DEPARTMENT OF AGRICULTURE.

DIVISION OF STATISTICS.

FIBER INVESTIGATIONS. REPORT NO. 3.

A REPORT

ON

SISAL HEMP CULTURE

IN

THE UNITED STATES,

WITH

STATEMENTS RELATING TO THE INDUSTRY IN YUCATAN AND THE BAHAMA ISLANDS, AND BRIEF CONSIDERATIONS UPON THE QUESTION OF MACHINERY FOR EXTRACTING THE FIBER.

BY

CHARLES RICHARDS DODGE,

SPECIAL AGENT.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Office of Assistant Secretary,
Washington, D. C., May 16, 1891.

Sir: I hereby transmit with my approval a special report on Sisal Hemp Cultivation in Florida, made under my direction by Mr. Chas. Richards Dodge, special agent in charge of the fiber investigations of this Department.

Inasmuch as considerable interest in this cultivation is being shown in the State of Florida, and active efforts are being made to establish the industry within our own borders, a knowledge of recent developments regarding the industry seems especially desirable at the present time. I take pleasure, therefore, in recommending the early publication of the accompanying report.

Very respectfully,

Edwin Willits,
Assistant Secretary.

Hon. J. M. Rusk,
Secretary of Agriculture.

LETTER OF SUBMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
May 1, 1891.

SIR: I have the honor to submit herewith a report embodying the results of my investigations during the past year into the Sisal hemp industry, with a view to its establishment in southern Florida. My sources of information are the extensive published records relating to the subject, covering a period of 50 years; the large correspondence of the Department in the field of fiber investigations; and, lastly, the information derived by a personal fiber survey of the entire coast line of Florida, from Jupiter Inlet on the east coast, to Charlotte Harbor on the Gulf, including explorations on the Keys, occupying several weeks in February and March of the present year. Necessarily, a great many interesting details have been omitted, but I am sure that sufficient information has been presented to answer, fully, the many inquiries on the subject that have been made to the Department in the past year.

I am, sir, respectfully yours,

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

Hon. EDWIN WILLITS,
Assistant Secretary.

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INTRODUCTION.

The imports of sisal hemp fiber into this country from Yucatan for the fiscal year ending June 30, 1890, amounted to 28,312 tons, in round numbers, worth $4,330,300, and for the year previous the imports amounted to over 35,000 tons. This does not take into account the imported manufactures from sisal hemp, which are considerable, the value of which can not be given. It is said that the United States purchases over 80 per cent of the marketable fiber produced in Mexico.

The fact that the sisal-hemp plant can be grown in this country in any quantity, as far as the mere question of cultivation is concerned, was satisfactorily demonstrated many years ago. Over fifty years have passed since the plant was introduced into Florida by Dr. Henry Perrine, and it is now growing wild in many portions of the State. With all these facts before us, and in connection with the knowledge that there is great interest in the cultivation of the plant at the present time, is it not worth while to make a serious attempt to speedily establish the industry in our own country? To the end of assisting in such an endeavor the Department of Agriculture has made the matter a subject of investigation, and the results of its work in this direction are now placed on record. The investigations are far from completed, as there is much yet to be learned concerning the growth of the plant and the best means of extracting the fiber, though for the purpose of giving early information to those who are seeking knowledge upon the subject it has been thought best to publish without longer delay.

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 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. We are further informed that the Aztecs prepared these fibers for use in the same manner that flax is prepared in other countries, the leaves being soaked in water, pounded, and the product dried, after which the fiber was made into coarse clothing, cords, ropes, and mats. In Mexico this and allied fiber is still used for many purposes, as cordage, twine, and hammocks, or woven into harness and even coarse cloths. In our own country its use is chiefly in the manu-

facture of ropes, binding twine, and similar cordage, and it is regarded as one of the most valuable of commercial fibers.

In 1845 the export of fiber from Mexico amounted to a little over $100,000, and in 1869, according to Squier, the imports into the United States amounted to less than $34,000. It is only in very recent years therefore, comparatively speaking, that this industry has become important.[1] At the present time not only is the fiber produced to an enormous extent in Mexico, but Cuba and the Bahamas are interested in its production, with a promise of practical results. An account of this industry as it relates to the Bahamas will be found in a report made to the State Department by U. S. Consul McLain, and reproduced in Appendix B, at the end of this report.

What can be done in the Bahamas, I have reason to believe, can be accomplished in this country with intelligent effort and attention to small details at the outset to avoid costly mistakes. We have the soil, the climate, and the plants. The combination of capital and inventive genius with these conditions must work out the problem, if indeed the question is not already practically solved.

I wish before closing to make acknowledgments to the following persons who, by their kind assistance at the time of my investigations in Florida and by statements of personal experience at various times, have added materially to the value of this report. I am indebted to Mr. J. H. Kuchler, of Jacksonville; Mr. John W. Denny, of the Coast Line Canal and Transportation Company, at St. Augustine; Mr. Robert Ranson, Titusville; Messrs. John H. Grant and John Cleminson, of Jupiter; Mr. A. M. Fields, of Juno; Mr. F. S. Morse, J. W. Ewan, J. A. McCrary, and William Brickell, jr., of Miami; Mr. Addison, of Cutler; Messrs. J. J. Philbrick and George H. Bier, of Key West, and to Dr. L. D. Washburn, director of the Tropical Sub-Experiment Station at Fort Myers. And acknowledgments are specially due to Mr. Kirk Monroe, of Cocoanut Grove, for the tender of his private yacht, by means of which it was possible to visit the Perrine Grant and to explore those of the Florida Keys, where the sisal hemp plant is found growing in greatest perfection, and to the Brelsford Bros., of Palm Beach, for assistance in securing photographs of living plants for illustration. To Mr. T. Albee Smith, of Baltimore, I am under obligations for statements regarding the industry in the Bahamas and for valuable illustrative material relating to Yucatan.

[1] Before 1854 it was exported after manufacture into hammocks, cordage, etc. The whiteness and pliability of these attracted the attention of foreign dealers, and the United States began to import the raw material. Yucatan producers were then forced to make their products known to European markets; they succeeded so well that the exportation of henequen which, in 1880, was estimated at 2,173,468 piastres attained in 1887 to 1888 the sum of 6,641,255 piastres. (*From a report on the Industries of Mexico, published for distribution at the Paris Exposition of* 1889.)

THE SISAL HEMP PLANT IN FLORIDA.

The plant producing this fiber, which for so many years has been a source of wealth to Yucatan and is becoming of commercial importance to the Bahamas, grows in many portions of Florida, where its cultivation long ago passed the experimental stage. The literature of the subject as it relates to the culture of the plant in our own country is quite extensive, enough having been published, even as far back as the fifties, to prove the adaptability of both soil and climate of Florida to successful cultivation.

The history of the introduction of the plant into Florida, by Dr. Henry Perrine, between 50 and 60 years ago, is almost too well known to repeat here, though a few brief statements may not be out of place.

Familiar with the account of Dr. Perrine's efforts to obtain a grant of land in southern Florida upon which to pursue his experiments in the culture of this plant, as well as the story of the tragic ending of the enterprise, it has been my good fortune to obtain from Mrs. Hester Perrine Walker, of Fernandina, Fla.—a daughter of the doctor, and an eyewitness to the Indian Key massacre—some interesting and more detailed statements regarding the introduction of the plant by Dr. Perrine, from which the following facts are gleaned:

Mrs. Walker informs me that the first introduction of the plant from Yucatan occurred in the years 1836 and 1837, a few plants having been sent to the royal botanical gardens of Cuba at the same time. Of the plants brought to Florida, part were taken to Indian Key and the others were planted upon "the Indian Hunting Ground," on the borders of Biscayne Bay. It is also stated that when these plants had multiplied to some extent the officers at Fort Dallas, at the mouth of the Miami River, 12 miles from this locality, were in the habit of gathering the young ones to send to greenhouses in the North, and also to other posts where they were grown as ornamental plants. One of the results of this practice was to introduce the plant into many new localities in Florida, where it soon obtained a foothold. The plants set out on Indian Key multiplied very fast, and a few years after the destruction of the enterprise, and the death of Dr. Perrine at the time of the Indian massacre, a schooner load of the young plants were gathered and taken away, though it is not stated where they went.

Mrs. Walker writes further:

After my father's death and our miraculous escape from the Indians Congress passed a supplementary act, giving to my mother and her children the same rights and privileges that were vested in him. In accordance with that act my mother hired men to plant on every section of the Perrine grant. This supplemental act was passed by the Congress of 1840 and 1841; whether in the first or second session I can not tell. The general planting of the Perrine grant occurred in 1846, by our agent, Mr. Charles Howe, who took six men with him upon the land for the purpose. This grant consisted of a township of 6 miles square, lying on Biscayne Bay, embracing portions of three sections, as allowed by the Land Office. We secured, in 1846, thirty-six families of Bahamians to go upon the grant to fulfill the condition of a settler upon each section. The men came over to build their houses and plant their gardens preparatory to bringing their families, when they were driven or frightened away by the Indians and could not be induced to return. It was about this time that the agave was planted upon each section.

Mrs. Walker also states that other agaves were introduced with the *sisalana*, all of which were called "century plants." Many other plants were introduced, in all some two hundred varieties, which were growing in boxes on the premises of Dr. Perrine and Mr. Howe, Indian Key, preparatory to the removal to the "grant" as soon as the war should cease. These were nearly all burned or destroyed at the time of the massacre, August 7, 1840.

From this first introduction of the *Agave rigida* into Florida the plants spread rapidly, especially on the mainland, being commonly transplanted to the gardens of the early settlers of south Florida chiefly for the sake of ornament. In 1842 the armed occupation act was passed by Congress, which gave a homestead of 160 acres to any person who occupied a tract 5 years. Mr. Robert Ranson of Titusville, Fla., makes statements in this connection as follows:

This resulted in a number of heads of families settling along the Indian River in the neighborhood of Fort Capron, and on nearly every one of these old settlements a small patch of Sisal hemp may be found grown into a dense thicket, descended from one or two parent plants set out over 45 years ago. These facts are considered worthy of mention, as showing that while every other evidence of former cultivation has long since disappeared, the sisal hemp, regardless of forest fires, weeds, and neglect, still holds its own and spreads year by year.

Those desirous of studying the bibliography of this subject will find a mass of valuable information, descriptions, etc., prepared by Dr. Perrine, in Senate Document No. 300, bearing date March 12, 1838, being a report[1] to accompany Senate bill No. 241.

The report is a collection of documents, letters, meterological data, botanical considerations regarding fiber plants, list of officinal and other economic plants, etc., making a printed volume of 142 pages and 24

[1] The introduction reads: The Committee on Agriculture, to whom was referred the memorial of Dr. Henry Perrine, late American consul at Campeachy, praying for a conditional grant of land in southern Florida to encourage the introduction and promote the cultivation of tropical plants in the United States, have had the same under consideration, and beg leave to submit to the consideration of the Senate the following report:

page illustrations of various tropical plants from which fiber may be extracted. The report has long been out of print and is difficult to obtain.

The chief information regarding the botany of the Sisal hemp plant is derived from two sources; the descriptions given by Dr. Perrine, from a study of the different forms of henequen as growing in Yucatan, and published in the Senate document referred to above (see pp. 35–40), and a valuable contribution on the subject of the "Jenequen," prepared by Dr. Schott, and published in the Annual Report of this Department for 1869. In the transactions of the St. Louis Academy of Science, Vol. III, December, 1875, Dr. George Engelmann reviews the statements and conclusions of these two observers, and as the matter is important in defining sharply the botanical differences in the species, I have reproduced it entire (see Appendix A). I will also refer the reader to an article on the subject of Sisal hemp in the Bulletin of the Royal Gardens, Kew, for March, 1877. A brief extract from this article, following Dr. Engelmann's conclusions, also appears in the appendix at the end of the present report.

The common names applied to the fiber are sisal hemp, Mexican grass, grass hemp, *Henequen* or *Jenequen*, *Sosquil*, and *Cabulla* or *Cabuya*, the latter being the Central American names. The native names of the seven species or varieties of plants recognized in Yucatan as producing henequen are enumerated by Dr. Schott as follows: (1) The *chelem* (or tshelem), which grows spontaneously over the country, finding its favorite range on the barren rocky districts of the northwest, with their border of maritime sand flats, thought to be *Agave angustifolia*. (2) The *yaxci* (or yaashki), with shorter leaf, of bright velvety green, produces less fiber, but excelling in softness, flexibility, and luster, and bringing a higher price in the market. Its cultivation is limited to the more genial soil and climate of the eastern and northern parts of the peninsula. (3) The *sacci* (saci or saqui), meaning white agave, which, while cultivated throughout Yucatan, appears to have its center of production in the northwestern part, or the district of Merida. It produces a far greater quantity of fiber than the preceding and furnishes the principal bulk of that exported. These two forms may be said to produce the sisal hemp of commerce. The leaves of the *sacci* are easily recognized by the wax-like bloom with which they are covered. (4) The *chucumci* (or tshucumki), resembling No. 3, though yielding a harder, rougher, and naturally inferior fiber, thrives best on the rocky flats and sandy regions near the coast. (5) The *babci* (babki or vavki), quite distinct from No. 3, of quicker growth, and producing twice as many leaves, but of smaller size, and therefore less profitable. (6) The *citamci* (or kitamki), with short narrow leaves, and producing poor fiber. This species is thought to come nearest to the wild plant. (7) The *cajun* (or cahun), like the first on the list, an indigenous species growing spontaneously along

the border of the mangrove region, can probably be referred to *Furcræa cubensis*. Of this species Dr. Schott says:

> It has large, thin, uniform leaves, of an agreeable green, 4 or 5 feet long, the margin armed with sharp, curved spikes like those of the *Agaves*, or the heavier armed species of *Bromelia*. In order to obtain the fiber the leaves have to be collected near the heart of the plant when they are cut, and parched over a light fire.

While Dr. Perrine recognizes the several forms, all of which in his opinion "merit to be transplanted to Cape Florida," and records at the same time that "the yashqui species of henequen yields the best quality of foliaceous fibers and the sacqui the greatest quantity," he nevertheless refers chiefly to the "yashqui" (*yaxci*) in his arguments in favor of the introduction and cultivation of the henequen in Florida, and Dr. Engelmann states that this is the form introduced into Florida.

It is a mistake, therefore, to confound the Florida form with that which is grown so extensively in Yucatan for the production of fiber for export. Indeed the difference is so apparent that no one would be misled after seeing the two plants together. (See Plates I and II at the end of this report). Outlines showing proportions of the leaves of the two forms are figured on page 13. Fig. 1 is from a leaf of the Florida form, grown on Boca Chica Key, near Key West, one of the broadest leaves I have seen. Fig. 2 is a leaf of the same variety, grown at Fort Myers, on the Gulf coast. Fig. 3 is the spined or Yucatan variety, but grown on Boca Chica. Fig. 4 shows the natural size of the spines on the sides of the leaf. Fig. 5 is a leaf of *Sanseviera*.

Mr. T. Albee Smith, in a recent conversation, referred to the striking difference between the two forms, and mentioned the fact of his having seen a "sisal hemp plant," such as is cultivated in Yucatan, growing in a sisal field in the Bahamas that could be recognized almost as far away as the plant could be seen.

I may mention, at this point, that a part of the original Perrine collection of fibers received by the Department from the Smithsonian Institution some 20 years ago is still in existence. I regret, however, that all but one of Dr. Perrine's labels have been changed, new ones having been substituted, and all record of the variety of the plant from which the fiber was taken lost, as the new labels only record the general name *Agave sisalana*. The one exception shows the sample of fiber it marks to be the Sacqui variety. With the remains of this collection, there are three rude implements of wood such as were used by the natives in cleaning the fiber at the time of Dr. Perrine's experiments. These are figured on Pl. II in the Senate document of 1838, before referred to.

In the remarks of Dr. Engelmann, in Appendix A, the "Yaxci" form *Agave rigida* var. *sisalana* is so fully described that there can be no doubt as to the plant that is meant. The late Dr. Parry, at one time botanist of the Department of Agriculture, found it in full bloom in February, 1871, at Key West, and on the adjacent islands, and describes the leaves as "pale-green but not glaucous, 4 to 6 feet long and

Fig.4.

Fig 1.

Fig.2.

Fig.3.

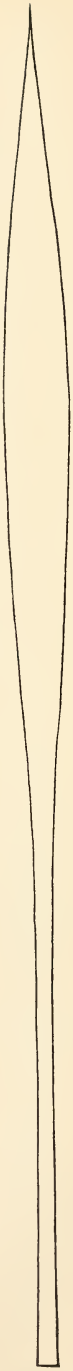

Fig.5.

D.Ogawa lith.

4 to 6 inches wide, generally smooth-edged, but here and there having a few unequal, sometimes very stout and sharp teeth." This is the plant introduced into Florida by Dr. Perrine, for fiber culture, and considered by Dr. Engelmann to be "the most valuable of the fiber-producing agaves."

This is the form that I found growing along the entire southern coast of Florida, on my recent survey, from Cape Canaveral on the east side, around to Charlotte Harbor on the west or Gulf coast, and including many of the keys. Hundreds of plants were examined, and my own observations perfectly accord with Parry's made 20 years before, with the one exception that I found no leaves wider than $5\frac{1}{4}$ inches, 5 inches being the common measurement. I also notice what is remarked regarding the presence, occasionally, of a few sharp, stout teeth where the other portions of plant showed only the smooth leaves. In some cases the teeth were present all along the edges of the leaves, but so abortive that it readily suggested a change by cultivation from the sharply spined form as grown in Yucatan to that with spineless leaves, save the terminal spine, which is always present.

Occasional plants of the stoutly spined form were met with, invariably shorter leaved and stockier in appearance. They were so uncommon, however, that it was necessary to search for them, even in tracts of considerable area. And it is remarkable that on Indian Key, where the entire island is encircled by these agaves, only a few very young plants of the spined form could be found, and these at a considerable distance from each other. The details of my recent tour of investigation in southern Florida are not important here, though a few notes regarding particular localities may prove interesting.

At Titusville, where I met Mr. Ranson, plants are growing thriftily, though chiefly for ornament in the gardens. Over on Cape Canaveral, however, Mr. Ranson has a small plantation which is doing well, notwithstanding the high latitude. There is no doubt that the plants will grow from this point southward, although it is my opinion that to secure the best results in culture plantations must be located south of Jupiter. The most interesting tract visited along this portion of the coast was found on the point perhaps a mile below the railroad station and wharf at Jupiter. Here I found a thicket of these agaves, both the smooth and spined varieties, many of the plants having shot up their "poles" or flower stalks, which were covered with blossoms and young plants. Mr. John Cleminson has a small plantation not far from this tract, and a mile or two above Jupiter I visited, with Mr. John H. Grant, a nursey of small plants, which were in flourishing condition.

At Juno, about 10 miles farther south, at the head of Lake Worth, I found another fine nursery of perhaps 100,000 plants, the property of Mr. A. M. Fields, who is quite enthusiastic on the subject. Fully 50 per cent. of his plants are not *Agave sisalana*, however, but a species which was subsequently met with at many points along the east and

west coast, as well as on the Keys, doubtless *Agave Mexicana*,[1] to which more extended reference will be made later on.

The Biscayne Bay region is undoubtedly the most favorable locality for sisal hemp cultivation. I found the plant growing here and there along the Miami River, in perfection, though only in scattered patches of a few individuals. And from Miami down the coast to Cocoanut Grove they appeared more or less abundantly. At Addison's Landing, near Cutler, I found myself on the Perrine grant, though Mr. Addison informed me that the plants were chiefly growing on his own section. He estimates the number of old plants at about 15,000, growing without cultivation, and states that these have descended from the comparatively few plants which were on the place 25 years ago when he first occupied the land.

The original planting, he states, was done by Mr. Charles Howe who was associated with Dr. Perrine. He has both the spined and the smooth-leaved varieties, but makes the interesting statement that the latter "spreads" much faster than the former. As a matter of fact I found plants of the spined form, at this place, exceedingly few and far between. Some fine living plants of both varieties were secured here, and these are now growing well in the conservatories of the Department.

From this point I sailed southward, but found nothing of particular interest until Upper Metecombe Key was reached, where some of the most superb plants observed on the trip were seen. In one thicket, to which it was almost impossible to obtain access save at the expense of torn clothing and lacerated flesh, magnificent plants were seen where the tips of the leaves were 2 feet above a man's head.

Indian Key, where Dr. Perrine lost his life, lies just below and beyond it is Lower Metecombe. Other keys of the group are Lignum Vitæ, Shell Key, and some lesser ones, upon all of which the true sisal hemp plants are found in abundance. A very rough estimate of the old plants in this group of keys would be a hundred thousand, though in making the estimate I have relied largely upon the statements of the intelligent Bahamians living upon them. Leaving this group of keys the agaves grow scarcer, until they are found abundantly again on Key West, Boca Chica Key, and Stock Island.

Other keys where they are growing are Knights, Umbrella, and Vaccus, and on the authority of Mr. Grant large quantities are to be found on Cape Sable, the extreme southwest point of Florida.

I did not visit Boca Chica, as Mr. George H. Bier, who has interests on the island, was to meet me at Key West and supply information regarding this group. The plant grows to greatest perfection in this locality, some of the largest and finest leaves I have seen coming from Mr. Bier's place on Boca Chica. Fig. 1, page 13, is one of these leaves.

My survey of the west coast was not as thorough as the east, but there is no doubt that the plants are grown in greater or less abundance from Cape Sable and Ten Thousand Islands up to Punta Gorda. Superb

[1] See *Agave Mexicana*, page 45.

plants were examined by me at Fort Myers on the Caloosahatchie River and at other points, though there were no such thickets as seen on the keys.

SOIL, CLIMATE, AND CULTURE.

As to the northern limit of cultivation of the sisal plant it was Dr. Perrine's belief that it might eventually be acclimated as far north as Virginia, taking its place "in the worn out cotton fields." Time has proved the incorrectness of this idea, for the frost line sharply marks the limit of cultivation. Mr. Ranson, a valued correspondent who has had long experience with the culture of the plant, draws the line from latitude 28° 30′ commencing on the Atlantic coast, in a southwesterly direction across the State of Florida, to the Gulf coast in latitude 27° 15′. He regards the cultivation safe south of this line, though he is careful to state that in exceptionally cold winters the ends of the three or four leaves last unfolded will be affected, causing a few inches of the leaf, down from the point, to turn black and dry up. This of course destroys the value of the leaf that has been so touched. Fully matured leaves will stand one or two degrees of frost without injury. Mrs. Walker speaks in one of her letters of some mature plants that were set out in Fernandina, which were destroyed after 2 or 3 years in the open air "by an unusually heavy freeze."

The majority of writers agree that arid, rocky land is suited to the growth of the plant. As long ago as 1855 Mr. William C. Dennis, of Key West, Fla., writing to the Commissioner of Patents,[1] stated that such conditions, and especially where there was a superabundance of lime, were more favorable to sisal cultivation. He says:

> This is precisely the condition of the soil of these keys and of the extreme southerly part of the peninsula of Florida, where alone it could be cultivated in the absence of frost. It requires less culture than other products, but is much benefited by keeping down the weeds; and though it grows best on lands which have the deepest soil, yet it grows well where but little soil appears among the rocks, sending its long, penetrating roots into the clefts and crevices in search of black, rich vegetable mold. In fact, the lands on these keys, and much of it on the southern point of the peninsula, are nearly worthless for every other agricultural purpose, so far as is known.

In the article published in the Kew Bulletin, before referred to, we are informed that 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 would result.

Our correspondent, Mr. Ranson, writes with positiveness upon this point, as follows:

> The fact of the plant itself flourishing better may be attributed to a combination of conditions existing both in the soil and surrounding atmosphere, principal among

[1] Patent Office (agricultural) report for 1855, p. 242.

which I notice the presence of salt making it retentive of moisture, and of lime phosphates resultant from decaying shells. Land bordering on the Atlantic coast, which is evidently alluvion to a comparatively recent date, is generally considered too poor in the constituents necessary to plant life to make it worth while to attempt any cultivation upon it, and whilst this may be true as regards a lack of decomposed vegetable matter yet the shelly, saline sands will be found to suit such plants as the yuccas, agaves, etc., both chemically and physically better than the rich, black hummock lands.

Mr. John Cleminson, who has a plantation near Jupiter, advocates "saw palmetto and scrub land—yellow subsoil," and states that "any old worn-out field is suitable." As Mr. Cleminson's plants were not as thrifty as they should have been, I fear he has planted in soil not suited to their growth.

As far as my own observations go, while the plant will thrive in rocky and comparatively arid situations, it will grow more luxuriantly in the deeper and better soil. On the Perrine grant I found a hedge of sisal plants growing on a stone wall 2 or 3 feet high, and noted, particularly, at one point where the wall was broken down and the plants were near the ground they were more thrifty and of better color than where the wall was higher. And as an example of the other extreme I saw plants in rich garden soil at Fort Myers which were a third larger and the leaves longer, thicker, and heavier. But without an actual test of the yield of fiber from plants growing in different soils it would be hazardous to state whether the very thrifty plants in good soil will be any more productive, as regards yield, than the plants growing in barren situations. The Department will make such tests at an early date. The soil of the Indian River region and at Jupiter differs materially from that of the Biscayne Bay region, and this somewhat from the soil of the keys. In the former there is the absence of the underlying homogeneous coral rock, resembling limestone, which prevails all along the coast of the southern peninsula. The soil of the upper region is more sandy and less compact, with the absence of lime-rock. The soil in which the plants are growing on the Perrine grant resembles fine sand mixed with humus and other coarse semi-decayed vegetable matter, and is dark in color, while that from Boca Chica is a rich chocolate brown, of a more peaty nature, appearing like vegetable mold but mixed with disintegrated lime-rock. The "rock" formation, (foundation) of the keys seems more recent than that of the mainland, the "coral" origin being very distinctly marked, and the soil thinner. Undoubtedly the pine barrens near the coast will give just the right conditions when cleared up and the palmetto and other "scrub" grubbed out. The hummock lands, of course, are richer.

Mr. Ewan, of Miami, thinks that "marl prairie" will give the best results, but it must be drained; does not believe in the poor-land theory. The soil, commencing at Miami and running along the entire Biscayne Bay region, is a combination of shell, sand, and vegetable matter, with coral rock cropping out here and there. He states that

on "marl prairie" the expense of clearing would be done away with. Cutting off the "scrub" and grubbing the average lands, with plowing, he thinks would cost $80 per acre. He suggests growing pineapples and vegetables while the sisal is coming on. The Bahamian purchasers offered him 7 cents per dozen for young plants, which was declined. White labor costs, at Miami, $1 and $1.50 per day, or $15 per month when boarded. A colored man gets about $1. Plants grown on hummock land, fertilized by hogs and horses, he thinks will produce leaves large enough to cut for fiber in 3 years.

The lands about Fort Myers are chiefly coral formation and disintegrated shell. It is called a sandy loam, but is in reality about 25 per cent. of disintegrated shell and 8 per cent. of phosphate, the remainder being sand and humus.

According to the report of Mr. Preston, special commissioner from the Bahamas to investigate the sisal industry of Yucatan, the Bahama growers employ "the old worked lands" in establishing a sisal plantation. He says:

> No one need go farther than the ground of Fort Charlotte, along the road west of Nassau, or look into the lots of each side of Shirley street leading to Fort Montague, for the sort of land its cultivation requires. In fact, any land that is shallow, impoverished, and that will grow nothing else, suits it. It is an air plant, requiring the ground only to hold it up.

The soil in the Merida district of Yucatan is described as stony and sterile and composed chiefly of disintegrated lime-rock. This region is only a few feet above the sea level, and the whole sisal country is described as low and flat.

Mr. John I. Northrup, in his admirable article on the cultivation of the sisal in the Bahamas,[1] makes the following statements in regard to the character of the land employed by the Bahamians:

> In Andros, which, as above stated, is the largest of the group and where most of the writer's time was passed, the land is locally described by one of three terms: it is either "coppet" or "swash" or "pine-yard." The coppet, which occupies, as a rule, the more elevated parts of the island, is composed of small angiospermous trees, often only 2 or 3 inches in diameter and so close together as to make an almost impassable thicket. Back of the coppet, which is mostly a fringe along the eastern coast, nearly the whole interior is one vast "pine-yard," made up of the Bahama pine (*Pinus bahamensis*). The trees are generally small, and from 10 to 20 feet apart. Under them is frequently a dense undergrowth of a tall brake, which is often 6 or 7 feet high, and is known by the natives as "Maypole."
>
> "Swash" is a very expressive term to donate the low, swampy ground of which there are thousands of acres on the west coast. Here the soil is soft and is composed of comminuted calcareous particles; it supports no vegetation except innumerable small mangroves (*Rhizophora mangle*), here and there small "buttonwoods" (*Conocarpus erectus*), a few "salt-bushes" (*Avicennia nitida*), and in some places palmettoes.
>
> So far as sisal cultivation is concerned, the "swash" is utterly valueless, but the "pine-yard" and "coppet" are both available. In neither of these, however, is there

[1]Popular Science Monthly for March, 1891, p. 606.

what we recognize here as "soil;" and at first it was a source of wonder to the writer that anything at all could grow there, for the surface is very largely the bare coral rock. However, it is rarely smooth, but is rough and jagged, with innumerable points and crevices, so as to resemble somewhat the appearance of a well-thawed mass of snow-ice. In most places, also, there are numerous holes, from a few inches to many feet in diameter, and it is in these holes, cracks, and crevices that what little earth there is can be found; still this little seems sufficient to support the dense vegetation. Some of the other islands—Eleuthera, for instance—have considerable depth of soil, but it is when growing on the bare rocky ground described above that the sisal is said to produce fiber of the best quality.

Here is valuable testimony, also, from a very recent report on the Bahamian fiber industry, made by James M. Rae to the governor, Sir Ambrose Shea, which confirms my own observations in Florida:

I have both read and heard it broadly asserted that sisal will grow and flourish anywhere, no matter how sterile or impoverished the land may be. My observations, however, do not confirm this. I do not mean to convey the idea that *really good rich land* is necessary for its successful cultivation, but merely to remove the impression, if such there be, that the plant will thrive in dry arid sand or on rocky land void of soil. Worn out "provision" and pine-apple fields appear to be well suited to its cultivation, while on broken, rocky surfaces containing innumerable "pot holes" and crevices in which is deposited the ordinary black or red earth the plant luxuriates. Nowhere have I seen it appear more flourishing than on such lands. Certain kinds of white sandy land, found in large quantities at some islands, also suit it admirably. One of these varieties, white on the surface from being bleached by the sun, on being turned disclosed a dark colored mixture resembling salt and black pepper, and is known locally by the term "salt and pepper land."

Another still darker colored sandy soil is termed "mixed" land. Yet another kind which, although white on the surface, is found to be of a reddish color an inch or two below is very fine and close. These varieties doubtless possess some organic matter and are not to be confounded with the loose coarse sand found in scrubby plains and bay ridges, producing a natural growth of stunted palmettoes and low brush and on which nothing else will grow. Persons who have seen sisal, cocoanuts, and guinea corn growing on the white land that fringes the eastern shore of Andros, and also on the white land of Abaco, Grand Bahama, and Harbour Island, will readily understand the description of soil to which I have reference. The sisal plants growing opposite "The Caves," in the western part of New Providence, afford another illustration.

In selecting such lands for planting the height of the indigenous growth will in general afford sufficient indication of its adaptability to sisal. Where this attains to 10 or 15 feet the land is all right, but where there is only a dwarfed growth of 3 or 4 feet the soil is too poor to cultivate anything on. It is, however, gratifying to know that there is but a small percentage of such land in the colony.

It is said that for this culture little or no soil preparation is needed beyond clearing the land of trees, stumps, and roots to facilitate the removal of weeds in the spring, as after the plants are well established no other weeding will be necessary. The plants are set out when about 18 inches high and will then come into maturity (that is, produce leaves fit for fiber) in 3 years. While this would appear to be a very simple form of soil preparation, clearing the land will prove to be a large item of expense in Florida in starting a sisal hemp plantation. Where large areas are to be cleared the work can undoubtedly be so systematized and performed under contract that the usual cost, as the

clearing is now done in a small way, will be reduced perhaps one-half. In the vicinity of Jupiter, as I was informed, the cost of grubbing out the palmetto and other roots is $10 to $15 per acre, with $8 more for plowing. Another estimate by a practical farmer, average for the entire east coast of Florida, was stated at $50 to $80 per acre. While at Miami I saw a piece of pine barren land which was being cleared by contract for $30 an acre, though a gentleman with whom I had considerable conversation at Miami was of the opinion that for the average of land in the Biscayne Bay region it would cost $75 per acre. It must be borne in mind that these are not contract prices, and that they have been based on the experiences of ordinary farm practice, where a few acres have been cleared as wanted for general cultivation of fruit and vegetables. Dr. Washburn, in charge of the tropical subexperiment station at Fort Myers, states the cost of grubbing out the twenty cords of palmetto roots, which an acre of land produces, at $25.

In the Bahamian literature of the subject very little is said upon this point that will apply to Florida. Mr. Northrup says of clearing the land:

> If it is pine-yard a fire is started, which burns off the May pole; the pines are then cut down and either made into charcoal or laid in rows across the fields and allowed to decay. If coppet, the trees and shrubs are cut down with axes or cutlasses, according to their size, and the brush is then burned.

Nothing is said of grubbing out roots or of the question of expense. As to the use of fire in getting rid of brush, etc., I am satisfied that unless done when the ground is wet the soil itself, at least in many localities I visited, would be burned out also and destroyed. And to put out a plantation, even in pine barren land, without clearing, would simply be to invite disaster, as the grass and palmetto are frequently burned over. Fire is particularly destructive to growths of the agaves.

Edgar M. Bacon, writing in the American Agriculturist, makes interesting statements upon the practice in the Bahamas as follows:

> When the right spot has been found; when the selection of seeds or suckers, the preliminary preparation has been accomplished; then the choice of season hastens or retards the work of preparing the ground for the reception of plants. Of course there is no winter; no frost or cold to contend with; no blizzard to calculate for. But there are rainy and dry seasons. One must calculate so that the necessary burning of cut brush and trees will not occur when the fires are liable to be extinguished by the violent down-pour of the "winter" rains, nor the planting delayed until the dry months interfere with the advance of the young plants.
>
> All the ground is gone over first with the machete, a long heavy cutlass-like knife, which the negro uses either as a tool or weapon. All trees and underbrush are cut down except the very large ones, which require an axe. Then the stumps are grubbed up, so far as they are likely to interfere with the work. Next, fire is employed, and quickly runs over the acres where the negroes have toiled in gangs with their cutlasses. In this work of clearing women are often found more satisfactory as laborers than men, and they receive but 36 cents where the men get 50 cents. Few laborers are paid by the day. Task work, *i. e.*, so much for clearing a piece of land

of a given size, called a "task of land," is the usual method. In clearing brush land in the Bahamas one-fourth of an acre is a task. When at last all the clearing and planting has been done, and thousands upon thousands of perfect plants in absolute symmetry of arrangement, with unbroken ranks, their rich green showing no blemish, stretch before the eye, the spectator (especially if he happens to have a financial interest in the plantation) feels that there is a beauty apart from mere picturesqueness.

In a description of sisal culture, published about 35 years ago,[1] it is stated that the plants should be set out when 3 feet high, which will give leaves ready to cut in 2 years. There is no advantage in this practice, however.

Regarding the distances at which plants should be set there seems to be the greatest difference of opinion. Mr. Cleminson, of Jupiter, advocates setting in rows 5 feet apart and 3 feet in the row, which is entirely too close in my opinion. In the Merida district of Yucatan they are set in rows 9½ feet apart and 6½ feet in the rows. According to the Bahamian Government report, made by Mr. Preston several years ago, the distance in old fields is stated at 9 feet between the rows and 4 feet in the row. Experience has shown however that when planted too closely the leaves are injured by being beaten together in high winds; consequently 11 by 6 and 12 by 6 was considered sufficiently close, requiring from 600 to 650 plants per acre.

It will be seen that the difference between this plan of setting and that advocated by Mr. Cleminson is the difference between 600 and 2,000 plants per acre. As to the danger of injury from winds, it is claimed that Florida plantations are seldom swept by hurricanes, and that there are no other objections to closer planting. Regarding the actual practice in the Bahamas let us again turn to Mr. Rae's report, published this year (1891), where the distances apart are stated as follows:

> The system adopted by those who have engaged largely in planting varies. Some have planted as near as 6 feet each way; others 7 by 7, 7 by 8, 7 by 9, 8 by9, and 9 by 9. The Monroe Company at Abaco plant three rows 8 feet apart with 7 feet interval between the plants, and leave a space of 12 feet between every fourth row. The "Bahama Hemp Company, limited," which is under the efficient supervision of Mr. Abbott, plant four rows 8 by 8, leaving a distance of 12 feet between every fifth row. Most planters, however, have found it advisable, owing to the rocky nature of the land, not to observe too strict regularity in planting, but while adhering as near as practicable to it, to put plants in the most favorable spots. Most of the laboring class who have engaged in planting have observed no method at all, but have put the plants in the ground wherever a good "pot hole" or chink in the rock occurs, and have planted much too thickly.

In Mexico, as far as I have been able to ascertain, the plantations are set out with more regularity.

Plate III illustrates the appearance of a hemp plantation on the farm Dr. Manuel Donde, near Merida, Yucatan, which is characteristic.

Many Bahamian growers utilize the spaces between plants with other crops, such as pease, corn, or even cotton. The plan is strongly recommended, provided the matter is not overdone. Not only are the sisal

[1] Report of the exhibition of 1853, in New York.

plants shaded in their early growth, but crops of weeds are suppressed, and the cost of keeping the land clear lessened. Sweet potatoes are injurious, as they cover field and sisal plants alike, retarding their growth.

As to the time of planting, the rainy season is most favorable. Mr. Cleminson's plan is to apply to each plant a handful of cotton seed meal, and, after two months' growth, lime and salt are spread at the rate of 20 bushels of the former and 5 of the latter to the acre. The lime and salt are said to kill the weeds and attract moisture. I should not recommend this without further experiment, however. After the plants are of sufficient size to shade the ground there is little trouble from weed-growth. The late Mr. Van Buren, of Jacksonville, made statements in this connection as follows:

All the after culture needed is just enough to keep down the weeds until the plants are large enough to shade the ground—say once or twice a year for the first two years; grass does not injure the plant, but it should not be shaded by undergrowth."

During my recent visit to Florida the bad effect of shade upon large plants was noted in several marked instances, the plants being less thrifty, and the leaves sometimes so spindling and thin as to have lost their rigid habit and to be bent and drooping. In several instances the thorns of one leaf had injured other leaves with which it had come in contact when the plant was swayed by winds. Dr. J. V. Harris, of Villa Franca, Fla., a correspondent of the Department, takes an opposite view of this question of little cultivation.

In a recent communication he says:

It is repeatedly stated that sisal hemp will grow upon the very poorest lands, and requires no cultivation, but will take great care of itself and kill out all other vegetation. I do not know how it will grow upon poor land, as all that I have ever seen in Florida was at Miami and on Indian and Knight's and other islands along the coast which are all extremely fertile. As to cultivation not being needed, this is only true where the land is so very rocky that it is impossible for enough vegetation to grow to interfere with the plants. Ordinarily it is safe to calculate that it will take just as much cultivation as any other plant, and that 4 years will have to be spent in every instance before each crop can be harvested.

In the Mexican official publication distributed at Paris, before referred to, the statement is made that the henequen plants received two dressings the first year and one every year afterward.

As to weeding, as before stated, other vegetation should not be allowed to interfere with the growth of the plants, especially while young. The kinds of weeds which spring up in the Bahamas are greedily eaten up by sheep, and in some localities the practice is to allow these animals to keep the ground clean. Regarding the danger of injury to plants by formation of suckers, the fact that young plants will be in great demand for several years to come will obviate all trouble from this source. As to the treatment of the young plants before setting out Mr. Preston says in his report:

The roots of the young plants are treated in exactly the same manner as pine-apple slips, and suckers are cleaned before they are planted. Pine-apple growers will quite understand this.

Mr. Rae, however, in his recent report deprecates this practice.

Upon the subject of cultivation and care of the plantation, Mr. Edgar Bacon makes suggestions as follows:

Experienced growers use 650 plants to the acre in rows 11 feet by 6 feet distant from each other. This will give room for the laborers to walk between the rows without being wounded by the terrible spurs, which like a cluster of keen spears make each plant a menace to the unwary. Besides this the closer planting would result in the piercing of innumerable leaves every time the wind blew, and the consequent destruction of much fiber. Stabs and bruises mean discoloration, and the expense of sorting damaged lots apart from the proportional loss would be an added and not insignificant item in the labor account of a plantation. Many people who have caught the sisal fever are planting acre after acre expecting nothing less than that the farms, when planted, will take care of themselves. To be successful in this enterprise requires unceasing activity and care. One must be Argus-eyed. One season of poor prices with the consequent discouragement which is apt to follow in the case of nine small proprietors out of ten, in a country where the peasantry are all negroes, will result in an overgrowth of suckers and the poling of mature plants till nothing short of absolute clearing and starting anew will save the farms. There is no cultivation where system and perseverance are more necessary to success. The dropping of the seed from a single "pole," if not watched and attended to immediately, will produce little spears enough to destroy a hundred plants, and I have frequently seen a dozen suckers start up around and under the leaves of their parent. After such crowding, the leaves would be worthless, even could they be reached; but no man, unless arrayed in metal armor strong and stout enough to withstand the thrust of steel, would be so foolhardy as to attempt to penetrate such a growth. What I want to impress is the fact that without that patient and systematic care which I nowhere observed as characteristic of the unled negro, a field of sisal is as valueless as a field of mullen.

It is desirable that the young plants be set out in perfectly straight rows and upright, for if not, and they grow up at angles in all directions, there will be difficulty in getting between them when the leaves are harvested. Regarding the suckers, there is no question but that they should be removed, for to allow them to remain will be a positive detriment to the parent plants. If they are not needed for the planting of new fields they should be thrown away. In setting out these suckers in Yucatan the planting is said to be very simply accomplished: a little hole is dug and the plant introduced, after which it is propped up by a few stones and left to take care of itself until the time for taking off the first leaves. When cultivating suckers in the nursery, the practice in Florida is to set them out 10 or 12 inches apart in rows, where they remain until large enough to set out in the fields. Suckers are not relied upon alone for the propagation of the plant. When the old plant flowers it sends up a stalk, or "pole," as it is called, to the height of 15 or some times 20 feet. After the tulip-shaped blossoms which appear have begun to wither there now 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.

A single "pole" or "mast" produces from one to two thousand plants, while only a few suckers are formed at the base of each old plant. The largest pole plants that I saw in Florida measured about 4 inches in length. But among a lot received from Mr. Bier recently was one which measured 10 inches, that had never been in soil. An illustration of this plant, reduced in size, is reproduced on Pl. IV at the end of this report. Fig. 2, Pl. IV, is a pole plant brought from the Bahamas in November last, and now growing in the Department conservatory.

The manner of growth of these plants, on the flower stalks, is shown in our illustration on Pl. V, with a view also of the entire plant in blossom. As bearing upon the statements frequently made regarding the wonderful hardiness of *Agave sisalana* where plants have been kept out of the ground for a long time in transportation, or from other causes, an experience with a lot of these pole plants is interesting. In march, 1890, a portion of a flower head was sent from Key West, together with a number of the newly formed plants. After examination the box containing the specimens was put to one side and not seen again until June. The plants were found alive and in good condition. About the 1st of November the box was again examined; the plants had apparently grown a little, and eight of them were sent to the greenhouse to be potted out. They began to freshen at once, and are now in a thriving condition and will make good plants.

Mrs. Walker tells me of a large plant sent to her at Albany, New York, some years ago, the roots of which had been cut off. It was kept as a curiosity for several weeks to show to friends who had never seen a sisal plant. It was then set up carelessly on one of the flower beds in the garden, where it took root and grew, and was finally potted and sent to the greenhouse of Mr. Erastus Corning, and was preserved by him among his collection.

In regard to the flowering of the plants in the field, while some writers state that the appearance of the pole should be watched for, and the stalk cut out to prevent blossoming, as the plant then withers, others state that because this indicates old age and the end of the usefulness of the plant, there is no advantage in attempting to save its life further.

In Florida the age of maturity in the wild state is about 6 or 7 years. In Mr. Rae's Bahamian report reference is made to a plantation of 500 "trees" that had been planted 6 years. They were fine healthy plants and 60 of them "in short leaf," that is, preparing to pole. A few had already sent up the "mast." From the experience of planters, several cases being cited, the following deduction is made:

Not only does the cutting of the leaves retard the period of poling, but it also lessens the size and productiveness of the pole.

In Yucatan the period of usefulness lasts from six to eight years—sometimes from fifteen to twenty years—and leaves may be cut until the plant has attained the appearance shown upon Pl. VI. This plant was 15 years old when the illustration was made.

RATE OF GROWTH, HARVESTING, AND YIELD PER ACRE.

As has been stated, a plant set out at 18 inches high will produce leaves fit for cutting in 3 years. The lower leaves, naturally, are the most mature and are cut first; these should be at least 3 feet long. Mr. Cleminson informs me that the average length of the leaf from 4-year old plants, as grown in Florida, is 3 feet 3 inches when cut, and for 3 years afterwards 6 inches longer each year. He also states that thrifty plants at 7 years will produce leaves 5 feet in length, and if the flowering stalk is cut when it first makes its appearance, the plant will continue to grow to profit for 25 years. Mr. Ranson gives his experience as follows:

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 2 years the leaves of the large plants were 2 feet 8 inches long and at the same time the leaves were 3 feet 2 inches long and were fit to commence cutting. The result of one plant here of 2½ 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.

As to my own experience, I saw plants in Southern Florida, with leaves over 5 feet long, that were said to be only 4 years old. As the gentleman above quoted records experiences in the Indian River region, I am inclined to the belief that the plants grow faster and mature earlier in tropical Florida.

The leaves are cut close to the trunk, a sharp knife being used for the purpose. In Yucatan the spines are removed from the edges of the leaf, together with its thorn-like point, after which 50 leaves are tied together to form a bundle. About 1,500 leaves, making just a cartload, are considered a day's work.[1]

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[1] In an article relating to this industry, furnished to the Farm Implement News by a Chicago gentleman who visited the Merida district a year or so ago, the following account of the method of harvesting appears:

"This is done by the Indians, who are almost nude, with a stroke of the knife, or *machete*, at the rate of, for one hand, of 2,000 to 2,500 leaves per day. Following the Indian who cuts off the leaves is an Indian woman, who, with a knife, cuts off the spike or thorn-tipped end and the thorny side of the leaf, ready for the machine. One foreman was understood to say that it costs about 38 cents per 1,000 leaves to cut, prepare, and get the leaves to the cleaning machines. On all the large haciendas visited were little railways into the fields, upon which on cars drawn by mules the henequen was taken to the mill and the waste was taken away."

Regarding cost of labor: This is now greater than formerly. "Mr. M—— said about 38 cents per day (their money is worth 80 cents on our dollar, or thereabouts); but probably the expert feeders of machines (or skilled workmen) make considerable

Opinions vary as to the yield of leaves per acre, and also in regard to the yield of fiber from these leaves. The late Mr. Van Buren stated that the product of nine hundred plants to the acre in the third year, allowing for two or three cuttings of five leaves each, equal to 12 or 15 pounds to the plant, would be 6 or 7 tons of green leaves to the acre, worth at least $3 per ton. He estimated the yield for the following year at 18 tons of leaves, from five or six cuttings, worth about $50 per acre. In the report of Mr. Preston it is said that in Yucatan a leaf 4 feet long weighs $1\frac{10}{16}$ pounds, and measures in the widest part $3\frac{3}{4}$ inches across from spine to spine and is one-fourth inch thick in the center of the leaf, 2 feet from either end. A similar leaf from the Bahamas is said to weigh $1\frac{1}{2}$ pounds and to measure $4\frac{1}{2}$ inches wide, and five-sixteenths of an inch in thickness.

Mr. T. Albee Smith, in a letter received last year, makes the following interesting statement:

> 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. I have seen 90 leaves cleaned in 5 minutes on one wheel with two feeders, but this speed can not be continued. One thousand leaves of henequen weigh in the rainy season 160 to 200 arroba (25 pounds each); in the dry season 100 to 160 arrobas per 1,000 leaves. One thousand leaves average a yield of 55 pounds of fiber.

Regarding the size and weight of Florida sisal leaves, the following tables, compiled from the weights and measurements of many leaves collected during my recent trip, will prove of interest:

EXPLANATION, TEXT PLATE, page 27.

Fig.	Variety.	Locality.	Length of leaf.	Width of leaf.	Weight of leaf.
			Ft. In.	*Inches.*	*Lbs. Oz.*
6	Smooth	Perrine Grant	4 8	5	.....
7	....do	Miami, Fla	4 10	$4\frac{1}{2}$	1 12
8	....do	Jupiter, Fla	4 2	$4\frac{3}{4}$	1 14

more, and much of the work is done by the thousand leaves, or by piecework. To each hacienda a lot of peons, Indians, or rather *mestchezoes*, attach themselves, and although not legally slaves, yet by the peculiarities of Mexican law and of their own habits they are serfs, and in a transfer of title to the estate they go with the land. They are mild, inoffensive and industrious, but the fact that they are not migratory or easily transferred, is a feature not to be lost sight of in calculating the future possibilities of an Indian in the production of henequen. Just as much can be done as the owner of the hacienda can do with the help he has, and no more; hence the value of labor-saving cleaning machinery. It will enable the hacienda owner to grow more hemp. Mr. M—— markets about 2,000 bales of hemp, and has 114 laborers; another hacienda owned about 500 people and only about 140 laborers, the remainder being children or women who could not do fieldwork. * * * The people are chiefly Maya Indians, the descendants of a race which in the remote past had attained a higher degree of civilization than any of the other aboriginal Americans."

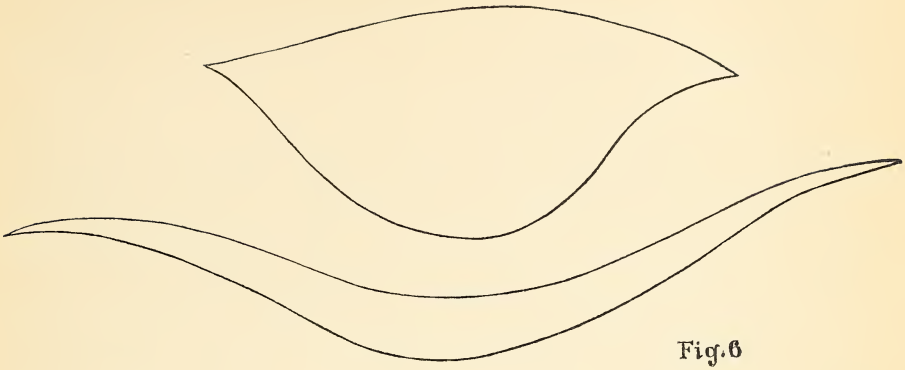

Fig.6

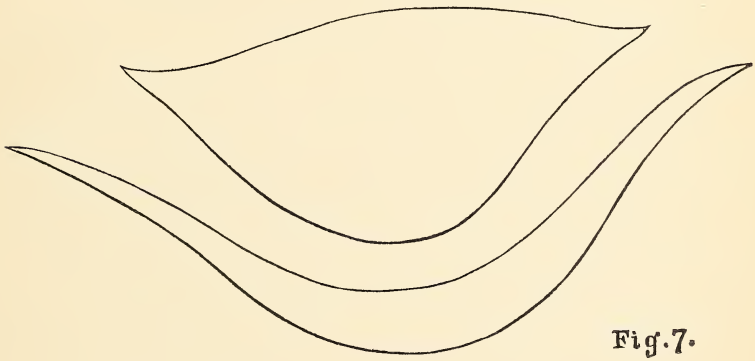

Fig.7.

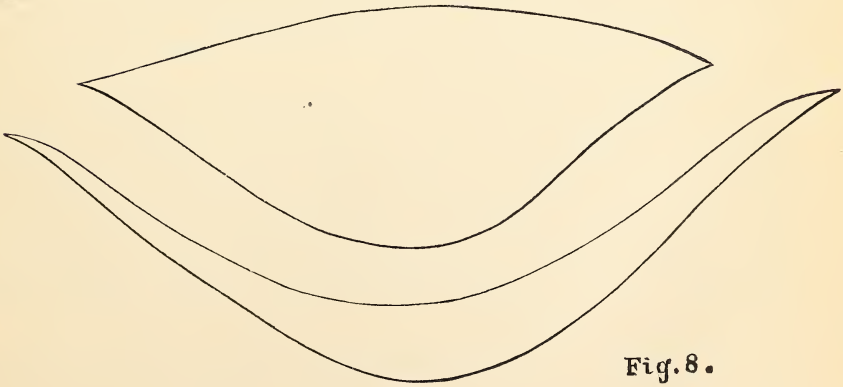

Fig.8.

EXPLANATION, TEXT PLATE, page 29.

Fig.	Variety.	Locality.	Length of leaf.	Width of leaf.	Weight of leaf.
			Ft. In.	*Inches.*	*Lbs.*
9	Smooth	Fort Myers	5 0½	4½	2
10	do	Upper Metecombe	5 8	5	
11	Spined	Perrine Grant	4 1½	5¼	

Outline drawings, made from the freshly cut leaf, to illustrate the thickness and shape of the leaf (cross-section), at base and center or widest portion, are reproduced on pages 27 and 29. It will be noted that with one exception these have been made from the smooth variety of leaf. They may be taken as typical examples and fairly illustrate the form and thickness of the leaf as grown in southern Florida. From this it may be stated that the full-grown mature leaves of Florida plants (var. *sisalana*), 5 feet in length, will weigh 1¾ to 2 pounds. Attention is called to the Fort Myers example, Figs. 2 and 9, which were taken from a leaf grown in garden soil. The drawings of cross-sections were made from tracings of the freshly cut leaves in the field.

Regarding yield, size of leaves, etc., in the Bahamas Mr. Rae, in his recent report, makes the following statements:

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 plant 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 2 years; I have also seen plants that, I was told, were 3 years old, from which leaves had been already cut.

For the present the yield per acre with us can be only a matter of calculation, in consequence of the industry having been so recently begun, but sufficient positive experience has been derived to determine this point with approximate accuracy. The number of leaves cut from many plants of 4 years' growth and upwards has given an average of 40 leaves per tree, with an average weight of 1½ pounds per leaf and a yield of 4 per cent. of cleaned fiber. With an average of 600 plants to the acre, and 40 leaves weighing 60 pounds to each plant, the yield would be 36,000 pounds of leaf and 1,440 pounds of cleaned fiber. If the estimate be reduced to 35 leaves there will be 31,500 pounds of leaf and 1,260 pounds of fiber, and this is certainly a very modest estimate. To guard against all possible disappointment, however, the yield per acre can be safely placed at half a ton.

The Department has not yet been able to make comparative tests in regard to yield of fiber in Florida, but it is hoped machinery will be in position on the Department grounds, before this report is through the press, that will enable us to make such tests, when the records of the experiment will be placed before the public. And I am satisfied that the results of the experiment will not be in the least disappointing. Upon this subject Mr. Bier, of Key West, writes in a letter of recent date as follows:

I find that our fiber, although somewhat finer in texture, is longer and stronger than that grown in Yucatan, and weight of fiber to the leaf is a fraction more in weight. The average per leaf of Yucatan is 490 grains, while ours averages 520 grains with less moisture.

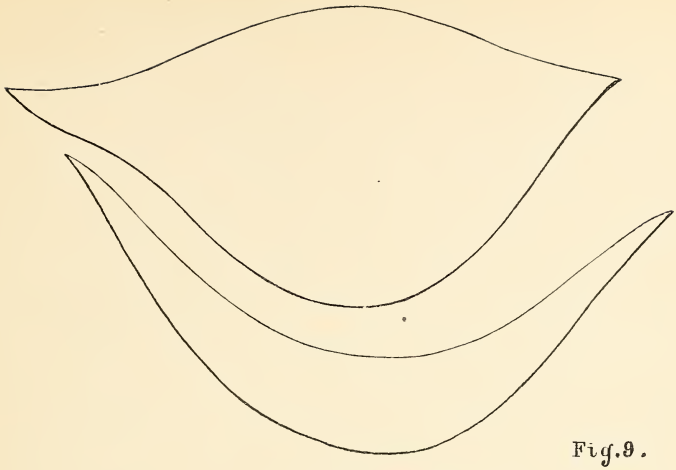

Fig.9.

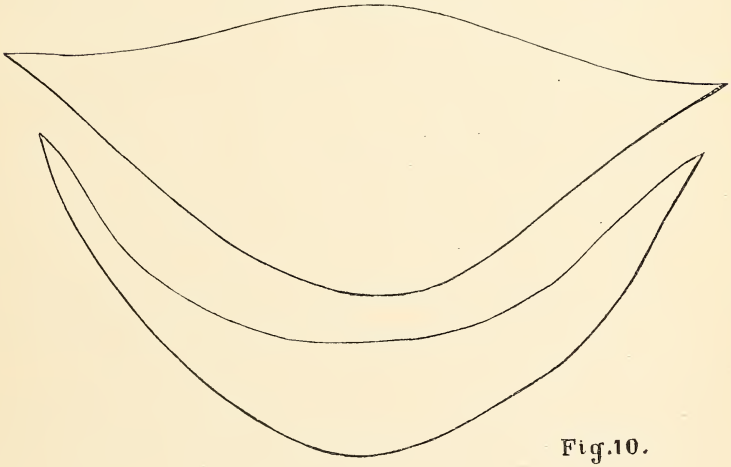

Fig.10.

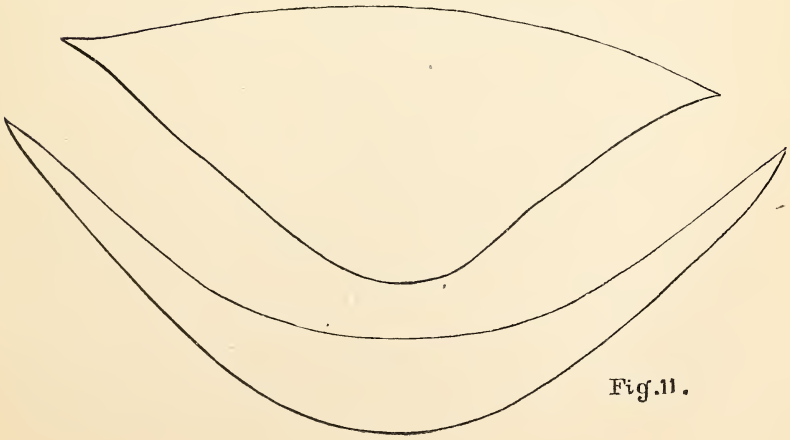

Fig.11.

In the Kew Bulletin it is stated (on the authority of Mr. Stoddard, who furnished to the government of Jamaica an account of the sisal-hemp industry of Yucatan) that 30 to 35 leaves per annum may be estimated for each plant, the return of hemp being at the rate of 1,000 to 1,200 pounds per acre, the net money return on a fiber plantation in Yucatan being estimated at 4 to 5 pounds per acre, or $19.48 to $24.33 in United States money. According to the Bahamian, report, 40 leaves may be cut annually from a mature plant. At the average of 1½ pounds to the leaf, on the basis of 650 plants to the acre, this yield gives a total of 39,000 pounds of leaves, or 19½ tons. Mr. Preston calls it 19 tons, and at the rate of $2.50 per ton, the value of the green leaves before cleaning, we have $47.50 per acre, or almost double the value stated by Mr. Stoddard. On one of the farms visited by Mr. Preston in Yucatan 48,000 leaves, or 72,000 pounds (36 tons) of crude material was cleaned daily. A yield of 5 per cent of fiber, which is his estimate, gives a little over 1¾ tons of fiber per acre from the 36 tons of leaves. Here is Mr. Preston's estimates based on figures of yield in Yucatan, with cost of labor in the Bahamas:

48,000 leaves (36 tons), at $2.50 per ton	$90.00
6 wheels, each two hands, at 48 cents	5.76
3 boys supplying feeders, at 24 cents	.72
3 women to remove and hang fiber, at 30 cents	.90
Engine driver, at $2	2.00
Fuel	2.00
Incidentals	2.00
	103.38

This shows a yield of 3,600 pounds of fiber from 72,000 pounds of leaves, at a cost of $103.38, making an average of $2.87, as the cost of producing 100 pounds of fiber the product of 1 ton of leaves.

Mr. John Grant, writing the Department from Jupiter, Florida, makes the statement that plants grown in Dade County, Florida, will yield 7 pounds of commercial fiber to every 100 pounds of leaves, which is equal to 140 pounds of fiber from a ton of the crude material. This approximates closely the statement made in the report of the New York exhibition of 1853, that "75 ordinary leaves are estimated to yield 7½ pounds of fiber." At the rate given by Mr. Grant, 75 leaves would give about 8 pounds of the cleaned product.

Mr. Bier has stated that the quality of fiber from Florida plants is finer than that which comes to market from Yucatan. The small samples in the Department collection bear out this statement, though I do not wish to record it authoritatively until there has been opportunity to examine fiber extracted in quantity by the Department from Florida leaves of the proper variety.

In an official letter just received from Mr. Alfred Greenwood, the private secretary of the governor of the Bahamas, occurs this paragraph:

We do not approve of the fiber plants received from Florida, which are very inferior in product both in quality and quantity to what we get from the indigenous plant.

Before giving much weight to this opinion it would be well to know precisely from what leaves this fiber was produced, with age, conditions of growth of the plant, and methods or machinery employed in extracting the fiber. It is a fact that many schooner loads of plants, purchased or "taken" from the Florida keys, or the mainland, were not sisal plants at all, but the species previously referred to in this report as probably *Agave mexicana*. Even if the fiber was obtained from the true *sisalana* the statement suggests rather a deterioration of Florida plants in Bahamian soil than actual inferiority. I am glad to have this opinion, but in the absence of the details of information I do not consider that it disparages in the least our attempts toward the establishment of a sisal hemp industry in Florida.

Fig. 12.

Fig. 13.

MACHINERY FOR EXTRACTING THE FIBER.

In Dr. Perrine's day the question of machinery for cleaning the leaves does not seem to have been considered so all important as at the present time. On plate No. 2 of the Senate report of 1838, before referred to, there are drawings of two rude wooden implements, which were used by the natives in extracting the fiber, as well as drawings of the leaf unscraped and scraped. Figures of the two implements are here reproduced, Figs. 12 and 13. The explanatory matter which accompanies the original plate gives a very good idea of the method of cleaning the leaves at this period.[1] The wooden scraper N is our Fig. 12, and T is Fig. 13.

[1] Here is the description:

"Plate No. 2, Fig. A1, represents an entire green leaf of *Agave sisalana*, or sisal hemp agave of Yucatan of the variety called Yashqui. Fig. A2; the fibers exposed from AA to the point of the leaf, by means of the *triangular wooden scraper T.* The unscraped butt end of the leaf is sustained by a board against the breast of the laborer, who then uses the scraping stick as curriers do their shaving knives. Fig. A3: the foliaceous fibers exposed by the notched wooden scraper N. The laborer takes the butt end of the leaf in one hand, and extends the remainder obliquely across a pole which is supported at an angle of 45 degrees by a post or wall; with the notched scraper in the other hand, one point of the notch is inserted through the leaf which is then drawn backwards, and the operation is repeated until the leaf is slit into five or six strips; each strip is then laid across the pole when the butt end of the leaf is drawn backwards and the fibers of that strip are then exposed; and so on successively till the cuticle and the cellular substances of the other strips are separated from the foliaceous fibers. By both figures it will be seen that these fibers are longitudinal and parallel, and are not connected by transverse fibers. The butt end of A3 exhibits the injurious effects of rotting by its own juices; and any process of maceration applicable to the dead, dried bark of common flax and hemp, preparatory to extracting their cortical fibers, is equally injurious to the color and strength of the foliaceous fibers in living green leaves."

In Squire's "Tropical Fibers," published only 30 years ago, the same laborious methods are described. Methods of fermenting the leaves in water and mud, steeping them in an alkaline pickle or confining the semi-crushed leaves in "an openwork wooden frame or box," placed in such manner that the ebb and flow of the tide should wash out the gum, are mentioned and dilated upon with no hint of existing machinery. Here is a brief extract from Squire's introduction:

I saw the native laborers at their work, slowly removing the pulpy and vascular portions of the agaves or *henequens*, with a triangular scraper, or a blunted knife, leaf by leaf, and ascertained that a few pounds of fibers, imperfectly cleaned, formed the total reward of a long day's toil. I turned away from the patient Indian laborer with a smile, half of pity, half of contempt, and asked my friend, the American merchant and planter, who had lived for many years in the country, "Why don't you import proper machinery for doing this simple work, and thus make a fortune out of tropical fibers?" "Because," was his answer, "there is no such machinery to be had. I long ago sent to the United States, to England, and France, and even to the Philippine Islands, where ten million dollars' worth of plantain fibers are extracted annually, and found that no machinery suited to the purpose had yet been invented. Everywhere, as far as I can learn, throughout tropical America, and the East Indies as well, the process of extracting these kinds of fibers is substantially that which you see practiced by yonder Indians." I was incredulous as to my friend's assertion, and when I returned to the United States I inquired for myself, but only to find his statement confirmed. I ascertained that although various machines had been devised for the purpose of cleaning the fibers of the pineapple plants, the agaves, and plantains economically and rapidly, none had succeeded in practice.

Until very recently the only machine in use in Yucatan was a clumsy affair stated to be a native invention, called a "raspador."[1] Rude as this piece of mechanism is, it is said that a native will clean 20 leaves a minute with it, though with quite a percentage of waste of fiber. While the raspador is said to have been superseded on some plantations, it is more or less generally used at the present time for extracting the immense quantities of sisal hemp exported. The average work of one machine is claimed to be 7,000 leaves per day with two feeders or operatives.[2]

It will not be necessary in this report to go into detail regarding the many machines that have been patented for cleaning sisal hemp during the last 40 years, or to even mention those that have been given thorough

[1] The following description of this machine, from a correspondent of the Syracuse Herald, in Yucatan, is so concise that it is worthy of reproducing here:

"It is simply a wheel, like a 4-foot pulley, 6-inch face, with pieces of brass an inch square and 6 inches long running across the face about a foot apart. This wheel runs in a heavy wooden case. When working well it makesabout 110 revolutions a minute. The leaf is put in through a small hole in the case, and being held by a strong clamp, is allowed to whip downward as the wheel moves around. A heavy block, like the brake of a car wheel, is, by lever, brought to bear on the leaf, pressing it against the revolving wheel. In a second the pulp is crushed and thrown into a pit under the wheel and the fiber is drawn back, one-half of the leaf being cleaned quicker than one can follow the motions. The leaf is reversed and the other end cleaned in the same manner."

trial on the Mexican henequen plantations and for one reason or another abandoned.

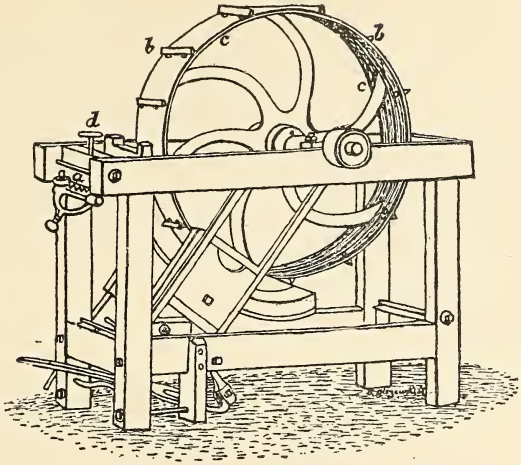

FIG. 14.—Raspador or Patruillo Machine.

Briefly, the machines may be referred to two types, those which take the leaf endwise (either passing it through at one operation, or reversing it when half cleaned, making two operations)[1] or those which take a continuous feed of leaves sidewise. The raspador belongs to the first class, the capacity of which must be limited, while to the second class belong the larger and more complicated machines, among which may be named the Stevens, the Prieto, and the Villamore, of larger capacity, costing several thousand dollars, and requiring special buildings and other machinery permanently located. In short, while the machines of one class are to an extent portable, those of the other class are for the central factory or mill and require a considerable plant and force of workmen.

I find in the United States Patent Office the records of an invention for cleaning sisal hemp, dating back to 1851, though the Patruillo machine, which is called the first machine of any practical value for this purpose, bears a date some 12 years later. As to the early cleaning wheels, there is little of interest to place on record in the present report. I may state, however, that one of these early machines has been described to me as constructed of wood, with a hub, spokes, and rim like a wagon wheel, having an iron tire shrunk on. Upon its periphery were bolted angle-pieces of iron for scrapers, and a block was arranged in front of the wheel, over which the leaf or fiber was bent, to hold it while being scraped. This rude machine is claimed to be the invention

[1] On another page is reproduced a drawing (Fig. 15) illustrating a gang of these rude wheels with Maya Indian attendants, on the farm of Edward Belio, near Merida, Yucatan. Fig. 16 shows the portable tramway used to transport the bundles of leaves to the mill.

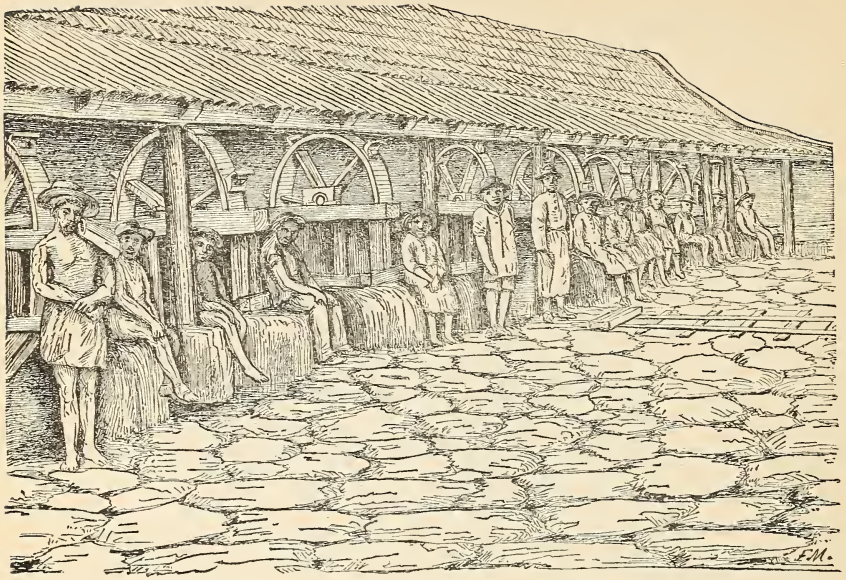

FIG. 15. Maya Indians cleaning sisal in Yucatan.

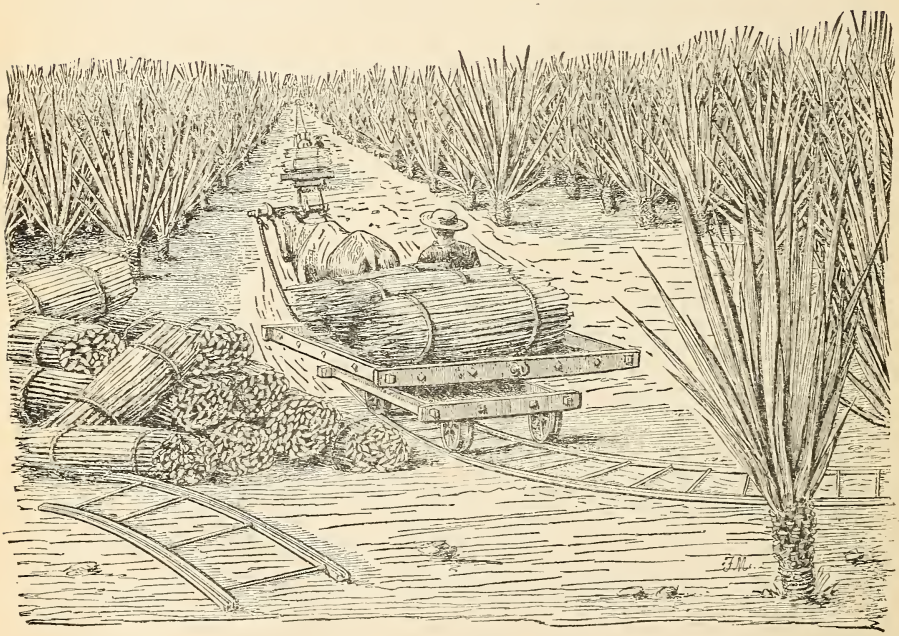

FIG. 16. Tramway used in transporting leaves to the mill.

of a Maya Indian, and doubtless suggested the principle of the raspador and all subsequent wheels of its class.

In Mr. Preston's report, which appeared two or three years ago, mention is made that on one farm visited he found six machines in operation of the "Death" pattern, driven by a 10 horse-power engine. The wheels are described as 50 inches in diameter with 8-inch face, and eight knives or scrapers, a 10 horse-power engine being required to drive them. The capacity of each wheel is claimed to be 8,000 leaves per day, or about 20 per minute. Two men are required at each wheel to stand between the wheel and rack containing the leaves, feeding them in as fast as their hands can move. One boy is required to a pair of wheels for supplying the feeders, and three boys carry the fiber to the drying ground.

Mr. Preston refers to this machine as the most simple thing possible, requiring no skilled labor. No water is used either for soaking the leaves or washing the fiber, and after exposure to the sun for two hours it is fit for baling.[1]

There are two machines patented by Mr. W. E. Death, one bearing date July 13, 1885 (American patent February 16, 1888), the other July 2, 1886 (American patent June 26, 1888). In both machines, however, water is used to assist in the cleaning of the fiber, while the inference

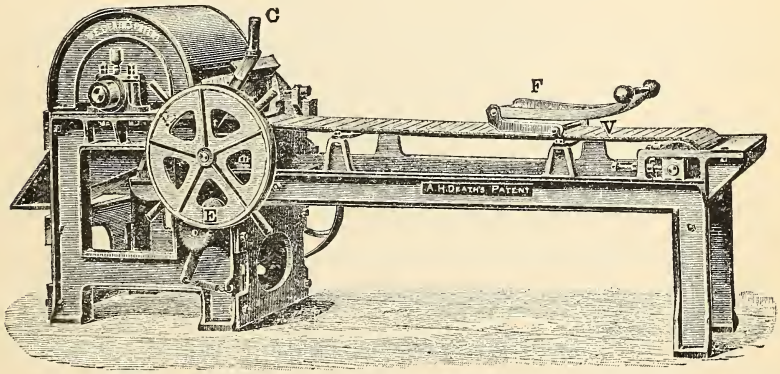

FIG. 17.—The Death cleaning machine.

[1] In a letter received from the Death's Fiber Machine Company, since the above was written, the explanation is made that the old Death and Ellwood machine works without water. The director says:

"We wish you particularly to note that the Death machine in use in Yucatan is the old Death & Ellwood scutcher and very much inferior to the new W. E. Death machine. The old Death & Ellwood machine works without water and causes a great waste of fiber; the new W. E. Death patent machine (of which we are the proprietors) works with water which cleanses the fiber from all acids and impurities, and delivers the fiber in a pure, white, and glossy state and practically without any waste. The difference between the machine patented July 13, 1885, and that of July 2, 1886, is this: The first named is the machine and the latter is the feed motion for supplying the leaves."

would be that no water is required in the machine referred to by Mr. Preston. The machine patented in 1885 is the simpler of the two. The latter machine was figured and described on page 26 of Fiber Bulletin No. 1, issued April, 1890, from information furnished by the Death Fiber Machine Company, Leadenhall street, London, last January (1890).

The illustration of this machine is reproduced above and the substance of the description given in the accompanying foot-note.[1]

A valued correspondent of the Department states that the improved machine did not come up to expectations in Yucatan, and that a previous machine was sold under the name of the Death machine, which was in reality the same thing as the Mexican raspador. I can not learn that the improved Death machine is now used in either Yucatan or the Bahamas, although they are in use by the Cuban Fiber Company, of London.

The manufacturers of this machine imform me that Cuban sisal fiber cleaned by it brought in the London market this year £50 per ton, while ordinary sisal, cleaned on the "old Death & Ellwood," brought but £28 per ton. It is said that new machines are being sent to Cuba the present year.

I give an illustration on another page of the machine built by T. Barraclough & Co., Manchester, England, which is described as follows:

This machine consists mainly of an iron cylinder, placed between two iron side frames; over the cylinder there is a cover. The cylinder is accurately turned and is fitted at regular intervals round its periphery with from eight to ten brass scrapers or scutching knives. In some cases brass spreaders are placed between these scrapers, their functions being to neutralize the tendency of the fiber to collect in streaks;

[1] This machine, for general fiber decortication, has attracted more or less attention for some years past, and a notice of it will not be out of place. It is the invention of W. E. Death, of Brixton, England, popularly known as the Death & Ellwood machine, patent bearing date July 13, 1885, improvements having been added. It claims to work well on all fibrous plants, from flax straw and hemp and ramie stalks to fleshy-leaved plants like the *agaves*. It is a single-drum machine, involving the beater principle, the breakers operating upon the fiber in conjunction with a stream of water, which washes out the refuse. The feed motion is worked as follows:

The upright handle C is for the self-acting motion to carry the leaves to or from the machine. By simply moving it backwards or forwards it puts friction wheels into gear which take the table to or from the machine. In working the holder F the levers are lifted by means of a knob at the end, and as many leaves or stems (as the case may be) as the machine will take are put across the part of the holder V and placed so that the grip on the holder may be taken near the ends of them. After securing the stems or leaves to be cleaned the clip is put on and the lever pressed down by the knobs, and the material fed into the machine by pushing the upright handle. When the holder has traveled as far as possible into the mouth-piece the handle is reversed for drawing the cleaned fiber out. The stems are then reversed in the holder and the fiber gripped in it and the ends sent forward for cleaning, as before. The wheel E is for working by hand, if desired.

The machine requires a 3 horse-power engine to drive it, the velocity being 400 revolutions per minute. From 300 to 400 gallons of water per machine per hour are necessary, and this it is reckoned is attainable by a 7-foot fall through a three-fourths service pipe. The capacity of the machine is placed at 2 cwt. of dry fiber per day of 10 hours.

they therefore spread it out and present it more evenly to the action of the scrapers. In front of the machine is placed a movable guide or scraping block, which is curved to the periphery of the main cylinder underneath. This scraping block is made of iron, faced with hard wood, so that whilst the leaf is being scraped it rests on the wood block. By means of suitable mechanism the distance of the scraping block from the action of the scrapers is regulated according to the varying thickness of the leaves, so as to insure the effective action of the scrapers and at the same time not to damage the fiber.

In front of the machine there is also an apparatus by means of which that portion of the leaf not under treatment is prevented from slipping into the machine. The machines are supplied with fast and loose driving pulleys, usually 26 inches diameter and 5 inches wide.

This is practically the raspador as now used in Yucatan, that is, in so far as it concerns the "raspar" or scutch wheel A, the block, B, the lever, C, for raising the block to the wheel when pressing the leaf to

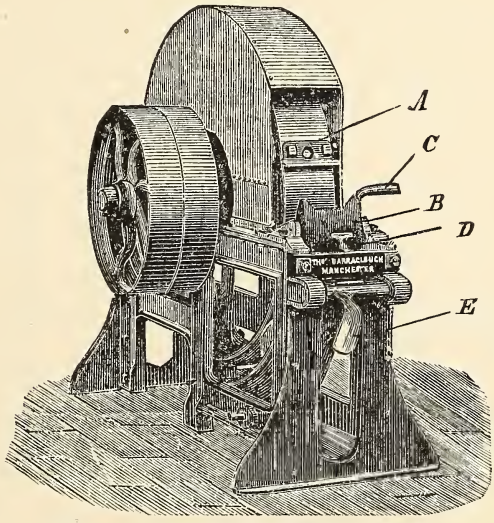

FIG. 18.—The Barraclough cleaning machine.

scrape it, the stud, D, which is used to wrap the fiber of the cleaned end of the leaf around while the last end is being scraped, and the clamp or grip, E, which is used to hold the leaf while the first end is being cleaned. I am informed by a mechanical engineer who is thoroughly posted regarding the industry of Yucatan that these five elements are found in all the machines used in Yucatan, of which there are almost 3,000.

In June, 1890, I saw in practical operation in Jacksonville the invention of the late E. R. Van Buren, called the tropical fiber machine. It is quite simple in construction and effective in operation, turning out remarkably clean fiber, though its capacity is limited on account of the necessity of withdrawing the half cleaned leaf and presenting the uncleaned end, making two operations, on the old raspador principle.

In operating this machine the material to be decorticated, a leaf of sisal hemp (henequen), or any other fibrous plant of similar growth, is passed over the top of the block and is drawn in between the block and cylinder by the motion of the latter, and is macerated by the striking of the beaters; the leaf is then withdrawn, and by so doing the loosened vegetable matter is scraped off by the combs and nothing remains but fiber contained in the leaf. This is exposed to the sun, bleached and dried, and is then ready for market. By changing the roller combs from coarse to finer ones the same machine can be adapted to a finer texture of fiber.

The device is described as follows: Two disks on circular plates of iron are fitted to a shaft about 8 inches apart (this shaft passes through the center of the disks); between them is a series of beaters which are in pairs and are journaled into each disk and work loosely; between each pair of beaters is a grooved roller, which serves as a comb; these parts when put together are mounted on a frame of wood or iron; on the same frame and front of the machine as described above is a wooden block, which is ajustable by means of screws either towards or from the machine; the face of this block is hollowed out to fit the circumference of the disks. A rapid revolving motion is given to above described cylinder by means of a belt pulley.

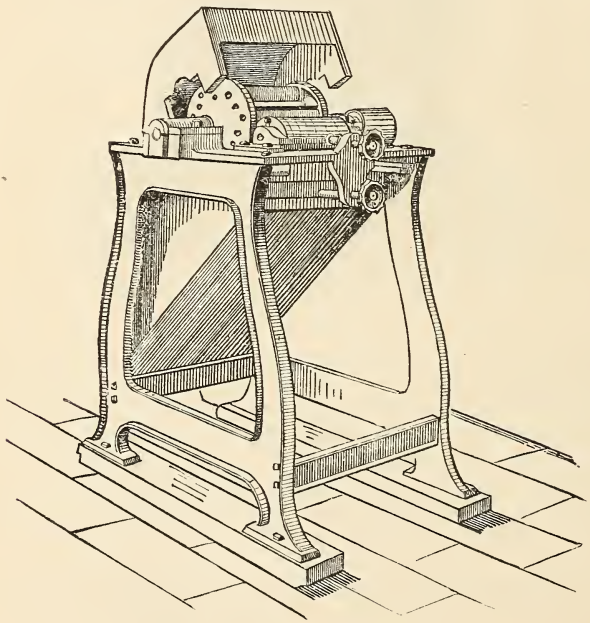

FIG. 19.—The tropical fiber machine.

In a letter received from Mr. Van Buren last fall it was stated—

All that remains to be done with this machine is to perfect some mechanism for feeding it, and thus increase its capacity, which is now about 200 pounds of cleaned and dry fiber per day of 10 hours.

I present herewith an illustration of the T. Albee Smith fiber-cleaning machine, which has been seen by me in operation. This may be described as a device composed of two cleaning wheels, each armed with scrapers around their periphery, in connection with an automatic feeding attachment, by means of which a continuous line of leaves are fed sidewise to the wheels. The first wheel cleans the spine end of the leaf for two-thirds of its length. The leaf then passes through to the second wheel, the point of grip being automatically changed in order that all of the uncleaned portion may be presented to the second wheel for cleaning. The fiber when wholly cleaned is then discharged, as shown in the cut, the point of discharge being on the opposite side of the machine to that shown. The short leaves entering the machine, in the illustration, are those of the Ixtle, *Agave heterocantha.*

Mr. Smith makes statements regarding the machine as follows:

Three automatic machines have been constructed—two for use in Mexico by the Mexican Machine Company, in the State of Coahuila, for cleaning ixtle, one for use in the Bahama Islands in cleaning henequen fiber. Seventy-five machines of a different design have been previously used by the Mexican Machine Company, and are now being displaced by the automatic.

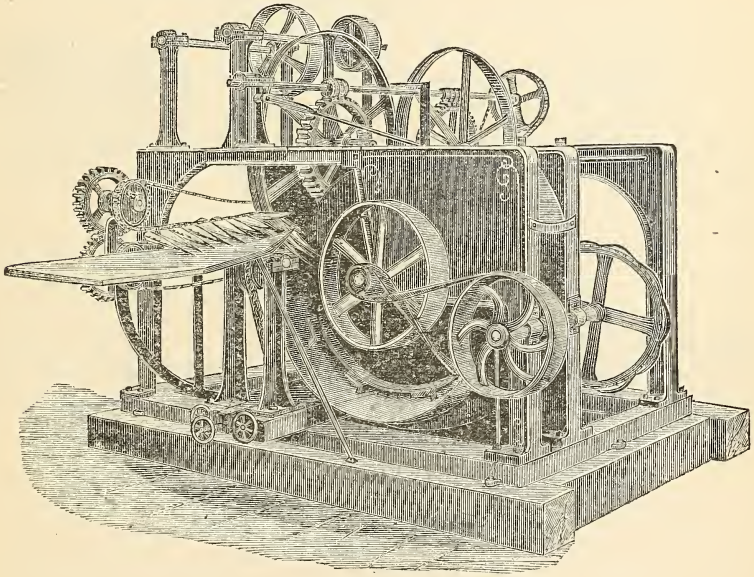

FIG. 20.—The T. Albee Smith machine.

The capacity of the henequen machine is 50,000 leaves per day. The services of 3 men are required at the machine, which weighs 6,000 pounds, and eight horse-power is required to drive it. The machine for cleaning ixtle weighs 1,500 pounds. Its capacity is 150,000 to 200,000 leaves per day, requires the services of 3 men at the machine, and five horse-power to drive it.

The machine is thoroughly automatic. The leaves being placed upon the feed table, are carried forward and into the machine and the fiber is delivered at the opposite side in a uniform and finished condition, drying only being necessary to ren-

der the fiber ready for baling. These machines are leased and a percentage of the fiber taken as a royalty. The repairs made necessary by the natural wear and tear are furnished without charge. These terms are considered a sufficient guarantee of their capacity and efficiency.

The Department has knowledge of another machine, not yet brought to the notice of the public, which promises good results, although nothing is known of its capacity save what is put forth in the claims of its inventors. While an end feeding machine, the fact that it will take several leaves at a time, and that its operation is continuous, are points in its favor. What it will demonstrate when completed and put into the field, in actual test, remains to be shown.

There are other machines already before the public which are claimed to work satisfactorily. Just what principles of construction are embodied in them, or how far the claims have been substantiated by actual performance, the Department has not been able to learn, though the endeavor has been made to secure such information. They are therefore omitted from the present report.

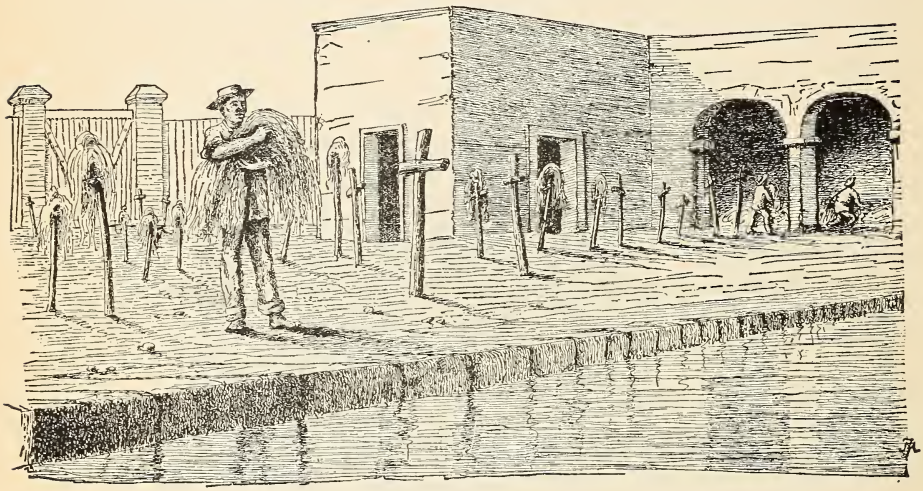

FIG. 21.—Method of drying fiber in Yucatan.

There is not the least doubt that the success of the industry in Florida depends more upon the question of machinery than upon any other factor. At the outset I give it as my opinion that we can not conduct this industry in Florida upon the same lines of practice as followed in Yucatan, and make it pay. As I have shown in my reports which deal with the flax industry in the Northwest, we must develop an "American practice" that will serve to equalize existing differences in cost of labor, by the use of the highest grades of improved machinery. The same may be said of the sisal industry. A practical, simple, continuous-feed machine, of good capacity, and that can be supplied at a comparatively low cost, is a desideratum.

A word in regard to drying the fiber may not be out of place before leaving this part of the subject. While any sort of a structure over which the fiber may be hung will suffice, such as a line of poles elevated from the ground, or a line of galvanized wire, the old method followed in Yucatan has been to dry upon posts 4 or 5 feet high, having a single cross-arm nailed on near the top, like the arms of a telegraph pole. Such a pole is shown in the accompanying illustration from a photograph of a dry-yard on a plantation near Merida, Yucatan.

THE INDUSTRY IN FLORIDA.

At present there is little more to record in relation to the establishment of the industry in our own country than a lively interest in the subject and the formation of two companies which begin operations this season. One of these companies, formed by Jacksonville (Florida) capitalists, has located at New River, about midway between Lake Worth and the Miami River, and the other, a New York company, proposes to plant large tracts of the original Perrine grant, both locations being on the east coast of the peninsula. I am informed that the company at New River has already made a beginning. Buildings have been erected on its lands, and a number of men employed to make clearings of ground for planting. One of the keys, where the plants are growing in abundance, has been leased, with privilege to remove the plants, and it is expected that some 50 acres will be put out at once.

Regarding individual efforts I have referred on previous pages to the small nursery plantations at Cape Canaveral, at Jupiter, at Juno, and to the plantation of both old and young plants on Boca Chica Key. Beyond these plantations I do not know of any tracts of sisal hemp plants not growing in a state of nature and composed of small thickets, or of groups of more or less scattered plants.

These wild growths are very valuable to us, however, as furnishing a certain supply of young plants for future commercial plantations, and the promoters of the new industry should be able to draw from them a considerable quantity of nursery stock, or young plants. To make the most of the available stock of young plants the times of "poling," or blossoming, should be closely watched, and the offspring carefully collected when in their prime, that none may be lost. Arrangements may be made with the owners of the different keys, or islands, when the plants are found in numbers, or with the owners of mainland tracts, and by cruising back and forth during a couple of months in the early part of the year, when the old plants are poling in greatest numbers, a large supply of young plants may be secured. As is shown on other pages, from one to two thousand of these plants may be secured from a single mast, 100 old plants supplying at least 150,000 of the pole plants without counting the suckers also obtainable. Thus a single

hundred old plants in bloom would furnish a supply sufficient to plant at least 200 acres.

As to the cost of young plants Mr. Bier tells me the price in his vicinity is a cent apiece, though the Bahamans paid as a rule something less, the lowest price being 7 cents a dozen; and some were taken without any payment. Both the Mexican and Bahamian governments have very stringent prohibitory laws against the exportation of these fiber plants, old or young. The State of Florida should certainly profit by this example, and place upon the statute books of the State, without delay, such an enactment as will preserve to the future use of the State all its available resources in this direction. The attention of the State authorities has been called to the matter, and as the aid of the Federal Government has been invoked in the establishing of this culture, the State of Florida should do all in its power to preserve existing supplies of plants, with which to build up an industry worth millions of dollars to its people.

The prohibitory regulations of other countries, from which supplies might be obtained, make it obligatory upon the people of Florida to protect themselves. In a letter from Mr. Van Buren upon this subject received last fall he says:

> The regulations of the Bahamas make it impossible for us to get the plants, except at a large cost, $10 per 1000, and a risk of fine and imprisonment besides. I have also a letter recently from the United States consul at Honduras, stating the same facts, and that the price there would be $50 per 1000, the government having imposed heavy duties to prevent their exportation. In view of these facts I would respectfully suggest that our Government should take steps to prevent plants being exported from our country.

It is a matter of regret that the duty of $15 per ton on sisal hemp could not have remained operative. However, when the time comes, and plantations have been established, and we know something definite as to the cost of producing the fiber for market in Florida, it might be advantageous to allow a similar bounty on the fiber produced as that offered by the Bahamian government, namely, 1 cent per pound. I would favor the granting of such bounty for a period of 5 years, upon evidence that it was needed by the growers to enable them to establish the industry on a remunerative basis.

In establishing sisal hemp plantations, it should be understood at the outset that small plantations, put out by individuals, isolated from each other, will not pay. A large tract is necessary for economical production of fiber, that the work of cutting the leaves and shipping the fiber may be systematically continued, for the most part, through the year. This is the system in vogue in Yucatan and the Bahamas, and we must follow it in Florida. Mr. Cleminson, writing upon this point, says:

> With regard to my own experience in Florida, it is certainly experimental, as I have had no returns. I have 50,000 plants one year old in nursery form, and 10 acres planted out with 2-year old plants. So far as the growth is considered it is satisfactory, but it requires about 500 acres to successfully enable one to operate machinery economically.

In the case of individual growers, in a community, the desired result may be attained by coöperation, and particularly when the plantations are reasonably contiguous. This will enable securing the fiber without undue expense for transportation of the raw material to the machine.

A word regarding past efforts in this direction: Published record shows that at various times during the last 40 years individuals have been interested in the growth of sisal hemp in Florida, though these efforts have gone no further than preparing small experimental lots of fiber, to demonstrate the possibility of establishing the industry.

Mr. J. J. Philbrick, a prominent citizen of Key West, informs me that about 1870 sisal hemp production was attempted at Key West, the leaves being grown on Key West at what is called the Salt Pond tract. Fifty tons of fiber were gotten out by a home machine and shipped to New York, the cost of production of the fiber being 12½ cents per pound. The machine was invented, I think, by John E. Null. The supply of leaves was derived from the plants growing wild in thickets. In this experiment it was demonstrated that 16 pounds of leaves would produce one pound of fiber.

In conclusion I must emphasize the importance of familiarizing ourselves with every phase of this culture as it relates to Florida, that the industry may be built up upon practical experience and a perfect knowledge of existing conditions in the localities where the home fiber is to be produced. The experience of the Yucatan and Bahama growers is valuable, but we must not rely upon it alone. It will be the aim of the Department, therefore, through its investigations, to record and disseminate all available information on the subject and to conduct experiments, and aid the industry in other ways as far as the limit of its power and means. And to this end the coöperation of all persons interested in the subject is earnestly desired.

OTHER LEAF FIBERS.

While in Florida several other plants furnishing foliaceous fibers were observed, regarding which a few statements should be made in this report, as they were subjects of investigation in connection with my studies of the *Agave sisalana*. On previous pages reference has been made to a plant frequently met with in Florida, which had been mistaken for the true sisal hemp plant, and which I was not able to identify, botanically speaking, as none of the plants were in bloom at the time of my visit. Some plants about to flower, however, were marked, and correspondents of the Department residing in their neighborhood will, at the proper time, forward flowers and leaves. The plants so closely resemble species of *Furcræa* that at one time I thought they must be referred to this genus. Recently, however, Mr. William R. Smith, superintendent of the U. S. Botanical Gardens, has identified the plant as *Agave Mexicana*, as there are a number of the plants growing at the Botanic Gardens. A photograph of a mass of these plants,

growing on a shell mound near Jupiter, is reproduced in Plate VII. Although not distinctly shown in the photograph, each of these mature plants had developed a foot-stalk several feet in length, clothed with the dead and dried old leaves. In Plate VIII will be seen two of these plants from the Department collection, the larger one from the Gulf coast, the smaller from the Lake Worth region. As this form of *Agave* comes nearest to the genus *Furcræa* in point of general resemblance, short descriptions of two species of *Furcræa* will not be out of place.

Furcræa gigantea.—Giant lily. This is also the *Cabouya*, or *Cabuja*, of the West Indies and South America. 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 Madras and in 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.

The fiber is very similar to that of the agaves, and indeed is sometimes called *pita*,[1] particularly in South America. In Brazil it is called *peteria*, and is described as "a white fiber of a silken luster, but of little tenacity." In Venezuela it is called *cocuisa*. Dr. Earnest, in the catalogue of the Venezuelan department (Exhibition, 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. The leaves of the plant I refer to in Florida are heavily armed.

Furcræa cubensis.—In this species the leaves are generally armed with long spines. It is sometimes known as silk grass, and is common in tropical America. Dr. Parry found the plant growing common in Santo Domingo in 1871, and brought back with him to the Department samples of the fiber. Reference has been made to this species on page 12 of this report, where the form of leaf is described. Dr. Morris, of

[1] 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. In fact its meaning is "fiber," and its use is frequently confounded with other words, as for example, "*pita de corojo*," meaning simply the fiber of the corojo palm. Out of the many instances where the term "pita" is used alone to designate a particular kind of fiber I can recall three which are noteworthy, as follows: The fiber of *Agave Americana*, of *Furcræa gigantea* (as above), 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.

the Royal Gardens at Kew, states that the plant is common in Jamaica, where it could be readily cultivated if desired. He describes the fiber as white, strong, and bright looking, and that it yields at the rate of 2.05 to 3.15 per cent by weight of green leaves. The value of the fiber in the London market is stated to be about £28 per ton.

In Dr. Schott's article in the Annual Report of this Department for 1868, the "cajun" or *Furcræa cubensis* is figured opposite to page 259. This shows that the plant produces a vast number of narrow leaves, a peculiarity I 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 Bahama and Florida cultivators. (See Plates VII and VIII.)

Agave Americana.—This is the century plant or American aloe, which is now found growing in many parts of the world. It gives a brilliant fiber of considerable strength, which is useful for many purposes. The Indians of Mexico and Arizona use it for saddlecloths and cordage. The "saddlecloths" are not woven, but are merely masses of fiber of regular thickness, tacked with thread at regular distances, in the same manner that mattresses are secured and their hair kept in place. In the West Indies it is employed by the negroes for making cordage, hammocks, and fishing-lines, and in Mexico is utilized in the manufacture of ropes for use in the mines, and in some cases for the rigging of ships. In South America it has even been used for large cables. Humboldt mentions a bridge in Quito with a span of 130 feet constructed of ropes of agave fiber, some of them 4 inches in diameter.

Among other uses of this agave it is employed in portions of southern Europe as a hedge plant, the spiny leaves particularly adapting it for the purpose. Soap is also manufactured from the juice, and the fresh leaves cut in slices are occasionally used for food for cattle. The most important product, however, is the sap, which forms an intoxicating liquor known as *pulque*, from which a kind of brandy is manufactured, as a further product, known as *aguardiente de maguay.* (See further remarks on this subject under *Agave Mexicana.*)

The plant is so well known from the examples to be met with in our conservatories that a description seems hardly necessary; however, the leaves are from 3 to 6 feet in length, are thick and fleshy, and formed of hard, pulpy matter intermixed with the fibers; they are armed with sharp spines, both at the point of the leaf and along the margins.

This well-known form of agave is growing in portions of Florida, together with quite a number of unidentified species, some of which are doubtless derived from plants introduced by Dr. Perrine. They are all interesting, but it will not be possible to consider them in this present report. The foliaceous fiber plants will, however, be treated in a separate bulletin, to follow the sisal hemp report, which will be issued before the close of the year.

Agave Mexicana.—There appears to be great confusion in the state-

ments of botanical authorities and industrial writers regarding this species, some claiming that it is the chief plant from which the liquors known as pulque and mescall are derived, while others state that *Agave Americana* is the species usually meant. I have reason to believe that *A. Americana* is *the* pulque plant, and that a variety of this species has been called erroneously *A. Mexicana*. In Perrine's report, published in 1838, this writer says: "The botanical errors of the notorious Humboldt, under the head of *Agave Americana* alone, have occasioned incalculable damage to the world in general, and to the United States in particular." But I think Perrine is himself in error in regard to *Agave Mexicana*. On Plate III of the report of 1838 (Senate Document 300, Twenty-fifth Congress), this species is figured as "the pulque plant." In the illustration the width of the leaf is shown to be one-fifth the entire length, making a leaf 2½ feet long, 6 inches broad—a very good illustration of leaves of *Americana* that I have seen recently. In Baker's monograph of the Agaves, the leaf of *Mexicana* is described as much narrower. There is no more variable species of Agave than *Americana*, and it is probable that Perrine figured a variety of this species as *Mexicana*. In a communication received from Mr. T. Albee Smith some months ago, this statement occurs:

"There is no doubt but that the fiber I have here is from the leaves of the *Agave Americana*, American Aloe, Century Plant, *Maguey*, which is the plant from which the *Agua miel* is taken, and when fermented is *pulque*, the Mexican drink. The error seems to be in calling the *Americana* by the name *Mexicana*, and *vice versa*."

Dr. Palmer tells me that *pulque* is made from several species of *Agaves*—any species, in fact, with a crown sufficiently large to be scooped out to form a receiving reservoir for the liquor as it exudes. He also informs me that the crown of *Mexicana* is eaten roasted, a statement that has been made before. The matter will be made the subject of early investigation, and by the time my next bulletin on leaf fiber plants is ready, I hope to be able to make authoritative statements regarding the two species.

Within a few days living plants of the false sisal (so-called) were submitted to Mr. William R. Smith, who identified them with plants growing at the United States Botanic Gardens, and unhesitatingly pronounced them *A. Mexicana*. Mr. Smith's plants resemble in every particular the plants I found in Florida, two of which were photographed for the illustration on Plate VIII. Fig. 2 is the typical form.

In Mr. Edgar Bacon's article, previously referred to, I find a statement that a gentleman in Jamaica with 500 acres prepared for hemp planting, showed him the plants which he proposed to use, and which were imagined to be good sisal plants. "These were the valueless *Keratto*." I am not acquainted with the plant referred to as *Keratto*, but in Hensley's Biologia Centrali-Americana I find *Agave keratto* given as a synonym of *A. Mexicana*.

As soon as our fiber-cleaning machine is in position on the grounds of the Department, we shall prepare the fiber from some of these leaves for examination. In the Kew Bulletin for 1887, p. 10, the fiber of *Keratto* is described as follows: "Little strength: not an even (but a curly) fiber: towy: value, £12 to £14 per ton." In other words, a worthless fiber.

This is as much as can be said concerning this so-called false sisal plant of Florida until the matter has been further investigated. The illustrations, Plates VII and VIII, will show the form of plant that is meant and the manner of growing in the wild state. I have begun a collection of living fiber plants, particularly those producing the leaf fibers, and hope in time to be able to show all the species of commercial importance; and I have no doubt it will be found that the name *Mexicana* has been loosely applied to several species of the agaves by industrial writers and others.

Sanseviera zeylanica.—I have found this plant growing in several localities in southern Florida. There are three principal species of *Sanseviera* which produce good fiber, *S. guineensis* furnishing the famous African or bow-string hemp. Samples of the latter species, recently secured from Trinidad, are nearly 6 feet long, very strong, white, and lustrous, and considerably finer and superior to sisal hemp. Samples of fiber obtained from the Florida species have been received and compared favorably with the Trinidad samples. Leaves of *S. zeylanica* sent to the Department from Boca Chica Key measured 6 feet in length, though botanical authorities state that the normal length of leaf is from 2 to 3 feet. The plants grow rapidly, in masses, and when mature can be cut with a scythe as one would mow grass, and it is said will grow up again in 18 months. A leaf from Boca Chica Key is figured on page 13 of this report.

APPENDIX A.

NOTES ON THE AGAVE RIGIDA, VAR. SISALANA.

In Dr. Engelmann's notes on the different species of agave, published in his memoirs (pp. 312–313), the following botanical considerations, relating particularly to the variety of plant introduced into Florida by Dr. Perrine, are set forth. The notes are of sufficient general interest to be republished entire:

The original plant was, according to Miller, brought from Vera Cruz; my specimens, on which the above diagnosis is based, were collected in Yucatan by Dr. Schott. Dr. Perrine forty, and Dr. Schott ten, years ago[1] studied in Yucatan this interesting plant, its various forms and economical uses, and left us accounts of it, the former in Senate Doc. 300, Washington, Mar. 12, 1838; the latter in the report of the Agricultural Department at Washington for 1869. Both agree that there is a common native species in Yucatan called *chelem* by the aboriginal inhabitants; but from time immemorial a number of varieties, all characterized by much longer leaves, and one also by the absence of marginal spines, and differing among themselves in the quantity and quality of their fiber, have been cultivated by the natives of Yucatan, and are a staple product of that country to this day, furnishing the well-known sisal hemp. The people know them as *Jenequen* (Schott) or *Henequen* (Perrine), and distinguish, as [317 (29)] Dr. Schott reports, the *yaxci* (yashki) as furnishing the best quality and the *sacci* (sacqui) with the largest quantity of fiber; *chucumci*, larger than the last, produces coarser fiber; *babci* has fine fiber but in smaller quantity; *citamci*, with small narrow leaves and poor fiber, stands probably nearest to the wild plant. Dr. Perrine mentions another variety, *istle*, evidently the *ixtli* of Karwinski, as furnishing a fine fiber called *pita*. These plants yield a return of leaves when 4 or 5 years old, and may last 50 or 60 years under proper management; the flowering scape is cut off as soon as 4 feet high, when, evidently, axillary branches continue the growth of the plant, which is thus kept so long alive by being prevented from flowering.

The trunk of the wild plant of Yucatan—which I refer with little doubt to Miller's old *A. rigida*—is 1 to 2 foot high, leaves 1½ to 2 feet long, and as many inches wide, contracted above the broader base and widest about the middle; lateral teeth three-fourths or even 1 inch apart, mostly straight, from a broad base 1 to 2 lines long, rather unequal, with smaller ones interspersed dark brown; terminal spine 1 inch long, 1¾ lines in diameter, straight or often somewhat twisted, terete, scooped out at base but not channeled, dark red-brown, a dark corneous margin extending down the leaf edge for several inches and bearing the uppermost teeth. Scape 12 to 15 feet high; flowers pale yellowish-green, 2¼ to 2½ inches long, perigone 16, tube 6 to 7, lobes 9 to 10 lines long; stamens inserted about the middle of the tube, "blood-red upwards," 1 inch longer than the perigone; anthers 10 to 10½ lines long; styles at last as long as stamens.

[1] This paper originally appeared in the Trans. St. Louis Acad. Sci. for Dec. 1875.

A. Ixtli, which in 1872 flowered in the gardens of the late Mr. Thuret, at Antibes, is entirely similar, flowers of the same dimensions, anthers a little larger (11½ lines long); capsules, which grow with the bulbs on the same panicle, oval, over 2 inches long, 1¼ wide, very short, stipitate; seeds uncommonly large, 4½ lines high, with a ventral hilum (in many other agaves I find the hilum more basal, a character which may be of some value). I believe this is the first time that the flowers of the Ixtli have been described; they identify the plant with the old *A. rigida*, or at least the above-described chelem. *A. Karwinskii*, Zucc., is probably the same thing.

With the name of *longifolia* I designate the variety known as *Saeci*, and extensively cultivated in [318(30)] Yucatan. It is principally distinguished by its much longer spiny leaves, 4 to 5½ feet long, 3½ to 4 inches wide; flowers very similar to those of the wild plant, but filaments greenish. *A. fourcroides*, Jacobi, Ag. 107, probably belongs here, and *A. elongata*, Jacobi, 108, I would also refer to this form if the description did not expressly mention a channeled terminal spine.

Agave sisalana is the name that Dr. Perrine gave to the plant known to the natives of Yucatan as *Yaxci*, the most valuable of the fiber-producing agaves, and which was introduced by him into south Florida some 35 or 40 years ago, during his efforts to acclimatize commercially valuable tropical plants in that almost tropical portion of our territory, efforts which were aided by Congress by a large grant of land, but which were destroyed, together with his own life, during the subsequent Indian wars. With this agave, however, he has been successful, as it is now fully naturalized and is quite abundant at Key West and the adjacent coast. Dr. Parry found it there in full bloom in February, 1871, and gives the following description of it: Trunk short, leaves pale green but not glaucous, 4 to 6 feet long and 4 to 6 inches wide, generally smooth-edged, but here and there bearing a few unequal, sometimes very stout and sharp teeth; terminal spine stout, often twisted, purplish-black; scape 20 to 25 feet high, panicle 8 feet long and half as wide. One of the largest plants examined had 35 branches in the panicle, the largest (near the middle) 2 feet long, upper and lower ones shorter. The flowers are slightly larger than those described, with a shorter, thicker ovary, stamens inserted a little higher up in the tube. The plants bore no fruit, but produced an abundance of buds, by which they propagate themselves and from which this interesting form has been multiplied in this country and in Europe.

If this plant is, as is most probable, only a cultivated variety of *A. rigida*, it is of the greatest importance for the study and the understanding of the agaves, indicating, as it does, the extent of variation which they may undergo. It shows that the size of leaf and scape and color of leaf are of no great specific value, and also that the presence or absence of spiny teeth on the margin is not an unalterable character, not any more than the [319 (31)] cartilaginous margin decurrent from the terminal spine. The presence of a trunk, the proportions of the leaf (in *A. rigida* and all its varieties the length equals 12 to 14 times the width), probably the form of the terminal spine, the character of the inflorescence, and, above all, the form and proportions of the flower and its parts, remain constant, and perhaps also the proliferous character of the inflorescence of some species.

The following extract, with further considerations upon the same subject, is taken from the Kew Bulletin for March, 1887:

Under this term (sisal hemp) are included fibers derived from probably more than one species of agave, and it is probable also that one species of Furcræa is used. According to the locality where the industry is carried on or the port of shipment the fiber produced in Yucatan is called sisal hemp, which is the recognized name in the English market; or Jenequen or Henequen hemp, which would appear to be the term more commonly used in the United States. Pita is another Central American fiber, but whether the produce of an agave (*A. americana*) or of a Bromeliad (*Karatas plumieri*) is not quite clear. Probably it is loosely applied to both.

As regards the species of agave yielding sisal hemp, Miller first described *A. rigida* (Dict. Ed. 8, 1768) in the following words: "Long, narrow, stiff leaves, entire, and terminated by a stiff black spine. These leaves are seldom more than 2 feet long, little more than an inch broad, being of a glaucous color. The side leaves stand almost horizontally, but the center leaves are folded over each other and inclose the flower-bud."

This may be accepted in a large sense as the representative species, of which there are several subspecies and varieties cultivated by the natives of Yucatan from time immemorial.

According to Dr. Engelmann (see the preceding), a common native species in Yucatan called *chelem* by the aboriginal inhabitants is identical with *Agave rigida* of Miller, but a number of varieties, characterized by longer leaves or the absence of spines, have been recognized, to which names more or less distinct are now applied.

Mr. Baker has given a synopsis of the genus agave in the Gardener's Chronicle (Vols. VII and VIII, new series, 1877). The plants mentioned below are included under the group *Rigidæ*, having the edge of the thin horny leaf without any distinct border and the teeth (when present) small but distinct and deltoid. He remarks that this is a considerable group, of which *A. lurida* and *A. rigida* may be regarded as the types intermediate between the groups Americanæ and Aloideæ.

From a study of plants at Kew, Mr. Baker was inclined to look upon *A. Ixtli*, Karw., as the type, and *A. rigida*, Mill., *A. elongata*, Jacobi, and *A. sisalana*, Perrine, as synonyms or varieties. But as in the first place *A. rigida*, Mill., has the priority in point of time, and (if we follow Dr. Engelmann) also represents the old aboriginal fiber plant of Yucatan (the *chelem*), it would be better to retain this as the aggregate species, and place the others among the varieties which have arisen in course of long cultivation in different parts of the peninsula of Yucatan. We have then,

A. RIGIDA, *Mill.*:

var. 1. *A Ixtli*, Karw.; A. ixtlioides; H. K. leaves 1½ feet long, teeth distant.
2. *A. elongata*, Jacobi; leaves 4 to 5 feet., glaucescent and toothed.
3. *A. sisalana*, Perrine; leaves 4 to 6 feet long, pale green, not glaucous, generally without teeth.

Appendix B.

THE SISAL HEMP INDUSTRY IN THE BAHAMAS.

The following official report regarding the condition of the sisal hemp industry of the Bahamas was made to the State Department in January, 1890, by Consul Thos. J. McLain. The report is so interesting and valuable that it is reproduced entire:

One year ago I made a report to the Department upon the culture of sisal hemp in this colony, calling attention to it as a new industry just being introduced, and which promised to bring substantial prosperity to these islands in the near future.

During the year, and especially within the last few months, so many letters have been received at this consulate from various parts of the United States, making inquiries upon the subject, that I am satisfied a statement touching the present condition of the industry would interest many of our people, and I therefore submit the following:

The progress made in the development of sisal culture in the Bahamas during the past 12 months is marvelous. One year ago there was scarcely a dollar of foreign capital, and very little local, invested in this business in the colony, while to-day parties from Great Britain, Canada, and Newfoundland, representing large resources, are interested in sisal, have bought tens of thousands of acres of Government land, and are industriously engaged in clearing and planting the same to the full measure of their ability to procure the material. A local stock company styled the Bahama Hemp Company, organized and managed by Nassau capitalists exclusively, has also purchased a large tract of land and is developing the same, whilst thousands of acres are being planted in every direction by individual owners of small pieces. American capital up to this date, I regret to say, for it is to its own disadvantage, has been conspicuous by its absence. One company, however, styled the Inagua Hemp Company, organized under the laws of the State of New Jersey, with D. D. Sargent, United States consular agent at Inagua, as manager, has lately procured about 1,200 acres at Inagua and has begun operations.

Messrs. Munroe & Co., of St. John's, Newfoundland, have obtained a grant of 18,000 acres of crown land at Abaco, and are planting the same. Another tract of 20,000 acres has been allotted to a London company on the same island. Mr. Alex. Keith, of Edinburgh, Scotland, has taken 2,000 acres on Andros Island, and is working upon it. But the largest demand has been lately made by two London companies, who are said to be applying for not less than 200,000 acres between them.

Many applications for land have not been reached at all as yet on the files, the surveyor-general's department being hard pushed in the matter of surveys and locations, whilst new applications are being constantly received and have to await their turn for consideration. So much land has been taken up that the governor, a short time ago, advanced the price of crown land from $1.25 per acre, the ordinary price, to $4 per acre, withholding also the benefit of the bounty. And lately it has been decided to sell no more large allotments of crown land at present, the quantity

already allotted with a view to cultivation being as great as the condition of labor in the colony will justify. The number of acres of crown land already disposed of is about 120,000 acres, whilst pending applications on file and not yet reached will amount to at least 200,000 more.

This substantial withdrawal of crown land is creating some movement in real estate—as is natural under the circumstances—between private parties, some old properties changing hands at prices double and treble their supposed value 2 years ago. Persons buying private lands and cultivating them will share in the bounty of 1 cent per pound provided by law on all fiber raised and exported. Private lands in New Providence can be bought, unimproved, for from $8 to $12 per acre, and for less on the out islands.

The employment given to laborers in clearing land and in setting out plants has already put considerable money into circulation, the beneficial effects of which are being felt in various quarters. There has been no special advance in the price of labor, field hands commanding from 40 to 60 cents per day, and finding themselves. Each month, however, witnesses a large increase in the number of those who find remunerative employment, and pleasant relations obtained between employers and employed.

The labor question has been and is one that here, as elsewhere, requires delicate treatment; but it has been skillfully met by Sir Ambrose Shea, the governor, who, long ago perceiving that to permit investors to locate upon adjoining lands would induce sharp competition in wages in thinly settled districts, adopted the plan of scattering the allotments about the different islands, or in localities remote from each other on the same island, so that each settlement should have its share of the benefits of the new industry by obtaining, at fair wages, employment for its local labor. In this way, also, a surplus of labor at one point and a scarcity at some other has been avoided. When the entire laboring population becomes employed, as will happen before long at the present rate of development, a new phase of the labor question will arise; but that time is yet in the future, and the remedy can be applied when the situation demands it.

Small shipments of fiber continue to be made by nearly every steamer, a few old plantings furnishing the material. It is not likely that shipments in any quantity will be possible under 2 years, but after that time an enormous increase may begin to be looked for, increasing steadily as new fields come into bearing, until the annual exports of the colony, which now average about $600,000, will leap well into the millions, as a moment's reflection will show. It is a very low estimate to expect half a ton of fiber per acre, and a very low estimate to call it worth $100 per ton, for it is worth over $200 per ton in the world's market to-day. When even the present quantity of land sold and applied for, to wit, 300,000 acres, is bearing, which ought to happen within 5 or 6 years, it will produce 150,000 tons a year, worth $15,000,000, an increase of prosperity that sounds more like a fairy tale than a strong probability deduced from reasonable figures. And yet 300,000 acres is but a small portion of the uncultivated lands within the limits of the Bahamas.

It is estimated that about 6,000 acres of land have already been planted in sisal (a plantation once started needs no replanting for many years), and that many additional ones have been made and cleared and made ready for the plants, the obtaining of which has been almost impossible, the industry being seriously retarded thereby. The price paid for plants has risen from 6 cents per dozen to 36 cents, so great has been the demand; but the price will now decline rapidly, since the supply of plants is developing enormously, about 2,000,000 being now available for planting, and others coming on speedily. The pita plant is being found on all the islands growing wild, and the stock of old plants is very great. From the center of the old plant rises a pole about 16 feet in length, on the branches of which small plants grow, averaging a thousand to each pole, and from these poles a vast supply is coming into market, creating a profitable business; for what were 2 years ago only noxious weeds

have all at once become worth $20 a piece for pole plants alone. Quantities of old plants have lately been discovered growing on the cays along the Florida coast, and small schooners are already buying these up and bringing them here for sale. This fact suggests the question whether this new hemp industry, which is about to revolutionize the condition of the Bahamas, may not be also developed in the southern portion of Florida. The plants are there found growing wild just as they are in these islands, and they flourish best in dry, sandy soil, fit for little else. I would earnestly call the attention of the Department of Agriculture to this matter, and suggest the propriety of looking into it, and of calling the notice of the people of Florida to this possible source of wealth and prosperity. The conditions of soil, climate, etc., which make its culture a success here may not obtain there, but the simple fact that the plant is found growing wild in Florida is of itself a consideration that should warrant an investigation at the hands of the Department.

The unexampled success of sisal industry in so brief a period in this colony is entirely attributable to the business-like, systematic manner in which it has been managed by the present governor, Sir Ambrose Shea, who has all along taken a most earnest interest in the matter. He is a man of large experience in affairs and had practical knowledge of the proper way to manage industrial enterprises. From the start he realized that this industry would be the salvation of the Bahamas, and, setting his heart upon it, he pushed it forward with great energy and prudence, overcoming numerous difficulties, surmounting obstacles, encouraging the faint-hearted, until now the people are touched with his own enthusiasm, and the industry is fairly afloat. He visited England, and by personal effort enlisted capitalists and procured large investments. To Sir Ambrose Shea the colonists owe a large debt of gratitude; and when the signal prosperity, which is already hanging over the island, shall have been developed to its full measure, they will more perfectly realize how, not only their individual interests, but those of outside investors, have been wisely and prudently promoted and guarded, from the very inception of the industry, by the practical, discreet, and conservative action of the governor.

There can be no doubt or question as to the success of sisal culture in this colony. It has passed far beyond the experimental stage, and is giving daily evidence that it will become a source of wealth to all concerned. The combined conditions of soil and climate especially adapted to the growth of first-class fiber give this colony a marked advantage over other West Indian islands, where the plants may grow luxuriantly enough, but will be found deficient in good, strong fiber. The poorer and more sterile the soil the better the result, and here the plant flourishes where ordinary vegetation seems almost impossible. It is a plant of unfailing growth; it will live without rain to moisten the soil; you can scarcely exterminate it if you try; it requires but little cultivation, and at the expense below that of almost any other agricultural product; and its value is substantial.

As two-thirds of the trade of the Bahamas is now with the United States; as their only steam communication with the outside world is by a subsidized line of American steam-ships running between Nassau and New York; as their increased wealth and prosperity means a larger and more profitable commercial intercourse with our own country, we should view this coming development of their material interests with pleasure, and with the warmest wishes for its complete success.

In conclusion I would add that I have sent by this mail four samples of the Bahama fiber for the information and satisfaction of the State Department, believing that the same would be of sufficient interest to justify me in so doing. These specimens are not specially selected but are only fair samples of the average fiber which is now being grown and shipped from the colony. Two of them have still attached a stub, or portion of the butt end of the leaf, which was purposely not passed through the machine, showing the character of the sisal plant whence extracted.

I append a tabulated statement, showing the present extent of sisal cultivation throughout the Bahamian colony, from Mr. Rae's report, January, 1891.

Name of island.	Acres planted with sisal.	Plants planted in fields.	Plants growing in nurseries.	Young plants (estimated) to be procured during the ensuing 6 months from plants that are now in pole.	Suckers (estimated) to be procured during the ensuing 6 months from plants that are now growing.
Abaco	1,977	1,228,000	708,000	362,000	395,000
Andros	214	124,000	31,000	10,000	45,000
Cat Island	130	116,000	7,000	40,000	60,000
Crooked Island	5	5,000	.....	.....	2,500
Fortune Island	5	5,000	.....	.....	2,000
Eleuthera	15	12,000	500	.....	7,000
Exuma	45	29,000	31,000	65,000	17,000
Grand Bahama	10	7,000	50,000	50,000	5,000
Harbor Island	109	135,000	88,000	88,000	90,000
Inagua	160	103,500	20,000	3,000	20,000
Long Island	67	43,000	46,000	75,000	25,000
New Providence	1,300	730,000	300,000	200,000	250,000
Ragged Island	5	2,500	1,000	500	1,000
Rum Cay	153	90,500	50,000	39,000	40,000
San Salvador, or Watling's	4	2,500	.....	5,000	1,000
	4,199	2,633,000	1,332,500	937,500	960,500

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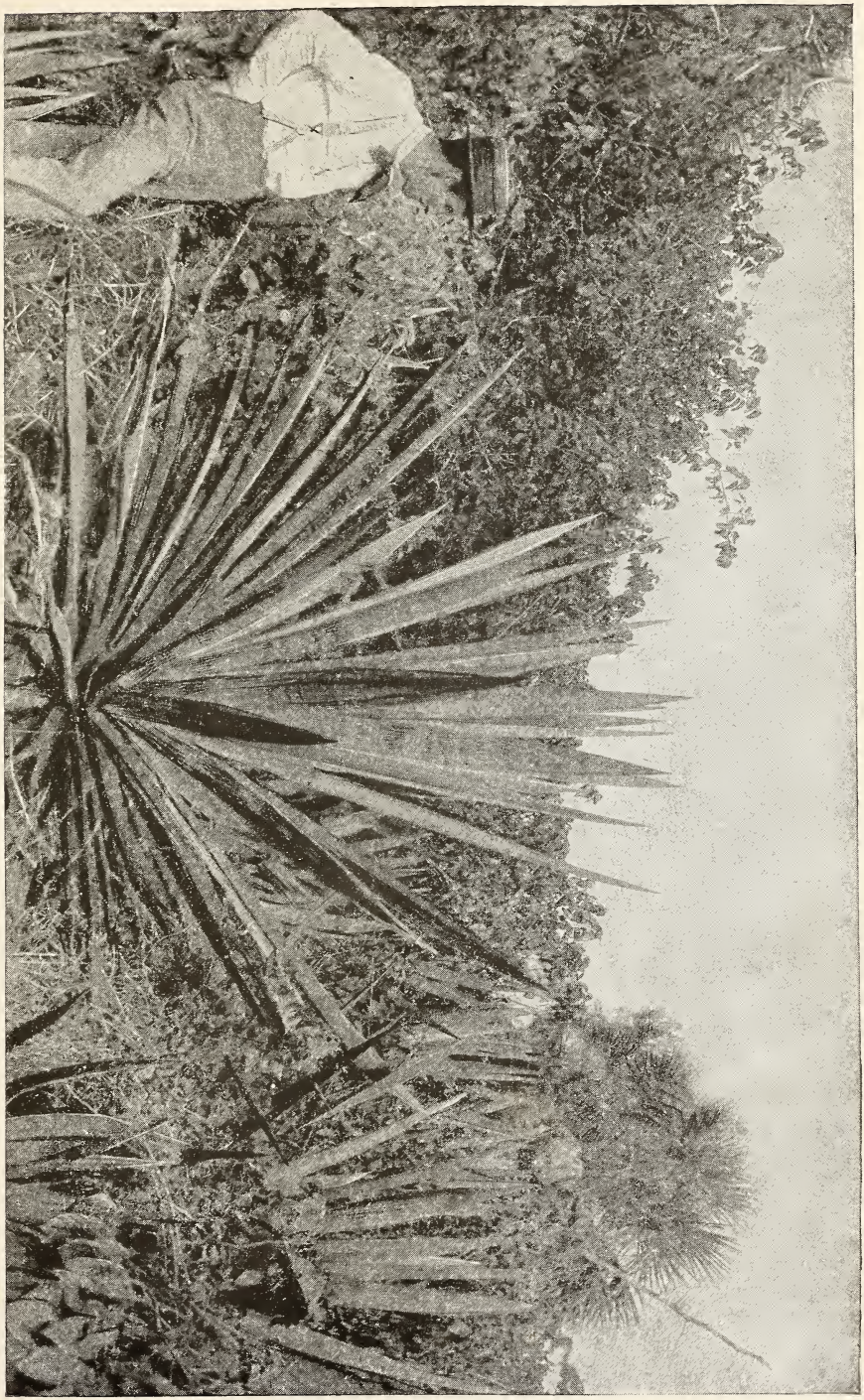
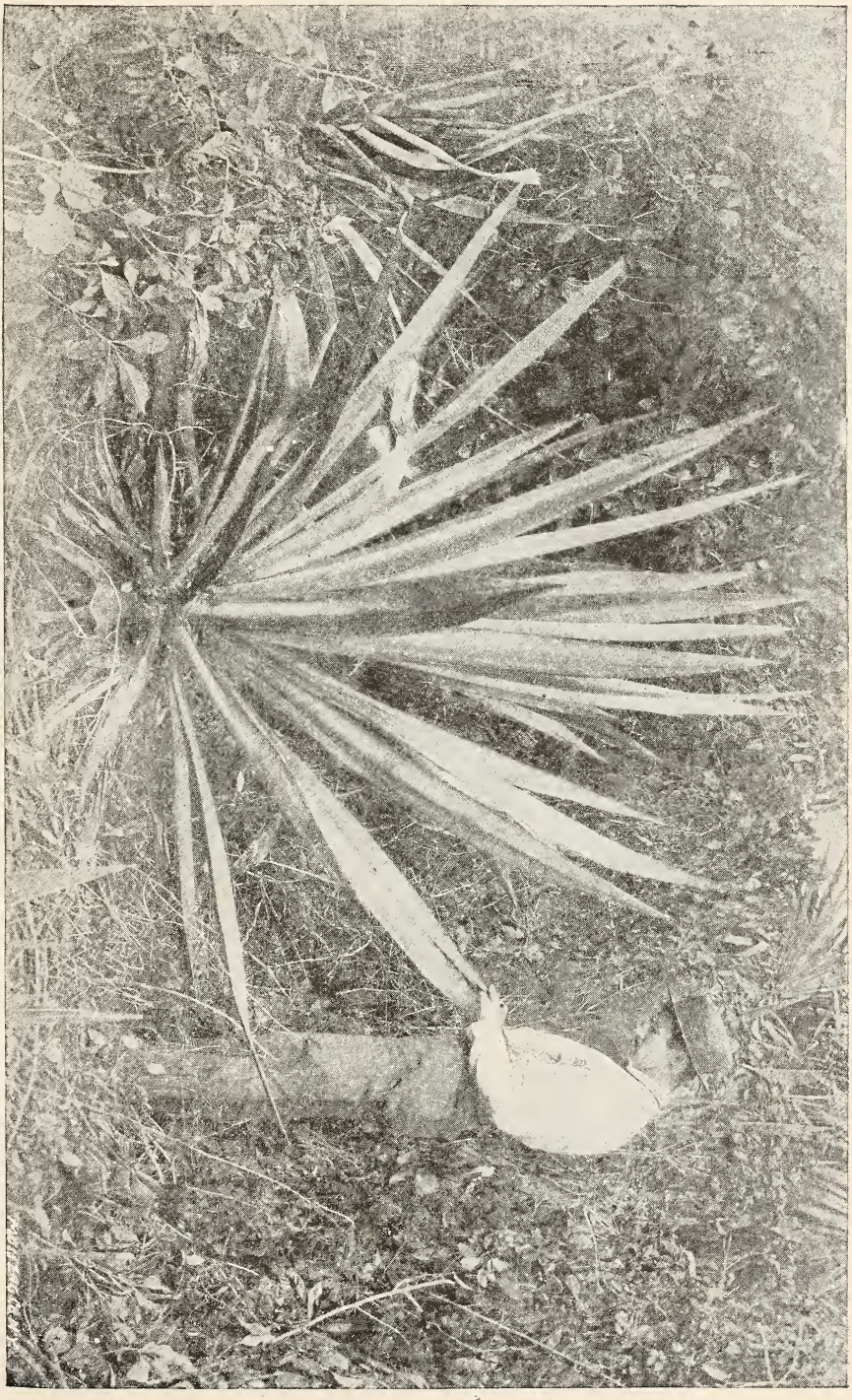


PLANT OF AGAVE RIGIDA, VAR. SISALANA—from Nature.



PLANT OF AGAVE RIGIDA, VAR. LONGIFOLIA—from Nature.

VIEW OF A SISAL HEMP PLANTATION IN YUCATAN—from Nature.

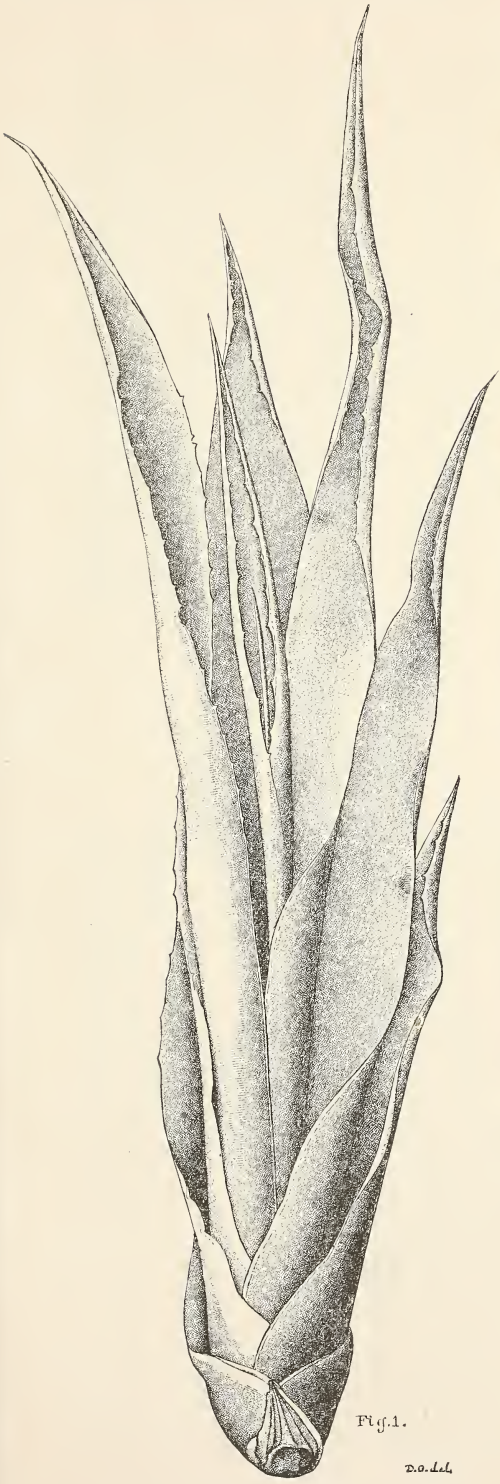


Fig. 1.

D.O. del.

"POLE" PLANT FROM FLORIDA.

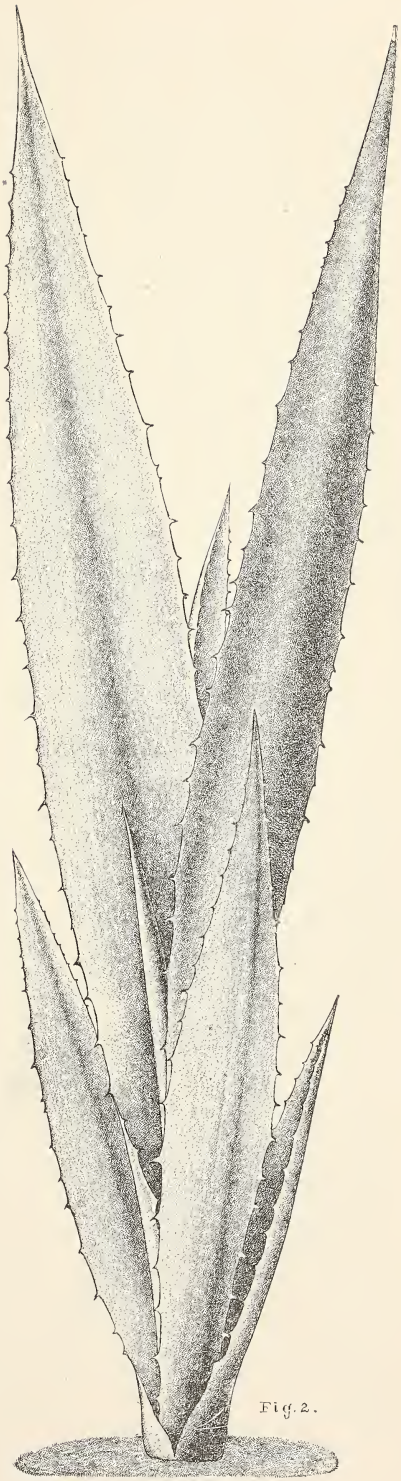
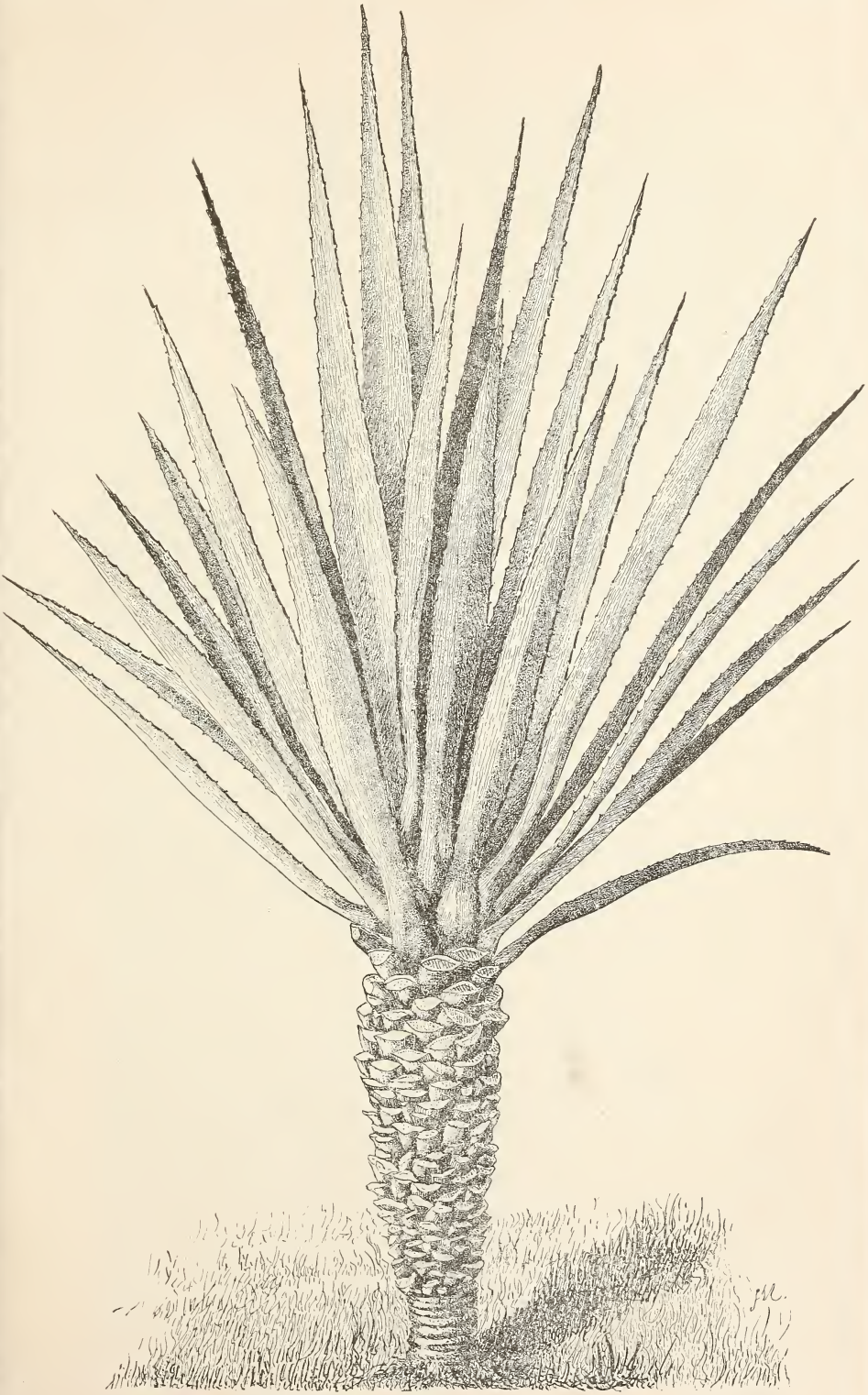


Fig. 2.

"POLE" PLANT FROM THE BAHAMAS.

SISAL PLANT IN "POLE" OR FLOWER.

SIDE BRANCH OF "POLE," SHOWING SMALL PLANTS—from Nature.



APPEARANCE OF A YUCATAN SISAL PLANT 15 YEARS OLD.

FALSE SISAL, SO CALLED- from Nature.

1. *Agave Mexicana* from Seven Oaks. 2. The same from Juno, Field's Plantation.