky grass, the fibrous leaves of which are employed locally in India for twine, cordage, and even for rope bridges, though such ropes do not last over a year. "The fiber yielded by this plant forms a small portion of what is exported to the plains under the name *bhábur*" (*Watt*). The true *bhábur* is *Ischæmum angustifolium*, which see. In the Kew Bulletin for July, 1888, is found an article on the *Ischæmum*, from which it would appear that *E. comosum* has been confounded with *Andropogon involutus* and the true *bhábur*, and that only a small part of the bulk of grass used by the natives in rope making is from *E. comosum*. Fig. 53 illustrates *E. angustifolium*, Europe. For further accounts see Dic. Ec. Prod. Ind., Vol. III; Bull. Royal Gardens, Kew, July, 1888.

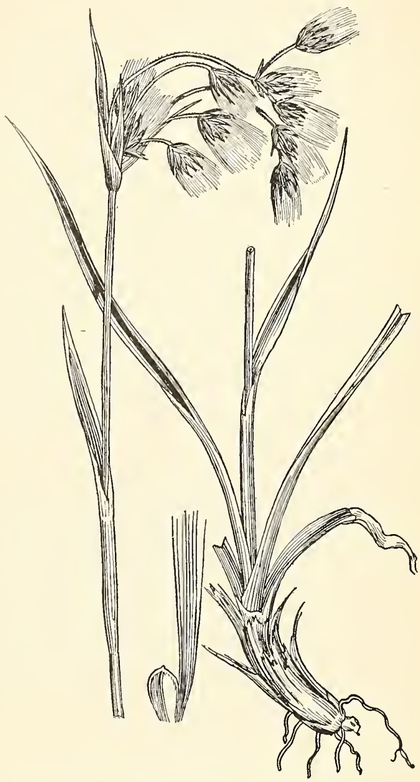

Fig. 54.—The lesser cotton grass, *Eriophorum latifolium*.

Eriophorum latifolium. COTTON GRASS.

Another species of *Cyperaceæ*. Common in Europe. "The British species all grow on wet bogs or turfy moors, where they frequently form very conspicuous masses of vegetation, in consequence of the long showy silky bristles of the flowers. The English name cotton grass is very expressive, the flowers of some of the species appearing like tufts of cotton." (*Dr. Moore*). The plant is known in Italy as swamp flax, *Lino della paludi*. The fibrous substance mentioned as cotton has no value. (See fig. 54.) The leaves of *E. cannabinum* have been plaited.

E. polystachion, a British species found in wet bogs and turfy moors, is mentioned in the Official Guide Kew Mus., paper and cloth having been made from it.

Erizo (see *Apeiba tibourbou*).

Erolin (see Uses of Flax, under *Linum usitatissimum*).

Erythrina indica. INDIAN CORAL TREE.

Exogen. *Leguminosæ*. Medium-sized tree.

India. Foothills of the Himalayas; Burma. While the plant is valued in India as yielding dye, gum, medicine, timber, and food, its bark is also said to yield a pale-yellow fiber that is excellent for cordage. There are several American representatives of the genus, but they have not been noted as producing fiber. *E. suberosa* is mentioned by Savorgnan as yielding a fiber used for cordage and ship cables.

Escoba (Venez.) See *Sida rhombifolia.*

Escobadura (Arg.). See *Pavonia.*

Escobilla (Cost. Ri.). See *Sida.*

Esparto, and **Esparto grass**.

The ——— of commerce, from Spain and Algeria, *Stipa tenacissima*. The name is sometimes given, also, to *Lygeum spartum;* ——— *chino*, and ——— *mulato*, Mex., *Fimbristylis spadicea*.

Espeletia sp. FRAILEJON.

An interesting genus of *Compositæ* inhabiting high elevations in Colombia, Ecuador, and Venezuela, often 13,000 to 14,000 feet above sea level. Some of them are only a foot high, though the larger number are taller.

SURFACE FIBER.—The plants are furnished with long, strap-shaped root leaves which are densely clothed with a white or rust-colored wool. Specimens of this wool were exhibited in the Venezuelan court, W. C. E., 1893, under the common name *Frailejon*. They were collected from the highest parts of the Cordilleras of Merida. Refer to *Culcitium*.

Esponja.
Estrapaja. } SPONGE CUCUMBER. See *Luffa.*

Estopa (Braz.)=tow.

Eta, or **Ita palm** (see *Mauritia flexuosa*).

Eucalyptus obliqua. THE STRINGY BARK. GIGANTIC GUM TREE.

Exogen. *Myrtaceæ*.

The trees of this large genus abound in Australia and Tasmania, though some of the species have been distributed to other countries. Over 100 species are recognized, and many of the trees are gigantic in size, and are exceedingly valuable for their timber. *E. globulus,* the blue gum, *E. gigantea,* the stringy bark, and *E. amygdalina,* the peppermint tree, yield the best quality. Eucalyptus oil has attracted some attention in late years, particularly since the Philadelphia exhibition of 1876. *E. globulus* is well known through its having been recommended for planting in malarial districts of this country.

BAST FIBER.—A specimen of the tow of *E. obliqua* was received from the Victorian collection, Phil. Int. Exh., 1876, prepared by Dr. Guilfoyle. The fiber is reddish in color, of little strength, and has been prepared experimentally. No data accompanied the specimen regarding its value, either for fiber or for paper stock, though the aborigines of Australia are known to manufacture both canvas and cordage from the eucalyptus, which would indicate not only strength, but considerable fineness. Fiber marked *Eucalyptus fissilis* was also sent to the Phil. Int. Exh., 1876, prepared by the director of the Melbourne Botanic Gardens, Victoria. Watt mentions that the bark of *E. globulus* yields a substance which has been found suitable for paper making in India. Dr. Ferd. von Mueller also mentions the following species: *E. gonicalyx,* white gum tree, good packing paper; *E. leucoxylon,* iron bark of New South Wales, rough packing paper; *E. longifolia,* packing paper; *E. stuartiana,* packing paper and pasteboard; *E. rostrata,* blotting and filter paper.

**Specimens.*—Mus. U. S. Dept. Ag.

Eugeissona insignis.

A species of palm found in Borneo. "From the roots the natives weave their hampers, baskets, and arm coverings" (*Savorgnan*). Spon mentions *E. tristis,* a native of Penang, the fibrous leaves of which are woven into mats.

Eupatorium cannabinum. HEMP AGRIMONY.

A species of *Compositæ,* native to Europe, found growing in wet meadows; called wild hemp, or, in Italy, *Canapa salvatica.* "The stalk yields material for cords," but of slight value. There are many representatives of the genus in North America, but none is recognized as the source of a useful textile.

Euphorbia palustris.

Exogen. *Euphorbiaceæ.*

Representatives of the genus are found in many parts of the world, some of the species that are cultivated in greenhouses being remarkable for the brilliant scarlet bracts of the involucre. Some of the species are used in pharmacy, and the milky juice of many, after drying, can be used as a gum or resin, though exceedingly acrid.

FIBER.—In the Italian work of M. A. Savorgnan the species named is stated to grow in marshy places and "to furnish textile fiber of very fine quality, but difficult to extract;" should be regarded as a curious rather than a useful fiber.

Euterpe acuminata.

Endogen. *Palmæ.*

The palms of the genus *Euterpe* are of "extremely graceful habit, having slender, almost cylindrical stems, sometimes nearly 100 feet in height, surmounted by a tuft of pinnate leaves, the leaflets of which are narrow, very regular and close together, and generally hang downward. The bases of the leafstalks are dilated, and form cylindrical sheaths round a considerable portion of the upper part of the stem, giving it a woolen appearance. Ten species are known, all natives of the forests of tropical South America, where they grow together in large masses; some inhabiting moist, swampy places on the banks of rivers, and others extending a considerable height up the sides of mountains."

STRUCTURAL FIBER.—Specimens of fiber from the leaves of this palm were catalogued in the exhibit of Costa Rica, W. C. E., 1893, from Talmarca, under the designation "*Fibras palmiche oscuro, Enocarpus utilis*" (= *Œnocarpus*). In my examination of the Costa Rican fibers for award the specimen was not found.

Euterpe oleracea et sp. div.

Dorca mentions three species that inhabit Peru, *E. oleracea, E. edulis,* and *E. ensiformis,* all of which yield a fiber useful for ropes and coarse textures. Orton mentions *E. oleracea* as occurring on the Amazon, known as the *Jussareira.* Agassiz refers to a Brazilian species as the *Assais,* and the Treasury of Botany gives, as the common name of *E. edulis,* "The Assai Palm of Para." The beverage manufactured from this species is also known as *Assai.* (See fig. 55.)

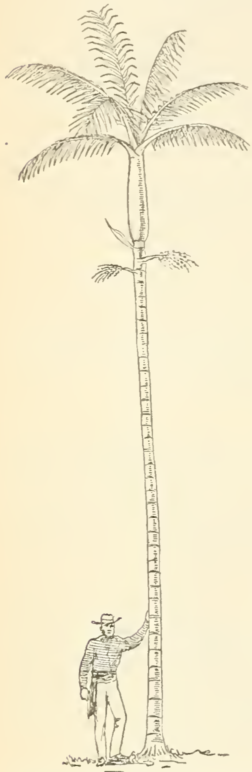

Fig. 55.—The Assai, *Euterpe oleracea.*

Evening primrose fiber (see *Gaura*).

False sisal hemp (Fla.). See *Agave decipiens.*

Fálseh (Pers.). See *Grewia.*

Fatsia papyrifera. The Rice Paper Plant.

Syn. *Aralia papyrifera.*

Endogen. *Araliaceæ.* A small tree.

"This plant grows in the deep, swampy forests of the Island of Formosa, and apparently there only, forming a small tree, branching in the upper part, the younger portions of the stem, together with the leaves and inflorescence, covered with copious stellate down. The stems are filled with pith of very fine texture, and white as snow, which, when cut, forms the article known as rice paper. Large quantities of the stems are 'taken in native crafts from Formosa to Chinchew, where they are cut into thin sheets for the manufacture of artificial flowers.' A lengthened account of this interesting plant will be found in Hooker's Journal of Botany." (*Dr. Thomas Moore.*)

Fern.

Tree ——. See *Cibotium,* source of Pulu fiber; Maiden Hair —— (see *Adiantum*).

Fe-ru (Afr.). Silk Cotton. See *Cochlospermum tinctorium.*

Fever Nettle. *Laportea crenulata.*

Fiber.

See Introduction. The classes of fibers recognized in this work are Bast, Structural, Surface, Woody, and Pseudo-fiber.

Fibras palmiche oscuro (Cost. Ri.). See *Euterpe.*

Fibrilia.

A textile material made by "cottonizing" the fibers of flax, hemp, jute, China grass, and similar vegetable substances, as a substitute for cotton. *Fibrilia* from flax is a form of "flax cotton" (so called). The account of an inquiry by the United States Government into the practicability of the establishment of a "flax-cotton" industry will be found in the Report of the Flax and Hemp Commission of 1863 (U. S. Dept. Ag., Washington, 1865), but now out of print. See Fibrilia, L. Burnett & Co., Boston, 1861. See also Uses of Flax under *Linum usitatissimum.*

Ficus spp. The Fig, etc.

This genus of *Moraceæ* comprises over 150 species, and a vast number of cultivated varieties, including the fig of commerce known to botanists as *Ficus carica.* The species of *Ficus* abound either wild or cultivated throughout the warmer portions of the globe. (See fig. 56, form of leaf of *F. religiosa.*)

There is scarcely a collection of tropical fibers that does not contain specimens labeled "*Ficus*," though, unfortunately, it has been so difficult in many instances to trace the botanical species that we do not know them. No less than nine species are named in Bernardin's Catalogue of Fibrous Plants, among which are *F. laurifolia*, Antilles; *F. macrophylla*, New South Wales, and *F. rubra*, Martinique, with the species yielding the fig, and another the caoutchouc of Assam, representing species abounding in southern Europe, Africa, the warm parts of India, and the isles of the Southern Ocean. Royle alludes to the genus and says "it is probable that the bark of some of the species, like that of the paper mulberry, may be converted into half-stuff, as the bark of one species is used for paper making in the island of Ceylon." The Museum of the United States Department of Agriculture contains many examples of fiber and manufacture from species of *Ficus* that are unidentified. In Dorca's manuscript list of Peruvian fibers, *Ficus dendroneida*, the *Matapalo* (doubtless *F. dendrocida*), is said to be used by the Indians, who make garments from the bark. He also mentions the *Hugicion*, *F. gigantea*, from which is made various kinds of filaments.

Fig. 56.—Leaves of *Ficus religiosa*.

In the Manual Hoepli three species are mentioned, as follows: *F. indica*, India and New Caledonia, the bark of which is used for cordage; *F. prolixa*, "a sacred tree among the natives of Oceanica, the fiber from the bark being used for making clothing and textures of all kinds; highly valued as an industrial plant," commonly called the Sacred Fig; the bark of *F. religiosa* is used in New Caledonia for cordage. The fiber of several Indian species is mentioned in the Dic. Ec. Prod. Ind., Vol. III, as follows: *F. cunia* bark used to tie the rafters of native houses, and affords a strong fiber useful for ropes; *F. hispida*, fiber prepared from the bark, in Bombay, used for tying bundles; *F. infectoria*, fiber used for ropes; in Burma a fiber is extracted from the bark of *F. religiosa*, which was formerly made into paper and used in umbrellas. Liotard also mentions this species as an India paper plant. *Ficus (ivapohy)* is included in the list of species of fiber plants of Argentina furnished by Dr. Niederlein.

In the collection of Brazilian fibers (Phil. Int. Exh., 1876) there was one specimen that closely resembled the fiber of *Broussonetia papyrifera*, which was obtained from a specimen of "wild fig" found growing on the Doce River, the milk of which is said to contain India rubber. Dr. Nicolan J. Moreira, reporting on fibers from Minas Geraes, in a little brochure of 16 pages, thus writes of the plant producing these specimens:

The trunk leaves, or stalk leaves (i. e., layers of bast), although they can not be separated into distinct fibers, nevertheless offer an interest not less industrial. By soaking, the leaves come out whole; when introduced between iron cylinders, in consequence of the compression suffered, they become very thin, yet preserving a remarkable width and length. In this condition, to say nothing of their being objects of curiosity, it is possible to transform them into thick garments for country laborers or other workmen. * * * Without further preparation, letters and official documents are written on the precious bark of the rich tree of the Doce River. M. Leverino Costa Leite has taken from one tree 275 cavados (206 yards) of bark sheets three-fourths of a yard wide.

Ficus benghalensis. THE BANYAN TREE.

Endogen. *Urticaceæ.* Large spreading tree, 70 to 100 feet.

India and tropical Africa.

Many of the species of this genus send out aerial roots from the branches, and these, descending to the soil, form lesser trunks, so that the tree covers a large area.

FIBER.—A coarse rope is prepared from the bark and from the aerial roots. Paper is also reported to have been formerly largely prepared in Assam from the bark, and to a small extent it is still so prepared at Pakhimpore and in Bellary in Madras. This fiber was used by the Sikhs as a slow match. The length of the ultimate fibers has, by Cross, Bevan, and King, been ascertained to be 1 to 3 millimeters. The fibers obtained from the genus *Ficus* contain from 40 to 60 per cent of cellulose, and under hydrolysis lose from 20 to 40 per cent of their weight. Chemically they are therefore worthless fibers. (*Watt.*)

Fimbristylis complanata.

This species belongs to a genus of cyperaceous plants which embraces upward of 200 species, chiefly natives of warm countries.

The culms of *F. complanata* have been used in Ceylon for making mats; the Kew Mus. collection contains a mat and rice plate from this species, and samples of *Gamelotte* fiber, and paper pulp and paper from the stems of *F. spadicea* sent from Vera Cruz. Mexican name, *Esparto chino* and *Esparto mulato.*

Fique.

In the collection of the United States Department of Agriculture there is a beautiful series of ropes, sandals, etc., collected in Ecuador, labeled with this name. Dr. Ernst states that *Fique* is the same as *Cocuiza* (Venezuela), *Furcræa gigantea*, which see.

Fireweed (U. S.). See *Epilobium angustifolium.*

Fitzroya patagonica.

Exogen. *Coniferæ.* Cone-bearing tree, 100 feet.

This is an evergreen tree, found in South America from Chile to Patagonia. According to Spon, its outer bark yields a fibrous substance used for calking ships. "The tree, which is found in the mountains of Patagonia, bears the ordinary winters of Britain" (*Prof. J. H. Balfour*).

Flachs (Ger.) = Flax.

Flax.

Ancient ——— (see *Linum angustifolium*); ——— for linen. *Linum usitatissimum;* False ———, *Camelina sativa;* ——— Lily, *Dianella tasmanica;* New Zealand ———, *Phormium tenax;* Mountain ——— (see *Cordyline*); Rocky Mountain ———, *Linum lewisii;* Travancore ——— (see *Crotalaria*); Swamp ———, *Eriophorum latifolium.* For references to "flax cotton" and "flax wool," see Uses of Flax, under *Linum usitatissimum.*

Fœtid aloe (Maurit.). *Furcræa gigantea.*

Fomes fomentarius. Amadou polypore.

This is a parasitic fungus on oak, beech, birch, and ash trees, from which is prepared the amadou or German tinder. Pileus bracket-like, hoof-shaped, 4 to 7 inches across, 3 to 5 inches thick at the base, attenuated toward the margin, smooth, distinctly concentrically furrowed, dingy brown, becoming hoary; cuticle thick, hard, persistent; context rather soft, compact, spongy, foxy rust color; tubes very long—½ to 2 inches; pores minute, subangular, ash colored.

Pseudo Fiber.—While it is hardly to be placed in the category of fibrous substances, slices of the fungus have been made into caps, table mats, artificial flowers, etc., specimens of which are preserved in the Kew Mus.

This species and other large *Polyporeæ* may be treated to form "*Spongio lignine,*" or "soft amadou," which has the appearance of a pliable leather and has been found valuable for chest protectors, hat linings, and various household purposes. The large pieces have even been sewed together for making dresses and coarse garments by some of the poorer inhabitants of Austria and Hungary. Badham (Esculent Funguses of England, 1863) related that several eminent surgeons of London used it extensively in their practice, preferring it to chamois skin on account of its greater elasticity. In America it is largely employed by dentists as an absorbent. Salmasius describes the process of its preparation for soft amadou. The fungus is first boiled, then beaten to pieces in a mortar, next hammered out to deprive it of its woody fibers, and, after being steeped in a strong solution of nitrate of potash, dried in the sun. (*B. T. Galloway.*) *F. fomentarius* has been employed from remote antiquity for the development and preservation of fire.

In the manuscript notes furnished me by Mr. Galloway mention is also made of *Dædalia quercina,* which is common on oak stumps, but which Hartig (Diseases of Trees) suspects to be also parasitic. Its preparation for tinder is accomplished after being beaten out and steeped in a solution of nitrate of potassa. *F. igniarius,* the fire fungus, is also mentioned, prepared in the same manner as *D. quercina.* This is the parasitic growth most frequently met with upon dicotyledonous trees.

Mr. Galloway states that the *Rhizomorphæ* have the strongest, coarsest fibers of any growths, but no record appears of their having been utilized in any manner. It would seem, perhaps, not impossible that the fine felt-like substance of *Zasmirdium cellare* Fr., the golden fibers of *Ozonium auricomum* Lk., and other filamentous mycelial growths might, under stress of necessity, be made into fabrics of some economic value.

Formio (Span.). New Zealand Flax. See *Phormium.*

Forster's palm lily (Austr.). *Cordyline australis.*

Fraxinus nigra. Northern Swamp Ash.

Exogen. *Oleaceæ.* A tree, 75 to 90 feet.

Common names.—Black ash, hoop ash, ground ash, northern swamp ash.

Southern Newfoundland, northern shores Gulf of St. Lawrence, to Delaware, the mountains of Virginia, southern Illinois, and northwestern Arkansas. The wood is used for interior finish, fencing, barrel hoops, cabinetmaking, etc.

Woody Fiber.—The wood is easily separated into thin layers, and on this account is largely employed as material for basket manufacture. Splint basket material is also made from white ash, white oak, hickory, basswood, etc. The different kinds of wood are prepared in the same manner. In preparing the wood for basket making the log is split as near the eye as possible, shaved to the proper thickness, pounded with a heavy hammer on an anvil; the stick is then held in such a position across the anvil that by pounding it the grains are loosened so that they can be pulled apart; these strips are then smoothed and braided on blocks, which, after being dried, are tightened and are ready for the rims.

Freycinetia banksii.

Endogen. *Pandanaceæ.*

This genus of plants is native to the Indian Archipelago, Norfolk Island, and New Zealand, and is distinguished by having the habit of growth of *Pandanus.*

"The fiber will probably be found valuable for paper making" (Spon). The species is not included in the Australasian lists of Dr. Guilfoyle, but is included on the above authority.

Furcræa cubensis. THE CAJUN.

Endogen. *Amaryllidaceæ.* Aloe-like leaf cluster.

NATIVE AND COMMON NAMES.—*Cajun* (Cent. Am.); Silk grass (Jam.); Tobago silk grass and *Langue Bœuf* (Trin.). (See Silk Grass in Catalogue.)

This plant is a native of tropical America, but has been distributed to and is cultivated in many tropical countries.

In this species the leaves are generally armed with long spines. Dr. Parry found the plant growing common in Santo Domingo in 1871, and brought back with him to the Department samples of the fibers. It is also common in Jamaica, and it is considered that there would be no difficulty in establishing it in cultivation for its fiber. Dr. Schott (U. S. Ag. Rept., 1869) describes it as it grows in Yucatan, placing it in the list of "sisal hemps." It differs from its congener, *F. gigantea,* in having no distinct trunk. The leaves are 3 to 5 feet long and 5 inches wide in the middle, bright green in color, rigid habit, and are armed with heavy spines. Dr. Schott says that the leaves of Yucatan plants are 4 to 5 feet long. It is growing in many places in Trinidad, being found at the Bocas Islands, the Maracas valley (where the fine variety *inermis* is found), and is cultivated at Brechin Castle estate and at the convict depot of Chaguanas. Consequent upon the anticipated demand for plants, many thousands were grown in the Botanic Garden a few years ago, some 20,000 plants having been produced.

STRUCTURAL FIBER.—This is white, strong, and bright looking, and yields at the rate of 2.05 to 3.15 per cent by weight of green leaves. From experiments carried on at Jamaica under a committee appointed by Government it was found that leaves of *F. cubensis* weighing 366½ pounds yielded 28 pounds of green fiber, which, when perfectly dry, weighed 7½ pounds. This was at the rate of 2.05 per cent by weight of green leaf. Value of fiber: (*a*) £28, good quality, but might be whiter; (*b*) fairly clean, fair color, value about £28 per ton; (*c*) superior to sisal and worth £27 per ton—a good fiber, not quite sufficiently white in the center. (*Dr. Morris.*)

Dr. Fawcett states that the fiber of this species may supply a small part of the sisal hemp of commerce. In Dr. Schott's article in the Annual Report of this Department for 1869, the "*cajun,*" or *F. cubensis,* is figured opposite to page 259. This shows that the plant produces a vast number of narrow leaves, a peculiarity noted in the plants mistaken for sisal in Florida, and at the time of my visit I believed that it was growing abundantly in Florida, and was the species mistaken for the true sisal hemp, both by the Bahama and Florida cultivators.

The extraction of fiber from this plant, which grows so readily in Tobago and Trinidad, was also tried by means of the Death and Kennedy machine, and was certainly the most promising of the plants under trial, as it gave the greatest output of fiber of first-class quality. From the ease with which it grows it is doubtful if any other plant will be able to be grown in competition with it for fiber production; and the fiber company of Tobago are sanguine as to their ultimate success with their indigenous plant in preference to the imported sisal, and it would appear that their reasons are sound; the fiber itself is first-class, the plant is easily and cheaply grown, land is easily available, and the want of an economic machine is the only difficulty, and one which we all hope will soon be overcome. The plant is being largely cultivated at the convict depot, Chaguanas, and large numbers have been planted on the Carrera's Island prison lands, under the supervision of Lionel M. Fraser, esq., superintendent of prisons. (An. Rept. Roy. Bot. Garden, Trinidad, 1890.)

Furcræa gigantea. GIANT LILY.

NATIVE AND COMMON NAMES.—The *Cabouya* or *Cabuja* (Cent. Am. and W. Ind.); *Cocuiza* and *Fique* (Venez.); *Pita* and *Pita floja* (Cost. Ri.); *Peteria* (Braz.); *Aloes vert* and fœtid aloe (Maurit.); giant fiber lily (Austr.). The fiber is known commercially as Mauritius hemp. Fig. 1, Pl. VII, is a greenhouse plant of this species growing in the United States Botanical Garden.

The plant is closely allied to the agaves and is found throughout tropical America. It grows in Algeria and Natal, and is cultivated in St. Helena and Mauritius. It has also been introduced into India, Ceylon, and Australia. It is of moderately quick growth and attains great perfection. Like the agaves, these plants have long-lived massive stems, immense fleshy leaves, and produce their flowers after many years upon tall central stems, in pyramidal, candelabra-like form.

STRUCTURAL FIBER.—The fiber very closely resembles the sisal hemp of commerce, and doubtless is often so called. Dr. Ernst, in the catalogue of the Venezuelan department (Phil. Int. Exh., 1876), states that the fiber is very strong and is used for cordage and gunny bags. It is prepared in the same manner as sisal hemp. Samples of the Venezuelan specimens are dyed in aniline to show that it will take color.

The plant is grown largely for fiber at St. Helena and Mauritius, and in the London market the product is known as Mauritius hemp. In the Kew Bulletin for March, 1887, the plant grown in Africa is described as having leaves 4 to 7 feet long, 4 to 6 inches broad at the middle, unarmed, light green in color, channeled down the face.

F. gigantea is supposed to have been introduced from South America to Mauritius about 1790. It has evidently found a congenial home there, for without any effort on the part of man it has covered waste lands and adandoned sugar estates to such an extent as to lay the foundation of a considerable fiber industry. The leaves are often 8 feet in length and from 6 to 7 inches in breadth. The pulp of the leaves when crushed gives off a strong pungent odor, and hence this species is sometimes called the fœtid aloe. The juice is strongly corrosive and soon acts upon wrought iron; it is said to produce less effect on cast iron, while it is practically inoperative on brass and copper. The plant grows in all soils and up to an elevation of 1,800 feet above the level of the sea. It has, however, more generally disseminated itself on the lowlands near the coast and on a few of the abandoned sugar estates that have become too dry for cane cultivation. A fiber industry was started at Mauritius about 12 years ago, when the wet or retting system was tried. The cut leaves were first passed through the rollers of a sugar mill and steeped in water for some days. The fiber was then washed and beaten out by hand in running water. This process was soon found unsuitable, as the fiber was discolored and rendered weak, and consequently commanded comparatively low prices. Attention was then directed to extraction by means of *gratteuse* or scotching machines. Many machines have since been tried, and it is believed that the purely mechanical difficulties connected with cleaning the fiber have been for the most part overcome. The amount of fiber obtained from leaves of the *Aloes vert* was at the rate of 3 per cent by weight of green leaves. The yield of fiber was at the rate of about 1½ tons per acre. A set of six machines driven by a steam engine of 8 horsepower (nominal) cleaned 1,155 pounds of fiber per day, which is at the rate of 193 pounds for each machine per day. (*Dr. Morris.*)

The production of this fiber is very great, especially in Barginsimeto, Coro, and the State Los Andas, where it is known under the name of *fique.* It is used principally in the manufacture of material for bags, horse blankets, fish nets, halters, etc. But it should be produced in even greater quantities to enable us to establish manufactories for cordage and bags necessary for the handling of the annual crop of grains, as these articles are exported more and more extensively every year, principally to the United States and Germany. (*Dr. A. Ernst.*)

Furcræa longæva.

"This species inhabits the mountains of Guatemala and Mexico at about 1,000 feet. It is recorded as fiber producing." (Spon.) I have not met with species in any Central and South American collections, or noted any mention of it in the fiber literature of tropical America that has come under my notice.

Furcræa tuberosa. CABULLA.

A sample of this fiber, somewhat resembling Sisal hemp, was exhibited in the Costa Rican collection, W. C. E., 1893. It is employed as a textile.

Fucus (see under *Macrocystis*).

Furquina (clothing). Colombia. See *Couratari.*

Gahnia beecheyi. UKI OF HAWAII.

A genus of *Cyperaceæ* the species of which are found in eastern tropical Asia and Polynesia, New Zealand, Tahiti, the Hawaiian Islands, etc. *G. beecheyi* is a grass found at lower elevations—from 1,000 to 3,000 feet—in Hawaii and Oahu. The stems are used to make cords.

Gahnia radula.

A native Australian species of *Cyperaceæ* commonly known as the Black Reed. Specimens of the fibrous material were secured at the Phil. Int. Exh., 1876, prepared by Dr. Guilfoyle. The label reads: "This coarse-growing sedge can be had in enormous quantities throughout the colony (Victoria). It is extensively used by the settlers as a thatching material." As a fiber it has no value, and it is doubtful if it would make good paper. The species is noted in Dr. Guilfoyle's Australasian list.

Galvan. Venetian name of *Andropogon gryllus.*

Gamalote (Venez.). See *Panicum myurus.*

Gamalotte (Mex.) See *Fimbristylis complanata.*

Gampo (Span.). See *Hibiscus cannabinus.*

Ganpi fiber (Jap.). See *Wikstrœmia.*

Gas (Ceyl.)=a tree.

Gaura parviflora.

This species, belonging to the Evening Primrose family, was sent to the Department from Boise, Idaho, as a fiber plant. The stalks were examined, but the fiber layer was found to be too thin to make the plant of any value whatever as a textile. Stalks of the Evening Primrose have been received from other inquiring correspondents. It is therefore included in this list.

Gayumba (Span.). See *Spartium junceum.*

Gebang palm (Java). *Corypha gebanga.*

Gelso reale (It.). *Morus alba.*

Genêt d'Espagne (Fr.). *Spartium junceum.*

Genipa americana. HUITOC OF PERU.

This species belongs to the Cinchona family, the tree being found in the American tropics. *G. americana* produces the Genipap fruit, which is about the size of an orange, and of agreeable flavor.

FIBER.—The bark of this tree, known in Peru as the *Yaguayagua*, or *Huitoc*, "furnishes a fiber that is used by the Indians for making rough clothing" (*Dorca*).

Geonoma baculifera. THE UBIM.

A genus of tropical American palms. The species occurs in British Guiana, where it is used as a thatch material.

Where the *troolie* (*Manicaria saccifera*) does not grow the small, transparent leaves of *dealibanni* (*G. baculifera*) afford a thatch which is in one respect still more convenient than *troolie*. They are gathered and fastened together by their stalks so as to hang close together, and with their sides overlapping, from a long lath cut from the stem of the Booba palm, *Iriartea exorrhiza*. Such rows of leaves, 10 or 12 feet long, and 2 or 3 deep, are arranged one above and overlapping each other. The advantage is easy removal to tie upon a new framework. (*E. F. im Thurn.*)

Specimens of thatch material from an unidentified species of *Geonoma* are exhibited in the Kew Mus., used by the Arawak Indians of British Guiana. Orton states that *G. baculifera* is called *Ubim* in Brazil. *G. multiflora*, see fig. 57.

Gesnouinia arborea.

An herbaceous perennial belonging to the *Urticaceæ*. Savorgnan states that *G. arborea*, Teneriffe, yields a fiber similar to that extracted from the ramie plant. I find no other reference to the genus as fiber producing.

Geta netul (Ceyl.). *Streblus asper.*

Ghaipat (Ind.). *Yucca gloriosa.*

Ghanga (Beng.). *Cannabis sativa.*

Ghay-mari, of Liotard. (Ind.). *Agave vivipara.*

Ghi-kavár
Ghirta-kumári } (Ind.). *Aloe vera.*

Giant asclepias (Ind.). See *Calotropis gigantea.*

Giant nettle (Austr.). See *Laportea gigas.*

Gietta and **Guyetta.** (Arizona.) *Hilaria jamesii.*

Gigantic gum tree (See *Eucalyptus obliqua*).

Ginestra.

A general term used in Italy to designate *Spartium junceum*, and similar grass-like plants. Some of the plants recognized in Italy under this name are: ——— *di spagna*, *Spartium junceum*; ——— *da granate, S. scoparium*; ——— *di bosco, Coronilla emerus*. *Parmo ginestrino* is *ginestra* cloth.

The employment of the small twigs of the *Ginestra* for binding up vines and gathering together bundles of herbs is very ancient, as is attested by Pliny, who writes: "*Genista quoque vinculi præstat.*" The increased use of this plant is indicated, in the thirteenth century, by the statement, "From *Ginestra* can be made tow or wadding and oakum which may be used in place of hemp or of flax." (Extract from the Treatise on Agriculture, Milan, 1805.) The peasants in many places wore cloth woven from the fiber of *Ginestra*. In Maremma from time immemorial they have produced fiber from this plant for the manufacture of coarse material.

Girardinia palmata. THE NILGHIRI NETTLE.

Syn. *G. heterophylla* and *G. zeylaniça*.

Exogen. *Urticaceæ.* A tall herb, 4 to 6 feet.

In the Dic. Ec. Prod. Ind., Vol. III, this important species of nettle is described under the name *G. heterophylla*, the two forms known as *G. palmata* and *G. zeylanica* being regarded as varieties. "It abounds in the temperate and subtropical Himalayas, ascending to an altitude of 5,000 feet. It is also met with in Assam, Sylhet, and Burma, and extends from Marwar and central India to Travancore and Ceylon. The variety *palmata* is a native of the Nilghiri hills and Ceylon, while *zeylanica* is confined to the latter locality and parts of the Deccan." (*Watt.*)

Bast Fiber.—The above authority states that the fibers from the three forms are perfectly distinct in many of their characters, and should therefore be considered separately. From the account given in the work cited above the following extracts are reproduced:

G. heterophylla: Stems often employed for making twine and ropes by the dry process, but these are not prized and perish quickly from the wet. Yields a fine, strong fiber, used for cordage and twine, but can not stand much moisture.

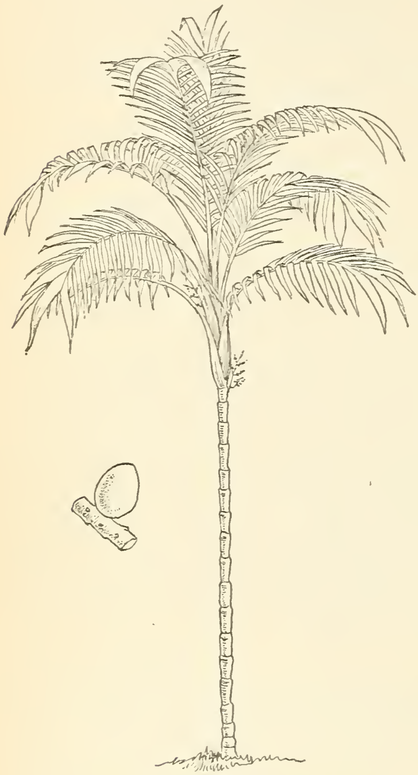

Fig. 57.—The Ubimrána, *Geonoma multiflora.*

G. palmata: The true Nilghiri nettle; it yields a finer and more valuable fiber than the preceding. Royle writes that the fiber is very long, soft, and silky, and has been much admired by many of the best judges of fibers. At Dundee it was thought a very good fiber, but rather dry. Mr. Dickson, who has passed it through his machine and solution, has rendered it a beautiful, soft, silky kind of flax and calls it a wonderful fiber, of which the tow would be useful for mixing with wool as has been done with China grass, and the fiber used for the finest purposes. In Spon's Encyclopedia the Girardinias are spoken of collectively under the name of *G. heterophylla*, but it seems that *G. palmata* alone is meant. The following extract may be found useful: "It succeeds well by cultivation. The bark abounds in fine, white, glossy, strong fibers which have a rougher surface than those of *Boehmeria nivea*, and are therefore more easily combined with wool in mixed fabrics." Owing to the high percentage of cellulose and the small loss from hydrolysis, the fiber is chemically one of the best produced in India.

G. zeylanica: Little is known regarding the fiber of this variety, although it is used in the Konkan and other parts of western and southwestern India. It would appear, however, that it is very similar to that produced by the true Nilghiri nettle.

Cultivation.—Like the China grass plant, it can be cut as a perennial and continue to throw out fresh shoots and roots for three or four years. The seeds are sown in rows 15 inches apart in alluvial soils, and the stalks are cut in July and January. It is stated that from the July crop an average of 450 to 500 pounds of fiber may be expected, 120 pounds of this being of superior quality. The January crop will yield 600 to 700 pounds of fiber; but the fiber of this crop is uniform, but of coarse quality, owing to the shoots being matured by the setting in of the dry season in December.

Ginger grass (see *Andropogon schœnanthus*).

Gleichenia glauca.

A genus of polypodiaceous ferns found in the Tropics of both hemispheres and extending to Chile and the Australasian region. The species named is found in the East. The Kew Mus. exhibits a Malay hat made from the fibrous bundles of the plant.

Gnetum spp.

These are trees or creeping shrubs found in tropical Asia and in Guiana. *G. gnemon*, found in the Isles of Sunda, New Guinea, the Philippines, etc., yields a fiber, derived from its bark, used for cordage and textures of coarse quality. *G. scandens* is an India species, the stems of which are employed by the natives of the Andaman Islands for the manufacture of fishing nets. The outer covering of the seeds of *G. urens* is lined with stinging hairs.

God-tree (Mex.). See *Bombax ceiba.*

Gomphocarpus physocarpus. QUOMOTANETU, OF NATAL.

Exogen. *Asclepiadaceæ.* A shrub.

The species of this genus are chiefly confined to southern and northeastern Africa and Arabia. *G. physocarpus* is found in Natal.

FIBER.—Produced from the bark. J. Medley Wood, curator of the Natal Botanic Gardens, gives an interesting account of the fiber in the Annual Report of the Durban Botanic Society for 1888 (p. 13). Samples of the fiber were received in the year named from Zululand, and from Durban, which were sent to England for report as to their merits and value. The fiber was described as very good as to color and strength, and if it could be produced in large quantities and be carefully cleaned, it would bring £25 per ton c. i. f., London.

"The peculiarity of this hemp is its exceptional strength, and no doubt if it could be produced in large enough quantities and the length increased, it would sell quickly and equally well with manila hemp, the present price for which is, say, £33 to £34 per ton."

Samples sent to Dr. Morris, Kew, were submitted to Messrs. Ide & Christie, the London fiber brokers, who reported adversely on the fiber on account of its bad preparation. Its value was estimated at £15 per ton, but it was thought that properly cleansed its value would be enhanced 75 or 100 per cent.

Gomphocarpus brasiliensis.

This Brazilian species is noted, in Löfgren's paper, as found on the plants of Sao Paulo called *Paina de seda.* Its seed hairs are used as upholstery material. The plant is cultivated and blooms in the winter months.

Gomuti fiber (Malacca). See *Arenga saccharifera.*

Goni. Sanskrit name of *Sansevieria roxburghiana*

Gonolobus maritimus.

Syn. *Ibatia muricata.*

An asclepiadaceous climber of Venezuela, "which yields a milky juice said to be a good pectoral. The seed hairs are brittle and can not be spun." (*Dr. Ernst*). The fiber was exhibited in the Venezuela court, W. C. E., 1893, under the name Silk Wool of Orozuz. It is a silk cotton, or surface fiber.

Goo-mao-mah (Austr.). See *Laportea gigas.*

Gorakha-amla (Bomb.). *Adansonia.*

Gossypium spp. COTTON.

Exogens. *Malvaceæ.* Tall herbs and shrubs.

COMMON AND NATIVE NAMES.—Hopi (moqui), Indian name, *Pucü; Algodon* (Span.); *Ychcaxihitvitl* (Yuc., or ancient Mex.); *Varai* (Tahiti); *Coton* (Fr.); *Cotone* (It.); *Baumwolle* (Ger.); *Pembeh* or *Poombeh* (Pers.); *Gatn, Kotan,* or *Kutn* (Arab.); *Cay Haung* (Cochin China); *Hoa mein* (China); *Watta ik* or *Watta noki* (Jap.); *Tonfai* (Siam); *Nurma* (Hind.); *Deo Kurpas* and *Deo Kapas,* God's cotton (Mysore and Bomb.); *Nu-wa* (Burm.); *Kohung* (Mong.), and many others.

HABITAT AND SPECIES.—The origin of the cotton plant is a question not easily settled, as cotton has been grown in many countries from an exceedingly remote period. It is probable that a plant numbering so many species is indigenous in different localities, though Rhind states that it may possibly have come from Persia originally, then crossed into Egypt, thence to Asia Minor and the Indian Archipelago. M. Bernardin, curator of the Industrial Museum of Ghent, in his "Nomenclature Uselle de Fibres Textiles," gives the origin of the several species named, crediting at least two to North America, *G. barbadense* from the West Indies, and *G. hirsutum* from Mexico. *G. herbaceum* he regards as originally an East Indian species. So much has been written upon this subject and authorities differ so widely that great confusion has resulted. To add to the complication, cotton has been cultivated in portions of the earth from remote ages, and in many countries for centuries—for a period of over 3,000 years in India—for we read that when Egypt was in the zenith of her glory the delicate cotton tissues of India were famous, and Egypt at that time had a cotton industry of her own. On our continent the Aztecs of Mexico and the Incas of Peru ages and ages ago spun and wove cotton, and the Hopi Indians of Arizona, preserving a tradition and the requirements of a custom that has come down from remote times, will only use in their religious ceremonials strings or cords made from native-grown cotton, twisted by the officiating priests. Regarding the countries where cotton is cultivated, see statements on the distribution of cultivation, page 178.

FIG. 58.—Blossom and boll of the cotton plant, *Gossypium.*

In a recent work on the cotton plant, Bulletin No. 33, prepared by the Office of Experiment Stations of the United States Department of Agriculture, the history, botany, culture, chemistry, and uses of this plant are treated almost exhaustively. From the chapter on the botanical consideration of the subject, prepared by Dr. Walter H. Evans, the statements regarding the different species of cotton, which follow, have been condensed: On account of their great variability the species of *Gossypium* are difficult of limitation, and various attempts have been made to classify them. Linnæus described at least 3 species, and since that time the number of species and synonyms has increased enormously. Two monographs of the genus have been published by Italian botanists, the first by Filippo Parlatore in

1866, in which the author recognized 7 species, with 8 others in doubt. The other monograph was by Agostino Todaro, published in 1877, in which are described 52 species, with 2 as uncertain. Hamilton sought to avoid confusion by dividing the genus into 3 species, the white seeded, black seeded, and yellow linted, to which he gave the names *album, nigrum,* and *croceum.* A recent publication, Index Kewensis, recognizes 42 species, of which but a very few are of economic importance, and mentions 88 others that have been reduced to synonyms, most of them being synonyms of species in common cultivation. The great variability and the tendency to hybridize make it difficult to determine to which species a given plant may belong. No cultivated plant responds so quickly to ameliorated conditions of soil, climate, and cultivation as the cotton plant, and to this fact is due much of the confusion as

FIG. 59.—Sea Island cotton.

to species and varieties. Another factor entering into the confusion is the imperfectly known types that have been described as species. It has been stated that some of the species now widely cultivated are wholly unknown in a wild state, and some of the specimens described by Linnæus were in all probability from plants that had long been in cultivation. The work of establishing the origin of the cultivated species has been still further complicated by the exchange of seed from country to country that has been going on for at least four centuries.

Among the species recognized to be of more or less economic importance are *G. arboreum, G. neglectum, G. brasiliense, G. herbaceum, G. barbadense,* and perhaps a few others. In this country only the herbaceous cottons are cultivated to any extent. The shrubby and arboreous are grown occasionally as curiosities, but they seldom or never produce any lint in regions having as low a mean temperature as the cotton belt of the United States.

The determination of the species of cotton grown in this country presents some peculiar difficulties. The authorities differ widely regarding the specific origin of the short-staple or upland cotton, while more nearly agreeing on that of the sea-island cotton. The latter is generally considered as having originated from *G. barbadense*. Species which have been considered synonyms of *G. barbadense* are *G. frutescens* Lasteyr., *G. fuscum* Roxb., *G. glabrum* Lam., *G. jamaicense* Macfad., *G. javanicum* Blume, *G. maritimum* Todaro, *G. nigrum* Hamilton, *G. oligospermum* Macfad., *G. perenne* Blanco, *G. peruvianum* Cav., *G. punctatum* Schum. and Thonn., *G. racemosum* Poir., *G. religiosum* Parlatore, *G. vitifolium* Lam., and perhaps others.

This species is indigenous to the Lesser Antilles and probably to San Salvador, the Bahamas, Barbados, Guadaloupe, and other islands between 12° and 26° north latitude. By cultivation, it has been extended throughout the West Indies, the maritime coast of the Southern States, Central America, Puerto Rico, Jamaica, etc., southern Spain, Algeria, the islands and coast of western tropical Africa, Egypt, Island of Bourbon, East Indies, Queensland, New South Wales, etc. It may be cultivated in any region having a hot and humid atmosphere, but the results of acclimatization indicate that the humid atmosphere is not entirely necessary if irrigation be employed, as this species is undoubtedly grown extensively in Egypt. As a rule, the quality of the staple improves with the proximity to the sea, but there are exceptions to this rule, as that grown on Jamaica and some other islands is of rather low grade, while the best fiber is produced along the shores of Georgia and South Carolina.

The yield of lint from Sea Island cotton is less than from any other kind grown in this country, but on account of the length and quality of the fiber it is adapted to uses to which the other kinds are not suited, and its high market value compensates for the small yield.

G. herbaceum: While scarcely any of the authors agree in the more important points when discussing the origin of upland cotton, the weight of opinion seems to be that the species is either *G. herbaceum* or *G. hirsutum*, which are considered synonymous, and the former name is employed to designate the species, which includes in its synonyms the following: *G. album* Hamilton, *G. chinense* Fisch. & Otto, *G. croceum* Hamilton, *G. eglandulosum* Cav., *G. elatum* Salisb., *G. glandulosum* Steud., *G. hirsutum* Linn., *G. indicum* Lam., *G. latifolium* Murr., *G. leoninum* Medic., *G. macedonicum* Murr., *G. micranthum* Cav., *G. molle* Mauri, *G. nanking* Meyen, *G. obtusifolium* Roxb., *G. paniculatum* Blanco, *G. punctatum* Guil. & Perr , *G. religiosum* Linn., *G. siamense* Tenore, *C. sinense* Fisch., *G. strictum* Medic., *G. tricuspidatum* Lam., and *G. vitifolium* Roxb., together with numerous others the descriptions of which are too indefinite or the specimens too meager to determine them positively.

The origin of this series is much more confused than that of the sea-island cotton. If we should separate the upland cotton into two species, viz, *G. herbaceum* and *G. hirsutum*, probably the question would be simplified, as the former is generally considered of Asiatic origin, while the other is attributed to America. Todaro (Rel. sulla coltura dei cotoni in Italia, 1877–78, p. 212) claims that the form called by him *G. hirsutum* originated in Mexico, whence it has been spread by cultivators throughout the warmer portions of the world.

To this form he ascribes the Georgia upland cotton or the long-staple upland cotton. Parlatore (Le specie dei cotoni, p. 43) considers it indigenous to some of the islands of the Gulf of Mexico as well as the mainland, and all green-seeded cotton, which is cultivated so widely, as originating from this form. On the other hand, he claims India, especially the shores of Coromandel, as the primitive home of *G. herbaceum*, from which place it has spread as extensively as its western congener, and is found in cultivation in nearly the same regions. Todaro says that *G. herbaceum* is spontaneous in Asia and perhaps also in Egypt, and he claims *G. wightianum* as the primitive form of the Indian cottons. Maxwell T. Masters claims *G. stocksii* as the original of all cultivated forms grouped under *G. herbaceum*. Others consider *G. herbaceum* as a native of Africa, and it seems impossible from the mass of conflicting evidence to determine just where it did originate. It seems probable that *G. herbaceum* is not a definite species, but one developed by cultivation from, perhaps, several wild species, and it represents not a species but a group of hybrids and forms more or less closely related. The cottons called "nankeen" are only color variations of the above, and may be found in nearly every species that is cultivated. Authorities agree that in all probability the yellow lint is the wild form of all cottons, and this character can not be used to designate species.

G. arboreum Linn. is a shrubby perennial, but in cultivation sometimes annual or biennial; fiber, two forms; one white, long, overlying a dark-green or black down; not readily separable from the seed. This species of cotton appears to be indigenous to India and the regions bordering on the Indian Ocean. According to Watt it is found near temples and in gardens, where it is said to be in flower most of the year. The plant is a perennial, lasting for five or six years or longer, and is not used as a field crop. The fiber is fine, silky, and an inch or more in length, but little of it is produced. The cultural name given it is Nurma or Deo cotton, and its use is said to

FIG. 60.—Upland cotton.

be restricted to making thread for the turbans of the priestly class. Its value is said to be greatly overrated. This species is sometimes known as *G. religiosum*.

G. neglectum Tod.: This species, indigenous to India, is very similar to *G. arboreum*, and by some is thought to be a hybrid between that species and some other, or it may be only a cultural form of the first. It is a large bush, although sometimes only 18 inches in height, and is extensively grown in India as a field crop. It is the Dacca cotton of Royle and Roxburgh and the China cotton of the same authors. This species is cultivated in Bengal, the Punjab, and the Northwest Provinces, and it constitutes to a large extent the Bengal cotton of commerce. Todaro has separated from the species two varieties—*roxburghianum* and *chinense*—corresponding to the Dacca and China cottons above mentioned. It is very probable that both the varieties and the species are not well founded, but are cultural forms. There is another Indian species, *G. wightianum* Tod., that is claimed to be the form chiefly cultivated in India. It greatly resembles the *G. herbaceum* of India, but differs from that species in that the latter has broader and more rounded leaves, and broader, thinner, and deeper-cut bracteoles. This species is said to readily hybridize with *G. neglectum*, and numerous species have been founded upon these cultural forms. Among these hybrids are some of the most valuable of Indian cottons. The typical forms of the foregoing species of cotton have their seed free from each other, but there is another group in which the seeds of each cell are closely adherent in an oval mass, from which appearance they are called "kidney" cottons. Most, if not all, of these species are tropical, and their presence in this country as anything more than curiosities is highly improbable. The most important of them is *G. brasiliense* Macfad., and in addition to the fact of the seed adhering in clusters the species is an absorbent plant with very large, 5 to 7 divaricate-lobed leaves and very deeply laciniate involucral bracts. The cottons of South America, known to the trade as Pernambuco, Ceara, Santos, etc., are evidently not of this species, but belong to the *G. barbadense* and *G. herbaceum* series.

For the botanical descriptions of the several species, which have been omitted here, the student is referred to Dr. Walter H. Evan's complete account in The Cotton Plant, previously mentioned, page 67.

SURFACE FIBER.—The lint or fiber of cotton is the seed hairs which are found in the fruit or boll of the plant after maturity. The value of the lint depends upon the length of these seed hairs, and this is known in commercial parlance as the "staple." Naturally, the "short staples" are less valuable than the "long staples." Upland cotton is an example of the former; sea-island cotton of the latter. Seen longitudinally, the fibers of cotton appear quite independent of each other; they are flat and always more or less twisted, like a corkscrew. This last feature is quite characteristic. The length of the fibers varies from 1 to 1½ inches for long-stapled, and from ⅜ to ¾ inch for short-stapled. (See fig. 4, page 27, Introduction.)

THE WORLD'S CULTIVATION.—Cotton in its several species and many varieties is a product which belongs to all intertropical countries, for the plant has been so widely distributed and has been in cultivation so long a time that in many of these countries it is considered indigenous. Spon gives the geographical parallels between which cotton is usually cultivated as stretching in varying girdles between 36° north latitude and 36° south latitude, though Dr. Evans places the parallels at 40° or more on either side of the equator, or to the isothermal line of 60° F. In this country, latitude 37° north about represents the limit of economic growth. The production of the world's cotton has been distributed in the following countries:

The American Continent.—In the United States the upland-cotton belt extends from southeast Virginia to Texas, and its distribution is mainly between the tide-water district and the foothills of the Appalachian Mountain system. The deep alluvial soils of the Mississippi Valley favor extension of cotton growing much farther northward, from the sugar district of southern Louisiana to the southern border of Missouri, including most of Arkansas and western Tennessee, while the higher elevation of central and eastern Tennessee limits culture and diverts sharply the line of limitation around the foothills of northwestern Georgia. Fifty years ago Mississippi, near the western border of cultivation, had surpassed other States and produced nearly a fourth of the product; now Texas, on the extreme west, yields one-third of a crop doubled in volume. Except a very limited area in Virginia, Kentucky, Missouri, and Oklahoma, cultivation is mainly confined to suitable and comparatively limited districts in North and South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Arkansas, Louisiana, and Texas.

Mexico, prior to the conquest by Cortez, produced annually 116,000,000 pounds, but the culture was abandoned in many sections under Spanish rule. In 1860 the industry received a stimulus on account of the war of the rebellion; since 1882 the culture has been still further extended, until, in 1895, the output was 25,000,000 pounds. The State of Coahuila produces the larger portion of the cotton of Mexico. The best cotton, however, is grown in the State of Guerrero, around Acapulco, and the most inferior in Chiapas. The three cotton sections of this country are the east and west coasts and in the central plateau, in the latter irrigation being necessary. Mexico is a purchaser of cotton from the United States.

A little cotton, perhaps 1,000 bales, is grown in the West Indies, whence at the beginning of the present century 25,000 bales were exported, chiefly to this country. The cotton produced was the sea island, known also as Anguilla, claimed to be indigenous in Hondurus. In 1874 the island of Puerto Rico produced 254,000 pounds, but the culture has declined.

Several of the South American countries cultivate considerable quantities of cotton. In Brazil it grows in nearly every province. R. B. Handy states that while it may be grown in almost unlimited quantities from Sao Paulo all along the coast to the Amazon, and for that matter throughout the whole Empire, in reality, however, its cultivation to a considerable extent is limited to the drier regions of the north, along the valley of the River Sao Francisco and in parts of the province of Minas Geraes. In the more southern provinces the amount of cotton grown for export is at present insignificant. Brazil exports about 60,000,000 pounds, chiefly to England. Ecuador is a small producer of cotton, and Dutch Guiana also produces a little, though early in the present century the cotton export in a single year amounted to over 3,000,000 pounds. Peru produces a peculiar native variety of "tree cotton," with a strong, rough, crinkly staple usually $1\frac{3}{8}$ to $1\frac{1}{2}$ inches long, known as "vegetable wool" and used by manufacturers for mixing with wool, and difficult to detect except by chemical tests. For this reason the woolgrowers, in a new wool tariff bill, have asked for a customs duty of 15 cents per pound on it. It is a varying product estimated at a minimum of 10,000 to a maximum of 50,000 bales of 180 pounds. In 1885 our imports were only 14 bales; 9,500 bales in 1890; 12,500 in 1891.

Europe.—Spon says: Of European countries Italy alone seems to possess the conditions requisite for successful cotton culture. The present centers are around Bari and Barletta, on the Adriatic; in the neighborhood of Salerno, Saron, and Castellamare, south of Naples, and in the provinces of Caltanissetta and Girgenti, on the south shores of Sicily. The products are known respectively as "Pugliar," "Castellamare," "Biancavilla," and "Terranova." Sardinia also grows a little.

The cotton of the Levant, Greece and Turkey and their provinces, amounts to not more than 8,000,000 pounds annually, 75 per cent of which is shipped to England and other parts of Europe. Cyprus grows in ordinary years 1,000,000 pounds, a small part of what might be produced, as the island is adapted to the culture.

Asia.—British India, or Hindostan, the part of India where cotton is raised, embraces four principal cotton regions: The Valley of the Ganges, the Deccan, western India, and southern India. The Ganges Valley is again divisible into two parts, the lower Bengal district and that of the Northwest Provinces, including Doab and Bundelcund, lying on both sides of the Ganges and Jumna rivers. In lower Bengal the cultivation of cotton is not of very great importance. In the plains of Bengal, which are so fertile in other produce, the production of cotton is very inconsiderable, and none is exported. The cotton raised here in former times, though short in staple, was the finest known in the world and formed the material out of which the very delicate and extremely beautiful Dacca muslin was manufactured. The border lands of the Ganges are too low and marshy and the rainfall too great for the successful cultivation of cotton, but the hills back from the river are suitable for this purpose, as they are better drained. The Doab and Bundelcund districts produce almost the entire crop of the Northwest Provinces, and furnish about 70,000,000 pounds of cotton for exportation, which is a good "India cotton." The climatic character of these districts is "first a flood and then a drought," with an inclination to an insufficiency of rain, in great contrast to that of lower Bengal. (*R. B. Handy.*)

The Deccan, or central India, is the great cotton section of India. It occupies the triangular area lying south of the Vindhyan Mountains, in latitude 23° north, and extends to the valley of the Kistna, at 16° north, with the Eastern and Western Ghauts on either side. It is an elevated table-land of undulating surface, having soil of great excellence and richness, and of a consistency to retain moisture for a long time. Nearly all the cotton for export is raised within this region and finds its market at Bombay. India, next to the United States, has been the largest producer of cotton. (*R. B. Handy.*) During the period of civil war in the United States extraordinary efforts were made to extend cultivation, but with so little success that American cotton attained the extreme price of $1 per pound, which fell rapidly as the breadth of cultivation was restored. It is not equal to our cotton in length or quality of staple, and always sells at a lower price. Seed from the United States has been used repeatedly, but deterioration from climatic influences prevents retaining permanently the standard of quality. The crop of 1895-96 is reported at 3,296,046 bales. In the previous year it was 2,688,546, and the average for five years has been about 3,000,000 bales, averaging about 400 pounds, or equivalent to 2,400,000 bales of our cotton. It is therefore between a third and a fourth of the quantity of our crop.

The Russian cotton is grown in Asiatic territory, in Turkestan and Transcaucasia. In 1890, 245,000 acres of cotton were planted in Turkestan, yielding more than 45,000,000 pounds of clean lint. American seed and American gins have been introduced into the country, the variety of cotton known as Ozier silk being highly regarded.

Turkish cottons are very low grade. The country around Smyrna produces the best, however. Other districts where grown, and which give name to the market varieties, are: Cassaba, Aidin, Denizili, Kirgagatch, and Danider. The Adana cotton comes from Tarsus. Cotton has been grown in Syria for ages, and a considerable quantity is produced about Erivan and the frontier of Persia.

Chinese cotton is largely produced in a region lying along and on both sides of the river Yang-tze-Kiang, where the soil is very fertile. In Korea it is grown chiefly in the provinces of Whang-Hai, Chul-La, and Kyng-Tanj, though to some extent in other localities. China and Korea, as far as can be estimated, produce at the present time 640,000,000 pounds of cotton. The production of Japan amounted in 1891 to 109,879,383 pounds, and the quality of the cotton was good, though the staple was short. In the East Indies, Java, Siam, etc., the plant is cultivated and there is a small export.

Africa.—Of African cottons the Egyptian is the most prominent. It has been grown on lands irrigated by the Nile since 1820, and in the upper regions of that river from time immemorial. There are several varieties, most of them yielding fiber of a brownish tint, 1 to 1½ inches long, strong and fine, more lustrous than our upland and commanding a higher price, but not so long or fine or valuable as the sea-island. Ellison (the Liverpool authority) gives 680,000 bales as the export to Europe and America during the last year, with a surplus still available of 33,000, or a total supply of 713,000 bales, equivalent to more than 1,000,000 bales of United States cotton. Nearly all of the Egyptian product is exported. A large increase in production has been made in the past six years, the average exports of the period being more than 50 per cent in excess of those of the preceding ten years.

In other portions of Africa, both on the east and west coasts, as Senegambia, Liberia, the Congo States, the Soudan, etc., a considerable amount of this staple is produced, the greater part of which is consumed at home.

In Australia cotton culture has been attempted, and while a little fiber is grown it can hardly be called a promising industry. Very small quantities are also produced in many of the islands of the Pacific, and in some of them the product shows a good staple. The Fiji and Tahiti cottons are exported.

COTTON INDUSTRY OF THE UNITED STATES.[1]—Soon after the invention of Eli Whitney's saw gin in 1793 the United States became the principal source of cotton supply for the mills of the world, at a period when spinning machinery was a recent invention and the modern factory system was in its infancy. In 1860, four-fifths of the consumption in Europe and America was of the cotton of this country. Production was nearly suspended during the years of civil war following, but in a year or two

[1] Contributed by J. R. Dodge.

after its close the proportion of the supply again exceeded one-half, became two-thirds in five years, and by 1880 nearly regained the antewar proportion.

The only reason for this prominence which needs to be adduced is the advantage of climate in the production of the distinctive type of cotton of the United States, the varieties of green-seed upland. Our cotton belt has the sunshine of Italy and a rainfall largely in excess of the national average; and cotton is a sun plant, fond of water, with a taproot to get it by piercing the friable and finely comminuted soil so characteristic of its areas of densest distribution. Hence any cotton suited to prevalent climatic conditions naturally improves under cultivation. Unlike Egypt and India, this fertile belt needs no irrigation. This climatic adaptation and soil suitability give a practical monopoly which cheap labor elsewhere may never hope to overcome; at least, not until some now unexplored and untested part of the earth's surface shall be discovered and exploited in successful cotton culture.

The enlargement of production has been phenomenally rapid. In the last decade of the eighteenth century it advanced from less than 10,000 bales to more than 150,000; in the first decade of the present century it had reached 300,000, and in the second 600,000, while in a third the record of 1,000,000 was one year made, and at the end of the fourth the 2,000,000 mark was passed. At this point Southern publicists discovered that planters had been guilty of "overstocking the market," when the annual Liverpool average price of middling for 1845 was reduced to 3.92d. per pound, the lowest yearly record ever made before, or ever made since until the great crop of nearly 10,000,000 bales in 1894 reduced the average to 3.34d. The mid-century reduction, like the recent fall, was the result of production quite beyond consumption, four of six successive crops having exceeded 2,000,000 bales, an increase of 50 per cent over the preceding period of six years. Thus 2,000,000 bales per annum caused plethora, while 8,000,000 does not now meet the requirements of consumption.

This fact suggests the remarkable increase in mill consumption in half a century, in Europe and the United States, from less than 3,000,000 bales to more than 10,000,000. It is also suggestive of possibility of further enlargement, as facilities for transportation and intercommunication bring cheap clothing within the reach of unclothed millions of populations developing under the influences of modern civilization. This is a hopeful indication for the future of cotton growing. But production must not materially exceed consumption, or instant fall in price will sound a note of warning against deliberate self-destruction. As a striking example of quick response of price to diminished supply, in 1895 a crop reduction of one-fourth advanced the export price 40 per cent, or from 5.8 to 8.2 cents.

A complete census of the area cultivated was never taken until 1879, when it amounted to 14,175,270 acres. In 1889 it had reached 20,175,270. In 1894 its largest breadth was attained, nearly 24,000,000 acres, which so reduced the price that a concerted and heavy reduction was made. The extension of cultivation was continuous up to 1860, when the breadth must have been nearly 12,000,000 acres. It was at least ten years after the close of the war and resumption of cultivation that the area of 1860 was restored. Increase in twenty years past has been very rapid.

Two-thirds of the product is exported; formerly a somewhat larger proportion. Increase of manufacture in the United States has more than kept pace with the active progress of production. The exports of the last two fiscal years were 11,625,123 bales, or 68 per cent of the crop movement of two years of 17,055,239 bales, though fiscal and crop years are not quite coincident in time. The largest exports ever made were in the year ended June 30, 1895, which were 6,965,358 bales, of which 3,502,067 went to Great Britain, 1,500,362 to Germany, 778,778 to France, 985,558 to other European countries, 105,040 to British America, 72,177 to Mexico, 280 to South America, 21,084 to Asia and Oceanica, and 12 to other countries.

The present relation of our cotton to the factory supply of Europe and America is shown by Ellison's computations, which for the present year require 8,853,000 bales of our crop of 476 net pounds, 830,000 of East Indian of 400 pounds, 713,000 of Egyptian at 741 pounds for British and 714 for Continental receipts, and 330,000 miscellaneous, in all, 10,726,000, or 10,355,000 reduced to bales of 500 net pounds. Our proportion is, therefore, 81.5 per cent of the whole. Including India, China, Japan, Mexico, and minor consumption elsewhere, it is not so easy to determine closely our proportion of the cotton annually used in the world, as there are no very accurate statistics of consumption in China and some other countries, but according to accepted estimates it usually ranges from 55 to 60 per cent of it.

Our cotton is of two types. The sea-island, or black-seed, cotton, confined to islands and shores of South Carolina and Georgia, to Florida, and to an extremely limited distribution along the Gulf coast, rarely produces more than 60,000 bales. It has the longest and finest staple and commands the highest price of any commercial cotton. More than 99 per cent of our crop, however, is known as American upland, having a green seed to which the filaments closely adhere, with a longer staple and better quality than the East Indian and most other growths, varying somewhat by selection and soil cultivation. It is only surpassed in length of staple and price by the Egyptian, which, in these respects, comes between the American upland and sea island. It is imported and used by our manufacturers for specific styles of goods, in increasing quantities; in the fiscal year 1896 a total of 43,609,625 pounds, valued at $5,131,967. If Egyptian would thrive here, a limited production would be desirable, but its attempted culture has not hitherto been attended with very gratifying success.

Cotton is grown in several countries of North and South America, Asia, and Africa, and the produce of each has its peculiar characteristics and uses, yet this country, with only one-twentieth of the world's population, produces of a superior quality of cotton more than all other countries together. This could not be the case, in this era of sharp competition by cotton manufacturing countries of great wealth and enterprise, were not our advantages for production superior to those of any other country. It is obviously, then, our opportunity and duty to supply liberally the needs of the world's consumption, without impairment of the legitimate profits of our cotton growers by unnecessary overproduction.

CULTIVATION.—Climatic conditions generally favorable to the production of cotton are found south of a line which crosses the country a little below latitude 37°. North of this line the short season and relatively low mean temperature are unfavorable; also the mountain region, altitudes above 1,000 feet, south of this line.

The essential features of a climate adapted to this culture are that the season must be sufficiently long for the crop to mature. One of the most important factors is the probable date of the last killing frost in the spring and the earliest frost in the autumn, for the first killing frost of autumn checks the active growth of the plant, and the bolls starting at this time will not develop into mature fruit. The next important consideration is the amount and distribution of heat and rainfall. By the first or middle of August the plant should have attained its full vegetative growth, and from this time on a decreasing temperature between day and night are favorable to the production of a maximum crop, by checking vegetative growth and inducing the maturity of the bolls. During the earlier period the rain should fall in frequent showers rather than in heavy storms, and the best seasons are when these showers occur at night, giving, with a large and well-distributed rainfall, a large amount of sunshine. As to the soil selection, cotton is at present cultivated with more or less success on nearly all kinds of soils within the region in which the climatic conditions are favorable to its growth and development. It is grown alike on light sandy soils, on loams, on heavy clay soils, and on bottom lands, but not with equal success on all these different types of soil. On the sandy uplands the yield of cotton is usually very small; on clay uplands, especially in wet seasons, the plants attain large size, but yield a small amount of lint in proportion to the size of the plants. This is also likely to be the case on bottom lands. The safest soils for the crop are medium grades of loam. On the bottom lands in very favorable seasons the crop often produces a very large yield, but it is not so certain, and in unfavorable seasons the plants are liable to disease and to insect ravages. (*Prof. Milton Whitney.*)

Formerly little attention was paid to the matter of fertilizers, though the manurial value of soiling crops, such as clover and peas, of fallowing and rotation, was well understood. "In the main," says Prof. H. C. White, "the great bulk of the cotton crop previous to 1860 may be said to have been grown without artificial fertilization and mainly upon virgin soils." In the limits of this brief chapter it will be impossible to make a comprehensive statement upon so vast a subject, or to make any statements further than that the necessity not only of using the best fertilizers, but of a knowledge of the chemistry of soil fertility, is now thoroughly appreciated. Among the fertilizers employed, in various combinations, are Peruvian guano, dissolved bones, land plaster, kainit, acid phosphate, the phosphate rocks, barnyard manures, the many forms of cotton-seed fertilizer, as rotted seed, meal hulls, ash, etc., and others. Those interested in the subject should consult the valuable literature published by the Department of Agriculture, and especially Professor White's comprehensive statements on the manuring of cotton in The Cotton Plant, to which reference has already been made.

Deep plowing and subsoiling have generally been considered essential in this culture. David Dickson, a successful Georgia grower, says that to stand a two weeks' drought, a cotton plant must have 4 inches depth of soil, 6 inches depth of subsoil, well broken, and for every additional week an inch more of soil with the same subsoiling. Spon says: In India, the limit as to the depth of plowing is commonly about 6 inches; in America, 12 inches, and in Guiana, 18 inches. It is certain that great benefit would arise from stirring the soil to a depth of even 30 inches, the increased penetration of the roots rendering the plant much more independent of drought, and other external influences. "Subsoiling and deep breaking are open to question. There is no question that a deep, mellow soil is to be preferred, but the efforts to obtain it are limited by the cost, by the risk of injury to some soils through leaching, and to others by bringing sterile earth to the surface. Sandy soils may suffer in the first way, and heavy clays in the second. Experiments to determine the value of these operations are conflicting and inconclusive." (*Harry Hammond.*)

The same difference of practice and opinion prevails regarding the time of preparing the land. It commences in November and continues to March and April, though Mr. Dickson says "the land should be broken as near the time for planting as practicable." After plowing and harrowing, the universal practice is to throw the land into beds or ridges. The plants are usually left 2 to 3 inches above the middle of the row, which in 4-foot rows gives a slope of an inch to the foot. This causes the plow in cultivating to lean from the plants, to go deepest in the middle of the row, and, as a consequence, to cut fewer roots. Four feet is the usually accepted distance between the rows. The perfect cotton planter is not yet invented. It should drop five or six seed in a single line at regular intervals, say a foot apart. In very dry seasons a narrow and deep coulter furrow, the dirt closing in behind it, is run immediately in advance of the planter. It freshens up the bed and assists very much the germination of the seed. (*Harry Hammond.*)

The once universal system of planting by hand, though still in vogue on areas of scattered distribution, has been displaced by some form of cotton-seed planter in the great centers of cultivation. Intelligent and enterprising cultivators are not willing to depend on antiquated methods. Formerly, after ridging and opening a shallow furrow, seed was scattered in it profusely, partly to secure a stand and partly as fertilizer for the young plants, the superfluous plants to be chopped out with a hoe to any required distance apart. This method requires a large amount of seed. Another plan in great favor was the marking by wheel or other device for measurement, for such cavities made by a dibble may seem popular with those who deem precision in planting essential. So various have been these methods of seeding, combining the idea of fertilization with germination, that the quantity of seed required per acre has scarcely ever been calculated or considered. The time of planting ranges from March 1 in southern Texas, to May 20 in northeast Georgia, and the first blooms appear May 15 in southern Texas to July 25 in northwest Tennessee. Several hoeings are necessary to keep down weeds, and the plants are thinned until only two of the strongest plants remain in the stand. Each hoeing is followed by the plow, which throws the earth around the stalk. The particular practice varies greatly, however, in different sections, though the same object is always kept in view to keep the soil free from weeds and the plants growing.

The first bolls open June 15 in southern Texas, and September 15 in north Arkansas. Picking commences in the two sections July 10 and October 1, respectively, and may continue until the middle of December.

Cotton is picked by hand, notwithstanding that considerable skill and capital have been expended in the efforts to produce a machine cotton picker. It can not be said that any of these machines have been successful, as they gather limbs, leaves, and hulls, necessitating the passing of the whole through a separator. As high as 333 pounds of cotton have been picked per day by one man, though it is probable that 100 pounds is nearer the day's work of the average plantation laborer. The picking of the crop of 1894 was estimated to have cost $60,000,000. (*Harry Hammond.*)

Ginning Cottons.—The devices for separating the lint from the seed are of two classes. The first class is known as roller gins, the other as saw gins. The roller gin is the most ancient. It was used from the earliest times by the Hindoos. In its simplest form it consists of a flat stone, on which the seed cotton was placed, and a wooden roller, moved by the foot, was employed to press the seed out. To this day two small rollers, a foot long, one of wood and the other of iron, geared to move in opposite directions and turned by hand, are used in India to separate the seed from the fiber. The task is 5 pounds of clean cotton a day, and the woman who performs it receives a daily wage of 5 cents. In Sicily, also, two grooved cylinders, turned by hand, are still used to pinch out the seed. In the Amoy district of China cotton is said to be cleaned by means of a heavy wooden bow suspended from a bamboo frame on the shoulders of the operator, who feeds the cotton along a board with his right hand, and with his left strikes it with the string of his bow, cleaning from 50 to 100 pounds a day, at a wage of 10 cents. The combination of the roller and the bow-string beater may be observed in certain of the modern improved roller gins used for cleaning the long-staple Sea Island cotton. The seed cotton is fed on a table to a leather roller (preferably walrus hide), the roughness of which engages the fiber, while a steel plate in close juxtaposition to the roller prevents the passage of the seed and a rapidly vibrating blade knocks them out. The cleaned seed fall through interstices in the table, and the lint is delivered on the farther side of the roller. Only cotton with naked seed has been successfully ginned in this way, the down on ordinary upland seed causing them when agitated to adhere to each other and prevents them from falling through the openings in the table. The construction of the roller gin has undoubtedly been greatly improved in recent times, especially as regards the ease with which it is worked and the quantity of cotton it cleans; but it is doubtful if the quality of the product is any better than it was in those ancient days when the Hindoos extracted with it the delicate fibers with which they made the wonderful tissues called the "woven wind." The saw gin, which works on another principle, is the machine which, in its improvements and modifications, has separated seed from fiber almost exclusively for a hundred years of American cotton growing. The seed cotton is held in a box, one side of which is a grate of steel bars or ribs. Through the intervals of the grate a number of thin steel disks notched on the edge and miscalled saws rotate rapidly. The notches or teeth of the saws engage the fiber and pull it from the seed. The seed as they are cleaned fall to the floor through a slit below the ribs. Behind the cylinder holding the saws is another and a larger cylinder (the brush) filled with bristles in contact with the saws. Both cylinders rotate in the same direction. The brush sweeps from the saws the fibers they have detached, and the draft created by the rapid revolutions of the two cylinders blows the lint out to a distance of 20 to 60 feet from the end of the gin, opposite to the one into which the seed cotton is fed. The defects of both methods of ginning are much the same. They fail to clean the lint thoroughly of foreign substances, such as dust, fragments of leaves, etc. Some of the seed, especially the immature seed known as motes, pass through with the lint. The fibers may be strained, weakened, or even broken, or, what is fully as bad, crimped and knotted (termed neps or naps) by improper force used in their removal. From all these causes a large amount of waste is always found in ginned cotton. (*Harry Hammond.*)

In a paper entitled "Treatise upon the cotton fiber and its improvements," submitted at a meeting of the New England Cotton Manufacturers' Association at Atlanta, Ga., October, 1895, Edward Atkinson, referring to the use of the saw gin, says: "We take three-quarters of the life out of our cotton by our murderous method of treating it. We nearly wear it out before we begin to weave it." And asks, "Would it not be better to nip these fibers between two elastic rolls, to draw them away from the seed without upsetting, tangling, and cutting them?" He argues at length in favor of the more extended cultivation of long-staple varieties, and of more earnest efforts to improve the roller gin, using the latter in connection with the recently introduced cylinder press.

Baling.—The standard size of cotton bale in this country is 54 by 27 inches, and contains about 500 pounds, inclusive of bagging and ties, or about 475 to 480 pounds of lint. Formerly weighing 300 pounds, the American bale has grown to 500 pounds. The Egyptian bale averaged 245 pounds in 1855 and 714 in 1892. In Peru, Brazil, and Persia the bales run from 175 to 220 pounds, and in Asiatic Russia from 250 to 325 pounds. India averages about 400 pounds, and the density of the bale is so much greater than the American that it weighs 39 pounds to the cubic foot, while compressed cotton in American bales is less than 35 pounds.

The bales are wrapped in jute bagging, with iron bands, the mere covering of the cotton adding 20 to 24 pounds to the weight of the bale. Among the other forms of baling, the Dedrich perpetual press, formerly used to some extent, puts up the cotton in bales of 100 pounds, and of a density nearly equal to that obtained by the compresses. The Bessonette cylindrical cotton bale is turned out by a self-feeding press, which receives the bat of lint as it comes from the condenser upon a spool between two heavy rollers. The friction of the rollers rotates the spool and winds the bat upon it so tightly as to press out nearly all the air and to form the roll into a package with a density of 35 pounds to the cubic foot and of uniform size and shape throughout. The pressure employed is only 25,000 pounds to the bale, against 5,000,000 pounds by the compress. The Bessonette cylindrical bale is of uniform length, with a diameter of 14 inches to 16 inches. The bales are covered with cotton cloth. The ends are capped with the same material, held in place by a small hoop of wire. No ties are used, nor are they necessary, for the bale retains its shape without them. It is claimed that the saving by the use of this bale in the expense of compressing, handling, insurance, transportation, etc., amounts to $4.25 per bale, and with the air completely pressed out, it is practically fireproof. See The Cotton Plant, United States Department of Agriculture, Washington, 1896.

Cotton manufacture in the United States.—The manufacture of cotton goods in the United States, exclusive of hosiery, knit goods, mixed textiles, cordage and twine, required in 1890 2,216,000 bales of cotton, used in 905 establishments, having 221,585 employees. The value of materials used was $154,912,979, and of products $267,981,724. The number of spindles was 14,550,323, an increase of 3,896,888 in ten years; nearly three-fourths in the New England States, and over one-tenth in the Southern, where the increase has of late been very rapid.

The percentages of cost of manufacture were: 43.81 for cotton, 14 for other materials, 6.24 for miscellaneous expense, 25.93 for labor, and 10.02 for depreciation and profit. The finer grades are mostly made in the New England States, where the quantity of cotton used per spindle, indicating degree of fineness, was 65.95 pounds, 78.46 in the Middle, 147.55 in the Western, and 161.41 in the Southern States. The development of all branches of cotton manufacture was active until arrested by recent depression, and equal progress may be expected in the future.

BAST FIBER.—Like all the species of *Malvaceæ*, the stalks of the cotton plant contain in their bark a fine jute-like fiber. This has at different times attracted the attention of industrialists, and various attempts have been made to bring it into use. There is no doubt that if the plants were grown thickly, like hemp, so as to shoot up slender and branchless, that a good fiber could be prepared from them. The experiments, however, have been conducted with the old bushy stalks remaining in the field after the lint cotton harvest.

In the collection of fibers sent to the Paris Exposition of 1889 was a fine example of the fiber of the cotton stalk, from a plant grown by Gov. J. B. Gordon, of Georgia, prepared by the American Consolidated Fiber Company, from a green stalk, sixty days from date of planting. In the letter transmitting the specimen it was stated that "the fiber is not only good for thread, but for a thousand other purposes; it is a splendid fiber for paper also, as it will not tear as easily as that made from wood pulp or rags." There is no doubt that this fiber would make an admirable twine, though its use in "thread" is somewhat overstated. It possesses fair strength, specimens I have examined by hand tests appearing somewhat stronger than jute. The fiber of old stalks that have stood in the field is of varying shades of russet in color, while that from fresh stalks is a yellow white.

The antagonism of the farmers of the South to the jute trust, in 1890, called renewed attention to unutilized Southern fibers for the manufacture of bagging with which to bale the cotton crop, the price of bagging having been advanced from 7 to 12 cents per yard. Various fibers were suggested as substitutes for the India product, and among them the bast of cotton stalks, which, it was claimed, could be supplied "from the 18,000,000 acres of cotton fields" in cultivation in the South. Among those who experimented with this fiber in manufacture was William E Jackson, of Augusta, Ga., who gave considerable attention to the enterprise, a company having been organized to carry on the work. According to the statement made the fiber was separated "on a machine which was patented and perfected for South American fiber experiments," the name of the inventor not having been given. The principle consisted in "running the bast between a corrugated concave bed, the charge between being washed by a flowing stream of water to wash away the residue of gum and bark."

Nothing was said as to the proposed method of harvesting the stalks, further than that fiber shown was taken from stalks that had been gathered late in February, after exposure to the weather for several months. The fiber produced from these stalks was sent to Mr. J. C. Todd, of Paterson, N. J., for manufacture, a few yards having been prepared experimentally. During a visit to the factory in Paterson a few months later, I was able to secure from the loom whence it was made a small specimen of the bagging, which is preserved in the collection of the Department. The fiber, which showed fair strength, was reddish in color, or a bright russet, though the sample exhibited at Paris approached nearer to straw color.

Like many other similar enterprises, the anticipated results were not realized, and it is doubtful if the harvesting of such rough and uneven material could be accomplished at economical cost, even if such stalks or branches could be successfully decorticated. A machine constructed to operate upon straight, clean stalks, half an inch or more in diameter, grown rapidly and close together in the field, such as hemp stalks, could hardly be expected to work smoothly upon the rough, irregularly shaped branches and often crooked material that would be yielded by cotton plants grown primarily for lint cotton.

The only further reference to the economic use of the bast of the cotton stalk for fiber is in the Dic. Ec. Prod. Ind., Vol. IV. "The stem yields a good fiber, which may be separated by retting. Several writers have alluded to this subject and recommended its utilization, but apparently the people of India are not aware of this fact, since no mention is made of their putting it to any useful purpose." As a native use, however, should be mentioned the employment of the bark of *Gossypium tomentosum* in the Sandwich Islands for rude twine.

Goun (Burm.). See *Boehmeria.*

Grama China. *Muhlenbergia pungens.*

Grass fibers.

While fibrous substance is extracted from many species of *Gramineæ*, the family of true grasses, the term is frequently applied to fibers derived from plants that are grasses in no sense of the word, and it is therefore misleading. Examples: "China grass," the fiber from a tall shrub (*Boehmeria*); "Sisal grass," the fiber from a fleshy-leaved *Agave*, and "Silk grass," which may mean *Bromelia* fiber, or almost anything.

Grass tree.

Resin ———, *Xanthorrhœa australis;* dwarf ———, *X. minor*, both of Dr. Guilfoyle's Australasian lists.

Grewia asiatica et sp. div.

This genus of *Tiliaceæ* comprises shrubs or small trees that are natives of the tropical and subtropical regions of Asia and Africa; also found in the Malayan Archipelago. The species that have been recognized as fiber producing are as follows:

G. asiatica (Ind. and Ceyl.). Bast fiber much employed in rope making.

G. lævigata (Ind., Malay Is., Austr., and tropical Afr.). The fiber is used for cordage in Kanara.

G. microcos (Ind.). Lisboa includes this species in his list of fibrous plants (*Watt*).

G. oppositifolia (N. W. Himalayas, Ind.). A coarse fiber, made from the bark, is used for ropes and nets. "It is neither very strong nor durable nor to be had in any quantity" (Trans. Agri. Hort. Soc. Ind.). Has been employed in paper making.

G. occidentalis (S. Afr.). Kaffir hemp. "A white fiber of great strength extracted by retting, and much used by the Kaffirs" (Spon).

G. scabrophylla (Ind.). Said to yield a fiber suitable for ropes.

G. tiliæfolia (Ind. and Ceyl.). The bark yields a cordage fiber. Routledge describes the fiber as "strong, harsh, wiry, and hard." Would not pay to export it for paper making.

Gru gru; also written *Groo groo* and *Gri gri* (W. Ind.). See *Acrocomia.*

There is confusion in the use of these names. The Kew Mus. Guide gives *Astrocaryum aculeatum* as the *Gri-gri*, and *Acrocomia sclerocarpa* as the *Gru-gru.*

Guamara (Mex.). See *Bromelia pinguin.*

Guano yarey (Cuba). See reference under *Thrinax argentea.*

Guaxinduba.

The bark of this Brazilian tree, species not identified, when beaten yields a kind of cloth which has been used by some of the Bolivian tribes as a dress material.

Guayubera americana.

Included in Dr. Niederlein's list of Argentina species. I have not seen the fiber.

Guayuco (clothing). Colombia. See *Couratari.*

Guazuma tomentosa.

Endogen. *Sterculiaceæ.* A small tree, 20 to 25 feet.

Tropical America and India.

This species is known to the French colonists of the West Indies as *Orme d'Amerique,* and in India and Jamaica as bastard cedar. Dr. Roxburgh experimented with the fiber of this species, and found it to show considerable strength, has been more recently examined and thought, with cultivation, to afford a good cordage fiber. In

Jamaica the tree is only regarded as useful on account of foliage and fruit, which are stock food, and for its timber.

Guazuma ulmifolia, fine samples of the fiber of which were exhibited in the Mexican exhibit of the W. C. E., 1893, is known in Mexico as *Huasima*. Mr. St. Hill, who sent a sample of fiber to the Department in 1871, states that the species is found in Trinidad. Samples of rough cinnamon-colored bast of this species are preserved in the Bot. Mus. Harv. Univ.

Guembipi (Arg.). See *Philodendron*.

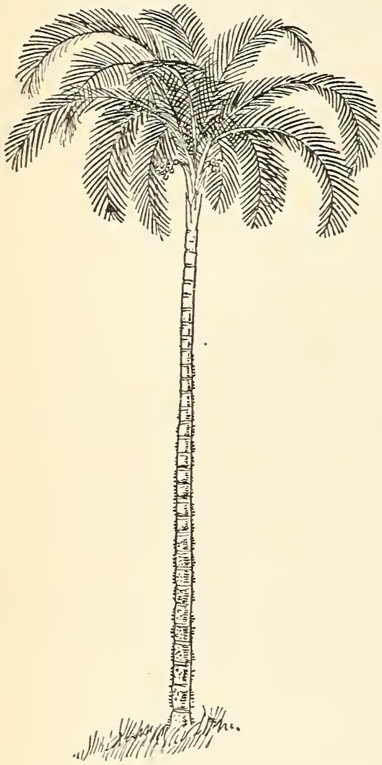

Fig. 61.—The peach palm, *Guilielma speciosa*.

Guilielma speciosa. The Peach Palm.

Endogen. *Palmæ*. Tree, 60 to 80 feet. Native of Venezuela and Guiana. The species is chiefly valued for its fruit, which is eaten by the natives, and which is prepared in several ways. Dr. Ernst includes the species in his list of Venezuelan fiber plants. (See fig. 61.) The revised name of this palm is *Bactris gasipaes*. See *Bactris*.

Guimauve. French name for the Mallow, which see.

Guineo (Venez.). See *Musa sapientum*.

Gumbo and **Gombo**, the Okra (see *Hibiscus esculentus*).

Gunda-gilia (Ind.). See *Bauhinia macrostachya*, under *B. racemosa*.

Gurach, or **Gúrcha** (Hind.). *Tinospora cordifolia*.

Guyetta. *Hilaria jamesii*.

Gymnostachys anceps.

A grasslike araceous plant, found in New South Wales, called Traveller's grass; "distinguished for its extraordinary tenacity." (*Savorgnan*.)

Gynerium argenteum. Pampas grass.

Endogen. *Gramineæ*. A giant grass or reed.

A native of the vast plains of South America, particularly Uruguay, Paraguay, and La Platte. Introduced into cultivation as an ornamental plant in many countries. The leaves have been used in paper making.

The leaves of *G. saccharoides* have been made into hats in Dominica and from the Rio Casiquiare.

Hair moss. *Polytrichum commune*.

Halfa, or Alfa (Alg.). *Stipa tenacissima*.

Han (Hawaii). See *Hibiscus tiliaceus*.

Hana (Ceyl.). *Yucca gloriosa.*

Hana-mushiro matting (Jap.). See *Cyperus unitans.*

Hanf (Ger.). *Cannabis sativa.*

Hapu-Ili (Hawaii). See *Cibotium.*

Harakeke. No. 2, common var. New Zealand flax. See *Phormium tenax.*

Hardwickia binata.

Exogen. *Leguminosæ.* A tree, 100 feet.

South and central India. A forest tree related to the Copaiva balsam trees of South America. It is recorded by Dr. George Watt as a strong cordage fiber and used without any special preparation by the natives where it abounds. Also used for paper. "A valuable fiber for cordage purposes" (Spon).

Hatiraukawa. New Zealand flax. *Phormium tenax.*

Hechima (Jap.). Sponge cucumber. See *Luffa.*

Heii (Hawaii). *Cibotium menziesii.*

Helianthus annuus. THE SUNFLOWER.

Exogen. *Compositæ.* Tall-growing herb.

Said to be a native of Mexico and Peru. Introduced into Europe about the end of the sixteenth century. Cultivated in America, Europe, and in India.

FIBER.—It has frequently been the subject of experiment in this country as a fiber-producing plant, though I have seen no samples of its fiber that would pay for the preparation, or that would serve any useful end when prepared, unless for paper stock, and there are many American plants better adapted for this purpose. Nevertheless, Spon states that the plant would repay culture for the fiber yielded from its stems. About 6 pounds of seed are required for an acre. In a note from Dr. Havard it is stated that the strong fiber in the stem forms a useful material for the manufacture of rough wrapping paper. There is no longer any doubt about the plant being a native of the United States.

H. tuberosus, the Jerusalem artichoke, is said by Balfour to yield fiber in its stems.

Heliconia bihai. BALIZIER.

The species of this genus of *Musaceæ* inhabit tropical America. A specimen of the fiber was sent to the Department from Trinidad in 1891, by Mr. St. Hill, who gives the following facts concerning it:

A wild plant which grows on cool soil, and its presence indicates superior land. The process of curing or obtaining the fiber is the same as that for the plantain or banana. The blades, which resemble the blades of the plantain, produce the fiber, but the blades grow from the roots of the bush like a pineapple, and they are 6 to 10 feet long. One acre will produce about 10,000 blades, and each blade will produce half an ounce of fiber. It is a coarse fiber, not so strong as the other fibers mentioned, but would be good for door mats and similar purposes. It may be reaped annually after three years. Not produced commercially.

Heliocarpus americanus.

Exogen. *Tiliaceæ.* A tree.

The representatives of the genus are confined to Mexico, Central America, and Colombia.

FIBER.—Specimens of a number of these tree basts were examined by me in the Mexican Court, W. C. E., 1893. Two fibers bearing the names of *Jonote* and *Jolocin* have since been identified by Dr. José Ramirez, of the National Institute, Mexico, as *H. americanus* and *H. arborescens*, respectively. Considered as tree basts, they were rated about 75 points out of 100, for strength, color, care in preparation, and utility. The uses of the fibers were not learned, though, doubtless, they are only valuable for rough native cordage and mats, and as paper stock.

Specimens of a tree bast named *Tolotzin*, or *Catena*, and referred to *H. mexicana*, were secured by me in the Mexican court, Paris Exp. Univ., 1889, said to make fine paper, and at that time claiming special attention. The fiber was sent from Tabasco.

**Specimens.*—Mus. U. S. Dept. Ag.; a fine example of the yellowish bast of *H. americanus* is preserved in the Bot. Mus. Harv. Univ.

Hemp.

The hemp plant proper is *Cannabis sativa*, or common hemp. It has also been known in different parts of the world by the following prefixes: American, Breton, English, Himalayan, Italian, Japanese, Kentucky, Persian, Petersburg, and Russian (hemp). The many other hemps are:

Ambari ———, *Hibiscus cannabinus;* Bengal, or Bombay ———, *Crotalaria juncea;* Black-fellow's ———, *Commersonia fraseri;* Bowstring ———, of Africa, *Sanserieria guineensis;* of India, *S. roxburghiana* and *S. zeylanica;* Florida bowstring ———, *S. longiflora;* Brown ———, *Hibiscus cannabinus;* Calcutta ——— (erroneously, for jute), *Corchorus* spp.; Cebu ———, *Musa textilis;* Colorado River ———, *Sesbania macrocarpa;* Cretan ———, *Datisca cannabina;* Cuba ———, *Furcræa cubensis;* Deccan ———, *Hibiscus cannabinus;* False ———, American, *Rhus typhina*, not described in this catalogue; False sisal ———, *Agave decipiens;* Giant ———, of China, *Cannabis gigantea* (Bernardin's Cat.), not described in this catalogue; Hayti ———, *Agave fœtida* (Bernardin's Cat.), synonym of *Furcræa gigantea;* Ifé ——— (see *Sanserieria cylindrica*); Indian ——— (see *Apocynum cannabinum*); Jubbulpore ———, *Crotalaria tenuifolia;* Ko ———, Japan (see *Pueraria*); Konkan ——— (see *Crotalaria*); Madras ———, *Crotalaria tenuifolia;* Manila ———, *Musa textilis;* New Zealand ——— (erroneously for New Zealand flax) *Phormium tenax;* Pangane ———, *Sansevieria kirkii;* Pita ———, *Yucca* spp., also *Furcræa;* Pua ———, India, *Maoutia puya;* Queensland ———, *Sida retusa* et spp.; Rangoon ———, *Laportea gigas* (Bernardin's Cat.); Roselle ———, *Hibiscus sabdariffa;* Sisal ———, *Agave rigida* and its varieties, *sisalana* and *elongata;* Sunn ———, *Crotalaria juncea;* Swedish ———, *Urtica dioica;* Tampico ———, *Agave heteracantha;* Water ———, *Eupatorium cannabinum* and *Bidens tripartita*, the latter not described in this catalogue; Wild ——— (see *Maoutia puya*).

Henequen.

The use of agave fiber on this continent goes so far back into the past that there are no records to show when its use began. Among the Aztecs "*maguey*" fiber and the fiber derived from palm leaves, known as "*icxotle*" and "*izhuate*," were woven into coarse cloths, the *maguey* being also known as "*nequen*," the orthography of which is not greatly different from the word "*henequen*," which is to-day the Mexican name of sisal hemp, *Agave rigida*, which see for description and uses of the fiber. See also Ancient Fibers in Introduction.

Hibiscus.

A very large genus of plants, containing many important fiber-yielding species, and belonging to the *Malvaceæ* which includes commercial cotton. The plants are tall shrubs distinguished by their large showy flowers, the Rose Mallow and Okra being representative American species. The species of this genus abound in all countries, and no fiber list may be examined that does not include from one to a dozen. While the fibers of some of the foreign species are classed as hemps, the native forms yield hardly more than jute substitutes, as the fiber resembles jute more than hemp.

It is unimportant to treat specially the many species of the genus which have been recorded as yielding fiber. The principal species are fully described in the appropriate place under their scientific names, and it will only be necessary to give brief mentions to a few of the others that have been recorded in the literature of the subject. Among the earlier specimens of fiber received by the Department are those from *H. rosa-sinensis*, the Chinese rose, and *H. liliiflorus*, source unknown. Specimens of the following species were received from the Australian exhibits of the Phil. Int. Exh., 1876: *H. sorbifolia, H. tetracus*, and *H. mutabilis*. A Victorian species is *H. heterophyllus*, "the bark of which is rich in fiber of good quality." (*Dr. Guilfoyle.*) The two first named species are not found in the Kew Index, but Dr. Guilfoyle's label names are retained on the specimens in the museum, and so referred to here.

Spon mentions Indian species as follows: *H. furcatus* is found in the southern province of India and in the interior of Bengal. The bark yields an abundance of strong white fibers; a line broke at 89 pounds dry and 92 pounds wet. The stems are cut when the plant is flowering, and steeped at once. *H. ficulneus*, native of Bengal, with a straight stem 6 to 14 feet high, and very smooth bark, thrives luxuriantly with little or no care, yet is very little cultivated for its fiber. The seed is sown in beds in May, and when the plants are 6 inches high they are set out in rows, 9 inches apart each way. The luxuriant growth and habits of the plant commend it to serious attention. *H. vitifolius*, common all over India, is a wild plant yielding a very white, fine and strong fiber, extracted by retting. Other Indian species from which fiber has been extracted are: *H. collinus, H. surattensis*, and *H. tricuspis*. *H. ludwigii* is a native of south Africa, and yields a fiber of great toughness. *H. sulphureus* is a Venezuela species mentioned in Dr. Ernst's list of fibers. Many others might be named, but the present list will suffice.

Vétillart states that the fiber of *Hibiscus*, when minutely examined in glycerin, appears as a bundle, the filaments strongly united together, so much so that they are with difficulty separated even after treatment in an alkaline solution. The fibers are short, stiff, and brittle; of sufficient fineness, but irregular in size, even in the same specimens. The central cavity, usually narrow, is prominent; cells generally terminating in fringed points, sometimes having notches or sinuosities in their outlines; some are large, ribboned, and creased, the exterior surface striated. These last have very slender walls, which explain the creases. Viewed transversely with a high power the fibers are seen to be polygonal, with sharp angles and straight sides, the polygons pressed compactly together. The walls are thick and the central cavity round or oval.

Hibiscus abelmoschus. The Musk Mallow.

Exogen. *Malvaceæ.* A herbaceous bush.

Common throughout the hotter parts of India, two forms being recognized in the Indian Flora, var. 1, *multiformis*, and var. 2, *betulifolius*, according to George Watt.

Bast Fiber.—In a series of experiments made by the Agricultural Horticultural Society of India, at the request of the Government, it was shown that the fiber of *H. abelmoschus* yielded the best crop of all fiber-yielding plants under experiment. With a Death and Ellwood machine a yield of 800 pounds of fiber to the acre was recorded. The society arrived at the conclusion that the cultivation of this plant offered no advantages over jute.

Hibiscus arboreus. The Mahaut.

I have not been able to verify this species. Described by Squier as growing to the height of 16 to 18 feet. He states that "its bark is tough, and not much, if at all, inferior to hemp for many purposes; white, soft, and apparently adapted to the manufacture of paper. Uses locally for making ropes." "The celebrated Cuban bastwood, the bark of which furnishes a coarse but strong cordage, in universal use wherever a rope or string is needed and which is not a bad substitute for chains;

grown in considerable quantity at Samana, (Santo Domingo) and was seen more sparingly along streams in the mountains" (*Charles Wright*). See *H. elatus*.

Hibiscus cannabinus. AMBARI HEMP.

This is the most valuable species of the genus. The plant is a native of the East Indies, and at present is largely cultivated for fiber throughout India, the product being almost wholly utilized by the agricultural classes where grown as a substitute for hemp. Its common names are Deccan hemp and Ambari hemp, the latter particularly in western India. In Madras it is called *Palungoo*. It is the *Mesta pat* of Bengal, and Deccan or Ambari hemp of Bombay. The Sanskrit name is *Nálita*. The plant has a prickly stem, the leaves deeply parted, and the stem attains a height of 6 to 8 feet.

BAST FIBER.—The fiber is described as soft, white, and silky, and by some writers is said to be more durable than jute for the coarser textiles. "It is largely grown by the natives of India and employed for agricultural purposes—ropes, strings, and sacks being made from it. The length of the extracted fiber varies between 5 and 10 feet. The fiber is somewhat stiff and brittle, and though used as a substitute for hemp and jute, it is inferior to both. The breaking strain has been variously stated at 115 to 190 pounds. It is bright and glossy, but coarse and harsh. It is sold with and as jute, and is employed in Bengal for the purposes of jute, including fishing nets and paper. Samples of the fiber exposed for two hours to steam at 2 atmospheres, followed by boiling in water for three hours, and again steamed for four hours, lost only 3.63 per cent by weight, as against flax, 3.50; manila hemp, 6.07; hemp, 6.18 to 8.44; jute, 21.39." (*Watt.*)

The fibers of carefully prepared Ambari are from 5 to 6 feet long. Compared with ordinary hemp they are paler brown, harsher, adhere closer together, though divisible into fine fibrils, possessed of considerable strength. Its tenacity tested with sunn is as 115 to 130. "Fiber stiff and brittle, has no superiority over jute, and it is very inferior to that of India hemp or sunn" (*Vétillart*). A roughly prepared sample of bast from this species was sent to the Department from the Alabama Experiment Station in May, 1896.

CULTIVATION.—Though thriving at all seasons of the year, it is generally cultivated in the cold season. The seeds are sown as thickly as hemp, in rich, loose soil, and it requires about three months' growth before it is ready to be pulled for "watering" and dressing, the mode of treatment being the same as that given the sunn hemp, *Crotalaria juncea* (see p. 139). Full-grown plants that have ripened their seed furnish stronger fiber than the plants cut while in flower, though the fibers of this species are more remarkable for their fineness than for strength.

In harvesting the plants are either cut close to the ground or pulled up by the roots, as the lower portion of the stem contains the best fiber. The stalks are submerged in water and allowed to remain from six to ten days, according to the weather, when the bark can be readily peeled by the hand. Too long steeping, while it makes white fiber, results in a loss of strength.

The fiber is prepared by bundling the stalks, which, after a few days, are steeped for nearly a week in water under stones. When sufficiently retted they are cleaned by beating them on the ground, the fiber is stripped off, washed, and dried. Five hundred stems about 8 feet high, as grown en masse in gardens, were recently taken at random and the fiber removed and cleaned in the usual way. The result was 5½ pounds clean and good fiber. The stems when carefully dried weighed nearly 20 pounds. Assuming the acre to be 40,000 square feet after allowing for waste patches the number of stems at 3 inches apart would be 640,000, hence the yield in clean fiber at 1 pound per 100 would be 6,400 pounds, equal to 2⁶⁄₇ tons. The stems would yield also 11 tons of poor fuel. (From Report Rev. and Ag. Dept. of India.)

USES.—A coarse sackcloth is made from its fiber in India (sometimes called gunny), though its chief employment is for ropes and cordage, it being the common cordage of the country in a few districts. Coarse canvas is also made from it. In Bengal it is employed at the present time for all the purposes of jute and also for making fish nets and paper. There is no doubt, however, that it is less cultivated than in Roxburgh's time, or even at a later period when Royle's work was published, and before jute came into commercial prominence. In the catalogue of the Indian department, Lond. Exh., 1862, it is stated that every ryot sows a small quantity along the edges of his crop for his own use. At that time it was valued at about 2 cents per pound, average.

"A universal practice exists in Egypt of sowing teale (*H. cannabinus*) around the cotton fields for protection from cold, sand storms, etc. The seeds are sown the same time as the cotton, not as a thick belt, but merely about 9 inches in width. The plant grows fairly rapidly, and soon reaches a good height. At the end of September or in October it is cut, steeped in water, and the fiber obtained used for making ropes, etc." (*George P. Foaden.*)

Hibiscus elatus. BLUE OR MOUNTAIN MAHOE. CUBA BAST.

Native of West Indies. A tree, 50 to 60 feet with roundish leaves and large flowers of a purplish-saffron color. (See fig. 62.)

BAST FIBER.—A specimen of the fiber from Demerara, sent to the Department in 1863, was described as very strong but coarse and suitable for making cordage, coffee bags, etc. "The fibers make good ropes. The lace-like inner bark was at one time known as Cuba bark (Cuba bast), from its being used as the material for tying around bundles of Havana cigars" (*Fawcett*). A small quantity of fiber known commercially as Cuba bast or *Guana* comes to this country, though latterly the supply is very small owing to the revolutionary troubles in Cuba. Messrs. Flint, Eddy & Co., the New York importers, have furnished information concerning it as follows:

FIG. 62.—Leaf and blossom of *Hibiscus elatus.*

The process of gathering entails the destruction of the tree, which is cut down, the bark peeled off, exposing the fiber, which is separated from the bark and spread out in the sun to dry, and subsequently packed in bales containing 150 pounds, or thereabouts. There are two or three grades of it, ranging in price from 25 to 75 cents per pound, the more desirable grades being the lighter and softer textures. It is used extensively in this country and Europe for making women's hats and millinery trimmings, such as braids, etc. Its porousness makes it very desirable for the above purpose, as it readily absorbs a dye without impairing its texture. We understand that it is also used to some extent in Europe for making hammock twine, narrow strips of it twisted into the form of twine having considerable tensile strength. In using it for millinery purposes it is slit into narrow strips and then woven, twisted, braided, etc.

**Specimens.*—Mus. U. S. Dept. Ag.

Hibiscus esculentus. OKRA.

Syn. *Abelmoschus esculentus.*

COMMON AND NATIVE NAMES.—Okra, gumbo of Louisiana, *gombo* (Fr.); *quimbombo* (Span.); *bamiyah* (Pers.); *bamiya* (Arab.); *bhindi* (Hind.); *baudaka* (Ceyl.), and many others.

The plant is a native of the West Indies, but cultivation has introduced it to all tropical and subtropical countries. It flourishes throughout the Southern United States, where it is grown for its pods, which form a useful article in the domestic economy. It is also cultivated in South American countries, as well as in countries of the Old World, the French estimating it highly as a food plant. In France it is known as *gombo*, and it is the "gumbo" of Louisiana, which is employed in a number of Creole dishes, the sliced pods often being used to thicken the soup known as "gumbo" or "chicken gumbo." During the late civil war, when the Southern States were cut off from communication from the rest of the world by a rigidly enforced blockade, coffee became very scarce and difficult to obtain. During this time many of the people of the Southern States, and especially the poorer classes, utilized the seed of the okra plant by either mixing with coffee or using it alone. They found the seed thus prepared a very fair sustitute for coffee.

A few years ago okra attracted considerable attention as a possible fiber for Southern cultivation to replace jute in the manufacture of "Cotton bagging;" a large correspondence with the Department resulted, and many articles on the subject appeared in the newspapers of the day. As is frequently the case, however, the value of the plant and the ease of its cultivation for fiber were very much overrated, and subsequent experiments did not substantiate the claims made for the plant.

BAST FIBER.—In color okra fiber is as white as New Zealand flax, much lighter than jute as usually prepared for export, but more brittle and showing less strength. The filaments are smooth and lustrous and are tolerably regular. "The fiber is long and silky and generally strong and pliant. When well prepared, as in portions of India, it is adapted for the manufacture of rope, twine, sacking, and paper. In Bengal its fiber is reputed harsh and brittle, owing doubtless to improper treatment, and it is but little manufactured there. In Dacca and Mymensing it is used to adulterate jute. It resembles hemp, and under this name is exported to the amount of a few thousand hundredweight yearly. In France the manufacture of paper from this fiber is the subject of a patent; the fiber receives only mechanical treatment and affords a paper called banda, said to be equal to that made from pure rags." (Spon.)

Dr. Roxburgh experimented with okra many years ago in India, and made repeated tests of the strength of the fiber. In preparing the material for these tests, the stems were cut when the seed was ripe, and were steeped a few days before preparing. His tests, compared with hemp and jute, are thus recorded: The okra fiber, dry (from India), broke with a strain of 79 pounds; wet, 95 pounds; jute (*Corchorus olitorius*), dry, 113 pounds; wet, 125 pounds; hemp (Bengal), dry, 158 pounds; wet, 190 pounds. *Hibiscus cannabinus* in the same test gave, dry, 115 pounds; wet, 133 pounds. Other species of Hibiscus gave as follows: *H. sabdariffa*, dry, 95 pounds; wet, 117 pounds, *H. strictus* (from the Mollucas), dry, 104 pounds; wet, 115 pounds; and, *H. furcatus*, dry and wet, 89 and 92 pounds, respectively. It will be seen by these tests that okra fiber is not only inferior to that from other species of mallows, but is inferior to jute, and not half as strong as hemp.

CULTIVATION.—The effort to bring okra into cultivation in the United States as a fiber plant began about 1890. A bagging and cordage company of Fort Worth, Tex., became interested in the fiber, and issued a circular entitled A Word to Farmers, which contained a lengthy account of the production of the fiber and its uses. It was hoped to make the culture of the fiber and its manufacture into bagging a success "in order to give a substitute for jute that would enable the farmers of the South to avoid paying tribute to the 'jute trust.'" The company named in the circular offered to sell seed to the farmers at cost and purchase all the product "that could be carted to the mill." The Department carried on a lengthy correspondence with

Dr. M. Chambers, who was named in the circular, and was much interested in a machine he was constructing, which, however, was never perfected. A large area was planted in okra near Forth Worth, but the Department was not able, subsequently, to learn how much fiber was secured, if any, or to obtain samples of either fiber or stalks. Like many other such enterprises, the advantages of the culture were very much overstated, and the ratio of cost of production to yield and value of product doubtless appeared, in actual practice, inversely, compared with the golden promises made at the outset of the experience.

"In the cultivation of this plant the seeds are thickly sown, on any rich soil, about the beginning of April in the South, and by the beginning of May in the North, in drills 6 inches apart. The seeds can also be sown broadcast, about 20 pounds to the acre; but here much care has to be taken to sow as uniformly as possible. In eighty or ninety days the stalks take a rosy color, and without irrigation they will then have attained a height of from 4½ to 5½ feet, while with irrigation during dry weather they will grow to a length of from 6 to 8 feet and even more. The stalks can then be cut with a mowing machine, having a dropper attached, 2 or 3 inches from the ground." (*Fremerey.*)

A Florida correspondent states that "the plant will not only grow from the seed almost without cultivation, but in this climate it will rattoon three years, the last crop nearly equal to the first, it being very rarely injured by frost." He places the yield of stalks at 15 tons per acre, though Dr. C. F. Panknin, of Charleston, S. C., who planted a small area in okra obtained results from his carefully conducted experiments as follows: A half acre of stalks was produced, one-half of which, when decorticated by his process, yielded at the rate of 180 pounds of fiber to the acre, the expense being in the neighborhood of $75. The fiber has been used experimentally in the manufacture of paper in Alabama.

From a careful consideration of the subject in all its details, not only as relates to our own but to other countries, and considering the weakness of the fiber compared with jute, I conclude that the cultivation of the okra plant for its fiber can not be made a paying industry in the United States. And this opinion is emphasized by the fact that there are several species of indigenous fiber plants which could be as easily grown and which are superior to jute in strength, while India jute itself will do well in many of the Southern States. For further accounts see Report No. 6, Fiber Investigations series, U. S. Dept. Ag. (1894); Kew Bull., Oct., 1890; Spon's Enc., Div. III; Dict. Ec. Prod. Ind., Vol. IV; U. S. Pat. Rept. (Agricult.), 1859.

**Specimens.*—Field Col. Mus.; Mus. U. S. Dept. Ag.

Hibiscus moscheutos. THE SWAMP ROSE MALLOW.

This is one of the commonest of the mallows, found in many parts of the temperate United States, according to Gray "inhabitating brackish marshes along the coast, extending up rivers far beyond the influence of salt water (as above Harrisburg, Pa.), also Onondaga Lake, New York, and westward, usually within the influence of salt springs." The plant grows from 4 to 8 feet in height and flowers late in summer. It is also found in India. It is known in Trinidad as African okra or *Gumbo misse.* (See fig. 63.)

BAST FIBER.—Samples of the fiber in the museum collections are evidently hand prepared, and show little strength. Those from experiments made in New Jersey in 1880 were considered "not only as good as India jute, but as secondary grades of imported hemps." The value of the fiber, however, was very much overestimated. Experiments with plant and fiber date back many years.

"Recent experiments with the rose mallow at Camden and Newark incline us strongly to believe that jute of equal quality may be obtained from it, and possibly under conditions more advantageous than from the Abutilon (*A. avicennæ*). One very important advantage the rose mallow would have over the Abutilon, in respect to the economy of cultivation, consists in its being a perennial. Like ramie, the plants once established, the annual cuttings from the stands would be a perpetual source of profit to the cultivator, in case the quality and cost of the fiber meet our present expectations." (Second Report of the Bureau of Statistics, Labor, and Industries of New Jersey, 1880.)

Although the plant is usually found, in a wild state, in marshes, or upon the margin of streams, or in low, wet places, experiments show that it will thrive upon uplands as well. Thirty-five years ago rose mallow roots were taken from the place of their natural growth and planted upon uplands on the Delaware River, with a view to utilization of the fiber, and for many years they held their own as tenaciously as when growing in their native swamps; and they may be growing upon these uplands to-day, for all that is known to the contrary.

**Specimen.*—Mus. U. S. Dept. Ag.

FIG. 63.—Leaves and blossoms of *Hibiscus moscheutos.*

Hibiscus mutabilis. THE CHANGEABLE HIBISCUS.

A native of China, but largely cultivated in India, and distributed to other countries. It grows in Trinidad and is known as the White Mahoe. *Shalapara* is one of the Indian names of the plant.

FIBER.—Hart says: "An introduced tree (in Trinidad) giving a poor bast fiber." Watt says: "The bark yields a strong fiber (in India), but from the inner layer soft and silky, that from the outer layer hard and of a lead color." Roxburgh considered it inferior for cordage purposes.

Hibiscus sabdariffa. ROZELLE HEMP.

This is the "Jamaica Indian Sorrel," the plant which furnishes the "*rozelle*" (or *oiselle*) hemp of the Madras territories. In India it is a small bush, cultivated in many portions of that country, its stems yielding a strong, silky fiber by retting the twigs when in flower. Its fleshy calyxes, of a pleasant acid taste, are much employed for making tarts as well as jelly, and in the West Indies the fruit is much esteemed for making cooling drinks. Another culinary use of the plant in India is the preparation of its leaves in salads. The species grows in southern Florida, where it is planted in March and comes to maturity in December.

Bast Fiber.—A superb sample of this fiber was shown in the exhibit of British Guiana, W. C. E., 1893, which was accompanied by the stalks some 10 feet high, as straight and clean as jute stalks.

The fiber was equal, if not superior, to much of the jute which comes to this country. In my examination for award it was given the following rating: Length, 90 points; strength, 75 points; color, 80 points; average, 81.6. "The stem yields a fiber (in Jamaica) which is fine and silky." (*Fawcett.*)

E. N. Knapp states that the plant thrives in cultivation, but that it will not stand much frost. It will grow on quite poor land, though it does best on good land, where it reaches a height of 8 to 10 feet. It can be produced from cuttings as well as from seed. Even in Florida it is much esteemed for its fruit, which is used soon after the blossoms fall. It is said to make an excellent jelly, and is used as a sauce, much as the cranberry is used in the Northern States.

**Specimens.*—Field Col. Mus.; U. S. Nat. Mus.; Mus. U. S. Dept. Ag.

Hibiscus splendens. Hollyhock Tree.

Fiber from this species, a native of Queensland and New South Wales, was received from Victoria (Phil. Int. Exh., 1876), prepared by Dr. Guilfoyle, who states that the species is a splendid tree, growing to a height of 20 feet or more. "It is very pubescent, bearing large pink flowers resembling hollyhocks in size and appearance. The fiber is suitable for cordage, fish lines, paper, etc."

Hibiscus tiliaceus. The Majagua.

Syn. *Paritium tiliaceum.*

Native and common names. *Majagua* (Venez.); *Huamaga* (Ecuador); *Emajagua*, *Damajagua*, and *Majagua* (Peru); *Mahoe-bord-la-mer* (Trin.); *Han* (Hawaii); *Bola* (Beng.); *Belli patti* (Bomb.); *Thinban* (Burm.); *Beligobel* (Ceyl.).

The species abounds in Central and South America, India, tropical Australia, and the Pacific Islands. "It was generally cultivated in America prior to 1492."

Bast Fiber.—The samples of fiber examined are not as good as the best jute, though, according to Roxburgh's experiments, it gains in strength by being wet, a point in its favor. The following results were recorded: "A line broke when white with a weight of 41 pounds, after being tanned with 62 pounds, and after having been tarred with 61 pounds. A similar line macerated in water for 116 days broke when white with 40 pounds, tanned 55 pounds, and tarred 70 pounds. These observations are of great interest, for, of the other fibers experimented with by Roxburgh, the majority were rotten after maceration, and no other fiber showed so marked an improvement for cordage purposes when tarred. English hemp and Indian grown hemp, treated in the same manner, were found to be rotten, and sunn hemp broke with 65 pounds, and jute with 60 pounds."

Mahoe-bord-la-mer does not grow inland in Trinidad, but is found on the seashore. The fiber, of fair quality, is obtained in lengths of 4 to 6 feet. "There are no large numbers of the trees existing and little manufactured. The bast is used for making ropes when the native has no money to buy hemp or manila. Ropes so made are good and strong, but there is little prospect of the trees being produced in quantity. They grow 15 to 20 feet high with stems 8 to 20 inches in diameter."

In Peru, where it is known as *Damajagua* or *Emajagua*, it is largely used by the Indians for the manufacture of ropes and cords. In Ecuador, where it is also known as *Damajagua* and *Huamaga*, it is used in lieu of cloth, a very fine sample of a sheet of fiber a foot wide by 2 feet in length, and as thick as felt, is preserved in the Herb. Col. Univ., N. Y. In Venezuela it is used for a kind of ordinary cordage, and the natives of the Sandwich Islands employ it for rough rope. In other countries it is used for cordage, fishing nets, etc. One of the native Indian methods of preparing the fiber, when a rope is wanted, is to strip the bark from a branch, and holding one end of a strip firmly with the toes it is twisted with the hands. The plant and fiber in India is fully described in Dic. Ec. Prod. Ind., Vol. IV, and by George Watt in Selections from the Rec. Gov. Ind. Rev. and Ag. Dept., 1888. Dr. Theo. Wolf says: A large tree, but not very thick; the bark is cut off and put in water, where it rots like hemp and loses its outer part, the remainder being a fibrous substance which is very strong and soft, and variously used.

*Specimens.—Mus. U. S. Dept. Ag.

FIG. 64.—Hopi Indian basket grass, *Hilaria jamesii*.

Hicoria spp. HICKORY TREES.

Syn. *Carya.*

The species of hickory need no special description. They do not produce "fiber," though the subdivided wood is used for many purposes in which the true fibers are employed. These are chiefly in the manufacture of basketry and brushes, from splints or strips of the wood.

The Chicago Fiber Company informs me that in the preparation of hickory splints for brush manufacture the material used is second-growth timber. The log is cut up into the lengths required and put in a steam vat for the purpose of softening and removing the bark, after which it is conveyed to a veneering machine, made especially for that purpose; then it is conveyed in large sheets to a chopper, where it is cut into splints in the width required; the splints are then set on a rack to dry, and when dry are pressed into bales from 100 to 300 pounds in weight, preparatory to shipment to the brush factory. For preparation of splints for basket making, see *Fraxinus*. Mr. Sudworth informs me that a bark fiber from hickory is used in the South.

Hierochloë odorata. VANILLA GRASS.

Syn. *Hierochloë borealis.* Now known as *Sarastana odorata.*

Endogen. *Gramineæ.* A sweet-scented perennial, 1 to 2 feet.

Inhabits moist meadows and mountains of the northeastern States, extending westward to Oregon. Grows also in England, where it is known as holy or sacred grass, from its having been used for strewing on church floors. Known in this country as vanilla grass, Seneca grass, sweet grass, etc. "This grass, remarkable for its fragrance, has long, creeping rhizomes, from which spring the flowering culms and numerous long-leafed sterile or flowerless shoots; woven into small mats and boxes by the Indians. Its odor resembles that of a sweet vernal grass, but is more powerful, especially when dry. In some European countries it is believed to have a tendency to induce sleep, and bunches of it are hung over beds for this purpose."

STRUCTURAL FIBER.—Dr. Havard states in Garden and Forest, 1890, p. 619, that the New England Indians, especially the Penobscots, make an extensive use of the holy grass (*Hierochloë borealis*). Its long, radical leaves become strongly involute in drying, forming flexible threads, which are braided into fine strips, and these are woven into baskets and other pretty fancy work. He has also found braids of the holy grass in a camp of the Crow Indians on the Yellowstone, but did not learn how they were used. The delicate and lasting fragrance of the dried leaves gives them an additional and perhaps not their least merit.

Higucion (Peru). See *Ficus gigantea.*

Hik-gas (Ind.). See *Odina wodier.*

Hilaria jamesii. BLACK BUNCH GRASS.

Endogen. *Gramineæ.* A stiff grass, 12 to 18 inches.

COMMON AND INDIAN NAMES.—Black bunch grass, Guyetta, Gietta; Hopi (Moqui) Indian, "*Takachü;* from *taka,* man, *cühü,* a wiry grass; the male *cühü*" (*Fewkes*).

A rather coarse perennial, with creeping rootstocks, and stems 12 to 18 inches high. It is common on the dry mesas of New Mexico and Arizona, extending eastward into Texas and Indian Territory. Where abundant it is regarded as one of the most valuable native grasses and furnishes excellent pasturage at all times when not covered with snow, and is frequently cut for hay. (*F. Lamson-Scribner.*)

STRUCTURAL FIBER.—The grass which the Hopi Indians assume to be the female *cühü* or *H. jamesii,* is used by the women in making the coil trays described under the title *Yucca glauca,* which see. These coil trays, called *poota,* are a famous Tusayan manufacture. (See fig. 64.)

Himalayan bamboo (see *Arundinaria falcata*).

Hkaw-ma of Liotard (Burm.). *Linum usitatissimum.*

Hoa-ko-chu (China). See *Broussonetia.*

Hoheria populnea. RIBBONWOOD OF OTAGO.

Exogen. *Malvaceæ.* A tree.

A New Zealand species, resembling the Aspen. "The delicate lace-like bast from its young branches, being strong and glossy, might be used for other purposes than matting and string." (*Dr. Guilfoyle.*)

Hollyhock fiber (see *Althæa rosea*).

Hollyhock tree. *Hibiscus splendens.*

Holostemma rheedianum.

Exogen. *Asclepiadaceæ.* Climber.

A native East Indian species, said by Royle to yield a fair fiber that is in best condition after the rains. Watt says, "A fiber about which very little information is available." It has been described as pure and silky and adapted to cordage and paper making.

Honckenya ficifolia. BOLO-BOLO.

Exogen. *Tiliaceæ.*

Specimens of fiber of this species were sent to the Royal Kew Gardens in 1888 from Lagos, west coast of Africa; known as *Bolo-bolo* in the Popo vernacular, and *Agbonrin-Ilassa* in Yaruba.

We consider this a very valuable fiber of the jute class, but distinctly superior to the latter in many respects, and more particularly in strength. It is of good length and well cleaned. If this fiber is capable of being produced in large quantities there is a very wide field open to it commercially. Its market value would be regulated by that of jute, but in our opinion it would always command a higher price. If it could be prepared of a whiter color it would prove still more acceptable, but even as it is we should be very glad to see large quantities placed on this market, where they would sell readily. (*Ide & Christie.*)

Honeysuckle fiber (see *Lonicera*).

Hoop ash. *Fraxinus nigra.*

Hop, Common (see *Humulus lupulus*).

Hordeum vulgare. BARLEY.

Syn. *H. sativum.*

Cultivated barley, which is represented by many varieties, appears to have originated from *Hordeum spontaneum* of southwestern Asia.

"Six-rowed barley has been in cultivation since prehistoric times in southern Europe; two-rowed barley is now largely cultivated in England and Central Europe, The four-rowed barleys are of later origin than the others, and are most generally cultivated in northern Europe and in this country. The barley crop of the United States for 1895 was 87,072,744 bushels, of which amount six States produced over 73,000,000 bushels, California leading with 19,023,678 bushels. Barley is the most important cereal of the far north, some of the varieties being cultivated in Norway to latitude 70°. It is employed in making bread also in northern Asia and Japan. Barley soup is an article of diet in central Europe. From naked barley (*Hordeum decorticatum*) a mucilaginous tea is prepared, used in medicine. The grain is largely fed to horses, both in this country and in Europe, but the chief use is for brewing beer." (*F. Lamson-Scribner.*)

STRUCTURAL FIBER.—The only country making a commercial use of barley straw for plaiting, as far as the author has investigated the subject, is Japan, where the manufacture of straw plait, both from rice and barley, is a great industry. The plait is mostly exported to this country and to France and England for hat manufacture, and has represented in a single year a value of 350,450 yen, or $228,000.

Two forms of straw are employed in Japan, there being three qualities of each. viz: *Nagawara*, produce of Omori-mura, and *Kiriwara*, produce of Yebara-gun, Tokyo. A large collection of the straw plait of Japan was exhibited at the W. C. E., 1893, at Chicago, there being over 20 forms in the series.

It was learned that some farmers bleach barley straw cultivated by themselves, in the leisure of field work, and sell it to manufacturers of straw plaits, but generally the farmers after harvesting and thrashing the barley cut the upper part of the straw to the length of 3 decimeters and sell it to the straw plaiters. Although the straw for plaiting in Japan is not so good as that of Italy, yet it is better in quality than that of China and other countries. In Japan several articles, especially playthings, have been made of straw from olden times; but recently, on account of straw plait being much exported to foreign countries, especially to the United States of America, the manufacturers of the plaits have increased year by year.

**Specimens.*—Mus. U. S. Dept. Ag.

Horsetail grass (see *Dichelachne crinita*).

Huachasso (Peru). See *Tillandsia.*

Huamaga (Ecuador). Same as *Damajagua.* See *Hibiscus tiliaceus.*

Huampo (Peru). See *Cheirostemon.*

Huang-li-Pu (China). Fabric from *Ananas sativa.*

Huasima (Braz.). See *Guazuma.*

Huhiroa. New Zealand flax. *Phormium.*

Huimba (Peru). See *Bombax.*

Huimbaquiro ceibo (Peru). See *Bombax ceiba.*

Huinari blanca (Mex.). See *Sida rhombifolia.*

Huirahuira (Peru). *Culcitium canescens.*

Huitoc (Peru). See *Genipa.*

Hujed (Arab.). See *Adansonia digitata.*

Humulus lupulus. COMMON HOP.

Exogen. *Urticaceæ.* Perennial twining herb.

This species, known and cultivated the world over, where there are brewers to use its product, may also be enumerated among textile plants.

FIBER.—The fiber is well suited for paper making, especially unbleached paper and cardboard. In Sweden it has long been applied to textile manufactures. It is extracted from the plant by steeping for twenty-four hours in cold water containing 5 per cent of sulphuric acid, or for twenty minutes in boiling water with 3 per cent of the acid. Another plan is to boil for three-quarters of an hour in water containing soap or soda, then to wash, and boil in very dilute acetic acid. The fiber is finally washed, dried, and combed, and then resembles flax. (Spon.) Its use for fiber has never been recorded in this country.

Huruhuruhika. New Zealand flax. See *Phormium.*

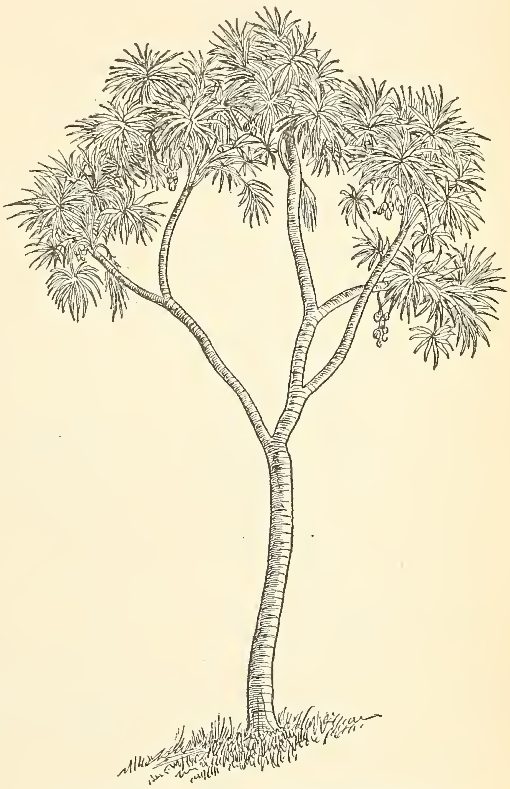

FIG. 65.—The Doum palm, *Hyphæne thebaica.*

Hymenæa courbaril. WEST INDIAN LOCUST.

A species of leguminous plant found in the West Indies and South America. It is the *jatai* of Brazil and the *simiri* of Guiana. Useful timber tree. Furnishes the Gum Animi. "It is covered with a very thick but light bark, which is used by the Indians for making their canoes."

Hymenodictyon excelsum.

A Ceylon species closely related to cinchona. Is mentioned by Liotard as a fiber-producing plant that might be considered for paper stock.

Hyphæne thebaica. THE DOUM PALM.

A palm of Egypt, exceptional from its normally branching trunk. Savorgnan states that fiber is derived from this palm that is adapted to various uses, especially for brush and broom making. (See fig. 65.)

Ibira (Span.) =tree, or wood.

Ibisco (It.) =*Hibiscus.*

i-Boonda (Natal). *Dombeya natalensis.*

Ifé hemp (see *Sansevieria cylindrica*).

Igi-ogura (W. Afr., Yorubaland). *Raphia vinifera.*

Imbe (Braz.). See *Philodendron imbe.*

Imbul (Ceyl.). See *Eriodendron anfractuosum.*

Inaja palm (Braz.). See *Maximiliana regia.*

Indian aloes. *Aloe vera.*

Indian Coral tree. *Erythrina indica.*

Indian gut (see *Caryota urens*).

Indian hemp (U. S.). *Apocynum cannabinum.* (Ind.) See *Crotalaria.*

Indian mallow (U. S.). See *Abutilon avicennæ.*

Indian paper birch. *Betula bhojpattra.*

Indian sorrel, of Jamaica. *Hibiscus sabdariffa.*

Indigo plant fiber (see *Indigofera*).

Indigofera atropurpurea.

A genus of the *Leguminosæ*, to which belongs the Indigo plant, *I. tinctoria.* The species above named is a small Himalayan shrub, the twigs of which are said by Watt to be used for basket work and bark bridges. In Kavirondo, British Central Africa, a species of this genus, with the common name *Tissiamena*, is used for basketry.

Ingipipa (Br. Guian). See *Couratari.*

Ipomœa digitata. CAFFIR COTTON.

Syn. *Batatas paniculata.*

The *Ipomœas*, belonging to the *Convolvulaceæ*, are widely distributed over all warm climates, with a few species extending into North America, extratropical Africa, and Australia. The morning glory is a representative of the genus.

This species is merely referred to in Bernard's catalogue, as one of the fiber plants of middle Africa.

Bernardin includes *I. gerrardi* in his list under the name wild cotton of Natal.

Irabirussú (Bahia). See *Couratari.*

Iriartea deltoidea. CAMONA.

A Peruvian palm, which Dorca states yields fiber used by the Indians.

Iriartea exorrhiza.

A Brazilian palm, used for thatch in connection with *Geonoma baculifera*, which see. The species is known in Brazil as *Paxiúba* or *Pashiuba*, while *I. setigera* is *Paxiúbamira*, and *I. ventricosa* is *Barriguda.* (See *Orton*, and *im Thurn.*)

These three species are now placed in as many genera, the title species being referred to *Socratea; I. setigera* is *Iriartella*, and *ventricosa* remains in *Iriartea.* (See figs. 67 and 68.)

Iris macrosiphon.

A genus of perennial plants belonging to the *Iridaceæ.* This species is found in California.

STRUCTURAL FIBER.—Dr. Havard states in Garden and Forest, 1890, p. 631, that the leaves of this species are much used in northern California and in Oregon to make ropes, fish lines, nets, and a cloth hardly distinguishable from coarse canvas. The leaves are 1 to 2 feet long and 1 to 3 lines wide, each with two strong fibers, forming the edges. These fibers are dexterously separated by the squaws with a sharp zinc thumb piece, then neatly and evenly braided into cord of variable size, or otherwise woven into nets, cloth, etc.

Iris pseudacorus is the Yellow Water Iris, a common weed of England and Ireland. The leaves are said by Spon to yield 60 per cent of available fiber for half stuff, which makes a fairly good paper.

Ischnosiphon spp.

A genus of *Marantaceæ,* and allied to plants in the old genus *Maranta,* which see. The Kew Mus. collections contain examples of Carab baskets, from Dominica, made of the split stems of *I. arouma,* and a suriana for carrying burdens on the back, made from the same material in British Guiana. Indian baskets are also made in the last-named country from the split stems of the *Mucro, I. plurispicatus. I. obliquus* is another British Guiana species the fiber of which is used by the Indians. See *Maranta.*

i-Tshanyela (Natal). *Athrixia phylicoides.*

Ischæmum angustifolium. BHABUR GRASS OF INDIA.

Endogen. *Gramineæ.* A perennial grass.

A grass closely approaching the esparto in habit, and possessing the qualities requisite for paper manufacture which was first brought to notice by Dr. King, of the Royal Botanical Garden of Calcutta, in 1877, though at that time confounded with *Eriophorum comosum.* The grass is used in paper making and in the manufacture of strings, ropes, and mats. (See fig. 66.) For further description, cultivation, etc., see Dic. Ec. Prod. Ind., Vol. IV, p. 526; Bull. Royal Gardens, Kew, 1888, p. 157.

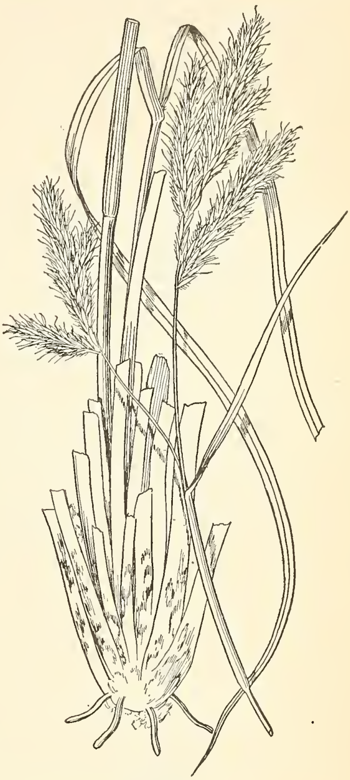

FIG. 66.—Bhabur grass, *Ischæmum angustifolium.*

**Specimens.*—Bot. Mus. Harv. Univ.

Isitebe mat (Natal). See *Kyllinga elatior.*

Istle (Mex.). Commercial Tampico. See *Agave heteracantha.*

Iturite fiber (see *Ischnosiphon obliquus*).

Itzle, the same as *Istle.*

Ivory plant. *Phytelephas macrocarpa.*

Iwaiwa (Hawaii). See *Adiantum.*

Ixtle (Mex.). See Istle.

See also *Agave aurea*. On the authority of R. de Zayas Enrique the name also applies to the fiber of *Agave ixtle* (= *rigida*) and has been applied to various Agaves and Bromelias mentioned in economic fiber literature. ——— mescal, *Agave wislizeni*.

Iyo (Yorubaland). The fiber of *Raphia vinifera*.

Jacitára (Braz.). See *Desmoncus*.

Jaggery palm (Ceyl.). See *Caryota urens*.

Jamaica Indian sorrel. *Hibiscus sabdariffa*.

FIG. 67.—The Paxiuba, *Iriartea exorrhiza*.

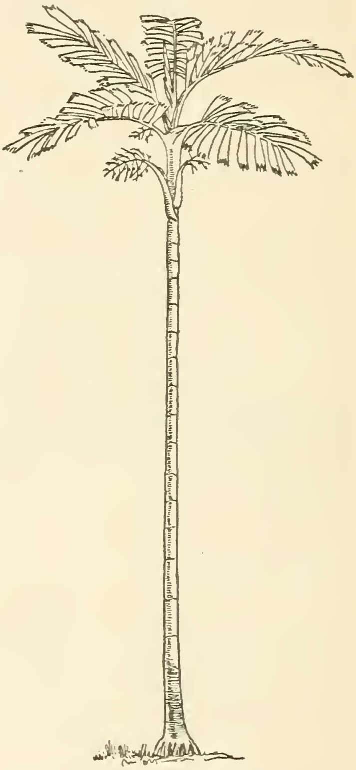

FIG. 68.—The Paxiúba-mira, *Iriartea setigera*.

Japanese matting rush, Bingo-i (Jap.). See *Juncus effusus*.

Jará (Braz.). *Leopoldinia pulchra*.

Jará assú (Braz.). *Leopoldinia major*.

Jatoba (Braz.). *Hymenæa courbaril*.

Jauary (Braz.). See *Astrocaryum jauari*.

Javas and **Javasa** (Turk.). *Linum usitatissimum*.

Jayanti and **Juyunti** (Beng.). See *Sesbania aculeata*.

Jeete, Jettee, Jítí, and **Chití** (Ind.). *Marsdenia tenacissima.*

Jenequen. Same as Henequen. *Agave rigida.*

Jequitiba (Braz.). See *Couratari.*

Jew's mallow, Jute (see *Corchorus*).

Jipijapa (Cent. Am.). See *Carludovica palmata.*

Jocuiste majahua (Mex.). See *Bromelia pinguin* and *Karatas plumieri.*

Jolocin (Mex.). See *Heliocarpus arborescens.*

Jonote (Mex.). See *Heliocarpus americanus.*

FIG. 69.—*Jubœa spectabilis*, greenhouse plant.

Jerusalem thorn. *Parkinsonia aculeata.*

Jouze-hindie (Arab.). *Cocos nucifera.*

Jubbulpore hemp (Ind.). See *Crotalaria tenuifolia.*

Jubæa spectabilis. THE COQUITO PALM.

Central Chile. A sweet sirup is formed from the sap of this palm, known as *Miel de Palma.* The nuts are employed by Chilian confectioners as sweetmeats, and the natives use the leaves for thatching. (*A. Smith.*) (See fig. 69.)

Jucca (It.) = *Yucca.*

Juncus spp. THE RUSH GROUP.

A large genus of *Juncaceæ*, which for the most part are marsh plants, and which are found in many countries. Their economic use is in the manufacture of mats or matting, though the representatives of allied genera are also used for these purposes.

The rush matting of Spain is made from *J. maritimus*, and the same species is employed for this purpose in Morocco. Savorgnan mentions three species: *J. acutus*, growing along the seacoasts of Europe; *J. canariensis*, used in brush and broom manufacture; and *J. conglomeratus*, employed for wicks of candles. See fig. 72. The two latter, however, are now regarded as identical with *J. effusus*.

Juncus acutus. BASKET RUSH.

A basket and mat rush of Italy. Specimens of this rush, in the form of basket material, has been received by the Department from California, used in the Buscolo or Bruscolo baskets said to be imported from Italy. The word Buscolo or Bruscolo, means, in Italian, "a slip of straw." These baskets are used chiefly as receptacles

FIG. 70.—*Juncus acutus.*

FIG. 71.—The Japanese mat rush, *Juncus effusus.*

for crushed olive pulp, which is then placed under the press. The word *Giunco* means not only the species of *Juncus*, but is applied to similar sedge-like forms such as the *Cyperaceæ* generally. Mats, coverings of bottles, baskets, etc., are enumerated among the manufactures from these sedges. *Lygeum spartum* and *Alfa*, or *Stipa tenacissima*, are also used in basket manufacture, the former being made into all kinds of baskets, which are exported from Italy to the United States, and many other countries.

Juncus effusus. BINGO-I MAT RUSH OF JAPAN.

Syn. *Juncus communis.*

Endogen. *Juncaceæ.* A rush, 4 to 5 feet when under cultivation. (See fig. 71.) This species is distributed over a large part of the globe, being the candle rush of Europe, and a very common plant of wet ground in the United States.

MATTING.—*J. effusus* is the *Bingo-i* mat rush of Japan, employed in the manufacture of the "*Tatami-omote*," or the handsomest and most costly mats used by the higher classes, while *Cyperus unitans* is employed for the cheaper grades used by the common people. The pith of the *Bingo-i* rush is also extensively used for lamp wicks.

CULTIVATION.—The soil best suited for growing *Bingo-i* is of a clayey character containing a small proportion of gravel and resting upon a rather hard subsoil. The plants, from the stubble cut in the previous summer, are rooted out and dipped in a dilute urine for twenty-four hours, and then divided into bundles of about ten such shoots, which are transplanted in well-prepared and manured land, in the same manner as rice plants are transplanted in the paddy field. The distance from one bundle of the plants transplanted to another is about 4 sun—that is to say, a bundle of ten plants occupies 4 sun square of ground. The transplanting usually takes place in the month of October or November, but in the warmer districts it may be as late as the beginning of January. After the transplantation the land is constantly watered as in rice fields and ordures and well-rotted farmyard manures are applied several times at due intervals, especially taking care to keep the land free from weeds.

In the middle of July when fine, settled weather is anticipated the rushes are harvested by reaping them with a sharp sickle, and they are immediately immersed in muddy water specially prepared in a small pond, by stirring in white clay, and then dried by spreading on grass land. The object of dipping the rushes into turbid water is to facilitate the drying by the effect of the adhering clay, and at the same time to protect "Bingo-i" from other noxious dusts. The most important point in harvesting Bingo-i is to pay great attention to the condition of the weather, for it is necessary in obtaining a superior quality to dry the reaped rushes as quickly as possible, not exceeding more than two days, otherwise they depreciate greatly in quality and value.

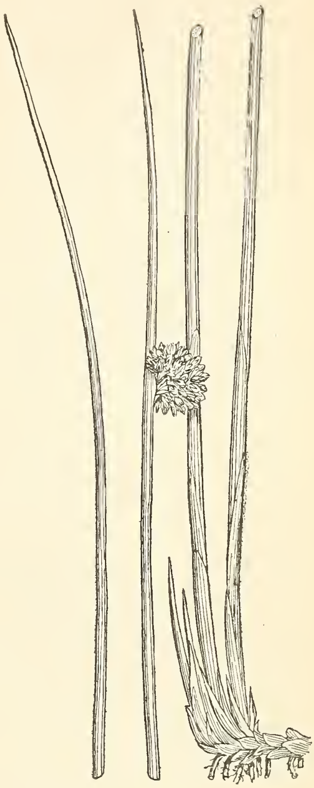

FIG. 72.—*Juncus conglomeratus.*

The largest importer of these mats is the United States, England, Austria, and Germany following in the order named. The qualities made are named as follows: Kinkwanyen, manufactured at Okayama. First quality Aya-mushiro, second quality Aya-mushiro, Damask Aya-mushiro, common Aya-mushiro, manufactured at Bittiū. First quality Somewake-mushiro, common Somewake-mushiro, Damask Hana-mushiro, common Hana-mushiro, manufactured at Bingo. Ordinary Hana-mushiro (best quality) manufactured at Chikugo.

Juncus pauciflorus. THE SHEATHED RUSH.

Syn. *Juncus vaginatus.*

Quite common in Victoria, where there are two forms. "One variety does not exceed 2 feet, while the other often attains a height of 5 feet." (*Christy.*)

STRUCTURAL FIBER.—Two specimens from this rush were received from the Victorian collection, and are among the many fibers collected and prepared by Dr. Guilfoyle. The plant is a native of Victoria and grows abundantly. It is regarded as a good fiber plant as well as an excellent paper stock, and the fiber is said to make a good substitute for human hair. It is a strong growing plant and is found extensively on the margins of lagoons and water courses. It is claimed that by boiling, this water rush yields a strong fine fiber. The museum specimens showed no such strength, however, as a twisted strand of the Victorian fibers was as easily broken as manila paper twine.

Dr. Guilfoyle's Australasian fiber list contains several other species of this genus: *J. communis*, the common candlerush (see *Juncus effusus*); *J. maritimus*, the sea or coast rush, which, under Ekman's process, is said to yield a promising fiber; *J. pallidus*, which can be obtained in vast quantities in the Australian colonies, is also named as a valuable paper stock with *J. prismatocarpus*.

* *Specimens.*—Mus. U. S. Dept. Ag.

Jungli (Beng.). See *Agave americana*.

Juniperus occidentalis. JUNIPER.

Exogen. *Coniferæ*. A tree, 18 to 40 feet.

Eastern Washington and Oregon to California, and south, along the high ridges of the Sierra Nevada, between 7,000 and 10,000 feet elevation, to the San Bernardino Mountains.

BAST FIBER.—Dr. Fewkes informs the Department that this species is found on the mesas, and that the bark is used by the Hopi Indians, without weaving, for breech clouts. There is little doubt that in olden times garments were made from this fiber by these people that were used in their religious ceremonials.

Dr. Palmer states that the fibrous bark of *J. californica* var. *utahensis*, a tree 20 or 25 feet in height, is made into saddles, breech clouts, shirts, and sleeping mats, by the Pai-Ute Indians.

Jupati (Braz.). See *Raphia vinifera*.

Jussareira (Braz.) *Euterpe oleracea*.

Juta (It.)=Jute.

Jute of India. See *Corchorus olitorius* and *capsularis*; ——of China. See *Abutilon avicennæ*.

Kabong (Malay). See *Arenga saccharifera*.

Kadi (Pers.). See *Pandanus*.

Kadia (see *Sida retusa*).

Kadsura japonica.

This species belongs to a genus of dicotyledonous plants of the *Magnoliaceæ*, which are climbing mucilaginous shrubs, indigenous to tropical Asia. *K. japonica* from Japan and the East Indies yields a fiber, derived from the bark, which is said by Savorgnan to be held in high esteem for its tenacity and whiteness.

Kajang, mats of (see *Nipa fruticans*).

Kakarally (Br. Guian.). *Lecythis ollaria*.

Kali (Timor). See *Borassus*.

Kalnan (Ind.)=*Agave*.

Kamá-khér (Beng.). *Andropogon nardus*.

Kan (Yuc., Maya). *Agave rigida*.

Kanghi (Hind.). See *Abutilon indicum*.

Kankhúra (Beng.). See *Boehmeria nivea.*

Kapa (Pacif. Is.). See *Broussonetia papyrifera.*

Kapas and **Kaipas** (Ind., Java, etc.)=Cotton. See *Gossypium.*

Kapok and **Kapok floss tree** (Java). See *Eriodendron anfractuosum.*

Karatas plumieri.

Syn. *Nidularium* (*Bromelia*) *karatas.*

Endogen. *Bromeliaceæ.* Aloe-like leaf cluster.

COMMON NAMES.—Mexican fiber, silk grass, and silk grass of Honduras (also given to other species), wild pineapple.

Common throughout tropical America, though has not been detected in Trinidad. Leaves 8 to 10 feet long, armed with recurved teeth or spines. Abundant in Jamaica, but the fiber used sparingly. This is one of the three or four species of *Bromelia,* the fiber of which has doubtless been confused with that of *Bromelia sylvestris* in collections made twenty-five or thirty years ago. This may be the species that J. McLeod Murphy sent to this Department in 1869, under the name *Bromelia sylvestris* (which see), as his economic descriptions in part may apply to the *Karatas.*

BOTANICAL DESCRIPTION.—*K. plumieri* E. Morren in Belg. Hort., 1872, 131; Antoine Brom. 35, t. 21–22 (M.D.). *Bromelia karatas* Linn. (Plum. Amer. Gen., t. 33); Jacq. Amer. Pict., t. 260, fig. 24; Hort. Vind. i, t. 32–33, III, t. 74. *Nidularium karatas* Lemaire. ——— Acaulescent. Leaves 30 to 40 in a dense rosette, rigid, spreading, ensiform, 4 to 8 feet long, 1½ to 2 inches broad low down, narrowed gradually to the tip, green and glabrous on the face, persistently white-lepidote and finely lineate on the back, armed with large pungent hooked marginal prickles. Flowers about 50 in a dense sessile central capitulum, at first 3 to 4 inches finally 6 to 8 inches diameter, surrounded by reduced ensiform inner leaves tinged with red; flower-bracts scariose, oblanceolate, 2½ to 3 inches long. Ovary cylindrical-trigonous, 1½ inches long, clothed, like the bracts and sepals, with loose brown tomentum; sepals linear, permanently erect, an inch long. Petals reddish, glabrous, exserted one-fourth to one-third inch beyond the tip of the sepals, united in a tube toward the base. Fruit 3 to 4 inches long, 1 inch diameter, pale yellow, with an eatable white pulp, tapering from the middle to both ends. Seeds globose, dull brown, vertically compressed, one-sixth inch diameter.

STRUCTURAL FIBER.—Dr. Morris says of this species: "A well-known and valuable fiber plant, said to be used by the Indians in making the finest hammocks in Central America, Guiana, and Brazil." In the young leaves the fiber is said to be fine and white, though growing coarser with increasing maturity.

Locally the fiber is used for bowstrings, nets, fishing lines, ropes, mats, sacking, and clothing. After being passed over the comb or hackles of a flax mill it has been pronounced greatly superior to Russian flax and equal to the best Belgian for application to the finest textile fabrics. Fiber which was useless for spinning or rope-making would probably yield very superior paper stock. The plants are of a most prolific nature, growing spontaneously in almost all kinds of soil and climate. Cultivation in its native land is therefore extremely simple, and it is surprising that the plant has not recieved more attention from planters in America and our colonies. The Indians cultivate the plant to some extent in Mexico, 1,221 gardens being recorded in 1830. They generally select forest for this purpose, removing the undergrowth by cutting and burning. The roots of old plants are then set out at 5 to 6 feet apart, and at the end of a year yield leaves fit for cutting. The leaves vary in size from 6 to 8 feet long and from 1½ to 4 inches wide, and are thin in proportion. In a wild state the leaves are edged with thorns, but these are diminished in size and number by cultivation. The fiber contained in the leaves varies in quality, according to age; in young leaves the fiber is fine and white; with increasing age it becomes longer and coarser. The native implements for extracting the fiber are exceedingly rude—a flat board and a heavy iron knife. No special machine seems to have been invented for the preparation of this fiber; but its close resemblance to the fibers of the agaves and that of the edible pineapple (see *Ananas sativa*) would indicate the applicability of existing leaf fiber machines. See Appendix A. After the first crop the leaves grow again, but the fiber subsequently produced is short and of bad color. (Spon.)

K. humilis, according to J. H. Hart, grows plentifully in Trinidad, but the fiber is not employed.

Karimgunji Jute (Ind.). See *Corchorus*.

Karpasi (Sansc.). Cotton. *Gossypium*.

Kat-kati (Ind.). See *Grewia villosa*.

Kattan (Arab.). *Linum usitatissimum*.

Kattú-uná (Ceyl.). See *Bambusa*.

Kattú-kapet (Afr.). *Sansevieria lanuginosa*.

Kehal (Ceyl.). *Musa sapientum*.

Kél and **Kéla** (Bomb.). *Idem*.

Kelpo (Java.). *Cocos nucifera*.

Kenab (Arab.). See *Cannabis sativa*.

Kendong (Java). *Broussonetia papyrifera*.

Kenda (Bomb.). See *Pandanus*.

Kenna (Ind.). *Crotalaria retusa*.

Keratto (Jam.). See *Agave morrisii*.

The *Keratto* of the Leeward Islands is *Agave polyantha*, according to Dr. Morris.

Keyá and **Ketki-keya** (Beng.). *Pandanus odoratissimus*.

Khan (Ind.). *Saccharum spontaneum*.

Khas (Hind.) and **Khasakhasa** (Bomb.). See *Andropogon squarrosus*.

Khatmi, Kanji, Khubazi, etc., (Ind.). *Malva sylvestris*.

In reviewing the many vernacular names of this plant, in India, Dr. Watt says that all the provincial names have been derived from the Persian *Kangai* or *Kangoi* and probably refer to *Abutilon*.

Khirvá (Arab.). *Ricinus*.

Khujar (Pers.). *Luffa ægyptica*.

Kian pak-kian.

"Body cloth made of very fine shreds of bamboo, passed between the teeth, and bitten until they become quite soft and fit for weaving. It is the only article of dress worn by the inhabitants of Celebes." (Off. Guide, Kew Mus.) A specimen is shown in the Kew Mus. that was made especially for the Rajah.

Kie-kie (New Zea.). *Freycinetia banksii*.

Kiki (Egypt). *Ricinus*.

Killut (Hind.). *Saccharum fuscum.*

King-ma (China). *Sida retusa.*

Kinkivanyen mats, of Japan. *Cyperus unitans.*

Kinnab (Arab.). *Cannabis sativa.*

Kirindi-wel (Ceyl.). *Rourea santaloides.*

Kitaibelia vitifolia.

A malvaceous plant peculiar to Hungary and sometimes found in English gardens.

FIBER.—Derived from the bark, and sometimes called Hungarian hemp. "From the fiber cloth is made not inferior to that from flax." (*Savorgnan.*) I can find no other reference to the use of fiber from this plant.

Kittool, Kittul (Ceyl.). See *Caryota urens.*

Kleinhovia hospita.

Exogen. *Sterculiaceæ.* A tree.

The species is a low branching tree, a native of the Malay Archipelago, extending eastward to the Solomon Isles. Its bruised leaves are said to exhale a perfume similar to that of the violet. The genus consists of but the one species.

FIBER.—A specimen of the fiber was received through the Smithsonian Institution in 1869, without data. It is similar in appearance to *Ochroma,* and of so slight tenacity that it can only be mentioned as fibrous material.

In the islands of the Indian Ocean the bark is used for making cordage and fishing nets. It is customary for the people to plant this species near their rural habitations for use in their agricultural pursuits, as it is adapted to all sorts of tying and binding and to uses requiring long, pliant twigs. They are quite superior to *Salix* for tying. (Manual Hoepli.)

Klooi (Siam.). See *Boehmeria nivea.*

Kniphofia spp. (See *Tritoma*).

Kodzu, Kozo (Jap.). *Broussonetia papyrifera.*

Ko hemp (Jap.). See *Pueraria.*

Konapli (Rus.). *Cannabis sativa.*

Kongangu (Austr.). See *Pipturus.*

Konje (Zambesi). *Sansevieria guineensis.*

The fiber is known as *Konje* hemp.

Konkan hemp (Ind.). See *Crotalaria.*

Konope (Pol.). *Cannabis sativa.*

Koosa (Ind.). *Andropogon squarrosus.*

Korako. New Zealand flax. See *Phormium.*

Koug-kuombi (Ind.). *Bixa orellana.*

Kowl, of Liotard (Ind.). *Careya arborea.*

Kozo (Jap.). *Broussonetia papyrifera.*

Krowa (Br. Guian.). See *Crowia.*

Kuda (Ind.). See *Hymenodictyon.*

Kuhila (Ind.). See *Æschynomene.*

Kukul-wel (Ceyl.). See *Calamus radiatus.*

Kumbi, Kumbya, Kumbha, etc., (Ind.). *Careya arborea.*

The name *Kumbi* is also employed for *Cochlospermum gossypium* in several provinces of India, in connection with others.

Kúrakkan (Ind.). *Eleusine coracana.*

Kurrijong (N. S. W.). *Commersonia fraseri.*

Kurtam ussul (Arab.). *Gossypium.*

Kuta (Fiji Is.). *Eleocharis interstincta.*

Kutan, or **tukhme-katán** (Pers.). *Linum usitatissimum.*

Kydia calycina.

Exogen. *Malvaceæ.* Bush or small tree.

Subtropical India and Burma. The Himalayas up to 2,000 feet elevation.

Fiber.—"The inner bark yields a bast fiber, used for coarse ropes, etc. In point of cellulose, and in power of resistance to hydrolysis, *Kydia* fiber is fairly useful, being about twentieth in order of merit of a list of some 300 fibers met with in India." (*Watt.*) The fiber, known as Warang bast, resembles the bast of the European lime tree, *Tilia europæa.* Savorgnan states that the bark, used in strips, can be applied to all purposes for which *Tilia americana* is employed.

Kyllinga elatior.

A cyperaceous plant found in Natal. There are nearly 50 species in the genus, natives of Brazil, South Africa, and Australia.

Structural Fiber.—Like all plants of this group the culms are employed in mat making. The mats of Natal, from this species, are called *Isitebe.*

Lace. See Appendix C.

Lace bark, of W. Ind., *Lagetta lintearia;* ——— of New Zea., *Plagianthus betulinus.* See also *Daphnopsis.*

Lagetta lintearia. Lace Bark Tree.

Exogen. *Thymelæaceæ.* A tree, 25 to 30 feet.

This is the well-known lace-bark tree of Jamaica, the bark of which is found in all fiber collections. The plant is said to be cultivated in Great Britain, in greenhouses, though only as a curiosity.

Fiber.—Derived from the inner bark, which can be readily detached in sheets or layers, like the layers of bark from the paper birch. It is suited to the most delicate textile purposes. "When carefully drawn out or stretched by the hands a pentagonal and hexagonal mesh is formed, in every respect like lace, and many ornamental things are made from it." (*Fawcett.*)

"It is reported that Charles II received as a present from the governor of Jamaica, a cravat, frill, and pair of ruffles, made of this material; and to this day it is used for bonnets, collars, and other articles of apparel, specimens of which may be seen at the Kew Mus., etc. The uses to which this natural lace is applied are not always so unobjectionable as those just mentioned, for it is likewise used in the manufacture of thongs and whips, with which, in former times at least, the negroes were beaten by their cruel taskmasters." (*Dr. Masters.*)

Savorgnan names *L. funifera*, now *Funifera utilis* as a South American species known as *Mahot-pincet.* This author states that cordage of great resistance is made from the bark.

Lagunaria patersonii. NORFOLK ISLAND COW-ITCH TREE.

Exogen. *Malvaceæ.* Allied to *Hibiscus.*

This beautiful shrubby tree is indigenous in Queensland and Norfolk Island, and is closely related to *Hibiscus.* The fiber sample was prepared by Dr. Guilfoyle (Victoria, Phil. Int. Exh., 1876), who accompanied it with a statement that it was suitable for manufacturing paper of a superior quality, samples of which were also presented, and for ropes, strong cordage, fine matting, and basket work. The fiber is fine, strong, and glossy, although the specimen can hardly be said to compare with *Sida rhombifolia* in any one of these particulars.

Lal-ambári (Bomb.). *Hibiscus sabdariffa.*

Lal-murga (Beng.). *Celosia cristata.*

Lamba (Borneo). Cloth from *Curculigo latifolia*

Lana de Enea (Venez.). *Typha angustifolia.*

Lana del Tambor (Venez.). See *Bombax cumanensis.*

Langue Bœuf (Trin.). *Furcræa cubensis.*

Lantern flower (Austr.). Fiber of. See *Abutilon molle.*

Laportea canadensis.

This species of *Urticaceæ*, found in many localities of the United States, is one of the stinging nettles, and furnishes a fiber of average quality. Specimens of the stalks and fiber have been received by the Department from time to time, but with better native fiber species it only deserves a passing mention. It is sometimes called Indian hemp, as it has doubtless been used for cordage and thread by the North American Indians, but this is a misnomer. True Indian hemp is an *Apocynum.* This species is mentioned by Spon, under the name *L. pustulata,* who also says it is the only foreign nettle that will withstand the cold of the European winter.

The fiber from this species, before the introduction of cotton, had an application more extensive than at present in Europe, where (particularly in Germany and in more northern countries) they manufactured the cloth called *ortica* (German, *Nesseltuch*), or nettle cloth (Manual Hoepli).

**Specimens.*—Field Col. Mus.; Mus. U. S. Dept. Ag.

Laportea crenulata. FEVER, OR DEVIL'S NETTLE.

An evergreen arborescent shrub found in Australia and India. Contact with its powerful stinging hairs causes excessive burning pains, which last for several days.

FIBER.—This plant yields a strong useful fiber, used by the hill tribes of Assam for cordage and in the manufacture of a coarse cloth. Major Hannay, who was one of the first to bring the fiber to the notice of Europeans, stated that it was fine, white, apparently of no great strength, and by report not very lasting. Messrs. Cross, Bevan, and King, however, in their recent report on Indian fibers, appear to hold a more favorable opinion, stating that the fiber "is good, is more or less allied to rhea, and, like that fiber, is very strong."

Laportea gigas. GIGANTIC NETTLE TREE OF AUSTRALIA.

NATIVE NAME.—*Goo-mao-mah.*

It is a native of New South Wales, and is very abundant on the McLeay and other northern rivers. In Bennett's "Wanderings of a Naturalist in Australia," the author states that the tree, when in full vigor, rises from its base by a series of buttresses of singularly regular outline, gradually tapering without a branch, to the height of 120 to 140 feet; the trunk then divides into a regularly formed, wide-spreading head, which excites admiration by its extraordinary size. The ordinary elevation of the tree is 25 to 50 feet. "The poisonous fluid secreted from the foliage is very powerful, particularly in the younger leaves, and their sting is exceedingly virulent, producing great suffering." The tree is also indigenous in Queensland, and Dr. Guilfoyle sends specimens of fiber from Victoria.

BAST FIBER.—The fiber is very strong and fine, and suitable for fishing lines, etc. In New South Wales its fiber is made into cordage of considerable tenacity. The specimens were accompanied by a dilly bag made by an Australian aboriginal. The wood of this tree is soft and fibrous, and might be pulped up for fiber. It is claimed that the best and strongest fiber is obtained from the bark of the roots. The fiber is easily prepared and can be obtained in quantity.

Larch (see *Larix laricina*).

Lasiandra (see *Tibouchina*).

Lardizabala biternata.

Exogen. *Berberidaceæ.* Twining shrubs.

Resemble the *Menispermaceæ*, and are natives of the cooler regions of South America and China. The species named is from Chile.

WOODY FIBER.—"The stems, of enormous length, in Chile are dried and used as ropes. It would probably yield good, tough cordage fiber." (Spon.)

Larix laricina. LARCH.

Syn. *Larix americana.*

Exogen. *Coniferæ.* A tree, 75 to 90 feet.

COMMON NAMES.—Tamarack, hackmatack, hacmac, swamp pine larch, red larch, black larch; N. Y. Indian name, *Ka-neh-tens.*

"Northern Newfoundland, Labrador, Hudson Bay, northern shores of the Great Bear Lake and valley of the McKenzie River, within the Arctic Circle. Through Northern States to northern Pennsylvania, Indiana and Illinois, and central Missouri. Found on moist uplands and intervales, or southward in cold, wet swamps." (*C. S. Sargent.*) Used for ship timber, railway ties, fence posts, telegraph poles, etc.

WOODY FIBER.—Dr. Havard states that the roots of this tree when split into long threads are a valuable material with the Chippeways, who make use of it for sewing the seams of their birch canoes. He also informs the writer that the roots of *L. occidentalis*, a Pacific States species, are employed by the Indians of the Yukon River for "basket kettles," which are woven very neatly, and ornamented with hair and with dyed porcupine quills. *L. griffithii* is an India species.

Lasiosiphon eriocephalus.

A small tree of India belonging to the *Thymelæaceæ*, known as *Naha*, the bark of which has been recommended as a paper-making material. *L. speciosus*, found in the Deccan (Ind.), and which furnishes the Remeta bast, is the same as *L. eriocephalus.* "The fibers are very strong and almost colorless." (Spon.)

Latania aurea.

This is a small genus of African palms growing to a height of 20 or 30 feet. *L. aurea* is found in Mauritius, where the leaves have been employed for brushes and brooms.

L. commersonii is found in the Mascarene Islands, where the leaves are employed in the manufacture of hats. Its fruit is about the size of an apple and is eaten by the negroes.

Lavatera arborea. TREE MALLOW.

Exogen. *Malvaceæ.* Large shrub, 3 to 4 feet.

The species of this genus for the most part are found in Europe, western Asia, and Australia. *L. arborea* is common in southwestern Europe, growing on the rocks on seacoast. Is grown in Madeira, and found in a wild state on the coasts of England and Ireland. Naturalized around Melbourne.

FIBER.—"The inner bark yields a strong fiber, somewhat coarse, but capable of manufacture into cords, ropes, and mats" (Spon). "Has lately been recommended for culture as a fiber plant, but the quality of the fiber is not good." (*A. Smith.*) Dr. Guilfoyle states that the fiber is highly recommended for paper stock. The tree attains a height of 8 to 10 feet in cultivation.

L. maritima, the sea mallow, another south European species similar to the above, has been introduced into Australia. Of its value Thomas Christy says: "Worthy of cultivation on a large scale for the very beautiful and excellent quality of its fiber." "A fine fiber 3 to 4 feet long." (*Dr. Guilfoyle.*) Savorgnan states that it is spontaneous in the environs of "Nice, in western Liguria, in Sardinia," etc. Cortical fiber, tenacious, used for cordage. Abundant, and the fiber does not deteriorate in salt water. Adapted to coarse hemp cables and marine uses.

L. cretica according to the same authority, is found on the Tuscan seacoast, where it is known as *Malva di Candia.* Its coarse, strong fiber has also been used for making cordage. *L. flava* is found in Sicily and northern Africa, and the fiber is fully equal to the preceding. *L. punctata* is another European species from which Cazznola extracted excellent fiber in 1875.

Lavatera plebeia. AUSTRALIAN MALLOW.

South Australia, Victoria, and New South Wales. "Successfully tried for rope and paper making." S. L. Swaab states that the species was brought into notice by Mr. Alex. Talmer of south Australia, who sent a quantity of the fiber to England, where it was made into a good paper. Appears in Spon as *L. plebeja.* "Is employed by the natives (of Australia) for baskets and fishing lines."

Another Australian species, a perennial evergreen, also found in south Europe, is *L. trimestris*, known as the velvet mallow. "It supplies from its bark a substance not unlike white horsehair and quite as useful for many purposes." (*Guilfoyle.*) Christy says the fiber can not be distinguished from that of *L. arborea.*

Layu (Peru) = *Ficus.*

Leaf fiber.

The structural fibers extracted from fleshy-leaved plants such as the Agaves, etc. The same as "structural" fiber, in the classification. See page 25.

Leather plant (New Zea.). *Celmisia coriacea.*

Leatherwood (U. S.). *Dirca palustris.*

Lechuguilla (Mex.). See *Agave heteracantha.*

Lecythis ollaria. MONKEY POT.

Endogen. *Myrtaceæ.* Large tree.

This genus is chiefly confined to Venezuela, British Guiana, and Brazil, and embraces 30 or 40 species. Many of them are large trees growing to a height of 80 feet or more. They bear a hard, woody fruit, some of the seeds or nuts being edible, such as the Sapucaia nuts, from Para. The inner bark of the species is composed of paper-like layers, which can be removed in strips.

FIBER.—Specimens of the bast of *L. ollaria* were received from the exhibit of British Guiana (W. C. E., 1893), known as *Kakarally.* As many as 100 layers of this bast have been taken from a piece of the bark of this species, the operation being hastened by beating. The ribbons of bast are used by the Indians of Brazil for cigarette wrappers, and in British Guiana, for cordage and basket work. An unnamed species, from the British Guiana exhibit, labeled "*Wina,*" is used for the same purposes. Another specimen of this fiber, named *Wadaduri*, and used for paper making was submitted to Dr. Ernst, who states in his manuscript notes that it is obtained from *L. grandiflora,* and likewise from *L. crassinoda.* In Venezuela, *L. coriacea* is known as *Marima colorada.* The fiber of a Brazilian species without name is said by Saldanha da Gama to be used for calking vessels. The bark of another species growing abundantly throughout the Amazon region, and known as *Matá-matá,* yields an oakum that is excellent for calking canoes, according to a catalogue of Woods of Amazon, W. C. E., 1893.

Leopoldinia piassaba. MONKEY BASS.

Endogen. *Palmæ.* Palm, 15 to 40 feet.

This tree grows abundantly near the White River, which flows into the Barra de Rio Negro, as well as on some of the tributaries of the Orinoco; it is also found in the Amazon basin; but the bulk of its fiber comes from the Barra de Rio Negro. Its habitat is low, sandy flats, where water may stand a little in rainy weather; but it avoids swamps. (Spon.)

FIG. 73.—The Para Piassaba palm, *Leopoldinia piassaba.*

One of the Brazilian palms which supplies the commercial *Piassaba,* or *Piaçaba* fiber now exported in such quantities. Two species furnish the commercial product, *L. piassaba,* the Para fiber, and *Attalea funifera,* the Bahia fiber, though in recent years another form has been sent from the west coast of Africa, known as West African Bass, *Raphia vinifera.* See also *Borassus flabellifer* and *Dictyosperma fibrosum.*

STRUCTURAL FIBER.—*Leopoldinia piassaba.* "The dilate margins of the petioles, where they clasp the stem, are produced into long ribbon-like strips, which afterwards split into fine, somewhat round fibers, about 5 to 6 feet long, entirely concealing the stem. These fibers, cleaned and combed by hand, form the *piassaba* of commerce." (*Dr. Morris.*)

The commercial fiber is used for brush making, and for brooms, though the natives employ it for cables, ropes, baskets, hats, as a tie material, and for other purposes.

*Specimens of heavy cordage from this species were received from the Brazilian exhibit of the Phil. Int. Exh., 1876, which are now in the museum of the Department. The Para "Bass" is said to absorb more water than the Bahia. The Para fiber now forms less than 5 per cent of the piassaba of commerce, and commands a high price.

Lepidosperma flexuosum. THE SLENDER SWORD RUSH.

Endogen. *Cyperaceæ.*

Found in Victoria and Tasmania. Several species of this genus have been enumerated as fiber-producing plants, fiber having been prepared from them.

STRUCTURAL FIBER.—A specimen of the fiber of *L. flexuosum* was secured from the Victorian collection, Phil. Int. Exh., 1876. It is exceedingly brittle, and can only be used in mats or similar articles, where it can be coarsely plaited. According to Dr. Guilfoyle, the material can be had in large quantities, and is extensively used by the aborigines for baskets, mats, etc. He states that "under proper treatment it yields a fiber of good quality," though the present sample would hardly verify the statement. It might, however, be used in paper making, though at best it is a poor "fiber."

At the same time an example of *L. elatius* was received, both specimens having been prepared by Dr. Guilfoyle. This is a much better and stronger fiber than the preceding, and would prove useful for making many kinds of coarse cordage. The leaves and flower stalks of the plant grow to a height of 9 feet in Victoria, and the plant is found in great abundance, and can be had in large quantities. It furnishes a pulp for paper making, and is used in various ways by the natives. This specimen is also from the Victorian collection (Phil. Int. Exh., 1876), and was prepared by Dr. Guilfoyle. Christy says it is an excellent paper plant. It yields its fiber by boiling.

Lepidosperma gladiatum. COAST SWORD RUSH.

Native of Australia and Tasmania, where it grows in great abundance on the coast lands. Will supply an annual crop, the roots throwing out fresh shoots. Spon says it is used by the natives for baskets and fishing lines, and suggests that its only industrial use will probably be paper making, "for which purpose it is considered equal to esparto."

L. squamatum is another Australian species, used for mats by the natives of the Wimmera, southeast Australia. *L. filiforme* is also employed by these people for basket manufacture.

Lepironia mucronata.

A cyperaceous plant found in Madagascar, tropical Asia, and Polynesia. One of the mat fibers of China. Such mats are made by the Chinese boatmen to cover their cargoes; also used for bags. A mat of fine workmanship, probably from this species, is preserved in the Kew Mus., made in Korea; obtained from the King's palace.

**Specimens.*—U. S. Nat. Mus.; Bot. Mus. Harv. Univ.

Leptadenia spartum.

Exogen. *Asclepiadaceæ.* A glabrous shrub.

Panjáb and Sind, in India. Arabia, Egypt, and Senegambia. An imported fodder plant, also used for thatching. The species are "erect leafless shrubs or twiners furnished with leaves, all having a grayish tomentum covering stems and leaves." (Treas. Botany.)

BAST FIBER.—Mentioned in Dic. Ec. Prod. Ind., Vol. IV, as "much used in Sind for making ropes to bring up water from wells, as water does not rot it."

Liabum ignarium.

An exogenous plant, a native of Quito, which Spon states has afforded a good fiber. (Spon Enc., pt. 3, p. 919.)

Liane a cordes (Fr.). *Bignonia viminalis.*

Ligustrum vulgare. PRIVET.

Of this genus there are about twenty representatives, in Europe, northern India, China, and Japan. Belongs to the *Oleaceæ.*

"A shrub used for hedges. In March it produces white, fragrant blossoms, similar to those of the olive. The leaves produce a yellow or green tint for dyeing. The branches are used for constructing cages for birds where fowlers set their traps."

Lime tree of Europe. *Tilia europæa*; ——— of South America, *Apeiba tibourbou.*

Lin (Fr.). Flax. See *Linum.*

Linden (see *Tilia*).

Lino (Span.)=Flax.

Lino d'India (It.). *Asclepias fruticosa.* ——— *dei Muri. Antirrhinum majus.*

Linum spp.

Exogens. *Linaceæ.* Small herbs or shrubs.

The representatives of the genus *Linum* are distributed over both hemispheres, though they are chiefly natives of temperate climates. While *L. usitatissimum* is considered the cultivated fiber species, botanists recognize upward of 100 species in this genus, De Candolle describing 54 in the first volume of his Prodromus. In many instances the distinctions between these species are so slight that the agriculturist or the industrialist would scarcely recognize them, and they are therefore of botanical rather than economic interest. Renouard, in *Études sur le Culture du Lin.*, refers to the fact that our gardens sometimes contain three varieties which differ greatly: Two species with yellow flowers, the *Linum trigynum* (*Reinwardtia trigyna*), originating in India; and the *Linum campanulatum*, which comes from southern Europe and from Egypt; also one with red flowers, the *Linum grandiflorum.* And plants with white flowers and flesh-colored flowers are sometimes seen. There are still others known by name only, as the species is very rare: such is the *Linum catharticum* the leaves of which have a bitter taste and are sometimes employed as a purgative. But among all these varieties the blue flowering, still designated by the name of *Lin commun*, or the *L. usitatissimum* of the naturalists, is the only industrial species and the only one really cultivated. In the grouping of species two general divisions have been made: Those having yellow flowers and those with flowers blue, flesh-color, pink or white, though a special distinction is made in regard to *L. catharticum*, "with flowers always white and leaves opposite." *L. usitatissimum* comes into the group having blue, white, pink, or flesh-colored flowers, though as far as the cultivation of these plants for commercial fiber is concerned it is the only species that interests us. Regarding the distinctions which separate the species of *Linum*, Renouard says: But these are so subtle that they evidently have no bearing upon the industrial uses of the flax and are of no value to agriculture. Often the most experienced operator and the countryman most familiar with this culture have had much trouble to classify the plants as above indicated. Moreover all these species may be obtained from one sort of seed. What has given rise to these distinctions is that when the flax does not appear all in one growth of stem, slender at the top and without branches, bearing one flower, it may remain short and ramify its stalk into a number of branches having several flowers and considerable seed. It is under this aspect that we see the plant designated as "*tetard*" (pollard or branched) also called *petit lin* (small or low

FIG. 74.—The ancient flax plant, *Linum angustifolium.*

flax) in contrast with the ordinary flax called *grand lin* (tall flax). Besides the above facts we may say that there have never been seen either entire fields or even parts of fields growing only the tetard, or the low flax. We therefore hold it to be inopportune to make such classification of the common flax into industrial species.

Some writers recognize *L. crepitans* as a cultivated species, this form growing less tall than *usitatissimum*, with much thicker stems which have the tendency of branching, and more abundant flowers, and therefore producing more seed. In a report from Consul T. E. Heenan at Odessa, it is stated that "*Linum usitatissimum, L. vulgare*, and *L. crepitans*, are being cultivated in Russia in several varieties of both kinds, but the difference in these varieties is so slight and they so easily blend that even those initiated in the trade of the article often fail to perceive it."

Several other forms of flax are mentioned by industrial authorities, but they are of little importance. *L. perenne*, which is known commonly as perennial flax, has been the subject of experiment, but beyond the fact that it is mentioned doubtfully as an oil plant in India, it does not concern us.

The most ancient cultivated species of flax is thought to be *L. angustifolium*, a form found growing wild from the Canary Isles to Palestine and the Caucasus. This is the species said to have been grown by the Swiss Lake dwellers and the ancient inhabitants of the north of Italy, while *L. usitatissimum* was the ancient flax of Mesopotamia, Assyria, and Egypt.

"These two principal forms or conditions of flax exist in cultivation and have probably been wild in their modern areas for the last five thousand years at least. It is not possible to guess at their previous condition. Their transitions and varieties are so numerous that they may be considered as one species comprising two or three hereditary varieties, which are each again divided into subvarieties." (Dic. Ec. Prod. Ind., Vol. V.)

In the United States two species of flax are used for fiber, *L. lewisii* by the North American Indians, and *L. usitatissimum*, in commercial cultivation largely for seed, but to some extent for fiber. There are other American species of *Linum*, but they have no economic interest.

Linum angustifolium. Flax of the Stone Age.

The species of flax cultivated in Europe in prehistoric ages. See this species in the chapter on ancient fibers, page 11. See also second and third paragraphs above and first paragraph under *L. usitatissimum*. (See fig. 74.)

Linum lewisii. Rocky Mountain Flax.

This species has a wide range in subarid western North America, extending from southern Alaska and the plains of western British America southward through the Rocky Mountains and Sierra Nevada region to the higher plateaus of southern California, western Texas, and northern Mexico. The plant differs from the common cultivated flax, in producing usually two or three stems from its stout perennial root and in having a capsule two or three times as long as the calyx. The Indians of the Oregon plains make it into a remarkably strong twisted cord, used in the manufacture of fish nets, in the binding of grass mats and basket frames, and for other purposes. (*F. V. Coville.*)

Linum usitatissimum. Cultivated Flax.

Common and native names.—Flax (Eng.); *Lin* (Fr.); *Flachs* (Ger.); *Lino* (Span. and It.); *Tisi* (Hind. and Beng.); *Alsi* (Hind.); *Javas, Javasa, Ziggar* (Turk.); *Kattan* (Arab.); *Zaghu* and *zaghir*, and *Kutan* or *tukhme-katin* (Pers.), etc.

Supposed to have originated in Eastern countries. "Thus the first Egyptian white race may have imported the cultivation of flax, or their immediate successors may have received it from Asia before the epoch of the Phœnician colonies in Greece, and before direct communication was established between Greece and Egypt under the fourteenth dynasty. A very early introduction of the plant into Egypt from

Asia does not prevent us from admitting that it was at different times taken from the East to the West at a later epoch than that of the first Egyptian dynasties. Thus the western Aryans and the Phœnicians may have introduced into Europe a flax more advantageous than *L. angustifolium* during the period from 2,500 to 1,200 years before our era." (*De Candolle.*) (See fig. 75.)

The flax plant is now widely distributed throughout the world. It is cultivated in temperate North America, to a slight extent in portions of South America, especially in Argentina (though more for seed than for fiber). It is produced commercially to a greater or less extent in Great Britain, Ireland, especially Sweden, Denmark, Holland, Belgium, France, Russia, Germany, Austria, Spain, and Portugal. It has been introduced into Algeria and into Natal, and its cultivation was old in Egypt at the dawn of the Christian era. In India large tracts are under cultivation, though more for the seed crops than for fiber. Japan has introduced its cultivation commercially, and it has been experimented with in the Australian colonies, where there is a wide range of soil and climate suited to its growth.

FIG. 75.—Common flax, *Linum usitatissimum.*

HISTORY OF FLAX CULTURE IN AMERICA.—A perusal of the historical records in this country shows that flax culture was one of the earliest of colonial industries, and we may be sure that the Puritan maidens, like the Greek maids of old, were familiar with the spinning and weaving of flax, if not with the spindle and distaff of Homeric times, for until comparatively recent years the culture and manufacture of flax in America have been household industries.

The American colonists brought with them the art of raising flax and of preparing and spinning it by hand, and even fifty years ago the custom prevailed among farmers of growing flax and having it retted, scutched, hackled, and spun by members of their household. In the history of Lynn, Mass., it is stated that about the year 1630 "they raised considerable quantities of flax, which was retted in one of the ponds, thence called Flax Pond." As early as 1662 the State of Virginia enacted that each poll district should raise annually and manufacture 6 pounds of linen thread. All the records of New England likewise give evidence of an earnest desire to promote the cultivation of flax and its manufacture. "About 1718 a number of colonists arrived from Londonderry, bringing with them manufacture of linen and other implements used in Ireland. The matter was earnestly taken up by the Bostonians, and a vote passed to establish a spinning school on the waste land in front of Captain Southack's, about where Scollay's buildings were." About 1721, at Newport, R. I., "hemp or flax used to be received in payment of interest, the former at 8*d.* and the latter at 10d. per pound." Pennsylvania offered premiums for several grades of linen thread in 1753, and the Society for the Promotion of Arts, Agriculture, and Economy, of New York, after adopting resolutions to arrest the importation of British goods, offered premiums for linen thread. The early records of Rhode Island develop further interesting facts concerning an association of plantation maidens about 1766. The order was known as the Daughters of Liberty. Its origin is ascribed to Dr. Brown, at whose house eighteen young ladies belonging to prominent families in Providence assembled by invitation and employed the time from sunrise to evening in spinning." (*A. R. Turner, jr.*)

The statistical records show that sixty-odd years ago almost three-quarters of a million pounds of flax fiber were produced in the United States, and flax was sent to market from Connecticut sixty years ago that was strong, clean, and as good as any raised in the United States at the present time. Very strong and flexible flax also came from northern New York and Vermont, but it was not clean. The poorest flax of those days came from New Jersey, though the State has been capable of growing flax equal to Archangel. In past time "North River" flax was regularly sent to market from New York State, it being very strong, but poorly cleaned.

The figures for flax fiber in the year 1869 show a product of over 13,000 tons, but this does not mean fine line, but the coarser fiber, or tow, used in the manufacture of bagging, for this period marks the highest point reached in fiber product before the collapse of the industry a year or two later, owing to the free introduction of jute for cotton-bagging manufacture.

At the present time flax is largely grown in the United States for seed, the straw, of inferior quality, when used at all, going to the tow mills or the paper mills, and worth from $1 to $8 a ton, the average in different sections being not more than $2.50 to $4. In the older States the area under present cultivation is very small and steadily decreasing; in the newer States, or States where agriculture is being pushed steadily westward from year to year, the area under cultivation about holds its own one season with another. Cultivation for fiber is beginning to attract attention, and good commercial fiber has been produced in very small quantities in Michigan, Wisconsin, and Minnesota. The Puget Sound region of the State of Washington has shown its ability to produce a fine grade of straw, the fiber from which, according to recent experiments made by the Barbour Company, in Lisburn, Ireland, is worth $350 per ton.

BAST FIBER.—Flax may be considered the most useful and valuable of all commercial fibers next to cotton, having, however, a wider range of uses. The fiber occurs in the greatest variety in regard to strength, length of filaments, color, and adaptability to manufacture, and, compared with cotton in fabrics, is the fiber of luxury, while the latter is the textile of the masses.

The dimensions of the fibers are as follows: Length, 0.157 to 2.598 inches; mean, about 1 inch; diameter, 0.0006 to 0.00148 inch; mean, about 0.001 inch. The chief characteristics of flax are its length, fineness, solidity, and suppleness. Its remarkable tenacity is due to the fibrous texture and the thickness of the walls; its suppleness permits it to be bent sharply; its length is invaluable in spinning, and the nature of the surface prevents the fibers from slipping on each other and contributes to the durability of fabrics made with them. Flax may be made lustrous, like silk, by washing in warm water, slightly acidulated with sulphuric acid, then passing through bichromate of potash vapor and gently washing in cold water. Samples of flax exposed for two hours to steam at 2 atmospheres, boiled in water for three hours, and again steamed for four hours, lost only 3.5 per cent of their weight, while manila hemp lost 6.07; hemp, 6.18 to 8.44; jute, 21.39. The conversion of flax into textile fabrics is a large and distinct industry. (Spon's Enc.)

USES OF FLAX.—Some of the uses of flax fiber are the manufacture of lace (see Appendix C), fine linens, cloth for shirtings, sheetings, etc.; handkerchiefs, dress goods and suitings, canvas and duck; for embroidery, flosses, "flax thread," and twine, from shoemakers' and harness thread to salmon twine and the rougher package twines; for warp in carpets, for the body of oilcloth, and even for rope and cordage. The rougher fiber is applicable to the manufacture of binding twine and paper, though little used for either purpose.

During the first years of the war of the rebellion an attempt was made to replace cotton in the manufacture of fabrics by a textile substance produced chemically from flax, hemp, and other textiles that would give a fiber claimed by those interested in the processes to be "stronger than cotton or wool and capable of taking better color than either; and be spun and woven on the existing cotton and woolen machinery at a cost below cotton or wool at any time, there being less waste." In the Report of the Flax and Hemp Commission of 1863 is an account of the various processes under experiment for this purpose, the substances produced being variously known as "fibrilia," "flax cotton," "clausenized flax" (and hemp), and "erolin" or "flax wool." The series of specimens that were received during this inquiry was deposited in the Mus. U. S. Dept. Ag., and formed a valuable and interesting historical exhibit. They are not in the present museum, however, nor is the writer aware of their existence.

VARIETIES OF IMPORTED FLAX.—The following statement concerning the kinds of flax imported into the United States, with the names and marks of grades, has been prepared for the Department by Robert B. Storer & Co., Boston, Massachusetts:

Russia: Russian flax is known as *Slanetz* (or dew retted) and *Motchenetz* (water retted), and the shipments from St. Petersburg are largely of *Siretz*, or ungraded kinds of the several districts. The flax from these districts is known under the name of Bejedsk, Krasnoholm, Twer, Kashin, Gospodsky, Nerechta, Wologda, Jaraslav, Graesowetz, Kostroma—all *Slanetz*. The *Motchenetz* sorts are Pochochon, Ouglitz, Rjeff, Jaropol, and Stepurin. From Archangel are shipped *Slanetz* sorts, known as First Crown, Second Crown, Third Crown, Fourth Crown, First Zabrack, and Second Zabrack. From Riga shipments are entirely of *Motchenetz* sorts and the marks are graded from the standard mark K, the others being HK, PK, HPK, SPK, HSPK, ZK, GZK, and HZK.

Holland: Dutch flax is graded by the marks $\frac{\mathrm{I}}{\mathrm{V}}$, $\frac{\mathrm{II}}{\mathrm{V}}$, VI, VII, VIII, IX.

Belgium: Flemish flax (or blue flax) includes Bruges, Thissalt, Ghent, Lokeren, St. Nicolas, and is graded $\frac{\mathrm{II}}{\mathrm{IV}}$, $\frac{\mathrm{I}}{\mathrm{V}}$, $\frac{\mathrm{II}}{\mathrm{V}}$, VI, VII, VIII, IX. Courtrai flax is graded $\frac{\mathrm{I}}{\mathrm{III}}$, $\frac{\mathrm{II}}{\mathrm{III}}$, $\frac{\mathrm{I}}{\mathrm{IV}}$, $\frac{\mathrm{II}}{\mathrm{IV}}$, $\frac{\mathrm{I}}{\mathrm{V}}$, $\frac{\mathrm{II}}{\mathrm{V}}$, VI. Fernes and Bergues flax is graded A, B, C, D. Walloon flax is graded II, III, IV. Zealand flax is graded IX, VIII, VII, VI. Friesland flax is graded D, E, Ex, F, Fx, Fxx, G, Gx, Gxx, Gxxx.

France: French flax is known by the districts of Wavrin, Flines, Douai, Hazebrouck, Picardy, and Harnes.

Ireland: Irish flax comes as scutched and mill scutched, and is known by the names of the counties where raised.

Canada: Has no standard of marks or qualities.

GROWTH FOR SEED AND FIBER.—It has been said that good seed and salable fiber can not be produced from the same plant, and this statement has been reiterated again and again. Experience in other countries, as well as our own, disproves the assertion.

The finest flax produced in Europe is grown in Belgium, where the seed is not only saved, but is used in some cases to produce the next year's crop of flax. The usual practice in that country is to import the seed annually, though in some localities a different custom prevails, as in the Brabant. Imported seed (Dutch or Russian) is planted the first year and the seed produced by this crop is planted the second year, giving, it is claimed, a better quality of flax than the first year; but for the next, or third, year's sowing new seed is again secured.

"About the fiber being coarse if the seed is saved, this will not be the case if the flax straw is pulled before being too ripe and hard. In France and Belgium our spinners get the finest fiber, and the growers there save the seed." (*John Orr Wallace.*)

"The crop must be grown with a view toward getting from the land the highest yield of straw that will produce the finest quality of fiber. The seed, which ought to be a large factor in profit, should be saved, etc." (*Irish Textile Journal.*)

Irish experiments have shown that an acre of land has produced 5 tons 9 hundredweight of green flax one week pulled, and 22 bushels prime seed. Experts in the country have shown that good fiber and good seed can be secured from the same crop, as set forth in the Reports of the Fiber Investigation Series of this Department.

Soil selection.—Too much care can not be exercised in the selection of the soil for this crop. The Belgian flax farmer selects a deep and well-cultivated soil that is not too heavy, experience proving that in a dry, calcareous soil the stalk remains short, while in a heavy, clayey soil it gives greater length, though at the expense of fine fiber. In Ireland any clean land in good state of fertility that will produce a good crop of wheat, oats, or barley is considered suitable for flax. On heavy soils the Dutch seed is thought to give best results, while Riga seed is sown upon the light or medium soils. Recent experiments in our own country have demonstrated that the heavier soils, when well drained and of proper fertility, are preferable to the lighter soils, known as sandy loams. In general terms, a moist, deep, strong loam upon upland will give best results. Barley lands in the Middle States and new prairie lands or old turf in the Western States are frequently chosen. Some former New York flax growers inclined to a heavy clay for the production of fiber and seed, though a wet soil will be fatal to success. A soil full of the seeds of weeds is to be avoided above all things, and weeds should be eliminated by previous cultivation as far as possible.

Soil preparation.—In this country too little attention is paid to the importance of deep plowing and reducing the seed bed to the proper tilth. Many foreign flax growers urge that the land should be fall plowed, though there are some who are of a different opinion, but it is recognized by all that the land should be brought almost to the condition of garden soil before the seed is sown. On small tracts of a few acres in Europe this is accomplished by spading over the land, although such laborious methods can not be adopted in the United States. Deep fall plowing with a cross plowing in the spring is a good practice to follow. Where there are heavy clay loams two plowings in the spring will give better results than one. The number of harrowings will depend wholly upon the lumpiness of the soil, as all clods must be broken up and the soil made fine and even. The roller should be used to make the ground as smooth and level as possible and to press into the soil any small stones that may be upon the surface. Heavy lands that from their situation are liable to to be more or less covered with surface water during the winter should be avoided. On account of the extra labor necessitated upon heavy land it is better, therefore, to choose the medium soils that will yield readily to the action of the elements and to the plow and harrow.

Fertilizing.—On the new lands of the West good crops may be grown for a number of years without manures, though in time fertility must be exhausted and poor crops will inevitably follow. The flax crop, of all crops, makes heavy demands upon the soil, and for this reason it is frequently called an exhaustive crop. The stem of the flax plant is tall and slender, growing rapidly, and the long roots, as they push down deeply, must have something to feed upon to make vigorous growth and good straw. It is on account of this habit of the plant to extend its roots to such depth in the earth that plowing and fine tilth are so essential; and the roots must find food or the plant will be of slow growth, woody, and deficient in fiber, and the product inferior both as to quality and quantity. Any crop is exhaustive to the soil that is grown year after year on the same land, where everything is taken away and nothing returned. In Belgium and other flax-growing countries, where land has been under cultivation for generations, stable manure is applied to the land before winter sets in. Then in spring, before sowing time, the ground is heavily treated with fertilizers, or night soil in solution is poured over it. A great deal of the material is brought from the towns and kept in closed receptacles or reservoirs until the time for using it on the ground. Stable manures are used in connection with chemical fertilizers. Of the latter it is common to employ from 600 to 800 kilograms per hectare, or, roughly, from 500 to 750 pounds per acre, and to go over the ground with the liquid night soil in addition. Stable manures should be well rotted to avoid fouling the crop with weeds, which germinate and grow with the flax. Dr. Ure formerly recommended a mixture of 30 pounds of potash, 28 of common salt, 34 of burnt gypsum, 54 of bone dust, and 56 of magnesia, which it was claimed would replace the constituents of an average acre of flax. Dr. Hodges, of Ireland, many years ago proposed the following, which he concluded by analysis would replace the inorganic matter removed from the soil by 2 tons of flax straw: Muriate of potash, 30 pounds; common salt, 25 pounds; burnt gypsum, 34 pounds; bone dust, 54 pounds, and sulphate of magnesia, 50 pounds. This is very similar to the formula given by Dr. Ure above.

Rotation of crops.—A systematic rotation of crops is considered essential in all flax-growing countries, though little practiced in the United States. A rotation formerly followed in New York, covering three years, was Indian corn, barley, oats, winter and spring wheat, and red clover, the corn being planted on land plowed from clover sod. The cleaning process, to rid the soil from weeds, began with the first crop which followed the clover sod. The Belgian farmers are particularly careful in this matter. In the Courtrai region the occupancy of the land with flax varies from five to ten years, the average being about eight years. In eastern Flanders it is five to nine, and in the Brabant five to eight. In some other sections a much longer time elapses between two crops of flax, and several generations back fifteen and even eighteen years were sometimes allowed to intervene. A common rotation is clover, oats, rye, wheat, and in some cases hemp. Crops of rape, tobacco, beans, and vegetables (these latter crops on farms contiguous to towns), or even onions and salsify, are grown as in middle Belgium. Clover is considered one of the best crops to precede a crop of flax, as its numerous roots go deep into the soil, and from their decomposition not only furnish nutriment to the growing flax roots, but enable them more easily to push down into the subsoil.

Sowing the seed.—An old rule in this country was to sow when the soil had settled and was warmed by the influence of the sun, and weeds and grass had begun to spring up and the leaves of trees to unfold. In fact, no definite rule can be laid down, experience being the best teacher, as the seeding must be largely governed by atmospheric conditions. Too early sowing may result in injury to the growing plants. A practice followed by some farmers, especially where the soil is at all weedy, is to allow the land, after it is put in condition, to lie until the weeds appear; then, just before sowing, give the surface a light harrowing, when the greater part will be killed.

In regard to the manner of seeding the crop, it is usually put in by hand, broadcast; in foreign countries, the experts at the business going from farm to farm, as their services are required. The seeding is accomplished in this country both by hand broadcasting and by means of the drill, though the latter method can not be recommended. The work should be done with great regularity to secure an even growth of straw and the same standard of fineness for different portions of the field. The objection to drilling in the crop is that the outside straw will always be coarser than that straw in the center of the drill row, and also will have a tendency to branch. The practice in Flanders is to sow in the morning and harrow the seed in with a close-set harrow; and after the seed has germinated, the land is rolled. When flax is grown for seed without regard to fiber, it is sown thin, at the rate of 2 to 3 pecks of seed per acre, in order that the plants shall branch and produce as large a crop as possible. A large seed is also desirable. When the production of fine fiber is the object, a thicker sowing is necessary, say, from 1½ to 3 bushels per acre. This prevents branching, the plants are shaded, and a crop of clean, slender, straight straw is the result. In Belgium, where the finest fiber is produced, the amount of seed sown varies ordinarily from 2½ to 3 bushels per acre, though in one district (Hainaut) it is claimed that the quantity sown is sometimes double this amount. Probably 3 bushels per acre comes nearer the general practice. Some growers hold that more should be used when the sowing is late than when early; at any rate, when planted too thickly, as is sometimes the case, it is afterwards thinned, though such a practice, of course, adds just so much to the cost of production.

Good fiber can not be grown from the average seed of the oil mills. Imported seed gives the best results, but if this can not be obtained seed must be sown that has been produced from plants grown for their fiber, also from selected seed. A proper flaxseed should be pure, free from the seeds of weeds and from all odors which would indicate mustiness and bad condition that would affect its germinating power. The foreign grower in purchasing his seed is subjected to a dozen forms of fraud, and the only safe plan pursued is to buy of reputable dealers exclusively. In all cases the heaviest, brightest, and plumpest seed should be preferred. J. R. Proctor, of Kentucky, writing upon this subject many years ago, advocated the white-blossom Dutch as the best seed for American flax growers. Eugene Bosse, a practical flax grower, states that his preference, based upon several years' experience, is for (1) "Riga seed, once sown in Belgium"—that is to say, imported seed grown on Belgian soil from seed procured in Riga; (2) seed imported direct from Riga, but it must be Riga and not Finland seed; (3) Dutch (Rotterdam) seed, and (4) American seed, which he reports "as good as Nos. 2 and 3 when well cultivated, though it will not stand the drought as well." No. 1 will produce about 8 bushels of seed to the acre, No. 2 10 bushels, and No. 3 between 8 and 10 bushels.

Weeding the crop.—In foreign countries this work is done principally by women and boys, who go over the ground on their knees, picking out the weeds by hand. This work is done usually when the plants are from 1 to 2 inches high, though a second and sometimes a third weeding is found necessary. The American flax grower must avoid the labor of weeding by having clean land, made as nearly clean as possible by careful culture. Where weeding becomes necessary it is performed when the plants are less than 5 inches high.

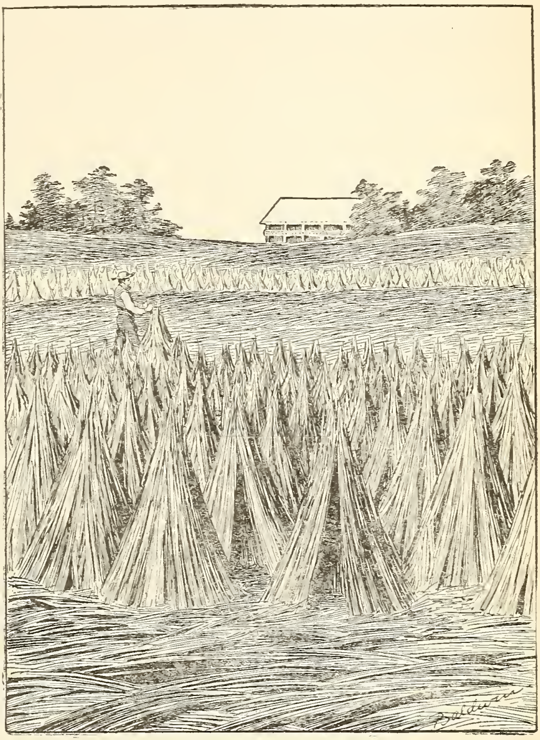

FIG. 76.—Method of forming stooks.

Harvesting.—In Flanders and other portions of Belgium where the seed is of secondary importance, and the main object is to obtain as strong and fine fiber as possible, the flax is pulled before it is fully ripe, or when it is just beginning to turn yellow, coarse flax ripening earlier than fine. The work is done (or begins usually) the last week in June, sometimes a little earlier, for, according to one of the old proverbs, "June makes the flax." An Irish rule is to pull at once when the straw begins to turn yellow and the foliage within 6 inches of the ground is drooping. For the best results, when the desired end is fine fiber, the straw must be pulled. This is not the usual practice of the Western flax grower, who cultivates for seed, however, and it has been urged that it is absolutely essential, where the object is to produce both fiber and seed, or, to state it more precisely, when the object is to produce a common grade of fiber and at the same time save the seed. If the land surface is made very smooth, so that the knives of the reaper may be set low, cutting by machine (rather than pulling) may answer. Several inches of the best portion of the stem will be lost and the square ends of the fiber will not work into the "silver" as smoothly as pulled flax when the fiber is being manipulated in the first stages of manufacture. A flax pulling machine is a desideratum, and for the past two or three years inventors have attempted to work out the problem. Where flax is pulled by manual labor, the course is to draw the handful of straw out of the ground, and by striking the roots against the boot the earth is dislodged. The straw is then laid in handfuls, crossing each other, so as to be readily made into bundles. In Belgium the flax is laid in handfuls upon the ground, a line of straw being first laid down, which serves to bind these handfuls when a sufficient quantity has been pulled to tie. When put into stooks to dry, the seed ends being tied together, the bottom ends are opened out, giving to the stook the appearance of an A tent. (See fig. 76.) After drying in the stook, the handfuls of straw are then tied into small bunches, or "beets," and piled something as cordwood is piled in this country, two poles being first laid upon the ground to prevent injury to the bottom layer by dampness, and two poles driven at each end of the pile to keep the "hedges" in form.

In the matter of saving the seed the common American practice has been to drive the straw through an ordinary thrashing machine, securing the seed, but rendering the straw utterly worthless in its tangled and broken condition. Some attempts have been made to save the straw even with the ordinary thrasher by opening the concave. This is done so that the teeth will just come together: then with one man to open and pass in the bundles, another takes them by the butt ends, and, spreading them fan shape, presents the seed end to the machine. The straw is not released, but is withdrawn as soon as the seed is torn off, when the bundles are again tied. The operation is not fully satisfactory, and the necessity of a rapid flax thrasher has stimulated invention, and several machines have been presented which will do the work more or less effectually, though an absolutely successful machine for this purpose is yet a desideratum. In the old days of flax cultivation in New York whipping the seed capsules against a sharp rock set at an angle of 45° was the method resorted to. In foreign countries various methods are resorted to from hand thrashing to passing the bundles through powerful machines with iron cylinders so constructed that only the heads are crushed, the straw remaining in the hands of the operator during the entire operation.

Retting the straw.—Three natural modes of steeping, or retting, are recognized—dew retting, pool retting, and retting in running water. There are also many processes for quick retting, where the temperature of the water is controlled, and also when chemicals are used, but few of these have given good results, and the flax of the world is largely retted by natural methods rather than by "processes," so called. For dew retting a moist meadow is the proper place, the fiber being spread over the ground in straight rows at the rate of a ton to an acre. If laid about the 1st of October, and the weather is good, a couple of weeks will suffice for the proper separation of the fiber and woody matter. When the retting is progressing unevenly the rows are opened with a fork or turned with a long pole. For pool retting the softest water gives the best results, and where a natural pool is not available, such as the "bog holes" in Ireland, "steep pools" will have to be built. A pool 30 feet long, 10 feet wide, and 4 feet deep will suffice for an acre of flax. Spring water should be avoided, or, if used, the pool should be filled some weeks before the flax is ready for it, in order to soften the water. It should be kept free from all mineral or vegetable impurities. The sheaves are packed loosely in the pool, sloping so as to rest lightly on their butt ends, if at all, for it is considered best to keep the sheaves entirely under water without allowing them to come in contact with the bottom. Irish growers cover with long wheat straw or sods, grass side down, the whole kept under water by means of stones or other weights. Fermentation is shown by the turbidity of the water and by bubbles of gas, and as this goes on more weights are required, for the flax swells and rises. If possible, the thick scum which now forms on the surface should be removed by allowing a slight stream of water to flow over the pool. The fiber sinks when decomposition has been carried to the proper point, though this is not always a sure indication that it is just right to take out. In Holland the plan is to take a number of stalks of average fineness, which are broken in two places a few inches apart. If the woody portion or core pulls out easily, leaving the fiber intact, it is ready to come out. The operation usually requires from five to ten days.

The finest flax in the world—the famous flax of the Courtrai region of Belgium—is retted in the sluggish waters of the river Leys. This is called by the French *rouissage au courant*, which was described as follows in the writer's report on Belgian Flax Culture, 1890:

"Crates or frames of wood are used, having solid floors of boards, the sides being open. These measure about 12 feet square and perhaps a meter in height, or a little over a yard. First a strip of jute burlap is carried around the four sides on the inside, coming well to the top rail of the crate. This is to strain the water, or to keep out floating particles or dirt which would injure the flax by contact with it. The bundles, which measure 8 to 10 inches through, are composed of "beets" laid alternately end for end, so that the bundle is of uniform size throughout. They are stood on end and packed so tightly into place that they can not move, each crate holding about 2,000 to 3,000 pounds of straw. When a crate is filled the entire top is covered with clean rye straw and launched and floated into position in the stream. It is then weighted with large paving blocks or other stones until it has sunk to the top rail, when it is left for the forces of nature to do the remainder. The time of immersion is from four to fifteen days, dependent upon temperature of the water and of the air, quality of flax, and other influences. There are several delicate tests which indicate when the flax should come out, although the near approach of the time is made known by the self-raising of the crate out of the water (often a foot or more), caused by the gases of decomposition. When ready to remove, the crate is floated opposite a windlass—and there are many along the shore—the chain attached, and the affair pulled halfway up the bank, when the bundles are at once removed. The big bundles are taken back to the field, and are now broken up and again put into the form of the little "A" tents already described. This work is done by boys, who show great dexterity not only in spreading and standing up the little bundle when it is first opened for drying, but in the subsequent operation of turning the tent completely inside out, so that the straw that was shaded in the interior may be subjected to the air and sunshine and the drying be accomplished evenly. After this drying process is completed, the flax again goes into the big bundles for a second immersion, and I was told sometimes a third, though rarely. This work begins in September and continues until too cool to ret the flax advantageously. Then it begins again in March and continues until all the flax has been retted. Much of the unretted flax is carried over to the next year in this manner. Not only is it thought to improve the flax in quality, but is better for the producers, enabling them to hold their product for good prices when the fall prices are low." (Report No. 1, Fiber Investigation Series, U. S. Dept. Ag.)

For an account of the practice followed in the cultivation of flax for household linen, see Report No. 4 of the above series, page 37.

Economic considerations.—Flax culture for fiber can not be established in the United States on the lines of practice in foreign countries. As the case stands, the farmer is hardly in position to grow flax, save in an experimental way, until he is sure of a market, and the manufacturer—that is, the spinner—is not in a position to make offers of purchase or to name price, because he is not sure that the farmer can grow flax of the proper standard, or that he can afford to purchase at any price, for his particular manufacture, such flax as the farmer may produce. This simply means that what isolated farmers can not accomplish alone must be accomplished by the establishment of little local industries. To borrow a foreign term, the future flax industry of the United States must be communal; that is to say, capital must establish scutch mills in localities where flax may be profitably grown, farmers of the neighborhood agreeing to produce 5, 10, or 20 acres of straw each, under the direction, if need be, of the managers of the mills, to insure the growth of a quality of straw that will give the proper standard of fiber. This relieves the farmers from any responsibility in the matter further than to produce a proper crop of straw. The scutch mills or tow mills attend to the retting and cleaning of the fiber, which in turn is sold to the spinner. One good scutch mill will prepare the flax grown on a score or more of farms, and as the work is accomplished under one direction, the product will be far more even as to standards than would be possible were it prepared by twenty different men. In Canada and in northern Michigan (in the neighborhood of Yale, where there are successful scutch mills) the practice is to sell the seed to the farmers, at the mills, at a fixed price per bushel, the farmers agreeing to sow a certain number of acres to flax, the straw from which the managers of the scutch mills agree to take at a fixed price per ton, in some cases $10 being named.

The farmers of the United States use improved implements and machines in all farm operations, and American farm implements are recognized as the finest in the world. What invention has done for other rural industries is possible for the flax industry, and by the use of improved machines in every stage of flax culture the difference in wages between this country and the Old World will be more than equalized. The "American practice," means simply an intelligent practice, for the growth of both fiber and seed, achieving economical production by the employment of labor-saving machinery, even in the pulling of the flax straw. Fine flax can be grown in the United States, providing the farmers grow it intelligently and perseveringly—not one year, or two, or three, but year after year, growing each year a little, and growing it well.

Statistical records.—Reference has been made to the large crops of flax grown in this country in previous years. The following figures of yield of seed and fiber, for five periods, from 1849 to 1889, are reproduced from reports of the Eleventh Census:

Year.	Bushels.	Pounds of fiber.
1849	562, 312	7, 709, 676
1859	566, 867	4, 720, 145
1869	1, 730, 444	27, 133, 034
1879	7, 170, 951	1, 565, 546
1889	10, 250, 410	241, 389

For the figures of yield by States, see Bulletin No. 177, Eleventh Census, by John Hyde.

The States producing fiber, largely coarse tow for upholsterers' use, in 1889, in the order of importance are Illinois, Kansas, Michigan, *Virginia, Ohio, New York, *Kentucky, Minnesota, Iowa, Wisconsin, Indiana, *West Virginia, *North Carolina, South Dakota, *Tennessee, Maine, Missouri, Nebraska, North Dakota, Pennsylvania, and Arkansas, the first with a record of 57,776 pounds, and the last named, 11 pounds. The figures for States denoted with an asterisk (*) doubtless represent in part the remnant of the old household linen industry, for in 1890 flax was still grown for homespun in the mountain regions of the States named. The total figures for the States thus indicated are 49,737 pounds. Virginia and Kentucky supply over 30,000 pounds of this quantity, and showing a mixed commercial and household industry.

Livistona australis.

One of the few palms found in Australia, attaining a height of 100 feet, its trunk being a foot in diameter. The species of this genus are found from upper Assam and southern China through Malacca and the islands of the Indian Archipelago, as well as Australia.

Fiber.—The unexpanded leaves of *L. australis* are prepared by scalding, and drying in the shade, when the material is used for making hats.

L. chinensis is used to make coarse fabrics for bags, etc., and also for cordage. *L. jenkinsiana* is the *Toko Pat* of Assam, and is used for making the peculiar umbrella hats of the natives.

Llanchama (Peru). See *Couratari.*

Locust (W. Ind.). *Hymenæa courbaril.*

Lodoicea callipyge. DOUBLE COCOANUT PALM.

COMMON NAMES.—*Coco de Mer, Coco des Maldives.*

This species of palm was unknown prior to the discovery of the Seychelles Islands in 1743, but its immense "double cocoanuts" were often found floating upon the waters of the Indian Ocean.

The tree has a nearly cylindrical trunk, scarcely exceeding a foot in diameter, and bearing a crown of fan-shaped leaves, some of which are upward of 20 feet long and 12 feet wide. They are of two sexes, both of which have three sepals and three petals to the flowers, those of the females being large, thick, and fleshy. The fruits externally are covered with a thick, fibrous husk, and contain usually one, but sometimes two or even three immense stones or nuts with excessively hard and thick black shells, each being divided half way down into two lobes, whence the popular name. In olden times important medicinal virtues were attributed to these nuts, water drunk out of vessels made of them being supposed to preserve people from all complaints, and extravagant prices were consequently paid for them. At the present day they are converted into various domestic utensils, while the wood serves many useful purposes." (Treas. Botany.)

FIBER.—From the dried leaves of this palm many useful or ornamental articles are manufactured, such as hats, fans, baskets, cigar cases, etc., and the leaves are also used for thatching.

Lonicera quinquelocularis. HIMALAYAN HONEYSUCKLE.

An Indian plant, also found in southern Afghanistan. It is worthy of only passing mention, as its bast, which is shed in long fibrous strips, is only suitable for upholstery purposes.

Loof. The fiber of *Luffa ægyptica.*

Loto (It.). *Celtis australis.*

Lotus, the sacred (Egypt). See *Nelumbium.*

Luff (Arab.). See *Luffa.*

Luffa ægyptica. THE SPONGE CUCUMBER. SNAKE GOURD.

Syn. *Luffa cylindrica*, etc.

Exogen. *Cucurbitaceæ.* A climbing vine.

The species of the genus are said to be natives of tropical Asia and Africa, though *L. ægyptica* is grown in many parts of the world. Some of its names are as follows: Sponge cucumber or Dish cloth plant, Papinjay, southern United States; *Estrapajo,* Venezuela; *Esponga végetal,* Argentina; *Dún-dúl,* Bengal; *Khujar,* Persia; *Luff,* Arabia; *Hechima,* Japan; etc. Fig. 2, Pl. VIII, is a sponge cucumber grown by the author, together with a specimen of the commercial sponge imported from Japan.

FIBER.—The dried fruit, after frost, is a network of interlacing fibers that can be used without further preparation as a substitute for the sponge, for bath purposes; sometimes used as a flesh brush in the Turkish bath. Some very fine examples of these vegetable sponges were secured from the Japan exhibit, W. C. E., 1893 (under the name *L. petola*), the fiber being used by the Japanese "for the heart of hats, the sole of sacks, or 'Tabi' for stuffing saddles, in place of sponges for washing, etc."

In the United States ornamental baskets are sometimes made from the sponge cucumber, and among the curious objects of the museum the visitor is shown a bonnet, worn in the South during the late war, made entirely of this fiber. To prepare it, the cucumbers were cut through lengthwise upon one side only, and opened out flat, the fibrous walls of the tubes before mentioned forming longitudinal ridges which appeared on the outside of the bonnet. Several cucumbers were required to make this dainty head covering, which was sewed together and afterwards shaped with scissors, and lined on the inside and trimmed with pink cambric. The fruit is from 6 inches to 1 foot in length, the interior being formed of a dense tissue of wiry fibers and containing three longitudinal tubes, in which are found the numerous black seeds.

THE COMMERCIAL PRODUCT.—The vegetable sponge does not appear to be an article of trade and export in any country but Japan, which exports over 1,000,000 sponges a year. They are chiefly exported from Yokohama, and some from the ports of Kobe and Nagasaki; and the principal destinations of exportation are London, Havre, Hamburg, San Francisco, New York, Shanghai, and Hongkong.

It is grown in every part of Japan, there being two varieties in common cultivation—one long and slender, being used for food, and the other more plump, as a fiber plant. The method of cultivation in Japan is to sow the seed in March, in a seed bed, transplanting to the cultivated fields as soon as the plants show four or five leaves. A horizontal network of bamboo poles is constructed above the plants, upon which the vines twine and spread. Four or five "cucumbers" are grown on a plant, and 24,000 may be grown to the acre. The harvest is in September.

Lupis. A form of manila hemp. See *Musa textilis.*

Lupulo (Peru). *Humulus lupulus.*

Lycopodium clavatum. RUNNING PINE.

Lycopodiaceæ. A club moss.

The club mosses are found in cold, temperate, and tropical countries, some being prostrate in their habit of growth, while others are erect, the latter frequently of large size.

L. clavatum abounds in this country in woods from Labrador to Alaska, south to North Carolina, Michigan, and Washington. Also found in Central America and in Europe. The species can scarcely be called a textile plant, though in Sweden it is used in the manufacture of door mats.

Lygeum spartum.

Endogen. *Gramineæ.* A perennial grass.

NATIVE NAMES.—*Sennoc* and *Albardine* (Afr.); known in Italy as *Lacrime salvatiche,* the weeping sylvan.

Mediterranean regions; northern Spain and northern Africa. The plant is often confounded with the true esparto, *Stipa tenacissima,* which abounds in the same regions, and which is the commercial esparto so largely used for the manufacture of paper. *L. spartum* is an evergreen, its culm solid and cylindrical, from 1 to 1½ feet in height, having generally only one node, from which comes forth the last leaf. The leaves are very narrow and from 40 to 70 centimeters in length, smooth and nearly cylindrical, sea green in color, very tenacious, and similar to those of *Stipa tenacissima.*

STRUCTURAL FIBER.—Both species are used in Italy in basket manufacture and as covering for the protection of bottles, these articles being exported to the United States and other countries. Savorgnan states that while the term *Giunco marino* (or sea reed) is applied to several species, *Lygeum spartum* is usually understood. Probably used, in connection with other species, in the manufacture of Buscola baskets. See *Juncus acutus.*

Lygodium scandens.

Filices. A climbing fern.

The species of this genus are widely distributed over the warmer parts of the world, extending to New Holland, Japan, and North America. Most commonly met with in our greenhouses. The Kew collection contains a broom made in Ceylon from the stipes of the species named, while the stipes of another species, found on the Island of Luzon, supply material for hats.

Lyme grass. *Elymus arenarius.*

Lyonsia reticulata.

A specimen of so-called fiber from the seed vessels of this plant was received from the Queensland collection (Phil. Int. Exh., 1876). It is worthless as a "fiber" and can only be classed with "silk cotton" from the Bombax, and with "vegetable silk" from pods of *Asclepias.* The plant is a creeper belonging to the dogbane family, having cucumber shaped pods, which are the source of the fiber. The plant is a native of Australia.

Maana (Ceyl.). *Andropogon nardus* of Dict. Ec. Prod., Ind. See *A. schœnanthus.*

Macanilla (Venez.). See *Guilielma speciosa.*

Macauba and **Macaw palm** (Braz.). See *Acrocomia sclerocarpa* and *A. lasiospatha.*

Machinery for extracting fibers. See Appendix A.

Macpalxochitlquahuitl (Yuc.). *Cheirostemon platanoides.*

Macrochloa tenacissima (see *Stipa tenacissima*).

Macrocystis pyrifera. GIANT SEAWEED.

This is a remarkable genus of dark-spored *Algæ,* belonging to the order *Laminariaceæ.* "Many species have been proposed by authors, but all are reducible to one, *M. pyrifera,* which girds the southern temperate zone and stretches up from thence along the Pacific to the Arctic regions, through 120 degrees of latitude. This plant, like the Sargassum, has been celebrated by all voyagers, to whom it is of great service in indicating the presence of rocks, acting, as it does, like a great buoy. Vast masses are thrown up on exposed coasts, where it is rolled by the waves till it forms cables as thick as a man's body. Single plants have been estimated on reasonable grounds as attaining a length of 700 feet. It is apparently indifferent to cold, if not extreme, but inasmuch as like its near allies it is a deep-sea *Alga* it requires a depth of at least 6 fathoms for its growth." (*Rev. M. J. Berkeley.*)

PSEUDO FIBER.—This is not strictly speaking a fiber plant, though it affords useful material that may be employed in the place of a fiber as a "cordage" material. No references can be given, but I have been informed that the *Macrocystis* is extensively employed in Alaska for the manufacture of fishing lines, which are strong and durable.

Other species of *Algæ* are used in a similar manner. W. H. Harvey, in Nereis Boreali-Americana (Sm. Inst., 1858), on the authority of Lightfoot, refers to the use of the stems of *Chorda filum,* which often attain the length of 30 or 40 feet and which are popularly known as Lucky Minny's lines. These are skinned when half dry, and twisted acquire so considerable a degree of strength and toughness that the highlanders sometimes use them as fishing lines.

Dr. H. Mertens, in Hooker's Bot. Misc., refers to a similar use of a species of *Fucus* by the Aleutians. It is said that these fishing lines from *Algæ* are not affected by freezing, and therefore can be used at low temperatures without danger of breaking.

Macrozamia spiralis.

This species, belonging to the *Cycadaceæ*, occurs in New South Wales, the representatives of the genus being found chiefly in Australia. *Specimens of the pulu-like surface fiber are preserved in the Bot. Mus. Harv. Univ. Fig. 77 is a leaf of *M. denisonii* in the Department conservatory.

Madar fiber or **Mudar** (Ind.). See *Calotropis gigantea.*

Madras hemp (Ind.). See *Crotalaria.*

Maggio piccolo (It.). See *Coronilla emerus.*

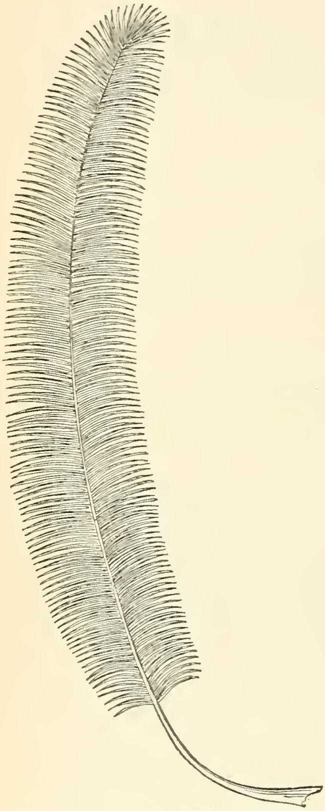

FIG. 77.—A leaf of *Macrozamia denisonii.*

Maguey (Mex.). See *Agave mexicana* and *A. americana;* ——— *blando, A. salmiana;* ——— *de tequila, A. americana, A. wislizeni,* etc.

The term *Maguey,* with and without an affix, has been used as a general term to designate many species of Agaves. Ignacio Blazquez enumerates 33 species and varieties of *Magueys* which grow or are cultivated on the plains of Apam, and names 16 species and varieties growing or cultivated in the district of Cholula which yield *pulque.* See also *Agave potatorum.*

Mah-line or **Malaing** (Burm.). See *Broussonetia papyrifera.*

Mahoe. Also written *Mahaut.*

This name is applied to several West Indian and South American species of malvaceous plants; sometimes written Mahaut. The species named in this work are: ——— *bord la-mer, Hibiscus tiliaceus;* cousin ———, *Triumfetta semitriloba;* blue or mountain ———, *Hibiscus elatus;* red ———, *Sterculia caribæa;* Congo ———, *Hibiscus clypeatus;* seaside ———, *Thespesia populnea;* wild ———, *Malvaviscus arboreus,* etc.; ——— pincet, *Funifera utilis,* see *Lagetta.* "Mahoe is a collective name for the bast fibers of *Paritium, Ochroma, Thespesia, Hibiscus,* etc. The word is the same as *Majagua* used in Venezuela, Colombia, and other countries." (*Dr. Ernst.*)

The name Mahoe is applied in Trinidad indiscriminately to the genera *Paritium, Thespesia, Daphnopsis, Ochroma, Apeiba, Heliocarpus,* and many others producing bast tissue or fibrous barks. (*J. H. Hart.*)

Maholtine (Trin.). *Abutilon periplocifolium* (now *Wissadula*).

Mahauli and **Marvil** (Ind.). See *Bauhinia racemosa.*

Maicha (Peru). See *Mamillaria.*

Maidenhair fern (see *Adiantum*).

Mayo or **Maioh** (Burm.). *Calotropis gigantea.*

Maize, or **Indian Corn** (see *Zea mays*).

Majagua.

A collective name employed in Spanish-speaking countries for the bast fibers of malvaceous and similar plants (see *Mahoe*); often used with an affix, as *Majagua clarellina* (see *Pachira*). Two unidentified fibers from the Mexican exhibit, W. C. E., 1893, were named ——— *de tomillo*, and ——— *de rejuco*. The term is applied in Costa Rica to *Hibiscus tiliaceus*.

Majaguillo (Venez.). See *Muntingia*.

Makaw palm (Braz.). *Acrocomia sclerocarpa*. The Great Makaw Palm is *A. lasiospatha*.

Makkah, Makkai, Makkajari, etc. (Pers. and Ind.) *Zea mays*.

Malachra capitata. WILD OKRA.

A malvaceous shrub occurring in tropical America, India, and other countries; probably a native of South America.

FIBER.—A fine example of its bast was secured from the exhibit of British Guiana, W. C. E., 1893, which, with a specimen from Trinidad, is shown in the museum collection. The first named was 8 or 9 feet long, jute like in appearance, though more yellow, and rather coarse. This, or an allied species, is found in Trinidad where the plant grows wild in damp situations. It is found in Venezuela. Spon states that when well cleaned it is almost as soft as silk, having a silvery luster, and is 8 to 9 feet in length.

In India it is supposed to be an introduced plant, native of the Congo basin of tropical Africa, and is regarded by Dr. Watt as a jute substitute. The fiber has been much admired in India, but efforts to introduce it into cultivation (in Bombay) resulted in failure. A very full account of the experimental cultivation of *M. capitata* in India appears in the Dic. Ec. Prod. Ind., Vol. V.

In Bernardin's list *M. radiata* (*Pavonia sessiliflora*) is mentioned from Trinidad, and *M. urens* from Jamaica, while the "*Guimauve*," a species with yellow flowers, found in the Antilles, is called *M. ovata*.

Malaguete (Braz.). *Xylopia sericea*.

Ma-lo (Figi). See *Broussonetia*.

Maloo climber (Ind.). See *Bauhinia racemosa*.

Mallow.

The common mallow of India, *Malva sylvestris*. The musk ———, *Hibiscus abelmoschus;* the swamp rose ———, *H. moscheutos;* the Indian ———, *Abutilon avicennæ;* marsh ———, *Althæa officinalis;* velvet ———, *Lavatera maritima*. Mallow is also a collective name applied to the family of malvaceous plants.

Malva sylvestris.

Exogen. *Malvaceæ*. Erect glabrous herb.

NATIVE NAMES.—*Khubaz* (Bomb. and Arab.); *khatmi* (Beng.) etc.; *mauve* (Fr.).

Western temperate Himalayas; distributed to Europe, Siberia, and northern Africa.

BAST FIBER.—Spon states that the fiber of *M. sylvestris, M. rotundifolia*, and *M. crispa* are widely utilized. *M. peruviana* is credited to Peru, and *M. sylvestris* to Spain, Portugal, and Italy, as well as to India. Royle states that *M. sylvestris* abounds in fiber.

Malvalisco (Braz.). See *Sphæralcea*.

Malvaviscus arboreus. WILD MAHOE.

A genus of malvaceous shrubs native of tropical America and Mexico. Said to be found in Mauritius.

FIBER.—A coarse bast, labeled *Civil*, secured from the Mexican exhibit, W. C. E., 1893, was referred by Dr. Ernst to this species. Employed for native uses. Fiber 6 to 7 feet in length. Savorgnan states that it is an excellent textile material.

* *Specimen* of the fiber, Herb. Col. Univ., N. Y.

Mamaki (Hawaii). See *Pipturus*.

Mamillaria senilis.

A genus of *Cactaceæ* for the most part confined to Mexico. *M. senilis* is also found in Peru, known as *Maicha*. Dorca states that it produces a surface fiber, a kind of yellowish wool. The revised name of this genus is *Cactus*.

The genus is, in most instances, readily distinguished from its allies by the fleshy stem, of which the plants solely consist, being entirely covered with tubercles of a teat-like form, giving rise to the generic name, from mamilla, a little teat. These are disposed in a series of spirals, each teat being furnished at the top with a tuft of radiating spines proceeding from a kind of cushion. *M. pusilla* is a very pretty little species, growing in crowded tufts usually of a hemispherical shape. The mamillæ, which are about the size of grains of wheat, have little tufts of white hairs between them and bear bundles of spines, consisting of from four to six straight stiff inner ones and from twelve to twenty outer ones like white hairs. (*A. Smith.*)

M. coronaria, reaching 5 feet in height, and *M. clara*, both Mexican species, produce a "white wool." The fiber is more curious than useful.

FIG. 78.—The Bussú palm, *Manicaria saccifera*.

Mandgay (Bomb.). See *Bambusa arundinacea*.

Mandua (Ind.). *Eleusine coracana*.

Manicaria saccifera. TROOLIE PALM.

NATIVE NAME.—*Bussú*.

A Brazilian palm inhabiting the tidal swamps of the lower Amazon, the individual leaves of which often measure 30 feet in length. (See fig. 78.)

Each gigantic leaf of the Troolie palm, *Manicaria saccifera*, is really a shelter in itself; and a few of these laid, without further preparation, so as to overlap like tiles, make a perfect roof. Before corrugated zinc was introduced a large trade was carried on between the Indians and the planters on the coast in these leaves, with which to thatch buildings on the sugar estates. (*E. F. im Thurn.*)

STRUCTURAL FIBER.—The fibrous spathes of this palm are well adapted for use in the manufacture of caps, mats, etc. They are also converted into bags, by simply cutting round them near the bottom and pulling them off entire, afterward stretching them open as wide as possible without tearing. When cut down one side and opened they supply a coarse but strong fabric, or kind of cloth.

M. plukenetii is a Guatemala species, represented, with the above, in the Kew Mus. collection—not now, however, considered as distinct from the above.

Manila hemp (Phil. Is.). See *Musa textilis.*

Manorrin. Chippewa Indians. *Zizania aquatica.*

Mao. In Jap., China grass, *Boehmeria;* in Hawaii, *Gossypium tomentosum.*

Maoutia puya. WILD HEMP; PUA HEMP.

SYN. *Boehmeria puya,* and *B. frutescens.*

Exogen. *Urticaceæ.* A shrub.

Native of tropical Himalayas, Assam Valley, Burma, Straits Settlements, and Japan. Known as *pói, pooah, púya, kyinki,* etc.

BAST FIBER.—Closely resembles the fiber of the Boehmerias and is prepared in the same manner. "*Pooah* is principally used for fishing nets, for which it is admirably adapted on account of the great strength of the fiber and its extraordinary power of long resisting the effects of water. It is also used for making game bags, twine, and ropes. It is considered well adapted for making cloth, but is not much used in this way." (*Royle.*) For further accounts see Royle, Fibrous Plants of India; Watt, Dic. Ec. Prod. Ind., Vol. V; Spon's Enc., Div. III.

Maraja (Braz.). See *Bactris.*

Marram, or **Marum** Holl. (see *Ammophila*).

Maranta.

Many species of the genus *Maranta* have been referred to other genera, but as their fibers are unimportant the few to which I find references will be mentioned under this genus. The species are chiefly natives of tropical America, though *M. arundinacea,* which supplies the arrowroot of commerce, has been distributed to other countries. *M. sanguinea* (now *Stromanthe sanguinea*) is mentioned both in Bernardin's Catalogue and in the Flax and Hemp Commission list, the fiber being described as 2½ feet in length. Fiber has also been produced from *M. arundinacea.* The split stems and leaves of *M. dichotoma* (now *Clinogyne dichotoma*), an India species, are made into mats to use as awnings. *Maranta obliqua* (now *Ischnosiphon obliquus*) is a native of British Guiana. Spon states that the fiber is used by the Indians for making their pegalls. See *Ischnosiphon.* Fig. 79 is *M. arundinacea.*

Marima colorada (Venez.). See *Lecythis coriacea.*

Marool (Ind.). See *Sansevieria.*

Marsdenia tenacissima. RAJMAHAL CREEPER.

Exogen. *Asclepiadaceæ.* Small climber.

COMMON AND NATIVE NAMES.—Rajmahal hemp (Ind.); *Jiti* and *Chiti* (Beng.); *Muruvá-dúl* (Ceyl.); *Tongus* (Hind). The *Jetee* fiber of Royle's Indian Fibers; sometimes called the bowstring creeper.

India, throughout the lower Himalayas, Assam, and Burmah; Lower hills of Bengal.

BAST FIBER.—The *Jetee* fiber of India. The plant is abundant in the Rajmahal hills of India in dry and barren places, and the fibers of the bark are employed for making bowstrings by the mountaineers. "The fibers are not only beautiful in appearance, but strong and durable." In Dr. Roxburgh's tests of twine made from *jetee*, he found that in the dry and wet states it bore a strain of 248 and 343 pounds, when hemp in the same states bore 158 and 190 pounds. More recent tests, however, place it below hemp in strength, but above it in elasticity. The fiber is much used for making nets, and is not liable to injury by being kept in water.

Marsh grass, or salt marsh grass. *Spartina juncea.*

FIG. 79.—*Maranta arundinacea.*

Martynia louisiana. DEVIL'S HORNS.

Syn. *Martynia proboscidea.*

Exogen. *Pedaliaceæ.* Herbaceous shrub.

NATIVE NAMES.—*Testa di Quaglia* (It.). An allied species is known in Mexico as *Ungulus Diaboli.*

A Mexican plant, but found in the western United States. The species of this genus are natives of tropical America. A starch is obtained from their tubers.

FIBER.—The pods of *Martynia louisiana* at maturity shed their fragile outer coat, leaving an inner part of an exceedingly tough, fibrous nature, black on the outside, and with two slender, divergent hooked horns, commonly 4 to 5 inches, or rarely 12 inches, in length. These horns are easily split into thinner strands, and in this form are used by several tribes of Indians in the southwestern United States to make the black ornamental figures of their finely woven baskets. (*F. V. Coville.*) See under *Salix lasiandra.*

Marul and **Murva** (Hind.). *Sansevieria zeylanica.*

Marzuolo (straw plait) (It.). See *Triticum.*

Massette (Fr.). *Typha angustifolia.*

Mastinazia spp.

I find no reference to this genus other than in the manuscript notes supplied by Mr. Dorca, of Lima, Peru. The *Cámona, M. cariotifolia*, and the *Chonta, M. ciliata*, are said to yield fibrous bark. *Camona* also given to an *Iriartea.*

Mata-mata (Braz.). *Lecythis coriacea.*

Matapalo (Peru). *Ficus dendrocida.*

Matondo (Afr.). See *Brachystegia.*

Mats and matting.

For table of fibrous substances used for, see Economic Classification, page 32.

Mati (Viti). *Wikstrœmia fœtida.*

Matting, commercial.

Chinese and Korean, refer to *Cyperus tegetiformis;* Indian, *Cyperus corymbosus, C. esculentus, C. tegetum;* Japanese, *Cyperus unitans* and *Juncus effusus.* The Tinnevelly mattings of India are made from *C. corymbosus* and *C. tegetum*, the former species being used in the finer kinds. Other species of rushes and sedges are also employed in matting manufacture, but the above species are most commonly used.

Mauritia flexuosa. THE ETA OF ITA PALM.

Endogen. *Palmæ.* Palm tree, 80 to 100 feet.

Native of Brazil, but found in British Guiana and other regions of South America. Abundant on the banks of the Amazon, Rio Negro, and Orinoco rivers. Known in Venezuela as the *Moriche* palm. The *Aguaje* of Peru. The sap yields a palm wine, the leaves supply another beverage, and a sago is prepared from the soft inner portion of the stem. The tree often inhabits swampy ground liable to inundation. (See fig. 80.)

STRUCTURAL FIBER.—This is prepared from the outer skin of the young leaves, the strips from which dry in a thread-like form. It is known as *Tibisiri* fiber in British Guiana, where it is used by the natives for hammocks and general cordage purposes. According to E. F. im Thurn, "the leaf when fully developed is fan-shaped, but it first appears folded in a spike, which springs from the very center of the plant. It is from this spike that the fiber is obtained. Fiber taken from the spikes of old plants is not nearly as strong as that taken from young plants. Each leaf or spike is taken off singly; a sharp, dextrous rub at the top separates the outer skin, and the whole is then torn off. This is the fiber, the rest is waste. It is further prepared by boiling, drying in the sun, and twisting into strings. The fiber from a dozen long spikes is sufficient to make a large hammock. Both *Tibisiri* and *Crowia* fiber are twisted into string in a very simple and ingenuous way, but one which would be impossible to all except people such as these Indians. A proper number of parallel fibers are held firmly by one end in the left hand, the remainder of the fibers resting across the naked right thigh. The palm of the right hand is laid across the fibers, and therefore parallel to the thigh. By a very rapid downward and sideward motion of the right hand, followed by a slight backward motion, the fibers are rolled downward along the thigh and become spirally twisted. The single straw is used for hammocks, three strands for bowlines, and three of the triple cords (sometimes nine strands) for making hammock ropes."

In Venezuela the fiber of this palm, known as *Moriche*, is used for making reins and cordage. "In fineness, strength, and durability the fiber is surpassed by that obtained from *Astrocaryum vulgare*" (Spon). Among the products of this palm exhibited in the Kew Mus. are fans and baskets and a canoe sail from British Guiana, the latter made from central portions of the leaf stalk; also sandals made from the leaf stalk by the Wascari Indians. "The most useful fiber to the natives of British Guiana." (*Quelch.*)

* *Specimen.*—U. S. Nat. Mus.

Mauritia vinifera. THE MURITI PALM.

A Brazilian species, known also as the wine palm of Para. It is a tall, graceful species with a cylindrical trunk. The wine or juice "is obtained by cutting down

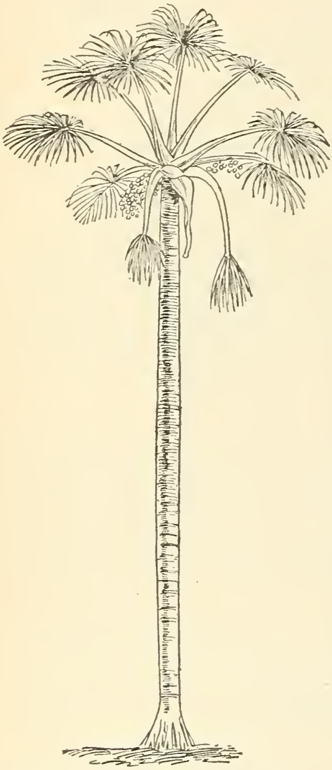

FIG. 80.—The Ita palm, *Mauritia flexuosa.*

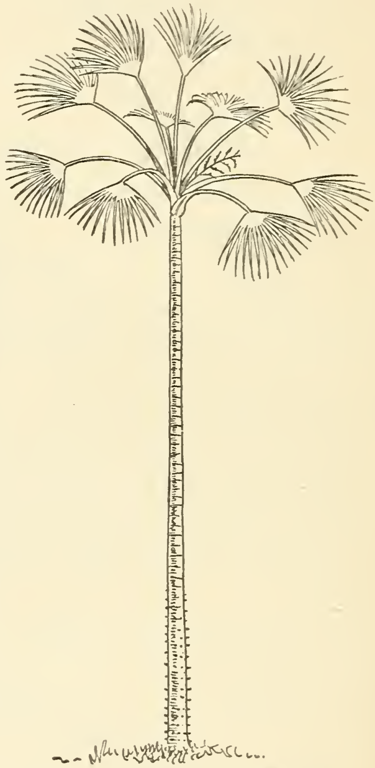

FIG. 81.—The Carana palm. *Mauritia aculeata.*

the tree and cutting into the trunk several holes about 6 inches square, three inches deep, and about 6 feet apart. In a short time these holes become filled with a reddish colored liquid which forms a very agreeable drink. On the Rio Negro the hard outside portions of the trunk are used for building purposes." (*Off. Guide Kew Mus.*) It also produces a pulp which, when boiled with sugar, is made into a sweetmeat. The young leaves and cuticle of the leaves form the raw material for the manufacture of hammocks and mats. In the handbook Notes of the State of Para, W. C. E., 1893, the fiber is called *burity*, and is said to be used for hats, baskets, and cordage.

Another species is noted in Brazil, *M. aculeata*, which "produces fibers of admirable fineness, resistance, and brilliancy." (See fig. 81.)

Mauritius hemp (see *Furcræa gigantea*).

Maurvi (Ind.). Thread of *Sansevieria zeylanica.*

Mauve. French name for *Malva sylvestris.*

Má-wéwel (Ceyl.). See *Calamus rudentum.*

Maximiliana regia. THE INAJÁ PALM.

Endogen. *Palmæ.* Palm tree, 100 feet.

One of the noble palms of the Amazon, which is crowned with leaves 30 to 40 feet long. The woody spathes are so hard they will stand fire when filled with water,

FIG. 82.—The Inajá palm, *Maximiliana regia.*

and are sometimes employed as cooking utensils. They are also used for transporting mandioca. There are many other uses of the tree in the domestic economy.

STRUCTURAL FIBER.—Extracted from the leaves by the natives and used in the manufacture of all kinds of native cordage, hats, etc.

Mazool (Ind.). See *Sansevieria roxburghiana.*

Mbocaya (Arg. Rep.). See *Acrocomia totai.*

Mecomba. (Apr.). See *Brachystegia.*

Megasse (see *Bagasse*).

Meibomia. See *Desmodium.*

Melic grass, purple. *Molinia cærulea.*

Melaleuca armillaris. SWAMP TEA TREE.

Exogen. *Myrtaceæ.* Small tree or shrub.

The genus is represented by several species, for the most part natives of Australia and the Indian Ocean. The above species abound in Tasmania.

BAST FIBER.—The friable lamellar bark can be converted into an excellent blotting paper—perhaps, also, filtering paper. It is worthy of record that many species of this genus yield a very similar bark, formed of innumerable membranous layers. The most gigantic species of the genus, *Melaleuca leucadendron,* which is common in south Asia and tropical Australia, exhibits such a bark, which thus may be turned to account. (*Dr. Ferd. von Mueller.*)

Melilotus alba. WHITE SWEET CLOVER.

COMMON NAMES.—Also called white melilot and bokhara clover.

Of Eastern origin, it is now found in Asia, Europe, and North America; common in many portions of the United States, where it may be recognized by its sweet odor, particularly when cut.

STRUCTURAL FIBER.—This can scarcely be called a fiber plant, though specimens of fibrous substance, extracted from its dead stalks, have been sent to the Department. As the stalks sometimes grow to a height of 6 or 7 feet (in Alabama) the fiber on the old stalks in the field blowing in the wind are sure to attract attention. It might answer for paper stock, though there are many better plants for the purpose. Bernardin also enumerates the species in his list.

Melocanna bambusoides.

A species of bamboo found in India. Its stems are sometimes beaten into fiber for various uses. For some of the uses of bamboo see *Bambusa.*

Melochia arborea.

Syn. *M. velutina.*

Exogen. *Sterculiaceæ.* Shrub or small tree.

Andaman Islands, Malay Archipelago, and Burmah, hotter parts of India, etc.

FIBER.—This is known as *betina-da.* It is a bast fiber, which when twisted into a stout cord is woven into the turtle nets used by the fishermen of the Andaman Islands. (*Watt.*)

Melodinus monogynus.

A species of *Apocynaceæ* found in Sylhet, which according to Roxburgh, produces a strong, tough fiber. He notes that in steeping the stems in a stream it killed the fish. Watt says the fiber is used as a substitute for hemp.

Merulius lachrymans (see under *Polyporus*).

Mesta pat (Hind.). See *Hibiscus cannabinus.*

Metl (Yuc.). Maya name for the *Agaves.*

Metroxylon sagu. THE SAGO PALM.

Syn. *Sagus rumphii.*

This genus of palms comprises six species, natives of the Malay Archipelago, New Guinea, and Figi. *M. sagu,* a native of the Moluccas, Sumatra, and Borneo, supplies a part of the sago of commerce, which is extracted from the pith. It has been called "a plant between a fern and a palm." (See fig. 83.)

STRUCTURAL FIBER.—Savorgnan states that the plant "is much sought for the beauty of its fiber, from which is manufactured cloth as well as very fine mattings. A delicate texture is made from the filaments drawn from the young, undeveloped leaves.

Mexican fiber. *Agave heteracantha.*

Mexican grass. Name sometimes given to sisal hemp.

Mexican whisk. *Epicampes macroura.*

Miyamóe (Burm.). See *Andropogon squarrosus.*

FIG. 83.—The Sago palm, *Metroxylon sagu.*

Milk weed. The Swamp, *Asclepias incarnata.* See also *Asclepias syriaca*, the common———.

Minbaw (Burm.). *Caryota urens.*

Mirganji jute (see *Corchorus*).

Miriti palm. Same as Muriti. See *Mauritia.*

Mitsumata (Jap.). See *Edgeworthia.*

Mocou-mocou. *Caladium giganteum.*

Mod, Mád, and **Máda.** (Ind.). *Cocos nucifera.*

Mohü (Hopi). *Yucca glauca.*

Molinia cærulea. PURPLE MELIC GRASS.

Also known in England, of which country it is a native, as blue moor grass. Has been proposed for paper making, and samples of paper stock and finished paper made from it are shown in the Kew Mus. It was shown in the Belgian section of the Vienna Exposition as a wrapping for Limburger cheese.

Monguba (Braz.). See *Bombax munguba.*

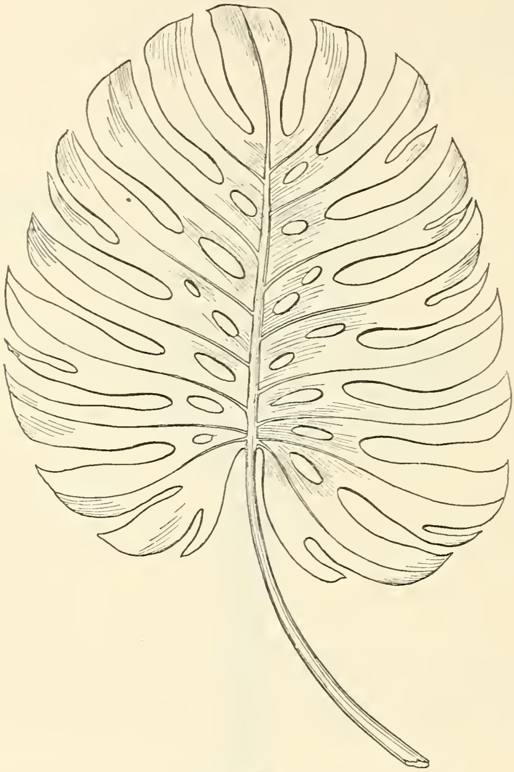

FIG. 84.—Leaf of *Monstera deliciosa.*

Monkey bass (Braz.). *Leopoldinia piassaba.*

Monkey bread tree. (See *Adansonia.*)

Monkey pot. *Lecythis ollaria.*

Monstera deliciosa.

Dorca includes this in his manuscript list of the fibers of Peru, the roots having been used in that country for ropes. The plant is better known, however, for its fruit. Frequently found in greenhouses in this country. (See fig. 84.)

Moonja (Ind.). See *Saccharum munja.*

Moorva, or **Moorgavee** (Ind.) See *Sanserieria.*

Moosewood (U. S.). See *Dirca palustris.*

Mora hair. *Tillandsia.*

Moræa robinsoniana.

An Iris-like plant, known as the wedding flower of Lord Howe's Island. Christy mentions that its leaves, which are 5 feet long and 3 inches broad, yield a fine fiber by boiling.

Moriche fiber (Venez.). *Mauritia flexuosa.*

Morning glory fiber. (See *Ipomœa.*)

Mororó (Braz.). See *Bauhinia.*

Morus alba. WHITE MULBERRY.

Exogen. *Moraceæ.* A tree, 40 to 50 feet.

Said to be a native of China and the north of India. Its leaves are used as food for silkworms, together with *M. indica.* *M. multicaulis* is the variety of *M. alba* which was planted so largely in this country many years ago at the time of the "multicaulis fever," when an attempt was made to introduce silk culture into the United States.

BAST FIBER.—The bark from twigs of *M. alba* and *M. indica* have been employed for paper stock in China, and the twigs without maceration have been used in India as a tie material. Savorgnan says that the plant has become naturalized in southern Europe, where it is known as *Gelso reale*, or royal mulberry, and is suitable for paper as well as cordage. *M. nigra*, cultivated chiefly for its fruit, gives a good fiber, said to have been used for cordage.

Morus rubra. RED MULBERRY.

COMMON NAMES.—Red mulberry, black mulberry, Virginia mulberry, *Murier sauvage.* (Fr.)

Western New England and Long Island, New York, west through southern Ontario and central Michigan to Dakota, eastern Nebraska and Kansas, south to Biscayne Bay, Florida, and the valley of the Colorado River, Texas. Wood used in fencing, for cooperage, etc., and in the South for boat and ship building.

BAST FIBER.—The fiber of this species is much used by the Indians for the manufacture of ropes, mats, and baskets. A good cloth is made from the fiber of the young shoots. Specimens of the bark and fiber of this species were sent to the Department from Missouri, prepared experimentally by Henry Koenig. Both twigs and sprouts were used, the former giving the best fiber. Only interesting from the botanical standpoint.

Mound lily (Austr.). *Yucca gloriosa.*

Mowana (Afr.). *Adansonia digitata.*

Mucujá (Braz.). See *Acrocomia lasiospatha.*

Mucuna (Braz.). Common name of *Mucuna urens.*

Mucuna urens.

A genus of leguminous plants found chiefly in tropical Asia and America, though represented in Africa and the Fiji Islands. "The plants of this genus are well known to travelers in tropical countries from the exceedingly annoying character of the seed pods, which are thickly covered with stinging hairs easily detached by the slightest shake, and causing great irritation if they happen to fall upon exposed parts of the body" (Treas. Botany, V. 2). The species named, known as the *Mucuna* in Brazil, furnishes a fiber for very strong ropes.

Mudar (see *Calotropis gigantea*).

Muhlenbergia pungens.

Endogen. *Gramineæ.* A perennial grass, 12 to 18 inches high.

COMMON NAMES.—Black grama, Grama China; Native Hopi Indian name, *Wügsi*, from *wügti*, woman, *sihü*, flower, a satiric name.

Grows abundantly in Nebraska, southward to New Mexico and Arizona, and along the Colorado River above Fort Yuma. "A rather rigid perennial, with firm, sharp-pointed leaves and open panicles. It has strong, creeping roots, and often does good service as a sand binder. In the sand hills region of Nebraska it grows abundantly around the borders of the so-called 'blow-outs,' preventing their extension and assisting materially in restoring the turf. In some parts of Arizona where it occurs it is a valuable forage plant." (*Scribner.*)

STRUCTURAL FIBER.—"The Hopi women of Arizona use this grass as a brush, the same bunch of grass serving a double purpose—with the stiff end they brush the hair and with the more flexible tip end they sweep the floor." (*J. Walter Fewkes.*)

Muhuba-branca.

Native name of an unidentified species of timber tree, 30 to 40 feet high, growing on the banks of the Amazon. The bark is used for calking canoes. A reddish dye is also obtained from the bark, used for coloring fishing lines.

Muka.

According to Royle, a native name of New Zealand flax fiber.

Mulberry.

The white ———, *Morus alba;* the Indian ———, *M. indica;* the black ———, *M. nigra;* the red ———, *M. rubra;* paper ———, *Broussonetia papyrifera;* Virginia ———, *M. rubra.*

Mummy cloth.

The linen of ancient Egypt, employed as "winding sheets" for the dead, hundreds of yards sometimes being used to wrap a single body. Made from flax.

Munj grass or **Munja** (Ind.). See *Saccharum.*

Muntingia calabura.

Exogen. *Tiliaceæ.*

Habitat, tropical America. It abounds in the West Indies and South America, where its wood is valuable for many purposes, and especially for making staves. In Venezuela it is known as Majaguillo.

BAST FIBER.—Specimens were received from the Venezuelan exhibit, Phil. Int. Exh., 1876, prepared by Dr. Ernst, who stated that its bark was sometimes used for coarse ropes and cordage. Its bast is very soft and pliable, twists easily, and if used in this manner, without attempting to separate or clean the fibers, is possessed of ordinary strength. The fibrils are exceedingly fine and silky, so much so that the bast, when broken, exhibits at the point of rupture the flossy appearance always seen at the raw ends of skein or embroidery silk. Separating the fiber would undoubtedly diminish its strength. It is employed slightly in Santo Domingo for cordage.

Muraró (Braz.). See *Bauhinia splendens.*

Murier. French for mulberry. See *Morus.*

Muriti palm (Braz.). See *Mauritia vinifera.*

Muru-murú (Braz.). See *Astrocaryum murumuru.*

Múrúrúni (see *Muriti*, above).

Muruvá-dul (Ceyl.). *Marsdenia tenacissima.*

Musa basjoo. THE BANANA OF JAPAN.

Exogen. *Musaceæ.*

The species of this genus abound in the tropical and subtropical regions of both hemispheres, and supply the fruits known as the banana and the plantain. The genus includes one of the most important commercial fibers, the manila hemp, *M. textilis,* which is described in its appropriate place. *M. basjoo* is cultivated in Japan where its fiber is also produced commercially.

STRUCTURAL FIBER.—Beautiful examples were received from the Japan court, W. C. E., 1893, together with specimens of the native cloths made from it. The fiber is a light salmon in color; is 4 to 5 feet long, bright and lustrous, and possesses fair strength. Regarding the specimens of cloth, I learn that the forms labeled "*Yechigo chijimi* (*a*) and *Okinawa jyōfu* (*b*) are used for summer dresses of the higher classes of Japanese. *Bashōfu* (*c*) is not used for cloth, but for ornamental bordering of "*Kakemo,*" and in place of wall paper, etc."

ECONOMIC CONSIDERATIONS.—In the descriptive catalogue of the exhibit it is stated that the banana is only grown commercially in Okinawa prefecture, "though it is widely distributed in the districts in the temperate zone where they are planted for ornamenting gardens only, accordingly, the annual produce of the fiber is not so great. The fiber is white in color and coarse to the touch. It is woven into cloth known by the name "*Bashōfu,*" which is highly esteemed for undershirts for summer, as it is lighter by about three-fourths to three-fifths of the weight of hemp and flax, and does not stick to the skin when perspiring."

Musa sapientum. THE COMMON BANANA.

This species and *M. paradisiaca* are, respectively, the banana and plantain of tropical America, Asia, and Africa, in which countries they have been cultivated from remote times, and where they are especially prized for their fruit. This article of food is so well known, however, both in its fresh state and as plantain meal, that its importance to the natives of the tropics need not be dilated upon here. These species abound everywhere in tropical America, from Florida, in the United States, through Central America and the West Indies to subtropical South America. While some writers have considered the banana and plantain as distinct species, the later botanical authorities as a rule have accepted the species *M. sapientum* as embracing both forms. The number of cultivated races, however, which bear fruits differing widely in appearance and quality is very large.

STRUCTURAL FIBER.—The Department collection is rich in specimens of banana fiber received in the past few years from many localities, though I do not know that the fiber is at present produced in commercial quantity anywhere in the three Americas. The fiber from the stalks of Florida-grown plants that I have extracted by machinery is very weak. Specimens from farther southward are better, though still do not approach in strength the fiber of manila hemp. In Mexico and Costa Rica, *M. sapientum* is known as *platano,* but in Venezuela, according to Dr. Ernst, *M. paradisiaca* is known as the *platano* and *M. sapientum* as the *guineo.* In the New South Wales Catalogue (Phil. Int. Exh., 1876), it is stated that "*Musa sapientum,* so generally planted in New South Wales for its fruit, yields a fiber second only in value of its kind to that of the manila hemp, which is obtained from *Musa textilis.*"

Speaking of *M. paradisiaca,* Forbes Royle says there is no doubt that the large cultivated plantain of India contains a considerable quantity of strong fiber, in the same way "that the yellow plantain does in Jamaica," and it seems worthy of inquiry whether the wild and useless plantain growing at the foot of the Himalayas "may not yield a stronger fiber than any of the cultivated kinds." A very full and complete account of this industry is given in Simmonds's Commercial Products of the Vegetable Kingdom by a correspondent in Jamaica. The plantain may be considered a valuable plant for paper making, and its fiber might possibly be extracted for this purpose alone at a considerable profit. Dr. Royle suggested utilizing the plant for this purpose in India nearly forty years ago.

As to the strength of plantain fiber, experiments by Dr. Royle gave most satisfactory results. Fiber from Madras bore a weight of 190 pounds, while a specimen from Singapore stood a strain of 360 pounds, and Russian hemp bore 190 pounds. "A twelve-thread rope of (India) plantain fiber broke with 864 pounds, when a single rope of pineapple broke with 924 pounds." Compared with English hemp and manila (see experiments in tenacity, under head of *Musa textilis*), a rope 3¼ inches in circumference and 2 fathoms long, made in Madras in 1850, gave the following results: The plantain, dry, broke at 2,330 pounds after immersion in water twenty-four hours; tested seven days after, 2,387; and after ten days' immersion, 2,050. Manila rope and English hemp dry, gave 4,669 and 3,885 pounds, respectively. Though common plantain fiber is not possessed of the strength of manila hemp, yet it is fitted for many purposes of cordage and canvas, and some of the finer kinds for textile fabrics "of fine quality and luster."

FIG. 85.—The banana, or plantain. *Musa sapientum*,

ECONOMIC CONSIDERATIONS.—The correspondence with the Department regarding the utilization of banana fiber in Florida has been quite large, many specimens have been sent in, and interesting statements regarding the possible production of the fiber have been made that I regret can not be produced in this limited space. In 1891 Mr. St. Hill, of Trinidad, sent specimens of both forms of fiber to the Department, and states that from 5 to 6 pounds can be produced from each stalk. The stalks grow 8 to 9 feet high, and 800 of them may be produced on an acre of ground. *Musa paradisiaca* grows 4 to 5 feet high, produces 2 to 3 pounds of fiber to the stalk, 800 stalks to the acre. It is the same as the plantain, except that it is less in size and quantity, and is prepared in the same way.

J. H. Hart, director of the Trinidad Botanical Gardens, says that the fiber can be prepared from the stems by any of the ordinary scraping machines now in use. The chief difficulty with the extracting is the large percentage of water in the stem.

EXTRACTION OF THE FIBER.—Forty years ago or more the production of banana and plantain fiber must have been a considerable industry in Jamaica. In the Commercial Products of the Vegetable Kingdom, by P. L. Simmonds (London, 1854), is given an exhaustive account of the cultivation, harvesting, and extraction of banana fiber, furnished by a Jamaican correspondent, from which it is gleaned that 100 pounds of stalk will give about 15 pounds of fiber, net weight, and when a whole tree furnishes 4 pounds of fiber one-fourth of the quantity is derived from the stalks. One hundred plantain trees can be crushed in twenty minutes with one horse, allowing five minutes for rest. After crushing, the fiber was boiled to separate the gluten and coloring matter, carbonate of soda and quicklime being used as chemical agents. To make 3 tons of fiber a day it was necessary to have four boilers of 800 gallons each, and to give 5 boilings in a day, which amounted to 1,650 pounds of net fiber for each boiler, or 6,650 pounds for the four boilers. About 300 pounds of soda were required and a proportionate amount of quicklime. As the different grades of fiber were pressed separately they were also kept separate in the process of boiling, the lighter fibers requiring about six hours to bleach, while the darkest required fully eighteen. A capital of $25,000 was required for carrying on the cultivation of the plantain on an extensive scale, 18 tons of fiber being produced on 5½ acres at a cost of $870, or a little more than $48 per ton. From official statements it would seem that no such industry has existed in Jamaica in late years, as it is said that 2,000,000 banana stems are cut down annually, after the fruit harvest, "without any attempt being made to utilize the fiber they contain."

The Bulletin of the Royal Kew Gardens, for August, 1894, contains a valuable summary of information relating to bananas and plantains, from which the brief extracts which follow have been taken:

"In Jamaica a series of experiments, undertaken by Mr. Morris in 1884, showed the plantain fiber (*Musa sapientum* var. *paradisiaca*) was whiter and finer than ordinary banana fiber and that it approached more nearly to the fine glossy character of manila hemp. A banana stem weighing 108 pounds yielded 25 ounces of cleaned fiber, or at the rate of 1.44 per cent of the gross weight. A plantain stem weighing 25 pounds yielded 7¼ ounces of cleaned fiber. This was at the rate of 1.81 per cent on the gross weight. A sample of fiber prepared from a red banana at Trinidad in 1886 was valued in London at £24 to £25 per ton. Usually, however, banana fibers are not worth more than £12 to £15 per ton. They would only fetch even these prices when there is a high demand for 'white-hemp fibers,' and there happens to be a short supply of manila and sisal hemps.

"Mr. A. D. van Gon Netscher, when proprietor of plantation Klein Pouderoyen, on the west bank of the River Demerara, in 1855, furnished the following interesting particulars relative to fiber from the plantain: The experience of ten years on a cultivation of from 400 to 480 acres in plantains has shown that: 1. On every acre from 700 to 800 stems are cut per annum, either for the fruit, or in consequence of having been blown down by high winds, or from disease or other reasons. 2. The planting of the suckers at distances of 8 feet apart has never been tried, but I am of opinion that if so planted and cut down every eight months, for the stem alone, an acre would give from 1,400 to 1,500 good stems every cutting, or about 4,500 in two years. 3. On plantation Klein Pouderoyen, after repeated trials, the plantain stem on an average has been found to give 2½ pounds clean, and 1½ pounds discolored and broken fiber, the latter only fit for coarse paper. This result, however, has been obtained by very imperfect machinery. 4. The average weight of the plantain stem is 80 pounds. 5. The stems can be transported from the field to the buildings for $1 per 100."

Banana fibers from *Musa sapientum* are shown in the Kew Mus. from the Andaman Islands, Jamaica, Mauritius, Ceylon, British Guiana, Madras, Australia. The Jamaica samples cleaned by the late Nathaniel Wilson are of excellent quality. A sample from British Guiana was valued in 1892 at £25 per ton, but usually the price is much lower, and when other fibers, such as manila and sisal hemps, are low, banana fiber is practically unsalable.

Fiber extracted from the Abyssinian banana (*Musa ensete*) at Jamaica by Mr. Morris yielded at the rate of 1.16 per cent of the gross weight. The fiber was somewhat weak and dull looking; it had none of the luster of the best plantain fiber, and it was valued in London at £12 to £14 per ton.

*Specimens of fiber and cloth, Mus. U. S. Dept. Ag.; U. S. Nat. Mus.

Musa paradisiaca (see *Musa sapientum*).

Musa textilis. MANILA HEMP. WILD PLANTAIN.

Native of the Philippine Islands, where there are about 12 different varieties of the plant under cultivation. Spon states that the largest areas are grown in the provinces of Camarines and Albay, in the south of Luzon. Smaller areas are on the islands of Samar Leyté, Cebu, and Mindanéo. Plants are said to be found in Borneo and Java.

NATIVE AND COMMON NAMES.—*Abaca* (Phil. Is.); *Pissangutan.* (Malay); Manila and Cebu hemps (English and commercial).

The Department made an effort to introduce this plant into Florida about 1890. The seed was well distributed, but no reports were received further than that it failed to germinate. Attempts to introduce the plant into the West Indies have also proved unsuccessful.

STRUCTURAL FIBER.—The fiber is white and lustrous, easily separated, stiff and very tenacious, and also very light, which is a great advantage when the fiber is used for the rigging and running ropes of ships. Viewed microscopically the bundles of fibers are very large, but are readily separated into smooth fibers of even diameter after the alkaline bath. The central cavity is large and very apparent, the walls being of uniform thickness. The ends grow slender gradually and regularly. The detached sections (cross sections) appear irregularly round or oval in shape, and the central cavity is very open and prominent. As to tenacity, compared with English hemp, it stands as follows: A rope of manila 3¼ inches in circumference and 2 fathoms long stood a strain of 4,669 pounds before giving way, while a similar rope of English hemp broke with 3,885 pounds. A second test of rope 1¾ inches in circumference, and the same length, gave 1,490 pounds for the manila and 1,184 pounds for the English hemp.

A large and valuable collection of abaca or manila hemp was received at the Phil. Int. Exh., 1876, comprising a large portion of the fiber exhibit of the Philippine Isles. The fiber is exhibited in different stages, as well as samples of abaca cloth and the manufactures from it. Other samples were received from the Queensland exhibit, prepared by Alexander McPherson, as well as from the other international exhibitions held since that time.

While the hemp is called *abaca* by the natives of the Philippine Isles, other names are given to the different qualities of fiber, as *bandala,* which appears to be the harder and stronger outer fiber, which is used for cordage. The finer fibers of the inner layer are called *lupis,* and are employed in weaving delicate fabrics, while the intermediate layers furnish the *aupoz,* which enters into the manufacture of the web cloths and gauzes. The natives distinguish the several varieties of the plant as follows: *Abaca brava,* or the wild *abaca,* called by the Bicoles *agotai*; the mountain *abaca,* which is used for making ropes, called *agotag* and *amoquid*; the *sagag* of the Bisayas; the *laquis* of the Bisayas, by whom the fibers of the original *abaca* are called *lamot.*

USES OF THE FIBER.—The manufacture of manila hemp in this country is for the most part confined to binding twine and cordage. Mr. Joseph Chisholm, a veteran manufacturer of Salem, Mass., states that manila hemp began to be used extensively in this country, in Salem and Boston, in 1824 to 1827. In 1820 a sample was brought to the first-mentioned city by John White, a lieutenant in the United States Navy, on the brig *Elizabeth.*

The fiber is imported in bales of 270 pounds, costing at present about 4½ cents per pound; January, 1890, 7½ cents per pound. One New York manufactory used in 1879 41,366,710 pounds of this fiber, equivalent to 153,173 bales. While American-manufactured manila goes into the rigging of vessels or is used on shipboard, it also finds use for every purpose for which rope is employed. In regard to the capability of the *abaca* for the manufacture of fine fabrics, M. Perrouttel, a French botanist, in the Annales Maritimes et Coloniales du France, states that from the finer sorts of the fiber tissues or muslins are made of great beauty, which are very dear, even in Manila. He says: I had a number of shirts made from the muslin, which lasted me a very long time, and were cool and agreeable in the use. But it is especially in France that tissues of this material are best made and of the greatest beauty. They receive all colors with equal perfection. Veils, crapes, neckerchiefs, robes, and women's hats—all of great beauty and high cost, as well as of wonderful durability—are among the manufactures from the fiber of *abaca*. Besides these are various articles of men's wear, such as shirts, vests, pantaloons, etc.

CULTIVATION.—The cultivation of the plant is simple. In Albáy and Camarínes the finest growth is obtained on the slopes of the volcanic mountains, in open glades of the forest, where shade falls from the neighboring trees. On exposed level land the plants do not thrive so well, and in marshy ground not at all. The necessary conditions seem to be shade and abundant moisture, with good drainage. Too rich a soil tends to produce luxuriant leaves with a diminution of fiber. In laying out a new plantation use is generally made of the young shoots, which very quickly throw up suckers from the roots. In favorable situations 10 feet is the usual distance between the plants; in poor soil, 6 feet. During the first season weeds and undergrowth must be kept down; afterwards the vitality of the plants serves to exterminate other growths. The forest shade also is no longer necessary, the leaves protecting the buds from the sun. In exceptional instances the plants are raised from seed. The ripe (but not overripe) fruit is cut off and dried. Two days before sowing the kernels are removed and steeped in water over night. Next day they are dried in a shady place, and on the following day are sown in holes 1 inch deep in fresh, unbroken, and well-shaded forest land, allowing 6 inches between the plants and between the rows. After a year, the seedlings, then about 2 feet high, are planted out and tended in the same way as suckers, care being taken to keep the soil heaped up around the stem. The plants raised from suckers require four years before producing fiber of any value; those raised from year-old seedlings need at least two years. (Spon's Enc.).

EXTRACTING THE FIBER.—The *abaca* is cut when 2 to 4 years old, just before its flowering or fructification is likely to appear. If cut earlier, the fibers are said to be shorter but finer. It is cut near the 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 fibers, which, in short, are the petioles of the leaves.

The fibrous coats, when stripped off, are left for a day or two in the shade to dry, and are then divided lengthwise into strips 3 inches wide. They are then scraped with an instrument made of bamboo until only the fibers remain. When sufficiently scraped, the bundles of fibers may be shaken into separate threads, after which they are sometimes washed, then dried and picked, the finest being separated by women, with great dexterity. After the fiber has been cleaned in this manner, it is ready for the manufacture of cordage and for all purposes where a coarse fiber is employed. The fine fiber, however, which is to be used for weaving, undergoes a still further operation of beating, which is performed with a wooden mallet, which renders the fiber soft and pliable, it having first been made up into bundles. The separate filaments are then fastened together at their ends by gumming, it is wound into balls, and is then ready for the loom. Sometimes it is dressed like flax, on a kind of hackle, and afterwards washed many times in running water until perfectly free from all extraneous matter, after which it is hung over poles or ropes to dry. Two men will cut and scrape about 25 pounds of the fiber in a day, the man that cuts the trees transporting them, stripping the layers, and cleaning the scraped fiber, though it is thought this is above the average. "From 150 to 200 trees are required to produce 1 picul, or 140 pounds of fiber, or 3,200 trees for a ton of 2,240 pounds." Thus an Indian prepares only about 12 pounds of fiber per day, for which he receives his half share, 18 cents, which is the value of 6 pounds of the hemp, "yet this insignificant pittance suffices for the wants of himself and family." Spon states that a plantation of mature shrubs will yield about 30 hundredweight of fiber per acre annually. For further information relating to the fiber of this and other species of plantains and bananas, see summary in the Kew Bulletin for August, 1894, previously referred to.

Musk mallow (see *Hibiscus abelmoschus*).

Musk ochra. *Hibiscus moscheutos.*

Nai (Pers.). See *Bambusa arundinacea.*

Naha (Ceyl.). See *Lasiosiphon eriocephalus.*

Náli and **Nálelá** (Ind.). *Hibiscus cannabinus.*

Nalika (Hind.). *Hibiscus cannabinus.*

Nalita pat (Ind.). See *Corchorus.*

Nangka (Java). *Artocarpus.*

Nangsi (Java). *Boehmeria.*

Nanat (Burm.). *Ananas sativa.*

Nannorhops ritchieana.

Endogen. *Palmæ.* Stemless gregarious shrub.

India and portions of Asia, where the plant is about 14 feet high. Dr. Watt mentions that mattings, fans, baskets, hats, and shoes or sandals are made from the leaves and leaf stalks. It was once used as a material for a rope bridge across the Jhelum, in place of *munj* (*Saccharum*), but proved an inferior substitute. "Scurf from the bases of the leaves (surface fiber) is used as tinder for matchlocks."

Napé (Tahiti). *Cocos nucifera.*

Nar (Ind.)=Fragrant.

Nara-woel (Ceyl.). *Naravelia.*

Narainganji jute (see *Corchorus*).

Naravali and **Narvilli** (Ind.). See *Cordia.*

Naravelia zeylanica.

Exogen. *Ranunculaceæ.*

A scandent shrub of India, Ceylon, and other regions, the stems of which are roughly twisted into useful ropes.

Nárel, náryal, etc. (Ind.). *Cocos nucifera.*

The Dic. Ec. Prod. Ind. gives over 100 vernacular names of the cocoanut, among which are *náriel* (Hind.); *nárikel* (Beng.); *naliyer* and *náryal* (Guj.); *naril, naural* (Bomb.); *nàralmád* and *mahad* (Mar.); *nari kadam* (Tel.); *narjil* (Arab.); *nargil* (Pers.); *nur* (Mysore); *nári-kera* (Sans.); etc.; others are formed from totally different roots.

Narnuli (Ind.). See *Cordia angustifolia.*

Neigella cloth. Fabric from sunn hemp. *Crotalaria juncea.*

Nelumbium speciosum. THE SACRED LOTUS.

This aquatic herb, with rosy, red, or white flowers, abounds in Africa and Asia. It is found in all parts of India.

BAST FIBER.—The long stalks of the lotus yield a sort of yellowish-white fiber, which is used principally for the wicks of sacred lamps in Hindú temples; and the Hindú doctors are of the opinion that the cloth prepared from this fiber acts medicinally as a febrifuge. (Dic. Ec. Prod. Ind., Vol. V.)

Nepal paper plant. *Daphne cannabina.*

Nepenthes distillatoria. PITCHER PLANT.

Exogen. *Nepenthaceæ.* Evergreen undershrub.

There are about 20 species of this genus, natives of Borneo, Sumatra, and the Indian Archipelago, *N. distillatoria* being found in Ceylon. The pitchers of this species are partly filled with water before they open; hence the specific name. In Ceylon it grows in great abundance in wet low country, particularly where the wet ground has a sandy bottom. The plants trail over trees and bushes.

WOODY FIBER.—This is called "one of the most useful cordage plants of Ceylon." The trailing stems afford cords known by the native name *bandura-wel.* "It is used very largely in building fences, walls, and sometimes in fixing the rafters of native cottages. In the manufacture of baskets it plays an important part, its pliability rendering it extremely easy to manipulate." (Handbook of Ceylon, W. C. E., 1893.)

Nesselhanf. German name for *Urtica* spp.

Nettle.

The nettles may be separated into the stinging and stingless forms; *Urtica* is an example of the former, *Boehmeria* of the latter. Other genera of nettles are *Girardinia, Laportea, Urera,* etc. The fever ———, *Laportea crenulata;* gigantic ——— of Australia, *L. gigas;* of India, *Celtis caucasica* or *australis;* The Nilghiri ———, *Girardinia palmata;* the stinging ——— of Europe, *Urtica dioca;* of the United States, *U. gracilis;* the stingless ———, common name of the China grass and ramie plants, *Boehmeria nivea* and *tenacissima.*

New Orleans moss (see *Tillandsia*).

New Zealand flax (see *Phormium tenax*).

Neyanda fiber (Ceyl.). See *Sansevieria guinëensis.*

Ngutunui (New Zea.). See *Phormium.*

Nidularium (see *Karatas*).

Niggi (Ind.). *Daphne cannabina.*

Nilghiri nettle (see *Girardinia palmata*).

Nin (Hawaii). *Cocos nucifera.*

Nipa fruticans. THE NIPAH PALM.

Endogen. *Palmæ.*

Portions of India and the Andaman Islands, in the river estuaries and tide lands. Dr. Watt states that the leaves are used for thatching houses and for mattings. Hats and cigar cases are made of the fronds. The palm has other economic uses, as for food, spirits, etc. Cigarette wrappers are made of the leaves, and commonly used in Malacca.

Nipah palm (see the preceding).

Niyanda (Ceyl.). See *Sansevieria guinëensis.*

Noix d'Areca (see *Areca catechu.*)

Nolina spp.

The plants of this genus resemble those of *Dasylirion,* the leaves being long and narrow, and finely serrated on the edges. They abound in the Southwestern United States where the *Yuccas* are found most common.

STRUCTURAL FIBER.—"*N. texana, N. lindheimeriana,* and *N. microcarpa,* of the Southwest, all have abundant narrow leaves, strong and flexible, much used by Mexicans for thatching, basketry, matting, and brooms; I do not know that the separated fiber has ever been examined" (*Dr. Havard*). In the Department collection the genus is represented by a single species, *N. microcarpa*, the leaves being very slender and fibrous.

Nona (Beng.). See *Anona reticulata.*

Oadal (Ind.). See *Sterculia villosa.*

Ochroma lagopus. CORKWOOD TREE.

Exogen. *Sterculiaceæ.* Tree, 40 feet.

West Indies, Central and South America. Is known as *Balsa* in Spanish-speaking countries. The soft, spongy wood of this species is used in Jamaica as a substitute for corks, and as floats for fishing nets.

SURFACE FIBER.—The fruit, or seed pod, which is about a foot in length, contains a vegetable silk, or silk cotton, that may be used in stuffing pillows and the like. Five specimens of this substance were exhibited in the Venezuelan and Costa Rican courts, W. C. E., 1893. The fiber is an ocher red in color, is very coarse and of little strength, though it might, if easily obtained, be useful for mattings and cordage requiring little strain.

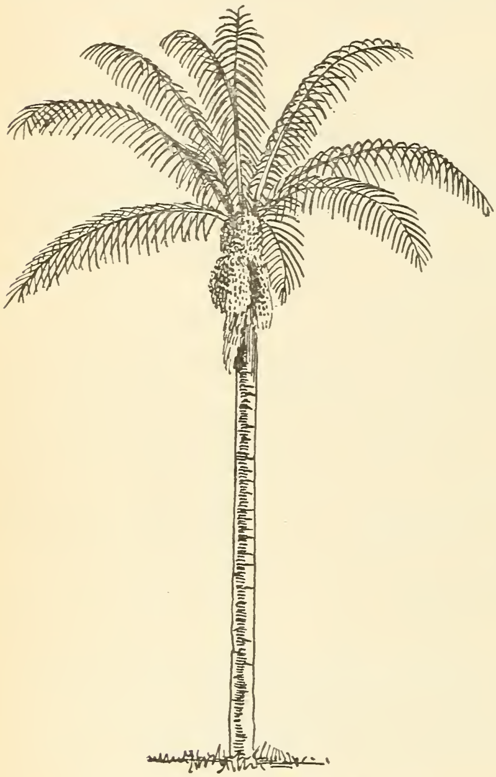

FIG. 86.—The Baccába, *Œnocarpus bacaba.*

Ocimum basilicum. SWEET BASIL.

A common herb of India, grown for its seeds. "It is cultivated to a small extent in the western portion of the Hooghly district on account of the strong fiber it yields for rope making." (Spon.) Doubted by Dr. Watt.

Ocotea sieberi.

A genus of *Lauraceæ*, chiefly large trees inhabiting tropical America. This species, formerly *Oreodaphne cernua*, is found in Mexico and portions of South America. In Trinidad it is known as *Bois ceip*. "The fiber is very strong, stands water well, and would be good for twine making. A tree will produce 2 to 3 pounds of fiber 4 to 6 feet long." (*St. Hill.*)

Odina wodier.

A species of *Anacardiaceæ*, a tree 40 to 50 feet, which grows in the hotter portions of India. The bark yields a coarse cordage fiber.

* *Specimen.*—Bot. Mus. Harv. Univ.

Oelta kamal (Ind.). See *Abroma augusta.*

Œnocarpus bacaba. The Turu Palm, or Baccába.

There are six or seven species of this genus of Brazilian palms, the plants abounding chiefly on the banks of the Amazon and Orinoco rivers. They are lofty trees, with smooth, straight stems, crowned with a cluster of pinnate leaves. The above species yields a Piassaba-like fiber. In some parts of British Guiana, where the tree is known as the Turu palm, the leaves are used for thatching. *Œ. bataua* is found in the State of Para, where it is said "to furnish the strongest ropes for the navy." *Œ. distichus* is an allied species, mentioned by Orton, and *Euterpe* (*Œnocarpus*) *acuminata* is the Anonillo of Costa Rica. Several of the species yield a colorless oil, which is used to adulterate sweet oil in Para. See figs. 86 and 87.

Oetan (Malay) = wild, or pertaining to forests.

Oil Palm of Africa. *Elæis guineensis.*

Oi-moi (China). Jute. See *Corchorus.*

Oiselle hemp (see *Hibiscus sabdariffa*).

Okra and **Okrho** (see *Hibiscus esculentus*).

Olona fiber (Hawaii). See *Touchardia.*

Op-nai (Burm.). *Streblus asper.*

Opuhe (Hawaii). See *Urera sandwicensis.*

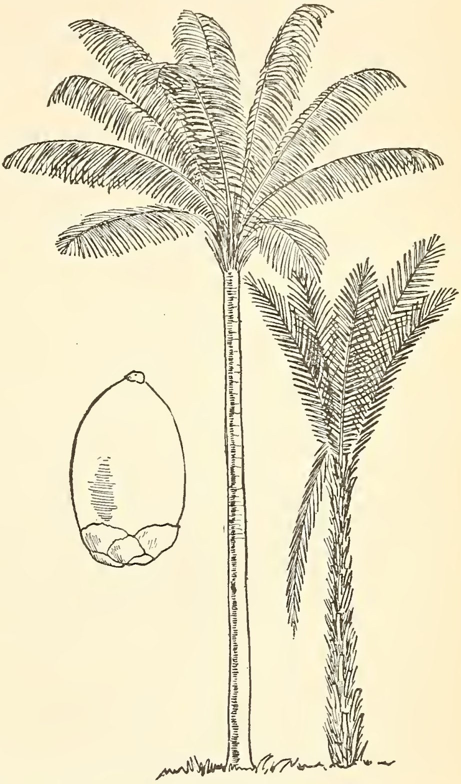

Fig. 87.—The Patáwa, *Œnocarpus bataua.* Young and old trees.

Opuntia spp. Prickly Pear.

The prickly pears form a large genus, confined to the American continent, though distributed to many other countries. *O. polycantha* is the species most common in western United States, while *O. humifusa* is found in Florida. *O. dillenii*, a South American species, has been noted as a possible fiber plant in India, but "the samples of fiber shown at the Colonial and Indian exhibitions were pronounced worthless by the paper makers who examined them." (*Dr. Watt.*) The experience of the writer with the prickly pear cactus in Florida leads to the suggestion that the mere gathering of the material would be a costly operation.

Oreodoxa regia. Royal Palm.

Endogen. *Palmæ.* A noble palm, 60 to 90 feet.

The magnificent palm is met with in certain localities in Florida, chiefly "Little and Big Palm Hummocks," 15 and 25 miles east of Cape Romano, and also on Elliott's Key. Grows in the West Indies, where it is known as Palma Real. The genus *Oreodoxa* includes six species of graceful palms indigenous to tropical America.

Structural Fiber.—Not used in Florida for any purpose; quite rare. Dr. Parry, who brought the museum specimens from Santo Domingo, says the large sheaths of the leaves supply material for thatching and lining the sides of houses. It is also used for floor matting and coarse baskets. The external ring of hard woody fibers on the main stem is pressed out into thin sheathing boards. The fruit of the species is in common use on the island for feeding hogs and cattle. Dr. Smith, in the Treasury of Botany, mentions *O. oleracea*, the West Indian cabbage palm, which sometimes attains a height of 100 feet. The semicylindrical portion of the leaf stalks are formed into cradles for negro children, and the inside skin peeled off while green produces a kind of vellum, which will take ink.

Orme d'Amerique (Jam.). See *Guazuma.*

Orthanthera viminea.

Exogen. *Asclepiadaceæ.* A shrub.

This plant, belonging to the milk-weed family, grows near the foot of the Himalayan Mountains, its long, slender, leafless, wand-like stems, 10 feet or more in length, furnishing a bast fiber of remarkable tenacity, suitable for rope making. "In Sind the unsteeped stalks are made into ropes for Persian wheels, a purpose for which they are admirably adapted as they do not rot readily from moisture." (*Dr. Watt.*)

Ortie blanch, etc. (see *Boehmeria nivea*).

Oryza sativa. COMMON RICE.

Endogen. *Gramineæ.* A grass.

The rice plant of commerce is supposed to be of Asiatic origin, though it is said to have been found, apparently in a wild state, in South America. As is well known, rice is the principal food of the laboring classes of China, India, and the Indian Archipelago, and forms the entire food of many people. As it is a marsh plant, it requires flooding with water, when under cultivation, to produce the best results. In this country it is grown as a food plant, chiefly in the lower pine belt, extending from 80 to 100 miles inland from the coast, from Virginia down along the Atlantic and Gulf coasts. "The plant was probably introduced into the United States about the year 1693, by Thomas Smith. It is said to have been grown successfully in England, Germany, and even in the colder parts of Siberia." (*Prof. Milton Whitney.*)

FIBER.—Its straw is chiefly used as a fiber product in Eastern countries. In the Japan exhibit, W. C. E., 1893, there was a very full series of samples of rice straw, rice-straw pulp and paper, and rice-straw plait, the latter made by inmates of the prison at Yamaguchi. It is worthy of note that this by-product in Japan amounts to not less than 15,270,000 tons annually. It is utilized in various ways, such as in bags for keeping and transporting cereals, root crops, etc., for making various kinds of ropes and cordage, mats, "*Mino*" or rain coats, sandals known as "*Zori*" and "*Waraji*," thatching roofs, making summer hats and other straw work. It is also largely used both as fodder and litter for horses and cattle.

"It has recently been chiefly consumed in manufacturing straw pulp, which, mixed with other kinds of fibers, is largely used for manufacturing printing paper. Until a few years ago, nearly all printing paper used for newspapers, journals, etc., was imported from foreign countries, but at present almost all demands are supplied with the homemade article, and there is every hope that in future, it may be exported to foreign countries, on account of its cheapness and the ease of obtaining the materials." Straw plait is also made in Japan from barley straw (see *Hordeum*).

Rice straw does not appear to be used in India, and little progress has been made toward its employment for any purpose in that country. Indeed, Dr. Watt states that the straw and roots are too valuable to the cultivators to offer for sale, as they are generally left to enrich the soil for the next crop.

Osiers (see *Salix*).

Oteri (New Guin.). *Cocos nucifera.*

Oulemari (Fr. Guian.). See *Couratari.*

Ovao (Tahiti). *Wikstroemia fœtida.*

Ozonium auricomum (see under *Fomes*).

Paat, and **Pat** (Ind.). Jute. See *Corchorus.*

Pachira alba.

This plant is the best known representative of a tropical American genus of *Sterculiaceæ*, allied to *Adansonia*, the baobab tree of Africa. The fruit is an oval, woody single-celled capsule, with a number of divisions and containing numerous seeds, covered more or less with down or seed hairs, forming a head of vegetable wool.

Fiber.—These plants yield both bast and surface fibers, the former in the bark, the latter in their seed vessels. *P. alba* is a New Granada species that is said to "furnish the entire country with cordage, both strong and durable."

Among other species may be mentioned *P. barrigon*, Panama, the seed hairs of which are used to stuff pillows and cushions. *P. insignis* is a small West Indian form mentioned as a fiber plant in the Flax and Hemp Commission list. Savorgnan enumerates *P. aquatica* from Martinique. "Fiber from the bark used for fishing nets and ship cables, and wadding is made from the down of the seeds."

The Mexican fiber known as *Majagua clavellina* is said by Dr. Ernst to be produced from *P. fastuosa*, referred to by Oliva in La Naturaleza, v. 89, as *Carolinea fastuosa*. The genus *Carolinea* was erected by the younger Linnæus, but, by the law of priority, botanists usually accept *Pachira.*

Pachyrhizus angulatus. Short-Podded Yam Bean.

This valuable economic plant is widely cultivated in the Tropics of both hemispheres, and yields tuberous edible roots as well as pods. Like many other species of the Leguminosæ, its stems are fibrous. The plant is known on the Fiji Islands as *Yaka* or *Wayaka*, and from its twining stems a tough fiber is produced that is used in making fishing nets. See Kew Bull., May, 1889. Compare *Dolichos trilobus.*

Pacoa (Is. Reunion). *Pandanus utilis.*

Pæderia fœtida.

An Indian climbing plant, of the *Rubiaceæ*, which has recently attracted considerable attention, as it yields a strong flexible fiber, silk-like in appearance. Indian name, *Bedolec sutta.*

The plant could doubtless be cultivated; moreover the supply of wild plants would not readily be exhausted, as on the plains, where they thrive best, the grass is burned down annually, and, during the rains, the roots throw up fresh shoots. The proper time for collecting the plant is the cold or dry season; during the rains the fiber comes off dirty and discolored. The stem is divided into sections, a joint occurring at every 12 to 24 inches. The cut stems, while still green, are divided at the joints, and the fiber is removed in the following way: The operator takes each section in both hands, and twists it as much as possible, to disengage the fibers, having first carefully stripped off all the bark of the stem. He then disengages at one end enough of the fiber to take hold of, and gradually strips it entirely away. The process would be too slow, laborious, and costly for commercial purposes. Machinery has not yet been applied to it. Probably a pair of crushing rollers and a simple scutching apparatus would suffice. (Spon.)

Paglia di capelli (It.) (Straw-plait). See *Triticum.*

Paina (Braz.) = Silk Cotton. See *Bombax* and *Eriodendron.*

Palm fiber.

The principal palms from which fiber, or fibrous material, has been obtained are as follows: Assai ———, *Euterpe edulis;* Bamboo ———, *Raphia vinifera;* Betel-nut ———, *Areca catechu;* Booba ——— (see *Iriartea*); Broom ———, *Attalea funifera* and *Thrinax argentea;* Busu ———, *Manicaria saccifera;* Cabbage ———, *Euterpe oleracea;* Cabbage ——— of Australia, *Livistona australis;* Carana ———, *Mauritia carana;* Carnauba, or Brazilian wax ———, *Copernicia cerifera;* Catechu ———, *Areca catechu;* Chusan ———, *Trachycarpus fortunei;* Cocoanut ———, *Cocos nucifera;* Cokerite, or Kokerite ———, *Maximiliana regia;* Coquito ———, *Jubæa spectabilis;* Curua ———, *Attalea spectabilis;* Date ———, *Phœnix dactylifera;* Doom, or Doum ———, *Hyphæne thebaica;* Double cocoanut ———, *Lodoicea callipyge;* Dragon's Blood ———, *Dracæna draco;* Fan ———, *Chamærops humilis,* (see also Palmetto); Gebang ———, *Corypha gebanga;* Gomuti, or Gomuto ———, *Arenga saccharifera;* Hemp ———, or Indian ———, *Trachycarpus excelsus;* Eta, or Ita ———, *Mauritia flexuosa;* Iú ———, *Astrocaryum acaule;* Ivory ———, *Phytelephas macrocarpa;* Jamaica ———, *Sabal blackburniana;* Jará ———, *Leopoldinia pulchra;* Jupati ———, *Raphia tædigera;* Macaw and Great Macaw ———, *Acrocomia lasiospatha* and *A. sclerocarpa;* Miriti ———, *Mauritia flexuosa;* Murumurú ———, *Astrocaryum murumurú;* Nipah ———, *Nipa fruticans;* Oil ———, *Elæis guineensis;* Palmetto ——— (see *Sabal* and *Serenoa*); Palmyra ———, *Borassus flabellifer;* Pashiúba, or Paxiuba ———, *Iriartea exorrhiza;* Bataúa ———, *Œnocarpus;* Peach ———, *Guilielma speciosa;* Piassaba ———, *Attalea funifera* and *Leopoldinia piassaba* (see Piassaba in Catal.); Pinang ———, *Areca catechu;* Raffia ———, *Raphia ruffia;* Rattan ———, *Calamus rotang, C. rudentum,* and other species; Royal ———, *Oreodoxa regia;* Sago ———, *Metroxylon sagu* (see also Sago in Catalogue); Silver thatch ———, *Thrinax argentea;* Talipot ———, *Corypha umbraculifera;* Thatch ———, *Sabal blackburniana;* Tecuma ———, *Astrocaryum tucuma;* Tucum ———, *A. vulgare;* Wine ———, *Cocos butyracea* and *Caryota urens;* Wine ———, of Para, *Mauritia vinifera;* Zanora ———, *Iriartea exorrhiza.*

Palm lily, The tall (see *Cordyline indivisa*).

Palma real (W. Ind.). See *Oreodoxa regia.*

Palmea (Mex.) Collective name for the *Yucca* group.

Palmet (see *Prionium*).

Palmetto.

The saw ———, *Serenoa serrulata;* the cabbage ———, *Sabal palmetto;* the African, ——— or Crin végétal, *Chamærops humilis;* royal, ——— *Sabal umbraculifera;* silver top ———, *Thrinax argentea.*

Palmite (Afr.). See *Prionium.*

Palmyra bass fiber, and **Palmyra palm** (see *Borassus flabellifer*).

Palo de Balso (Peru). See *Ochroma.*

Palungoo (Tam.). *Hibiscus cannabinus.*

Pameta. Florida vernacular for *Palmetto.*

Pampas grass (see *Gynerium*).

Pandanus utilis, et sp. div.

The genus *Pandanus,* or screw pines, embraces some 30 species or more, which abound on the islands of the Indian Archipelago, the Mascarene Islands, India, China, etc., and are distributed to other countries. In the economic literature of American fiber plants I find no reference to the uses of these plants for fiber, though M. Bernardin gives *P. spiralis* as a Jamaican species. Screw pines, however, are common in conservatories.

Structural Fiber.—*P. utilis*, known in Mauritius as the Vacona, or Bacona, is cultivated for the sake of its leaves, which are made into sacks for coffee, sugar, and grain. The leaves are not cut till the third year, and are regularly cropped every second year afterwards. A plant will yield leaves enough for two large bags. The leaves are prepared as soon as taken from the tree; the operation consisting merely in splitting the leaves into fillets, which are three-fourths to 1 inch broad at the base, but taper to a point. They are 3 to 4 feet in length. "One of them will support the weight of a bag of sugar, or 140 pounds, without breaking." A plant yields material for two sacks. In the South Sea Islands "the leaves are also made into matting, baskets, hats, and thatch, and are used for cordage and other purposes. The root fibers are much stronger than those from the leaves, and are occasionally used for making cordage, and for admixture with jute in gunny bags." (Spon.)

P. odoratissimus: This species is found in India, the Straits Settlements, China, Australia, and the South Sea Islands, known as the Caldera bush. Some of its native names are *Cadhi*, Arab.; *Kadi*, Pers.; *Kenda*, Bomb.; *Pandang*, Malay; *Keyá* and *Ketki-keyá*, Beng.; *Waeta keyiva*, Ceyl., etc. Regarding the fiber, Dr. Watt states that the leaves are composed of tough longitudinal, white, glossy fibers which are employed for covering huts, making mattings, cordage, and in South India the larger kinds of hunting nets, and the drag ropes of fishing nets. The roots also are fibrous and are used by basket makers for binding. When cut into lengths and beaten out they are very commonly used as brushes for painting and whitewashing. "It is possible that this root fiber might be found suitable for brush making as a substitute for bristles, a form of fiber which is now in great demand." Both roots and leaves may be used as paper stock. (See fig. 2, Pl. IX.)

The Kew Mus. contains specimens from several species of Pandanus found in Eastern countries and the isles of the Pacific. *P. caricosus*, Fiji, is represented by baskets, fans, mats, etc., made from the leaves. The fibrous portions of the drupes of *P. leram*, an India species, are combed out into a kind of brush which is used for removing dust from the feet. *P. amaryllifolius*, Java, supplies, in its leaves, material for sleeping mats; in Ceylon chair mats are made from *P. humilis*, and the leaves of *P. houlletii*, Siam, are made into other forms of mats. Other species furnish material for scrubbing brushes in Burmah, and a native dress is shown from Polynesia made from the leaves of an unnamed species. The most notable species are named above

Pangane hemp. See *Sansevieria kirkii.*

Pangara (Ind.). See *Erythrina indica.*

Pani grass, or **Panni** (Panj.) (see *Andropogon squarrosus*).

Panicled acacia (see *Acacia leucophlœa*).

Panicum myurus. Camelote.

Endogen. *Gramineæ.* A grass.

The genus *Panicum*, which includes many of the fodder grasses and millets, numbers over 800 species, some of which are well known in the United States. Some of them are coarse forms. Their common names are legion. They are not fibrous in the sense of yielding a textile, but many of the species have been employed by natives in the manufacture of objects of domestic economy.

Panicum myurus is found in Venezuela, known as *Gamelote*, or, more properly, *Camelote*, growing in extraordinary abundance on all the plains of the country. The fiber is considered a useful grass for paper stock. In the Venezuelan Exhibition of 1883, according to Dr. Ernst, specimens of the grass and pulp made from it were exhibited, and it was proposed to utilize the product of the vast Camelote fields in paper manufacture. While the paper made from this grass is not of fine quality, it is strong and suitable for wrapping paper.

A grass fiber exhibited in the Mexican Court, W. C. E., 1893, under the name *Zacata de Manati*, is referred by Dr. Ramirez to *P. crus-galli* (fig. 88). "*Zacate* is a name given to various species of *Panicum; manati* doubtless refers to its growing on the river banks where the manatee can feed upon it." (*Ernst.*) The species is a common weed in this country.

FIG. 88.—Barnyard grass, *Panicum crus-galli.*

The flowering panicles of *Panicum acariferum* (now *Thysanolæna agrostis*) are made into brooms, which are much used throughout portions of India for sweeping houses. *P. maximum*, Guinea grass, is an American introduced species, the fruiting spikes of which are used for brooms in the Seychelles, etc. See also *Paspalum.*

Paper.

The value of a paper material depends largely, next to supply, upon the percentage of pure cellulose it contains. Esparto grass is one of the best substances for paper because of the high percentage of fine fibrous or cellular tissue which can be obtained from it. Five groups of paper materials are recognized in this work: 1. The spinning fibers—(*a*) in the form of waste from textile industries, or as second qualities; (*b*) the same in the form of rags. 2. The soft basts. 3. Palm-leaf fiber, etc. 4. The grasses. 5. Woody fiber, or the natural wood of trees reduced to cellulose. See *Linum*, *Gossypium*, *Corchorus*, *Edgeworthia*, *Broussonetia*, *Serenoa*, *Stipa*, *Bambusa*, *Zea*, and the *Gramineæ* generally, *Pinus*, *Picea*, *Abies*, *Populus*, and other genera in this work. See, particularly, *Picea mariana*, under which statements are made regarding the wood pulp industry.

Paper, Ancient (see *Cyperus papyrus*).

Paper birch (see *Betula*).

Paper mulberry (see *Broussonetia papyrifera*).

Papinjay (see *Luffa ægyptiaca*).

Papyrus, of the ancients (see *Cyperus papyrus;* ——— of Sicily, *C. syriacus*).

Paritanewha. New Zealand flax of the high regions. See *Phormium.*

Paritium elatum (see *Hibiscus elatus*).

Parkinsonia aculeata. JERUSALEM THORN.

Exogen. *Leguminosæ.* Spiny shrub.

This species is found in the West India Islands; introduced into all tropical countries, and in the hotter regions of India employed as a hedge plant. Its fiber is white, but short and brittle. Might be grown as a paper plant.

Parrotia jacquemontiana.

A shrub of the *Hamamelidaceæ,* found in northwest Himalayan district of India, the strong fibrous twigs of which are "used in the Panjáb for binding loads, making baskets, and very largely for constructing the rope or twig bridges of the Himalayan rivers." (*Dr. Watt.*)

Parsid (Bomb.). See *Hardwickia binata.*

Paspalum spp.

A genus of grasses which includes a considerable number of species of well-known pasture grasses, such as knot grass, Louisiana grass, purple paspalum, etc. Like the species of *Panicum* previously enumerated, some of the species are employed in industrial economy by natives in the countries where they grow. Notable examples are the wire grass of Jamaica, *Paspalum filiforme,* which has been made into halters, and *P. virgatum,* which supplies a rough material for ropes in Antigua.

Pat (Ind.). See *Corchorus.* The word in Singhalese also means leaf.

Pata (Ceyl.). Equivalent to fibrous bark.

Pati-kori (Beng.). See *Saccharum fuscum.*

Patsan and **Pitwa** (N.W. Prov. Ind.). See *Hibiscus cannabinus.*

Patta-appele (Ceyl.). *Urena lobata.*

Paullinia grandiflora.

Belongs to the *Sapindaceæ.* The representatives of the genus are nearly all climbing shrubs confined to tropical America. The above species is known in Peru as the *Turui,* and, according to Dorca, its bark is used for bands, tie material, etc. The seeds of some of the species yield an active principal identical with theine of tea, and this is employed in a beverage as a nervous stimulant.

Paukpan (Burm.). See *Æschynomene.*

Pavonia spinifex. ESCOBADURA OF ARGENTINA.

This genus of *Malvaceæ* is chiefly confined to tropical America, though a few species are found in Asia. They are small shrubs. Fiber of this species was shown in the Argentine Court, W. C. E., 1893. The species is very common in the northern half of Argentina . *P. odorata* and *P. zeylanica* are Indian species (*West Prov., Burm.* and *Ceyl.*) and "yield fiber of excellent quality." "It is, if anything, of a finer texture, softer, and whiter than *Hibiscus,* and stands a good chance of coming into commercial use as a substitute for *Hibiscus,* and even jute." (*Dr. Watt.*)

Paxiuba (Braz.). *Socratea exorrhiza.* See *Iriartea.*

Paxiuba-miri (Braz.). *Iriartella setigera.* See *Iriartea.*

Pemm (Yuc.). Maya name for *Ceiba pentandra.*

Pendang (Malay). See *Pandanus.*

Pendha (Ind.) = Rice straw.

Penghwai jambi (Java). *Cibotium barometz.*

Pennisetum alopecuros.

A coarse perennial grass of central India, with strong, tough leaves, from which ropes are made on Mount Abu.

Perezia wrightii.

Syn. *P. arizonica.*

Exogen. *Compositæ.* Perennial herb 1 to 3 feet.

Southwestern Texas to southern Arizona.

Surface Fiber.—At the junction of the branches with the roots, and covering the greater part of the former, is a soft, silky substance, which is used by the Apache Indians in gunshot and other wounds to stop hemorrhages, for which it is well adapted. (*Dr. E. Palmer.*)

Periploca aphylla.

An asclepiadaceous shrub of India, Persia, Arabia, and Nubia. The fiber resists water, and for this reason "is employed in Sind, with that of *Leptadenia spartum*, for making into ropes and bands used for wells." (*Dr. Stocks.*) Savorgnan also mentions *P. lævigata*, the peluria, or down, from the fruit of which is utilized as quilts for beds.

Peteria (Braz.). See *Furcræa gigantea.*

Phalsá and **Phalsi** (Ind.), **Pharsá** and **Phulsá** (Hind.). See *Grewia.*

Philodendron sp. Guembipi of Argentina.

A genus of air plants found in tropical America, described as having scrambling stems which attach themselves to trunks of trees. "An epiphyt with long aerial roots. Fiber is prepared from the leaves, and the bark of the roots is used for ropes that are indestructible in water." (*Niederlein.*) Examples were shown, Argentina exhibit, W. C. E., 1893.

Philodendron imbe, known as the *Imbe* in Brazil, is also enumerated in the list of useful fibers in the State of Para.

Phœnix dactylifera. The Date Palm.

This palm, the cultivation of which goes back into the ages, is found in all tropical eastern countries, and has been distributed to other lands. It has been introduced into cultivation in Florida, in the United States, though wholly for its fruit. Its native names are legion, but as it is more regarded for its fruit than its fiber, and many of its names refer to the fruit, it is not important to enumerate them.

Structural Fiber.—According to Royle, the natives of Arabia and the north of Africa have long used the leaves for mats, baskets, etc., and the foot stalks of the leaves for cordage. In the Dic. Ec. Prod. Ind. the following account is given regarding the uses of the plant as fiber by the natives of that country.

In the Panjáb, mats, fans, baskets, and ropes are made from the leaves, which are known as *bhútrá*, *pattra*, and *khúshab*. The petioles (*chhari*) make excellent light walking sticks, and, when split up, furnish material for making crates and baskets. The fibrous network which forms the sheathing base of the petioles, called *kabál*, *khajúr ka bokla*, or *khajúr múnj*, is used for making pack saddles for oxen, and the fiber separated from it for cordage. The bunch of fruit stalks, *buhárá*, is said to make a good broom, and is employed for that purpose in the Panjáb. See chapter on "Uses of Fibers," Introduction.

The huts of the poorer classes are entirely constructed of its leaves; the fiber (*lif*) surrounding the bases of their stalks is used for making ropes and coarse cloth, the stalks themselves for crates, baskets, brooms, walking sticks, etc., and the wood for building substantial houses. (See fig. 89.)

Other species.—*P. acaulis* is the dwarf date palm. Rope is made from its broad leaves, and it also supplies thatch material for native huts. The leaves of *P. farinifera* are made into coarse sleeping mats in India, while the split petioles are fashioned into baskets. In China the fiber is used for brushes. The leaves of *P. paludosa* supplies material for rough ropes in the Sundarbans, which are used for securing boats, logs, etc., and its leaves are also employed for thatching. *P. sylvestris,* the wild date, is an India and Ceylon species. In Bengal its leaves are used for baskets, mats, and bags, and in Bombay for brooms, brushes, and fans. The fiber is also adapted for paper making.

Phormium tenax. New Zealand Flax.

Endogen. *Liliaceæ.* A liliaceous plant growing in bunches.

Native names.—Nearly sixty native names are enumerated by Dr. Hector. Among these may be mentioned: *Atiraukawa* or *Hatiraukawa,* used for finest mats; *Harakeke,* name of all but the *Wharariki* form; *Huhiroa,* long fiber, mats, fishing lines, etc.; *Huruhurukika,* for rough garments; *Korako,* for best garments; *Ngutunui,* for best garments, quick grower; *Oue,* narrow leaf, fine fiber, next to *Tapoto; Paretaniwha,* strong fiber for fishing lines, nets, etc.; *Rataroa,* from East Cape, and the strongest of all. *Taihore,* light green leaf, with wide black edge; *Tapoto,* leaves narrow, deep purple margin; *Tarariki,* fine and soft; *Tihore,* plant of any variety, in Waikato best var. cultivated. *Wharariki,* weak fiber; etc. The fiber is known as *Muka.* *Harakeke* is the common variety of the lowlands; *Paritanewha,* the yellow var. of the high regions or hills, and *Taihore* the best quality.

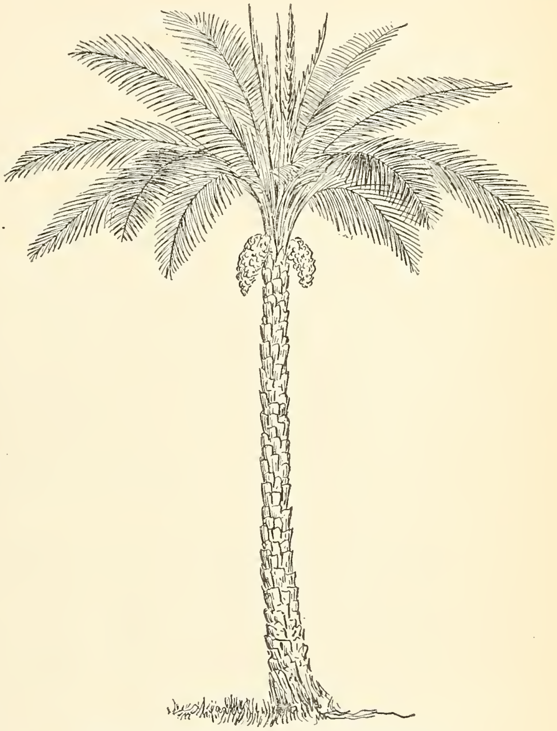
Fig. 89.—The date palm, *Phœnix dactylifera*

Native of New Zealand, and found on Norfolk Island and in other portions of Australia. Distributed to the Azores, St. Helena, Algiers, South France, and introduced in 1798 into the south of Ireland. Thrives on the Pacific Coast (California) where it is cultivated as a tie plant. In its native countries it is never found far from the sea. Captain Cook first brought this fiber to the notice of Europeans, he having found it in common use by the natives of New Zealand, as he speaks of "a grass plant like flags, the nature of flax or hemp, but superior in quality to either, of which the natives make clothing, lines, etc." It also flourishes on the west coast of Scotland, though the winters have occasionally been too severe for it. The leaves of the plant in Ireland grow to 5, 6, 7, and 8 feet high, and it is propagated by offsets which are not removed until the parent is 4 years old. Fig. 2, Pl. VII, is a greenhouse plant of New Zealand flax.

Structural Fiber.—New Zealand flax fiber is almost white in color, flexible, soft, and of a silky luster. The bundles of fibers form filaments of unequal size, which are easily separated by friction. It has considerable elasticity, but readily cuts with the nail. Microscopically examined, according to Vétillart, the fibers are remarkable for their slight adherence. The individual fibers seem very regular, having a uniform thickness, and the surface is smooth; they are stiff, straight, and very fine, and the central cavity is very apparent.

The Department of Agriculture was able to secure from the New Zealand exhibit, Phil. Int. Exh., 1876, a collection of over 100 specimens of this fiber and its manufacture, the series well illustrating the many uses of this valuable textile, the methods of preparation, and the native manner of dyeing it. The machine-prepared series was very full, and the samples of manufacture included nearly everything that can be made of fiber. In cordage there were 3-inch cables and ropes of all sizes, horse halters, small cordage, lead lines, fish lines (for sea fishing), and twine of the finest finish. The series of mattings illustrated the many ways that the fiber may be used in the household, as door mats, parlor and bedroom mats (in colors), and hearth rugs, while the finer kinds of fiber were made into cloth not unlike linen duck, into satchels, table mats, shoes (a kind of sandal), sacks, etc. Floor matting, carriage and railway mats were exhibited in variety, plain and in colors. The nets, of which there were many samples, could hardly be told from linen, both in color and finish. It is hardly necessary to state that these were not of native manufacture, as much of the fiber was exported, made up into the various articles enumerated. This was due to the fact that the English ropemakers did not pay for flax fiber a price proportionate to that given for manila hemp, and it was, therefore, found more profitable to manufacture at home and export the rope rather than the baled fiber. Some of the specimens were, to the touch, as soft as the finest flax, and such fiber is doubtless well adapted to fine fabrics. Varying quantities of the fiber have been imported into the United States for the manufacture of cordage and binding twine, though at the present time the imports are small. There was a sudden increase in the quantity, however, about 1892, and it was subsequently learned that the fiber was largely used in the construction of the "staff," or outer covering of the principal World's Fair buildings at Chicago. It was used to toughen and hold together the plaster and other materials, which, when combined, formed this building material.

As to tenacity, Royle gives the breaking point of New Zealand flax, compared with flax and hemp, as 23.7 to 11.75 and 16.75, respectively. In the Official Handbook of New Zealand it is stated that "during a late severe gale at Auckland it was found that flax rope, when subjected to the same strain as manila hemp (*Musa textilis*), remained unbroken, while the other gave way." Experiments by Professor Hutton with leaf strips one-eighth inch in breadth from middle part of young full-grown leaves showed the following breakage strain for four varieties: *Tihore*, 48 pounds; *Harakeke*, 42 pounds; *Paretanivcha*, 42 pounds; *Wharariki*, 34 pounds. He concluded that *Tihore* is the most valuable variety for all purposes; but the kinds that should be cultivated would depend upon the nature of the soil, for swamp flax of excellent quality could be grown in places where the superior *Tihore* could hardly live. But all the varieties of *P. colensoi* (now *P. cookianum*) should be carefully avoided, or, if manufactured into fiber, should not be sent into the market under the same name as fiber from *P. tenax*, or the latter will fall in the estimation of the public, from the inferior strength of the former.

Production.—On the best lands an acre may contain 2,000 bunches of the plant, or 100,000 leaves. These leaves, after cutting off the gummy and useless butts and drying in the sun, weigh about five to the pound, so that an acre may give nearly 10 tons of sun-dried leaves. When the outer leaves only are taken the quantity will be reduced to 4 tons. Assuming a yield of 15 per cent of clean fiber upon these 4 tons, the return should be 12 hundredweight an acre, to which may be added about 8 hundredweight of tow. The weight of green leaf required to produce 1 ton of fiber is stated by different authorities as follows: 5½ tons, 6 tons, 6½ tons, 6¾ tons, 7 tons, 7 to 8 tons. To obtain 2,000 bunches to the acre, however, the planting must be very close. (Spon.)

New Zealand Flax in California.—The plant has been grown in California for several years, and thrives in many localities. I have endeavored to learn the history of its introduction, but am unable to make positive statements at this writing. Professor Hilgard, the director of the State agricultural experiment station at Berkeley, has grown it at the station for some time, sending plants to substations and to farmers to be grown for leaves that are used instead of rope for tying vines. He informs me that the area on which it can be successfully grown is very large, as it seems to require much less water than is currently supposed. A tall variety is common as an ornamental plant in the gardens about the bay; the one he has been growing and distributing for years is of lower habit, but its fiber seems to be stronger and finer. Once started, it will do without irrigation almost anywhere in the Coast Range where frosts are not too heavy. In the Great Valley it seems to be limited to over 8 to 10 inches of rainfall, unless irrigated, but with irrigation it will grow fairly anywhere within the valley, and up to 2,000 feet in the Sierra foothills.

Small lots of leaves received by the Department from California were cleaned by W. T. Forbes, and a strong, valuable fiber was obtained from them. An effort was also made to secure leaves in sufficient quantity to obtain enough fiber for practical test, but as the leaves do not stand transportation, and would necessarily be several weeks on the way, the attempt was abandoned.

About 1890 the Department received (through the State Department) a quantity of seed sufficient for experimental purposes, which was distributed in Florida and other Southern States. The seed must have been injured, however, as it failed to germinate, even in the conservatories of the Department. In future experiments plants should be distributed instead of seeds, as the supply can easily be secured from the Pacific Coast, and it is claimed that seedlings do not inherit the characteristics of the plants from which the seed is derived. Besides, the early growth of plants from seeds is very slow. As New Zealand flax culture is possible in the United States, a full account of the practice in New Zealand is given.

Cultivation.—*Phormium tenax* will grow in almost any soil, but the more suitable the soil the finer the quality. It grows best on light, rich soil, by the sides of rivers and brooks, where sheltered from the wind. A rich, dry, but not deep, clay soil having yellow clay subsoil, with plenty of light and air, is very suitable, but the greatest crops are reared on deep volcanic soil. A well-drained swamp gives large returns, this fact having been verified by observation in the Upper Waikato and elsewhere.

Stagnant marshes are prejudicial to the growth of flax, but as soon as they are drained and the water sweetened the same flax will grow rapidly. The drains should be open, and the water therein should flow about 12 inches below the surface. If practicable, swamp land should be plowed as soon as it is dry enough for the purpose, and allowed to remain all summer, or till March, when it should be again plowed, and planted immediately thereafter. The soil will be well pulverized by that time. Should the land become very dry in summer, the drains might be stopped, so as to irrigate the soil; any land that is periodically inundated is very suitable for promoting rapid growth. Alluvial soil should also be plowed in winter or spring, and allowed to dry until autumn, when it should again be plowed and planted—that is, in March or April, or as soon as the autumn rains arrive; in fact, the earlier the better, for the plants make roots all winter, and are ready to come away with a vigorous growth in spring.

The plants should be sown in rows, and in the same way as trees are planted; but opinions differ as to the distance from row to row, and from plant to plant in a row. It seems to be overlooked that planted *Phormium* will not be allowed to grow into large bushes, as it does in the uncultivated state. On the contrary, the constant cutting which will be carried on will confine it within a comparatively limited space. The roots thrown out by the first plants will undoubtedly spread around it, but still it will always be practicable to keep the bunches within small areas. With this view, the rows might be only 4 feet apart, and only 3 feet between plants in the row. At all events, the quantity of soil that would be saved in this way would justify the experiment on a small scale. In this case the roots should be planted across the lines in rows. Six feet is generally recommended to be between rows and between plants, because closer planting might impoverish the soil; but it should be kept in view that flax needs shelter, and the proximity of the plants to each other would afford this, and assist in drawing up the leaves and making finer fiber. If suitable land is chosen, it is thought that impoverishment of soil will not result from the close planting.

With the view of still further economizing space, it has been suggested that about 10 or 12 rows should be planted, then a break of 10 or 12 feet should be left for drays to pass along and collect the leaves when cut. Then other 10 or 12 rows should be planted, then another break, and so on. The extent of the ground to be planted must, however, regulate this. About one thousand roots, planted 6 feet apart each way, will cover an acre of land; but if the land is planted 4 by 3 feet, as recommended above, about one-third more will be required for an acre. In one plant of *Phormium* there will be from 20 to 50 roots for transplanting. Opinions differ also as to the number of roots that should be planted together; one, two, and three are variously recommended. If two or three are planted together, a large space of ground would be required to be left around. Care should be taken to avoid planting the roots from which a seed stem has been thrown out, or planting the center portion of an old plant, which is not so productive as young shoots, having a tendency to run to flower, when it requires more nourishment than all the leaves do. The flower stalk should therefore be cut down as early as possible; and when this is done the cut part should be rubbed over with a little earth to prevent "bleeding," or, better still, twisted off. But if the close planting be adopted, only one root should be planted at one place. (*Dr. Hector.*)

PREPARATION OF THE FIBER.—The maturity of the leaf is ascertained by its texture and firmness, or by its being split at the point, or by the recurving of the blades from the central midribs. The leaf of the best *Phormium* should be over 5 feet in length, excluding the butt. The top of the leaf should feel soft to the touch, and droop a little; this occurs in winter.

The habit of the plant is to form large tufts, its sword-shaped leaves growing in opposite rows and clasping each other at the base.

One variety forms leaves 5 and 6 feet long, while another is not more than half the length. Mr. Salesbury, of the botanic garden, Chelsea, found that plants three years old will produce on an average 36 leaves, besides a number of offsets. Six leaves have produced 1 ounce of dry, available fiber after having been scutched and cleaned, at which rate an acre of land cropped with these plants, growing 3 feet apart, would yield more than 600 pounds of dressed fiber. The leaves being cut in the autumn, others spring up anew the following summer. It is said that the plant may be shorn of its leaves in the morning and before the sun has set they will be ready for weaving into cloth.

The principal operation is scraping and then separating the fibers with the thumb nail, after which combs are employed for a more minute separation. The fibers are subsequently dried in the sun, and are perfectly white—some short and strong, others fine and silky. According to the reports published by the New Zealand commissioner at the exhibition of 1876, the Maoris (or natives) only use a portion of the fiber upon one side of the leaf, the leaves being selected with great care. They scrape the leaf with a mussel shell, or piece of hoop iron, on the thigh, after which it is soaked in water and then dried. Their finest samples are obtained from particular varieties of the plant, only the youngest and best leaves being used, and careful attention being paid to the manipulation. "This native-dressed fiber, however, constitutes but a small portion of the fiber actually prepared on the island, as large manufactories have been erected, where the fiber is stripped by machinery." Two modes of dressing the fiber are practiced, known as the "cold" and the "warm" water dressing. The leaves of the flax are fed to a machine called a stripper at the rate of 100 to 120 feet per minute. The drums of these stripping machines are driven at the rate of 1,000 to 2,000 revolutions per minute, their diameter being from 14 to 20 inches. After passing through the strippers, the partially cleaned fiber is hand washed in bundles of about 20 leaves; these bundles are suspended in water and are allowed to soak for about two hours, the fiber is then spread out on the bleaching ground for a time, which varies according to the weather, and then hung on lines to dry. It is then either scutched or hackled, or both, packed in bales, and pressed for shipment. When the stripper is in good order, and the fiber has been fairly cleaned, the loss in scutching amounts to from 3 to 5 hundredweight per ton, and in hackling from 2 to 3 hundredweight. In the warm-water dressing the same operations are gone through with, with the exception that the fiber is washed and placed to soak from six to twenty-four hours in tanks filled with warm water, which is kept heated by means of either fire or a steam pipe.

In a report to the State Department by United States Consul Connolly the following note occurs:

"To imperfect machinery and carelessness in the selection of green plants may be ascribed the apparent coarseness and the inferiority so often complained of in the flax exported from certain portions of New Zealand. But with improved flax-dressing machinery and proper care exercised in the selection of the raw material, a very superior article can be produced. The fiber of *Phormium tenax* is susceptible of a much higher degree of preparation than has been bestowed upon it up to the present. This, however, is not altogether the fault of those who are engaged in its manufacture; it is for want of the necessary machinery. The hand-dressed article prepared by the natives is as fine as silk as compared with the modern machine-dressed flax of to-day. This only demonstrates the fact that the fiber may be reduced to a much finer quality, and all that is necessary to do this is an improved machine. If New Zealanders can not produce the requisite machinery, I trust the inventive genius of America will come to the rescue. There is certainly a splendid opportunity and a fortune for any man who will invent a machine that will successfully and economically reduce New Zealand flax to a proper degree of fineness."

FIG. 90.—Reed-grass, *Phragmites communis.*

For further accounts see following authorities: Phormium tenax, a Fibrous Plant, edited by Sir James Hector, New Zealand, 1889; The Leaf Fibers of the United States, Report No. 5, Fib Inv Series, U. S. Dept. Ag., 1893; U. S. Consular Report, May, 1890; Spon's Enc., Div. III.

**Specimens.*—U S. Nat. Mus.; Mus. U. S. Dept Ag.; Field Col. Mus.

Phragmites communis. COMMON REED OR REED-GRASS.

One of the largest of our native grasses, growing to the height of 12 feet, the rather stout culms bearing numerous broad, spreading, and sharply pointed leaves 1 to 2 feet long. It has deeply penetrating and extensively creeping rootstocks, making it one of the most valuable grasses for binding the banks of rivers subject to periodical floods. It is occasionally found along the coast in brackish marshes and sometimes upon sandy soils, and possibly may be employed with advantage for binding drifting sands or those liable to be shifted by high tides. The young shoots are liked by cattle and the mature stems make the best of thatch. It is very widely distributed throughout the temperate regions of both hemispheres, growing along river banks, borders of lakes, etc. (*F. Lamson-Scribner.*)

The revised name of this species is *Phragmites phragmites.*

FIBER.—In Mexico, where the plant grows 20 to 25 feet high (near to water), the stems are used for various purposes by the natives, according to statements made by Dr. E. Palmer, who says that they cut it to certain lengths and having split it, beat it flat and then weave it in and out, making a large square mat, with which they form the ends of their houses. They place it over the rafters before the tule thatch is put on. It is also used to cover verandas, and as screens for doors. (See fig 90).

The species is very common in Europe, where it is sometimes utilized in industrial economy. It has been employed in Italy for the manufacture of grass whisks.

* *Specimens* are shown in the U S. Nat. Mus.

Phrynium dichotoma. Synonym of *Clynogyne*, see under *Maranta.*

Phul shola (Beng.). See *Æschynomene.*

Phulahi (Ind.). *Acacia modesta.*

Phytelephas macrocarpa. THE IVORY PLANT.

A curious South American plant allied to the palms, which produces the vegetable ivory nut of commerce. It is known in Peru as the *Palipuntu*, and its leaves are sometimes employed in the manufacture of articles of domestic economy, besides as a thatch material for native huts.

Piassaba and **Piassava**; also written **Piaçaba.**

——— of Para (see *Leopoldinia piassaba*); ——— of Bahia (see *Attalea funifera*). (See also *Dictyosperma fibrosum, Borassus flabellifer, Raphia vinifera*, etc., which are piassaba-like fibers. Both *piassaba* and *piassava* are used in the economic literature of the bass fibers. I prefer, however, the spelling of the specific name of the Para form—*piassaba.*

Picea canadensis. WHITE SPRUCE.

Exogen. *Coniferæ.* A tree, 50 to 150 feet.

COMMON NAMES.—White spruce, single spruce, skunk spruce, cat spruce, etc.

This tree is found in low and rather wet soils, or borders of ponds and swamps, and is most common along the northern boundary of the United States; also Newfoundland, British Columbia, and Alaska. A valuable timber tree.

WOODY FIBER.—"The tough and flexible root was formerly made into rope and twine by the Indians, and used to stitch together their birch-bark canoes." (*Dr. V. Havard.*)

The Indians and woodmen in New Brunswick make use of spruce roots to tie up small packages, moose calls, etc., and the Micmacs of Nova Scotia also make use of the root for the same purpose. The root is used most commonly just as it comes from the ground, and is then quite pliable and very tough; less often—and then only when it is desired to make a somewhat long string—the root is pounded under water between two stones, care being taken to bruise and mash the wood cells without breaking the bark. In this condition it is possible to knot and tie the roots with nearly the same ease as that of a fiber proper, and the roots retain considerable of their original toughness. (*Dr. Wirt Tassin.*)

Picea mariana.

Syn. *Picea nigra.*

COMMON NAMES.—Black spruce, double spruce, blue spruce, yew pine, and many others; *Epinette jaune*, Quebec.

Ranges from Newfoundland and Labrador to Hudson Bay, northwest to north of Mackenzie River, eastern slope of Rocky Mountains, south through northern States to Pennsylvania, central Michigan, Wisconsin, Minnesota, and along the Alleghany Mountains to high peaks of North Carolina.

A soft wood, used for timber, fences, posts, and other purposes; largely employed as a material for wood pulp in paper manufacture.

WOODY FIBER.—The product of forest trees, known as wood pulp, is included in the second group of the classification of fiber substances. About 50 per cent of the substance of wood consists of cellulose, the percentage of cellulose in a paper product fixing the economic value of the plant as a source of paper material. A larger percentage of cellulose occurs in soft woods than in hard woods, and hence the soft woods are the more useful for the manufacture of wood pulp. The following table from "Cellulose," by Cross and Bevan, will serve to illustrate this point:

Wood.	Water.	Cellulose.	Aq. extract.	Resin.	Noncellulose.
Birch	12.48	55.52	2.65	1.14	28.21
Beech	12.57	45.47	2.41	0.41	39.14
Box	12.90	48.14	2.63	0.63	35.70
Ebony	9.40	29.99	9.99	2.54	48.08
Oak	13.12	39.47	12.20	0.91	34.30
Alder	10.70	54.62	2.48	0.87	31.33
Lignum vitæ	10.88	32.22	6.06	15.63	35.21
Lime	10.10	53.09	3.56	3.93	29.33
Chestnut	12.03	52.64	5.41	1.10	28.82
Fir	12.87	53.27	4.05	1.63	28.18
Mahogany	12.39	49.07	9.91	1.02	27.61
Poplar	12.10	62.77	2.88	1.37	20.88
Pine	13.87	56.99	1.26	0.97	26.91
Teak	11.05	43.12	3.93	3.74	38.16
Willow	11.66	55.72	2.65	1.23	28.74

Cellulose is the preponderating constituent of all vegetable tissues. In addition to the cellulose there are present in the wood nitrogenous substances, resins, gums, and (mineral) ash, which are to be removed, more or less, in order to produce the fiber or pulp. To do this economically and in such a manner that the fiber may remain long, pure, and white, and the mass preserve its "felting" qualities as much as possible, is the aim of the various processes.

ECONOMIC CONSIDERATIONS.—While many species of trees are used in the manufacture of wood pulp, the larger amount is prepared from spruce, a frequent practice being to add some poplar or aspen pulp to whiten the spruce pulp. Among other woods that are employed are cottonwood, bass wood, birch, buckeye, gum, balsam fir, hemlock, jack pine, cedar, etc., while in the South, pine, cypress, and other woods are used.

The kinds of wood employed in this industry depend upon three things: (1) The resulting product as to quality and yield; (2) the cheapness and convenience of the necessary plant and chemicals; (3) the application to various woods.

Coming to the practical matter of the preparation of wood pulp, or wood fiber, Dr. Samuel P. Sadtler states that two varieties of pulp for paper making may be obtained from wood, viz, mechanically and chemically prepared pulp. Of these, the mechanical wood pulp obtained by shredding the wood serves for the inferior grades of paper only, as its fibers are too short and do not "felt" or interlace sufficiently. It can, therefore, be used only as a filling material. Moreover, the resin present resists strongly the action of bleaching agents, and the paper becomes yellowish after a time. On the other hand, what is termed chemical wood pulp has met with great favor as a very pure and easily obtainable form of cellulose. Two main processes for its production are now in use, the caustic soda process and the bisulphite process. In the former, the wood chopped up and crushed is boiled under pressure with caustic soda. This is either done in cylindrical boilers at pressures varying from 4 atmospheres (60 pounds), as first used by Watt and Burgess, to 14 atmospheres (210 pounds), as used by Sinclair, or by Ungerer's graduated method in a series of nine connected vessels, using low pressure and partly saturated lyes upon the fresh wood and increasing the pressure and using fresher lyes upon the partly converted wood. Somewhat more than 50 per cent of the soda used is recovered again from the washings. The alkali process is, however, being gradually displaced by the bisulphite process. As first proposed by Mitscherlich, acid calcium sulphite was used. The temperature is brought gradually to 118° C., which is not exceeded, the pressure being from 2 to 3 atmospheres. In Ekman's process, acid magnesium sulphite is used, and a pressure of from 5½ to 6 atmospheres is attained. Still another process is that of Franke, which uses bisulphite of lime again. Cross and Bevan explain the efficacy of the bisulphite processes by saying:

"The chief agency is the hydrolytic action of sulphurous acid, aided by the conditions of high temperature and pressure; and the subsidiary agencies are: (1) The prevention of oxidation; (2) the removal from the sphere of action of the soluble products of resolution in combination with the sulphite as a double compound, for it is to the class of aldehytes that we have shown that the noncellulosic constituents of wood belong, and (3) the removal of a portion of the constituents in combination with the base, i. e., with expulsion of sulphurous acid."

The several bisulphite processes, as compared with the ones mentioned previously, yield a larger amount of pure fiber. They preserve its original strength, which is not done when caustic soda acts upon the loosened fiber under pressure, and there is a greater economy of chemicals.

In Dr. Fernow's account of the wood-pulp industry the following classes are recognized: (1) The mechanical or ground pulp is produced by grinding the wood after proper preparation on rapidly rotating stones under constant flow of water (Voelter process). (2) Brown wood pulp, mainly a mechanical pulp, except that the wood is steamed before grinding, under a pressure of 2 to 6 atmospheres. (3) Chemical wood pulp, or cellulose proper (in this country called "chemical fiber"), is produced by treating finely divided wood or wood shavings with various chemicals, which dissolve or render soluble the incrusting substances, leaving the fiber as long, elastic, and pure as the raw material will furnish it, while the above mechanical processes naturally shorten and deteriorate the fiber mechanically. The chemical processes can be again classified into alkaline and acid processes, according to the kind of chemicals used.

By the alkaline processes are obtained *soda pulp* and *sulphate pulp*. The acid processes are more numerous. Electro pulp is derived from a more recent process, in which the wood is digested in a solution of common salt, at 250° to 260° constantly electrolyzed. For detailed accounts of these processes, see Report of the Division of Forestry, Annual Report of the United States Department of Agriculture for 1890; Cellulose, by Cross and Bevan; and Sadtler's Handbook of Industrial and Organic Chemistry. The wood-pulp industry in 1890 represented 183 mills, located in 22 States, and with a total daily capacity as follows: Mechanical or ground pulp, 407,000 pounds; chemical soda fiber, 149,000 pounds; chemical sulphite fiber, 105,000 pounds. The average yield per cord is 1,700 pounds for ground pulp, 1,000 for sulphite, and 800 for soda pulp. By the different processes the value of a cord of wood may be brought to $24.50 to $30.

"In 1888 the stumpage consumed for pulp was valued at $2,235,000. The product, 225,000 tons ground and 112,500 tons chemical pulp, was valued together at $12,375,000, the capital employed being estimated at $20,000,000. The consumption, in round numbers, was indicated in 1890 to amount to 1,000,000 cords of wood per annum. When it is considered that about 1,000,000,000 pounds of book and news paper are consumed annually in this country, two-thirds of which might be made of wood fiber, there is still a considerable margin for this use alone to be supplied by wood pulp." (*B. E. Fernow.*)

Picea sitchensis. TIDELAND SPRUCE.

COMMON NAMES.—Tideland spruce, Sitka spruce, Menzies spruce, etc.

Alaska, south to Mendocino County, Cal., not extending more than 50 miles inland from the coast. "A large tree of great economic value, largely manufactured into lumber used for construction, interior finish, boat building, dunnage of vessels, cooperage, wooden ware, etc." (*C. S. Sargent*). J. G. Cooper states that the long, tough, fibrous roots are used by the Alaska Indians to make very strong baskets and bags. "*P. engelmanni*, the white spruce, or Arizona spruce, a Rocky Mountain and Pacific States species, has similar fibrous roots, which are used as basket material." (*Dr. V. Havard.*)

Pigna cloth (Phil. Is.). Same as piña. *Ananas sativa.*

Pilea scripta.

Exogen. *Urticaceæ.* Large-leaved herb.

An Indian plant, growing in the temperate Himalayas, 3,500 to 6,000 elevation. Referred to by Royle as a fibrous plant. *P. smilacifolia* is also mentioned by Dr. Watt, though no definite information is to be obtained regarding its fibers.

P'i-ma (China). See *Ricinus.*

Pimelea axiflora.

Exogen. *Thymelæaceæ.* Slender, branching shrub.

Habitat, Australia. The genus *Pimelea* comprises some 70 species, natives of Australia, New Zealand, Tasmania, etc. "The *curryijong* of the aborigines is a tall, glabrous shrub, with smooth bark, of exceeding toughness. It is found plentifully in the forests and gullies in alpine and subalpine situations." (*Dr. Guilfoyle.*)

BAST FIBER.—A specimen was secured at the Phil. Int. Exh., 1876, prepared by Dr. Guilfoyle, who states that all the species of the genus have more or less tough, stringy bark, suitable for textile purposes. It is made into fishing lines, whipcord, etc., and is adapted to paper making. The seeds of *P. axiflora* yield an oil from which the genus—derived from the Greek *pimele*, a fat—received its name. *P. clavata* is a shrub, 8 or 9 feet, native to western Australia, which also produces fiber.

Piña (Phil. Is.). Pineapple, and pineapple cloth. See *Ananas sativa.*

Pindayba, or **Pindahyba** (Braz.). *Xylopia sericea.*

Pine, Wood of (see *Pinus*).

Pineapple (see *Ananas sativa*).

Pine fiber and **Pine wool** (see *Pinus palustris* and *sylvestris*).

Pinguin (W. Ind.). See *Bromelia pinguin.*

Pinuella (W. Ind.). See *Karatas plumieri.*

Pinus palustris. LONG-LEAF PINE.

Exogen. *Coniferæ.* A large tree, 80 feet.

In the United States, from Norfolk, Va., southward to Texas, and as far north in the middle section as Tennessee. The turpentine pine of the Southern States.

STRUCTURAL FIBER.—One of the most interesting series in the fiber collection of the Department is that of the pine-fiber specimens furnished by the Acme Manufacturing Company, of Wilmington, N. C. The raw material is the leaves or needles of the long-leaved pine, which also produces the turpentine of commerce. The particular process is said to be the invention of A. F. Scott. The exhibit includes a branch of pine, the gathered needles, and samples illustrating processes of cooking, rubbing, and carding. These are followed by the various products obtained, as pine hair, surgical dressing lint, pine oil, burlap, matting, and finally bagging. When the jute trust put up the price of bagging for baling the cotton crop, about 1890, as high as 1,000,000 yards of pine-fiber cotton bagging was produced, and the industry gave promise of being extended. Very little, if any, of this bagging is manufactured, however, at the present time.

A physician of Wilmington has stated that the fiber made of pine straw is a most valuable agent in the treatment of simple and compound fracture, surgical dressing after operations, and suppuration of wounds. It is superior to cotton-batting, lint, or oakum. Its aromatic odor drives away flies and prevents maggots from burrowing in wounds, and I think it is a disinfectant of the first order.

Preparation.—The green pine straw or leaves, gathered in the surrounding forests, is brought to the mills, where the company purchases it at 15 cents per hundred pounds. After having been weighed, the straw is carried into a shed 100 by 25 feet, and is spread upon the floor to be cleaned and to prevent it from becoming heated. An elevator takes it to the second floor of the building, where it is placed in two iron cylinders set up on end and surrounded by steam pipes. These extractors are 10 feet deep and about 4 feet in width. In these the pine leaves are thoroughly steamed, the vapor going through pipes into the ordinary distillery worm in an adjoining house. Here it is condensed. The result is the pine-leaf oil, the leaves yielding about one-half a gallon of oil to 100 pounds of straw. The oil is a valuable product, and is destined to take an important place in the advanced pharmacopœia. It is very highly antiseptic, possesses the advantage of being useful for internal as well as external application, and is valuable for many surgical and medicinal purposes. The liquid which is condensed from the vapor with the oils is useful for various purposes in the manufacture of other fabrics.

After the oil has been extracted, the pine straw, which has become a very rich black in color, is placed in six large iron vats, 7 feet wide, 8 feet long, and 5 feet deep, and with a capacity of holding 3,000 to 4,000 pounds each. It is here mixed with water and alkali and thoroughly boiled, the process being necessary to remove the silica which forms the outside covering of the leaf. This is a difficult operation, requiring great skill and care. The silica which is removed is used for tanning and other purposes. During all this process of cooking the pine still retains its aroma. The last boiling process continues for twelve hours, after which the straw is soaked forty-eight hours more, and then it is ready for the machinery for rubbing up the leaves.

The straw taken from the vats, and still damp, is first put into a "rubber," as it is called, and which consists of a number of cylindrical screws working together with both rotary and lateral motions. The machine is quite complicated, and further description need not be given in this condensed account. Suffice it to say that the straw being fed into it comes out of the other side a pure fiber of a rich dark-brown color and of a soft texture. During all these processes it is kept saturated with water, but it is next taken to the wringing and bleaching machine, where the water is squeezed out and the curing process is begun. It is then carried to the carding machine, through which it passes, and thence to the drying machine, where every particle of moisture is evaporated, and thence to the press, where it is put up in bales ready for market. The fiber is packed in burlap bales, 225 pounds to a bale.

Pinus sylvestris, Scotch Pine, is the European species, which is used in the same manner in Silesia, Thüringer Wald, Sweden, Holland, etc. This textile material is employed in underclothing as a substitute for flannel, and accredited with valuable medicinal properties. The leaf needles are first distilled with water, for the extraction of the oil contained in them. The waters are used in medicinal baths. The remaining material is treated with boiling soda solution, for the removal of the vegetable matters. The resulting fiber, equal to about 13¼ per cent of the fresh needles, is spun into yarn and then woven. The material is largely used in Vienna and Breslau for hospital and military blankets. The fiber is also employed as a substitute for horsehair in stuffing.

Pinus sabiniana. DIGGER PINE.

COMMON NAMES.—Bull pine, digger pine, Sabine's pine, gray leaf pine, etc.

California, Shasta County, along the foothills of the Coast Range and the western slope of the Sierra Nevada, below 4,000 feet elevation. The wood is light, soft, and strong, brittle, compact, but not durable. The edible nuts supply the Indians with food, and "the big fibrous roots are used by them for weaving into many domestic articles." A tree, 75 to 100 feet.

Pinus strobus. WHITE PINE.

The common white pine needs no description. Sargent says of it: "More largely manufactured into lumber, shingles, laths, etc., than any other North American tree."

WOODY FIBER.—The species is only introduced in this catalogue on account of its being one of the woods commonly used for the packing material known as "excelsior," which is to that extent a fiber substitute, used also for upholstery and for filling cheap mattresses. Other woods used for this purpose are poplar and spruce.

There are a dozen different kinds of machines in use for reducing lumber to the sort of fine shavings which form excelsior. After cutting the lumber to right lengths and properly seasoning it, it is run through the machine, which practically cuts it first into thin ribbons and then into threads of fiber by means of closely set parallel cutters. Second-growth timber and clean body wood is usually employed in the manufacture.

Pipturus argenteus.

Exogen. *Urticaceæ.* Tall shrub or tree, 50 to 60 feet.

A North American plant, also found in Australia and the islands of the Pacific. In Queensland it is known as the Queensland grass-cloth plant, or native mulberry, and is called in the vernacular *Kongangu.* Met with on the banks of rivers and smaller streams. Dr. Christy states that it affords a fiber of fine texture and great strength, but difficult of preparation. The bark also yields a brown dye. *P. asper* is a Cuban species. *P. gaudichaudianus* is a Sandwich Island species, cited by Hillebrand as *P. albida,* "the *Mamake* of the n tives of Hawaii; one of the two principal Kapa plants, not known from elsewhere."

Pissang utan (Malay). See *Musa textilis.*

Pita.

The term "*pita*" has been given to the fiber of several distinct species of fleshy leaved plants, and is, on this account, confusing as a name to distinguish any particular kind of fiber. It is used oftentimes as a prefix, *pita de corojo* being an example, meaning *corojo* "*fiber,*" or *corojo* "*hemp,*" from *Acrocomia lasiospatha.* It has also been given as a distinctive name to the fiber of *Agave americana, Furcræa gigantea, Karatas plumieri,* and *Bromelia sylvestris.* I think the name should either be abandoned altogether or used exclusively to designate the fiber of *Agave americana,* to which it has been most commonly applied. In addition to the above might be mentioned several compound names such as *pita floja,* from *Furcræa gigantea,* etc.

Pite (Fr.). *Agave americana.*

Plagianthus betulinus. RIBBON TREE OF NEW ZEALAND.

This species belongs to a small genus of *Sterculiaceæ,* confined to South Australia, Tasmania, and New Zealand, and when full grown is a tree 70 to 80 feet high, though often seen as a straggling bush. It is sometimes called the lace bark tree.

Bast Fiber.—Its bark is of a beautiful lace-like texture, tearing into shreds with greatest ease, but flexible and strong. According to the Treasury of Botany, the tree is called *Akaroa* by the New Zealanders, who extract a fibrous material from the young branches, known as New Zealand cotton, which is not only fine, but exceedingly strong, though resembling flax or hemp rather than cotton. The fiber of the ribbon tree is utilized in the manufacture of fishing lines and nets, and to some extent of cordage and paper.

Plagianthus pulchellus, the Victorian hemp bush, is an allied species. It is a quick grower and reaches a height of 6 to 12 feet, resembling a birch in appearance. It is invariably found growing on the banks of rivers and creeks, and is said to be plentiful on the Yarra River, near to Melbourne. It is surprising that as a fiber plant of great value this should be so long overlooked. It is fully equal to the Queensland hemp (*Sida retusa*), which has already become an article of commercial importance in that colony. The *Plagianthus* possesses the advantage of being much longer in staple. The fiber is very soft and glossy, and should form a good warp yarn, either by itself or as admixture with some other material. This and the preceding species were secured with the Australasian collection at the Phil. Int. Exh., 1876, prepared by Dr. Guilfoyle.

Plagianthus sidoides.

Native of Australia. Another plant of this region to which has been given the name *currijong*. It grows to a height of 10 to 12 feet, and according to Spon is found on the Strzelecki Range, on the Gippsland gold fields, and on the Dandenong Range, and occurs in Tasmania.

The fiber is prized by the miners for cordage purposes, and might be applied to the manufacture of hats, textiles, and paper. The bark is readily removed from the trunk and branches.

Plantain (see *Musa* spp.).

Platanillo (Venez.). *Asclepias curassavica.*

Platano (Venez.). See *Musa sapientum.*

Poa abyssinica. Teff.

This is another extensive genus of grasses which includes many cultivated American species of fodder grasses.

P. abyssinica is particularly interesting, as it was cultivated by the ancient Egyptians, and was used by them for "straw" in brickmaking. It has been found in ancient clay bricks. At the present time it is largely cultivated in Abyssinia as a cereal.

P. cæspitosa, Wire grass or Australian Meadow grass, is a native grass of Victoria, from which the natives make mats. "Our Victorian Wire grass, which grows to a height of 4 feet, might, with proper appliances, even rival the celebrated Esparto of south Europe" (*Guilfoyle*). *P. cynosuroides* is found in northern Africa and southern Asia. In northwest India it is said to be used for cordage and for mats. Would prove a serviceable paper stock.

Poa pratensis. Blue Grass.

Common names.—Kentucky blue grass; blue grass (in Kentucky and Tennessee); green grass; June grass (in New England); smooth meadow grass; common spear grass; spear grass; English grass; smooth-stalked meadow grass (fig. 91).

This is apparently native throughout the temperate regions of the Northern Hemisphere. It ranges from Labrador to South Carolina, westward to the Pacific Coast, and northward to Alaska. In the limestone regions of Kentucky and Tennessee it attains its greatest perfection, and is there regarded as the king of pasture grasses. It requires a good soil containing some lime in order to yield profitable crops. It is largely employed in the Eastern and Middle States as a lawn grass, for which use it is well adapted. There are several varieties, which differ chiefly in the breadth and length of the leaves, particularly those at the base of the stem. It is not so well adapted for the production of hay as it is for pasturage. (*F. Lamson-Scribner.*)

Structural Fiber.—Useful for fine straw plait. In 1822 a silver medal and 20 guineas were awarded to Miss Sophia Woodhouse, of Connecticut, for a new material for straw plait, this species having been employed. It was then supposed to be equal to the Italian straw for the finer kinds of braids.

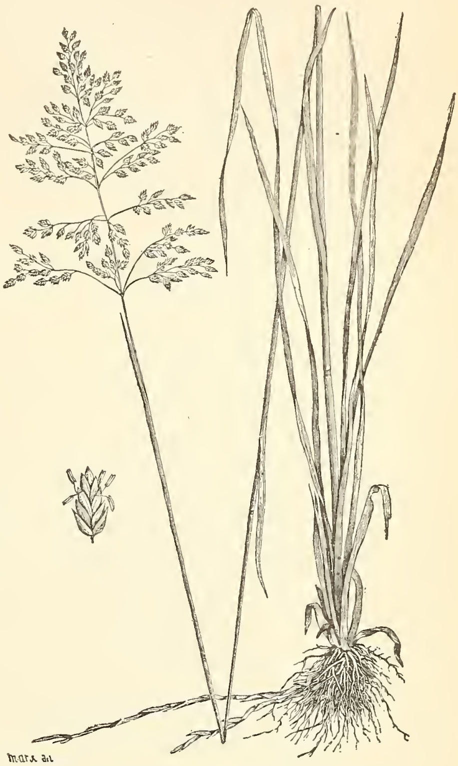

Fig. 91.—Kentucky blue grass, *Poa pratensis.*

Poah (Nepal). See *Boehmeria.*

Pochote (Mex.). See *Ceiba pentandra* and *Eriodendron anfractuosum.*

Pói (Ind.). See *Maoutia puya.*

Polechi (Malay). *Hibiscus sabdariffa.*

Pollinia (It.). *Chrysopogon gryllus.*

Po-lo-ma (China). See *Ananas sativa.*

Polyalthia longifolia. Indian Fir.

Exogen. *Anonaceæ.*

A tree of the hotter parts of India; "commonly planted on avenues along roads in Bengal and south India."

Fiber.—Said to produce a good bast fiber, samples of which were sent to the Amsterdam Exhibition. *P. coffeoides,* found in the forests of Wynaad and Ceylon, yields a cordage fiber in the western Ghats, according to Dr. Watt.

Polygonatum multiflorum. Solomon's Seal.

A moderate genus of *Liliaceæ,* distributed over the temperate parts of the northern hemisphere. The familiar species are graceful woodland herbs. A curious example of the utility of the above species as a textile is a parasol cover from Ireland preserved in the Kew Mus.

Polyporus betulinus. The Razor-strop Fungus.

Found upon both living and dead birch trees. Pileus from 3 to 6 inches broad, smooth, corky, elastic, hoof-shaped, at first pale, then becomes brownish gray; margin incurved; pileus covered with a thin epidermis, which easily peels off; pores white or tinged with brown. The whole plant when dry is very light; the lower surface is frequently rough, with numerous needle-like projections, making it resemble a *Hydnum* when viewed horizontally.

Pseudo-fiber.—While the substance prepared from this fungus more nearly resembles leather than a textile fabric, it is similar in structure to *Fomes fomentarius,* and is therefore included. "The preparation of the fungus for razor strops requires that it be cut in the autumn, when its substance has become dry and firm, subjected to pressure for twenty-four hours, carefully rubbed with pumice stone, sliced longitudinally, and pieces entirely free from the erosion of insects glued upon a wooden stretcher. The excellence of this material is probably due to the minute crystals it contains being sufficiently hard to act upon the steel. Cesalpinus mentions this use of fungous growths, and the barbers of that period were familiar with it It seems strange that so valuable a material should have been overlooked in modern times." (*B. T. Galloway.*)

P. squamosus, the Dryad's Saddle, may be mentioned in the same category. *Merulius lacrymans,* the dry-rot fungus, the mycelium of which assumes various forms when spread out in thick, skin-like sheets, serves also for razor strops. See also *Xylostroma giganteum* and *Fomes fomentarius.*

Polytrichum commune. HAIR MOSS.

An interesting example of the economic use of this moss is a hammock preserved in the Kew Mus. from Yorkshire; also "brooms from Sussex and from Berne in Switzerland, where they are used by weavers under the name of *Weber-Bürste,* or *Wurzel-Bürste.*"

Pooah (Ind.). *Maoutia puya.*

Populus deltoides. COTTONWOOD.

Syn. *P. monilifera.*

Exogen. *Salicaceæ.* A tree, 75 to 150 feet.

COMMON NAMES.—Cottonwood, cotton tree, Carolina poplar, necklace poplar, etc.

Shores of Lake Champlain, Vermont, through southwestern New England to western Florida; west along northern shores of Lake Ontario to eastern bases of the Rocky Mountains of Montana, Colorado, and New Mexico. Wood used largely in the manufacture of light packing cases, fence boards, wood pulp, and for fuel. (*C. S. Sargent.*)

BAST FIBER.—The tree yields an abundance of long, soft, fibrous bark, used by the Indians along the Colorado River for ropes, twines, sandals, mats, etc. "Whoever has seen the petticoats made of the inner bark of the cottonwood (*P. fremonti*), worn by the squaws along the Colorado River, must have realized the possibility of utilizing the same material as well as that of the allied species." (*Dr. V. Havard.*) *P. trichocarpa,* the black or balsam cottonwood of the Northwest, is much used by the northern California Indians for the brown work of the woof of their hats and baskets.

Potari (Beng.). *Abutilon indicum.*

Pothos violaceus.

A genus of *Araceæ,* natives of India, China, Madagascar, New Holland, etc. They usually have cord-like stems, and send out false roots, which attach themselves to trees. *P. violaceus,* the wild cocoa, is named in the Flax and Hemp Commission list as "a substitute for straw plait." The revised name of this species is *Anthurium scandens.*

Pouk (Burm.). *Butea frondosa.*

Pouzolzia spp.

The plants of this genus of *Urticaceæ* are allied to the *Boehmerias,* and are natives of the Tropics of both hemispheres. *P. pentandra, P. viminea,* and *P. indica* yield useful cordage fibers in India.

Prairie grass (see *Spartina cynosuroides:* also *Sporobolus cryptandus*).

Prickly pear (see *Opuntia*).

Prionium palmita. THE PALMET, OR PALMITE.

Endogen. *Juncaceæ.*

HABITAT.—South Africa, where it grows in the beds of rivers, often choking the stream. It resembles in appearance a bromeliaceous plant, with its trunk 5 to 10 feet in length and its tuft of sword-shaped leaves.

STRUCTURAL FIBER.—"The leaf sheaths contain a network of strong, black fiber, suitable for brush making, or, when curled, as a substitute for horsehair. The leaves themselves are useful for plaiting and thatching, and also yield a very good fiber." (*A. Smith.*) Its leaves are used for making hats, baskets, etc., and the fiber might be employed in textile uses, such as for cordage, brushes, and upholstery.

Prosopis pubescens. SCREW BEAN.

Exogen. *Leguminosæ.* A bushy shrub.

This species abounds in the southwestern United States and Mexico. Representatives of the genus are also found on the plains of Buenos Ayres and Patagonia, known as *Retorguillo.*

The pods of this species are twisted like a corkscrew. The fruit or bean is employed largely for food by the Indians along the Colorado River, in Arizona, and by the Utahs, who collect large quantities to store for winter food. (See Ann. Rept. U. S. Dept. Ag., 1870, p. 412.)

BAST FIBER.—The bark of this plant, torn off in strips, is used by the Mohave Indians of Arizona for binding pottery. Better prepared, it would make a fair cordage fiber, although when produced in the form of ribbons, as in the specimens collected by Dr. E. Palmer, it can only be regarded as a tie material.

Pseudo-fibers (see Classification of Fibers, p. 25).

Pteris decipiens (see note under *Adiantum*).

Pterocarpus santalinus.

Exogen. *Leguminosæ.* A large tree.

There are 15 or more species in the genus, and all are plants of large size, scattered over tropical Asia, Africa, and America. The plant yields a deep red dye, known to commerce as "red sanders," large quantities of which are exported from India annually. Gum kino is obtained from two species of *Pterocarpus*, one growing in India and the other in Africa. Some of the barks are also used for tanning.

BAST FIBER.—The fiber is reddish in color, composed of quite fine filaments of moderate strength. From the size and appearance of this specimen, which is quite old, I judge it has only been extracted experimentally. A twisted cord of the fiber, about the size of common manila-paper twine, would show about the same tenacity. It would doubtless make a good paper stock, if it could be cheaply extracted and in large quantities.

Pua hemp (Ind.). *Maoutia puya.*

Pueraria thunbergiana. KO HEMP.

Exogen. *Leguminosæ.* A twining plant.

HABITAT.—China and Japan.

BAST FIBER.—Dr. Morris states that the fiber of this trailing vine, long known in China and Japan, is obtained from the succulent green stems, and is used, but less than formerly, for summer clothing. It is said to be more durable than China grass cloth.

Pulipunta (Peru). See *Phytelephas.*

Pulu (Hawaii). See *Cibotium* spp. See under *Woodwardia.*

Punj (Ind.). *Sterculia guttata.*

Puta and **Puttiya** (N. W. Prov. Ind.). See *Kydia.*

Quahitl (Yuc., Maya) = a tree.

Quasb (Arab.). *Bambusa arundinacea.*

Queensland hemp. *Sida rhombifolia.*

Queimora (Braz.). *Couratari.*

Quimbombo. Spanish for *Hibiscus esculentus.*

Raffia.

The name given to a surface fiber which is produced by stripping the epidermis of the leaves of species of palms of the genus *Raphia,* which see. Epidermal strips similar to raffia may also be produced from the leaves of many other species of palm such as *Cocos nucifera,* the cocoanut, *Borassus,* the Palmyra palm, etc., specimens of which are preserved in economic museums.

Ragi (Ind.). *Eleusine coracana.*

Ragweed. *Ambrosia trifida.*

Rain-coats, Fiber for. Jap., *Oryza sativa ;* China, *Trachycarpus excelsus.*

Raiz de Zacaton (Mex.). *Epicampes macroura.*

Rajmahal hemp (Ind.). See *Marsdenia.*

Rameta bast (see *Lasiosiphon eriocephalus*).

Rami (Peru). *Boehmeria.*

Rami-tsjina (Malay). See *Corchorus.*

Ramie and **Ramee.** *Boehmeria tenacissima.* See also *B. nivea.*

Ramio (Span.). Ramie, or species of *Boehmeria.*

Ran or Ban-bhendi (Bomb.). *Malachra capitata.*

Ran-shewra (Bomb.). *Sesbania.*

Raphia ruffia. RAFFIA PALM.

Endogen. *Palmæ.*

There are several species of this genus, natives of Africa, where they abound in low, swampy lands upon river banks or near the sea upon both the east and west coasts. One species, however, is found in similar situations in Brazil. They produce gigantic pinnate leaves often 50 feet in length, trees frequently being found 70 feet in height. The immense fruit spikes often weigh 200 or 300 pounds, and bear a large number of one-seeded fruits larger than eggs. The genus is a prominent one, as it contains three species yielding important commercial fibers.

R. ruffia is a Madagascar species, growing abundantly on the coast and inland, reaching an altitude of 4,000 feet. The leaves average 25 feet in length and are made up of a series of long grass-like pinnate fronds. (See fig. 92.)

The revised name of this species is *R. pedunculata.*

SURFACE FIBER.—This fiber is derived from the cuticle of the leaves, which are taken before fully expanded and peeled upon both sides. The thin strips of fibrous material thus obtained are afterwards divided into narrower strips by a kind of comb, according to the purpose for which they are to be used.

It appears as flat, straw-colored strips, about half to three-quarters inch wide and from 3 to 4 feet long. It is capable of being divided into fine threads. In Madagascar it is used for delicately plaited goods, hats, mats for covering floors, and wrapping up goods. The loose strips are extensively used in this country in place of Russian bast or tie bands by gardeners and nurserymen. More recently it has been woven into superior matting, tastefully colored, and used instead of tapestry for covering walls in London houses. Raffia usually reaches this country (England) loosely plaited in hanks weighing from 1½ to 3 pounds each. These are made up into bales weighing 1½ to 5½ hundredweight. The preparation of raffia is one of the most extensive industries in Madagascar. The men cut the palm leaves in the forests and bring them home for the women to complete the work. The fiber is cured the same day it is stripped. (*Dr. Morris.*)

Fig. 92.—The Raffia palm, *Raphia ruffia.*

The Kew Mus. contains examples of coarse cloth made by the natives of the upper Congo. This cloth is the universal clothing of the Malagasy slaves. The fiber is exported to the United States in the hanks described above, its only use being as a tie material in nurseries, etc.

Raphia tædigera. The Jupati Palm.

Found on the banks of the lower Amazon and Para rivers in Brazil, but unknown in the interior. The cylindrical leafstalks, often 12 feet or more in length, are employed by the natives for walls or partitions of their houses, and used in other ways.

Fiber.—The fiber is similar in every respect to the preceding and is used for the same purposes, some of the strips being exported to England for use as tie material, especially in hop fields. Among its native uses may be mentioned cordage and fishing nets.

This species is now regarded by botanists as identical with the next.

Raphia vinifera. Bamboo Palm.

Common and native names.—Wine palm of West Africa. (The Palm) *Igiogura, Eriko,* and *Akpako,* Yorubaland; (the fiber) *Iyo.*

Abundant on the borders of rivers intersecting the countries near the sea, in the kingdoms of Oware and Benin, west Africa. The tree is of medium height, the leaves measuring 6 or 7 feet in length. The stems are used for the framework of native dwellings, and the leaves, bound with lines, are used for thatching. From the trunk an intoxicating beverage called Bourdon is obtained.

The governor of Lagos, in a report to the Kew authorities in 1891, states that it would be impossible to calculate the area occupied by these forests, but it may be accepted "without doubt that they extend throughout the length of the colony, and to a distance of at least 15 miles from the seacoast, and that over this area of about 5,000 square miles they form a considerable proportion of the vegetation, next only in numbers to the oil palm and the mangrove." (See fig. 93.)

Structural Fiber.—This is the "African bass" of commerce. It is in appearance a stiff and wiry fiber, varying in color from dark brown to light red, dependent for its shades on duration of soaking. It is most readily obtained in lengths of from 3 to 4 feet, beyond which length it is inconvenient to pack and difficult to procure without injury to the tree. In diameter it varies from one-sixteenth to one-thirtieth of an inch, the latter of which may be accepted as the limit of fineness to be admitted in a commercial sample for the European market.

Fig. 93.—The Jupati palm, *Raphia vinifera*.

The fiber is obtained from the fibrous sheathing at the base of the petioles, in lengths of 3 to 4 feet. It has been a regular article of commerce since 1890, though the prices are somewhat lower than those quoted for Para and Bahia piassaba, which are employed for the same uses, that is, for hard brushes. Epidermal strips are also secured from the leaves of this species, though shipments of the fiber made in 1895 were reported upon as badly prepared, the strips being too short, and curled up, resembling fine twine.

Everybody in the colony is aware of the manifold uses of the *Raphia* palm; how, from its leaves, hats, cloth, and cordage are made; from its leaf stems, rafters, fences, and walls, and from its crown of young unopened leaves palm wine of excellent quality. Of one part only the use seems not generally known, and it would appear that this particular portion of the tree, though hitherto treated as useless, is in reality of more value than all the rest. When the "Bamboo" cutter clears away the leaves from the lower stem of the palms the trees present a very ragged and uneven appearance owing to the practice of leaving a portion of the leafstalk adhering to the parent stem. These base stalks partially incase the bole of the tree and project upward and outward forming the scaly covering which gives so strange an appearance to a grove of *Raphia* palms. From these stumps of the leafstalks the native fishing lines are made. The fiber is extracted by a process of soaking and scraping, which is exceedingly simple and is fully understood by every bamboo cutter and line maker. It is this fiber which is known in the European market as "African bass," and there is no apparent reason why, with a population who are in the habit of preparing it, and a source of supply which may be regarded as practically unlimited, we should not be able to compete on even terms with the sources of supply which at present monopolize the market. (*Alfred Molony, governor of Lagos.*)

OTHER SPECIES.—*R. hookeri* is the *Ukot* of Old Calabar, where it is cultivated as a wine palm. The natives also manufacture cloth from the epidermis of the leaflets. On the Sherboro, in Sierra Leone, they make hammocks from it, as well as all sorts of basket work, mats, etc. This is one of the largest of the *Raphias*, the whole plant often attaining a height of 70 feet. The fronds are 40 feet long, with leaflets 4 to 5 feet long. If in other respects suitable, this should yield *Raffia* fiber as long as the

FIG. 94.—A plant of *Ravenala*.

best from Madagascar. (Kew Bull., 1895.) *R. welwitschii* is a new species from Angola. The natives manufacture the epidermis from the leaflets into cloths, etc. *R. textilis*, a closely allied species, also yields textile filaments.

Rat (Ceyl.) = red.

Rataroa. New Zealand flax. See *Phormium.*

Rattan cane (Ceyl.). See *Calamus rotang.*

Ravenala guyanensis.

Endogen. *Musaceæ.* Giant wild plantain. (Fig. 94.)

Known by the French as Traveler's tree, as it stores up water in the large cup-like sheaths of the leafstalks. Found in British Guiana and a second species, *R. madagascariensis*, in Madagascar, the gigantic leaves being used by the natives of both countries as a thatch material. "The blades of the leaves are oblong in form and are larger in size than those of any known plant except the *Victoria regia*." (*Dr. Masters.*)

Rawaye (W. Afr.). *Cochlospermum tinctorium.*

Razor strop, fibrous.

In Florida and the West Indies a very serviceable razor strop is made from the soft inner part of the flower stalks of "poling" species of Agave. They are about 15 inches in length and 1½ inches square, one end being made round for a handle. See also *Fomes fomentarius.*

* *Specimen.*—Mus. U. S. Dep. Ag., from *Agave sisalana.*

Red mulberry. *Morus rubra.*

Red silk cotton. *Bombax malabaricum.*

Reed mace. *Typha angustifolia.*

Reed, Scriptural (see *Arundo donax*).

Retama (Peru). *Spartium junceum.*

Rhea (Ind.). See *Boehmeria tenacissima.*

Rhus trilobata. AROMATIC SUMAC, OR SQUAW BERRY.

Exogen. *Anacardiaceæ.* A shrub, 5 to 8 feet.

NATIVE INDIAN NAME.—Hopi or Moqui, *Cübi*; from *Cükü*, pungent, alluding to its acid berries, which are called *siwipsi;* a syncopated form of *Cübisiadta; Cübi*, its seeds. (*Fewkes.*)

Found in the Rocky Mountains, at least as far north as Colorado, in California, and southward to Mexico. "The dry shrub is one of the four prescribed fuels for the kivas. The buds are regarded as medicinal, and the seeds are eagerly eaten by young people. Its twigs are used for many ceremonial purposes, and also for coarse basketry." (*Fewkes.*)

In Utah, Arizona, southern California, and New Mexico the Indians depend solely upon this plant for material out of which to make their baskets. It is far more durable and tougher than the willow, which is not used by these Indians. The mode of preparation is as follows: The twigs are soaked in water to soften them, and to loosen the bark, which is scraped off by the females. The twigs are then split by the use of the mouth and both hands. Their baskets are built up by a succession of small rolls of grass stems over which these twigs are firmly and closely bound. A bone awl is used to make the holes under the rims of grass for the split twigs. Baskets thus made are very durable, will hold water, and are often used to cook in, hot stones being dropped in from time to time until the food is done. (*Dr. E. Palmer*, Am. Nat. 1878.)

Ribbonwood (of Otago) (New Zea.). See *Hoheria.*

Rice.

Chinese ——— paper (see *Fatsia papyrifera);* ——— straw, for straw plait (see *Oryza);* wild ——— (see *Zizania aquatica*).

Ricinus communis. CASTOR OIL PLANT.

COMMON NAMES.—*Palma Christi, Huile de Castor* (the oil) (Fr.); *Kiki* (Egypt); *Pi-ma* (China); *Endaru* (Ceyl.); *Kyeksu* (Burm.); *Khirrá* (Arab.); *Bedanjir* (Pers.), and many others.

Supposed to be a native of Africa, from whence the plant was introduced into

India, and has spread to many parts of the world. Cultivated largely for its oil derived from the seeds. Grown in the United States as an ornamental plant.

WOODY FIBER.—I can not learn that this plant has ever been used for fiber save in India. "While *Ricinus communis* does not itself yield fiber, it is largely cultivated in Assam to feed the eri silkworm. An excellent paper pulp is, however, said to be made from the stems with their bark, the latter containing a fiber though not of sufficient value to justify its separation. As some 500 maunds of stems are obtained from an acre of land, it seems probable that where grown in the vicinity of paper mills it would be more profitable to dispose of the stems to the paper maker than to use them as fuel or thatching as is the present custom." (Dic. Ec. Prod. Ind.)

Robinia pseudacacia.

Exogen. *Leguminosæ.* A tree.

An ornamental tree with hard wood, known as the false acacia, or North American locust. Native of the Southern United States. Savorgnan mentions that fiber has been produced from it, though it can hardly be enumerated as a useful fiber species. Bernardin, however, gives the species place in the list of 550 useful fibers, for manufacturing stuffs and paper.

Rocou (see *Bixa orellana*).

Rooee Ru and Ruí (Ind.). *Gossypium herbaceum.*

Rourea santaloides. THE KIRINDI-WEL OF CEYLON.

A creeper, belonging to the family *Connaraceæ.* Allied to the bean family. The genus comprises 40 or more species, distributed over tropical Asia, though represent, atives are found in Africa and America. They are trees and shrubs, a few of them-as *R. santaloides,* being scandent.

WOODY FIBER.—The twining stems of this species are used in Ceylon for a powerful cordage, which is produced by twisting them together. These ropes are employed in constructing strong fences or stockades; and in agriculture "where fascines have to be erected for the support of temporary earthwork, etc." The cordage is also used for tethering cattle.

*Specimens were exhibited in the Ceylon court, W. C. E., 1893.

Rozelle hemp. *Hibiscus sabdariffa.*

Rusa grass (see *Andropogon schoenanthus*).

Rush.

The different species of rushes are used in the manufacture of mats, mattings, rough cordage, and for paper stock. Some of the rushes described in this work will be found under *Cyperus.* See also *Juncus.*

Rye straw (see *Secale*).

Sabal palmetto. THE CABBAGE PALMETTO OF FLORIDA.

Endogen. *Palmæ.* A tall palm, 25 to 50 feet.

One of the most northerly palms. Found in South Carolina, Georgia, and Florida, in the latter State often appearing in large groves. The species of *Sabal* are all natives of tropical America, chiefly the West Indies, and the southern United States. The trunks of old examples of *S. palmetto* are smooth, but the young trees are covered with a lattice of the dead leafstalks, arranged with geometrical regularity. They are used for piles, and are said to be more enduring than the ordinary timber species for this purpose. Seminole Indian name, *Tah-lah-kul-kee.* Fig. 1, Pl. X, is a group of cabbage palmetto at Jupiter Inlet, Florida.

STRUCTURAL FIBER.—The manufacture of brush fiber from the cabbage palmetto forms a considerable industry in Florida, this material being produced in the works located at Jacksonville. The source of the fiber is the "boots," or spathes of the leaf stems, which surround the "bud," or cabbage, and in securing these buds, with the leaf stems, the tree is sacrificed. The buds are cut out in the localities to the southward, where large groves are to be found, and are shipped to the central factory. Here they are steamed, to soften and loosen the mass, when the boots are removed and are immediately crushed by passing under a series of stamps similar to the device formerly employed in crushing gold ore in Colorado. The softened and crushed boots are then subjected to an automatic combing machine, which takes out the soft fiber, leaving about 25 per cent of the original fibrous material, in the form of stiff reddish fibers, considerably finer than piassaba, and averaging 15 to 18 inches in length. These fibers are then sorted, or "drafted," and are made up in bundles of different lengths, to be oiled and polished. The ends are then cut square, and the fiber, in the form of small bundles, is ready for the brush maker. The different lengths are known as "long draft," "short draft," etc. The brushes produced are made in many forms and are useful for many purposes.

The soft or tangled fiber has not been largely utilized, otherwise than to strew over the streets of Jacksonville, possibly as a kind of "sand-bind" material. It has been used to slight extent as the fibrous portion of artificial board, though not to the extent of making it an industry. It might be used as a cheap substitute for coir. The selected leaves of the cabbage palmetto are capable of manufacture into hats for summer wear, of great beauty and finish. In the bazaars of Florida cities that are winter resorts ladies' hats made of this material are regularly sold, and men's hats are also made from this species. For hat manufacture the leaves are whitened by brushing with a solution of oxalic acid once or twice, after which they are bleached by exposing to the fumes of burning sulphur. The leaves are also plaited into ornamental basket work, and are also used, when torn into strips, in the manufacture of fly brushes, which are regularly sold in the local bazaars and house-furnishing establishments.

The bud, or "cabbage," of *S. palmetto* is prized by the Seminole Indians as an article of food; after cutting out and trimming the bud it is boiled. *S. adansoni* is the dwarf palm of Georgia and Florida. The stem is short or entirely under ground. Its leaves are used for plaiting into hats. *S. blackburnianum* is known as the Bermuda palm, and its leaves are manufactured into hats, baskets, fans, and other useful articles. *S. mexicanum* is a Mexican species, which is said to be cultivated. Like the preceding species its leaves are utilized, being made into mats and other articles. *S. umbraculiferum*, the palmetto royal, is a form of *S. blackburnianum*, which is utilized in Jamaica, the outside portions of the trunk being employed for boarding up native huts and forming partitions. Savorgnan states that hats and sandals are made from this palm, the fiber being very strong and indestructible. See also *Serenoa*, the saw palmetto.

*Specimens of Sabal palmetto brush fiber in series, and various articles from the leaves, are preserved in the Mus. U. S. Dept. Ag.; the U. S. Nat. Mus., and the Field Col. Mus.

Saccharum officinarum. SUGAR CANE.

This species belongs to a genus of grasses of the tribe *Andropogoneæ*. Over 60 species have been described, covering a wide geographical range, though for the most part natives of tropical and subtropical countries. *S. officinarum* was probably first cultivated in India, although its varieties are now spread over the world. It has been cultivated in tropical America since 1610.

STRUCTURAL FIBER.—The fiber from this species is derived from the refuse after the cane has passed through the crushing mills. In India it was recommended as a useful paper material by Liotard. A further use in manufacture in a small way, according to the Dic. Ec. Prod. Ind., Vol. VI, pt. 2, is for well ropes, and on the Chenab it is twisted into rough cordage used for tying logs into rafts. The destruction of the fiber is one of the reasons why the natives of many parts of India object to the improved iron rollers now very generally employed in the expression of the juice. It is noted that the dried material is not used as fuel or manure.

Refer also to "Bagasse" in the alphabetical index, where this subject is further treated.

* Specimens of Bagasse, Mus. U. S. Dept. Ag.

Saccharum sara.

Syn. *S. ciliare* and *S. munja.*

NATIVE NAMES.—*Sarapat, Sarpatta,* and *Munja* (Hind.); *Sara* (Hind and Beng).

Northwest Provinces of India, especially the Panjáb, where it is sometimes planted as a boundary hedge.

STRUCTURAL FIBER.—The *Munj,* or fiber, from this species is much valued on account of its strength, elasticity, and power of resisting moisture, and is extensively employed in the manufacture of rope, string, mats, baskets, and paper. *Munj* matting is said to be proof against the attack of white ants. * * * *Sirki* is the light thatch used in covering carts in wet weather, and is composed of the *til,* or upper portion, of the flowering stem; the lower and thicker parts, called *kána,* are used in the manufacture of chairs, tables, baskets, and screens; also for roofing, for lining Kachha wells, and for covering stores or grain. (*George Watt.*)

The Kew Mus. collection contains many interesting objects made from the fibrous portions of this and other species of *Saccharum.* Among these may be mentioned ropes and twines, the fiber being valued for such uses on account of its elasticity, strength, and power of resisting moisture. Mats are also shown, including a Sirkar mat from Calcutta; also a necklace made from the straw, and half stuff for paper, made from the culms.

S. spontaneum is another Indian species that is employed for cordage, while *S. fuscum* is recorded as a Himalayan species, known in Hindoo as *Killut* or *Tilluk,* and *Pati-khori* in Bengal. Of this species, George Watt states that the culms are used in the manufacture of pens, screens, and light fences, the leaves and reeds for thatch, and the leaf-sheaths, like those of most wild species of the genus, may be used to supply the fiber from which the sacrificial thread is prepared.

Saci, Sacci, or **Sacqui**=White agave.

The form of sisal hemp which has its center of production in the northwestern portion, or the district of Merida—*Agave rigida elongata.* This form furnishes the principal bulk of the sisal hemp exported from Yucatan. See also *Yaxci.*

Safed-babúl and **Safed kikar** (Beng. and Hind.). *Acacia leucophlœa.*

Safed-semal (Hind.). *Eriodendron anfractuosum.*

Sago palm. *Metroxylon sagu.*

Sago is also derived from *Caryota urens, Phœnix farinifera, Corypha gebanga,* and other palms that are valued for their fiber.

Sagu (Peru). *Areca catechu.*

Sala (It.). See *Carex paludosa.*

Sala minore (It.). *Typha angustifolia.*

Salacia diandra.

A genus of *Hippocrateaceœ,* containing some 60 or more tropical species, for the most part abounding in India and the Asiatic islands, though found in other parts of the world. They are erect or trailing evergreen shrubs, and are sometimes cultivated in greenhouses. *S. diandra* is an East Indian species said to have been employed for the native manufacture of ropes and cordage of great strength.

Salcio.

This word, used with affixes, forms the common Italian names of different species of osiers, or willows, used in the industrial economy. ——— *da vinchi* is the osier, or water willow; ——— *vitrice*, the brittle willow; ——— *viminali*, the pliant willow; ——— *legare*, the binding willow, and many others. See *Salix*.

Salix spp.

Exogens. *Salicaceæ*. Willow trees.

The willow family is so well known that a description of the trees is unnecessary. There are many species, distributed over the northern hemisphere, and they are more numerous in the Old World than the New.

Bast Fiber.—While the largest use of the willow is in the manufacture of basketry, etc., some of the western Indians make use of willow bark, specimens of which are exhibited in the U. S. Nat. Mus. Dr. Palmer states in the American Naturalist for October, 1878, that the willow trees along the Colorado River, Arizona, yield abundance of long, soft bast, from which the Indians on this stream make ropes and twine for domestic purposes, as well as sandals and mats. The females generally dress scantily, only that part of the body from the waste to the knees is hidden from view. This custom is observed by most of the Indian females living along the Colorado River. They strip off the bark from these trees and bury it in blue mud for a few days, after which it is taken out, washed clean, and dried. It is now soft, pliable, and easily handled. Being cut into requisite lengths, they are fastened very thickly to a belt of the wearer.

Woody Fiber.—Several species of *Salix*, more commonly known as osiers, are employed in the manufacture of willow ware, which includes baskets, furniture, perambulators, and a variety of other useful articles. While this manufacture is more largely carried on in European countries, the twigs of a few of our own species, are so employed in this country, such as *Salix purpurea*, the rose, or whipcord willow, which is mentioned in Gray's Manual, sixth edition, as "growing in low grounds, and cultivated for basket rods." Other species are doubtless employed occasionally, or in small local industries.

There is hardly a tribe of Indians in North America that is not familiar with the rude plaiting or weaving of withes, reeds, grasses, etc., into articles of domestic economy, and several species of willow are employed by them for wickerwork, such as *S. cordata, S. sericea, S. petiolaris* in the Eastern and Middle States, the last two of real value; *S. lasiandra, S. lasiolepis* and *S. lævigata* in the Western and Pacific States. Of the last named only the roots are used by the Hoopa and Klamath Indians.

In the study of the subject, one first thinks of oziers or willows as the ordinary and proper material, but it is well known that our willows do not possess the softness and pliability which make several species of so much economic importance in Europe. Even when cultivated in this country these species become woody and hard. From all the information within my reach, I am led to believe that the native willow most used in this country, at least west of the Rocky Mountains, is *Salix sessilifolia*. From the region of the Hoopa and Klamath Indians of northern California and southern Oregon to that of the Papagos of southern Arizona, this plant furnishes one of the best materials for the warp of basket work. Young shoots, 2 or 3 feet long, are cut in the spring or early summer, stripped of their bark, and dried. They are soft and remarkably flexible, sometimes quite tenuous, almost filiform. This species deserves attention as one most worthy of cultivation for the production of valuable ozier. In order to keep it well pruned down and provoke new growths of young, tender shoots, the Indians of northern California set fire to the woods, an operation likewise intended to improve the hazelnut, another highly esteemed basket plant." (*Dr. V. Havard.*)

The woody fiber of *S. lasiandra* is largely used with other materials by the Pai Utes and Shoshones at Ash Meadows, Nevada, in the construction of pack baskets, water and pot baskets, and a kind of flat-bottomed bowl, a few inches deep and sometimes 18 inches across. The Panamint Indians of California also make loosely woven bird cages of these withes. Frederick V. Coville gives the following interesting account of this manufacture in a paper on the Panamint Indians of California in the American Anthropologist, October, 1892, which will serve to illustrate the methods employed by North American Indians in the manufacture of "willow ware" or baskets, etc., from withes of *Salix* and other species:

All these wickerwork utensils are woven by the squaws at the cost of a great deal of time, care, and skill. The materials are very simple. They consist of the year-old shoots of some species of tough willow, commonly *Salix lasiandra;* the year-old shoots of the aromatic sumac, *Rhus trilobata;* the long, black, slender, flexible horns on the mature pods of the unicorn plant, *Martynia louisiana,* locally known as devil horns, and the long, red roots of the tree yucca, *Yucca brevifolia.* These materials give three types of color—the white of the willow and sumac, the black of the devil horns, and the red of the yucca roots. This last material, although it has a strong fiber and a pretty red color, is rarely used, for it is too thick to plat closely and the resulting fabric is full of interstices. Sumac and willow are prepared for use in the same way. The bark is removed from the fresh shoots by biting it loose at the end and tearing it off. The woody portion is scraped to remove bud protuberances and other inequalities of the surface, and is then allowed to dry. These slender pieces of wood, that they may be distinguished from the other elements of basket materials, will be called withes. The second element is prepared from the same plants. A squaw selects a fresh shoot, breaks off the too slender upper portion, and bites one end so that it starts to split into three nearly equal parts. Holding one of these parts in her teeth and one in either hand, she pulls them apart, guiding the split with her fingers so dexterously that the whole shoot is divided into three equal even portions. Taking one of these, by a similar process she splits off the pith and the adjacent less flexible tissue from the inner face, and the bark from the outer, leaving a pliant, strong, flat strip of young willow or sumac wood. This is here designated a strand. Both withes and strands may be dried and kept for months and probably even for several years, but before being used they are always soaked in water. The pack baskets and some, at least, of the water baskets are made of these strands and withes. They begin at the bottom with two layers of withes superimposed and fastened by their middles at right angles. The free ends are bent upward, and in and out between them the strands are woven, new withes being inserted as the basket widens. An attempt at ornamentation is frequently made by retaining the bark on some of the strands or by staining them, and by slightly varying the "weave." A squaw commonly occupies an entire month constructing one such basket. The plan of the pot baskets and plates is very different from that of the pack baskets. The materials are all carefully selected and prepared. They consist of willow or sumac strands like those described above, but narrower and of the finest quality, similar black strands from the devil horns, and the long-jointed, slender stems of a native grass, *Epicampes rigens.* The strands of devil horns are exceedingly tough, of a coal-black, very persistent color, and attain a length of from 4 to 10 inches. The grass is particularly adapted to this use from its firm texture and the fact that the portion above the uppermost joint, which alone is used, is very long, often 18 inches. Starting from a central point a bundle of two or three grass stems and one very slender withe is sewed by a willow strand to the part already finished. The process is very similar to the crocheting of a circular-lamp mat. At the proper point the bundle is drawn more tightly, so that the remainder of the spiral forms the sides of the basket. The wall has the thickness, therefore, of one of these bundles, and is composed of a continuous spiral of them. The willow withe furnishes a strong hold for the stitches, and the punctures are made by an iron awl. When such an instrument can not be obtained an admirable equivalent is substituted in the form of a stout, horny-cactus spine from the devil's pincushion, *Echinocactus polycephalus,* set in a head of hard pitch. The grass stems, when the stitches are drawn tightly, make a perfect packing, and the basket when finished is water-tight. Curious patterns in black are woven into the basket by the occasional substitution of strands of devil horns for those of willow.

Osiers for wickerwork are cultivated in Europe and in Eastern countries, and the manufactures from them are often large industries. Among the European basket willows, *S. triandra* is doubtless the best species for purposes of manufacture, its twigs being light, flexible, and white. This is the *Vetrice de ceste* of Italy, commonly used for hampers, children's carriages, etc. *S. purpurea* is said to be cultivated in France, Germany, and England for ornamental basket work and fine manufactures. *S. fragilis* is a coarser species, also employed for baskets and the like. *S. alba* (the binding willow, *Salcio da legare* of the Italians), is the species employed in making the celebrated charivari chairs. *S. viminalis*, the species most commonly referred to as the osier, is "more distinguished for the quantity than the quality of its twigs." It is also known as the water willow. (*Dianthera americana* is also called water willow.)

Among the species of *Salix* used for wickerwork, etc., in Eastern countries are *S. acmophylla* for binding; *S. alba*, or common white willow, used in Kashmir for basket work; *S. babylonica* for baskets, wattles, weirs, fences, etc.; *S. tetrasperma*, basket work; and *S. wallichiana* baskets, the smaller twigs being used for toothbrushes.

Salt marsh grass. *Spartina juncea.*

Samahuma (Braz.). *Eriodendron samauma.*

Sambal (Java). See *Æschynomene.*

Samóa (Hopi). *Yucca baccata.*

Samohú (Arg.). *Chorisia speciosa.*

San, Sana, Sani (Hind.). *Crotalaria juncea.*

San kokra and Sankokla (Ind.). *Hibiscus cannabinus.*

Sanabu (Ind.). *Crotalaria juncea.*

Sansevieria. THE BOWSTRING HEMPS.

An important genus of *Liliaceæ*, with representatives in tropical regions of both hemispheres. They are found on the coast of Guinea, around Ceylon, and along the Bay of Bengal, extending to Java and the coasts of China. They are stemless, perennial plants, throwing out runners, and having only root leaves, which are thick and fleshy, and usually sword or lance shaped, with sheathing bases. They flower from January to May, and the plants grow wild in the jungles. They are 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.

The best known species are *S. guineensis*, *S. roxburghiana*, *S. zeylanica*, *S. cylindrica*, and *S. longiflora*, the latter species abounding in southern Florida, where beautiful examples of its fiber, 6½ feet in length, have been extracted. *S. kirkii* is an African species, found on the east coast, the fiber of which has been prepared experimentally. *S. ehrenbergii* is another African species known as Somali-land fiber, and *S. sulcata* gives a fiber similar to *S. cylindrica*, though not so valuable. *S. lanuginosa*, called *Katu-Kapel*, is found on the Malabar coast. This plant, upon experiment, according to Royle, has produced fiber as fine and soft as human hair, and possessing extraordinary strength and tenacity. Very superior examples have been likened to raw silk, and the firmness of the fiber "induced the Rev. J. Garrow to have it woven into cloth, which he declared was as fine a piece of cloth as he had ever seen." *Sansevieria* fiber was formerly considered a valuable paper stock at Trichinopoly, where the tow was used, while the fiber served as packing for steam engines.

Sansevieria cylindrica. Ifé Hemp.

Endogen. *Liliaceæ*. Stemless, lance-leaved plant.

South Africa from Zanzibar to Angola. Differs from other species of the genus in that the leaves are cylindrical, or round in horizontal section; when fully developed 3 to 4 feet long, and about an inch thick.

Structural Fiber.—Specimens of fiber prepared from plants growing at Kew and submitted to Ide & Christie, London, were estimated to be worth £28 per ton. "Except that it does not appear quite as strong, it is almost equal to *S. longiflora*." Samples are exhibited in the Kew Mus. from Mauritius and from Sierra Leone. "The cordage and rope made of this plant appear to the eye of excellent quality, whatever experience may prove them to be." Experiments recently made with this cordage have shown it to be the strongest and best fitted for deep-sea sounding of any fiber known; indeed this is the less surprising, seeing that other species of *Sansevieria* (the well-known *S. zeylanica* and *guineensis*, for example) are cultivated in almost all tropical countries on account of the strength and durability of the fiber, under the name of bowstring hemp.

Sansevieria guineensis. African Bowstring Hemp.

Native name.—*Konji*, Zambesi; the fiber, *Konje* hemp.

Native of Guinea; found in Central America, Abyssinia, and Mauritius, distributed to tropical America, particularly the West Indies. Cultivated in greenhouses with *S. zeylanica* and other species.

This is the best known form of plant producing bowstring hemp, and is one of the oldest species. It has hoary, erect lanceolate leaves, 3 to 4 feet long, 3 inches broad at the middle, narrowed gradually to an acute apex, not distinctly bordered with red, copiously mottled on both sides with broad, irregular bands of white.

Structural Fiber.—The fiber of this species has been said to resemble manila hemp, and it is applicable for cordage manufacture. Specimens of the fiber from Trinidad submitted to Ide & Christie, London, were reported upon as follows: "In point of cleanness and softness of fiber it seems well prepared; but to compete successfully with manila hemp it would require to be of a better color and of equal if not superior strength. We value it for rope-making purposes at £20 per ton in London. Another example of machine prepared was valued at £23 per ton. In our experimental trial carried on at Jamaica, 1,185 pounds of green leaves of *S. guineensis* yielded 29 pounds 10 ounces of dry fiber.

Culture and preparation.—The following statements regarding the growth of this and allied species of *Sansevieria*, in Jamaica, are reproduced from the Kew Bulletin for May, 1887.

In the first instance plants may be set out at 3 feet by 3 feet, which, allowing for roads and paths, would give about 3,000 to the acre. If the soil is kept well broken and moist, the plants by the extension of root suckers will spread in all directions, so that ultimately the whole ground, with the exception of certain paths, which should be kept permanently open, will be covered with plants. As regards the time which must elapse between planting out and the first yield of leaves suitable for fiber there would appear to be a great difference of opinion. Plants which I saw at St. Thomas at 3 years old were only just ready to be cut; and Baron Eggers, who had planted them and kept them under close observation during the whole of that time, was of opinion that *Sansevieria* could not be depended upon to yield a crop before three or three and a half years.

Refer to the account of *S. longiflora*, the species common in Florida.

Sansevieria kirkii. PANGANE HEMP.

This species grows abundantly near Pangane on the mainland opposite the island of Zanzibar; discovered by Sir John Kirk.

STRUCTURAL FIBER.—The robust habit and large size of the leaf of this plant render it valuable for fiber purposes. Under exceptional circumstances a leaf will attain a height of 9 feet. The fiber from plants growing at Kew was valued in 1887 at £27 per ton. It is used by the natives, and yields a long and useful fiber. (*Dr. Morris.*)

Sansevieria longiflora. FLORIDA BOWSTRING HEMP.

Native of equatorial Africa, but distributed to tropical America; occurs in Trinidad and is common in garden cultivation in southern Florida, or in localities or on some of the keys, in a semiwild state where introduced plants have been neglected. The Florida species was at one time thought to be *guineensis*, but on receipt of plants of both *guineensis* and *longiflora* from the royal Botanic Gardens of Trinidad the form growing in Florida was properly identified. The leaves are similar to those of *S. guineensis*, but larger, longer, and flatter, not so firm in texture, and not invariably blotched, the spots being more irregular and the entire plant (in Florida) often a lighter green. The flowers are 3½ to 4 inches long, while those of *S. guineensis* are 2 inches. (See fig. 3, Pl. VIII.)

STRUCTURAL FIBER.—A specimen of fiber from plants grown at the Royal Kew Gardens in 1887, and submitted to London fiber brokers, was described as very bright, clean, and strong; in every way a most desirable commercial article, and was valued at £30 per ton. Fiber extracted by the Department, in 1892, at its experimental factory on Biscayne Bay, Florida, from nearly a ton of leaves grown on Boca Chica Key, was in every way superior to sisal hemp. Some of it was produced from a hundred pounds of selected leaves that averaged 6½ feet in length, and fiber even 7 feet long was secured, while the shortest was 2½ feet.

Careful estimates based on the quality of *Sansevieria* fiber produced in these experiments would fix the yield at about 40 pounds of fiber to the ton of leaves. The *Sansevieria* waste was not weighed, but it is very safe to state that with only reasonable wastage (cut fiber and fiber drawn out with the pulp) the yield of fiber per ton would come nearer to 50 pounds. Even if this is considerably lower than the yield of sisal hemp, the quick growth of the plant, the ease with which it can be harvested, and the higher price of the fiber will probably more than make up for the difference in the yield of cleaned fiber.

The material is too good for cordage in the usual acceptance of the term. It is so much finer and better than the cordage fibers, so called, that it would doubtless find a use in the manufacture of fine twines, and with proper preparation might be made into a fair spinning fiber, and possibly be employed on some new form of manufacture. The fiber is fine, white, and lustrous, the leaves yielding readily to treatment in the machine in the fresh state.

HISTORY IN THE UNITED STATES.—During the investigations of the writer, in Florida, in the winter of 1890–91, this plant was found growing at several points, principally at Key West, on Boca Chica Key, and at Miami on the east coast. Nothing was accomplished, however, further than to demonstrate that it would thrive out of doors, in southern Florida, though a brief mention was given to the plant in Bulletin No. 3, on sisal hemp culture (Fib. Inv. series), and a reference made to the value of the Florida-grown fiber, several samples having been secured. As early as the spring of 1890 several letters were received relating to this plant, one of the first being from Dr. J. V. Harris, of Key West, who spoke highly of the value of this plant for fiber cultivation. Letters were also received from Mr. George H. Bier, of Key West, upon the subject, in one of which the statement was made that the plant after introduction into the British West India Islands, found its way to Cuba as an ornamental plant, and in 1866 was brought as an ornamental plant from Cuba to the keys, and that the people, though ignorant of its value as a fiber plant subsequently became alarmed at its rapid extension, and endeavored to eradicate it. A little later Dr. Harris became interested in the growth of the plant with a view to embarking in its cultivation as an industry. Beyond establishing a small plantation, however, I have been unable to learn that any practical results followed.

Preparation and cultivation.—In 1892, when the writer visited Key West, he was able to secure from Dr. Harris interesting information regarding the best manner of multiplying the young plants, which were photographed in different stages of growth. In propagating the plant, for convenience the leaves are cut into sections about 4 inches long and inserted into boxes of earth to the depth of about 2 inches. The soil must be moderately dry, as too much moisture will cause the leaves to rot. The boxes must be placed in a moderately shady place, and in a few weeks' time the slips will put out numerous fibrous roots, which will soon be followed by suckers. The plant can also be readily propagated by sections of its rhizomes or roots, which grow without any difficulty. It was stated that the plant requires good, rich soil to succeed well, and will under favorable circumstances acquire its full growth in about twelve months' time; ordinarily, however, it will not acquire its full growth until sometime in the second year. In the reports of experiments with another species, in Jamaica (Kew Bull., May, 1887), the time of growth to maturity is placed at three and a half years. (See remarks on culture, under *S. guineensis.*) Dr. Harris, nevertheless, states that when once the land is stocked with its growth it will always, when cut, give a full growth from the roots inside of twelve months; so that it is perfectly safe, after the second year, to count on a full crop every year, the growth of each year becoming denser, and in a few years becoming so thick that it would appear to be impossible to cultivate it; which, however, appears to be needless, as when once fully established it takes entire possession of the soil, entirely eradicating everything else. It does not appear to materially exhaust the soil, as it will grow for a number of years in the same place and continue to make vigorous growth.

As to yield, it was stated that after a plantation is well established it is possible to secure a crop of 5 tons of clean fiber per acre. The experiments of Dr. Roxburgh, however, do not give such figures of yield, as 1,613 pounds of fiber at a gathering was estimated, or, at the rate of two crops a year, a little less than 2½ tons of fiber.

* Specimens of the plants are growing in the conservatory of this Department, and of the fiber, in series, are preserved in the Mus. U. S. Dept. Ag. See Report No. 5, Fiber Investigations series, Dept. Ag., chapter on Sansevieria.

Sansevieria roxburghiana. Moorva.

This species has been known and prized in India from remote antiquity under the name of *Moorva* or *Murva.* In the catalogue of Indian fibers, London (Exhibition, 1862), it is called *Moorga, Moorgavee,* or *Moorgahvee.* It is also known under the vernacular names of *Murgari, Murga,* and *Mazool.* Its Sanskrit synonym is *Goni.* The plant "was long confused with *S. zeylanica,* but Sir Joseph Hooker (Flora of British India, VI, p. 271) has shown it to be quite distinct. The leaves reach 4 feet in height, narrow and semicircular in transverse section, faintly clouded with black. The plant is cultivated for the sake of its fiber, and is the original bowstring hemp plant. The many uses to which the fiber is applied in India are fully described in Watt's Dictionary of the Economic Products of India, VI, pt. 2, p. 460." (*Dr. Morris.*) From this it would appear that the following statements by Dr. George Watt refer to *S. roxburghiana* the true Indian species, and not to the Ceylon species *S. zeylanica.*

Structural Fiber.—From the succulent leaves is extracted a fiber held in high esteem by the natives on account of its elasticity and consequent suitableness for bowstrings, Sir W. Jones says: "From the leaves of this plant the ancient Hindus extracted a very long thread called *Maurvi* of which they made bowstrings, and which for that reason was ordered by *Menú* to form the sacrificial zone of the military classes." Roxburgh, in his detailed account of this fiber, makes the following somewhat interesting remark: "I am inclined to think that the fine line called China grass, which is employed for fishing lines, fiddle strings, etc., is made of these fibers." (Roxburgh thus would seem to have regarded China grass and Rhea as two widely distinct fibers.) In his experiments 80 pounds of the fresh leaves yielded 1 pound of clean, dry fiber. He therefore concluded that the plant might be cultivated with advantage on account of its fiber. (*George Watt.*) It is, in fact, easily cultivated. The fiber is used for the preparation of cordage and matting in the regions where it occurs, and is much valued in Europe for ropes used in deep-sea dredgings. Has been used for paper but is too expensive a fiber for this use. The fiber is pliant, soft, and silky, and much resembles that of the pineapple. It is usually prepared by taking the fresh leaves and placing one of them on a smooth board which is raised at one end. The lower end of the leaf is then pressed down by the toe of the workman, who squats on the plank, and with a blunt knife, or piece of iron plate scrapes upward along the surface of the leaf and thus deprives it of its fleshy pulp by successive scrapings, turning the leaf over and over, as may be necessary. When the pulp is thoroughly removed, the fiber is washed for three or four minutes, and dried in the shade. Washing in brackish or salt water, or continuous soaking in water is said to destroy the glossy white appearance of this fiber.

Sansevieria zeylanica. THE NEYANDA.

Another Indian species cultivated in Ceylon. Commonly cultivated in greenhouses, in the United States, and readily known by its shorter, darker leaves, heavily mottled or banded with white. The leaves are semicircular in transverse section, 1 to 2 feet long, dull green with a red margin, and copiously banded with white. The Singhalese use the fiber in numerous ways for string, ropes, mats, and a coarse kind of cloth. Generally the fiber is prepared by retting or by simply beating and washing. The small size of the leaves, and the difficulty of handling them in large quantities, would render this species of less value commercially than any of the preceding. In the Handbook of Ceylon, W. C. E., 1893. it is said that the plant grows in a wild state in the dry, drought-stricken districts of the country. It is usually found growing among rocks, and affords a magnificent fiber of great strength. It is largely made up into ornamental ropes by an outcast race of Singhalese called the Rhodias, who do a small trade in this product.

Sapindus saponaria. SOAP BERRY.

Exogen. *Sapindaceæ.*

This genus consists of trees and shrubs found in the Tropics of both hemispheres. The outer shell or covering of the fruit of the above species contains a saponaceous principle that gives it its name. Found in tropical America. The plant is given in Dr. Ernst's catalogue, with the common name *Parapara.*

FIBER.—The bast of this species yields a coarse fiber, suitable for native cordage. It is said to be cultivated in India.

Sapucaya (Braz.). See *Lecythis ollaria.*

Sara, Sarapat, and **Sarpatta** (Hind. and Beng.). See *Saccharum sara.*

Sarali (Ind.). See *Alnus nitida.*

Sarcochlamys pulcherrima.

Syn. *Urtica pulcherrima.*

This urticaceous species is described by the Dic. Ec. Prod. Ind. as a bush or large shrub, with a stem often as thick as a man's leg. It is found in Assam, the Khásia Hills, Sylhet, Chittagong, and Burmah; distributed to Sumatra. Yields a dye, and the bark gives a good fiber for ropes.

Saw palmetto (Fla.). See *Serenoa serrulata.*

Sarkara, Sanscrit name for sugar.

Schœnus nigricans.

An European species of sedge grass that is used in Italy for rough ropes. *S. melanostachys* is a Queensland species, the culms of which are used in basket manufacture.

Scirpus lacustris. THE BULRUSH. MAT RUSH.

A tall sedge abounding in ponds and swamps throughout North America; common in Europe, northern Asia, Australia, and some of the Pacific islands. Known in Italy as *Giunco da stuoie;* in Hawaii as *Akaakai.* (See fig. 95.)

STRUCTURAL FIBER.—The entire stem is used in many parts of the world for mats and mattings. Among the curious and interesting objects manufactured from this sedge grass are baskets, beehives, horse collars, etc.; in England, shoes, used in Denmark when thrashing buckwheat to prevent crushing the grain; packsaddles, in Guernsey, for conveying "wrack" from the seashore. The Kew Mus. exhibits a great coat made from this rush, in Portugal. A variety of the species, *occidentalis,* is the Tule of the Pacific Coast. Used in California as cases for the protection of wine bottles packed for shipment, just as straw covers are used for the same purpose in Europe. See also *Eleocharis palustris.*

The Yokuts of the Tulare Lake region of California construct very rude, frail punts, or mere troughs of Tule, about 10 feet long, in which they cruise timidly about the Tulare Lake, near the shore. (*Stephen Powers.*)

* Specimens of Tule, Mus. U. S. Dept. Ag.

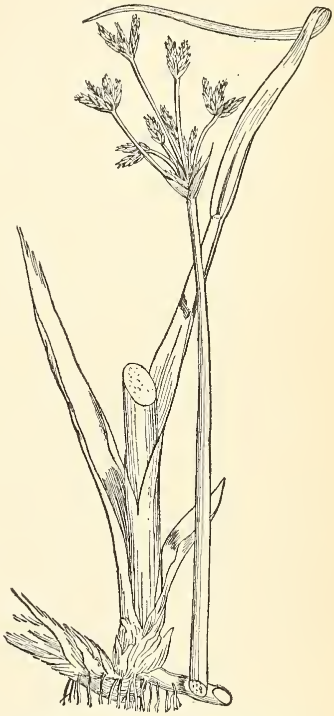

FIG. 95.—The Bulrush, *Scirpus lacustris.*

Screw pine (see *Pandanus*).

Scriptural fibers (see Introduction, Ancient Uses of Fibers).

Sea rush (or coast rush). *Juncus maritimus.*

Sea mallow. *Lavatera maritima.*

Sea mat grass. Sea reed and sea-sand grass. See *Ammophila.*

Seaside grass. *Cyperus tegetum.*

Seaweeds.

While these marine plants are not strictly speaking fibrous, several species are employed in place of fibers, such as the *Macrocystis,* from which fish lines are obtained. In southern Europe the leaves of another form of marine or aquatic weed (see *Zostera*) is employed as a packing material. These plants belong, however, to the grass wrack order, and are in no way related to the true seaweeds or *Algæ.*

Sea wrack, Grass wrack, etc. *Zostera marina.*

Secale cereale. RYE.

Endogen. *Gramineæ.* A cereal grass.

An annual, 4 to 6 feet high, with flat leaves and a terminal, somewhat flattened, bearded spike 4 to 6 inches long. The rye crop of the United States in 1895 was 27,210,070 bushels, nearly half of which was produced in the States of Pennsylvania, New York, and Wisconsin. Rye is more largely cultivated in central and northern Europe than in America, and the grain is there very largely used for making bread. Rye straw is little valued for fodder, but when green it is esteemed as a forage plant, and is sometimes sown for this purpose in the Southern States, cattle being allowed to graze it during the fall and winter months.

STRUCTURAL FIBER.—Rye straw is used as a straw-plait material, particularly in Italy, where the straw of both wheat and rye are employed in this industry. As the Italian use of the straw is interesting, the following condensed account, from the work of M. A. Savorgnan, is presented: The stem of the rye reaches a greater height than that of the wheat sown in March, and when this plant is cultivated with especial care for its utilization as straw it becomes finer and whiter than that of the wheat, in many cases therefore this is selected, although it may be less durable. This straw is especially suited to the thatching of cottages, for the making of beehives, of large baskets for the transportation of dry figs, beans, and similar products, also various uses about gardens. It is, besides, used in plaiting very fine braids for making hats of superior value. It is to be noted, however, that the stems should be cut before the maturity of the grain and that the straw of the *segale* is difficult to manufacture, and that it splits easily. There are still found in the markets some hats, although they have almost gone out of use, said to be made from rice straw (*Paglia di riso*), but they are such only in name, for they are made from the fiber of a kind of *salce* (willow) or from exceedingly fine strips of wood in which case they would more justly be called chip-hats, or hats made from shavings.

Securidaca longepedunculata.

The genus *Securidaca* belongs to the *Asclepiadaceæ* and is composed of trailing shrubs, many of which are natives of tropical America. *S. longepedunculata* is a South African species, which grows in great abundance along the lakes and rivers of Cape Colony, South Africa.

BAST FIBER.—The material employed for making the beautiful fish nets used by the Makouba tribe on Lake Ngami. "Two kinds of fiber appear to be furnished by the plant; one from the bark of the twigs is very strong and durable, and would seem to be the fiber from which the nets are made, known in Zambesiland as *Buáze* fiber; the other from the stem, cross sections of which show layers of fibrous bark between layers of wood." *Buáze* fiber seems to have been first introduced to notice by Dr. Livingstone in 1857. In his Missionary Travels and Researches in South Africa, published in that year, he says (p. 645) that he submitted a small quantity of the fiber to Messrs. Pye Bros. of London, who reported that "The *Buáze* evidently possesses a very strong and fine fiber, assimilating to flax in its character, but we believe when treated in quantity by our process it would show both a stronger and finer fiber than flax; but being unable to apply the rolling or pressing processes with efficiency to so very small a quantity, the gums are not yet so perfectly extracted as they would be nor the fiber opened out to so fine a quality as it would then exhibit." The opinion obtained by Messrs Pye Bros. from Messrs. Marshall, of Leeds, was as follows: "The *Buáze* fiber appears to resemble flax, and as prepared by you will be equal to flax worth £50 or £60 per ton, but we could hardly speak positively to the value unless we had 1 or 2 hundredweight to try on our machinery. However, we think the result is promising, and we hope further inquiry will be made as to the probable supply of the material." Dr. Livingstone adds that the plant is stated to grow in large quantities in the "Maravi country, north of the Zambesi, but it is not cultivated, and that the only known use it has been put to is in making threads on which the natives string their beads. Elsewhere the split tendons of animals are employed for this purpose. This seems to be of equal strength, for a firm thread of it feels like catgut in the hand, and would rather cut the fingers than break." (Kew Bull., Sept., 1889.)

Notwithstanding the comparatively favorable report on this fiber, received so far back as 1857, nothing has since been done to further its utilization.

Semenzuolo (It.). Straw-plait from wheat. See *Triticum.*

Sennoc (Alg.). *Lygeum spartum.*

Serenoa serrulata. THE SAW PALMETTO.

Endogen. *Palmæ.* A trunkless palm.

This is sometimes called the scrub palmetto, as it forms the undergrowth of vast areas of pine lands, and is found in other uncultivated tracts in Georgia and Florida, and is also found in Alabama and Louisiana. The supply of the plants is almost inexhaustible, for the palmetto grows everywhere, and its big roots, often as thick as a man's leg—and which are produced at the rate of 20 cords to the acre—will send forth an entire new crop of leaves within a year after clearing. The species is allied to *Chamærops humilis* of northern Africa, the leaves of which supply the *Crin végétal* of commerce. Fig. 2, Pl. X, illustrates the manner of growth of the saw palmetto, in the pine barrens of the South; hence its name scrub palmetto.

STRUCTURAL FIBER.—The fiber secured from the leaf stems is used commercially in the manufacture of a substitute for cows' hair, used in mixing mortar for plastering houses, a product both cheap and durable, as lime does not destroy it. It is known as Nassau plastering fiber. The stiffer fiber when combed out is also used in the manufacture of a coarse kind of whisk broom. A coarse cordage might also be made from it, but it would lack in softness and strength compared with the commercial fibers. The leaves can be shredded to make a good upholstery material, and they also form a most valuable paper stock. Unless the cost of production should prove an obstacle, there is no reason why a valuable Florida industry should not be created by shredding the leaves of this palmetto for mattress fiber, as 1,000 to 2,000 tons of such fiber is brought from Africa to this country annually. (See *Chamærops humilis.*) Even if it did not pay to ship to the northern fiber markets, local industries could be established that would make a home demand for the fiber. A difficulty, heretofore, in preparing this fiber, has been to give it the "curl" that is found in imported *Crin végétal,* and which adds so much to the elasticity or springiness of the fiber in a mattress. This curl is given to *Crin végétal* by twisting the shredded fiber into coarse ropes for compactness in shipping.

Attempts have been made at various times to establish this industry, and while a number of satisfactory machines have been constructed for shredding the leaves, the industry has never attracted attention. It has been claimed that to sell the mattress material at $25 per ton, in order to compete with *Crin végétal,* would entail a loss to the manufacturers. In a statement from the manager of a company that was formed seven or eight years ago, to manufacture this fiber, it was said that the raw material was purchased at $3 to $5 per ton, and that there was about 70 per cent loss by waste and evaporation.

The fresh roots of *S. serrulata* which are 3 to 5 inches in diameter, are made into cheap brushes. They are sawed into disks an inch or more in thickness, the pulp scraped out to the depth of two-thirds of an inch by means of toothed scraping wheels, when the longitudinal fibers, thus exposed, form the bristles of the brush, the untouched portion of the disk forming the back. This takes a fine polish, and when the sides are shaped and polished the brush is completed.

Both roots and leaves of the palmetto contain a large percentage of tannin, and the extraction of the tannin from palmetto leaves has already become an industry. Leather is said to be tanned with this product in twelve days, and it is claimed that it can be more economically produced than the leather tanned with oak or hemlock bark. The residue forms a valuable paper stock, which is also utilized. After the tannin has been extracted the palmetto is steamed in a chemical solution, which removes the silicate contained in the palmetto and changes the glossy shield to a gummy mass, which can be removed without injury to the fiber. In making imitation horsehair this gummy mass is allowed to dry, as it adds to the elasticity of the fiber. There are several combinations in which the production of tannin and fiber can be advantageously operated. Tanneries situated in the vicinity of paper mills can grind the palmetto in the same manner as bark; the residue, after bleaching, is in the proper shape for the paper mill. In this way palmetto can be profitably shipped and used at long distances. Showing the cheapness of the supply of raw material, it is stated that the cost of cutting and gathering the palmetto will no exceed \$2 per ton; hauling and baling will cost about \$1 per ton, and if 50 cents be paid for stumpage to the landowner it is claimed that palmetto ought to be delivered at the cars from \$3 to \$4 per ton, f. o. b.

C. B. Warrand, who established a palmetto tannery at Savannah, Ga., stated that palmetto fiber, not chemically treated, sold at wholesale at \$80 per ton and retailed at 8 cents per pound; \$70 per ton for a better article ought to be readily obtained at the works. In this process there is less loss than in spinning fiber, and 650 pounds of bedding fiber and 150 pounds of plastering fiber to the ton of palmetto can be safely relied on.

The leaves of the saw palmetto are a favorite thatch material with the new "homesteader," whose first house is a palmetto hut, and very comfortable and picturesque dwellings they make. The Indians also know the value of the plant as a thatch material.

*Specimens, in complete series, are preserved in U. S. Nat. Mus., Field Col. Mus., and Mus. U. S. Dept. Ag., all prepared by the writer.

Sesbania aculeata. DHUNCHEE.

Exogen. *Leguminosæ.* An annual shrub.

NATIVE NAMES.—*Dhunchee, Dhanicha* (Beng.); *Jayanti* (Ceyl. and Hind.); *Ranshe-wra* (Bomb.).

The plants of this genus are slender, shrubby annuals, found in the warmer parts of both hemispheres. *S. aculeata* is an erect, slightly branched species that is cultivated on the plains of India, from the western Himalayas to Ceylon and Siam, and has a cosmopolitan distribution in the Tropics.

BAST FIBER.—This is the well-known *Dunchee* of India, which is highly esteemed for the manufacture of ropes and cordage, and is regarded as a coarse substitute for hemp. The plant is a native of the Malabar coast, and also grows in China. The plant grows to a height of 6 to 10 feet; the fiber is long, but much coarser and harsher than hemp. Bengalese fishermen make the drag ropes of their nets of this substance on account of its strength and durability. It is generally grown in wet soil, requiring little preparation, as the plant is hardy and of rapid growth. It is sown at the rate of 30 pounds of seed to the acre. In northwest India, during the rainy season, it springs up in rice fields and other wet, cultivated lands. A peculiarity of the fiber is its remarkable contractability, as from contraction alone ropes made of it are said to be able to carry away the mainmast of a ship.

A biga of land—which is one-third of an acre in Bengal—will produce 173 pounds of fiber and 92 pounds of seed. A woman will dress 4 pounds a day. Royle states that the product of an acre is 100 to 1,000 pounds of ill-cleaned fiber. At the Int. Exh., 1851, the fiber was valued at £30 to £35 per ton. It is prepared in the same manner as sunn hemp, *Crotalaria juncea,* which see for further information regarding the extraction and cleaning of the fiber.

S. ægyptiaca is another Indian species, the fiber of which has been used for cordage. *S. grandiflora,* the *agust, agusta, agasti,* and *agati* of southern and eastern India and Burmah, is a soft-wooded tree 20 to 30 feet, "the inner bark of which appears likely to yield a good fiber." (*Dr. Watt.*) It produces, also, a gum, medicine, food, and fodder for cattle.

Sesbania macrocarpa. COLORADO RIVER HEMP.

Sesbania is the only genus in the family *Leguminosæ* that has attracted attention in this country as fiber producing. Specimens of the straight, stiff canes of *S. macrocarpa,* or the wild hemp of the Colorado River region, have been sent to the Department at different times in the past years, the best samples of stalks and fiber having been received from the veteran collector, Dr. E. Palmer. Dr. Parry, formerly botanist of this Department, noted many years ago the abundance of the species on the alluvial banks of the Colorado, and also that it grew in South Carolina, Arkansas, and Texas.

Bast Fiber.—Early specimens of the fiber, received by the Department, and now loaned to the Field Col. Mus., were 4 feet in length. Specimens twice or three times as long might be secured, however, as stalks 12 feet in height are common. The filaments as extracted are exceedingly coarse, and resemble flat ribbons of fiber, uncommonly white and lustrous, and clear and smooth to a remarkable degree. Single filaments are quite strong, but when several are twisted together they lose a part of their strength, a defect sometimes observed in better fibers. It is somewhat elastic, but its smoothness and elasticity are not in its favor where tenacity is required, as the filaments will not cling when worked together. It is sufficiently strong for small cordage for ordinary use, though too coarse for fish line or twine, as roughly prepared. Among the manufactures for which it has been claimed that this fiber is fitted are wrapping, writing and bond papers, twine and cordage, "sacking, overall stuff, Irish linens," and a fabric "better than the best Japanese pongee silk." The museum samples of fiber, collected by Dr. Palmer and known to be *Sesbania macrocarpa* are hardly capable of manufacture into "Irish linens" or "Japanese pongee silk," although the filaments can be very finely divided. A specimen recently submitted to Dr. Taylor was subdivided down to one ten-thousandth of an inch.

Efforts to utilization.—At different times, in past years, efforts have been made to bring the plant into prominence. In an early letter from O. F. Townsend, of Yuma, Ariz., statements were made as follows:

An indigenous plant commonly known here as wild hemp, producing a fiber of great excellence, grows profusely on both sides of the Colorado River from Yuma to tide water at the Gulf of California. The large fields lie in Mexican territory and cover nearly 100 square miles of area. Numerous experiments have been made with different kinds of machinery to utilize the valuable plant. The old hand-brake system produces 20 per cent of fiber. The Indians work it into nets and fish lines.

From statements by D. K. Allen, of Yuma, Ariz., some interesting facts regarding the species have been gleaned. The wild hemp ripens from the 1st to the 3d of July, as a rule, and still in many places it holds green until September 1, and the late growth until October 1. It grows on the clean, clear soils or lands lying along the sloughs or branches of the Colorado and New rivers, which are dry during the fall and winter months. The first rise in the Colorado comes in February and lasts into March. The second comes in May and June and runs from that time on till the next February. The seed of the wild hemp sprouts and begins to grow in April and May, running up and appearing exactly like wild or overgrown mustard stalks—in fact, one could hardly tell one from the other except for the difference of taste in the seeds. When young they are not at all alike. As soon as the water recedes in August, and from that on, one can go almost anywhere through the hemp lands, although some of the sloughs, or branches of them, contain a little water which would have to be bridged. But they are very narrow, only 10 to 20 feet wide and only 2½ to 5 feet deep, with plenty of wood, brush, and timber with which to build the bridges. Some of the hemp can be cut with a machine, but much of it will have to be cut by hand. In April there are stalks of the hemp which, a foot above the ground, will measure 10 inches in circumference, or more than 3 inches in diameter. One of the McCormick reapers, rigged with guards of the proper size and with a sickle to correspond, can be arranged so as to cut easily where they are not larger than a man's finger. The hemp can be dried and pressed into bales on the ground where it grows. It now grows all along the river, and back from it for 10 to 12 miles, to a distance, up and down, of 100 miles. Many of the sloughs where water remains throughout the year can be used. Flat boats that can carry 10 to 15 tons can be loaded and towed with horses or mules, poled or towed by Indians when the banks are too soft. Sails can also be used to take the hemp to the river, where it can be loaded on steamers and brought to the railroad, or down the river to the gulf, where it can be loaded upon vessels for any part of the world.

It has been estimated that at the very least there are 50,000 acres of it, and that in the poorest years it will yield 500 pounds of the dressed fiber per acre. This makes 25,000,000 pounds—12,500 tons, or 1,250 carloads of 10 tons each. Repeated efforts have been made by the Department to secure several hundred pounds of the fiber for test, but even the offer to purchase it at a fair price has not brought any practical results. Even considering the coarseness of the fiber, should it be found quite inferior to the commercial cordage fibers, the fact that it grows over such vast areas without cultivation, and with such large yield, commends it to our attention, for if it can be cleaned cheaply it has a value for some purpose, and when subdivided by after chemical treatment there is no doubt that the fiber might be used for higher purposes of manufacture.

Sesbania platycarpa: A few years ago P. S. Clark, of Hempstead, Tex., stated that this species had suddenly made its appearance in his neighborhood. He described the fiber as very strong, and thought that it would make a good bagging fiber for baling the cotton crop.

Seubbara (Arab.). *Agave americana.*

Shacapa (Peru). *Attalea spectabilis.*

Sheathed galingale rush. *Cyperus vaginatus.*

Sheathed rush (Vict.). *Juncus pauciflorus.*

Shemolo (Ind.). *Bombax malabaricum.*

Sheoak (Austr.). See *Casuarina.*

Shichito-i mattings (Jap.). *Cyperus unitans.*

Shining galingale rush (Vict.). *Cyperus lucidus.*

Shivan and **Shewun** (Ind.). *Gmelina arborea.*

Shoe-string grass (U. S.). *Sporobolus cryptandrus.*

Short-podded yam bean. See *Pachyrhizus.*

Shral (Ind.). *Alnus nitida.*

Shwet-simul (Beng.). *Eriodendron.*

Sida rhombifolia.

Syn. *Sida rhomboidea, S. retusa.*

Exogen. *Malvaceæ.* A perennial shrub.

COMMON AND NATIVE NAMES.—Sida, and Tea-plant (U. S.); Queensland hemp (Australian colonies); *Atabula* (Sanc.); *Swet Bariala* and *Sufet Bariala* (Ind.); *Escoba* (Venez.).

Abounds in the tropical regions of India; distributed to Australia and to North and South America. According to the Des. Ec. Prod. Ind., the Linnean varieties accepted by botanists are as follows: *scabrida, retusa, rhomboidea, obovata,* and *rhombifolia.* It seems probable that the sida fiber experimented with in Bengal has been chiefly obtained from *S. rhombifolia* or *S. romboidea. S. rhombifolia* abounds in many portions of South America. Dr. Ernst states that it is very common in Venezuela, growing wild in all localities, the fiber being readily extracted, and fine and strong.

As far back as 1889 the Office of Fiber Investigations received from South Carolina statements regarding *S. rhombifolia,* which, on the authority of J. P. Porcher, of Eutawville, in that State, had been known as a weed throughout that region for many years, at least since 1880. Later, when visiting Charleston, the attention of the writer was called to the plant by Dr. Panknin, who states that it had made its appearance in comparatively recent years, and was now a common roadside weed. As it was early in June, the stalks had not sufficiently matured to give particular evidence of value as a fiber plant, although later some good hand-prepared samples of the fiber were secured. It has also been grown in Alabama.

Bast Fiber.—Chemists say that although closely similar to jute in structure and general chemical characteristics, it is in appearance a superior fiber, being softer to the touch and in all respects more uniform.

A beautiful example of the fiber labeled *Sida retusa,* and known as "Queensland hemp," was received by the Department in 1876 from the Queensland collection (Phil. Int. Exh., 1876), accompanied by another specimen from Victoria labeled *Sida rhombifolia.* The first named was prepared by Dr. Guilfoyle, who stated that the plant had established itself in Melbourne, and was of very quick growth, seeding freely. He regarded the fiber as suitable for fine paper and for the manufacture of cordage. The sample of *S. rhombifolia* is very white and lustrous, the filaments fine and even. In a portion of the museum sample the ribbon-like character of the bark is retained, filled with delicate indentations, giving it a lace-like appearance. These ribbons of fiber break easily, but a twisted cord of the finer prepared fiber, the size of cotton wrapping twine of the shops, broke only after repeated trials with the hands. The fiber was prepared by Alexander McPherson. In India the bark yields "abundance of very delicate flax-like fibers," which Dr. Roxburgh thought might be advantageously used for many purposes. Forbes Watson, in the Descriptive Catalogue of the East Indian Department, International Exhibition, 1862, pronounces the fiber similar to jute in appearance, "but considered to be intrinsically so superior that it is worth from $5 to $6 more per ton, and he places it next that fiber" in order to attract to it the attention which it deserves. Experiments with the fiber of *S. rhombifolia* demonstrated the fact that a cord one-half inch in circumference would sustain a weight of 400 pounds. In speaking of Dr. Roxburgh's specimens, Royle says "the fibers are from 4 to 5 feet in length, and display a fine, soft, and silky fiber, as well adapted for spinning as jute, but infinitely superior." Further experiments in India have demonstrated that sida fiber is also superior to jute from the fact that under hydrolysis, or bleaching and cleaning with alkali, "it loses a very much smaller proportion of its weight, is therefore less easily disintegrated by the action of water, and is consequently more durable." The fact that its stalks are not more than half the length (or size) of jute is a disadvantage compared with jute, as indicating a much smaller yield. George Watt, of the revenue and agricultural department of India, was of the opinion, regarding the Indian experiments, that the properties of the sida fiber recommended it as worthy all the time an expenditure necessary to ascertain whether or not all its advantages are counterbalanced, from the money standpoint, by a less acreage in yield. Thirty years ago the fiber of "*Sufet bariala*" (*S. rhomboidea*), as produced in India, was considered worth from $25 to $30 more per ton than jute.

Growth in the United States.—The species has been cultivated in parts of the South as a forage plant. Statements received from Hon. G. D. Tillman, of South Carolina, in 1890, throw some light on the habits of the species:

"I do not remember seeing a sprig of *S. rhombifolia* until about four years ago (1886), when a small patch of it first appeared in the back yard of my residence, whence it has spread over the yard, covering an acre or more of land, and scattering sprigs of it are appearing here and there at numerous localities over the large plantation. Last summer I saved 3 or 4 bushels of seed, and in the fall scattered them in waste places and in my pasture. In traveling about the State last year I discovered the plant flourishing in the waste places of the streets in nearly every village and town. I also found it thriving in the lanes and along the roadside of the forest lands in the Tertiary formation or 'low country' of South Carolina, where a clay subsoil prevails, and wherever there was moisture as well as clay (in a shallow ditch, for instance), each separate sprig of thick-growing sida was 3, 4, and sometimes 5 or 6 feet high. One striking peculiarity of the plant is that a single sprig growing by itself will bunch, or rather branch out from the stem just above ground, so as to resemble a squatty thicket of many short-limbed shrubs, with only one root, however; but when the sprig grows thickly, each from its own root, the plants are straight and without limbs or knots on the stems, except at the very top, and as tough as hickory, boxwood, or perhaps any other wood. I have several acres of this plant growing for pasture only. It is neither fit for hay nor for soiling, but it is a good pasture plant for cattle, sheep, and hogs. Horses do nor seem to relish it much, while cattle in particular appear to like it and thrive on it almost as well as upon Japan clover (*Lespedeza striata*). The plant has a wonderful tap root and a large leaf, besides the habit, where left to reseed itself, of standing very thick on the land and shading almost every inch of the surface of the soil. For these reasons I have thought it must be an excellent green manure plant, and am trying some experiments to test it as such. I am glad to hear from you now that my mucilaginous pet, sida, 'when planted thickly and allowed to mature, produces a finer fiber,' a virtue I did not dream it possessed, although I had often observed the great toughness and strength of its bark."

The stalks of sida that have been sent to the Department for examination, as well as those seen by the writer in the field, from South Carolina are too small to be of value for the extraction of the fiber. Some stalks grown in Alabama, however, from India seed (marked *S. retusa*), reached a height of 5 feet. The conclusions of the writer regarding the cultivation of the plant on American soil—based upon the results of limited experiment, it is true, and from examining stalks from different localities—would lead to the statement that the plant is too slow in growth, and the stalks too small when grown, to make it of commercial value as a fiber plant. And it is doubtful if the bast will yield as readily to treatment as jute, for when steeped in water it is said to require almost double the time necessary to properly macerate the jute bast.

* *Specimens.*—Mus. U. S. Dept. Ag.; Field Col. Mus.

OTHER SPECIES.—*S. carpinifolia* is found in the hotter parts of India, its stems yielding a good fiber which is employed in native uses. It is also found in Brazil where it is employed for making brooms with which to sweep the huts of the natives. This species is now regarded as identical with *S. rhombifolia.*

S. cordifolia (Syn. *S. rotundifolia*) is a small perennial weed generally distributed over tropical and subtropical India. "The plant yields a fine white fiber." (*George Watt.*) A good example of the fiber of *S. paniculata* is preserved in the Bot. Mus. Harv. Univ.

Silk, Artificial (see *Artificial silk*).

Silk cotton.

See this name under cotton—silk cottons, in alphabetical arrangement.

Silk grass.

This term is applied indiscriminately to many structural fibers, derived from foliaceous plants, and as a distinctive name it is worthless. Some of the species of fibers that have been called silk grass, silk grass of Honduras, etc., are *Ananas sativa, Karatas plumieri, Bromelia sylvestris, Furcræa cubensis,* and other similar forms, while the name has even been applied to the fiber of some of the Agaves. Its use, therefore, without the botanical name of the species can only add to the confusion which already exists.

Silk, Vegetable (see *Silk cotton*).

Silk wool, of Orozuz. *Gonolobus maritimus* and *Ibatia muricata*, of Dr. Ernst's list.

Simal tree, of India. *Bombax malabaricum.*

Sincara (Peru). See *Maranta.*

Sinlo-kawa (Jap.). *Cocos nucifera.*

Sinu-mataiavi (Fiji). *Wikstroemia viridiflora.*

Sisal hemp (see *Agave rigida*, varieties).

Slender spike rush. *Eleocharis acuta.*

Slender sword rush. *Lepidosperma flexuosum.*

Slough grass (used for binding twine). See *Carex vulpinoidea.*

Snake gourd (see *Luffa ægyptiaca*).

Soap berry. *Sapindus saponaria.*

Soap plants. *Chloragalum pomeridianum, Sapindus saponaria, Yucca baccata.*

Sola, or Shola (Beng.). *Æschyomene aspera.*

Solidago canadensis. CANADA GOLDEN ROD.

Exogen. *Compositæ.* A perennial herb.

The golden rods are so familiar that they need no description. They can hardly be called fiber plants, but Dr. Havard informs me (on the authority of V. L. Porcher) that the stalks of the above species, which are numerous, straight, and almost 5 feet in height, afford very strong fiber when treated in the same manner as hemp.

Somewake-Mushiro. Japan matting. *Cyperus unitans.*

Sosquil. One of the Mexican names ot sisal hemp. See *Agave rigida.*

Soymida febrifuga. INDIAN BASTARD CEDAR.

Exogen. *Meliaceæ.* A lofty tree.

Northwestern, central, and southern India, extending to Ceylon. Known as *Rohun*, Hind., *Rohan*, Beng., etc. The reddish fiber, derived from the bark, is used in Chutea Nagpur for strong ropes.

Spanish bayonet (U. S.). *Yucca aloifolia* and other species.

Spanish needle (Trin.). *Yucca aloifolia.*

Sparmannia africana.

Exogen. *Tiliaceæ.* Shrubs, 3 to 12 feet.

Native of Africa. Common in greenhouses, and thus introduced into many countries; flourishes in Victoria, where its growth is rapid.

BAST FIBER.—The museum specimens of this fiber were received from the Phil. Int. Exh., 1876, and were prepared in Victoria by Dr. Guilfoyle. The fiber is of a beautiful silvery-gray color when it has been properly prepared. Some of the filaments are brilliant and lustrous, and it possesses considerable strength; in fact, seems almost equal to China grass in tenacity. "The fiber, which is produced in large quantities (in Victoria), is of a very fine texture. For many purposes it is equal, if not superior, to the Chinese grass cloth plant." (*Dr. Guilfoyle.*)

The advantages which *Sparmannia* has over all other fiber plants, and which elevates it to the highest rank of agricultural products, are, that it is perennial; it is one of the very best forage plants in existence; its enormous yield, both of fodder and fiber, the great strength and dazzling whiteness of the fiber, the facility with which it takes dyes, and the extremely low prices at which it can be produced making it accessible even to the paper manufacturer. (*Jean Roth.*)

Economic considerations.—In 1890 the Department received from Dr. Harris, of Key West, an interesting account of the culture and preparation of this fiber plant from notes from the South African authority quoted above. From these notes it is learned that *Sparmannia* grows in almost any except a brackish soil. It requires deep plowing and is much benefited by manuring, although it grows luxuriantly in South Africa in soils where no other crop will grow without fertilization. The seeds should be sown in drills 28 inches apart, and the plants thinned out to the distance of 14 or 16 inches in the drill as soon as all danger from frost has passed. The plants taken up in thinning transplant as easily as mangel-wurzel. It has no insect enemies of consequence.

As soon as the plants are from 12 to 18 inches high they should be nipped, or budded, if they do not branch out freely. From 12 to 18 stalks should grow from each plant the first year. After the first cutting upward of 50 stalks will spring out; the greater the number the slenderer the growth and the stronger the fiber. Reaping may begin about six months from the time of sowing and continue six months. In climates where the orange tree grows four crops would be certain, which would amount to 12 tons per acre during the year. The stalks for fiber should be cut about 6 inches above the soil and may be treated to extract the fiber at once. They should not be cut, however, more than twelve hours in advance. For this purpose any of the various hemp or flax machines will answer. A jet of water, however, must always flow over the place of friction. Before the fiber is dried it should be sulphured similarly to straw goods. Another way of extracting the fiber is by retting the stalks in water, which is the cheaper and easier way. This is done in vats, which should be so constructed as to be easily emptied, and should not be more than 4 feet deep. A vat 20 by 40 feet, and 4 feet deep, will hold enough stalks to produce a ton of cleaned fiber. To secure a uniform whiteness of the fiber water should be gently running from one vat to another all the while, and never at a temperature lower than 18° C. in the daytime. When a vat is packed with stalks narrow inch boards should be placed across it on the stalks, so that tubs or casks filled with water can be put upon them so as to hold the stalks constantly under water at least 2 inches, where they should be allowed to remain ten or fifteen days, when they will be found ready for washing. The washer now takes his station alongside of the vat, and taking a handful of the stalks in his hand, catching them in the middle, he turns the top ends toward the surface of the water at an inclination of about 45° and pokes the thin ends three or four times into the water, when, if the stalks are sufficiently retted, the fiber at the upper end hangs down in a lock of which the washer takes hold and lets loose the middle, so that the whole handful hangs upon the lock or loose fiber. He then gives two or three jerks with the hand, holding the fiber lock upward, and all the stalks free from fiber drop out. This is repeated until he has a good handful separated from the stalk. He again takes them at the end and lowers the hand until about 6 inches from the water, so that the fiber nearly floats upon the surface. He then moves the hand quickly from right to left several times and the fiber is washed as white as snow. Then taking the clean end in his hand, he repeats the operation with the other end; the whole operation is done quickly. Half an hour's practice will make a skilled washer of any person of ordinary intelligence. One person can wash out 100 pounds of clean fiber in ten hours. This shows how easily the fiber is extracted and cleaned, and how simple the machine must be to supplant hand decortication. The syndicate used ordinary scutchers with water jets, after the plan of the W. E. Death patent. They found out that the retting and hand decortication was the best and cheapest, as there was no waste.

Spartina cynosuroides. FRESH WATER CORD GRASS.

Endogen. *Gramineæ.* An erect grass, 2 to 9 feet. (Fig. 96.)

COMMON NAMES.—Cord grass; fresh water cord grass; marsh grass; bull grass; thatch grass; slough grass.

The species of this genus are chiefly natives of America; there are British representatives, but they are rare. "The above species is a native, common along our ocean and lake shores, borders of rivers, etc., ranging from Maine to the Carolinas, and westward to the Pacific. It makes a fair but rather coarse hay when cut early, and has been successfully employed in the manufacture of paper. The strong, creeping, scaly rootstocks of this grass adapt it for binding loose sands and river embankments." (*F. Lamson-Scribner.*)

STRUCTURAL FIBER.—Twenty years ago or more this grass was utilized in paper manufacture at Quincy, Ill., where it was found in vast quantities. It cost at the mill about $5 per ton, and made a very firm, better class of brown wrapping paper—superior to straw—samples of which can be seen in the museum of the Department of Agriculture. The bruised stalks present quite a fibrous appearance.

S. gracilis is another possible paper-making species, found on the plains and in the Rocky Mountain regions.

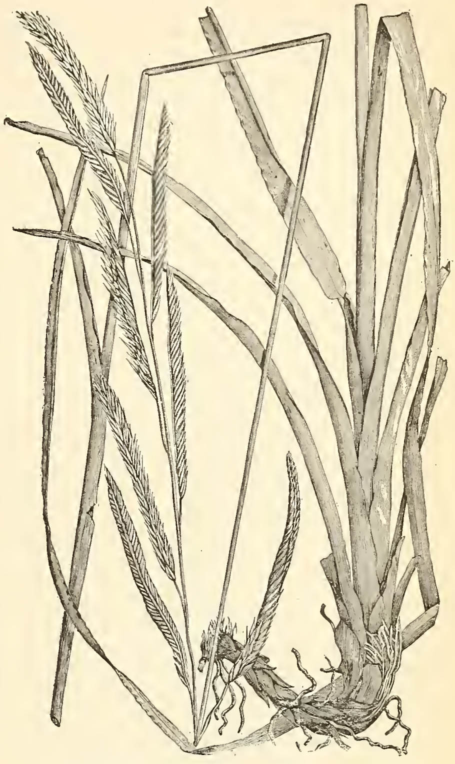

FIG. 96.—Cord grass, *Spartina cynosuroides.*

Spartina juncea.

COMMON NAMES.—Fox grass; white rush; marsh grass; salt grass; sea salt grass; salt marsh grass; rush marsh grass.

A rather slender species, 1 to 2 (rarely 3 to 4) feet high with two or four slender, erect, or widely spreading spikes. This is common upon the salt marshes, and is one of the most valued species which go to form the salt hay that these marshes produce. It ranges from Maine southward to Florida and along the Gulf coast to Texas. It is useful for packing glassware, crockery, etc., and in the larger towns along the coast is much used for this purpose. (*F. Lamson-Scribner.*)

S. stricta, the creek sedge, branch grass, etc., grows along the Atlantic and Pacific coasts, and is also found in Europe. It is sometimes used as a thatch material.

Spartium junceum. SPANISH BROOM.

COMMON NAMES.—The *Ginestra di Spagna* of the Italians; the *Genét d'Espagne* of the French; *Gayumba*, Spanish.

A native Mediterranean species of broom, widely cultivated as an ornamental plant, and as a forage plant, and formerly for its fiber. Found in southern France, Spain, and Italy. One of the ancient fibers known to the Greeks and Romans, its generic name being derived from *sparton*, meaning cordage.

STRUCTURAL FIBER.—This is obtained from the young shoots by maceration and subsequent separation of the woody portions of the stem somewhat as flax is prepared, after which the fiber is combed and cleaned ready for spinning. It has been employed in paper manufacture, as upholstery material, as a tie material, for cordage manufacture, and, lastly, for weaving into fabrics. At Casciana, in Italy, on the Leghorn and Florence Railway, hot-spring water is used for the retting; and a company was some years since formed for growing the plant and manufacturing the fiber on a large scale. Specimens of the fiber were exhibited at the Vienna Exhibition of 1873 from Florence, Italy, with a memorandum as follows: Taking note of the expense necessary to render this filament flexible and fit for weaving, we find that it is considerably less than that for flax and hemp and that the fabric obtained is more tenacious and also lighter, since from 11 kilos of flax we obtain 60 meters of cloth, while the same measure woven from ginestra weighs only 7 kilos, and the cost of the first is 72 lire, while that of the second, according to the experiments made, cost only 45 lire.

In Spain very fine tissues are made from this species, and even lace, which is highly prized. In southern France likewise, ordinary fabrics are made from the plant, which are worn by the peasants in the mountainous regions, and said to be very durable.

The ancient use of this fiber is very interesting. The Greeks, Romans, and Carthagenians employed it for cordage of all descriptions, nets, bags, and even sails. Pliny writes of the *Ginestra*, and in the thirteenth century the fiber was employed for wadding and in tow "that may be used in place of hemp and flax." The Italian peasants from time immemorial have used this fiber for the manufacture of the coarse *Parmo Ginestro* or Ginestra cloth, though the factories have never employed it in spinning and weaving.

Cultivation.—The seed is sown in winter, with some other crop. For three years the plant receives only an occasional thinning out. The young spring shoots are cut in February–March, or sometimes not till after harvest, the former being preferable. Toward the end of August, they are collected in small handfuls, and laid on the ground to dry, after which they are made up into large bundles, of 25 to 30 handfuls each, and stored. On a damp day they are beaten with a mallet, so as to flatten them without breaking them, and toward the end of September they are put under stones in a river for half a day. In the evening they are taken out and arranged in rows on a specially prepared plot of ground, near the stream, ready for watering. For this purpose a bed of fern, straw, or chopped box is prepared, and in this the bundles of broom are placed one over another, the whole heap being finally covered with another layer of straw or box, on the top of which stones are placed, so as to keep the whole secure, and exclude sun and air. Thus placed, it is watered every night for eight days, allowing about 1 hectoliter water for each bundle of 50 handfuls. On the ninth day the retting is complete. The bundles are then alternately washed in running water, and beaten on a flat stone, till the fiber is separated from the woody portion. The bundles are next spread fan-wise on the ground to dry and bleach, when they are again collected and put away till winter. (Spon.)

Spatholobus roxburghii.

Syn. *Butea parviflora.*

A gigantic climber, belonging to the *Leguminosæ*, found in the "forests of the sub-Himalayan tract from the Jumna eastward to Bengal and Burmah. The plant yields a gum, the seeds an oil, and the bark a fiber that is twisted into ropes and bow-strings." (Dic. Ec. Prod. Ind.)

Spathodea rheedii.

A tall tree belonging to the *Bignoniaceæ*, found in portions of India and Malabar. The species of this genus are natives of Asia and Africa. "A fiber is extracted from both the branches and roots, used for making nets." (Spon.) The revised name of this species is *Dolichandrone rheedii.*

Spear Lily (Vict.). *Doryanthes excelsa.*

Sphæralcea cisplatina.

This genus of *Malvaceæ* is closely allied to Malva, and includes a number of tropical American species. *S. cisplatina,* the fiber of *Malvalisco,* is used in Brazil to a slight extent. *S. umbellata* is a Mexican species, known in Australia as the Globe mallow. Guilfoyle states that its bast yields silky fiber, useful for cordage.

Sphagnum spp.

A genus of mosses, essentially aquatic plants, or plants requiring a great deal of moisture. They do not yield fiber, but on account of the softness and elasticity of the plants in mass they make an admirable packing material. The plants form turf beds rapidly, but unless mixed with other plants the turf is spongy and unfitted for use. *S. cymbifolium,* bog moss, is used in Norway, in house construction, for stuffing between the timbers to render the house water-tight. "*S. vulgare* is a German species, which has been used for paper." (*Bernardin.*) Some of the American species are employed in nurseries as a packing material for living plants. In other countries the material has been used in a dry state for packing fine glassware.

Spike rush (see *Eleocharis*).

Sponge cucumber (see *Luffa*).

Sponia (see *Trema*).

Sporobolus cryptandrus. PRAIRIE GRASS.

A strongly rooted perennial grass 2 to 3 feet high, common on the Western plains and in the Rocky Mountain region. It is well liked by stock, and where it occurs abundantly is very generally regarded as an important forage plant. (See fig. 97.)

FIG. 97.—Prairie grass, *Sporobolus cryptandrus.*

STRUCTURAL FIBER.—In 1891 a specimen of this grass was sent to the Department from Kansas by a correspondent, who stated that its superior strength recommended it as a useful fiber plant, and that it was worthy of cultivation as a raw material for paper stock, and possibly for cordage manufacture. The grass first makes its appearance on ground that has been plowed, and that has lain fallow for one or two years. The farmers have given it various names such as "tow grass," "leather grass," "shoe-string grass," etc.

The fibrous portion of the plant appears to be the leaf sheaths of the blossom stalk, and some of these are very strong, but of too short length to utilize in manufacture. The average of several tests of these leaf sheaths, twisted together, showed a breaking strain of 65 pounds, while the lower stem portion of the plant broke at 20 pounds. The length of the sheath is from 12 to 15 inches. The grass would make a very strong paper, of better quality than ordinary wrapping paper, and no doubt writing paper could be made from it. As before stated, the fiber is too short, however, to be spun into cordage or yarns, though when rubbed out in the hand it is fine, but brittle and harsh to the touch.

"Where the old growth is thick on the ground the fiber is so tough and strong that it can not be cut with a common mowing machine." (*J. W. Cooper.*) The leaves of the inflorescence, which are the fibrous part of the plant, are too short, however, for employment as a fiber.

Sporobolus indicus. SWEET GRASS.

COMMON NAMES.—Carpet grass; drop-seed grass; Parramatta, or tussock grass (in Australia). The Brazilian name is *Capim maurão.*

A tufted, wiry, erect perennial, 1 to 3 feet high, with narrow, densely flowered, spike-like panicles 4 to 12 inches long. This grass is widely distributed throughout the warmer temperate regions of the world, and has become quite common in many parts of the Southern States, growing in scattered tufts or patches about dwellings and in dry, open fields. Occurs in Brazil.

STRUCTURAL FIBER.—While the plant is not used industrially in this country, it is employed in southern Brazil as a straw-plait material. "The stalks from the flower to the last knot serve for the manufacture of straw plait used for hats and other articles made of straw, which are softened by means of sulphur. It grows easily but prospers best in humid places. Blooms late in winter and in spring.

Spruce (see *Picea* spp).

Spurge laurel. *Daphne cannabina.*

Stenosiphon virgatum.

An uncultivated plant, belonging to the *Onagraceæ*, found in Texas, where it grows to a height of 6 feet. A correspondent sent stalks to the Department, several years ago, as a possible fiber plant, as the fiber, being fine and silky, was thought to be of value. Like many fibers of this class the species is more interesting than useful.

Sterculia.

Nearly all the species of this genus are trees, many of them of large size, and most abundant in Asia and the Asiatic islands. They are also found sparingly in America, Africa, and Australia, and for the most part inhabit tropical countries. The inner bark of the *Sterculias* is composed of tough fiber which is not affected by wet. Some of the species are as follows:

Sterculia acerifolia. THE FLAME TREE.

Exogen. *Sterculiaceæ.* A very large tree.

This species is a native of New South Wales, and is a lofty tree. Dr. Guilfoyle states that the bark is fully 2 inches thick when the tree is full grown, and furnishes bast for a most beautiful lace-like texture. The fiber is very simply prepared by steeping, and is suitable for cordage and nets, ropes, mats, baskets, etc., and is useful as a paper material. The tow is of a very elastic nature, and is suitable for upholstering purposes, such as stuffing mattresses or pillows. The specimens were received from Victoria (Phil. Int. Exh., 1876), and were prepared by Dr. Guilfoyle. The species is found in many portions of the globe. Other Australian species follow.

Sterculia diversifolia, the Victorian bottle tree, also known as *Currijong*, is a native of Victoria, and is a stout, glabrous tree, having a peculiar bottle-shaped trunk. The bast is similar to that of *S. acerifolia*, but coarser in texture. The fiber is suitable for coarse ropes and cordage. It would also make fine matting, and could be used as a paper material. Specimens from Dr. Guilfoyle's Victorian collection.

Sterculia rupestris, the Queensland bottle tree, is a native of Queensland, where the tree attains a considerable height, and has an enormous bottle-shaped trunk, from which it derives its name. Its bark is thick and strong, and can be used for the same purposes as the other species. (*Dr. Guilfoyle.* Victorian collection.)

Sterculia lurida is the "sycamore" of the colonists. This species is a native of New South Wales. The tree is of large size, resembling *acerifolia* in appearance. "Its bark is a valuable fiber-yielding material." In New South Wales it is made up into a variety of fancy articles by the colonists. The fiber is the inner bark of the tree, and when freshly stripped has a lace-like character which adapts it for fancy work. (*Dr. Guilfoyle.* Victorian collection.)

Sterculia fœtida: This species, a native of New South Wales, is also indigenous in the East Indies and the Malayan Peninsula. The fiber is similar to the preceding, and is manufactured into mats, bags, cordage, and paper. *S. quadrifida* is another New South Wales species, also represented in Dr. Guilfoyle's collection. *Specimens of the above are in the Mus. U. S. Dept. Ag.

Sterculia caribæa. RED MAHOE.

Found in Trinidad and New Caledonia. A large tree, 40 to 50 feet in height.

BAST FIBER.—The fiber is of considerable strength, but it requires retting to get out the mucilage which is so common in *Sterculiaceæ*, *Tiliaceæ*, and *Malvaceæ*. It could not be treated commercially unless large areas were planted, as the trees, though common in places, are by no means numerous.

Sterculia guttata.

Native of Malabar. Found in India, Eastern and Western Peninsulas, Ceylon, and the Andaman Islands.

The bark of trees, of the tenth year, is employed by the natives on the western coast of India for making coarse clothing and cordage. The tree is felled, its branches are lopped, the trunk is cut into pieces 6 feet long, a longitudinal incision is made in each piece, and the bark is opened, taken off entire, chopped, washed, and sun dried. In this state, it is very pliable and tough, and is used for clothing without further preparation. (Spon.)

Sterculia villosa. THE UDAL.

Northwestern India, Bengal, and Malabar; tropical Himalayas.

FIBER.—Royle states that the bast, or rather all the layers, can be stripped from the bottom to the top of the tree with the greatest facility, and fine, pliable rope is made from the inner layers, while the outer ones yield a coarse rope, which is strong and durable and little injured by water.

A valuable fiber is obtained from the liber, which is made into ropes and bags. It is very strong, and in southern India and Burmah is much esteemed for the purpose of making elephant ropes. In northern India the ropes from this fiber are chiefly used in making cattle halters. The rope is said to become stronger for a time from being frequently wetted, and if constantly exposed to moisture it seldom lasts more than eighteen months. A good paper is said to have been made from it in India, but the samples of fiber sent to Europe were not favorably reported on as paper-making materials. (See Kew Bull., 1879.)

Compared with jute, according to Dr. Roxburgh's experiments, *Sterculia* fiber (*S. villosa*) stood a strain of 53 pounds, against 68 pounds for jute, *Corchorus olitorius*—*C. capsularis* sustaining 1 pound less. Among other Indian species may be mentioned *S. colorata*, inferior fiber, harsh and wiry. Reported as a worthless fiber by Hemp and Flax Com. of Agri. Hort. Soc. of India. *S. lanceæfolia*, fiber made from it in the Panjáb. *S. urens* yields a good fiber, samples of which were sent to the Paris Expos. 1878, employed for paper. *S. tomentosa* is an Angola species which is said to afford excellent fiber.

Stinging nettles.

These plants belong to the genus *Urtica*, *Laportea*, etc., the stingless nettles, or cultivated species, being the *Boehmerias*, etc. (see Nettle). *Urtica dioica* is the common stinging nettle of Europe.

Stipa tenacissima. ESPARTO GRASS.

Syn. *Macrochloa tenacissima.*

Endogen. *Gramineæ.* A wild and cultivated grass.

NATIVE AND COMMON NAMES.—*Alfa* or *Halfa* (Alg.): Esparto, Spanish and (commercial) English; *Sparte*, French.

Native of north Africa, Spain, and Portugal, and is said to be found in Greece. A plant occupying a large area in northern Africa and the southern Mediterranean provinces. In Algeria, in the provinces of Oran Algiers and Constantine. In Spain it covers an area of plateau land comprised within a triangle including Malaga, Valencia, and Madrid. It is abundant in the provinces of Mercia and Almeira. In the south of Portugal, in the Iberian peninsula. In Morocco it borders the seacoast as far as Tangiers, on the high Daharian plateau which succeeds that of Oranais. This cultivation has extended into south France. The plant is said to have been seen in Greece, but this is contradicted by Algerian authorities.

It thrives in varied situations in the regions where it grows, from the level of the seacoast to elevations of 6,000 feet, frequently crossing the foothills, where it forms their only vegetation. It is also found in deep forests, and abounds in such desert regions as lie to the southeast of Laghaout and Tripoli. The plant is frequently confounded with *Lygeum spartum*, under the name *Sparte* (*"Sennoc"* or *Albardine* Alg.), and also with *Ampelodesmos tenax*, or the *Diss*, these three species being the abundant grasses of the north of Africa. *Halfa* or esparto is a perennial plant with branching roots, which form first a homogeneous stump which becomes a tuft when the center roots perish. The exterior branches, which also form a tuft, separate as they become further removed from each other and their center and become the nucleus of new clusters, which likewise form tufts, which are hollowed out at the center and send out branches, which in their turn form other tufts if the soil permit. The leaf, which varies with the age and condition of the plant, is from 25 to 120 centimeters in length, but has a mean length of from 50 to 80 centimeters. During growth it spreads out in an even, ribbon-shaped blade. Its upper surface is relieved by seven large veins, which are separated by deep furrows and entirely covered by down or hair. The under surface, which, by torsional movement in the length of the leaf, is turned upward, is smooth, glossy, and without salient veins. Under the influence of drought the two halves of the leaf meet and form a tough, dry, and rush-like blade. The point of the leaf is sharp, rough, prickly, and slightly yellow. Upon healthy, strong plants, and during the wet season, the leaves are of a fine dark green. Under the influence of drought this green becomes canescent. The leaves of the esparto are persistent, remaining at least two years upon the plant. When old they become a prey to cryptogams Disintegration commences at the point of the blade and finally covers the whole. These darkened leaves cumber the stalk and form a veritable gray felt, through which the young leaves emerge. Usually the old leaves turn yellow and are disarticulated from the sheath at the point at which they join. An early attack made upon the points of the leaves by cryptogams depreciates the esparto, and it is distinguished in accordance with these attacks and their effects, first, as the green point; second, sharp, dry point, *pointe d'orée* (golden point); third, gray point and disintegrated by cryptogams. (L'Halfa. Pamphlet, Paris Exp., 1889,—Extraits d'une Étude sur l'Halfa, par L. Trabut, 1888.)

STRUCTURAL FIBER.—The fibers are extremely fine, uniform, transparent, and from the purity of the cellulose the substance is admirably adapted for paper making. The commercial product varies from 15 inches to 2 feet or more in length, is greenish yellow in color, presenting the appearance of a smooth, stiff, tapering stem. While its commercial use is in paper making, it has been employed in the countries where grown for the manufacture of cordage, sandals, basket work, etc. It has also been used, after crimping, as a mattress material, and it is said that the fiber has been employed in the Scotch carpet trade in Kidderminster and Brussels goods. The chemical constituents of the fiber are said to be yellow coloring matter, 12; red matter, 6; gum and resin, 7; salts forming the ash, 1.5; paper stock, 73.5.

EXPERIMENTS IN THE UNITED STATES.—An effort was made in 1868 to introduce the culture of Esparto into this country. Seed was obtained from Paris seedsmen, which was distributed in the South for planting on the hill lands and mountain slopes, but nothing practical was accomplished. Viewing the culture in this country from the agricultural standpoint, there is no doubt it will thrive in many localities, but from the economic standpoint it can never become an American industry.

SOIL, CLIMATE, AND CULTURE.—The plant does not thrive in clay, on marsh lands, or in a pebbly soil. Soils impregnated with oxide of iron are favorable, and calcareous soils produce strong fiber. On argillaceous soils (decomposed shale, etc.) the grass is shorter but the fiber stronger. It requires a decidedly hot and somewhat dry climate. Spon states that the plant succeeds best at moderate elevations on the seacoast, none comparing with those where the plant is under the immediate influence of the sea air. Here the fiber is fine, short, and even. At the same time, much finer Esparto, with longer leaf, is found inland, but instead of being all of uniformly superior kind the prime will form only one-half or one-fifth even of the whole, the remainder being coarse and rank. Sunshine is eminently beneficial, if not essential. The coast grass is preferred by paper makers, while the longer growth from the interior is sought after for making sieves, baskets, etc.

The plant is propagated by seed, by transplanting old plants, and by burning over the tracts. "The surface portions are alone affected by the fire, the stalks sending up a vigorous growth, producing in five years a *halfa* much sought after, the *halfa blanc*, the flexible leaves of which are used in manufactures." (*Trabut.*) When transplanted, in autumn, the roots are divided into several pieces and set out in rows 2 feet apart and about 8 inches in the row. Spon states that transplanted plants are productive in six to eight years, while from the seed no return may be expected before twelve years.

HARVESTING.—The leaf of the *halfa*, when thoroughly developed, is composed of two parts, the blade or lamina and the sheaf, which are united by articulation. The tissues are not continuous; the innumerable fibers, which give the blade its remarkable solidity, cease suddenly on a line with this articulation. By a slight thrust the blade is separated from the sheath. This ease of disarticulation is the starting point of all the processes of stripping or extraction. The blades can be gathered by hand if a stout pair of gloves be worn, and in this way the more carefully selected. This is by far the best method if we would preserve the plant, but it is not always practiced. A laborer does not accomplish so much in this way as by the old way of beating them with a small stick, which is followed entirely in factories, and has been from the most remote periods. The laborer, having in his left hand a stick 40 centimeters in size, with a leather strap at the handle, seizes a handful of leaves with his right hand, wraps them around the stick, which is held obliquely, and then pulls strongly with both his hands. Numberless blades become disarticulated, and two or three roots of the stock break and come with them. The laborer passes his right hand under the lower edges up the blade and encounters the pendant rootlets, which he throws away with the leaves that adhere to them, keeping, if possible, only the disarticulated blades, of which he makes a bunch or "*manoque*" by putting together the product of several bunches. Notwithstanding this first sorting, the *halfa* carries with it to the factory many sheafs. The ends of the stalk and the sheaths are used as forage, and are gathered with the plants that are used for this purpose. Horses and camels are very fond of the base of the sheath. When *halfa* has been dried, assorted, and classified, it is weighed, baled, and subjected to hydrostatic pressure; then it is taken to the seaboard and exported.

An industrious laborer will average from 300 to 400 kilograms of green *halfa* in a day, a native from 150 to 200, a woman or old man 100, children 12 or 15 years old from 35 to 50 kilograms. The same method of gathering *halfa* is practiced throughout the halfa region, and there seems to have been no change in it since the time of Pliny. This gathering by means of the batonnet or stick will not be given up until a machine shall have been invented which will yield a larger return. (*Trabut.*)

COMMERCIAL ASPECTS.—According to Ide & Christie's London Circular for July 1, 1896, over 200,000 tons of Esparto was imported into the United Kingdom during the year, worth from £3 to £5 per ton. No large quantities, however, are brought to this country, as the value of Esparto and other grasses imported for paper stock for the year ending June, 1895, reached only about $1,500. For further accounts, see Rept. U. S. Dept. Ag., 1868; Spon's Enc., Div. III.

Stipa spp.

S. semibarbata is a native of Tasmania. Spon states that "after the seed has ripened the upper part of the stem breaks into the fiber, which curls loosely and hangs down. The quality of fiber in this state must be inferior to what it would become under proper treatment."

S. gigantea is a closely allied but taller species, confined to Spain and Portugal. In Australia occur *S. setacea*, *S. pubescens*, and *S. micrantha;* in Argentina several other species are found, but they are not especially regarded for their fiber.

Stout spike-rush. *Eleocharis sphacelata.*

Stramanthe sanguinea (see *Maranta*).

Straw plait, Commercial.

The art of plaiting straw, the stems of grasses, and the leaves of palms and similar plants is almost as old as the human race, for plaiting was practiced before weaving, and became known when primitive man laid off the skins of animals for clothing and adopted tissues made from animal and vegetable fibers. Commercial straw plait, however, is understood to mean material produced by braiding the split stems of wheat, rye, barley, and rice, these braids or plaits being employed in the manufacture of hats.

The finest straw plait is the Italian or Tuscan, and is largely produced from wheat straw. Bohemian straw plait is also made from wheat straw. In Japan and China, rice straw is largely used for this purpose, though considerable barley straw is also utilized. In our own country the braiding of straw has been an industry in past time, though chiefly prepared by the women of the household; and as late as thirty or forty years ago it was quite an industry in Massachusetts. The large manufacturers of straw goods in this country, however, rely upon the imported article for their plait. The principal countries producing commercial straw plait are Italy, France, Germany, Austria, China, and Japan. For further information see *Triticum vulgare*, *Hordeum distichum*, *Secale cereale*, and *Oryza sativa* in this work. See also *Poa pratensis* and *Sporobolus indicus*, among grasses used for the same purpose.

* Specimens of straw plait, in series, are shown in the museum of the Department of Agriculture.

Streaked lantern flower. *Abutilon striatum.*

Streblus asper.

Exogen. *Urticaceæ.* A rigid shrub, or gnarled tree.

NATIVE NAMES.—*Op-nai* (Burm.); *Geta-netul* (Ceyl.); *Ton Khoi* (Siam).

Widely distributed throughout India, Ceylon, and tropical Asia, and known under many native names.

BAST FIBER.—From the bark is obtained a fiber similar to that from *Broussonetia papyrifera*, from which paper is made in Siam. The process of manufacture is simple. The smaller branches of the tree are cut, and steeped in water for two or three days. The bark is then stripped off, and brought in bundles and sold to persons who make the paper. The bunches of bark are put in water for two or three days by the paper maker, and, having been cleansed from dirt, are taken out and steamed over a slow fire for two days, a little clean stone lime being sprinkled through the bark. It is then steeped in water in earthen jars, and more lime is added. After a few days it is taken out of the jars, and having been well washed to free it from the lime, it is beaten with a wooden mallet (for about two hours) until it becomes a mass of pulp. A frame of netting about 6½ feet long, and of width varying from 18 to 5 inches, is set afloat in water, and the pulp, having first been again mixed up in water, is skillfully poured out onto the frame so as to be equally distributed over it. The frame is then lifted out of the water, and a small wooden roller is run over the surface of the pulp. By this process the water is squeezed out and the pulp pressed together. The frame with the pulp on it is then set to dry in the sun. In the course of some ten hours it is quite dry, and the sheet of paper can then be lifted off the frame. It now only remains to smooth the surface. This is done by applying a thin paste of rice flour to the surface, and then rubbing it down with a smooth stone. (Kew Bull., March, 1888.)

Stringy bark, The. *Eucalyptus obliqua.*

Structural fiber (see Classification of Fibers, page 25).

Sufet bariala (Ind.). *Sida rhombifolia.*

Sugar cane fiber (see *Saccharum officinarum*).

Sujjádo (Pers.). *Hibiscus cannabinus.*

Sumauma (Braz.). *Eriodendron samauma.*

Sunflower fiber (see *Helianthus*).

Sunn hemp. *Crotalaria juncea.*

Surface fiber (see Classification of Fibers, page 25).

Swamp rose mallow. *Hibiscus moscheutos.*

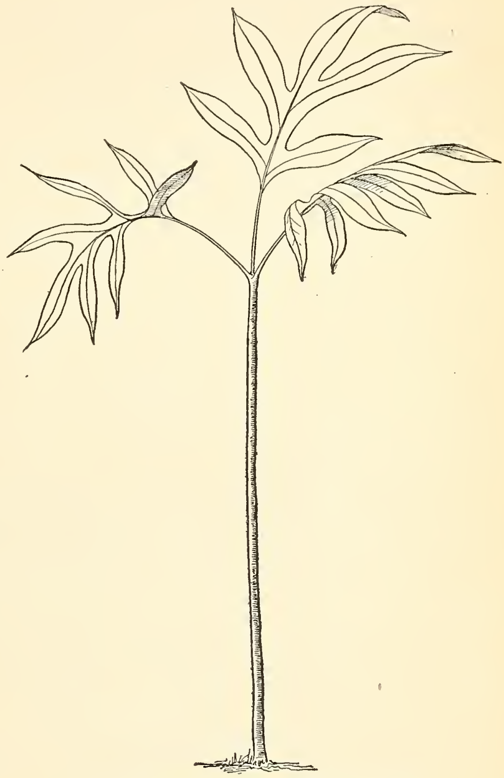

FIG. 98.—*Tacca pinnatifida*, young plant.

Swet bariala (Ind.). *Sida rhombifolia.*

Sword rush (see *Lepidosperma*).

Taag (Ind.). *Crotalaria juncea.*

Tabago silk grass (Trin.). *Furcræa cubensis.*

Tacca pinnatifida.

A genus of perennial herbs found in tropical America, Asia, Africa, the Indian Archipelago, and the Pacific Islands. *T. pinnatifida* is an East Indian and New Holland species, growing in open places near the sea. (See fig. 98.)

STRUCTURAL FIBER.—The leaf stalks are employed as a plaiting material for hats, and is used by the Society Islanders for bonnets. Also made into brooms.

Tah-lah-kul-kel (Seminole). *Sabal palmetto.*

Tahuari (Peru). See *Couratari tauari.*

Takachü (Hopi). *Hilaria jamesii.*

Talhuari (Peru). See *Couratari tauari.*

Tal, Tari (Hind.), and **Tal-gas** (Ceyl.). *Borassus flabellifer.*

Talipot palm (Ceyl.). See *Corypha umbraculifera.*

Tampico fiber (see *Agave heteracantha*).

Tan and **Htan** (Burm.). *Borassus flabellifer.*

Tang-tiau (China). *Calamus rotang.*

Tanner's cassia. *Cassia auriculata.*

Tapoto (New Zea.). See *Phormium.*

Tappa cloth. Also written Tapa and Kapa. See *Broussonetia.*

Refer also to division C. Natural Textures, Economic classification of uses, p. 31, Introduction. See *Brachystegia, Couratari, Daphne, Hibiscus, Lagetta,* etc., for other cloth substitutes.

Tarapota (Peru). *Iriartea ventricosa.*

Tarariki. New Zealand flax. See *Phormium.*

Tataja (Columbia). See *Couratari.*

Tauary (Braz.). See *Couratari.*

Taxodium distichum.

The cypress of North Carolina, which has a range from Virginia southward to Florida and westward to Texas. A specimen of its fibrous inner bark was sent to the Department for the W. C. E., 1893. It might be twisted into coarse cordage for local uses, but is not utilized as far as can be learned.

Tchou (China). *Tso, so, shoo,* a plant or tree.

Tchou-ma (China). *Boehmeria nivea.*

Teale (Egypt). *Hibiscus cannabinus.*

Tea plant (Fla.). *Sida rhombifolia.*

Tecoma viminalis.

Formerly known as *Bignonia viminalis,* the most commonly used name, which see.

Tecum (Braz.). See *Bactris setosa* and *Astrocaryum tucuma.*

Teff (see *Poa abyssinica*).

Tekapu (New Zea.). *Celmisia coriacea.*

Tha-ma-chok (Burm.). *Abutilon indicum.*

Theobroma cacao. Cocoa or Chocolate Tree.

Exogen. *Byttneraceæ.* A tree, 16 to 18 feet.

Native of tropical America, and in cultivation spread over the West Indies and the more northern countries of South America. Source of the cocoa and chocolate of commerce.

FIBER.—The bast yields a good fiber, samples of which are preserved in the Museum of the Department. J. H. Hart, of Trinidad, says, however, that the tree is too valuable ever to be cut for its fiber.

Theometl (Yuc.). *Agave vivipara.*

Thespesia populnea.

Exogen. *Malvaceæ.* A tree, 40 to 50 feet.

The species is common on the sea shores of many tropical countries, as the West Indies and South America, the Pacific Islands, western Africa, and India. In the latter country it is largely cultivated along roadsides. It yields in India a gum, a dye, and an oil, and is valued in pharmacy. The leaves are employed in Hindoo religious ceremonials. In Tahiti it is also a sacred tree, and its leaves used in ceremonials as in India. The wood, which is almost indestructible under water, has been much used in boat building; also used for cabinet work, and in Ceylon for gunstocks.

FIBER.—There are many references to the use of its bark for fiber, but it does not appear to have been specially valued as a fiber plant save in Demerara, where formerly its bast was employed in the manufacture of cŏffee bags. In India a strong fiber is derived from its bark, which is used in the rough state for coarse cordage for tying bundles of wood, etc. It is also used for cordage in Burma. The fiber, which resembles the better mallow fibers, is very resistant. As the species is a large tree, its cultivation for fiber could never become an industry.

Thinban and **Thengben** (Burm.). *Hibiscus tiliaceus.*

Thinbawle (Burm.). *Eriodendron anfractuosum.*

Thrinax argentea. THE SILVER-TOP PALMETTO.

Endogen. *Palmæ.* A low-growing fan palm, 20 to 40 feet.

This is a well-known West Indian species, found in Cuba and Jamaica especially, but also abundant in semitropical Florida. Found on the Florda keys as follows: Elliotts, Largo, Piney, Gordon, Boca Chica, Key West, etc. The species of the genus are known as thatch palms, and none of them exceeds 20 feet in height. A common name of *T. argentea,* in Jamaica, is the Silver Thatch palm. Known in this country also as the Brickley Thatch, and Brittle Thatch. *T. parviflora* is the Silver-top palmetto, found on Florida keys from Bahia Honda to Long Key. The trunk is used in making sponge and turtle "crawls." (See fig. 99.)

STRUCTURAL FIBER.—Both in Cuba and Jamaica the leaves of this species are employed in the manufacture of palm hats, baskets, and fancy articles in the same manner as the leaves of Florida palmettos. It has been suggested, however, that these articles are also made from other species which abound in the West Indies. The tough leaf stalks are also employed in manufacture by weaving into baskets and other objects. When employed as thatch material, the entire leaves are used. In Panama, where the palm is known as *Palma de escoba,* its leaves are made into brooms.

A few years ago a correspondent of the Department in Cuba submitted samples of palmetto fiber said to have been derived from *Chamærops humilis* (which is the African species yielding the *Crin végétal* of commerce), but this is doubtless an error. From the fact that the plant, known in Cuba as *Guano yarey,* grows wild, and its leaves have long been employed for making fancy hats, hampers, etc., it is more than likely a species of *Thrinax.* The stem of the leaf of the *Guano yarey* was experimented with, and the fiber extracted was made into good cordage. It is doubtful, however, if fiber from the tough leaf stalks can be extracted at sufficiently low cost to compete with the commercial leaf fibers for which there is already adequate machinery and a commercial demand. The leaf stems of the saw palmetto are now treated for their fiber in Florida, but at best it is a coarse and imperfect cordage material.

In the Kew Mus. mats are shown from *T. morrisii* made in Anguilla, together with a series of baskets, fancy articles, etc., from *T. argentea,* Cuba and Jamaica.

Thuja gigantea. RED CEDAR. CANOE CEDAR.

Exogen. *Coniferæ.* A very large tree, 90 to 120 feet.

NATIVE NAMES.—Red cedar, gigantic red cedar, Pacific red cedar, gigantic cedar, shinglewood, arbor vitæ of California.

Alaska, south, along the coast ranges and islands of British Columbia, through western Washington and Oregon, and the coast ranges of northern California to Mendocino County, extending to western slopes of the Rocky Mountains and north

FIG. 99.—Plant of *Thrinax parviflora.*

Montana. "Largely used for interior finish, fencing, cabinetmaking, and cooperage, and exclusively used by the Indians of the northwest coast in the manufacture of their canoes." (*C. S. Sargent.*)

BAST FIBER.—The inner bark is a heavy layer of soft bast which the Indians of the North Pacific Coast make use of in all of their industries. In their houses it frequently forms the roof; the mats made of it serve for doors, for hangings, for beds, for coverings of boxes, and for ornamental purposes. In their costumes it is used for headdresses and hats, and an immense number and variety of ceremonial headdresses are made from the material shredded. It also serves for covering of the body, for kilts or skirts, for cradles or cradle linings, and the soft pads that are placed on the heads of infants in flattening them. In their canoes the mat forms the covering of the seat and the soft piece on which the rower or paddler kneels. In fact, there is scarcely a common industry among these Indians into which this substance does not intrude itself. (*Contributed by Dr. O. T. Mason.*)

Ti. New Zealand, *Cordyline indivisa.* In Tahiti, *C. terminalis.*

Tibisiri fiber (Br. Guian.). *Mauritia flexuosa.*

Tibouchina papyrifera.

Exogen. *Melastomaceæ.* A tree.

Thin, paper-like strips of bast from this specie are preserved in the Bot. Mus. Harv. Univ., under the name *Lasiandra papyrus.* They are creamy in color, and very fragile.

Tiglio (It.).=*Tilia.*

Tilia americana. LINDEN. BASSWOOD.

Exogen. *Tiliaceæ.* A large tree, 60 to 125 feet.

COMMON NAMES.—Basswood, Am. linden, linn, lime tree, bee tree, white lind, wickup, lein.

Found in New Brunswick, west to the eastern shore of Lake Superior, and north and west to Lake Winnipeg and the valley of the Assinniboine River, southward through the Atlantic States to Virginia and the Alleghany Mountains, to Alabama and Georgia, west and eastern Dakota, Nebraska, and Kansas, the Indian Territory, and eastern Texas.

"One of the most common trees in the northern forests. Largely sawn into lumber, and under the name of whitewood, is used in manufacture of woodenware, cheap furniture, the panels and bodies of carriages, and the inner soles of shoes. One of the principal woods used for paper pulp, but unfit for white paper." (*C. S. Sargent.*)

FIBER.—The inner bark can be readily peeled into long strips of bast, which in this country have found occasional use as rough cordage, and for coarse woven mattings for nurserymen and florists with which to protect hotbeds. See *T. cordata*, etc.

Tilia cordata, T. platyphyllos, and **T. vulgaris.**

Syn. *Tilia europæa.*

COMMON NAMES.—Lime, linden (English); *Tilo* (Span.); *Tiglio* (It.); *Tilleu* (Fr.).

The above species, all of which have been known as *T. europæa*, are common in different portions of Europe. The small leaved form is indigenous to Britain, but the large-leaved variety is common in the south of Europe. The wood is used by carvers and turners, and is prized by instrument makers for sounding-boards.

FIBER.—Like the preceding species, the bast of European lindens is readily extracted. It is used in Russia in the manufacture of an exceedingly coarse kind of rope; for making the matted shoes worn by the peasantry, and also for the manufacture of the mats which are used to a considerable extent by furniture dealers for packing. They are also used by gardeners as a covering or protection to glass frames. For the larger and better kinds of mats, trees 8 to 16 years old are used, which are cut when full of sap and the bark immediately separated from trunk and branches. It is then stretched upon the ground to dry, two or more strips being placed together. When required for use simple soaking in water separates the cortical layers, the best of which are in the interior and the coarsest on the outside. As many as 14,000,000 pieces of matting have been produced in Russia alone in a single year, as these mats are a considerable article of export. Their manufacture is largely confined to Russia; Sweden, however, has furnished a portion of the mats exported. The Swedish fishermen use the inner fiber or bast for the manufacture of fishing nets. Among the uses of lime-tree bast given by Savorgnan and not above recorded, are baskets and hampers, the prepared fiber being used for nets, hats, and fine cordage, coarse packing cloth, and a paper said to be remarkably smooth. The Japanese form, *T. cordata*, is much esteemed in Japan for its fiber or bast, which is used for strings and ropes, and sometimes for making a very coarse cloth. An important branch of industry is the manufacture of mosquito nets, the bark of this species being used for the purpose. No Indian species is recorded.

Tillandsia usneoides. SOUTHERN MOSS.

Endogen. *Bromeliaceæ.*

COMMON NAMES.—Spanish moss, New Orleans moss, Old man's beard, vegetable hair; *Barba de Palo* (Venez.); *Igan* (Arg.).

Abounds in the Gulf States from South Carolina and Florida to Louisiana, where it is seen hanging in dense gray masses from the branches of the trees, upon which it is epiphytal. Common in the West Indies, Central America, and portions of South America, as far south as Argentina.

STRUCTURAL FIBER.—This is the whole plant after the epidermis has been removed. It is used as a substitute for curled hair, and its production is a recognized American industry. Manufactured at present chiefly in Charleston, S. C., and New Orleans, La. The moss was formerly buried for a short time, or thrown up in a heap partially covered, to destroy the epidermis. Cleaning machines are now used, however, to remove the epidermis, after which the fiber goes through a dusting machine and is subsequently dyed a rich black. The fiber is used in this country for genera upholstery purposes. It is used in Venezuela and in Brazil for the same purposes, though in the latter country the unprepared moss is also employed as packing material for glassware and porcelain. The plant is allied to the pineapple.

Tilleul (Fr.) = *Tilia.*

Tilo (Span.) = *Tilia.*

Tilluk (Ind.). *Saccharum spontaneum.*

Tinnivelley matting (Ind.). *Cyperus corymbosus* and *C. tegetum.*

Tinospora cordifolia.

A climbing shrub belonging to the *Menispermaceæ*, found throughout tropical India, the aerial roots of which are used for tying bundles. The principal value of the plant is in pharmacy, stems, roots, and leaves being used. Its Hindoo name is *Gurach*, or *Gúrcha*, though there are nearly a hundred Indian names of the plant and of parts of the plant.

Ti-raurika (Austr.). *Cordyline australis.*

Tísí (Hind. and Beng.). *Linum usitatissimum.*

Tobago silk grass. *Furcræa cubensis.*

Toi; also **Ti** (Austr.). *Cordyline indivisa.*

Tolotzin, or **Catena** (Mex.). *Heliocarpus.*

Ton khoi. *Streblus asper.*

Toothe-nai (Ind.). *Abutilon indicum.* See also *Tuthí nar.*

Totora (Peru). See *Typha augustifolia.*

Totte de maguay fino (Mex.). *Agave americana.*

Touchardia latifolia. THE OLONÁ OF HAWAII.

Exogen. *Urticaceæ.* A shrub, 4 to 8 feet.

This species, allied to the *Boehmerias*, is found in deep ravines on all the islands of the Sandwich Island group, but is not common.

FIBER.—"This is the *olona* of the natives, which yields a bast fiber highly prized for its tenacity and durability, and is chiefly employed for making fishing nets." (*Hillebrand.*)

The nets (of the Hawaiians) made of twine spun from the strong and durable fiber of the *olona* (*T. latifolia*) were of many different patterns and sizes, which may be divided into two classes—long nets, sometimes over one hundred fathoms in length, and bag nets. The long nets were often drawn into large circles, so as to inclose shoals of fish, and sometimes ropes hundreds of fathoms in length, having dry *ki* leaves braided to them by the stems and hanging down in the water, were used to sweep around and drive the fish into the net, thus inclosing thousands at one haul. (*W. D. Alexander.*)

Samples of the unprepared bast forwarded to the Department show a fiber of great strength and fineness. Specimens subsequently further prepared show a fiber resembling China grass and capable of being spun into fine yarns.

Toung-chi. Rice paper. See *Aralia.*

Toung-ong and **Taung-ong** (Burm.). *Arenga saccharifera.*

Trachycarpus excelsus. CHINESE COIR.

Endogen. *Palmæ.* A small fan palm.

Said to be a native of Japan, but found in China and other parts of Asia. Cultivated in the province of Chekiang. Introduced into other countries as an ornamental plant.

FIBER.—In China "the fibers of the leaves are locally used in the manufacture of sandals, brushes, hats, matting, and cordage, and occasionally for textile fabrics." (Spon.) The Kew Mus. exhibits a rain coat and hat made from the fiber of this palm as worn by the Chinese; also brushes, cordage, and other articles made from the fiber obtained from the bases of the leaf stalks.

*Specimens of fine chocolate-colored cordage, small ropes, etc., Bot. Mus. Harv. Univ.

Trachycarpus fortunei. CHUSAN PALM.

Similar to the preceding, credited to China, but according to the Indian Agriculturist introduced on the Nilghiris, India. Can be grown to any extent on the Nilghiris at elevations ranging from 4,000 to 6,000 feet. Height, 10 to 15 feet. (See fig. 2, Pl. VI.)

FIBER.—The whole of the trunk from the ground upward is clothed with a thick moss of structural fiber which can be easily removed by hand, and only needs to be combed out and bundled in lengths to be a most valuable article. Introduced for brush making. (Indian Agriculturist, Feb., 1893.)

Traveler's grass (Austr.). See *Gymnostachys anceps.*

Treccia (It.) (straw plait). See *Triticum.*

Tree mallow. *Lavatera arborea.*

Trema orientalis. INDIAN NETTLE TREE.

Syn. *Sponia orientalis.*

Exogen. *Urticaceæ.* A small evergreen tree.

COMMON AND NATIVE NAMES.—Charcoal tree; *Chikun* (Beng.); *Sap-sha-pen* (Burm.).

South India, Bengal, southward to Travancore and Singapore; common in Ceylon, Coromandel coast. "The inner bark consists of numerous reticulated fibers used for clothing by some of the native races." (Spon.) George Watt states that the inner bark yields a fiber used for tying rafters or native houses, for binding loads, and in Assam for coarse cloth.

Trema wightii, regarded as a synonym, is included in Spon's list under the name *Sponia wightii*, and known commonly as *Chitrang*. "This plant is a native of India, being especially abundant in the Concans. The fibrous bark, or bast, occurs in strips 12 to 30 inches long, 3 to 15 feet wide, and 0.0039 to 0.03 inch thick. It is used not only as bast, but also in the manufacture of cordage. This fiber is said to be utilized in Mauritius and Venezuela." (Spon.) A species of *Trema* is valued for its fibrous bast in Argentina. (See *Celtis orientalis*.)

Triodia irritans.

An Australian species, known as porcupine grass, that has been recommended as a paper plant. It is not noted, however, in Guilfoyle's list.

Tristachya leiostachya.

Endogen. *Gramineæ*.

Löfgren states that this is considered in Sao Paulo, Brazil, an excellent forage for all sorts of animals and is eaten with avidity. At the summit of the stalk, as far as the flower, it contains a quantity of pure cellulose. Grows in fields; flowers in May to August; might be useful for paper.

Trithrinax brasiliensis.

A Brazilian low-growing palm, native of the province of Rio Grande; found also in Entre Rios and Corrientes, Argentina, where fiber from the leaves is made into brooms, fans, and other articles.

T. campestris, which is grown in San Luis and Cordoba, Argentina, is used for basket work, fans, etc. *T. mauritiæformis* is a New Granada species.

Triticum sativum. CULTIVATED WHEAT.

This with its many varieties which have been produced by cultivation is one of the most, if not the most, important of the true grasses. It is one of the oldest of the cultivated cereals. the grains having been found in very ancient Egyptian monuments, dating back to 2,500 to 3,000 B. C. (*F. Lamson-Scribner*.)

STRUCTURAL FIBER.—The straw of several varieties of wheat, including the variety *æstivum*, is used in many countries for the manufacture of braids, or straw plait. The finest braids, which come from Italy, and which include the celebrated Tuscan plait, from Florence, are produced from varieties of wheat cultivated especially for the straw and without regard to the grain. Wheat straw is likewise used for braids in other countries of southern Europe and in Germany, the Bohemian braids also being well known. Some wheat straw braid is also produced in China. The straw-plait industry of Europe gives employment to thousands of people, not only in the countries where the straw is produced, but in England, Switzerland, and other countries which purchase the product for manufacture into hats.

Tuscany formerly sent abroad the finished hats, but now the export is largely in the form of braid. The first fine Tuscan hats sent to England were those worn by the peasants, and they are still in common use in Tuscany. The work of braiding is largely done by women and children and is, to that extent, a household industry. It is easily accomplished, though practice from childhood has produced some very expert braid makers In the Manual Hoepli, M. A. Savorgnan gives a most interesting account of the Italian straw-plait industry, from which extracts are reproduced.

The variety of grain which is employed is the so-called *Marzuolo* (*Triticum sativum var. trimestre*), of which there are two subvarieties. The one is very prolific in seed, and is adapted for rather meager soil; the other has less and smaller seed, but it is very fertile. They are, however, rather changeable types, as they easily merge into each other if sown near and thickly together. We find two qualities of seed; the *Marzuolo,* which is furnished from Modena, also from the mountains of Tuscany, and especially from Monte-Amiata, it being from the latter place that the seed most adapted to a fine quality of straw is procured, and the *Semenzuolo,* a very small grain, which is used for hats and grows to perfection only in the district of Pisa. The *Marzuolo* (meaning sown in March) wheat straw is not a plant which differs much from the other varieties of grains having small seeds, and if cultivated under conditions favorable to the development of the seed would make good bread grain. With us, however, the aim is to lessen the production of seed and cause the stem to acquire length, fineness, and consistency, thus rendering it valuable. It is the effort to make each seed produce one stem, which shall be flexible and as long as possible. Very little care is required for the grain, especially if sown very thick. The harvest is never delayed until the grain is perfectly matured, but the stems are drawn out about the last of May or the first of June.

This uprooting process is generally given out by contract to the operators. The straw is then tied in bundles and left to dry under shelter. If the weather is dry, the straw may be spread for three or four days on the ground, on an open threshing floor or the dry bed of a stream, so that the sun and dew will alternate and effect a bleaching. After this the separating and arranging of the straw takes place. The operator holding the stem in one hand, takes hold of the husk which contains the barley seed with the other and draws off the top straw which is attached to it and which serves for making fine hats. These are selected and tied in bundles again, weighing 100 grams each, which are afterwards combined into packages of 6 to 8 kilos. The straw remaining after this operation is useless for the industries, but is used for animals.

The production of straw for hats reaches 7,000 or 8,000 kilos per hectare, weighed when just taken from the earth, but when fully dried, bleached, and separated the real straw for plaiting weighs about 1,000 kilos. It usually sells for 5 or 6 lire per 100 bundles. For 30,000 to 35,000 bundles 1,500 to 2,000 lire should be received. Otherwise selling by weight, it brings 1.50 lire to 2 lire per kilo, equivalent to 1,500 or 2,000 lire. [A lire is about 25 cents.] After Tuscany the Province of Vicenza ranks high in this product. Switzerland at present exports the greater number of straw hats. England produces an immense quantity of these hats. From 60,000 to 70,000 persons are engaged in this manufacture.

The Chinese wheat straw plait industry is located in the provinces of Chihli, Shansi, Honan, and Shantung, and gives employment to many of the poorer classes of women and children, who are able to produce from 35 to 40 yards of braid per day, worth 14 to 20 cents. The principal varieties are known as white and black Shingkee, Shansi, Shantung mottled, and Honan mottled. The first shipment of 35 bales of braid to the United States was in 1873. In 1886, 6,000 bales were shipped, a bale representing 240 bundles of 165 feet each.

The cultivation of wheat straw from which the braid is worked, and the manufacture of straw hats for water use, has been a special industry in the northern provinces of China for more than a century. It was not until after Tientsin was opened to foreign trade that the farmer began to pay much attention to the cultivation and curing of the straw so as to secure greater uniformity of color as well as fineness of quality. The great desideratum is to obtain as perfect a white straw as possible by means of bleaching in the sun. The process is to pull up the plants by hand when the grain is in the milk and only about half developed. Great care must be taken to prevent exposure to rain. After bleaching, the straw is cut at the first joint from the top, all below that joint being useless for making braid. (*U. S. Consul E. J. Smithers.*)

Tritoma spp. TORCH LILY.

Endogens. *Liliaceæ.* Aloe-like leaf cluster.

The torch lilies are natives of the Cape of Good Hope, but distributed to other portions of the globe, their elongated spikes of brilliant scarlet or yellow flowers making them favorite ornamental garden plants.

The revised name of this genus is *Kniphofia*.

STRUCTURAL FIBER.—It is said that *T. recurvata* and *T. uvaria* are utilized as fiber plants at the Cape of Good Hope. The leaves are crushed and macerated in hot water, when the fibers readily separate. "As fiber plants they were first brought under notice by me in 1875, samples of five kinds having been prepared in the Botanical Gardens, and since forwarded to several exhibitions. It will be seen that the present specimens are of fair strength and quality, and possibly they are capable of being woven into fine textile fabrics. The plants are all quick-growing perennials, producing a wealth of long leafage, and are readily increased by root division and seeds. With good cultivation they would yield two crops per year, and the fiber can be obtained within a few hours by boiling or steaming the leaves. The great-flowered Torch Lily (*Kniphofia grandiflora*) and the 'Recurved Torch Lily' (*Kniphofia recurvata*) are probably the strongest and best in quality, and these give the greatest percentage of fiber. A letter from a London firm of manufacturers states the value of this fiber and that of *Sparmannia africana* to be from £17 to £17 10s per ton." (*Dr. Guilfoyle.*) The fiber of *T. uvaria*, known as the Queen's torch lily, furnishes a strong fiber of a chocolate color. The uses of these fibers in manufacture are not stated in any of the works examined by the compiler.

Triumfetta rhomboidea.

Endogen. *Tiliaceæ.* A shrub.

INDIAN NAMES.—*Chikti* (Hind.); *Bun-ochra* (Beng.).

The plants of the genus are both numerous and widely distributed, abounding in tropical countries in many parts of the world. *T. rhomboidea* is found in tropical India and Ceylon. "The plant yields a soft, glossy fiber which is said to be considerably utilized in Madras." (*Watt.*) This is a jute-like fiber, the genus being very closely allied to Corchorus.

Specimens of the fiber of *T. semitriloba* were received from the Smithsonian Institution in 1869, without data save the name. The fiber very closely resembles jute in color, strength, and general characteristics. This species is grown in Trinidad, where it is known as Cousine Mahoe, but it is regarded more for its medicinal properties than for its fiber. *T. longicoma* is a useful Brazilian species, reported by Löfgren.

Tronadora (Mex.). *Abutilon incanum.*

Troolie palm (Guian.). *Manicaria saccifera.*

Trumpet tree. *Cecropia peltata.*

Tsai-lai and **Hsele** (Burm.). *Daphne cannabinum.*

Tsjo (Jap.). See *Boehmeria nivea.*

Tucum and **Tecuma** (S. Am.). See *Astrocaryum* spp.

Tukhme-katán (Pers.) *Linum usitatissimum.*

Tule (California). *Scirpus lacustris.*

Tulhtula (Pers. and Arab.). *Musa sapientum.*

Turu palm (Br. Guian.). *Œnocarpus.*

Tururi (Peru). *Paullinia grandiflora.*

Tuthi-nar or **Tutti** (Ind.). *Abutilon asiaticum* and *indicum.*

Tye plant of Australia. *Commersonia fraseri.*

Typha spp. CAT-TAIL FLAG.

Endogen. *Typhaceæ.* A reed or rush.

COMMON NAMES.—The bulrush (erroneous); cat tail, reed mace, elephant grass (Eng.); *Massette* (Fr.); *Rohrkolbe* (Ger.); *Sala minore* (It.); *Lana de Enea* (Venez.); *Totora* (Peru).

A genus of tall aquatic plants with long, flat leaves found over a large part of the world. *T. latifolia* and *T. angustifolia* are the North American species, common also in Europe, while *T. elephantina* and other species are found in Asia. In this country its chief use is in cooperage, its leaves being employed to fill open seams in the heads and between the staves of barrels. Its fruit stems, crowned with the brownish, velvety mass of fiber which clothes the female spadix, are also used for household decorative purposes. The down is sometimes used for stuffing, and at one time a considerable quantity of it (the fiber) was secured commercially in New Jersey.

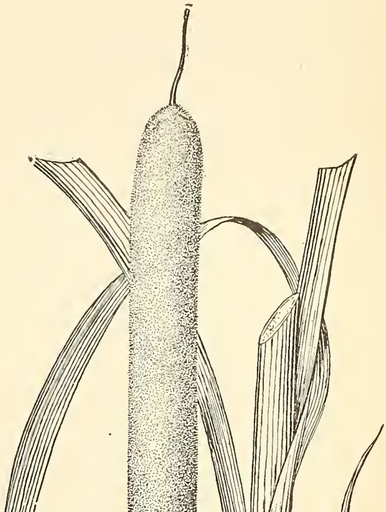

FIG. 100.—Cat-tail flag, *Typha angustifolia*.

STRUCTURAL FIBER.—There are so many references to the uses of the plant as fiber that a few general statements will suffice. A very soft and fine fiber has been prepared from the leaves in this country, experimentally, but it is of little value compared with many other fibers which can be prepared from native weeds. "The tough leaves, dried and split, are extensively used to make chair bottoms, also woven into baskets and mats, and even twisted into strings and ropes." (*Dr. Havard.*) The plant is noted in Venezuela, where the fibrous material borne on the spadix is employed for stuffing pillows. A species reported as *T. domingensis* is noted as a fiber plant in Peru, where it is called the *Totora*. *T. latifolia* and *T. angustifolia* abound in Europe, where both the fiber of the leaves and the fibrous substance of the spadix have been employed, the first as a material for making hats, baskets, chair bottoms, etc., and the latter for upholstery. A sample of its fiber prepared in Victoria was sent to the Amsterdam Exhibition of 1876, at which time it was stated that a French company had been formed to utilize the fiber in commerce. The uses of the plant in India are even more varied; used for making sieves in Kashmir; for thatching huts and house boats in the Punjab; for soft mattings, ropes, and baskets in Kulu and Kúmaon; for the same purposes in Sind, and also for building rude wicker boats, employed for crossing the Indus during floods. Used for paper making with success. "The fiber has been examined in Europe, and is said to be of fine texture, tolerably strong, and capable, with the aid of machinery, of being converted into textile fabrics." (*George Watt.*) Savorgnan states that the leaves of *T. latifolia*, are employed in

Italy for making mats, hand baskets, and also to cover chair seats, bottles, and flasks; and, finally, the leaves are employed for calking vessels, and filling the seams in casks and barrels.

Uaisima.

In Orton's Andes and the Amazon this name is given to a light-wooded, slender tree of the lower Amazon, the inner bark of which is said to contain a strong, silky fiber. If the name was written phonetically it may refer either to *Urena lobata*, or to *Guazuma ulmifolia*, as it is very similar to the Brazilian names of these species, which follow.

Uaixyma and **Guaxima** (Braz.). *Urena lobata.*

Uauassú palm (Braz.). See *Attalea.*

Uaycima (Venez.). *Guazuma ulmifolia.*

Ubim (Braz.). See *Geonoma.*

Udal (Ind.). *Sterculia villosa.*

Uki (Hawaii). See *Gahnia beecheyii.*

Ukot. *Raphia hookeri.*

Ulat-kamball (Ind.). *Abroma augusta.*

Ulmus alata. THE WAHOO.

COMMON NAMES.—Winged elm, wahoo, wahoo elm, witch elm, cork elm, mountain elm, water elm.

The elm belongs to the family *Ulmaceæ*, which for the most part are large trees. *U. alata* is a species which abounds in the hummock lands of middle Georgia. The bark is very tough, and when stripped from the trees and steeped in water for several weeks becomes quite pliant, and is said to make excellent horse collars. *U. pubescens* (formerly *U. fulva*) is the slippery elm, its fibrous and mucilaginous bark being well known. Fiber from "Red elm" bark has been received from Missouri.

Ulmus campestris.

This is the common Elm of Europe, thought to have been introduced into Britain by the crusaders. Savorgnan states that the bark of the young branches is adapted to making a common kind of cordage.

The bark of *U. wallichii*, a species occuring in India, contains a strong fiber used for cordage and for making bedstrings and sandals. Fiber is also said to have been made from the scape of the flower stalks.

Umbauba (Braz.). *Cecropia peltata.*

Umbogozembe (Natal). *Urera tenax.*

um-Vemvani (Natal). *Sida rhombifolia.*

Uniola racemiflora.

A West Indian grass, the stems of which have been made into ropes. Also proposed for paper stock.

Upas tree (Java). *Antiaris toxicaria.*

Uram (Malay). *Abutilon indicum.*

Urena lobata. Cæsar Weed.

Exogen. *Malvaceæ.* A small shrub.

Common and native names.—Cæsar weed (Fla.); *Cadillo,* (Venez.); *Guaxima,* or *Uaixyma* (Braz.); *Bun-ochra* (Ind.); *Patta-appele* (Ceyl.); *Ake-iri* (Yorubaland).

This species is almost cosmopolitan, as it is found in both temperate and tropical countries in many parts of the world. It is a very common species in many portions

Fig. 101.—The Cæsar weed, *Urena lobata.*

of the United States, but has been particularly remarked as a fiber plant in Florida, where uninformed persons have taken it for ramie. It occurs in South America, India, Africa, and other tropical countries. (See fig. 101.)

Bast Fiber.—Resembles many of the mallow fibers, both as to color and strength, and would make a good jute substitute, though the stalks are short and small. The museum contains many specimens of this fiber, several from Brazil and Venezuela. Dr. Ernst describes the fiber as a meter in length, very fine and white, very strong, taking dyes readily. Some very fine samples of the Brazilian fiber were received through the Phil. Int. Exh., 1876, with the statement that it is extracted readily and makes very strong cordage: "takes color well, and the dyes are lasting." In the East Indies it has been used for the manufacture of paper. Spon states that slips of sized paper weighing 39 grains made from this fiber sustained 75 pounds, against Bank of England note pulp 47 pounds. Used in India for the manufacture of sacking and twine, and is considered a fair substitute for flax; is easily extracted. It is a common shrub in portions of Africa, and in Yorubaland is used for rope, and as a tie material in house building. An allied form found in India, *U. sinuata*, yields a similar fiber that is employed for the same uses. This is known as the *Hin appele* in Ceylon, and *Kunjia* in Bengal.

Urera subpeltata. ORTIGAO.

Exogen. *Urticaceæ*. A shrub.

A genus allied to *Urtica* or the nettles. The species named occurs in southern Brazil, where it is found in briary copses. It is medicinal, being often employed in forms of tea made from the bark as a remedy for pulmonary diseases. It forms an excellent food for horses.

BAST FIBER.—It contains a strong fiber, from which the Indians make nets, their short hip clothing, and other articles. It should be one of the best of the vegetable productions for the manufacture of paper. Also called *Cansanciāo*. (*Alberto Löfgren.*)

Urera tenax. UMBOGOZEMBE.

Exogen. *Urticaceæ*. A shrub, 8 to 10 feet.

This species abounds in Natal, and was brought to notice as a fiber plant at the Colonial and Indian Exhibition, London, 1886. "The shrub is of moderately quick growth and is easily propagated. Plants have been reared for distribution, but no one seems to care to give it a trial. One reason for this may be probably found in the more or less complete failure of all machines yet invented for profitable extraction of the fiber. Should such a machine be perfected, I believe the plant under notice would be found easier to work than the 'China grass.'" (*J. Medley Wood.*) (See fig. 102.)

FIBER.—This is described as strong and of good color. Is used by the natives for making sleeping mats. The stripped bast resembles China grass, but is more brittle and is not so lustrous. The plant is figured in the Kew Bulletin for March, 1894.

Urera sandwicensis. OPUHE.

Abundant in the Sandwich Islands. Hillebrand describes this species in the Flora of the Hawaiian Islands, and states that the plant yields a most valuable fiber, especially esteemed by the natives, and used in the same manner as the *olona*, *Touchardia latifolia*, which see. *U. alceæfolia* is a Tahiti species.

Urtica spp.

This genus gives its name to a large family of fiber-producing plants, the *Urticaceæ*, the representatives of which are found in every country. The *Urticas* are commonly known as stinging nettles. The species of *Boehmeria*, such as ramie, China grass, etc., which are closely related, differ in that they are deficient in the stinging hairs which characterize many of the Urticas, and hence the name stingless nettle, one of the common names of the China grass plant. Bernardin names fourteen species of *Urtica* as fiber yielding, though many of them have been referred to other genera. Among the less important species are *U. pilulifera* and *U. cannabina*, Oriental, and *U. urens*, European.

In the United States several species are recognized, one of which, *U. dioica*, has been introduced from Europe. Another species has been recognized as a valuable fiber plant and is treated under the title *U. gracilis*. *U. urens* and *U. chamædryoides*, the former a Southern form, the latter more widely distributed, are of small importance as fiber plants. *Urtica holosericea*, of the southern Pacific States, yields a very strong fiber, used by Indians to make bowstrings, twine, rope, etc. (Represented in the Bot. Mus. Harv. Univ. by one sample of very good fiber.) *U. breweri* probably yields the same kind of fiber. (*Dr. V. Havard.*)

The Treasury of Botany mentions many species of Urtica that have been prized for their fiber, in different countries, but in the modern nomenclature these have been referred to other genera, such as *Boehmeria, Girardinia, Debregeasia, Laportea, Maoutia, Pilea, Pouzolzia, Touchardia, Villebrunea, Urera,* and others, which see. The principal species still retained in the genus are described below.

Urtica dioica. THE COMMON STINGING NETTLE OF EUROPE.

COMMON NAMES.—The stinging or great nettle. In India it has been given such names as *Bichu, Chicru,* etc., meaning the scorpion or stinger.

FIG. 102.—Plant of *Urera tenax.*

Common in the United States in waste places, Nova Scotia to Ontario and Minnesota; southward to South Carolina and Missouri. Introduced from Europe where it is a common species. Found also in India, in the Himalayas, at altitudes of 8,000 to 12,000 feet.

BAST FIBER.—Has not been reported as a fiber plant in the United States, but is said to have been prepared in Germany, the "fiber made to become as fine as silk." Is also used in Europe for fish lines and, it is claimed, has been manufactured into fabrics. Savorgnan states that it is known as Swedish hemp, and that the plant is cultivated in Sweden, and its fiber used for cordage and cloth. In India the "stems yield a well-known fiber, which is said to rival in tenacity the best hemp." (*George Watt.*)

U. parviflora is an Indian species found in the temperate Himalayas. It yields a fiber, though little is known about it; like the allied species, is doubtless used in cordage, etc.

Urtica gracilis. THE SLENDER NETTLE.

Nova Scotia to British Columbia; southward to North Carolina, Louisiana; Kansas. A native species, abounding throughout the United States and Canada. As it is related to the ramie plant it naturally possesses a good fiber in its bark, though the stinging hairs which clothe its stalks and leaves make it unpleasant to handle.

BAST FIBER.—Many specimens have been received by the Department of Agriculture gathered from weather-beaten stalks found standing in the fields, though the special agent in charge of fiber investigations has never seen a properly prepared sample of the fiber from fresh stalks, and is unable to describe its characteristics. A few years ago it attracted attention in Minnesota, and an attempt was made to reduce the fiber, though the experiment was interrupted before completion, and no report could be made. From a communication to the Department by J. Carmichael Allen, in 1891, the following extract is produced:

I have about a half ton of the straw of *Urtica gracilis* retting, and will furnish you with samples of the fiber as soon as ready. It seems a close relative of the *Boehmeria* fiber, though whether dew retting will prove a successful system or not for this plant I shall not be prepared to say until I scutch some of it. I inclose a sample of tow I made from a few stems this afternoon. You will see it is not sufficiently retted and the fiber though soft does not appear to be over strong. From the nature and feel of it I expect it will be better adapted to mix with wool than as a substitute for flax, and this comes more under the Rhea class.

In this connection, it may be stated that the fiber of *Girardinia palmata* (*U. heterophylla*), which is found in Coromandel, Nepal, Burmah, Assam, etc., is known as vegetable wool, and it is claimed that the filaments of this species, "having a rougher surface than those of *Boehmeria nivea* (China grass), are, therefore, more easily combined with wool in mixed fabrics." Another species which may be mentioned is *U. caracasana*, a Tahiti form, from which a good fiber is obtained.

Uruca (Braz.). *Bixa orellana.*

Urucurí palm (Braz.). *Attalea excelsa.*

Usír (Arab.). *Andropogon squarrosus.*

Uttariya jute (Ind.). See *Corchorus.*

Vacona (also **Bacona**) (Maurit). *Pandanus utilis.*

Vanilla grass. *Hierochloë odorata.*

Vasha and **Vellacoi** (Malay). *Musa sapientum.*

Vegetable silk (see cotton—silk cottons; refer also to artificial silk).

Vegetable wool (see *Girardinia palmata;* see also *Urtica gracilis*).

Velvet mallow. *Lavatera maritima.*

Vendi, or **Venda-kaya** (Ind.). *Hibiscus esculentus.*

Vetivert. *Andropogon squarrosus.*

Viburnum spp.

An extensive genus of shrubs, natives of the temperate regions of North America, Asia, and Africa. The wood of several species is used for turnery, etc. Another yields a fruit from which ink is made, and still another yields a dye. The ancients used the word viburna to signify a pliant, branched plant that could be used in tying. *V. canadensis* is noted in Manual Hoepli. "Has very flexible and tenacious branches, which are utilized, either split or entire, as bands for binding bales and large packages." This name is unknown to botanists; probably *V. cassinoides*, witherod, is meant.

Vigna catjang. The Cowpea.

Syn. *Dolichos sinensis*.

Exogen. *Leguminosæ*. Annual forage plant.

Common names.—Southern cowpea, field pea, stock pea, cherry bean, Chinese vetch.

Of unknown origin. Cultivated in the United States and in Oriental and other warm countries. Economic value, as a forage plant, as an article of human food, and as a fertilizer when the crop is plowed under.

There are many named forms or cultural varieties, all of which, however, are considered by botanists to be derived from one species. It so readily adapts itself to different soils and changes its characters so readily under cultivation, that there has been much difficulty in determining the limits of the various named forms. The cowpeas are of three general classes, according to their habit of growth, consisting of "bunch" varieties, which grow erect and compact; "runners," which start off erect and then throw out running branches; and "trailers," which grow flat upon the ground with long stems sometimes 15 to 20 feet in length. There is also much variation in size, shape, and color markings of the seeds, and in the manner in which the seeds are borne in the pod, the seeds of some being closely crowded together, called "crowders," and others with the seeds wide apart and the pods constricted between each seed, called "kidney" peas. The bunch varieties are the ones which are best adapted to growing for hay or ensilage, while the runners and trailers are valuable for soiling purposes or for turning under as green manure. The length of season required for maturity also varies greatly, the bunch varieties, as a rule, requiring only a short season. (*F. Lamson-Scribner.*)

Bast fiber.—A field sample of the fiber of this plant has recently been received from Dr. W. J. Mason, of Activity, Ala. Weather retted, by exposure to the elements, its characters can not be defined. In the matter of strength, however, it is interesting to note that a cord about half the size of binding twine showed a breakage strain of 38 pounds, Kentucky hemp binding twine averaging about 100 pounds.

Dr. Mason writes as follows: "As you are aware, the pea is to the South what clover is to other sections in restoring fertility to the soil; then it is one of the finest food and forage crops for both man and beast. Now, if the fiber could be manufactured into twine and baling stuffs, I do not see why it would not open a new field for manufactures and add a new source of profit to the Southern farmers. The sample forwarded has lain in the open fields all the winter, and you will notice that it is stainless and possessed of great strength." While the fiber is strong and good it would be difficult to extract it commercially at paying cost, in competition with such a fiber as hemp, which is produced in straight, slender, rigid stalks, which can be handled with ease in the harvesting, curing, and breaking, to clean the fiber. No doubt the fiber could be used for some purpose if it could be secured at economical cost.

Villebrunea integrifolia.

Exogen. *Urticaceæ*. A small tree.

Abounds in many parts of India and Ceylon, together with an allied species, *V. frutescens*.

Bast Fiber.—"One of the strongest of India fibers" (Spon) The fiber in Sikkim and Assam has been made into ropes, nets, and cloth. The *Ban-rhea* of the Assamese.

In Dr. George Watt's Rhea and allied Rhea fibers (selections from the records of the Government of India, revenue and agricultural department) there is an exhaustive account of the fiber of both *V. integrifolia* and *V. frutesceus*. See also Dic. Ec. Prod. Ind., Vol. VI, Part IV.

Vismia cayennensis.

The *Vismias* are mostly tropical American plants, though several species are found in Africa. Some of the species, such as *V. cayenneusis*, from Guiana, yield a resin known as American gamboge. This species is found in Trinidad, known as *Bois Sang*. Mr. J. H. Hart states that it yields a coarse bast fiber.

Vitis adnata.

Belongs to the *Vitaceæ*, a slender climbing plant met with in the hotter parts of India, Ceylon, Java, Philippine Islands, etc., and allied to the common grape, *V. vinifera*. It is reported that the Santals prepare a good cordage fiber from the stems.

Voivoi (Fiji Is.). *Pandanus caricosus*. See under *P. utilis*.

Volandera (Cent. Am.). *Cavanillesia plantanifolia*.

Vonitra (Madagascar). See *Dictyosperma fibrosum*.

Wadara (Br. Guian.). See *Couratari*.

Waduri (Java). *Calotropis gigantea*.

Waduri bast (Br. Guian.). See *Lecythis*.

Waeta keyiva (Ceyl.). *Pandanus odoratissimus*.

Wahoo elm (see *Ulmus alata*).

Wal (Ceyl.)=Wild.

Wal-kaihil (Ceyl.). *Musa sapientum*.

Walola (New Guin.). See *Polyporus*.

Warang bast. *Kydia calycina*.

Washingtonia filifera.

A California palm—southern California to western Arizona—found in rocky localities in dry, sheltered canyons. Fibrous material is said to have been produced from it by the Indians. Mentioned by Romyn Hitchcock in list of fibers published by the U. S. Nat. Mus., 1884.

The revised name of this species is *Neowashingtonia filamentosa*.

Water iris, Yellow (see *Iris*).

Water weed. *Elodea canadensis*.

Wawla bast. *Holoptelea integrifolia*.

Wax palm (Braz.). *Copernicia cerifera*.

Wayaka (Fiji Is.). See *Pachyrhizus angulatus*.

Wedding flower, Lord Howe's (Austr.). *Moræa robinsoniana*.

Wel (Ceyl.)=Climber. A common affix in Ceylon names.

Weni-wel (Ceyl.). *Coscinium fenestratum*.

West Indian locust. *Hymenæa courbaril*.

Wharariki (New Zea.). *Phormium tenax.*

Wheat straw (see *Triticum*).

White cotton tree, of India. *Eriodendron anfractuosum.*

White melilot. *Melilotus alba.*

White mulberry. *Morus alba.*

White silk cotton tree. *Cochlospermum gossypium.*

White sweet clover. *Melilotus alba.*

Wicopy (U. S.). *Dirca palustris.*

Wikstroemia canescens. GANPI, of Japan.

Exogen. *Thymelæaceæ.*

This genus is distributed over the warmer parts of Asia, Australia, and the Pacific islands, some of them being shrubs and others trees. The genus is related to *Daphne. W. canescens* is employed to a commercial extent in Japan for paper making.

BAST FIBER.—Beautiful examples of the raw and prepared bark, and a large series of samples of paper made from it, were received from the Japanese exhibit, W. C. E., 1893.

This plant is very rarely cultivated, the bark being gathered chiefly from wild growth. Soil fit for the plants is clay, of red or yellow color, in an exposed situation, such as mountain or hillside facing south. Seed is sown at the end of March or beginning of April and covered slightly with earth. After germination weeding should be performed, manuring with some liquid manure and drawing the earth around the plant. In the dry summer of the first year litter from horse or cow stables is spread around the plants and watering is repeated as required. In the succeeding years hoeing and weeding are done during the summer, weeds being collected around the plant and allowed to decay there. Harvesting time varies, according to circumstances, from the third to the seventh year from the time of sowing. It is harvested by pulling instead of cutting, and new shoots come up from the old roots left in the ground; moreover, seed dropped germinates naturally, and plants do not need to be transplanted again. The product from 1 acre of land is estimated at about 500 or at most 700 kilograms of the raw bark. The bark is at once stripped on the farm, for if the stems become dry the fibers are difficult to get out, and scraping the coarse outer bark should be done while the stems contain some moisture. In performing the latter operation, the raw bark is steeped in water and scraped carefully with a knife, and then washed thoroughly with water to free it from adhering matters, and dried perfectly by hanging on bamboo poles. (Cat. Agl. Products of Japan, W. C. E., 1893.)

Wikstroemia viridiflora.

NATIVE NAMES.—The *Akia* of Hawaii; *Orao* of the Tahitians; *Mati* of the Vitians; the *Sinu mataivi* of the Fiji Islanders.

A treelike shrub, 2 to 4 feet, found in the valleys of all the Hawaiian group, and also in the Fiji, Society, and Viti islands, eastern Australia.

BAST FIBER.—Derived from the bark. The bark is extremely tough, but is easily separated. The fiber obtained is used for making rough native cordage, nets, fish lines, etc. Hillebrand does not mention the species economically, but the U. S. Nat. Mus. contains specimens of rope and twine prepared by the Hawaiians from its bark under the name *W. foetida.* (Rept. Nat. Mus., 1890.)

Wild cotton of Natal. *Ipomœa gerrardi* (according to Bernardin).

Wild hemp. *Maoutia puya.*

Wild Ipecacuanha. *Asclepias curassavica.*

Wild mahoe. *Malvaviscus arboreus.*

Wild okra. *Malachra capitata.*

Wild pineapple (W. Ind.). *Bromelia pinguin.*

Wild rice. *Zizania aquatica.*

Willow, Species of (see *Salix*).

Willow herb. *Epilobium angustifolium.*

Wina (Br. Guian.). Probably *Lecythis* (Ernst), which see.

Wine palm of Para (Braz.). *Mauritia vinifera.*

Wissadula rostrata (see *Abutilon periplocifolium.*)

Wistaria chinensis.

A genus of leguminous plants found in Japan, China, and North America. *W. frutescens* is a well-known climber with conspicuous flowers. Cultivated on trellises and walls in this country. *W. chinensis* is stated, on the authority of Savorgnan, to yield a fiber, in Italy, which is very white and fine, and which may serve for light textures.

The revised name of this genus is *Kraunhia.*

Wood reed grass. *Epicampes rigens.*

Woodwardia radicans. THE CHAIN FERN.

A genus of *Filices* represented in many portions of the globe, the above species occurring on the Pacific Coast.

STRUCTURAL FIBER.—This fern has two long stalks, each containing two fibro-vascular bundles, in the shape of large, flattened brown threads, tough and flexible. While still fresh the stalks are bruised and pounded so as to liberate the threads, which are then cleaned and stained in an infusion of alder bark. These threads become brittle in drying and must be used moist. (*Dr. V. Havard.*)

An allied species, *Sadleria cyatheoides*, which is common on all the Hawaiian Islands, is another fiber fern. "The soft, curly, hair-like scales are gathered for the same purpose as the hairs of *Cibotium*, and are called *pulu amamau.* In former times the stipites, macerated in water, were beaten together with the bast of '*mamake*' or '*wauke*,' to serve as a sizing, perhaps also to impart a reddish dye, in the manufacture of 'kapa' or native cloth." (*Hillebrand.*) See also *Adiantum.*

Woody fiber (see Classification in the Introduction, page 25).

Wrack grass (U. S. and Europe). *Zostera marina.*

Wuckoo (Ind.). *Crotalaria juncea.*

Wügsi (Hopi.). *Muhlenbergia pungens.*

Xanthorrhœa australis. RESIN GRASS TREE.

Endogen. *Liliaceæ.* Palm-like tree.

The species of *Xanthorrhœa* are known to the natives of Australia as black boy or grass gum trees. Most of the species have thick trunks, though in some the trunk is quite short. Two species yield forms of resin.

STRUCTURAL FIBER.—*X. australis* is mentioned by Dr. Guilfoyle as a fiber plant. "A small percentage of silky fiber can be extracted, which probably is of little value, although the trunk yields a fragrant resin, which has been used as a varnish, for dyeing purposes, and in the manufacture of lacquer for tinware. It also affords a large percentage of wood spirit." *X. longifolia* is the dwarf grass tree of Victoria, native tussock grass or mat rush of Dr. Guilfoyle's list.

Xerophyllum tenax.

Endogen. *Liliaceæ.*

Coast Range, Monterey to British Columbia; also Sierra Nevadas. This liliaceous plant has very stiff, slender leaves, that are admirably adapted for plaiting.

Structural Fiber.—"The plant is useful to the natives. Out of its very tenacious leaves they weave the water-tight baskets which they use for cooking their victuals in." (*F. Pursh.*) "Its slender leaves, 2 to 3 feet long, are strong, tough, and flexible; they do not contain separable textile fibers, but are largely used by Indians for the finer grades of their basketwork." (*Dr. V. Havard*). An allied species is found on the Atlantic Coast, but it is not known to have been used economically.

Xerotes longifolia.

Endogen. *Juncaceæ.* A perennial rush.

Common names.—Tussock grass; Australian mat rush.

Coast of Australia; especially common in Victoria in dry, open sand localities, where it covers miles of country.

Structural Fiber.—"It is reckoned as the best indigenous substitute for Esparto for paper making" (Spon). The culms are used by the Yarra tribe of southeastern Australia for manufacturing baskets. The Kew Museum Guide notes a dilly bag made from the culms of the *Boombi* (*X. multiflora*) in New South Wales.

Xtuc (Mex.). Fiber of *Yucca.*

Xylopia sericea. The Pindayba or Malaguete.

Exogen. *Anonaceæ.* A tree.

The species included in this genus are South American trees or shrubs, several of which are found in Brazil and a few in the West Indies. They are noted for the bitterness of the wood and for the aromatic properties of their fruit and seed.

Bast Fiber.—The fiber of the species named, if so it may be called, is of the coarsest description and consists only of the cortical layers of bark, which are torn from the trees in ribbon-like strips. These have no use that can be dignified by the name of manufacture, and are only rudely twisted or plaited by the natives into a kind of coarse cordage, which is used to tie fences and sometimes to secure cattle. A sample of this coarsely twisted rope was received from Brazil (Phil. Int. Exh., 1876), and is a little more than half an inch in diameter, composed of three strands, each of which contains about nine or ten of these ribbons or strips of bast, the interior ones being quite harsh and woody. Doubtless, in skilled hands, finer specimens of cordage might be produced, though, strictly speaking, it does not possess fibrous material. It would be available for mats.

* *Specimens.*—Mus. U. S. Dept. Ag., and Bot. Mus. Harv. Univ.; labeled *Embirama.*

Xylopia frutescens is another Brazilian species, which furnishes a fiber that has been used for similar rough cordage. It is a native of Cayenne. *X. grandiflora,* also found in Brazil, is known in Sao Paulo as *Embira branca.* "The wood of this tree is highly esteemed, and from its bark is drawn a fiber which is strong and from which nets are made." It is also called the *Pindahyba* or thorn tree.

Xylostroma giganteum.

This is the sterile *mycelium* of some *Hymenomycete.* It is found in trunks of trees or logs, where it may form large masses, and sometimes between boards in lumber piles, where it forms sheets perhaps a foot in breadth and several feet long. It is very similar to white or soiled kid leather, and makes excellent razor-strop material, probably requiring no preparation beyond care in the selection of suitably soft pieces. (*B. T. Galloway.*)

Yachan (Arg.). *Chorisia speciosa.*

Yagua-yagua or **Huitoc** (Peru). *Genipa americana.* (Dorca's list.)

Orton gives *Yagua* as the common name of a species of *Attalea.*

Yaka fiber (Fiji Is.). *Pachyrhizus angulatus.*

Yashqui and **Yaxci** (Mex.). See *Agave rigida.*

Yatay-pony (Arg.) See *Diplothemium.*

Yaxche (Mex.). *Bombax ceiba.*

Yercum (Ind.). *Calotropis gigantea.*

Yolba (Andam. Is.). See *Anadendrum.*

Youn-padi-sí (Burm.). *Hibiscus esculentus.*

Ysote (Mex.). Yucca.

This name has been given both to *Yucca aloifolia* and *Y. filamentosa.*

Yucca spp.

Endogens. *Liliaceæ.* Shrubs with clustered ensiform leaves.

The species of this genus are chiefly natives of the southern United States and Mexico, though many of them have been distributed to Europe, Africa, India, and Australia, and several are found in the West Indies, Central and South America. Some are familiar ornamental plants, and are quite hardy. One species, *Y. filamentosa,* finds its way into our gardens even in more northern sections of the country, and is conspicuous in the blooming season for its large, white, lily-like flowers, as well as for its long, sword-shaped leaves, each terminating in a sharp point. The species of Yucca flourish on the poorest soils. Probably no other leaf fiber has so often been the subject of correspondence with the Department, and but for the short length of the fiber it would doubtless have come into commercial use long ago. The important species of Yucca growing in the United States are *Yucca aloifolia, Y. baccata, Y. filamentosa, Y. glauca,* and *Y. gloriosa.* These are variously known as dagger plants, Adam's needle, bear grass, spanish bayonet, dwarf palmetto. etc., the Mexican general name for the group being *Palmea.*

There are no records to show that these structural fibers have ever been employed otherwise than experimentally in this country, if we except the limited use made of the fiber by Indians and Mexicans of Arizona or Sonora, in manufactures, at the present day; and there are no records, save the relics from the mounds of burial places of the ancient inhabitants of North America, to show how long the fiber of Yucca has been used in the rude domestic economy of these people. Sandals, mats, etc., from the burial mounds show fiber or leaves which undoubtedly have been derived from Yucca, and possibly *Y. glauca, Y. elata,* or allied narrow-leaved forms. We know that *Yucca glauca* is largely used by the Arizona Indians in basketry, etc., and *Y. baccata* and similar species have been employed by different tribes for ropes and cordage. The uses of these fibers by our farmers, and the records of their experimental application to the useful arts, are noted under the names of botanical species, which follow in alphabetical order.

A few of the less important species, which should be mentioned, are: *Yucca arborescens* (see Plate XI), the tree-like California desert form, regarding which Spon states that "existing supplies of the plant are being rapidly consumed for paper making," though no American citation can be given showing that this unwieldly source of fiber is utilized commercially, excepting the statement by William Trealease that, some years since, the proprietors of an English newspaper established a mill in the home of one of the three *Yuccas,* intending to make paper pulp from its wood, but the enterprise was shortly abandoned. Kew has examples of its fiber taken from the trunk. *Y. treculeana* should also be mentioned, the species having been sent to the Department from Texas and New Mexico, the large leaves of which would work readily on the sisal hemp machines. Dr. Havard states that it yields a good fiber, somewhat similar to that from *Y. baccata.* Among other species of Yucca, William Trelease names *Y. guatemalensis, Y. australis,* and *Y. rupicola,* a Texan species, besides several varieties of common species which need not be referred to in this catalogue.

The economic literature of the Yuccas of Mexico is badly confused, as far as the botanical nomenclature is concerned. It is learned, however, that several species, such as *Y. aloifolia, Y. filamentosa, Y. gloriosa, Y. glauca,* and *Y. treculeana,* are regarded as fiber plants in the interior, and in some instances the attempt has been made to produce fiber from them commercially. In preparing the fiber the leaves are thrown into barrels of hot water, brought to the boiling point, after which they are crushed between two cylinders to remove extraneous matters. The crushed mass is then placed upon hurdles, in such manner that the fibers may be kept straight and separate. The hurdles are then let down into an alkaline bath heated to the boiling point. This is composed of ashes and water, 45 pounds of the former to 121 gallons of the latter. The leaves remain in this solution four hours, though good judgment is necessary that the leaves may be neither over nor underheated. After taking out of the bath the fibers are washed, dried, and combed, the result being a delicate, strong, lustrous, and white fiber, which is known as *Xtuc.* (Condensed from La Revista Agricola, Vol. V, p.194.)

Yucca fiber possesses a moderate tenacity, but is somewhat brittle, and can not be made to lose its harshness. The filaments of Yucca are described as white in color, brilliant, and stiff, composed of irregular bundles, the most of which are large. By rubbing briskly between the fingers the bundles break up into finer fibers, but always preserving a great deal of stiffness. The walls are usually thick and the central cavity very apparent. The ends grow slender regularly, and are rounded at the extremity.

Yucca aloifolia.

Common names.—Aloe-leaved Adam's needle (Victoria); Spanish needle (Trin.); dagger plant (W. Ind.); Spanish bayonet (Fla.). *Ysote* (Mex.).

This species abounds in southern Florida, in thickets of wild vegetation near the coast. Found in many portions of tropical America, southern Europe (as an ornamental plant), North and South America, Australia, etc.

Structural Fiber.—From the Australian collections (Phil. Int. Exh., 1876) the Department secured examples of *Y. aloifolia,* the aloe-leaved Adam's needle, prepared by Dr. Guilfoyle, who stated that, though a native of South America, it succeeds admirably in Victoria, and is of moderately quick growth.

A. aloifolia abounds in Florida wherever the false sisal is found. Sometimes the tracts of this species extend for miles along the coast in broken patches or clumps, the masses of bud leaves often rearing aloft their spiked crowns a dozen feet from the ground. The leaves of this species are too difficult to secure, and too short when secured, to ever prove valuable for fiber production. It produces a fair quality of fiber, however. About 40 pounds of leaves cut on Sands Key and passed through the machine gave a product of about 1 pound of dry fiber, not over 12 to 15 inches long, or the equivalent of 56 pounds to the ton of leaves. This would not pay commercially, as the yield is low for an inferior fiber. Pineapple fiber with the same yield would be three or four times as valuable, while the leaves could be gathered for one-fourth the cost.

**Specimens.*—Mus. U. S. Dept. Ag.; Field Col. Mus.

Yucca baccata.

High table-lands between the Rio Grande and the Gila, New Mexico, also California, Nevada, Utah; western Texas to southern Colorado. (See fig. 2, Pl. XII, an allied species.)

Employed by the Hopi Indians of Arizona for basketry, the name of the plant being *Samóa*, the edible fruit, *sahü*, and the soapy root *Samomobi*. (*Fewkes.*)

Structural Fiber.—Both the leaves and the root of this species yield fiber that has been employed by the Indians. The Museum collection contains several examples of the fibrous root and prepared fiber from it; also cordage, the most interesting example being a coil of half-inch rope from New Mexico. The fiber is coarse and wiry, but shows great strength. "The leaves yield an excellent fiber, long, white, glossy, strong and very durable, but stiff. Were it possible to prepare it economically, almost an inexhaustible supply could be obtained from this and the allied *Y. macrocarpa* in the arid regions of the southwest. Specially useful for brushes, mats, bagging, hammocks, saddle blankets, paper, etc. The parenchyma or pith obtained in the process of separating fibers is highly valued for washing purposes, probably containing saponin (as in root) and having marked detergent qualities." (*Dr. V. Havard.*)

The fiber of the leaves being strong, long, and durable, are adapted for Indian manufactures, and the savages of southern California make therefrom excellent horse blankets. All the tribes living in the country where this plant is found use it to make ropes, twine, nets, hair brushes, shoes, and mattresses. The Diegeno Indians of southern California have brought the uses of this plant to notice by the various articles they make from its fibers and sell to white settlers. In preparing a warp for the manufacture of saddle blankets it is first loosely twisted then, when wanted, it receives a firmer twist. If the blanket is to be ornamented a part of the warp during the first process is dyed a claret brown, oak bark being used for that purpose. The loom in use among the Indians of to-day is original with themselves, and not borrowed, as some suppose, from the Spaniards. It is a simple affair, consisting of two round, strong, short poles, one suspended and the other fastened to the ground. Upon these is arranged the warp. Two long wooden needles with eyes are threaded with the filling, which is more loosely twisted than the warp, in order to give substance or body to the blanket. Each time that the filling is thrust between the threads of the warp by one hand the Indian female, with a long, wide, wooden implement in the other hand, beats it into place. This tool resembles a carving knife, but is much larger and longer. One edge is thin, and in this is made a number of teeth or notches not so sharp as to cut. This plant, so fibrous and so abundant on land utterly worthless for the growth of anything more valuable, can be had for the gathering; and as paper materials are scarce, either alone or mixed with straw, would be valuable in the manufacture of that article. (*Dr. E. Palmer.*)

Yucca filamentosa. Bear Grass.

Common names.—Adam's needle; Eve's thread; silk grass (erroneously); bear grass; thready Adam's needle of Australia.

This is the common species of *Yucca* of the Southern States. Hardy as far north as New England. It has also been distributed to other portions of the world. Fig. 1, Pl. XII, is the bear grass of the Southern States, photographed from a plant in the grounds of the United States Department of Agriculture.

Structural Fiber.—The name bear grass should belong distinctively to the fiber of this species. Bear grass is used all over the South in a rude way as a "tie plant," the twisted leaves being employed for hanging hams and in other similar uses.

Bear grass grows on our poorest sand hills, and is considered quite a pest when the land on which it is found is cultivated for any of our crops. It is hard to destroy; is propagated either by seed or by the roots. The roots when cut will sprout and put up new plants, so an attempt to destroy it often increases the growth and causes it to spread. It is evidently benefited by the effort to destroy it in cultivating other crops. It is used by farmers for strings to hang up bacon, and sometimes for other purposes. It is prepared for this use by scalding in hot water. It is very strong and durable and has been used to make cords, and would be used more if some process could be invented to convert it into rope without the aid of machinery, and cheap enough to be in reach of the ordinary farmer. (*E. N. Robeson.*)

ECONOMIC CONSIDERATIONS.—Twenty years ago this fiber had attracted serious attention in the South, and at that time fine specimens and a rough fabric resembling matting were sent to the Department from Mr. Stoner, of Stonypoint, La., who patented a machine for the extraction of *Yucca* fiber. After passing through the machine the "mashed" leaves were subjected to "a thorough system of washing," which left the fiber "as white as Irish linen." Notwithstanding the efforts of Mr. Stoner, the industry did not succeed.

Further experiments were made by Walter T. Forbes in 1890, and it was claimed that 85 per cent of pure fiber could be secured at very low cost. In 1893 a quantity of the leaves of this plant were secured by the Department in Georgia and sent to J. C. Todd, Paterson, N. J., to be cleaned on the Todd sisal hemp machine. The cleaning was successfully accomplished, and a supply of the fiber was thus obtained sufficient for examination and for testing. This fiber was very dark, yellowish in color, harsh, and somewhat brittle. The result of a number of tests with this fiber, twisted by hand to the size of binding twine, showed a breakage strain varying from 45 to 55 pounds, which is about half the strength of Kentucky hemp. This should not be regarded, however, as an authoritative test, as such a trial should be made with machine-manufactured twine to be comparative. However, the fiber will doubtless be found inferior in strength to any of the commercial cordage fibers now in use, and quite inferior to manila and common hemp.

If the plant could be grown over an area sufficiently large to supply the amount of fiber needed to cover or wrap our cotton, it might be used to make a better wrapping than jute. Bear grass might be given a trial for this purpose. While it has been accepted that fiber under 2½ feet in length can not be advantageously used by manufacturers, Mr. Todd states that a shorter cordage fiber can be worked, though possibly not on all forms of machinery. The question of the cost of gathering the leaves and of extracting the fiber may need to be investigated before an attempt is made to establish a bear grass fiber industry. Regarding the extent of supply of leaves, it would seem to be almost inexhaustible, as large wild tracts of the plants are found in many of the Southern and Western States, and special cultivation would not be necessary, as the leaves are reproduced rapidly after cutting. The Georgia leaves cleaned by Mr. Todd in December, 1892, were received from John T. Haunson, Longview, Ga., who states that they had grown since July of that year.

In Bernardin's list I find *Yucca filamentosa* is also called *henequen* (*Agave rigida*, etc.), from which it may be inferred that the Yucca has been regarded to a certain extent a commercial fiber, probably exported with the sisal fiber under the one name, henequen, just as *Cannabis sativa* is sometimes exported from India with *Crotalaria juncea*, under the name sunn. "It seems certain that in the cargoes of Pita which arrive at the markets of Europe there is found a proportion, more or less considerable, of Yucca fiber. It is difficult to distinguish the one from the other, and it is adaptable to the same uses." (*Vétillart.*) The species referred to is not known, but it is not *Y. filamentosa*, for the color of this fiber and of "*Pita*," doubtless *Agave americana*, are so unlike that the fraud would have been detected at a glance.

**Specimens.*—Mus. U. S. Dept. Ag.; Field Col. Mus.; U. S. Nat. Mus.

Yucca gloriosa.

COMMON NAMES.—Adam's needle (U. S.); mound lily (Austr.); *Petre* hemp (Sp.) (the latter name valueless).

The species is common in the Carolinas, Georgia, Florida, and the southeastern coast to Texas; not noted by the author in southern Florida. Introduced in other countries, as Africa and India. Fiber similar to that from *Y. filamentosa.*

Yucca glauca.

Syn. *Y. angustifolia.*

HOPI INDIAN NAME, *Mohü.* Its soapy root *mohu-mobi.* (*Fewkes.*)

Southwestern United States, Arizona, and Mexico, extending northward to Montana.

STRUCTURAL FIBER.—Dr. Palmer says of this species, "The leaves yield the softest fiber of all the Yuccas." A very good fiber is extracted from this species which is capable of employment in general cordage. The specimens in the Museum came from San Diego, Cal. The Kew Mus. shows a series of the fibers of both *Y. glauca* and *Y. gloriosa.* "All the Yucca plants are used for basketry and other purposes." (*Fewkes.*) This species is largely used by the Indians of the regions where it grows, and particularly by the Moquis, Zuñis, etc., for basketry of all kinds, horse bridles and halters, and rude cordage. In basket manufacture the leaves are either used entire or are split, sometimes even to the fineness of grass fiber, and woven in connection with the peeled twigs of other plants, grasses, etc. In the manufacture of coil baskets by the Hopi Indians, which have the appearance that would be presented by coiling a half-inch rope into the form of a shallow tray, a common grass *Hilaria jamesii* (see) is used for the center of the "rope," this being wrapped round and round, as the coil is being made, with narrow strips of the leaves of this Yucca, the whole when knit together forming a strong and very ornamental basket, as the leaf strips are dyed in different colors. Simpler forms of bowls, trays, and baskets are made from the entire leaves by plain weaving, mat fashion, using the broad bases of the leaves, which are turned over the edge of the basket, for a finish. The natural yellow color of the leaves, showing white where the leaf is split, makes an attractive article. The U. S. Nat. Mus. has a large series of basketry from *Y. glauca,* as well as many other objects.

* *Specimens.*—Fiber, Mus. U. S. Dept. Ag.; U. S. Nat. Mus.

Yucca elata is another narrow-leaved species, found in New Mexico and along the more northerly range of *Y. glauca,* the leaves of which closely resemble that species, though they are whiter in color and more brittle. The edges of the leaves are also filamentous. No reference to its use as a fiber plant can be cited.

Yucca whipplei.

This is another Californian species of Yucca, samples of fiber and cordage of which have been received, collected by Dr. E. Palmer, who states that the leaves yield a very soft white fiber, which is capable of being made into very nice thread. Indians use this fiber to form a padding for their horse blankets, the outer part of which, being made of the fiber from the *Yucca baccata,* is very rough. A wooden needle is threaded with twine made from the same fiber, and the lining is firmly quilted to the saddle blanket, forming a soft covering, without which it would injure the animal's back.

Yute (Peru) = Jute. *Corchorus.*

Zaghú and Zaghir (Pers.). Ziggar (Turk.). *Linum usitatissimum.*

Zasmidium cellare (see under *Fomes*).

Zea mays. INDIAN CORN.

Endogen. *Gramineæ.* A giant grass.

COMMON AND NATIVE NAMES.—Indian corn, corn, maize (Eng.); *Maïs* (Fr.); *Mais* and *Turkischkorn* (Ger.); *Trigo de Indas,* etc. (Sp.); *Durah-shámi* (Arab.); *Guadumemakkah* (Pers.); *Cholam* (Malay); *Bulta,* Junri, *Makka, Makkajári,* etc. (Ind.). (*Makkai,* = "Mecca," or "Mecca corn.")

Native America; cultivated from a remote antiquity by the Peruvians and Mexicans; unknown to Europe prior to the discovery of America. Cultivated throughout the world, chiefly as food for both man and animals.

The many varieties differ much in the form, size, color, and hardness of the grain, and in the time required for ripening. Husk maize, in which the kernels are separately enveloped in broad, herbaceous glumes, may approach the native form, which doubtless had its origin in tropical America. *Mais de coyote,* regarded by some as a distinct species, is said to grow wild in some parts of Mexico. Aside from its great value as a cereal, ordinary field corn is the best of the annual forage plants for soiling, and is also valued and used by many farmers for ensilage, being cut for this purpose when the kernels commence to glaze. (*F. Lamson-Scribner.*)

STRUCTURAL FIBER.—The husks or *spathes* inclosing the ears of maize have been used in various ways in many countries: (1) As a fiber for yarns, for crash; (2) for plaiting, like many of the reeds; (3) for filling mattresses and in upholstery, and, lastly, (4) for making paper. "There is a record of two maize-paper establishments existing in Italy in the eighteenth century." (*J. R. Dodge.*)

ECONOMIC CONSIDERATIONS.—The commercial industry belongs chiefly to Germany, Austria, and Hungary, though a patent for a maize-paper process was issued by the United States in the beginning of the present century to John Harkins, of New Jersey, in 1802; another was issued in 1838 to Homer Holland, of Massachusetts, and in 1860 a patent was issued for making paper pulp of corncobs. Among the first serious experiments in manufacturing paper from maize were those made just prior to 1860 by Moritz Diamant, a Bohemian, who suggested to Baron Bruck, Austrian minister of finances, a process for making paper from maize. The imperial paper mill at Schlögelmuhl, near Gloggnitz, undertook the manufacture, under Diamant's direction; the product was not quite satisfactory either in quality or cost of manufacture. His first application for Government aid was in 1856. After the unsuccessful experiment, followed by effectual efforts to induce private individuals to continue the work, he made a second request of the minister of finance, fortified with recommendations from judicious, practical men, and the experiments were continued, but were not yet fully successful. To reduce the cost, a "half-stuff factory" was erected in a maize district, designed to cut off the heavy expense of transportation of the crude material. The product was so inferior that Diamant became disheartened, absented himself, and was released from his position, leaving the question unsolved. The cost of this experiment was about $13,000, which had been advanced by the imperial paper mill. The direction of the Schlögelmuhl paper mill, not disposed to discontinue the effort to make a good and cheap paper, continued the experiments, aiming first to reduce the cost of production, and, secondly, to investigate the cost of using only the finest husks inclosing the ear, rather than the leaves of the stalk entire. The result was, if not a material for paper cheap as rags, the discovery of a new fiber capable of being spun and woven, and furnishing, in its waste, a cheap paper. Specimens resulting from these Austrian experiments were sent to the United States Department of Agriculture. Among them were yarns, to be used as a substitute for flax in crash, and oilcloth made from it, with a variety of papers, including "Royal Chancery," letter paper, flower paper, cigarette paper, silk paper, and drawing paper, ranging in price from $1.60 to $4.80 per ream.

The progress made in perfecting the manufacture of paper has of late been very satisfactory. Evidence of this is abundantly afforded in the specimens recently received at the Department from Dr. Chevalier Auer de Welsbach, director of the imperial printing establishment at Vienna and superintendent of the imperial paper mills at Schlögelmuhl, who had been unremitting in his efforts, which have been crowned with a large measure of success. Among these papers are found parchment and document papers of great strength and durability; tracing paper of superior tenacity and transparency, an effect of the natural gluten of the husks, rendering unnecessary the present expensive process of its manufacture and supplying draftsmen with the cheapest material known; letter paper in various styles and in several colors, with a smooth and polished but soft surface, which takes the ink kindly; "chancery papers" of great variety in size, very heavy and durable; beautiful silk paper of several colors, of wonderful delicacy in structure and finish; paper for the manufacture of artificial flowers, in lilac, rose, blue, green, and brown, gossamer-like yet strong, weighing but 6 pounds to the ream; and cigarette paper, but little heavier, weighing but 7 pounds to the ream. Of most varieties both machine and hand papers are produced. A peculiarity of this paper, due to the large proportion of gluten it contains, is worthy of mention. Placed with common paper in water, and left to soak until the latter will fall to pieces by its own weight, the maize paper on trial seems nearly or quite as tenacious as ever. The process of manufacture is claimed to be simple; the humblest laborer can readily understand it with little instruction and practice it with success. The cost of the husks (and it seems that leaves are to some extent included) is from 32 to 56 cents per 125 English pounds (per centner), or $9 per ton at the higher price, which represents more the labor of gathering than the value of the material. This is, of course, in the locality of their production. The cost of extracting the fiber from 100,000 centners (6,250 tons) is estimated: For coal and other material, $15,705; labor, $6,400; interest and loss, $4,296; raw material, including local freight, $80,000; total, $106,401. To this add for laborers and repairs to swell the total to $109,496. The product is 10 per cent of spinning fiber, 19 per cent of paper stuff, and 11 per cent of feed stuff, or 40 per cent in all, leaving a loss of 60 per cent. The spinning stuff is worth $64,000; paper material, $72,200; feed stuff, $15,400; total, $151,600. Deducting the expenses of manufacturing, a profit of $42,104 is shown. (*J. R. Dodge.*)

The use of maize husks in the United States is largely as upholstery material in the manufacture of mattresses, and for similar uses. Horse collars are made of the husks or "shucks" in the South; door mats are also made in some of the Northern States, these being very serviceable. The husks split into strips are also employed in Florida in the manufacture of "chip-hats" which, when properly trimmed, are both stylish and pretty. These are sold in the Florida bazaars.

Some of the Indian tribes of the West, according to Dr. Fewkes, use the maize husks for plaiting into food trays. The Moqui tribes are expert weavers of these trays or utensils.

The Kew Mus. maize collections contain a South African door mat made from husks, and a hat from Jamaica from the same material.

The prepared pith of the stalk of corn is also made into many forms of pottery, which sell for high prices in the Florida bazaars. Some of these, tinted in delicate colors—greens and grays—are exquisite decorative novelties for the drawing room.

Cellulose.—An interesting use of the cellulose of maize stalks, or corn pith, is recorded in a recent paper by H. W. Cramp, read before the American Society of Naval Architects and Mining Engineers, December 11, 1896. The corn-pith cellulose is employed as a packing material in the cofferdams in connection with the armor plating of United States war vessels. The corn pith is suitably cleaned and pressed into blocks when it is ready to use. "A cellulose belt of 3 feet may be said to be as efficient as 6 inches of best steel." Experiments have shown that there is no danger of the substance being washed out through shot holes by the action of the sea, and it is considered better in many ways than other substances, such as cocoa fiber, which have also been used. Coir fiber, employed as packing, has been ignited, while corn pith has proved incombustible. A special advantage results from its great absorbtion of water, whereby a shot hole is soon filled up through the swelling of the corn pith packing.

While this work is going through the press, the following statement regarding the preparation and uses of cellulose has been received from Mr. Henry C. Watts, of the Marsden Company, Philadelphia, accompanied by a series of specimens. These form a part of the exhibit of this Department in the Government Building at the Tennessee Centennial Exposition of 1897.

The stalk, when taken from the field in October, or later, is delivered to the central factories, where it is submitted to a continuous process, yielding two distinct products, one of value to the purchaser of live stock, the other indispensable to the applied arts. The first product, "live stock food," is the result of the complete separation of the outside shell or envelope from the inner pithy portion of the plant. This separation is made by a machine that performs its work perfectly, cheaply, and with a yield of about 10 tons per day. The product from this process consists of particles varying in size from one-half to 3 inches in length. This is automatically delivered to a grinding mill and there reduced to a meal. This meal is the finished food, free—by reason of its having been subjected during the manufacture to a comparatively high temperature—from moisture and all bacillic impurities, and showing, both by analysis and actual feeding tests, a higher percentage of flesh-producing ingredients than any other fodder. This product alone gives a value to the cornstalk that at once removes it from the list of waste products. The other product, from the central pithy portions of the plant, is separated in the same machine as the above in the form of granules of varying sizes. This product is an agglomeration of cellular tissue free from sap and other impurities. This gives a natural pure cellulose, easily and cheaply produced from an inexhaustible supply. This cellulose contains the same elements that cotton or wood cellulose contains, but to a higher degree of perfection, as in a natural product there are no extraneous matters to be eliminated. The application of cellulose in the arts and manufactures has been limited to a few substances, such as paper, celluloid, etc. The newer uses are as yet mostly in the experimental stage, but enough has already been demonstrated to warrant the statement that this source of cellulose will make possible the practical production of many articles that have heretofore been only laboratory experiments. That the field is large will be appreciated when it is stated that 200 practical applications of cellulose have already been enumerated. Cellulose from this source, by reason of its quantity and quality, broadens the field of application and places on the raw cornstalk an incalculable value.

The following applications of corn-pith cellulose have already been made and are now in active use: Packing for battle ships, use in the manufacture of a floor covering superior to linoleum, paper pulp, mattresses, horse collars, viscose, nitrates, insulation for refrigerator cars, steam pipe and boiler covering, dry cells for electric storage batteries, and Marsden's New Corn Product (cattle food)—the refuse and epidermis.

* *Specimens.*—Mus. U. S. Dept. Ag. Large series of maize products.

Zebra plant. (See *Calathea zebrina*).

Ziggar (Turk.). *Linum usitatissimum.*

Zizania aquatica.

Endogen. *Gramineæ.* An annual aquatic grass.

Common names.—Indian rice, wild rice, water rice, tuscarora rice, water oats, reed.

This tall, erect, annual, 3 to 10 feet high, grows in shallow water along rivers and lakes from Canada southward to Florida and westward to Texas. It grows very rapidly in 1 to 8 feet of water, and matures its seeds in August or early in September. This grass is abundant in the tide waters of the rivers of the Middle States, notably in the Delaware below Philadelphia, where it is always designated as "the reeds." The stems are used by coopers for making the joints of barrels intended to hold whisky or petroleum perfectly tight. This grass is the *Manorrin* of the Chippewa Indians, who gather the grain for food. (*F. Lamson-Scribner.*)

Zostera marina. Grass Wrack, or Sea Wrack.

This is an aquatic or marine herb, belonging to the *Naiadaceæ.* "They are submerged fresh or salt water plants, found in most parts of the world; they are of little economic value" (Guide Kew Mus.). Two species of the genus are indigenous to Britain but occur in other parts of the world, from Ireland south to the Cape of Good Hope, Tasmania, and New Zealand. It is also found in the United States.

Pseudo-fiber.—The common sea wrack has leaves varying from 1 to several feet in length, and rarely more than a quarter of an inch broad. These are commonly used for packing, and by upholsterers for stuffing mattresses and cushions, being sold for that purpose under the names of *Ulva marina* or *Alva marina.* They contain a small amount of iodine, and a considerable quantity of potash. (*A. Smith.*)

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APPENDIX A.

BRIEF STATEMENTS REGARDING FIBER MACHINERY.

In countries like the United States, where the rates of wages are on so different a plane from the prices paid for labor in countries like China and India, the success of new fiber industries is largely dependent upon mechanical means for extracting the raw product after the crop has been grown.

Cotton cultivation in the United States only began to be extended after the invention of the Whitney cotton gin, and in like manner the establishment of the sisal hemp industry outside of Yucatan has only been possible since two or three improved automatic machines for separating the fiber have been placed on the market.

The production of China grass or ramie in many countries is so dependent upon the settlement of the machine question that not a pound of commercial fiber is produced in these countries, although, as in the American Gulf States, the plant thrives in the proper soils, and the machine question has been before the people for thirty years. What is true of the cotton, the sisal hemp, and the ramie industries is true of other possible American fiber industries, not excepting the production of hemp and flax, the fiber of which the perfecting of several special machines would largely aid in extracting.

In China the fiber of Boehmeria is extracted by hand, and the partially degummed "grass" can be laid down in New York City at 6 cents per pound. In India the bast of jute is thrashed off by the ryot who stands waist deep in a pool of stagnant water, and it can be sold in New York at 3 cents per pound. American farmers, who are used to the finest agricultural implements that can be procured will never resort to Old World primitive methods—nor can they afford to do so—and the machine becomes the most important factor in the problem.

On these pages it is not possible to give a detailed account of the vast number of fiber machines that have been brought to public notice during the past fifty years, or even to enumerate them, and, therefore, general statements only can be made.

FLAX MACHINERY.

It is a little surprising in this age of invention that the machine used for scutching flax in many countries to-day, if machine it may be called, is older than the invention of the steam engine by Watt. The scutching mills in Belgium, visited by the writer, were supplied with this appliance. Through the rooms, from end to end, runs a wrought-iron shaft to which are attached, at intervals of a few feet, systems of wooden beater blades, which revolve rapidly.

The workmen stand in small compartments partitioned off from the room, but open on one side, the flax being presented to the action of the wooden blades through a bevel-edged slit in the side of the partition. The blades as they revolve strike the already broken flax, held firmly in the hand, knocking out the shive or waste matter, when the opposite end is cleaned in the same manner. The accompanying illustration, from Spon, will explain the device. See fig. 103; *a* is the shaft; *b* the supporting pillars of iron or wood; *c* the wiper ring, to which the blades *d* are attached; *e* is the partition; *f* the bracket at top, by which it is stayed to the beam *g*, which connects the line of pillars; *h* is the opening through which the flax is presented to the blades. These blades are sometimes long and narrow, somewhat resembling the blade of an oar.

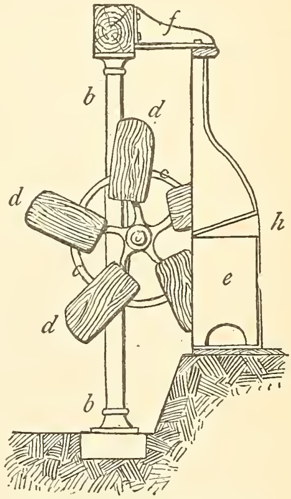


FIG. 103.—Flax scutching device.

The fiber of flax surrounds a slender stem, straw-like or sometimes woody, which, by retting, is easily broken, and the filaments partially separating from the crushed bits are readily freed from them by the operation of beating. A perfect machine, therefore, would be one that would break the straw or wood into fragments without injury to the fiber, separate the long filaments from all waste matters perfectly, doing away with hand labor, and accomplishing the work without waste of fiber and at economical cost. It would seem a simple proposition, but from the fact that none of the many improved machines that have been brought to public notice have been largely adopted by mill men, and the old-fashioned berth scutching described above is still practiced even in this country, we may infer that the machine scutchers are not fully practicable. These differ in form and the manner in which they operate as well as in the quality and quantity of flax produced, but they need not be described here. Machines that the Department has taken cognizance of are described in Fiber Investigations Series, Report No. 1, pages 21 to 26; Report No. 4, same series, page 70; Annual Report, United States Department of Agriculture, 1893, page 578. See also Spon's Encyclopedia, pages 970–975.

An improved scutching machine to prepare the fiber for market is a desideratum, but two other machines are needed in establishing the flax industry in the United States—an economical thrasher to save the seed without injury to the straw, and a flax-pulling machine to do away with the laborious and costly operation of hand pulling. Several machines have been invented in the latter classes, but there is room for improvement in flax thrashers, and the flax-pulling machines are still in the experimental stage (see Annual Report, United States Department of Agriculture, 1893, p. 578, and Report 4, Fiber Investigations Series, Department of Agriculture, pp. 29, 31).

RAMIE DECORTICATION.

It is not important in the limits of this paper to record here the consecutive history of ramie-machine invention in America, particularly as it would necessitate describing almost a score of machines that, one after another, were brought to the attention of the public for a time, only to be practically abandoned when it was proved they were unable to fulfill the claims of their inventors. Since 1867 the persevering effort to produce a satisfactory machine has naturally resulted in a gradual improvement in mechanical construction and substantial progress has been made, though at this date (1896) the question has not been practically settled. Ramie machines may be divided into two classes—(1) delignators, or simple bark strippers, and (2) decorticators, which not only remove the bark but make some pretense of removing the outer pellicle or epidermis and the layer of cellular matter covering the fiber layer proper. The bark strippers produce the fiber in the form of flat ribbons, only the wood of the stalk being eliminated, and they are usually constructed with some form of knife or knives, with which the stalks are split before being subjected to the action of the breakers and beaters. The decorticators usually first crush the stalk by means of metal rollers, presenting the flattened mass to the action of the breaking or beating devices, and frequently there is a system of mechanisms for combing the fiber before it is finally delivered to the aprons. The product of the delignators is always the same, a flat ribbon of bark whether the dry or green systems of decortication have been employed. The product of the decorticators, on the other hand, is almost as variable as the machines which turn out the fiber. In some of the poorer machines this product is little more than a mangled strip of bark, neither a delignated ribbon nor decorticated fiber, but something more fit for the trash heap. In the best of them, individual filaments, by the green system, somewhat resemble China grass, though darker and less clean, while by the dry system the fiber is already soft enough to spin into coarse cordage without further manipulation. Between these two extremes every quality of "ribbon" is represented. Taking China grass, or commercial ramie, as the highest form of the fiber, since it is degummed with a loss in weight of only 15 to 30 per cent, it will readily be seen that the value of the machine-cleaned ribbons to the manufacturers must be in exact ratio to the degree to which the cleaning and freeing from gum have been carried.

We have considered that these varied products, or grades of product, differ only in the degree to which the elimination of the gum and waste matters have been carried, and that the proportion of gum, cellular matter, and epidermis is the only consideration. In point of fact, the product of many machines which otherwise might be called "good fiber" has been so filled with fragments of the woody portion of the stalks, or so "chewed up" by harsh treatment, or, finally, so snarled and tangled in the delivery that it has had little value for any purpose. The product should be delivered straight, unsnarled and untangled, free from chips, and without breaks, cuts, or bruises, whether in the form of stripped bark or semicleaned fiber, and its value will be determined by the percentage of pure fiber it contains. It may be fairly assumed, then, that the nearer a machine approaches in its product the ramie of commerce, Chinese hand-cleaned fiber, the higher the price of its product and the more desirable the device producing it as an economic agricultural implement.

For an account of the machines that have been officially tested by the United States Government, see appendices to Report No. 7, Fiber Investigations Series of the United States Department of Agriculture. See also the work of Félicien Michotte, Paris, in which the principal French and American inventions are described, as well as the chapter on French machines in Report No. 1, Fiber Investigations Series of this Department. Since the publication of Report No. 7 several new American and foreign machines have appeared, but as these have not been tested by the Governments of France, Great Britain, the United States, or other countries no authoritative statements can be made concerning them.

HEMP AND JUTE MACHINERY.

These machines may be classed together, as a successful bast-fiber machine might with slight modification be made to extract either fiber. It has been shown also, in ramie-machine trials, that an unsuccessful ramie machine may prove a fair jute machine, and two machines the Department has tested have worked on the three fibers, hemp, jute, and ramie.

It is claimed that nearly 300 patents have been issued in the United States for machines for breaking hemp, many of which have proved absolute failures, while none of them filled the requirements of an economically successful hemp-cleaning device, the Kentucky hemp grower of to-day relying upon the rude and clumsy five-slatted hand brake of his grandfather's time, a device similar in all respects to that used for the same purpose at the present day by the hemp farmers of Brittany. The French brake is only a slight advance upon that used in this country, being smaller, composed of both wood and metal, and having seven instead of five slats. While a less clumsy affair than the American device, a French workman can not clean with it more than half the quantity of hemp in a day that an average Kentucky negro operator produces on the American brake. Thirty to 35 kilograms of fiber per day is the limit of production for a single brake on a Sarthe farm—equal to 65 or 75 pounds of fiber. It is more carefully prepared, however, being twisted into small "streaks" or loose ropes, a number of these making up a bundle of several kilograms in weight, this being the form in which French hemp goes to market. In Kentucky breaking is an expensive operation, costing $1 to $1.25 per hundred pounds of fiber. The work is performed in the winter by negroes, and the best workers will not average more than 150 pounds in a day. A number of patented machines, possessing more or less merit, have been brought to public notice in the past four or five years, several of which have been examined by the Office of Fiber Investigations. The fact remains, however, that while several of the more recent inventions that have been looked into are "promising," the hemp growers of Kentucky do not consider that a perfectly satisfactory machine is available at the present time. See Report No. 1, Fiber Investigations Series, page 73, and Report No. 8, same series, page 18. See statements also on jute machinery, same report, page 39. The Kentucky hemp brake is figured on page 109 of this work.

LEAF FIBER MACHINES.

Probably a greater degree of success has been achieved in the invention of machines for extracting of the fiber from such fleshy leaved plants as the Agave, etc., than for any other classes of fiber plants. Since the establishment of the Office of Fiber Investigations, several successful machines have been placed on the market which will enable a sisal-hemp grower to market his crops without recourse to the clumsy raspadore used so many years in Yucatan. It is not necessary to enumerate these machines, as they have been fully described in the special reports of the Office of Fiber Investigations, particularly in Nos. 3 and 5. The makers of some of the best of the American machines in this class have, since those reports were published, constructed other machines that are said to clean the leaves of such plants as the pineapple, yucca, etc. A good machine for extracting the fiber from the husk of the cocoanut is included in the category.

COTTON MACHINERY.

The Department has made no special study of the various gins, presses, etc., for baling the crops that are available. Brief statements are made under the title Gossypium, in the body of this work, and reference is also made to The Cotton Plant recently published by the Department of Agriculture. See also Spon's Encyclopedia, noted in list of authorities.

Many other forms of fiber machinery have been devised for employment in the Old World; they have not been studied by the Department, as the fibers are not utilized in this country. Some of them are described in the bulletins of the Royal Gardens, Kew, and in Spon's Encyclopædia, while many are noted in special reports and bulletins that are not readily available to the general public, so that special reference will not be made to them. The Department will always be glad to answer any questions regarding this phase of the fiber subject, as far as possible, upon application for information by letter, and will feel under obligations to correspondents who will send accounts of new machines, confidentially or otherwise.

APPENDIX B.

ON THE IDENTIFICATION OF FIBERS.

By William H. Seaman, M. D.

It is frequently desirable to be able to ascertain the nature of fibers composing textile goods, to detect mixtures, or for some other reason. The fibers employed in the commercial industries naturally separate themselves into three great classes, of which two, silk and wool, are derived from the animal kingdom, while the vegetable kingdom furnishes an immense variety, as the pages of this work testify.

The means by which fibers may be identified are also grouped under two heads—chemical and microscopical. For many purposes, the methods are combined together, the chemical reactions being carried out and studied on the stage of the microscope. We will first indicate some of the more obvious reactions by which these classes of fibers may be recognized, and then discuss more particularly the microscopical characters of the vegetable fibers by which they may be distinguished from each other.

As all animal fibers contain nitrogen, which on burning evolves ammonia, recognizable by its smell, a strong smell from a burning fiber not saturated with any nitrogenous substance clearly reveals its animal origin, because vegetable fibers contain so little nitrogen that its presence is not easily made out and they give no ammoniacal odor on combustion. The vegetable fibers also do not leave any residue, if well burned, while the animal fibers leave a crispy coal.

Both silk and wool are soluble in strong hydrochloric acid, the solution being hastened by heat, but in dilute acid silk is soluble and wool is not. Vegetable fibers in the same reagent are disintegrated but not dissolved. Numerous processes have been invented for separating vegetable fibers, burs, etc., from wool, in order to clean the wool from seeds and other foreign vegetable matters that would be injurious to its manufacture, and also to permit the reuse of woolen rags, etc., which have cotton sewing threads in them or that have been made partially of cotton. These processes depend usually upon the destruction of the vegetable matter by acting on the mass with chlorin, or some compound of chlorin, or with dilute acids, such as hydrochloric or sulphuric, of suitable strength. By the action of these reagents the vegetable matter is rendered brittle so as to easily break in pieces like dust when the mixed mass is subjected to the action of a shaking machine known as a willow, and this dust is blown away, leaving the wool substantially intact. Mungo and shoddy are thus obtained. When hydrochloric acid has been used as the disintegrating agent, if after its action the fiber is steamed, the silk, if any is present, will also be partially dissolved so that it can be removed and a pure wool fiber obtained.

In strong, cold sulphuric acid silk quickly turns yellow and dissolves: cotton disintegrates slowly without color; flax and hemp make a black mixture, and wool is scarcely affected. Both silk and wool turn yellow and are soluble in nitric acid, the first more speedily, while vegetable fibers are slightly affected. Vegetable fibers are composed almost wholly of cellulose, which dissolves readily in Schweitzer's reagent, which is a solution of copper oxid in ammonia. Vegetable fibers are also capable of being nitrated in different degrees by the action of a mixture of sulphuric and nitric acids, forming soluble cotton, gun cotton, etc., important products in the manufacture of photographic collodion, celluloid, and explosives.[1]

Fibers may be presented for examination in the form of raw material or as manufactured goods. In the first case it often happens that some preliminary treatment is required to remove the incrusting or coating material which would otherwise prevent the direct action of chemical reagents upon the fiber. Animal fibers are covered with oil; cotton with a vegetable fat, and bast fibers, like flax and hemp, have more or less resinous cementing matter attached to them. This will usually be removed by a preliminary soaking in ether or benzine, and, if desirable, the weight of such adventitious matter can be determined by the difference in the weight of the material before and after treatment. In the case of cotton a preliminary weak alkaline bath is often used.

If the material is in a manufactured state, as spun or woven, the warp and weft should be carefully separated, as they often consist of different fibers, and the threads should be untwisted so as to give the reagents free access to the entire surface of the fibers. They may then be examined according to the tables on page 354, adapted from Dammer's "Illustriertes Lexicon der Verfalschungen."

[1] For further information on these subjects, consult Allen's Commercial Analysis, Vol. II.

TABLE A.—*For the examination of fibers, showing their behavior when treated with aqueous solutions of the reagents specified.*

Caustic alkali as caustic soda.	Zinc chlorid.	Lead acetate.	Remarks.	
Entirely soluble.	Completely soluble.	Alkali solution does not blacken.		Silk.
	Partially soluble.	The soluble portion does not blacken; the insoluble does.		Mixed silk and wool.
	Insoluble	Blackens		Wool.
Partially soluble.	Partially soluble.	A part blackens	The part insoluble in zinc chlorid partly dissolves in caustic potash: the remainder is soluble in cuprammonium.	Mixed silk, wool, and cotton.
		Does not blacken.	On treatment with picric acid, part colors yellow, part remains white.	Silk and cotton.
	Insoluble		On treatment with nitric acid, part turns yellow, part remains white.	Mixed flax and cotton.
Insoluble.	Insoluble		Chlorin, water, or ammonia colors the fibers red brown, nitric acid red.	New Zealand flax.
			The fibers remain colorless on treatment with chlorin, water, or ammonia. Alcoholic fuchsin (1–20) gives a permanent color. I and H_2SO_4 give yellow.	Hemp.
			The fibers remain colorless on treatment with chlorin, water, or ammonia. Potash soluble dyes yellow. I and H_2SO_4 give blue.	Flax.
			The fibers remain colorless on treatment with chlorin, water, or ammonia. Potash does not color and fuchsin washes out.	Cotton.

It will be seen that the first step is to treat with caustic alkali, 10 to 20 per cent, whereby animal fiber is dissolved, and vegetable fiber not. If, now, lead acetate be added to the mixture it darkens immediately from the formation of lead sulphid if wool is present. Or, if silk be suspected, warm in strong sulphuric acid, when the silk will darken rapidly and the wool more slowly. A solution of basic zinc chlorid may be made by taking a solution of 1.70 sp. gr. and dissolving therein an excess of zinc oxid. In this fluid silk dissolves readily in the cold, but wool and vegetable fibers remain unaffected. By heating a weighed portion of the material in this bath for five minutes, then drying and weighing, the amount of silk is determined by loss. On heating the remainder in a 10 per cent solution of caustic soda, drying and weighing as before, the amount of wool is found; the rest is vegetable fiber. The more common vegetable fibers may be distinguished from each other by means of the following table:

TABLE B.—*Showing the reactions of the more important vegetable fibers.*

Fiber.	Iodin and zinc chlorid.	Iodin and sulphuric acid.	Cuprammonium.	Anilin sulphate.	Phloroglucin.
Cotton	Violet	Blue	Blue solution.		
Flax	do	do	do		
Hemp	do	do	do	Pale yellow	Violet red.
Jute	Brown yellow	Green blue	do	Golden yellow	Deep red
Ramie	Dull violet	Dull blue	do		
Manila	Yellow to violet.			Yellow	Red.
New Zealand flax.	Golden yellow	Green blue	Bluish	Yellowish	Pale red
Aloe	Yellow to brown	Yellow	Swells up bluish.	do	Pink
Cocoa	do			Bright yellow	Purplish

The solution of iodin in zinc chlorid is prepared by taking 100 parts of zinc chlorid solution of 1.8 sp. gr., adding 12 parts of water, and 6 parts of potassium iodid, then add iodin till the vapors thereof begin to form. The brown liquid should be kept protected from light.

The solution of cuprammonium is made by adding sodium carbonate to a solution of copper sulphate, by which a mixture of copper hydrate and carbonate is formed; this is well washed and treated with just sufficient ammonia of 0.91 sp. gr. to dissolve it. It should be well shaken, filtered, and is then ready for use. Anilin sulphate in 1 per cent solution dyes woody fiber cells pale to deep yellow according to the amount of woody deposit.

The phloroglucin reagent requires two liquids which are kept separate, first a 5 per cent solution of phloroglucin in 95 per cent alcohol, and second strong hydrochloric acid. Apply to the section under examination first a drop or two of phloroglucin solution, and then in like manner the hydrochloric acid. Lignified cells will be stained red, those not lignified will remain colorless. This reagent is much used for determining the presence of wood pulp in paper claiming to be made of rags. A 5 per cent solution of anilin chlorid may be substituted for the phloroglucin and applied in the same way, but the lignin will be stained yellow instead of red.

For the application of iodin and sulphuric acid, a little iodin is dissolved in alcohol, and diluted with water till a pale wine-colored liquid is obtained. The sulphuric acid used should be diluted with two parts of water, and the sample treated with the reagents alternately till the full effect is produced. Fuchsin is employed in a 5 per cent alcoholic solution. Lead acetate in 5 per cent water solution. Picric acid, a saturated water solution.

Vegetable fibers are composed of long cells, which may be attached in a single row, end to end as in cotton, or, in bast fibers like linen and hemp they are spindle-shaped with very tapering ends, which lie side by side and are united to each other by a kind of cementing or intercellular substance. Something of the strength of the fiber depends on the strength and the resistance which this cement offers to the action of ordinary solvents, like water and soap; if it dissolves readily, as in the case of jute, goods made of such a fiber will not stand washing. In any case the fibers which are to be examined should be separated into their ultimate cells by soaking in alkali, then rubbing between the fingers or teasing out with needles, or recourse must sometimes be had to boiling in a 10 per cent soda lye or labarraque solution, and fraying in a mortar.

When the ultimate cells are obtained, they should be stretched on a slide moistened with a little glycerol for microscopical examination. The glycerol will prevent any tendency to crisp or curl when they are stretched out, and a cover glass laid on, and the whole slide is placed upon a micrometer scale to measure the length. Transparent glass scales may now be obtained, which are very convenient for this work.

After finding the length, sections of the fibers must be made to determine the diameter of the cells. For this purpose the writer has sometimes rolled a little bundle of the fibers in a piece of sheet wax made warm enough to be pliable. The wax is allowed to cool, and the sections cut in any section cutter, of which there are now a great many forms in use by microscopists. If the fibers are hard, the wax is not sufficiently resistant, and an embedding mass must be used that may be prepared by dissolving 70 grams of clean gum arabic in an equal weight of distilled water. Then digest 4 grams isinglass in 16 grams cold water till swollen, then heat to complete solution.

Strain one-half through a piece of fine muslin and mix with the solution of gum arabic, throwing the rest away, and add 10 or 12 cubic centimeters of glycerol, warm and mix thoroughly, and in each bottle put a small piece of camphor. It is best to put it up in small bottles, as it solidifies on cooling. When it is to be used, warm the bottle, and taking a little bundle of the fibers, about the size of a slate pencil, tie a thread around one end and saturating the bundle with the glue, stroke the fibers till they are straight and parallel, then hang the bundle up to dry for about twelve hours, when it will be hard enough to cut. The slices are placed on the slide, and wet with iodin solution, which is in turn absorbed by strips of blotting paper till all the glue is dissolved and removed. When the sections are made in wax, benzine or turpentine may be used for this removal, and the iodin applied subsequently. When the sections are clean, a drop of the dilute sulphuric acid is put on them, the cover glass is placed in position, and they are ready for examination on the stage of the microscope. Or the cover glass may be put on before the addition of the sulphuric acid, and the acid then placed on the slide at the edge of the cover glass, when it will slowly creep under, and its progressive action can be watched as it penetrates the sections. Pure cellulose takes a blue color, lignin a yellow, and intermediate tints will be produced in proportion as the cells are more or less lignified. When the saturation is complete, the outline of the sections will be sharply made out, and their diameter, shape of outline, and character of the interior canal should be noted. As the relative proportion of lignin and cellulose differs much in the cells of different plants, but is tolerably constant for the same species, it is possible to classify fibers according to their reactions, which taken in connection with the size of their ultimate fiber cells, offer us the most certain means of identification, and these characters will be found synoptically arranged in the table following. By a careful use of strips of blotting paper to take up any excess of reagents, all injury to the microscope may be avoided and much better results obtained than by a sloppy, careless method of work. For measuring the diameter of the cells a Jackson eyepiece micrometer is to be preferred. The gross appearance of the fibers should be noted in most cases. If the ends are frayed and worn it indicates shoddy in wool and paper stock in cotton. In the United States, where much paper stock is of wood, different kinds of wood are employed not mentioned in the following table, such as poplar, which in some parts of the country is the common name of species of *Populus*, but in New York and elsewhere is often applied to the *Liriodendron tulipifera*, also known as whitewood, while the *Tilia americana* goes under the name of basswood. As all woody fibers are more or less lignified, they give the yellow reactions of the Dicotyledons with the linden and willow as in the table following.

The reaction between iodin and sulphuric acid is sometimes a little slow and the color is temporary, only lasting a few hours. Bent or creased fibers color deeply in the flexures, and striæ, either longitudinal or radial in sections, will show more plainly as the coloration progresses. In many of the coarser fibers particularly, pieces of parenchyma will be seen that always color yellow, and may readily be known by their irregular shape.

Most of the fiber cells used in the textile industries, such as flax and hemp, are parts of the inner layer or bark of Dicotyledonous plants often known as bast cells.

In Monocotyledons the fiber cells are often scattered irregularly through the stem, and are white, coarse, light, and often brittle. (See Study of Fibers, in the Introduction.) There are, however, many exceptions to the latter statement, especially among the palms, which are Monocotyledons. The blue reaction in this class is not so definite as in the other classes, quite a proportion of the cells of alfa or esparto turning yellow, there being apparently two kinds of cells in this plant, which are not mixed indiscriminately in the stem, but form separate layers, each of which maintains its characteristic reaction, but becomes intermixed in processes of manufacture. The following table is a summary of the distinguishing characters of the principal vegetable fibers. The mean length and diameter are derived from a comparison of many measurements, and hence do not in all cases represent the mean of the extremes given

TABLE C.—*Synoptical table for the determination of fibers of vegetable origin.*

[All measures in millimeters. The reactions are understood to be with iodin and sulphuric acid.]

DICOTYLEDONS GIVING BLUE REACTION.

Common name.	Botanical name.	Length of fiber cells.			Diameter of fiber cells.			Remarks.
		Shortest.	Mean.	Longest.	Smallest.	Mean.	Largest.	
Flax	Linum usitatissimum	4	27/30	66	0.150	0.022	0.037	Cavity fine, yellow line.
Hemp	Cannabis sativa	5	15/25	55	.016	.022	.050	Striate with yellow sheath.
Hop	Humulus lupulus	4	10	19	.012	.016	.018	
Nettle	Urtica sp	4	27	55	.02	.05	.07	
China grass	Boehmeria nivea	60	120	200	.05	.08	.....	
Paper mulberry	Broussonetia papyrifera	6	15	25	.025	.030	.035	
Sunn	Crotalaria juncea	4	7.8	12	.....	.....	.....	Canal scarcely apparent.
Broom	Cytisus scoparius	2	6	9	.....	.....	.....	Yellow envelope.
Spanish broom	Spartium junceum	5	10	16	.....	.....	.....	
Melilot	Melilotus alba	5	10	18	.....	.....	.....	Cavity large.
Cotton	Gossypium sp	10	25	40	.....	.....	.....	Flattened and twisted.

TABLE C.—*Synoptical table for the determination of fibers of vegetable origin*—Cont'd.

DICOTYLEDONS GIVING A YELLOW REACTION.

Common name.	Botanical name.	Length of fiber cells. Shortest.	Length of fiber cells. Mean.	Length of fiber cells. Longest.	Diameter of fiber cells. Smallest.	Diameter of fiber cells. Mean.	Diameter of fiber cells. Largest.	Remarks.
Hibiscus	Hibiscus sp	2	5	6	0.014	0.021	0.033	Color more intense on surface.
Linden	Tilia sp	1.25	2	5	.014	.016	.020	Canal very small.
Jute	Corchorus, sp	1.5	2	5	.020	.020	.025	Stiff; canal prominent.
Lace bark	Lagetta lintearia	3	5	6	.01	.015	.02	
Willow	Salix alba	.....	3	3	.017	.022	.030	

MONOCOTYLEDONS GIVING A BLUE REACTION.

Common name.	Botanical name.	Shortest.	Mean.	Longest.	Smallest.	Mean.	Largest.	Remarks.
Esparto	Lygeum spartum	1.3	2.5	4.5	.012	.016	.020	
Spanish grass	Stipa tenacissima	0.5	1.5	3.5	.007	.0125	.018	Curly; cavity small.
Pineapple	Ananas sativa	3	5	9	.004	.006	.008	Cavity fine; coloration slight.

MONOCOTYLEDONS GIVING A YELLOW REACTION.

Common name.	Botanical name.	Shortest.	Mean.	Longest.	Smallest.	Mean.	Largest.	Remarks.
New Zealand flax	Phormium tenax	5	9	15	.01	.015	.02	Coloration intense.
Adam's needle	Yucca sp	5	4	6	.01	.015	.02	
Bowstring hemp	Sansevieria sp	1.5	3	6	.015	.02	.026	
Century plant (Pita)	Agave americana	1.5	2.5	4	.020	.024	.032	
Manila hemp	Musa textilis	3	6	12	.016	.024	.032	
Palmetto and palms in general.	Chamærops humilis, etc.	....	.....	.....	.....	.....	.....	

It is worth noting that artificial silk, made by Chardonnet and others, now often forms a part of some kinds of silk goods. A company is being formed in this country to manufacture artificial silk under the Chardonnet patents, the mill to be erected at Paterson, N. J. (See under Artificial silk in this work.)

In closing, I may refer to a few works containing descriptions of the fibers commonly employed in commercial industries. Very few books have been published relating exclusively to fibers, and especially in this country. In most books on dyeing, some description of the materials employed is prefixed, usually of a very superficial character; but there are no special American publications on the technology of fiber work. This list must be understood as including only the more important publications on this subject. See in list of authorities William Crookes, Knecht Rawson and Loewenthal, Vétillart, Thomas Christy, Leo Vignon, F. H. Bowman, Julius Sachs, Griffin and Little, Edson S. Bastin, and Cross and Bevan. Vétillart's work is the most thorough that has been published, up to the present time, as regards the identification of fibers by means of microchemical reactions. Some of the matter, together with information on a large number of new fibers, is incorporated in the work by Thomas Christy. The Text-Book of Botany by Julius Sachs is one of the highest authorities on the structure of plants.

APPENDIX C.

DESCRIPTION AND HISTORY OF LACE.

By Dr. Thomas Wilson.

Lace is an ornamental open-work fabric made with threads by sewing, knotting, or twisting. It is not a textile, is not woven, is not embroidery. Its principal difference from these, wherein consists its peculiarity, is that it is made mesh or loop at a time, each one being complete in itself and not made on any previously prepared foundation, as in weaving or embroidery. There are many fabrics which have intimate relation with lace and are called by that name wherein there may be a mixture of both weaving and embroidery. There are other fabrics which, made purely by lace-making process, still are not lace because of a failure of their ornamental character. It is only by employing the word "ornament" in the definition that one can exclude the fine sardine nets in use on the western coast of France. They are netted as is lace; they are not made by any previously prepared foundation; they are of fine linen thread, but they are utilitarian and are not ornamental, and so are not lace.

The making and use of thread and the art of weaving are of great age, being well known in prehistoric times in the Neolithic and Bronze ages. Examples of both have been found in the Neolithic stations of the Lake Dwellers of Switzerland and Italy. The more advanced arts of sewing, weaving, and embroidery were in a high state of development at the beginning of all historic periods in almost every known country. The Bible is full of descriptions of objects of high art in these regards. Modern discoveries in Egypt and Assyria carry these arts much further into antiquity. There is every reason to believe that all or most of these arts antedated the culture manifested by written characters and by the higher orders of architecture.

Lace is, however, entirely a modern product. There were in early times, to be sure, knitted fabrics, and some of them may have been darned or embroidered in such way as to produce a fabric which now passes as antique lace; but the art of lace making, according to the foregoing definition, by sewing with the needle as in the manufacture of point lace, or by twisting as in the manufacture of bobbin lace, is not pretended by anyone to have existed earlier than the last half of the fifteenth century, and it is extremely doubtful if any particular specimen can be identified as having been made prior to the middle of the sixteenth century, at which time lace first appeared as a perfected fabric. The country entitled to the honor of the invention of lace making is unknown. It has been claimed by Italy, Belgium, France, and Germany, with a considerable show of evidence in favor of each.

It is remarkable that lace making should have sprung up or been invented at about the same period of time by two entirely distinct processes without relationship or evolution between them, and that the people of the countries wherein either of the inventions was made were not only unknown to each other, but apparently neither had any knowledge of the process of lace making invented or employed in the other country. One of these processes is by the employment of the needle and a single thread, wherein the work was perfected mesh by mesh, each mesh being completed as the work progressed. The other process was by the use of many threads at once, each one attached to bobbins for the purpose only of separating them, the meshes being made by twisting the threads a greater or less number of times. When each mesh is only partially completed, the thread is carried on to the next, and so on from side to side the entire width of the fabric. While the countries in which these processes were invented are unknown, the evidence points to Venice as the seat of the former and to Belgium as the seat of the latter.

By these two totally distinct processes fabrics are produced so nearly alike as often to require an expert to distinguish the difference, which, though many times easily determined, yet not infrequently requires the aid of an expert.

During the first two centuries of lace making it may be assumed that it was always made with linen thread, but during the nineteenth century the improvements in making cotton thread have been so extensive that the latter fiber has been considerably employed. Practically all machine-made lace is of cotton fiber. Lace making has in later days been carried by the principal European nations into their colonies, and lace is thus oftentimes made by peoples who are barbarous, or at best not more than half civilized. The native population of many of the South American states carry on lace making, which was taught them in early times by pioneer missionaries, and the art has become specialized and localized, and is taught and continued from generation to generation, and now furnishes a staple industry. Under the tuition of the French the natives of Madagascar make a fair representation of antique lace which, however, unlike the South American, is not for their own use, is not used by them, but is intended as a source of revenue and is for sale or export.

Regarding Nanduty (*Ñandutí*) lace, William Eleroy Curtis writes me that the material used is the *pita* fiber, and that it is the same used by the people of Ecuador and northern Peru for the very fine Panama hats, which are all made on the west coast of South America between Buenaventura and Callao. "They are called Panama hats because Panama is the market of distribution."

In "The Capitals of Spanish America," by Mr. Curtis, who is recognized as the highest authority upon all subjects referred to therein, statements are made on page 638, as follows:

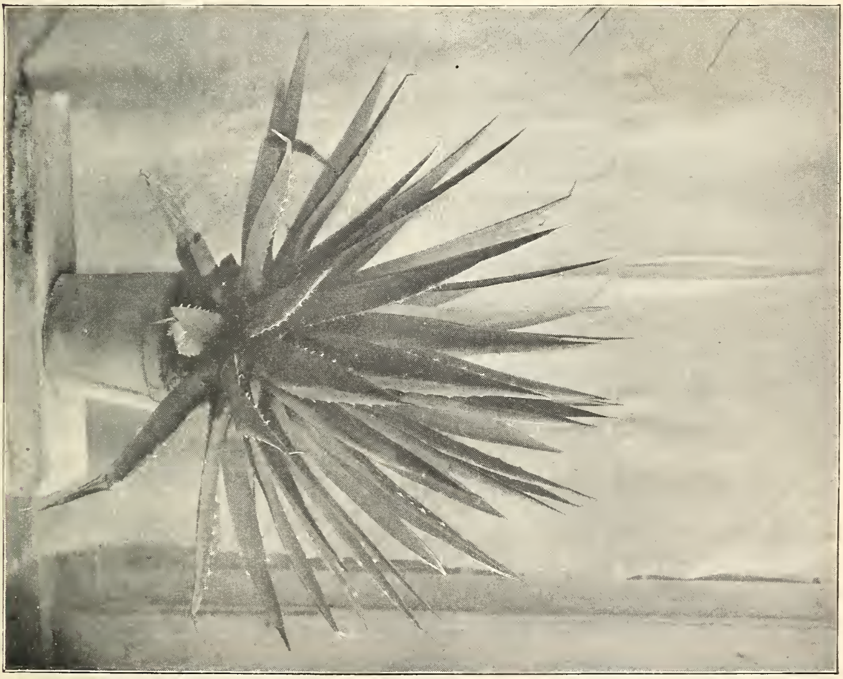
The men are very skillful in the use of tools and in the manufacture of gold and silver ornaments, and the women make a very fine lace which is called Nanduty. The lace-making art was taught the women by the Spanish nuns. They do not use cotton thread, but the very fine fibers of a native tree, which are as soft and lustrous as silk. Some of their designs are very beautiful, and the fabric is indestructible. Lopez had his chamber walls hung with this lace, on a background of crimson satin, and the pattern was an imitation of the finest cobweb. It is said to have required the work of 200 women for several years to cover the walls, and that every one of those women was a discarded mistress of the despot. The lace is fastened to the wall by clamps of solid gold of the most unique workmanship. There are 400 of the clamps, each worth from $12 to $15."

In regard to the above reference to Panama hats, it should be noted that the true Panama hats are made from the split leaves of *Carludovica palmata.* It is to be regretted that the name of the botanical species of plant used in the manufacture of this lace could not be given, as the name *pita* is used for so many different fibers. [See *Pita* in catalogue, Ed.] The Nanduty lace differs from some other laces in being made in small squares and joined together.

In addition to the fibers above mentioned the writer possesses some specimens of lace made of the fiber of the aloe from Corfu and Zante. Reference may also be made to the aloe lace wrought by the women of Fayal, and referred to in this work under *Agave americana.*

White lace may be made of flax, cotton, silk, wool, ramie, and possibly other fibers; flax and cotton are rarely colored. Almost all black lace is silk or wool, or possibly ramie, though as yet this fiber has not come into general use.

1. THE CENTURY PLANT, AGAVE AMERICANA.



2. TAMPICO HEMP PLANT, AGAVE HETERACANTHA.

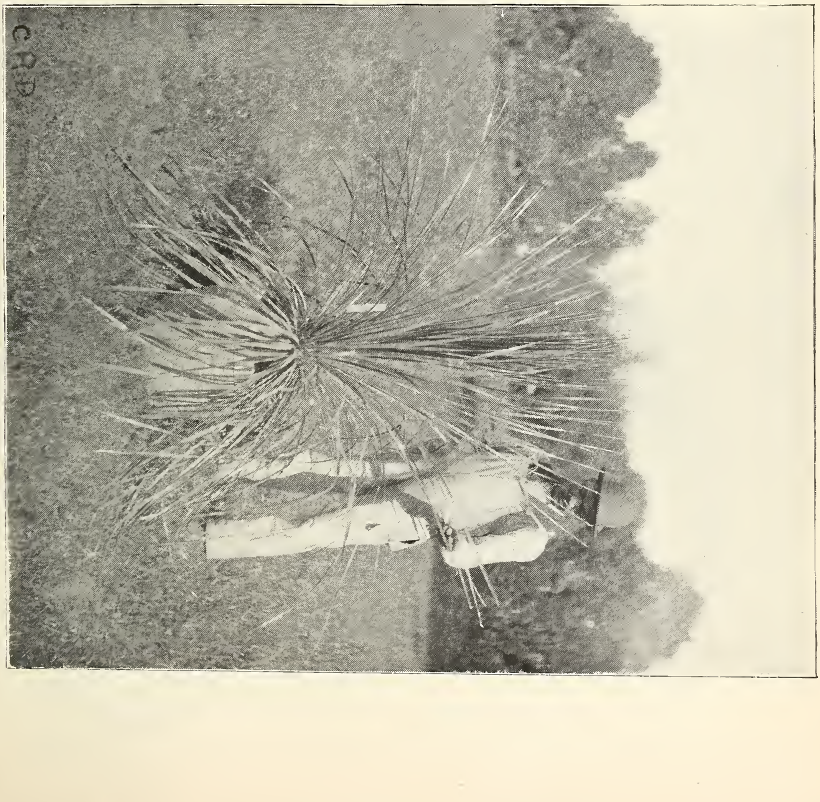
1. SISAL HEMP, AGAVE RIGIDA SISALANA.

2. FALSE SISAL HEMP, AGAVE DECIPIENS.

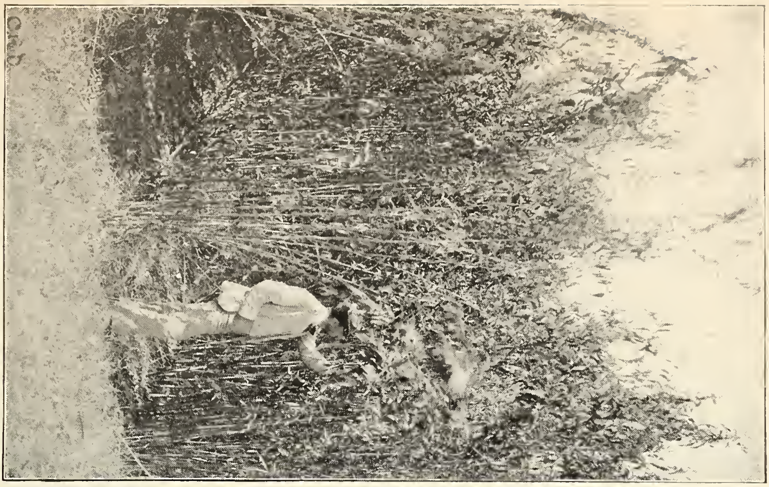
1. AN UNIDENTIFIED FLORIDA AGAVE.

2. PINEAPPLE PLANT, ANANAS SATIVA.

1. A BUNCH OF COCOANUTS, COCOS NUCIFERA

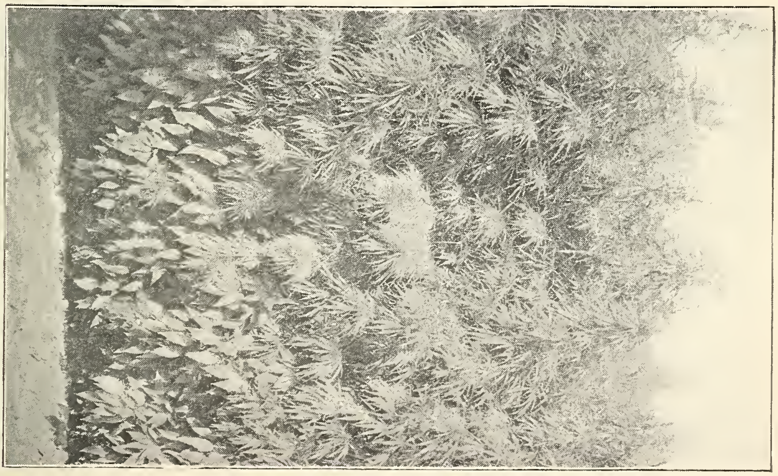


2. A SPECIES OF DASYLIRION.

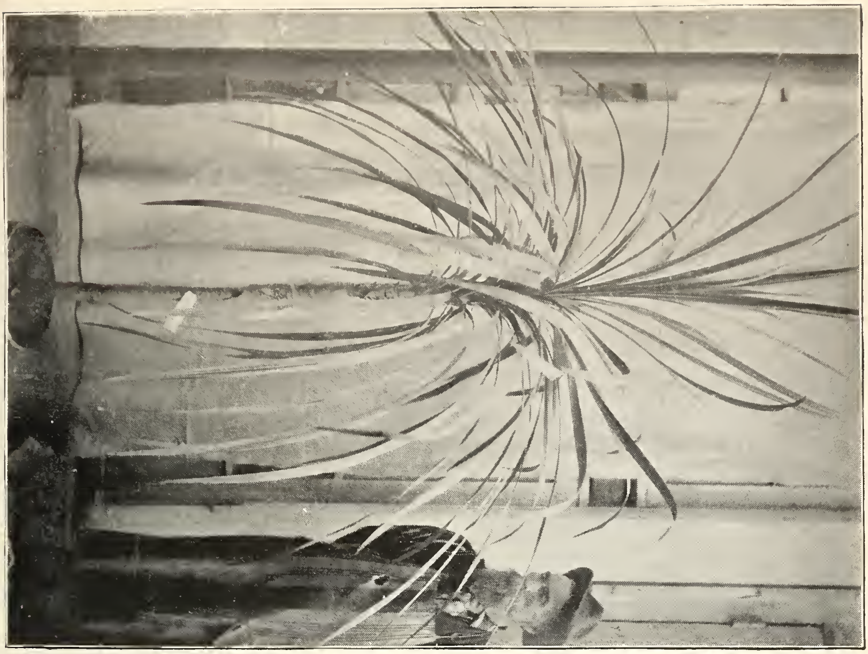


1. LOUISIANA JUTE, CORCHORUS.

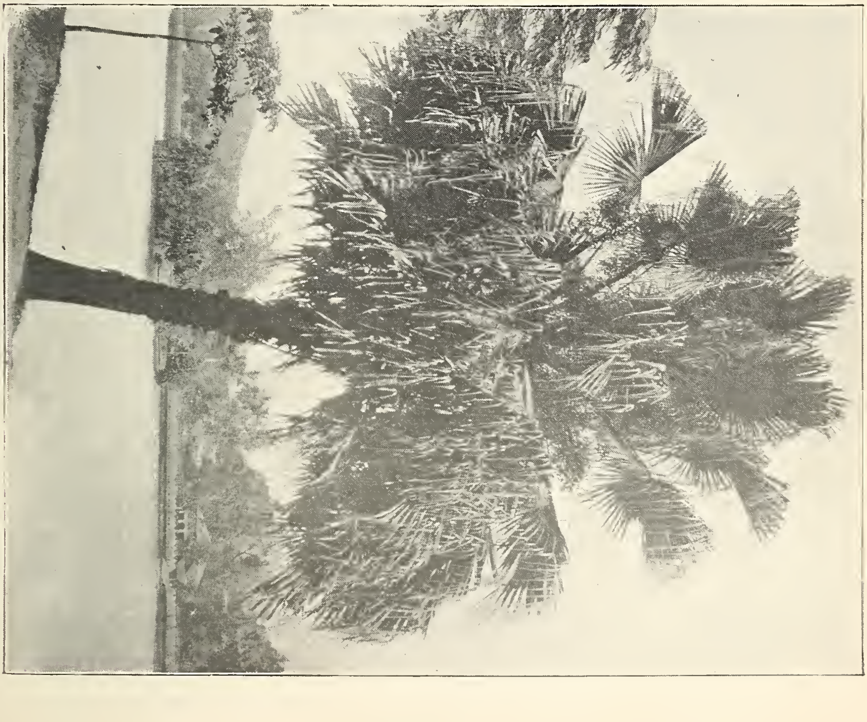
2. SUNN HEMP PLANTS, CROTALARIA JUNCEA.



3. CALIFORNIA HEMP, CANNABIS SATIVA.



1. FORSTER'S PALM LILY, CORDYLINE AUSTRALIS.



2. THE CHUSAN PALM, CHAMÆROPS FORTUNEI.

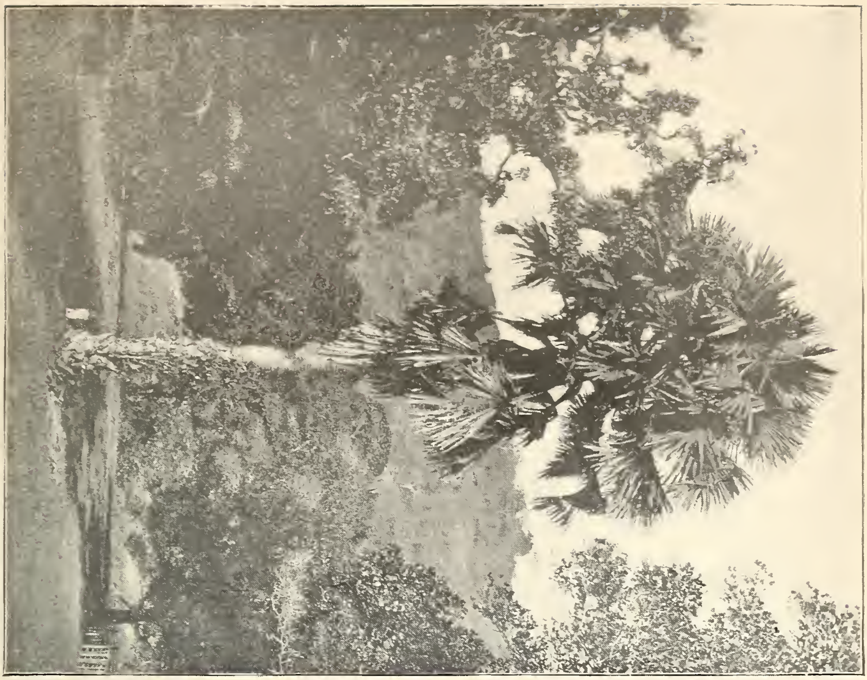
1. MAURITIUS HEMP PLANT, FURCRÆA GIGANTEA.

2. NEW ZEALAND FLAX, PHORMIUM TENAX.

1. CHINA GRASS FOLIAGE, BOEHMERIA NIVEA.

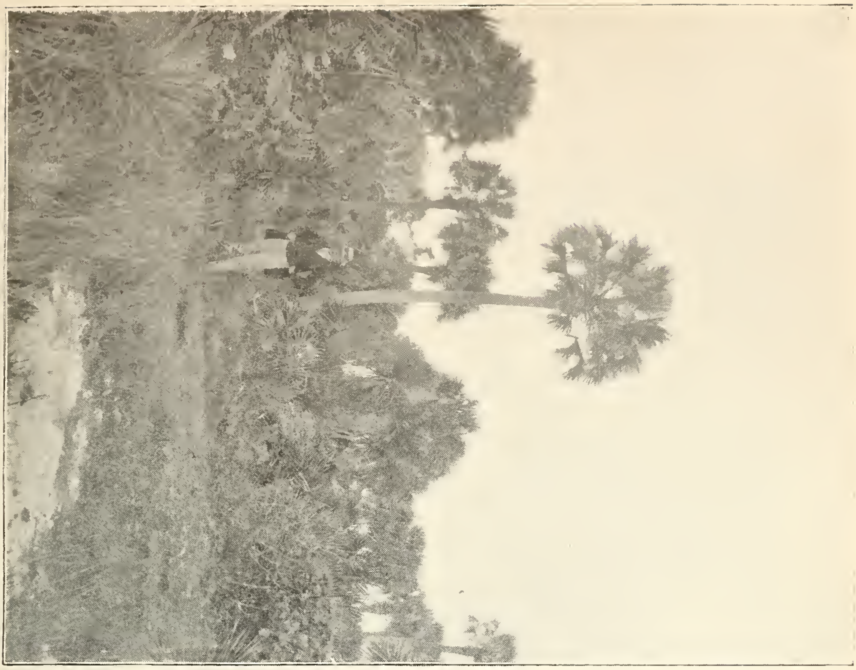
2. SPONGE CUCUMBER LUFFA ÆGYPTIACA,

3. A PLANT OF SANSEVIERIA LONGIFLORA.

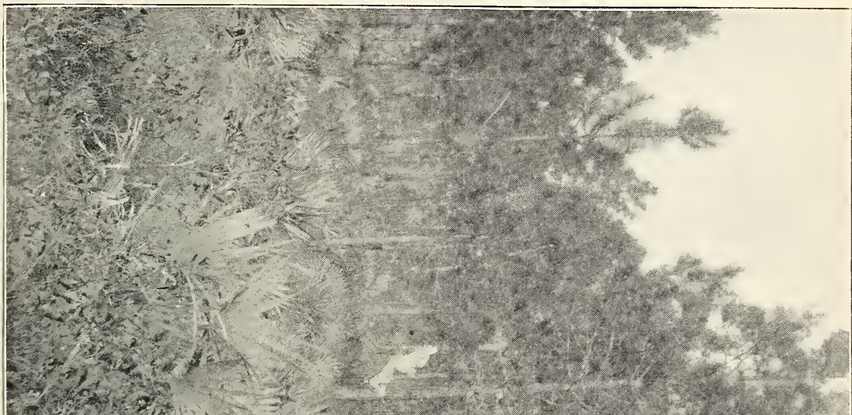


1. TALIPOT PALM, CORYPHA UMBRACULIFERA.

2. SCREW PINE, PANDANUS ODORATISSIMUS.



1. CABBAGE PALMETTO, SABAL PALMETTO.

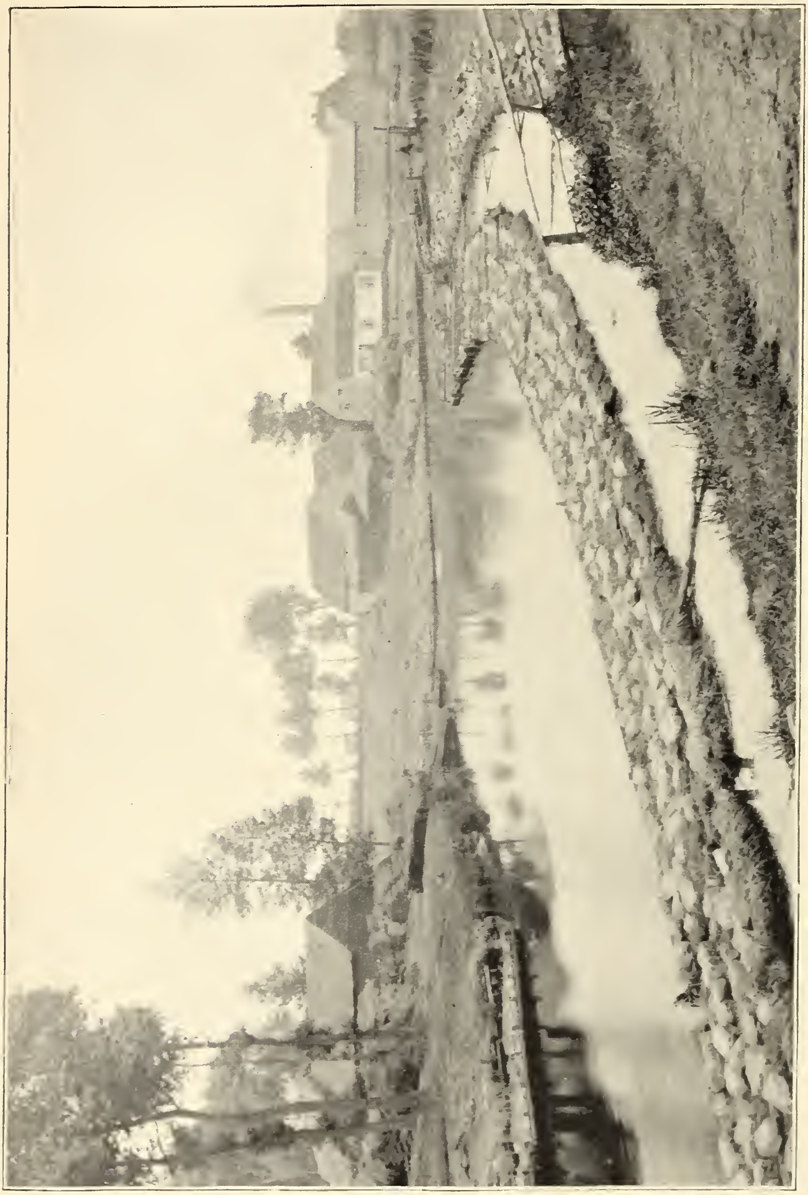


2. SAW PALMETTO, SERENOA SERRULATA.

THE TREE YUCCA, YUCCA ARBORESCENS.

1. BEAR GRASS, YUCCA FILAMENTOSA.

2. A PLANT OF YUCCA, SP. ALLIED TO BACCATA.



RETTING FLAX IN THE RIVER LYS, BELGIUM.