DEPARTMENT OF AGRICULTURE.

REPORT

OF THE

FLAX AND HEMP COMMISSION,

APPOINTED UNDER

ACT OF CONGRESS FEBRUARY 25, 1863.

LETTER

OF

THE COMMISSIONER OF AGRICULTURE,

TRANSMITTING

The report of the commission appointed under an act of Congress approved February 25, 1863, "for investigations to test the practicability of cultivating and preparing flax or hemp as a substitute for cotton."

DEPARTMENT OF AGRICULTURE,
Washington, D. C., February 28, 1865.

DEAR SIR: I beg through you to present to the Senate the report of the commission appointed by me under an act of Congress approved February 25, 1863, for "investigations to test the practicability of cultivating and preparing flax or hemp as a substitute for cotton, twenty thousand dollars."

I regard the report as one of great interest, and suggest to you that twenty thousand copies be ordered to be printed for this department.

Very respectfully,

ISAAC NEWTON, *Commissioner.*

Hon. H. B. ANTHONY.

REPORT OF THE FLAX AND HEMP COMMISSION.

INTRODUCTION.

To the Commissioner of Agriculture:

We, the undersigned, who were appointed to act as commissioners to investigate and report upon the subject of textile products, as provided under the act of Congress making an appropriation for this purpose, beg leave to tender our report, after having made earnest and extensive investigations into the subject. In so doing we have to regret that, at the present stage of our examination of the subjects committed to our charge, we cannot render so full and complete a report as would be desirable, and that we must leave unsettled some very important questions which recent inventions and discoveries have developed in relation to the adaptation of the fibres of flax and hemp for spinning on cotton machinery.

When we entered upon the labors of our commission we found that the provisions of the law were not very explicit as to the mode of conducting our investigations, and we were left free to put our own construction upon the intent of Congress. This induced us to take the most comprehensive view of the subject, and we have endeavored to embrace in our report the results of our investigations into the whole subject of textile plants, so far as they have come under our observation, and presented claims of utility. We have called for contributions to the *Department of Agriculture of specimens of fibres and of the products prepared from them by the several parties who were engaged in the preparation of these materials. These have been critically examined, and when the results were promising, we have further investigated the processes and apparatus; and, finally, we have experimented upon such materials as appeared to be in the most advanced stage of development, and have tested their adaptation to the machinery of the country. In this way we have endeavored to avail ourselves of the knowledge of those who have devoted years to the investigation, and we have avoided the risk of incurring very heavy expense in repeating the experiments which have already been tried by others, and which have in many cases proved abortive, or at least fruitless of valuable results. We have also availed ourselves of the services of one of the best microscopists of the country, who from years of practice has become an expert in the investigation of fibrous materials, and whose rich and extensive cabinet of these substances has been opened for our examination. To Dr. George C. Shaffer we are indebted for the very interesting exhibition of the cellular constitution of many of the products that have been presented before us. Such a course has been pursued by the commission in the full belief that in this way only they could render to the country the best and most useful account of their stewardship, and furnish a mass of information that would be valuable to the people.

We suppose that in the brief language of the act, "*flax and hemp*" were used as representative terms, these plants being universally known and widely cultivated in our latitudes. But there are many plants, several of them natives of our own country, others that have been successfully introduced, and others that may be introduced with advantage, which present fibres of the greatest value, and which, therefore, should claim the attention of this commission.

A notion appears to have prevailed somewhat extensively that the appropriation of Congress was intended expressly and solely for the encouragement of the preparation of what is familiarly called *flax-cotton*, which necessitates such

* These specimens are preserved in the Agricultural Museum.

a shortening of the beautiful long filaments of the flax-plant as should adapt them for spinning upon the machinery which a century of improvements has so admirably fitted to the handling of the short staple of cotton. This interpretation appears to gain some encouragement from the words of the act " as a substitute for cotton," and also from the fact that many of the extensive manufactories of our country were standing idle, in consequence of the scarcity of the product of the cotton fields, caused by the desolation of the rebellion in the southern States. The radical differences that exist in these substances, as displayed by the microscope, make it appear almost impossible to substitute one for the other without also introducing some modifications of the machinery to be employed.

The commission has found it difficult to ascertain the value and amount of fibrous products that have been produced in the United States. The cotton crop has long been one of so much importance to the commerce of the world that its values have been regularly reported, and this has been set forth by the Superintendent of the Census Bureau as having been the subject of a wonderful increase in the last decade, amounting, indeed, to 110 per cent. The annual exportation at the beginning of this century was less than 5,000 bales. In 1849 the quantity grown had reached 2,445,703 bales of ginned cotton, of 400 pounds each. In 1859 it had further increased to 5,196,944 bales.

From the same source* it appears that the product of hemp fibre for 1850 was 3,943 tons, and that of the dressed fibre of flax was 3,783,079 pounds, equal to 1,891½ tons, making a total of these two products of 5,834½ tons, against about 489,120 tons of cotton fibre reported as the product of the same year, so that the relative amounts of these two classes of fibres are widely different. It is true that many reasons exist to explain the comparatively small amount of flax and hemp fibres that have been produced, some of which will presently be considered; nor is it easy to compute the extended ability of our country to furnish these products, which we firmly believe may be grown in various parts of the United States to any desired extent; and we find that the stimulus of advanced prices, and still more, the improvements in various agricultural machines, but especially in apparatus adapted to the preparation of the fibres of these plants for market, will have the desired effect, and that they have already had the effect of increasing the area of land devoted to flax and hemp. Hitherto the leading difficulties have arisen from the supposed necessity of employing hand labor in almost every stage of their production, from the sowing of the seed to the baling of the finished product when ready for the market. These obstacles have in a great measure been overcome by modern ingenuity, and we find that the seed may be sown with a drill machine, and more evenly distributed than when cast upon the soil by the most practiced hand, and in this condition the young crop can be hoed by horse-power with suitable cultivators, instead of the tiresome and expensive hand-weeding universally practiced in Europe, but which could never be accomplished by the farmers of our country. When we come to the harvesting of the flax, instead of the weary, tedious, and expensive labor of pulling the stalks from the soil, as formerly practiced, we have harvesting machines that cut the crop rapidly and as closely as may be desired, though not retaining the straw in as perfectly straight a condition, it is true, as the regular streiks or handfuls of the European flax gatherer, and yet sufficiently well to answer the ends of the manufacturer, who can afford to lose a percentage in the increase of tow or codilla, caused by the tangled condition of the straw. When dry, the flaxseed may be removed by a very simple apparatus of rollers that separate it without disturbing the straw, or by a slight modification of the common threshing machine, and the bundles are kept straight. When the tangling of the stalks is not objected to, as is the case with the tow machines next to be noticed, the threshing machine

*Preliminary Report of the Eighth Census, p. 84.

or tramping by horses may be resorted to. These tow machines are recommended as among the most important appliances in this branch of agricultural improvement. Tangled flax and hemp fibres have been found available in a great many kinds of manufacture where formerly the straight or long line, as it is technically called, was used. With the various improvements in modern machinery an unlimited amount of flax straw may be cheaply adapted to the use of the manufacturers of coarse linens, and may also be prepared for combination with wool in a large class of fabrics into the preparation of which it had already been introduced, in some cases mingling the fibres upon the cards preparatory to spinning, and in others, as the linseys and carpets, combining the threads of wool with those of flax when they are woven in the loom.

These flax machines, as they are called, are found in various parts of the country wherever the raw material is produced in abundance, and they have resulted in rendering valuable and useful an immense amount of fibre that was before wasted, and thus they have stimulated the growth of a crop formerly sown only for the seed.

In pursuing our investigations, and in making up this report, we have thought that a subdivision of the subject would be advisable, and, therefore, have considered the several topics in the following order:

1. The agricultural aspect, including the production of the crops, and the most appropriate treatment of the soil and of the plants to be produced.

2. The mechanical treatment of the product, which is to include the first processes of the preparation of the raw material, and which has been performed by the farmer, but which we think could more appropriately be assigned to such operators as will come near to the seat of production, with machinery adapted to the purpose of separating the fibres of these plants from the accompanying matters with which they are naturally combined.

3. The chemical processes which are needed, in many cases, to perfect the preparation of the fibres. Some of these processes, such as those of bleaching, are often deferred until after the manufacture of the tissues.

4. The manufacturing stage, which is the most important part of the investigation, since here the thorough utilization of the products is perfected, and because this will be the only safe test of the value of some of the substances brought before us.

5. Peculiarities of fibres, and their classification, in which their adaptability to certain distinct purposes in the arts will be made apparent, and their unfitness for other purposes will be shown, with illustrations of the cells of which these fibrous substances are composed.

6. Next will follow the consideration of several other textile plants, and the native modes of their preparation in separating the fibres.

7. Lastly will follow a list of the exhibitors and of the various articles they have presented for the examination of the commission.

In conclusion, we respectfully submit this report upon these interesting investigations. We have continued the research to a point where the most flattering results appear ready to open, and regret that the limit set upon the commission renders it necessary that the pursuit should be relinquished when the desired end is almost in view.

J. K. MOORHEAD.
JNO. A. WARDER.
CHAS. JACKSON.

WASHINGTON, *February* 27, 1865.

Having examined and approved the above report, I respectfully submit the same to Congress.

ISAAC NEWTON,
Commissioner of Agriculture.

WASHINGTON, D. C., *February* 27, 1865.

AGRICULTURAL.

In taking up the consideration of this portion of our subject, it is proposed to treat of the culture and production of flax and hemp as farm products, with the necessary details of the preparation of the soil, culture, and management of the crops, as well as of harvesting and disposing of them, until turned over to the manufacturer. We conceive it to be very important, in this as in many other branches of agronomic production, that there should be a well-defined limit between what are properly the duties of the farmer and those more appropriate to the manufacturer or the manipulator of his crops; this will establish a subdivision of labor that cannot fail to exert a happy influence upon the productions of agriculture, instead of hampering it by increasing its labors, which are already, in many instances, too onerous. In the case under consideration, it would, we think, be best for the farmer's labors to terminate after the harvesting of the crop, with the separation of the seed and the delivery of the crude straw to the manufacturer.

In some instances, where the producer occupies an isolated position, it may be found best to use a simple farm-brake so as to enable him to compress his produce into a smaller compass, and thus reduce the expense of transportation; by this course, too, he would be able to retain a large portion of the waste products at home upon his farm to be returned to the soil; but even then we should recommend a division of labor, and think the brakes had better belong to practiced workmen, who should attend to this branch of business in the preparation of the fibre for a neighborhood, going from farm to farm, as is often done for the grain crops by the owners of the modern threshing machines.

We shall offer some general considerations upon the subject of the culture of this class of crops which will be of interest, and, we hope, of value to the agriculturist. These will involve the question as to the exhausting properties of these fibre plants, their analysis, and the analysis of the soils best adapted to their production. We shall also examine the facts with regard to the place these crops should occupy in a judicious rotation.

In regard to the derivation of the word which is in common use to express the products of flax, it is somewhat singular that *linen* should appear to have a doubtful origin. We generally and most naturally attribute it to the root of the Latin word *linum*, meaning flax, and this is derived from the Greek *linon*, having the same meaning, as appears from its use by Homer in his Odyssey, referring to linen cloth made from flaxen fibres. But, in the ancient Greek language we also find that the word *xylinos* means, made of cotton; this word, however, had another signification—made of wood, which was its more natural meaning, seeing that its root-word *xylon* was their word for wood. May not this show that those who invented or used this original term realized a similarity in these fibres, such as we now perceive? But the great naturalist, Pliny, uses the word *xylinum*, in his extensive work on natural history, to *express* cotton, and this is the more remarkable when we consider that the old Irish word for flax and flaxen is so nearly the same, with only the introduction of the peculiar aspirate of that language, and that their word for flax was *lhin*.

HISTORY OF FLAX.

The flax plant, called by the botanists *Linum usitatissimum*, or the most useful, has been in cultivation since the earliest historic period, and, therefore, it becomes difficult to decide upon its first origin in a state of nature, but it is generally claimed as European. Be this as it may, the Egyptians are known to have cultivated this plant, to have manufactured it, and to have used it to envelop their mummies, and this is demonstrated to us in modern times, after the lapse of centuries, both by their hieroglyphics and by the revelations of the microscope. Upon the pyramids are delineated processes representing the agriculturist preparing the crop, and with the aid of the microscope we discover the very nature of the substance of the tissues used in embalming their dead. We learn from Scripture, also, that flax was an important crop in Egypt, and that the Almighty sent a plague of hail by which the "flax and the barley was smitten; for the barley was in the ear, and the flax was bolled." Isaiah speaks of those "that work in fine flax, and they that weave net-works," in Tyre and Sidon, when referring to the destruction of those ancient cities in the Levant.

Having thus referred to its antiquity, which has concealed its origin in a state of nature, we may allude to the fact that botanists describe many other species of flax in different parts of the world. The native country of the flax of cultivation appears to be an unsettled question among botanists, and this plant is found growing wild in most countries where the physical conditions are suited to its cultivation. The general opinion, however, ascribes it to the East. Be that as it may, the disposition which it possesses of suiting itself to a vast range of soils and climates is of infinite importance to man, as it enables him to avail himself of the advantages resulting from its cultivation to a far greater extent than he otherwise would be able to do.

The numbers of the natural family of plants to which our subject belongs are generally remarkable for the tenacity of their fibres, the elegance of their forms, the beauty of their flowers, which are tinted blue, red, or white, and for the emollient and demulcent properties of their oleaginous seeds. All of this family are harmless plants.

Although the culture of flax has long been quite extensively practiced in many parts of our western and northwestern States, the seed has heretofore been the only marketable product, while the straw has been almost wholly neglected and destroyed. Many thousands of acres are annually devoted to flax culture, producing from eight to ten bushels of seed per acre, and which should have furnished also about one ton of straw to the same surface. The extensive area devoted to this crop, and the large amount of seed produced, is not a tythe of the productive ability or capacity of our fertile country; but the same obstacles appear to limit us here, as have so prejudicially retarded the extension of flax cultivation in Great Britain. There is, besides the difficulty of obtaining hand labor and the high price of wages in this country, "the general opinion that flax is an exhausting crop." This question will be separately discussed upon another page.

The old methods of reducing the harsh stalks into the shining flax, which were slow, expensive, and laborious, after having been practiced from the remotest antiquity, have at length been supplanted by others which are rapid, simple, elegant, economical, and cheap, so that, by the exercise of a small portion of that enterprise which characterizes our countrymen in an eminent degree, every region in which the cultivation of the large staple *flaxseed* exists may be also the recipient of bounties flowing from the sale of a *staple* of still greater importance, the flax lint, a product which has been an incumbrance to the farmers of our day.

In former times flax was grown for the sake of its fibre chiefly. Every homestead had its little field of flax, often a mere patch, which was pulled by hand, and by the same hands rotted, dried, broken, heckled, and scutched. Other hands in the same household next took it to the spinning-wheel and to the loom, with which the shining fibres were deftly transformed into the woof and web which constituted their domestic treasures, and which enabled the industrious and frugal spinster to bring a valuable contribution to the establishment of a new household.

Why should not our American people grow flax and manufacture linen enough to supply themselves, and give steady and remunerative employment to thousands, and in this way keep at home many millions of dollars which annually go from the United States to Great Britain to pay for the products of this plant which is so well adapted to our own country? The entire history of the flax products of the past few years most convincingly shows that prosperity has been a constant attendant upon this crop. And we, in this country, need not go back to the barbarous and uncultivated condition that was so long suffered by Europeans—we can begin with the benefits of their improvements and our own. We know that in Belgium, the German states, Great Britain, and France, they struggled through centuries of bad management of the flax crop, but Americans have the advantage of all their experience to commence with, and those of us who would now enter upon this new field of enterprise may have a bright future promising success.

PROFITS.

The following cases are cited to show what may be done with this crop. It is reported in the American Agriculturist for February, 1864, that Aaron Kimball, near Worcester, Massachusetts, planted one hundred and thirty-six square rods, rather more than four-fifths of an acre, which yielded him for the 401

pounds of flax	$106 26
130 pounds tow	5 20
8 bushels seed	36 80
Total product	148 26
Deduct expenses	54 58
There is left clear profit	93 68
Or to an acre about	110 00

Mr. M. B. Brown, of Alleghany county, Pennsylvania, communicates the following results of a flax crop:

He ploughed four acres of creek bottom, a very rich black loam. He made the soil as fine as a garden, by using the roller and harrow. On the 18th of April he sowed broadcast at the rate of one bushel of seed per acre, and covered with a light harrow and followed with the roller. In four days the seed came up very evenly. Owing to a long-continued drought the straw was short—say about two feet high. On July 14 it was cut with the scythe, and cured like hay, in the swath. He carted it to the barn and threshed it August 1st to 10th, using a horse-power threshing machine and separator, receiving fifty bushels of seed, which sold for $2 25, or $112 50. The straw was spread on a meadow, and occasionally turned, for two months, when it was taken to Pittsburg and sold for $25 per ton, two tons making $50. Thus the crop from four acres yielded $162 50, or $40 62 per acre.

He considers it a pleasant crop to handle, giving about as much trouble as wheat. In a wet season he thinks it would produce much more flax, and that the quantity sown is about right for a crop of both seed and lint.

IS FLAX AN EXHAUSTIVE CROP?

It is often asserted the flax is an exhaustive crop. Let us look into this question and sound it by the light of scientific experiment and inquiry. Some investigations were made by Dr. Hodges for the purpose of ascertaining the relative proportions of the produce of flax, and of the distribution of inorganic matters in them. The flax had been steeped, and contained .173 of ashes. Of the dried straw 4,000 pounds were taken, which produced—

Of dressed fibre	500 lbs.
Of fine tow	132 lbs.
Of coarse tow	192 lbs.
Total of fibre	842 lbs.

These products contained—

In the dressed flax	4.48 lbs. of ashes.
In the fine tow	2.08 lbs. of ashes.
In the coarse tow	2.56 lbs. of ashes.

Making a total of................................ 9.12 lbs. of inorganic matter; so that 59.08 pounds which the crop had withdrawn from the soil remained in the useless portions, while only 9.12 pounds were carried off in the dressed fibre. Comparing these results with those obtained from an analysis of an acre of wheat, we shall see that that crop, in grain and straw, abstracts about 365 pounds of inorganic matter from the soil.

Flax has been cultivated in Ireland from a very early period, and its introduction into that island has been attributed to the Phœnicians. Irish writers claim that their ancestors cultivated and manufactured this staple before the English became an agricultural people. That they very early were possessed of a knowledge of its treatment is evident, and it has ever since been so important a crop with them that Irish linen is proverbial. In their language, the name for thread is *lhin*, which was also applied to flax. The early Brehan laws required that the farmers should be acquainted with the mode of working flax.

It appears, however, that it was not until the Huguenots settled in Ireland that the manufacture of linens became well established. Among them was Lewis Crommelin, who settled near Lisburn, to whom Ireland is indebted for the permanent establishment of the linen manufacture. He had looms, implements and spinning-wheels imported from Holland, by means of which an improved style of goods was produced. Government aids were bestowed upon the manufacture, so that it was well fostered. The Royal Dublin Society, as early as 1739, exerted itself to supply the cultivators with practical instruction, by means of agents who had been trained under the skilful flax-growers of Belgium. The great impetus, however, was given by the establishment of manufactories to spin the thread by machinery; and at the same time there was an irregularity in the supply of raw material from the continent, which induced the manufacturers of Ulster, in 1811, to organize the society " for the improvement of the growth of flax." This society was fostered by government, and extended its operations over the island, and now has its headquarters at Belfast, and actively diffuses information among the farmers, and offered liberal premiums for improvements in machinery.

The committee of this society congratulate the members in the following terms in the report of 1850:

" The society has now been nearly nine years engaged in its arduous labors to accomplish the great national object for which it was formed. Although it has had many difficulties to surmount, and many prejudices to contend with, and although the complete attainment of its aim is apparently yet distant, a dispassionate review of what it has already accomplished must show that it has been productive of much good, and that its further progress will be more rapid than the past. During the period that has elapsed since its foundation in 1841 it has succeeded, notwithstanding the opposition that prejudice and long-rooted habits have presented, in generally improving the growth and preservation of the flax-plant in all the districts of Ulster to which its operations have been extended. It has introduced scutching machinery of a very superior description to that formerly in use, and has thus accomplished a great economy in labor and material. It has induced the saving of a large portion of seed, formerly lost in the steep pools, thereby enabling the grower to increase the profits of his crop by the sale of the seed, or its use in feeding his cattle. It has protected the farmer from the frauds under which he frequently suffered in the purchase of seed for sowing, and has succeeded in establishing his legal claims for redress, in cases where there has been a deception on the part of the seller.

"Since its attention has been directed to the districts of the other provinces, it has done much towards the great extension of flax cultivation at which it has aimed. Outside of the twenty-three counties of the provinces of Leinster, Munster, and Connaught, its operations have been extended to twenty-one. In some of these—Cork, Mayo, Limerick, Tipperary, Queen's, Wexford, and Lowth—it may now be said to have firmly taken root; and in the rest, it is in a greater or less state of progress, according to the circumstances of the districts or the period at which the society took them in charge. Where the flax has been extensively grown during the late years of distress, it has been of the utmost service to the poorer class of farmers by enabling them to reserve for the support of their families and live stock the food crops that would have otherwise gone to pay rent and taxes, but whose place for this purpose flax has supplied. The amount of employment thus given has been very great, more especially to the weaker classes of the population. And it has paved the way to an improved system of husbandry by the attention which it exacts in the preparation of the soil.

"When the society was instituted, flax was the only crop in which the Irish farmer had to maintain an open competition with the foreigner. While all kinds of grain, produce, and cattle were subject to high duties on importation, the duty on foreign flax had been reduced to a mere nominal amount. This premium upon other crops resulted in the neglect of flax, notwithstanding the peculiar suitability of our soil and climate for its growth. A change, however, has now occurred in this respect." * * * * *

England has become famous for her threads, and at the present time there are upwards of eighty spinning-mills in Ireland, in which fully half a million of spindles are daily employed, and the manufacture is now ahead of the agricultural production.

RUSSIA.

Mr. Ward tells us in his pamphlet that, of the 150,000 tons of flax annually consumed in the United Kingdom, 70,000 tons only are of home growth, while 80,000 tons are imported. Of this, Russia supplies 60,000 tons, which was formerly rendered at from $120 to $144 per ton.

The extensive cultivation of flax in that country is mainly owing to the alluvial soil upon which it is grown, and the low price of labor among the serfs. The vast plains of the interior are traversed by large rivers which annually overflow and leave a rich deposit upon the soil, which encourages the growth of the crops. The soil is well adapted to the flax culture, but a want of care accounts for the low grade of Russian flax. The quality of the fibre varies, however, and is partly distinguished by its color. The silver-colored is the best, and that from Wasnikow and Carelia is remarkable for a shining whiteness. It is mostly brought from beyond Moscow by water, in large, flat-bottomed boats or barges. Several thousand of these reach the lake Ladoga in the spring and summer. Greater care is taken in sorting the flax at Riga than at St. Petersburgh, hence the superiority and greater trade at this point.

The following table will show the sources from which the British demand is in a great measure supplied, giving Russia credit for a still larger share of the supply:

From Dickson's work it appears that the Belfast flax spinners report, that in 1832 the yarns exported from Ireland were valued at $25,000; but that—so great had been the increase of the production during the next twelve years—in 1843 the export amounted to $6,000,000.

The linen manufactures of Great Britain are estimated by the same author at more than twenty millions of dollars.

The average annual production of fibre, in the chief countries where flax is grown, is given by Dr. Ure as follows:

Russia	130,000 tons.
France	48,000 "
Belgium	18,000 "
Holland	9,000 "
Austria	60,000 "
Prussia	32,000 "
Ireland	35,000 "
Egypt	10,000 "
Total	342,000 "

Adding all other countries, the amount may be estimated at 400,000 tons. The value of this fibre may be $100,000,000, and of the seed produced, $25,000.000, making a total value of the raw material of flax amounting to one hundred and twenty-five millions, which has its value very much enhanced by the processes of manufacture into woven fabrics or into oil.

From Morton's Cyclopædia of Agriculture we learn that in six years the total importation of flax was:

In 1840	62,662 tons.
1841	67,368 "
1842	55,113 "
1843	71,857 "
1844	79,174 "
1845	70,921 "
Total	407,095 "

Thus the flax imports during those six years give an annual average of 67,849 tons, which, at a fair valuation, or £67 ($335) per ton, is equal to	$22, 729, 415
Add annual imports of flax-seeds for sowing and feeding, 616,000 quarters, (English,) valued at £4 per quarter, being twenty shillings per quarter below the price for many years in Ireland	12, 320, 000
Add annual imports of oil-cake, 86,000 tons, valued at £9 per ton	3, 870, 000
Total	38, 919, 415

The same authority informs us in respect to the individual and personal advantages which flax culture will confer on the farmer. The following instances are actual facts bearing on this subject. Flax has been grown to leave a profit of $100 per Irish acre, (eight of which are nearly thirteen imperial acres,) after paying expenses, which is verified by the following statement:

	Dr. Flax.
Rent of one acre of land	£1 6*s*. 9*d*.
2½ bushels seed	1 10 3
Ploughing and sowing	0 15 0
12 hands, weeding	0 12 0
12 hands, pulling	0 18 0
6 hands, watering and grassing	0 10 0
Lifting and carting home	0 8 0
Scutching 60 stone	3 0 0
Taxes and rates	1 0 0
Total	10 0 0

	Contra Cr.
By produce of one acre of second quality of flax, 60 stone, at 10 shillings	£30 0*s*. 0*d*.
Deduct rent and expenses	10 0 0
Net profit	20 0 0
Or	$100 00

Again: Mr. Warnes, of Trimmingham, of Norfolk, in one of his published letters on this subject, says: "A great proportion of my flax is produced at the rate of one ton from three acres of land, or at £85 per ton, at the rate of £28 per acre; or at £53 per ton, at £17 10*s*. per acre, exclusive of seed, which, in some instances, amounted to twenty-six and twenty-eight bushels per acre; but taking twenty as the average, at the present prices of English linseed, £7 per acre may be added to the above sum."

By this statement Mr. Warnes, it appears, can, by growing the coarse quality of flax at £53 per ton, have for the produce of one acre: Flax, £17; seed, £7; gross produce, £24.

And I may add a few certificates in further proof of my assertions as to the profits made by flax culture when a proper system has been followed:

MODEL FARM, *Caledon, November* 29, 1845.

SIR: In answer to yours of the 24th, I have much pleasure in favoring you with an account of the flax crop, and expenses thereon, grown on the Earl of Caledon's model farm in 1845:

CROP.

Produce of 1 acre, 1 rood, 39 perches, sold at 11*s*. 3*d*. per stone	£55 16*s*. 7*d*.
Tow, (or shorts of the flax)	0 8 8
130 bushels of bolls, which I consider worth 8*s*. per bushel	4 6 8
	60 14 3

EXPENSES OF CROP.

5 bushels of seed, at 15*s*. 3½*d*. per bushel	£3 16*s*. 6*d*.
Weeding	0 10 0
Pulling, rippling, and steeping	4 3 8
Taking out of steep and spreading	2 1 4
Lifting and tying	1 2 8
Scutching	4 9 4
	16 3 6

Leaving a balance of £44 10*s*. 9*d*, or, at the rate of £29 13*s*. 10*d*. per acre after deducting all expenses.

It is but fair to add that we had to carry the flax to and from the steep on barrows for eight perches, as the steep was in a bog.

JOHN BARR, *Manager*.

J. W. ADAMS, Esq.

ANALYSIS OF THE CROPS.

Professor Kane read a paper before the Irish Academy, in which he pointed out that many of our most valuable vegetable productions were composed chiefly of simple compounds of a few elements combined with very small portions of the mineral elements of the soil; among these are sugar, gum, starch, and ligneous fibre.

Though the valuable product be thus constituted, it is observed that the plants which are most productive of these substances must be in a vigorous, healthy state of growth, and that, in their development, various mineral elements of the soil must be consumed by them; therefore they are exhaustive crops. But as the valued product does not contain them, the waste portions may be returned to the soil to keep up its fertility.

Prof. Kane presented a series of analyses, which he had made to determine their constituents.

The stem of hemp, dried at 212° Fahrenheit, he found to contain—

Carbon	39.94
Hydrogen	6.06
Oxygen	48.72
Nitrogen	1.74
Ashes	4.54
	100.00

The leaves of hemp contained—

Carbon	40.50
Hydrogen	5.98
Nitrogen	1.82
Oxygen	29.70
Ashes	22.00
	100.00

The ashes of the hemp-plant consisted of—

Potash	7.48
Soda	.72
Lime	42.05
Magnesia	4.88
Alumina	.37
Silica	6.75
Phosphoric acid	3.22
Sulphuric acid	1.10
Chlorine	1.53
Carbonic acid	31.90
	100.00

Dressed hemp fibre gave but 1.4 per cent. of ashes, after having been dried at 212° Fahrenheit. Its organic composition is similar to that of woody fibre, and devoid of nitrogen. The characteristic constituents are lime and nitrogen. The substances dissolved by water in steeping hemp contain a narcotic principle used in medicine. Sir Robert Kane evaporated some of this liquor to dryness and analyzed the product, with the following results :

Hemp extract.

Carbon	28.28
Hydrogen	4.16
Nitrogen	3.28
Oxygen	15.08
Ashes	49.20
	100.00

Exclusive of the ashes, in the same proportion, we have—

Carbon	55.66
Hydrogen	8.21
Nitrogen	6.45
Oxygen	29.68
	100.00

Approaching azotized animal substances in its composition, and forming a very rich manurial application. The ashes of the hemp-leaves contain only 8.05 per cent. of soluble matter, while those from the hemp extract had 60.4 per cent. of soluble matter.

He next examined the stem after it had been steeped and peeled. After drying at the usual temperature, he found that this matter consisted of—

Carbon	56.80
Hydrogen	6.48
Nitrogen	.43
Oxygen	34.52
Ashes	1.77
	100.00

The ashes contain but a trace of alkali, and the nitrogen is in very small quantity. Hence it appears that, though hemp be an exhausting crop, the valuable fibre takes up but a small portion of the wealth of the soil, and that the valuable elements are left upon the farm.

Mr. Kane's examinations as to the composition of flax led to similar conclusions, as will appear from the following analysis :

The stems of flax dried, with some leaves, yielded—

Carbon	38.72
Hydrogen	7.33
Nitrogen	.56
Oxygen	48.39
Ashes	5.00
	100.00

The flax contains very little nitrogen. In hemp there is more oxygen than necessary to form water with the hydrogen; but in flax there is an excess of hydrogen. The composition of the ashes is also different, as will be seen by the table :

Potash	9.78
Soda	9.82
Lime	12.33
Magnesia	7.79
Alumina	6.08
Silica	21.35
Phosphoric acid	10.84
Sulphuric acid	2.65
Chlorine	2.41
Carbonic acid	16.95
	100.00

Lime is in smaller proportions; soda, potash, magnesia, and phosphoric acid are in larger proportion; hence the exhausting properties of the crop are explained.

The extract from the steep water, properly dried, yielded—

Carbon	30.69
Hydrogen	4.24
Nitrogen	2.24
Oxygen	20.80
Ashes	42.01
	100.00

The ashes of the plant yielded 33.90 per cent. of soluble matters; that from the extract gave sixty per cent. of soluble matter; hence the value as a manure of the steep water. The composition of the waste, or stem, from which the fibre had been removed, was very similar to the corresponding portion of the hemp.

We should also investigate the constitution of what are considered the waste products of the flax crop, and in so doing we are delighted to find that, according to the analysis of Mr. Way, the shives contain, of oil and fatty matters, 7.02 per cent.; of albuminous matter, 9.93 per cent.; of starch, gum, sugar, &c., 26.29 per cent.; so that this dry woody substance, as it appears when cursorily examined, is really a valuable substance for stock-feeding. How much more so when separated from the unrotted straw may be readily imagined.

Professor Hodges gives a somewhat different result as derived from his investigations, with other specimens. He found of nitrogenous matters 3.23 per cent.; of oil and fatty matters, 2.91 per cent.; of gum and soluble matters, 14.66 per cent.

An analysis of the residual oil-cake by the same authority gives, as the average of seven examinations—

Nitrogenous matters	28.47	per cent.
Fatty matters	12.90	"
Gum and soluble matters	39.01	"
	80.38	"

Showing the great value of this material for stock-feeding.

It must be remembered that the seed crop is brought to the market for two distinct purposes—for sowing as seed, and for the production of oil and the resulting oil-cake. Different regions of the globe are called upon to furnish supplies for these several objects. That which is sold for sowing is all produced in the northern countries, while that which is purchased exclusively for the manufacture of oil is brought from Russia, Hindostan, and the southern portions of Europe. In a large portion of the United States also this crop is grown almost exclusively for the production of oil.

Professor Hodges, of the Society of Belfast, gives the following comparative analysis of the New Zealand flax, *Phormium tenax*, and of common flax, grown in Ireland:

The ashes, respectively, contained—

	New Zealand.	Ireland.
Potash	14.93	20.32
Soda	5.38	2.07
Chloride of sodium	8.75	9.27
Lime	28.52	19.58
Magnesia	1.41	4.05
Oxide of iron	1.21	2.83
Sulphuric acid	4.64	7.13
Phosphoric acid	18.96	10.24
Carbonic acid	13.12	10.72
Silica	3.86	12.80
	100.78	99.01

[*From Morton's Cyclopædia.*]

ANALYSIS OF SOILS.

"The composition of the soil on which the cultivation of flax may best be carried on, being a problem of the highest practical interest to this country, the Flax Improvement Society of Ireland commissioned their agent to make analysis of some soils which had produced remarkably good flax. The soils were light clay loams, and afforded the following results, which are extracted from the report of the society:

	No. 1.	No. 2.	No. 3.
Silica and silicious sand	73.72	69.41	64.93
Oxide of iron	5.51	5.29	5.64
Alumina	6.65	5.70	8.97
Phosphate of iron	.06	.25	.31
Carbonate of lime	1.09	53	1.67
Magnesia and alkalies, with traces of sulphuric and muriatic acids	.32	.25	.45
Organic matters	4.86	6.67	9.41
Water	7.57	11.48	8.73
	99.78	99.58	100.11

The organic matter in these soils was rich in nitrogen; their fertility is, therefore, from the analysis, easily understood.

At a meeting of the society Sir Robert Kane said:

"Every farmer present is aware that crops exhaust the soil; that the plants take out of the ground a number of materials, and that it is necessary to restore similar materials to the soil in order to keep up its fertility; therefore, the manure which the farmer puts in with or before his seed is, in a degree, the raw material of which the grown crop is made. It is just as much a part of the plant as the seed itself. Then the farmer sells and sends away his grown crop to be used for food, as in the case of wheat, oats, and potatoes—he thereby sends away and sells the essence of the manure which he had put into the ground; and as he thus gets paid for the manure which he has exhausted, he must put in as much more for the next crop, which is to be dealt with in the same way. Now, in the case of flax, there is the important peculiarity that *it is not eaten*, and hence does not return to the land any manure in the ordinary way, whilst it takes out of the soil just the same materials as oats or potatoes, so that it is really a very exhausting crop, if we look only to the growing of it. But the flax crop differs from other crops in this, that the value of oats or potatoes, and all food crops, depends on what they take out of the ground, whilst the valuable part of the flax is the fine fibre, or thread, which has taken nothing out of the ground. If you burn a bundle of flax stalks it will leave behind a large quantity of white ashes, which consists of the different substances which the plant took out of the ground; but if you burn a bundle of well-dressed flax it will leave *no ashes*. They have evidently been carried off with the waste parts of the plant in the steeping and scutching. They are thrown away, and yet they are materials of which the plant had robbed the soil, and which should be given back to the land in order to keep up its fertility. To the practical farmer it is, therefore, of the greatest importance to recollect this principle, that the fibre, or valuable part of the flax, is not formed by the exhaustion of the soil, but the materials which the plant takes out of the land are all found in the steep-water and the chaff; and that if these be returned to the earth they will restore its fertility, and that thus the flax crop may be rendered one of the least injurious to the ground and most remunerative to the farmer."

The true analyses of the fibre, as given above, show that it does yield ashes, and that this does contain inorganic or mineral matter, though in very small amount, as will be shown. We must now present some testimony of an opposite character and equally imposing:

Professor Hodges states that the "result of an analysis of the fibre of the flax plant proves that that part of the plant is not destitute of matters derived from the soil," and that the scutching-tow contained a still larger proportion of such elements. The professor admits that "flax is an exhausting crop; that is, like every other plant that is cultivated for food or clothing, or that springs up along the highway, it takes certain matters from the soil. When only a part of the plant, like wheat, is sent to market only a part of the matters of the soil is lost to the farm, and its exhaustion is delayed." But he claims that flax is not so exhaustive as some other crops, and gives the following table showing the amount of phosphoric acid and alkalies contained in a hundred parts of the ash of several plants:

	Phosphoric acid.	Potash & soda.
Flax	7	12
Wheat straw	3	13
Oat straw	3	29
Bean straw	7	55
Red clover	8	36
Cabbage	12	32
Potato stalks	7	44
Turnip tops	9	34

Mr. Ward says that flax cannot be an impoverishing crop to the farmer, as the seed and chaff make better manures, when the cattle are fed with it, than any other fodder. Liebig states that the seed and refuse of the plant are rich in phosphates.

It has been ascertained in Scotland and in England that the finest crops of wheat may be grown immediately after flax in a rotation, and this is confirmed by the statements of some of the most intelligent farmers of Ohio, many of whom speak very highly of the flax crop to take the place of a naked summer fallow as a preparation for wheat, and some very fine crops of wheat have been harvested after flax.

Hence it may safely be concluded that flax is not a remarkably exhausting crop, although it belongs to that class called man-crops, in England called white-crops, which do not usually make any important return to the land, and which may therefore, to the extent of the valuable elements they withdraw from the soil, be fairly considered exhausting. And yet flax is to be continued in a suitable rotation to take its place with other profitable crops.

It is fortunate for us that flax has a very wide range of soils in which it may be cultivated: Sands, loams, light and heavy clays, gravels, chalk, marls, alluvials, peat, and reclaimed marsh lands, are all seen, under ordinary circumstances, to produce a crop of this fibre. Sandy loams and alluvials appear, however, to be best adapted to its cultivation. In Ireland large crops are obtained on peat bogs, with a clay substratum. This plant needs an open soil through which the water may percolate freely, as its roots are of a fibrous nature and extend both laterally and vertically to a considerable distance. The conditions required for its successful cultivation are that the soil be deep, in good heart and in good tilth, well drained, and free from weeds; if these exist, we may, under ordinary circumstances, expect a good crop. Owing to the rapid growth of the plant, and the consequent shortness of time it occupies the land, it offers many opportunities to the grower, and admits of more changes in the rotation than most other farm crops.

In some of the best Belgian flax districts the soil is a sandy loam, containing as much as ninety per cent. of silicious matter, and depends for its superior excellence entirely upon the persevering industry of its skilful cultivators. A moderately tenacious subsoil, neither so loose as to allow the water to run away too rapidly, nor so compact as to cause it to stagnate about the roots of the plants, is considered by the continental farmers as the most desirable. The soil must be deep, and the Belgians have a popular saying that the flax has roots which go as deep into the soil as the stem grows above the ground.

In our own country we find a great variety of soils that appear well adapted to the production of this crop. River alluvials, level uplands, mucky flats, and the deep, black prairies of the west, particularly those that rest upon a strong clay subsoil, sufficiently deep below the surface, are all of them well adapted to the growth of flax.

Mr. Denman, a Belgian gentleman who was employed by the Royal Flax Society of Ireland as a teacher of the proper methods of managing the crop, recommends as of the greatest importance in the culture of flax that the land be well drained and repeatedly and carefully cleansed from weeds, and thus reduced to the finest, deepest, and cleanest tilth, in order to facilitate the penetration of the roots, which often go to a depth equal to the height of the plant above ground.

"A light ploughing immediately after harvest is required for all soils; but if they be heavy and stiff, they should be laid in ridges before winter, and thus to remain until a fortnight before sowing, when they should be deeply ploughed. Light soils may have their last ploughing before the setting in of winter. If the land be not sufficiently rich, liquid manure or rape-cake powder should be applied before sowing the seed, after which it should be harrowed and rolled, and should look like a garden."

As the expense of preparing grass land directly for flax may be too great, he advises that some other crop should intervene, of such plants as do not occupy the land long, and which require the frequent stirring of the earth, such as beans, peas, turnips, &c; we should say Indian corn. This cultivation will have the effect of rendering the sod sufficiently fine and loose, and will help to kill the weeds which would otherwise be a serious injury to the flax crop. It is asserted that the Livonians, when clearing a forest, burn the wood upon the surface as a preparation for flax, and that they prefer soil thus prepared to all others. Stiff soils should be exposed to the action of winter frosts, to loosen their textures, and when not too wet in February, some rotten manure may be ploughed in.

Denman recommends from two to two and a half bushels of seed to the acre, when sowed broadcast; but if the land is rich and the season favorable, there may be danger of sowing too much seed, as the flax will lodge, and the fibre will be materially damaged. When drilled, a smaller quantity will be sufficient; and if the intervals be wide, half the quantity will suffice. He recommends from the middle of March to the middle or end of April as the best time for sowing in that country. In the south of Europe it is sown in September and October, but these autumnal-sown crops are not so productive in fibre as the spring-sown fields, though their product of seed is better. It is laid down as a general rule that land intended for flax should be brought to an exceedingly fine tilth before the seed is put in, and that it should be enriched by suitable manure.

The roots of flax penetrate deeply; therefore the soils best adapted to the crop are such as consist of a deep loam, which is not liable to be surcharged with moisture on the one hand, nor to become too dry on the other, and which is susceptible of receiving a very fine tilth; river bottoms are generally of this character. If water exist permanently a short distance below the surface, it is by some considered an advantage to the crop, as is the case in Zealand, which country is remarkable for the fineness of its flax, and where the soil is deep and rather stiff, with water almost everywhere at one and one and a half or two feet below the surface. If well manured and well tilled, and if the seasons be not too dry, fine flax can also be produced on elevated lands. The soil should neither be too rich, so as to make the flax coarse from its luxuriance, nor too much exhausted, so that the yield would be small. Neither light sandy soils nor hungry gravels are recommended for this crop.

A great deal of our prairie lands in the western States contains a soil which is admirably adapted to the production of flax, and the experiments which have been stimulated within a few years by the high price of seed, and by the introduction of machinery for the preparation of the product, have most abundantly demonstrated the admirable character and adaptability to this object of immense tracts of land in the prairie States which now are lying in a state of nature, or merely used for grazing.

Flax culture requires very careful preparation of the land; deep tillage, and thorough pulverization of the earth is very essential to success. By these means flax may be grown to advantage on almost any soils, though some are much better adapted to it than others. The best is considered to be a sound clay loam, or a dry loam with a clay subsoil; but this must not be too compact, and is always better for being loosened, and by all means well drained, for if saturated with water above or below, it will injure the flax. Nor is it considered in Flanders good policy to grow successive crops of this plant; once in ten years is sufficient. In this country farmers pay little attention to the subject of rotation of crops, which is found to be a matter of great importance in the improved agriculture of Europe.

A favorite rotation in Flanders is: 1st, potatoes; 2d, barley, seeded with grasses; 3d, meadow, cut for soiling stock; 4th, pasture; 5th, flax, or one half in oats, so that on the return of the rotation the part that was in oats may be put into flax.

After wheat one ploughing is deemed sufficient in Ireland on light soils; but two are still better, and three are better still. In this country a fall ploughing is very desirable, and this should be stirred as early as practicable in the spring; the harrow should follow, reducing the soil to a very fine tilth; if the ground be very loose on one hand, or at all cloddy on the other, it will be well to roll before sowing. After applying the seed as evenly as possible, a brush harrow, or light harrow with short teeth, should be drawn across the surface, and in some cases the roller should be applied to render the field as smooth as possible and to compress the earth about the seed, so as to insure its early vegetation and to have it come up as evenly as possible.

The quantity of seed sown per acre is a question upon which there is great diversity of opinion among farmers as well as among writers upon this subject, the amounts varying from half a bushel to three bushels and a half. The smallest quantity is that commonly applied in this country, where the farmer grows this crop exclusively for the seed and takes no care for the fibre. The plants not being crowded, branch freely and produce a greater amount of flowers and seed to each individual than where crowded. This error, which is very injurious to the character of the fibre, should be combated by all who desire to see the highest results from the encouragement of this important crop in our country.

Mr. Todd, author of the prize essay offered by the American Agriculturist, insists upon a thorough preparation of the soil; but, having sown the seed, he will not allow a hoof to trespass upon the mellow earth, preferring to use a light brush harrow drawn by hand, which, he says, can be done almost as fast as the seed is sowed. His objection to the introduction of the team with either brush, harrow or roller upon the soft, mellow earth, is that the heavy tramping of the animals cannot fail to make depressions that would bury portions of the seed too deeply and cause it to vegetate unevenly. He thinks a light brush, which merely hides the seed, covers it sufficiently. The brush harrow is made by boring holes in a piece of scantling, into which bushy twigs two feet long are fastened. If more brush is needed, additional pieces are nailed on to the scantling; a light pair of shafts are secured to the brush-head, by which the machine may be dragged steadily by a man or boy.

Our western farmers, especially, who grow the crop almost exclusively for the seed alone, sow but half a bushel, or at most three pecks; but in the eastern States, on poorer soil, the farmers desiring to secure crops both of seed and of fibre, sow five pecks, and it is found that they obtain a larger amount of seed per acre than the average in the west. In Europe two bushels, and even more, is a very common allowance for seeding an acre, where it is desirable to produce a fine lint, and they also often harvest twenty bushels of seed. Some experiments in heavy seeding in the United States have not proved entirely satisfactory, for though the stalks were very fine and slender, and the lint produced was very fine, the straw was too short; this may have arisen from the poverty of the soil where the thick seeding was tried. In the thoroughly farmed and highly manured fields of the flax region of Belgium, we find the largest amounts of seed are sown with the best results; on such lands, deeply cultivated and highly enriched with liquid manures, three bushels of seed to the acre has yielded crops of flax that gave very fine lint, the straw being three feet high, and valued at one hundred dollars per acre in the field; for, in Belgium the farmer sells his crop to the manufacturer, and is relieved from further care after it is ready to harvest.

There are immense tracts of excellent flax lands in our country, and there is no doubt that, with proper care and sufficient seed, our rich alluvions will produce a superior quality of lint whenever the enterprise of the manufacturers shall elaborate and produce proper machinery for the preparation of the crop; a desideratum which this commission is happy to announce has already come near to its accomplishment, as will be shown under the head of machinery in the mechanical section of the report.

But to return to the seeding: we consider it very important that a sufficient amount of seed be applied to the soil; whatever that amount shall be, must be settled by the experience of the farmer in each section of the country. In sowing the flax it will be of the greatest importance to the crop to have it evenly spread upon the surface, and this, while a matter of great moment, is not easy to accomplish. The seed is very smooth and slippery, and great skill, derived from long practice, is necessary to distribute it evenly. It has been suggested that this work may be best done by the use of some of our broadcast sowing machines properly adapted to this seed. The drill machines may be used if properly adjusted for this crop, but the rows must be made very close to prevent the straw from branching. In broadcast sowing the plants should stand at about one inch apart over the field. Great care should be taken to have the seed perfectly clean, and the soil selected for flax should not be foul with seeds of weeds, which are very injurious to the flax crop; nor can we ever expect to hand-weed our fields in this country, as is constantly done in the flax culture in Europe.

In the flax regions of the Old World there is a great prejudice against using home-grown seed, and we have found in this country also an impression in favor of importing seed, under the idea that the plant has got used to yielding lint there, and has become habituated to yielding seed only in this country. This is a mere theory without any foundation whatever; and, on the contrary, the American and Riga seed are preferred in Europe for the opposite reason, as it is argued that, where the crop has been grown for the seed alone, these will have been better ripened and more robust than when the crop has been crowded and prematurely harvested for the sake of the fibre. Some very carefully-conducted experiments to ascertain the value of different kinds of seed are reported in the proceedings of the Flax Society of Ireland, from which it appears that the home-grown Irish seed yielded the best results, as will be seen from the tables given. The season having been very unfavorable, the amounts are not large, but answer for a comparison:

Kind of seed.	Clean flax.	Seed.	Flax per acre.	Seed per acre.
	Pounds.	*Quarts.*	*Pounds.*	*Bushels.*
American	42	46	336	11½
New Riga	54	40	432	10
Dutch	49	44	391	11
Irish	70	42	540	10½
Old Riga	45	40	360	10

In Europe, after the ground has been pulverized and well cleaned, it is rolled and sown; and if the land has not been ploughed in ridges, the surface is marked off in divisions eight or ten feet wide. After sowing, the seed-harrow is passed over the ground three times, forward, back, and across, or anglewise, so that the seed shall be equally spread, and the land furrows be filled up. The work is finished by the roller, which compresses the soil about the seeds, that are buried about an inch deep. It is desirable to have them vegetate as evenly as possible. Grass seeds are sometimes sown with the flax, but if they grow well it must be at the expense of the crop.

The writer of the prize essay, above alluded to, makes an admirable suggestion with regard to sowing flaxseed, which is a process that is universally represented as a very nice matter, to be well executed, on account of the smooth and slippery character of the seed. He advises and reports as his practice the partial soaking of the seed, and then rolling it, or rather mixing it, while wet, with ground plaster, that enables him to handle it readily, and to distribute it evenly upon the ground, where its early vegetation is accelerated by the addition of this material.

From the latest accounts of the statistics of Ohio, it is manifest that the flax crop has been much increased in area. Mr. Mansfield, the statistical reporter of that State, reports that the breadth of flax in 1862 was 52,546 acres, but in 1863 it had extended to 95,170 acres.

The following very practical remarks were communicated to the commission by W. S. Lowrey, of Saratoga Springs, New York, and are introduced on account of their worth and brevity:

In this section the past year flax produced but one half the crop of ordinary seasons of both seed and fibre.

Soil.—Heavy clay loam stands first best as regards both fibre and seed. Gravelly loam second best, or produced but half a crop. Light sandy loam and coarse gravel third best, or from one-fourth to one-sixteenth of a crop the past season.

Preparation of soil.—We plough well. Harrow three or four times previous to sowing, to form a good seed bed. Time of sowing from the 15th of May to 30th. Flax, to coat well, must grow in cool weather. Quantity of seed I sowed, one and a quarter bushel per acre; one and a half would have been better.

Time to pull.—This should be done when one-half to two-thirds of the bolls are brown Allow me to remark that work on the flax crop has just commenced at this period of its growth, and that if the flax is uneven, poorly coated, and in the wet spots badly lodged, it will be impossible by any method to produce good fibre. On the other hand, if the flax is in quality and yield of fibre prime at this stage, and care be not exercised in handling and rotting, the result will be the same. Many of the best crops in the country were spoiled the past season by carelessness in handling and overrotting. Acres were badly damaged, and hundreds of dollars lost by making too large bundles to cure well at the time of pulling. They should be just large enough to reach around with both hands, fingers and thumbs touching.

Method of pulling.—Clasp several straws in the right hand, pass them to the left, and pull with both hands. Repeat this until the hand is full, lay this down, repeat again, and then tie both handfuls in one bundle. At night we set up all that is pulled during the day in loose stooks. This method preserves uniformity in curing, and part of the flax is not sun-burned while the other is green and unfit for sheltering. As soon as it is dry draw it into the barn to whip.

Whipping.—Place a flat stone on the barn floor, with one edge inclined to an angle of forty-five degrees, set another under it to block it up, clasp the bundle with both hands near the roots, raise it, and, with a smart stroke bring it down across the stone. Repeat it several times, until the seeds are mostly broken from the straw. Clean the seed with a fanning mill.

Rotting.—The common method is to spread the flax in thin swaths on close fed meadows, exposed to the dew, until the shive parts readily from the fibre. It is then turned bottom side upwards by running a pole under the straw; after three or four days longer it is raked and bound to convey to the barn. A better method is to place the straw in large beds on the surface of a shallow pond of soft water, roots uppermost and tops down, place some slabs or boards on the roots loaded with stones to sink it, and in from twenty-four to forty-eight hours, and from that to two weeks, according to the temperature, it will become soft, and the shive will part readily from the fibre. We then take it out and dry it on the grass by spreading it in thin swaths, and when dry rake, bind, and set it in stooks to air. When it is well aired it is not splintery like the dew-rot, but wiry and tough like a withe. The best way to rot flax we think we have discovered. This method is the perfection of simplicity, enabling any man who has an unfailing supply of soft water, with less than five hundred dollars capital, to rot flax for five dollars per ton, in from twenty-four to forty-eight hours, and in less time with larger capital and conveniences; the fibre every way being equal to water-rotted flax by the common method.

Why water-rot is better than dew-rot. 1st. It saves from fifty to one hundred pounds dressed flax to the ton, of the same quality. 2d. It finds a ready sale at the highest market price, and buyers assure us that in large lots it will command a premium over the dew-rotted. 3d. It is more durable. For proof, lay flax rotted by the two methods side and side, exposed to the action of the weather. 4th. The first method rots; the second cures.

Why we rot flax. 1st. There is a market for rotted flax at fair prices. 2d. We have at present no better method of preparing flax fibre. 3d. We rot because manufacturers leave for the farmer to do what should be done at the mill—a serious difficulty in the way of its extensive cultivation, which we believe can be obviated by adopting our method.

Severe sickness in the family prevents my writing but a few facts. Those few, however can be proved.

Yours, for the success of flax culture,

WM. S. LOWREY.

Herman von Bielke, of Bon, Schleswig, who is said to be a practical flax-grower, makes the following statement:

"Although in general the saving of seed is rather injurious to the flax, yet it is very desirable, for many reasons, that every flax-grower should yearly appropriate a small part of his flax ground, and especially that where it grows the thinnest, for the saving of seed. In the first place, because the Russian seed does not generally produce such fine flax as that which has been saved on the spot; secondly, because the grower is certain that, by proper and careful treatment of the saved seed, he will have what he can depend upon. This is not always the case with Russian seed, which is frequently either too old or too much dried by storing, from which it always suffers, or it is mixed by the dealers with other seed. Thirdly, because the Russian seed is often at so high a price in the spring. The seed should be allowed to ripen well before harvesting, and may be treated according to the Courtrai method; that is, dried in bundles in the field and not rippled till the winter or spring following. The capsules should not be threshed clean at first, to separate only the best seed. Seed of two or three years old is better for producing fine lint. If new seed be sown, it should first be thinly spread upon an airy floor, and frequently turned. It is not necessary to renew the seed from abroad if proper care be taken to select it. A small part of the crop may be allowed to stand till fully ripe."

Some of our best agriculturists have arrived at similar conclusions with regard to the choice of seed, and consider it always safest to select a portion of their own crop from which to save their seed. This is allowed to ripen fully, and, when dry, it is subjected to just so much action in threshing as shall separate only the ripest and heaviest seed, which is kept by itself, after being thoroughly cleaned from admixture of the seeds of weeds and imperfectly developed grains. This seed should be very carefully preserved, so that it shall neither contract moisture, nor be subject to heating in bulk. It should be moved occasionally from one cask to another to prevent the latter result.

In purchasing seed, the heaviest, brightest, and plumpest should always be selected, and that which has not been mixed from different crops should be preferred.

Mr. Ward tells us that the successful cultivation of this crop does not so much depend upon the quality of the soil, the nature of the climate, or the amount of capital and labor applied to it, as upon the favorable influence which the first two may exercise when combined with the judicious application of the others. When all these elements of production are in harmonious co-operation the result may be easily predicted; but when one or other of them is deficient, or partially defective, it becomes no easy task to assign to each its power or agency. This complication of production is widely extended in Belgium, and largely predominates in the flax districts; for the general condition of the soil is by no means so favorable for agricultural processes as that of Ireland, nor is the climate comparable to that of the latter as regards the flax plant; but the amount of labor which the Belgians so energetically and so judiciously apply to their soil more than compensates for any elementary deficiency that may exist. The old maxim that success crowns labor, therefore, deservedly characterizes agricultural pursuits in Belgium, and its application is never more justly felt than when it gives point to a material fact such as the flax cultivation of that industrious country presents.

A great portion of the soil of Belgium is alluvial, partly formed by the recession of the sea, and partly by the elevation of the land, the country being chiefly made up of the deltas of the great rivers of Europe—the Rhine, the Scheldt, and the Meuse. The agriculture of Holland and Belgium is therefore arable; artificial means are requisite to bring the soil under cultivation. The soils are generally inferior, but this is overcome by the labor of the people, who often commence with an almost hopeless sand whose loose and undulating surface seems to defy all vegetation. The first crops are generally oats, rye, or broom; the former are used for forage, and the tops of the broom are similarly applied, though the plants remain for three years, when they are ploughed in to enrich the soil. When the farmer is able to keep a cow, by growing turnips or clover, the manure of every kind is saved with care, and the conversion of the arid sand into productive soil is quickly effected.

The great feature of Flemish husbandry is deep cultivation. This is performed either by the spade or plough, and often by both conjointly. The land is gradually trenched to the depth of twenty inches or more. It is laid out in stitches about six feet wide, with the plough; between these a ditch is dug with the spade, about a foot wide, and the soil thrown upon the stitch. The next year a foot in width is taken from one of the stitches and thrown into the adjoining trench, so that in the course of six seasons the whole soil will have been trenched over.

All plants do not equally require a depth of soil, but many that appear superficial in their wants will frequently extend their roots much further than is generally supposed. The root of the flax plant, for instance, is known, under favorable circumstances, to go as deep below the surface of the soil as the top ascends above it. The object of the Belgian farmer is to obtain a deep and friable soil, equally enriched throughout, which is only accomplished with great care and attention. The land has the appearance of the most perfect garden cultivation.

The mode of subsoiling in Belgium is worthy of notice. After the plough, laborers follow with the spade, dig out the bottom of the furrow, throwing the soil upon the ploughed land to expose it to the action of the atmosphere; the next furrow being thrown into this opening, the soil is inverted completely, and this is trenching rather than subsoiling, and is not applicable where the subsoil is so tenacious as to retain water. Great attention is also paid to drainage.

In the Courtrai, Plock, and Tournoi districts, where the best flax is grown, the land is prepared with the utmost care, and the health of the plants is secured by the most unremitting attention. In these districts flax is rarely sown upon the same land oftener than every eighth year, and it generally follows wheat or oats. The portion of land set off for flax the ensuing season is covered with farm-yard manure immediately after harvest. Twenty-five or thirty cart-loads per acre are frequently applied. This is spread and ploughed in four or five inches deep, and remains for three or four months, when it is harrowed and ploughed in again a little deeper; and it is also trenched with spades at the same time. In this state it remains during the winter, and in the spring it is harrowed, and the roots are removed. Liquid manure is then applied to the extent of 2,500 gallons per acre.

It is then harrowed, picked, and rolled, and afterwards harrowed with a light, wooden harrow to loosen the surface, when the seed is sown at once. The average quantity is 166 pounds to the acre, the harrow follows, and, after picking and rolling, the work is done.

In Courtrai the flax is dried in the field, and then stacked without rippling, and left for steeping until next spring. To insure the preservation of the seed, the straw is put into stooks without tying it into sheaves. These are placed on cradles to preserve them from the damp. The seed ends are put in alternate layers, and the stooks are from four to six sheaves in height, and from three to four wide, and the whole thatched with straw. When perfectly dry, these are brought together and put into stacks like ordinary grain, and is considered to be improved by three years' keeping, as it will then scutch more easily and profitably.

Belgian flax, treated upon this method, commands almost fabulous prices, amounting very commonly to a yield of from £40 to £60 per acre; and for the finest quality from £80 to £100 has been obtained. The export of this fibre to France and England is one of the chief sources of profit to Belgium, and this has amounted to nearly one million of pounds sterling per annum. In Leeds and Belfast the finest numbers of yarn, those of 160 leas, or 15 hanks to the pound, are almost exclusively spun from the Belgian flax. This is confirmed by the reports of juries at the international exhibitions, which will be presented upon another page.

Some of these fine qualities are worth £70 per ton, some as high as £150 per ton, and the finest £200 per ton. But these prices are excelled by the fibre from which the Brussels and Mechlin lace is made, which has been known to sell at £4 per pound weight, nearly £9,000 per ton. Yet even this is small compared to the value of the manufactured article, since a lace handkerchief, weighing about two ounces, has been known to sell for £100.

The climate of Belgium, we are told by Bravoine, is not altogether favorable to the growth of flax, because about the first of April they often have a drought, and if the land is at all cloddy the vegetation of the seed is irregular, and that which springs is exposed to the ravages of insects.

Weeding is considered an essential part of the treatment, and is done by hand, when the flax plants are about two inches high. In Belgium the weeding is done by women and children, who creep about over the field upon their hands and knees, and always work towards the wind, so that the young flax plants may be raised again by the current of air coming in an opposite direction to that in which they have been pressed down.

In this country we shall not soon resort to hand-weeding, on account of the expense involved, but we must be careful to avoid as much as possible the necessity by selecting clean ground, and, with our perfected machinery, we are already able to avoid sowing the seeds of many weeds that are frequently mingled with foreign flax, because we can separate them with our superior winnowing apparatus. When, however, weeds make their appearance, they are either neglected, or, in some cases, they may be cut off with the scythe just above the heads of the flax-plants, or, better still, the coarser weeds may be cut at the ground with a sharp knife and carried out of the field.

The following directions are taken from Morton's Encyclopædia:

"In order intelligibly to detail the right method of flax culture, I shall suppose myself about to cultivate a farm of one hundred acres of such soil as I have named—hardly suited to wheat culture. Then, as draining is indispensable for flax culture, I should drain the land and commence my rotation thus, giving flax the lead: 1851, flax; 1852, clover; 1853, grass; 1854, oats; 1855, turnips; 1856, barley; 1857, clover; 1858, grass; 1859, oats; 1860, turnips. Then supposing the field to have been in barley in 1850, it should have been ploughed in October of that year as deeply as possible in ridges about six feet broad. After being ploughed the furrows should be deepened with the spade twenty inches deep and eighteen inches wide, and all the stuff thrown upon these ridges to remain until spring under the frost and snow of winter. About the end of March I plough the field again deep and level; then harrow it, and mark it lightly in ridges, so as to direct me in top-dressing it with the liquid manure; and in a day or two after I apply the manure, I sow broadcast about two and three-fourths bushels of good new seed per acre, taking care not to have mixed seed, (the seed of 1849 and 1850,) for the reason that they do not vegetate together. The seed being sown, I then apply a light short-tooth harrow to cover it, and on giving it a finishing stroke I sow the clover and grass seed; and after one stroke of the harrow I use the roller in order to close the ground. Frequently clover and grass seeds are left until the first weeding of the flax is about to be performed; and being sown, the treading of the persons weeding, and the pulling up of the weeds, affords sufficient covering for the seed. The flax being a short time on the land, being pulled sometimes in July and at others early in August, when vegetation is still active, the pulling up of the flax stalks moulds the young plants of clover and grass, and they generally make rapid progress afterwards. I seldom, if ever, knew failures of clover to occur when sown with flax.

"It is most important that a sufficient quantity of seed be sown, as the fibre must be regarded the chief consideration, and its quality is essentially improved by thick sowing. This arises from the closeness of the plants forcing themselves upwards with a single stem to gain access to the air, and thus prevent their branching, which shortens and renders the fibre irregular. I could not have the quantity of seed by sowing two and three-fourths or three bushels to the acre that I should have if I only sowed two bushels; but, in the cultivation of this plant I would make everything subservient to the formation of a long and delicate fibre, as to it alone I must look for remuneration.

"The flax crop in Ireland is in general sown much too thin, and this is the chief cause of the inferiority of the produce. This appears strange and unaccountable when we consider that the seed is seldom saved. If flax be sowed thin, say two bushels or two and one-fourth to the acre, you are certain to see it branch off when about one foot or so high, and thus produce a great quantity of seed; but when we understand that this object is effected at the expense of the fibre, which is not only rendered coarse but very deficient in quantity, we should guard against such losing practices. The cause of deficiency in quantity must be attributed to not only a lesser number of stalks per acre, but it will be found also to arise from the *shortness* of the fibre, as there never will be flax produced on the branches, and as a consequence we can only have fibre from the branched or forked part to the root end; therefore the production of seed in quantity is incompatible with the large returns from the fibre; and as it will be the wish of every well-doing farmer to practice the culture of that which will be most remunerative, the fine, long, and delicate fibre of the flax plant being the most valuable, he should regard the production of the seed as a secondary consideration. I have often observed in a field where the crop had been thick and abundant that the plants had rarely more than two or three seed bolls on a short forked top: the stalks, like trees planted closely in a young forest, spring up quickly without branches, whilst those scattered thinly are covered with branches. The weeding I should direct being done as the Flemish farmers do; no better mode can be taken."—(See Flanders, Agriculture of.)—*Morton's Cyclopedia.*

HARVESTING.

This is recommended by all European writers to be done by pulling—a slow, tedious, and expensive process which will never be performed by our farmers in the large way, and we know of many operators who are sowing some hundreds of acres apiece who could not possibly procure the labor necessary to pull their flax. Machinery again comes to our aid, and with proper care in the laying down of the land our improved harvesters may be adjusted so as to cut the crop very close to the surface of the ground. There is a prejudice, that is not without foundation, that one inch of the straw at the base is worth two at the top of the plant, but the roots themselves are of little value for lint. With proper care the straw may be delivered from the machine sufficiently straight for all practical purposes, and the amount wasted by being tangled is much more than compensated for by the cheapness of the process compared to hand labor.

The proper period for harvesting the straw is a point of great importance. When gathered for the lint alone the seed should not have become fully ripe, but if gathered too soon there will be great waste in the scutching and hackling, though the fibre may be very fine; whereas, when too ripe, the fibre, though of greater weight, is also coarser and more harsh. When the seeds begin to turn brown, and the stalk is turning yellow for about two-thirds of its length, the crop is considered sufficiently ripe for harvesting. It is desirable to keep the buts of the gavils as snug and even as possible; in all the operations, therefore, attention should be paid to this point if the crop be designed for the preparation of long fibre, which is much the most valuable. The flax should be set up as soon as possible that it may dry thoroughly, and at the same time shade itself to a degree from the scorching sun, which injures the fibre. The bundles should be made quite small. Dickson considers exposure to the sun very injurious to the fibre.

Rippling consists in separating the seed bolls from the straw; it is performed either at once in the field, or it may be done in the barn during the winter. In Ireland a great deal of the flax is immersed in the steeping pool without having the seed separated. This is a most wasteful plan, and should never be allowed. The loss to the Irish farmer is estimated by Mr. Ward at from £3 to £4 per acre. Rippling is performed by drawing the heads through a coarse heckle, made of iron or steel teeth, or pointed rods, that are set in a solid block of wood. The workmen seize small handfuls or streiks firmly near the but end, and draw them across this comb. The apparatus, if in the field, should be placed upon a large winnowing sheet, or the space around may be smooth and tramped hard to receive the seed; or the rippling may be done on a tight barn floor more comfortably, and with greater economy of time during the winter, but in case of stacking or storing in the barn we must guard against the injury from rats and mice.

One of the best methods for separating the seeds from the straw, when we desire to keep this straight, is to pass the heads through plain rollers set pretty close; the bundles may be spread out and allowed to pass between them, or they may be held, as in rippling, but kept in the direction of the axis of the rollers, the heads only passing into the bite, when the bolls are crushed and the seeds separated.

The crop should not be allowed to remain in the field any longer than is necessary to have it thoroughly dried, when it should at once be stored away in the barn, or carefully put up in stacks, and these should be made sharp and covered with straw, or even thatched, so as to exclude the rain entirely.

With regard to the choice of seed it should be of a bright, brownish color; it should feel cold and oily to the hand, and should be heavy. The European authorities tell us that the seed from Holland ripens sooner and yields a greater quantity of fibre than most others; they say that American seed produces good flax; that from Riga is coarser in fibre, but more productive in seed than any other, and is adapted to a great variety of localities. It is supposed by some that this Russian seed, coming from a poor soil, feels the improved condition of better land, and produces a luxuriant crop, which will incline to be rank. They think that if it be resown upon the same land after the interval of a year it will produce the best quality of fibre, but that it becomes degenerated afterwards.

It is also considered very important that the seed to be sown should all be of the same age, that it may vegetate evenly, and thus all the plants of the crop will start together. Some farmers think that old seed will produce the best lint.

FARMING OUT THE SEED.

It is a very common practice in some parts of this country for those who have oil mills to furnish flaxseed to the farmers, with an agreement that they shall have the refusal of the seed produced. This custom has a tendency to encourage the culture of flax for the seed alone. In this case it may be the interest of both parties to use as little seed as possible, so as to produce as large a proportionate yield of seed as can be obtained.

From a series of data based upon the amounts of seed issued in this way by the dealer, and the returns made to him by the farmer, it appears that in the fertile valley of the Miami, in Ohio, the yield was only seven bushels and three-tenths per acre last year, 1864, though in one case, where a single bushel of seed had been sown upon two acres, the yield had been thirty-two bushels, or sixteen bushels per acre.

On the contrary, we are assured that, by proper management and under favorable circumstances, even larger crops than this last mentioned have been harvested, besides a heavy yield of good long straw, so that it is not considered impossible to combine the profitable cultivation of flax for both its valuable products, and thus it stands pre-eminent among all the competitors for favor both as an oil-producing and as a fibre-yielding plant. There is now a new element in the field encouraging the production of this crop; those who have machinery to prepare the fibre have also adopted the plan of loaning seed to the farmers as well as their predecessors of the oil mills, and it is to their interest to have the farmers sow more seed, and to produce taller straw with better lint.

This is well set forth by a writer in the Prairie Farmer who is thus interested. Mr. Clemens says that "the pursuit of the crop for the seed only will never secure the firm establishment of flax culture. The additional inducement of a production of the valuable fibre is necessary to make flax culture a leading farm interest. Crops of flaxseed may be grown with poor cultivation and thin sowing, when the straw will be worthless from its coarseness and the weakness of the lint, and from the admixture of grass and weeds. To obtain flax of the highest value for the seed only, it is advisable that the cultivation be conducted with special reference to the production of the largest yield of good fibre in the straw. This conclusion is justified by the fact that the average product of flaxseed per acre in those districts, in the eastern States where flax is grown more especially for the lint, is greater than at the west, where the seed only has been sought for, while the quality of the eastern seed, grown with the crop of lint, is also superior. The carelessness of management attendant upon growing this crop for the seed, in connexion with thin sowing, tends to deteriorate the quality of the flaxseed for oil-making, as well as for the production of lint."

Mr. Dodge, in his article in the agricultural report of the department for 1863, p. 103, gives an instance of success in the combined production: "In Henry county, Illinois, upon two acres of prairie land, well ploughed, and sown with one bushel of seed, thirty-five bushels of clean seed and two tons of straw were produced; the straw yielded eight dollars per ton. In Boone county, Illinois, three and a half acres yielded thirty-five bushels of seed and five tons of straw. The net profit was $28 35 per acre.

SUMMARY OF CULTURE.

Adopt a judicious rotation of crops, and avoid the too frequent recurrence of flax, placing it after a cleansing crop, if possible.

Select suitable soil, a good loam of sufficient depth, but not too rich.

Plough deeply in the fall, and leave the soil exposed to the frosts of winter. Plough again shallow, as early as possible in the spring; harrow perfectly level and smooth, removing all roots and obstructions.

Sow, as soon as the ground is in suitable condition, from one half bushel to two bushels and a half of the best and cleanest seed that can be obtained, cover very lightly with a short-toothed harrow, or with a brush drag, draw some very light water furrows, and then roll the land smoothly.

Harvest as soon as the seeds begin to ripen and the stalks are turning yellow; dry as rapidly as possible, set in open shocks to shade itself, ripple the seed, and secure the crop from the weather as soon as dry, and sell the straw to the nearest manufacturer.

HEMP

This plant, called by the botanists *Cannabis sativa*, has obtained as wide a range as flax, being grown in almost every country from the tropics to the extremes of the temperate zones. Hence, with its excellent fibre, it has long been extensively cultivated and highly valued among civilized nations. Like flax, the hemp plant is composed of a central, woody stem, upon which are disposed very strong fibres, made up of bast cells, arranged parallel to the axis of the stalk, and united together in long filaments. These are covered externally by a coating or epidermis that envelops the whole stalk. Like flax, hemp needs to be treated in such a manner as to separate these groups of bast cells from the external bark and from the internal woody portions. All of these parts being intimately connected together by an agglutinating substance, as is the case with the flax plant, similar means and processes are required for their separation.

Soils.—Hemp is a coarse plant, growing rapidly to the height of several feet, and requires a good, strong soil for its production. Any good, rich, loamy land is adapted to this crop, which is largely cultivated in the rich blue-grass region of central Kentucky, in the limestone prairies of western Missouri, and in the fertile plains of Illinois, but it may be produced in the greatest abundance in most of the States of the great northwest.

In Europe and Asia hemp is found to grow remarkably well upon suitable lands, both in high and in low latitudes, for, being an annual plant, requiring but a short period for its maturity, it finds an appropriate season even in the brief summers of northern Europe, and is very largely cultivated in Russia, which country is indeed as noted for its hemp as Ireland has long been for its linens.

A deep friable loam, especially a rich alluvial soil, with natural or artificial drainage, is best adapted to the production of hemp.

Preparation of the soil.—What has been already stated as a suitable preparation of the soil for flax is equally applicable for this crop, and may be briefly repeated. The ground should be thoroughly and deeply stirred; if ploughed in the fall or winter so as to receive the meliorating influence of the frost, heavy soils especially will be much improved for the reception of the seeds. In the early spring the land should be again stirred, and for both of these crops it is advised that the ploughing at this season should be quite shallow, so as to retain at the surface the mellow soil that has been acted upon by the frost. In this condition it furnishes a fine seed-bed for the crop, which hastens its germination, and it is also asserted by some practical farmers that these plants do best when the deeper layers of soil have not been recently loosened, but have lain still and become partially compacted since the deep ploughing of the previous autumn; still, the roots descend deeply, and they require that land should have been thoroughly broken up at the fall ploughing.

Seeding.—After the spring ploughing, which may be done with any of the cultivators in use upon our farms, the ground may be allowed to lie a few days to receive the genial influences of sunshine. If the land be foul with weed-seeds, as is often the case with fields that are adapted to the growth of flax and hemp, this spring cultivation will have destroyed the first crop of weeds, many of which start into life very early in the season; then by waiting a few days another crop will soon germinate, and these may be destroyed by the use of the drag-harrow, which also pulverizes the soil and thoroughly prepares the seed-bed for the legitimate crop, which should be sown as early as possible after these arrangements and preparations have been completed and the soil is sufficiently dry and warm. The hemp will then have an opportunity to start evenly with the weeds, and by its vigor it will maintain a proper ascendency over them to insure success.

From two to three bushels of fresh seed should be sown, as evenly as possible, upon the recently harrowed surface, and immediately covered with the brush, or with the light short-toothed seed-harrow, followed by the roller, to compress the soil and thus accelerate germination, but neither the harrow nor the roller should be used when the soil is at all wet or sticky, as they will prove very injurious to the crop if used under such circumstances.

With careful preparation of the land as above directed, and judicious selection of good fresh seed, properly committed to such a fine seed-bed as has been recommended, the hemp crop will now take care of itself, and occupy the field to the exclusion of all intruding weeds. Indeed, hemp has been proposed by some agriculturist to be introduced into a rotation as a cleansing crop, to precede flax, for the sake of its destructive effects upon the weeds natural to the soil. While this effect of hemp is acknowledged, the farmer need not be reminded that the great principle of alternation, which should regulate all crop rotations, is here lost sight of, and though, in some of our very fertile alluvial soils, the results might be satisfactory, it would not be wise to pursue such a course of cropping as would bring these fibre crops in continuous succession.

Seed-plants.—In growing hemp for fibre it is sown so thickly as to run up to its full height without any branches. This gives us long, straight, undivided rods, that are evenly clothed with the valuable fibre. When allowed room to develop itself, however, the hemp plant branches at almost every leaf from near the ground to its summit, and these branches produce their inflorescence at the axils of their leaves. Hemp is diœcious, bearing its male and female flowers on different plants, so that a portion of them only are productive of seed. To produce the best result, a portion of land is planted in hills or drills, for the especial object of seed-growing; the plants are cultivated and thinned out to allow of their fullest development. Some farmers only sow a corner of the field thinly, or trust to failures in parts of the crop, where the plants standing thin on the ground will produce seed.

Harvesting.—Hemp was formerly pulled by hand, and this was done at two operations; the first pulling was performed when the male plants had shed their pollen, and were turning yellow. The female plants were left to mature their seed, and were taken at the second pulling.

The male stalks were ready for steeping as soon as dried; but the female plants were first divested of their seeds; if the seed crop was not wanted, all was pulled or cut together. The female plants require about three weeks to perfect the seed after blossoming, and they may be allowed to stand until the lower seeds begin to ripen, when they should be carefully pulled or cut, and the bundles set up in shock to dry. These seeds shatter very easily, and if not carefully handled much will be wasted. They are nutritious food for birds, and produce much oil, but are chiefly preserved for seeding.

The original method of pulling hemp has given place to cutting, at or near the ground, with heavy knives made for the purpose. These are crooked on the edge, and bent towards the shaft of the handle in such a way as to sever the stalks near the ground when thrust against them by the harvester with a rapid stroke. Hemp-cutting, though a great improvement upon pulling, is still hard work, and the usual length of the stalks requires a wide space to be cut, upon which the crop may be spread to dry. Care should be taken to keep the but-ends even as the stalks are laid down and taken up.

When the crop is of moderate height, and has been sown so thickly as to be of slender growth, farmers often prefer to use the common grain-cradle for harvesting hemp. A careful hand, who carries his scythe low, and cuts a level swath, may do excellent work in this way, but many workmen will waste too much of the best portion of the stalk, by leaving a high and uneven stubble. Then again, cradling hemp is very hard work, and we turn hopefully to the reaper to solve the difficulty by substituting horse-power for human muscle. Harvesting machines are easily adapted to this crop by a modification of the platform, suiting it to the length of the stalks of an average crop of hemp.

After the crop has lain upon the surface long enough to dry, the leaves will chiefly fall off as it is taken up to be tied in bundles of moderate size, which should be set up in shocks to dry perfectly before being stacked.

The proper period for harvesting may be known by the condition of the male plants, which, very soon after blossoming, cast their leaves, and the stalks begin to turn yellow, while the female plants continue green, and the bunches of seeds at the axils of the leaves near the top increase in size and weight. The crop is then ready for the knife.

Hemp is considered an exhausting crop; and so it is, for it removes from the soil a considerable portion of inorganic matter, but these substances, as shown by analysis, are not abundant in the fibre, which is taken off of the farm, but are chiefly found in those portions of the plant which constitute the refuse, and which may be returned to the soil as manure. Unfortunately, in our country little attention is ever paid to this restoration for the sake of maintaining the fertility of our soils.

Fortunately for our unphilosophical and wasteful system of agriculture, the hemp crop makes its own return to the soil to a certain extent, in the falling leaves and in the stubble and deeply penetrating roots, that when cut are in full vigor and remain to decay in the soil, which is left in a very fine condition after this crop. Valuable as is this contribution of carbonaceous matter to the humus of the soil, acting both chemically and mechanically for its melioration, it still does not compensate for the abstraction of the mineral constituents which the crop of hemp has taken from the land, and which a wise agriculturist will restore to maintain the fertility of his soil.

In the fertile hemp-fields of the west, particularly in Missouri, there is no apprehension felt as to the exhausting nature of this crop; on the contrary, many farmers speak of it as an improver of the land, like clover, and they claim that, while its deep roots descend into the lower strata of soil in search of nourishment, they bring valuable elements to the surface; besides which, they add a large amount of carbonaceous matter in the leaves of stubble, which has been gathered by the plant from the atmosphere. Certain it is that many fields have been planted in hemp for twenty-five successive years without apparent diminution of the crop, which continues to produce an average of 800 pounds of clean lint. In the hemp regions it is considered essentially a negro crop, and is esteemed on account of its affording steady occupation to the large farm force during the winter months, when they would otherwise be idle.

The annual production of hemp fibre in the United States, as reported in the last census, amounts to eighty-seven thousand one hundred and ninety tons, of which eighty-three thousand two hundred and forty-seven tons were dew-rotted, and only three thousand nine hundred and forty-three tons were water-rotted. There is a decided preference among the manufacturers for the water-rotted material, and the navy regulations indicate that experience considers this the preferable mode of preparation. But few of our farmers are willing to take the trouble to adopt this process; indeed few have the necessary skill and appliances; but it would be performed to much better advantage by those who make it their especial business, and who have prepared suitable vats for the purpose. Some of our correspondents in Illinois appear to have made extensive vats, with the expectation of rotting largely. This is a suitable subdivision of labor.

From the kindness of Mr. H. F. Driller, assistant secretary of the Board of Trade at the Merchants' Exchange, St. Louis, we have learned the product of hemp in that State for three years to be as follows:

In 1862, arrived at this port	88, 720 bales.	
" arrived at other ports, about	22, 100 "	
Total		110, 820 bales.
In 1863, arrived at this port	68, 131 bales.	
" arrived at other ports	17, 000 "	
Total		85, 131 "
In 1864, estimated at this port	74, 150 bales.	
" estimated at other ports	20, 100 "	
Total		94, 250 "
Total in three years		290, 201 bales.
Average per year		96, 733⅔ bales.

Kentucky and Missouri are the two leading States in which this crop has always been of considerable importance.

Farmers generally complain of hemp that it is a hard crop to deal with, on account of the manual labor which it requires, but it is also urged that it is uncertain in its results because of the fluctuations of the market value. Its chief value is for cordage, bagging, and sail-cloth, but the fibre is very similar to that of flax; the ultimate cells are almost identical under the microscope, and it is applicable to the preparation of linen cloths. The manufacture of bagging and bale-rope in Kentucky having been mostly suspended, since the withdrawal or suspension of the demands of the cotton-fields, the extent of the crop has also been diminished, and the fibre has been largely worked into tow, and shipped in the bale to eastern and European factories.

George M. Campbell, of Lewistown, Illinois, writes that he has grown hemp for more than twenty years—first in Kentucky, and afterwards in the prairie State—and that he finds the latter produces the best and largest quantity of lint. He says that his crops average 1,000 pounds per acre, and that one season he obtained the unusual amount of 1,380 pounds. He thinks Illinois could supply the world with this fibre, if the farmers would turn their attention to its culture.

He prefers a rich deep loam, which is well prepared with the plough and harrow, when he sows five pecks of seed per acre, and harrows both ways. If dry or cloddy, he also rolls. With what he calls a drag-hook he cuts half an acre a day. When cured, he ties and shocks the stalks till dry, when it is stacked.

He advises cutting as soon as the blossoms fall, but the seed crop is planted in rows, and the seed plants are left for the seed to mature, when they are to be cut and shocked, and left three weeks to cure.

MACHINERY.

When they were considering the subject of treating the flax-straw by any of the chemical operations to which it has been subjected for the purpose of aiding the separation and preparation of the fibres, whether these consisted of dew-rotting, water-rotting, or other more scientific or more elaborate processes, the commission endeavored to set forth the great importance of a proper subdivision of labor, so that the farmer, with his manifold and pressing cares, might be relieved from the responsibility of conducting these delicate operations, for which, indeed, he is not always qualified. Here again we desire to urge upon those engaged in making arrangements for further treatment of the material by the mechanical handling of the straw, and its conversion into the beautiful fibre, the great advantages that will result from a separation of these duties from those appropriate to the farm. Indeed it is so apparent to us that the rotting and breaking of flax are truly manufacturing processes, requiring skilled labor and experienced management, that the continuance of their assignment to the farm laborer can only be viewed as a remnant of those peculiarities of the early stages of civilization which are here and there found to cling to us in an advanced condition of society. In former times the farmer, with the assistance of his family, was obliged to produce the raw material, to prepare it for manufacturing, to spin, and to weave it upon his own premises; but as we advance from such a primitive condition, the better subdivision of labor is progressively introduced, and we believe, as stated on a previous page, that the farmer's duty should always end with the harvesting of the crop, the separation of the seed, and the delivery of the straw to the manufacturer. In portions of Belgium, to which country we may well look for the highest degree of development in the preparation of flax, since there the finest fabrics are produced, we find that the ownership of the crop is transferred from the agriculturist to the manufacturer so soon as its prospective value can be safely estimated, and this is immediately after it has blossomed in the field; so that the farmer's duties and interests terminate at a still earlier period than that we have recommended to our countrymen.

Notwithstanding our urgent desire for a proper subdivision of the labors of the production from those of the preparation of flax, and other textile plants, we know that in many parts of the country, where flax and hemp may be profitably grown by the farmer, the mechanic has not yet made his appearance with the needed machinery for operating upon the product. Indeed, the raw material is not to be found in sufficient quantities to justify the erection of large establishments for its preparation in many regions where it is and should be grown. Therefore we congratulate those isolated farmers who may be induced to cultivate this class of crops upon the fact that our ingenious mechanics have already provided for their wants by inventing and erecting farm machines, of moderate capacity, and at reasonable expense, which will enable individuals so situated to utilize their products, and put them into a condition that will bear transportation to market, or that will readily prepare them for home consumption.

In early times the most rude and simple apparatus was used in the preparation of these fibres, and we find remnants of these barbaric customs still remaining. In some parts of Europe the flax is broken by women, who hold the straw across the top of a post and crush it by beating with clubs; and it is claimed that in this way they prepare the nicest and softest flax.

Laying the straw upon a hard floor and beetling it with a maul or beetle, the face of which is grooved, is still recommended as the initiatory process of breaking. In some parts of Ireland the straw is spread across the hard road, and crushed by the wheels of carts that are passed over it preparatory to its being taken to the scutch-mills.

In Egypt, where we expect to find remnants of primitive modes of work, it is found that, after water-retting, the natives crush the straw with flat stones, and then strike it against a wooden post to free the shives. And yet the early Egyptians made cambrics that were finer than the modern fabrics.

The breaking of these plants consists essentially in so comminuting the woody materials, and separating the interstitial matter and the enveloping epidermis, that the filaments, or groups of true bast cells, may be set free from the matters with which they were associated in the straw. The original brakes consisted of wooden blades or jaws that closed into one another in such a way as to crush the boon or woody matter into shives, while the more resisting harl or fibre was liberated. The adhering portions of woody fibre, and the remaining interstitial matter, as well as the remnants of the outer covering or epidermis, were next separated by the process called scutching. This consisted in beating the handfuls or streiks of fibre with a blunt knife while it was held over the sharpened edge of an upright board. Finally, after being cleansed as perfectly as possible by these means, the filaments or bundles of cells were still further subdivided, and the loose portions that had been separated as tow were removed by drawing the streiks through elastic pointed wires, which constitute what is called the hatchel. This is a combing process, and is applicable only to the preparation of what is known as long-line, or the normal condition of the finished flax product. All of these several processes are performed by hand labor, but the inventive genius of the age has brought its mechanical appliances to the aid of the laborer in each of these processes, and we now find a multitude of contrivances to substitute manual labor. Many of these are admirable, and some of them are adapted to the use of the small farmer, who is thus enabled to prepare his crop for market, where, formerly, the formidable amount of hard work that was required of him prevented its being converted into any useful condition, and it was wasted or burned upon his farm, and sometimes cast into the mire-holes of the public highway. A few of these machines will be mentioned in this report, some of which have been found to produce satisfactory results in actual practice under our observation.

The multitude of inventions that we find in this department of labor-saving machinery may be classified not only as small and great machines, adapted severally to the farmer, or to the manufacturer, but they may be divided into two great classes according as they are calculated for the preparation of the perfect long-line flax from straight straw that has been carefully handled, or for the production of the confused mass of fialments, commonly known as tow, which can be separated by these appliances from the tangled straw. This is the common result of the flax crop in most parts of the country where it is grown especially for the seed, cut by the scythe, or by machinery, tramped out by horses, or otherwise threshed, and left in a confused mass, from which it could never be extricated in the form of long-line, but in which, nevertheless, lies a valuable product that may be separated in shorter filaments, and used in the production of important manufactures. These last are the tow machines which have come into use extensively within a few years in the flax-producing regions, fitting the crop for transportation. The necessity for some suitable machinery to aid and relieve human labor in breaking and preparing the fibres of flax and hemp was very early felt, and efforts were made to supply the deficiency. Of this there is manifold testimony in the collection of models at the museum of the Patent Office, where every conceivable application of power is represented

Some inventors contented themselves with applying machinery to the old fashioned brake; others used beaters and stampers of various kinds; but most of the inventors, and those are among the most successful, have adopted the application of rollers, which are generally fluted; these flutes are coarse and fine, and of varying form, so as to crush the boon as the straw is passed through them. In all of them it is somewhat difficult to preserve the parallelism of the stalks of straw during the process so as to keep the fibres straight, and thus avoid tangling and waste in the subsequent processes of its preparation. These machines break up the boon, but generally leave the broken pieces, called the shives, entangled among the fibres, from which they must next be separated.

One of the earliest plans adopted for the application of power to this purpose was based upon the principle of the old bark mill, rolling and dragging a wheel round a pivot upon a table or floor that received the flax which was thus crushed, but left full of shives, which were difficult to separate. A modification of this was introduced in the hemp brake of Kentucky, which consisted of a platform of strong triangular pieces of hard wood laid like the radii of a circle, and having spaces open between them. Upon this circular table a large conical fluted log of wood was made to traverse by a horse walking round the outside periphery. By this arrangement the shives were broken, and the turning of the hemp loosened them so that they fell through to the ground below.

Of all the various machines that have been attempted to be introduced for breaking flax and hemp, those which apply the crushing power of fluted rollers appear to have been the most successful, and yet among these there is a great diversity. Some have very coarse flutes, and some have them exceedingly fine; some revolve slowly, and some with great rapidity. In some machines the straw is passed repeatedly through a single pair of rollers, while others, being made of a number of pairs, effect the breaking while the material is passing once through them. In some of these multiple roller brakes the gearing is so arranged as to make them all traverse with the same speed, and in some it is accelerated in the forward rollers which thus tear up and shorten the fibre; these will not make the long-line.

Many, indeed most of these machines, require a considerable power to drive them, and they are generally found in flax mills, where also the scutching is done by machinery, in a simple arrangement, by which four or five swingling knives are placed in the rim of a pulley about thirty inches in diameter. Several of these sets of knives are attached to one shaft, which is made to revolve rapidly, bringing the blades close to the scutching boards where the workmen hold the flax that is to be operated on.

Mr. C. Beach, of Penn Yan, New York, has invented a machine for grinding up the straw, and thus separating the fibres. The straw is first cut, then passed under a wheel, within a cage, that rubs off the fibre, and a strong draught of air blows out a large portion of the shives and dirt. It is claimed for this machine that it is equally adapted to unretted as to retted flax, and that it will clean from one to two tons of flax straw in ten hours. It requires fifteen horse-power, and costs $1,000. As operated at Toledo, Ohio, there appears to be a great waste of fibre.

Crowell's flax brake and scutching machine is a combination of fluted rollers that is said to be adapted for retted or unretted flax straw, leaving the fibres clean and fine, either broken into short lengths for carding, or in full length for long-line, as may be desired, taking a ton or more of straw in ten hours, from which six hundred pounds of clean fibre per ton is said to have been produced. This, we think, is too large an estimate.

Randall's brake is a very successful application of fluted rollers, and is used with great satisfaction in many of the flax mills of the country.

The most successful application of machinery to this subject that we have seen is the arrangement of fluted rollers, with an oscillating motion backward and forward, but advancing more than it retrogrades. This is the Mallory & Sanford machine, which they call "a portable flax and hemp dresser." Owing to the peculiar form and motion of the rollers the boon is crushed into shives of less than a quarter of an inch in length, and the harl is rubbed off from the straw with very little breaking of the filaments, while at the same time the shives are nearly all shaken out of the flax which is broken and scutched at the same operation, and appears to need very little after scutching to finish it. This machine saves a great deal of fibre; indeed, there is scarcely any found with the shives which are nearly clean, instead of being, as they are often seen, a tangled mass of filaments and shives about the brakes.

The latest modification of this apparatus, wherein the rollers are arranged in a vertical series fed from above, was tested in the presence of the commission with very satisfactory results, and they do not hesitate to declare that the work was performed rapidly and well. The apparatus was new, and therefore some allowance should be made for its working capacity. The large machine is said to require a driving force equal to two horse-powers, and its capacity for work is estimated at one and one-eighth tons of straw per day. The makers of this machine in its later or upright form, with a succession of fluted rollers placed horizontally and set one above the other, when they use two breakers and one finisher combined, all feeding from above, claim that they can produce one thousand pounds of clean fibre per diem, with the assistance of four hands to the brakes, one hand to scutch, and two boys to assist.

As originally constructed, we have heard it objected to these machines that their mechanism involved a hard motion, and apprehensions were felt that the machinery might give way. At an establishment in Pennsylvania, it was stated that four scutchers were needed to cleanse the fibre produced by three workmen, running three thousand pounds of straw each day through one machine. We cannot help thinking that this result, so different from our own observations, and from the testimony of many practical workmen who have adopted these machines, must have arisen from a want of experience in the laborers, and from their attempt to put through too much straw; and that, had they attempted to break less, they would have found the scutching a small matter, with revolving knives.

Messrs. Mallory & Sanford's machines have been recommended for breaking straight straw for the preparation of long-line, and as being equally well adapted for the breaking of the most tangled flax, that it comes from the threshing floor. It is also claimed that they will separate the shives from green or unretted straw more perfectly than any other apparatus. Specimens on exhibition, and others broken in our presence, are entirely satisfactory evidence that such breaking can be done where desirable, though at the expense of a partial rupture of the filaments themselves, which, in the preparation of long-line, would be productive of a larger percentage of tow or tangled fibre than results from the handling of properly retted straw.

In the preparation of short fibres this partial rupture of the filaments is a matter of no consequence, but, on the contrary, the breaking without previous retting, and its attendant staining of the fibre, is considered a great desideratum by those who desire to manipulate the fibres in their processes of cleansing and disintegration to which they subject this material in preparing it for spinning upon cotton machinery. It is found much easier to bleach and prepare the fibres of unretted, than those of retted straw, and the result is much more satisfactory.

Before dismissing the consideration of the Mallory & Sanford machines, which have given the commission such satisfactory results, and which present great encouragement to our farmers who have heretofore been deterred from flax-growing by the labor attendant upon the preparation of the fibre, the commissioners desire to mention an additional appliance to these brakes, by which the most tangled mass of straw has its stalks straightened out, and presented to the fluted rollers at a right angle, so as to be most perfectly acted upon in its passage through the machine. By this means the efficiency of the brakes, when acting upon tangled straw, is greatly increased.

Scutching consists in separating the loose shives and dirt, but also results in the removal of a considerable portion of the fibre, as coarse tow; the first exposure of the broken flax to the scutching knives removes the most of the shives and makes the coarse tow; the second scutching gives a more valuable tow product; but the next or heckling process produces the fine tow, which consists of the tangled and broken filaments that are combed out of the streiks of flax as they are subjected to this instrument. Heckling is almost exclusively done by hand. Heckled tow contains very little shives.

Rowan's scutcher is a series of metallic beaters which revolve with great rapidity on the periphery of a drum, in close proximity to a breast or plate of iron, over which the workman holds the streik, so as to expose the ends alternately to the beating process. The work is done rapidly, and the cleaning is very well performed, but with the production of a large amount of waste tow. This machine is also used as a brake, but appears to waste a great deal of fibre, which falls with the shives. The advantages of this machine are, small space occupied, and rapid work.

One of the most promising scutching arrangements we have seen is that of a model of Mallory & Sanford, which consists of a vertical drum four feet in length, composed of clamps for holding the streiks of flax. These are made to revolve very rapidly after being charged with the fibre. The centrifugal force beats the flax against the edge of an upright scutching board that is fixed near the periphery of the revolving drum of clamps. When the ends of flax are cleaned the machine is stopped, the clamps are removed, loosened, and the flax is shifted so that the other ends of the streiks shall be exposed to the scutching process. It was found in experiments before the commission that this machine, with one scutching-post, would clean both ends in fifty seconds, and by applying four upright scutching-boards, and four clamps to each drum, it was estimated that the whole charge would be cleaned in half a minute.

In confirmation of our favorable impressions of the Mallory & Sanford machines, we subjoin some extracts from the report of the special committee on flax machinery of the New York State Agricultural Society. This committee report :

"That they carefully examined the machine presented by Messrs. Mallory & Sanford, New York, and tested it under a great variety of circumstances.

"Experiment 1st. Ten pounds three ounces of unretted straw, precisely as it came from the field, was passed through the breaking machine. The time occupied was two minutes fifty seconds, and the weight after breaking was six pounds ten ounces. The scutching process occupied six minutes, and the flax weighed after scutching just two pounds.

"Experiment 2d. Ten pounds of half retted flax (dew-retted) was passed through the breaking machine; the time occupied in the process was two minutes fifty seconds, and the flax weighed five pounds. It was scutched in nine minutes and twenty seconds, and weighed two pounds three ounces.

"Experiment 3d. Twenty-one pounds one ounce of thoroughly retted (dew-retted) flax straw were passed through the machine in three minutes fifty seconds, and weighed nine pounds. The broken straw was scutched in eight minutes thirty seconds, and weighed four pounds fourteen ounces. With the ordinary facilities of a factory, two men could do with ease what it required four men to do at the trials.

"The average work of the machine during these three trials was 1.158 ounce per second, which at ten hours work per day would be equivalent to 2,668 pounds of flax straw.

"The total weight of broken straw in these three experiments was twenty pounds ten ounces, which was scutched in twenty-three minutes fifty seconds, which is equal to 0.772 ounce per second. Running steadily for ten hours, a scutching machine will dress 1,737 pounds of broken flax-straw.

"It, of course, would be difficult to work the machines regularly as fast, or to do as much work with them as was done at these trials, but we have no doubt that the brake could run through 2,000 pounds of straw daily, and that two scutching machines would dress the flax as fast as it was broken by the first machine. Six-horse power would probably be amply sufficient to run the brake and the two scutchers.

"The unretted flax in these experiments yielded 18.9 per cent. The half-retted yielded 21.9 per cent. The well-retted yielded 23.1 per cent. of dressed flax.

"The day devoted to these experiments was a very rainy one, and the straw had lain upon the ground for several hours ; it had therefore imbibed much moisture, and was in a very bad condition for dressing. If the experiment had been tried in a clear, dry air, much better results would have been obtained."

In conclusion they say:

"1st. That the machine of Mallory & Sanford does more work, with less power, than any other.

"2d. That it detaches more of the worthless from the valuable portions of the straw than any other.

"3d. That it wastes less of the fibre. On a careful examination of the shive after the experiments, we could not detect a single particle of the fibre.

"4th. It is cheap and durable and not dangerous to either life or limb. The cost of the largest machine is $355; the second size, 255; the third, $155.

"5th. It does not require skilled labor to operate it. This remark applies to the brake, and not to the scutcher.

"6th. It requires but a very small space; the largest size occupies but four feet square and weighs 1,100 pounds."

McBride's machine is in operation at Delaware, Ohio; as a scutcher it is very efficient and ingenious. The flax is applied in the bite or twist of a double, endless rope, which receives the streik at one side, carries it through the scutcher, where it is well dressed throughout; during its passage, the rope shifts its hold of the flax by the torsion action, so that all is scutched and delivered to the workman at the other side of the machine, who lays away the bundles of clean flax. This machine will dress from four hundred to six hundred pounds a day.

Mr. McBride has also constructed a machine for treating tangled straw, by which he says he can dress from three to four tons of rough straw per diem, and which, he thinks, will produce from one to one and a third ton of clean fibre, at a cost of half a cent per pound. This machine is to cost about five hundred dollars, and, he thinks, will produce 30 per cent. of clean fibre from retted straw.

Several of the machines already noticed are adapted to the preparation of long-line or of tangled tow, according to the condition of the flax straw, whether it has been carefully handled and kept straight from the time of harvesting, or has been left in a tangled and confused mass by the harvesting machine, and afterward by the threshing operation and subsequent treatment.

Since, in a large majority of cases in this country, where flax has been grown for the seed alone, and little or no care has been bestowed upon the straw, this material is in a tangled condition, it becomes a matter of the highest importance to provide apparatus that can take this product and reduce it to a marketable condition; receiving it in the bulky form of straw from the neighboring farmers, machinery is needed to break and clean the fibrous product, which can then be baled and compressed so as to adapt it for transportation to market.

Many of the machines already mentioned will work equally well with tangled or with straight straw, and lay in their claims to public favor for this purpose; but there are others which are essentially tow-machines. One of the first of this class was introduced by Mr. Allen, of Boston, who claimed the production of "fibrilia," or shortened filaments of flax and hemp.

The extended culture of flax in some portions of our country for seed alone has also yielded an immense quantity of the fibre-bearing straw, which it is desirable to utilize so as to add to the wealth of the nation. For this purpose machinery has been supplied in addition to the flax-brakes already in use, and which were especially adapted to the preparation of long-line. These machines have been constructed for the purpose of breaking and of cleaning the tow, without having any regard to the length of the fibre, and in some instances purposely calculated for shortening it, by the arrangement of pickers and beaters, and also of alternating rollers, that revolve in common with increasing speed upon the advancing sheet of fibre as it passes through the machine.

A great variety of apparatus is employed for this purpose, but one or two of the inventions need to be noticed.

One of the most powerful of these tow-machines is that of S. A. Clemens, now at Chicago, Illinois, the capacity of which is such that it requires two active men to supply the raw material upon the feeding-apron, and the product of pretty well cleaned tow amounts to about a ton per diem. Mr. Clemens has long been engaged upon flax inventions.

G. F. Davies & Co., of Dayton, Ohio, have put up a machine which possesses the merit of cleaning tow in a very thorough manner by purely mechanical means. The fibrils are broken and divided, and reduced to a commendable degree of fineness and shortness, so that the inventor feels confident that this substance, which he calls "erolin," or flax-wool, may be spun on cotton machinery. That it will work well with wool has been demonstrated. This machine will be more particularly described in the section on manufactures.

CHEMICAL.

When we come to investigate the details that properly appertain to this subdivision of our subject we must again observe what is the natural condition of the agricultural product which is to be dealt with, its composition, and its condition as it comes from the field, and thus we shall be prepared to appreciate the difficulties that lie in the path of improvement, and to understand the object of the various processes to which the material is subjected.

The round stalk of flax or hemp is composed of a woody heart or central portion, which is hollow. Around this column, closely packed together, and in immediate contact with the woody matter to which they are intimately attached, we find the delicate and strong fibres that give value to the plant. Outside of these is the exterior integument or skin, called the epidermis. These fibres are composed of regular bast cells, united together into filaments or bundles of cells, which are connected with other filaments, and also cemented to the adjacent tissues by a nitrogenous substance that has been called gluten; it is an albuminous compound, which is extremely difficult to remove by mechanical agencies.

When these stalks have been exposed to the action of the weather for some length of time, the bast cells are found to be in a state of partial separation, and the long fibrous material, which is gathered by the birds for the construction of their nests, was no doubt very soon collected by man and applied to his purposes.

This slow and uncertain separation of the fibres must have attracted attention, and there is little doubt that artificial means for accelerating and regulating the process were very long ago applied; and we now find very primitive races of men making use of similar products of many plants, which are treated in different ways to induce them to part with these interesting bundles of cells or fibres, to be applied to economic purposes.

It is almost universally conceded that some process is necessary to prepare the dry straw before attempting the separation of the fibres; a partial decomposition is to be effected to set them free from the aglutinating material that attaches them to the woody matter or boon constituting the stem.

This is generally effected by the process called retting, and is done by exposing the straw to moisture, with or without artificial heat. Water-retting or steeping is done by immersing the straw in tanks or pools of soft water, in which a degree of fermentation is soon set up, causing the decomposition of the nitrogenous matters, and rendering the woody portion short and brittle, so as to be easily broken and removed, while the more tenacious fibres have resisted the decomposition and retain their strength and value. Dew-retting more nearly resembles the natural process of disintegration which is often observed in many fibrous plants that have been exposed to the weather where they grew.

The process of retting may be considered under three different heads. In the first, the separation of the fibre is effected by fermentation simply. An incipient decomposition is made to separate the parts. This is steeping, or water-retting and dew-retting. In the second, the liberation of the fibre is due to the abstraction of the azotized extractive principles by the agency of chemical solvents, which are chiefly alkalies. In the third, simple water is used, either heated or introduced as steam.

In the first method fermentation is carried on at the expense of the matters contained in the plant, either originating within itself, or introduced from without. In either case offensive and noxious products are generated by this process of retting. In the second method the combining matters are removed by the aid of chemical ingredients; and by the third process the whole of these substances may be preserved in a state that is useful, and that may be applied as a valuable feeding material.

The process of steeping, including also dew-retting, is the one generally adopted over the country, and the commonest and most ancient mode consists of dew-retting. The straw is spread out upon the grass, and exposed to the natural moisture of dews and rains, or it is carefully watered by artificial means, so as to have a supply of moisture sufficient to set up and maintain fermentative action within the tissues of the plant. This is a tedious process, requiring several weeks, and in cold weather a longer period; and yet, with all its uncertainties, it is a favorite method, particularly when conducted in the winter season, and many manufacturers prefer snow-retted flax. The period required for natural retting will depend upon the heat and humidity of the atmosphere, and in a dry season this will be very much extended, and will require from three to six weeks.

The usual method is that known as water-retting, when the flax-straw is immersed in tanks or pits constructed for the purpose, where the liquid may be at rest, or very slowly changed by the ingress of a small stream of water. It is advised that the water used for this purpose be soft, and that it be collected in a reservoir and allowed to stand for some days before being admitted to the straw to be acted upon by it. Slowly moving streams of water are sometimes selected for the rotting-pools, in which the flax is introduced and left until the desired decomposition is effected. In Belgium, where retting constitutes a distinct branch of the trade, wooden crates, twelve feet long, eight feet wide, and three feet deep, are made, which, when filled with the flax, are carried into the stream and weighted down, and left to be retted, and removed from the water so soon as sufficient decomposition has taken place. This is done chiefly in the river Lys, the water of which stream is believed to have superior qualities, so that flax is brought from a great distance to be retted in it, and the product is made into the finest linens, shirtings, cambrics, and damasks. Nothing peculiar has been discovered by analyses. A similar arrangement has been contemplated by a flax company in the northwest, who are to pack their straw in large crates, to be transported into the water on wagons from which they can be unloaded, left there till retted, and then removed by the same wagons and transported to the drying grounds.

In the tanks or pools, whether these be in the open air or under the cover of buildings, the flax is placed nearly upright, inclined, but loose; the water is let in, and the straw is weighted down to keep it under. This weight often needs to be increased during the progress of fermentation, which is indicated by the appearance of scum upon the surface of the liquid, and by the escape of bubbles of gaseous matters extricated below, and by the rising of the bundles above the surface of the water.

Constant care is required in this process, that it be not carried too far, and result in the destruction of the valuable fibre as well as that of the foreign matters associated with it. Close attention must be paid to the condition of the straw, and at this stage repeated trials should be made to ascertain if it be sufficiently retted, when it must be immediately removed from the vat, for a little too much retting will destroy the value of the fibre. Experience is necessary to enable the workman to decide when the proper period is reached, and this matter is usually intrusted to one who has made himself an expert, and who has the necessary judgment. If the fermentation have not been carried far enough, the fibre will be coarse and harsh; but, if overdone, though soft and fine, it will be tender, and there will be great loss in tow when the flax is heckled.

Steeping in pools is not so slow and tedious a process as dew-retting, but still considerable time is required, generally from ten to fourteen days, according to the temperature; but in streams, which are still colder than the ponds in which the fermentative action affects the temperature, from two to three weeks will be required. In all cases much depends upon the quality of the water and upon the temperature. Impurities, such as lime and iron, are considered injurious, and thought to retard the fermentation as well as to injure the fibre.

Schenck's process depends upon the use of hot water, by which the fermentative process is hastened, and yet it may be controlled. By this plan a saving of time is effected, as from seventy-two hours for the fine qualities, to ninety-six for the coarse, is all that is needed, instead of two or three weeks. This process will be explained in detail upon another page.

Chemical methods.—Many plans have been devised for dissolving out the extractive matters of the straw by the use of chemical agents, both acids and alkalies; even weak solutions of these substances are found to have this desired effect. Their action is accelerated by temperature. The Chevalier Claussen patented a process for this purpose, which will be considered in detail in the section of this report which will be devoted to the consideration of the claims and merits of flax-cotton.

All of these processes for the separation of the filaments from the wood and from one another will be understood when we recollect the nature of the interstitial substance that unites them. Being nitrogenous, it acts as a ferment when exposed to a gentle heat and moisture, either in the retting vat or in the open field. The elements of decay are present, only awaiting circumstances favorable to the establishment of that process. In the case of chemical agencies their action depends upon the solvent power which alkalies exercise upon the intercellular matter combining the cells and cell-bundles into the fibres and filaments that we desire to separate.

In the processes next to be mentioned, though a separation be effected, it is important to recollect that certain elements of destruction are still left in the fibre thus treated, which are liable at any future period to undergo fermentation if they be subjected to circumstances favoring such action.

Hot water.—The use of simple solvents, such as water or steam, remain to be considered as agencies to remove the foreign matters from the fibre and to cause its ready separation from the stalks or boon. By the use of such means we find the process accelerated, and as we have no fermentative action, we not only avoid the noxious and disagreeable effluvia and exhalations, but we save the use of expensive and sometimes dangerous chemicals; there is less prospect of injuring the fibre, and the products of the operation are found to be valuable. This is called Watt's method, and will be fully described on another page.

This method presents a great advantage in saving of time, as it only requires thirty-six hours from the commencement until the flax is dried and scutched ready for market. There is also claimed a great saving of fibre, for the product was found to be 18 lbs. of fibre per cwt. of crude straw, or 26½ lbs. per cwt. of the steeped and dried straw, which by this process had already been divested of a large portion of its original matter, washed out with water.

Hitherto the first four processes in dealing with the crop of flax have been the separation of the seed from the straw, the steeping of the straw, and the drying afterwards, and the separation of the fibre by breaking and scutching. These operations have been agricultural, whereas they ought to have been manufacturing processes. It is manifest that all of them may be performed much more systematically and economically in the routine of a factory, with practiced hands, than could be done by the slovenly laborers of the farm.

Mr. Ward urges the Irish farmer to confine himself to growing the flax and to harvesting it in proper condition; when the crop should pass into other hands, who, with more efficient aid, would convert it into a better quality of fibre. If the farmer performed his part judiciously, which he is more likely to do by omitting subsequent processes, manufactories could be introduced which would be beneficial to him. If the straw be not carefully harvested its fibre will be lessened in value to a large extent; this loss no subsequent treatment, however judicious, can possibly obviate. If, therefore, an improved method of preparation be introduced, it must, in a great measure, depend upon the co-operation of the farmer.

From report of Juries at the International Exhibition 1851.

"Schenck's method has been introduced into Ireland and found economical of time and labor. The Royal Society at Belfast recommend it highly. Mr. McAdam, secretary of this society, gives the following account of it:

"Simple wooden sheds contain the vats and drying shelves. In one end of the buildings are four vats; these are made of inch deal, fifty-six feet long, six feet broad, and four feet deep. There are false bottoms perforated with holes; underneath these are steam-pipes crossing the vats and having stop-cocks, to let on or cut off the steam as required. This is generated in a small boiler, which also works the two hydro-extractors, which drive off a portion of the water as the flax comes from the vat. The flax is packed in these vats on the butt end, half sloping, only one layer deep; then the water is let on, while a frame on top confines the straw in its position. The steam is let in by turning the stop-cock, and the water is eighteen or twenty hours in becoming heated to eighty-five or ninety degrees; when fermentation commences no more steam is required, but the process continues forty hours, or sixty hours from the commencement, when the flax will be perfectly retted. If the water be heated before it is put into the flax, or if the temperature be raised above ninety degrees, the process is not hastened, but the fermentation is rather retarded. The gradual heating of the water is necessary if we wish to preserve the quality and color and to have a uniform retting.

"When thus retted the flax is taken out and the vat is emptied and cooled for the reception of a fresh charge of straw, water, and steam as before. As taken from the vat, the flax is placed in the hydro-extractor, where it is rotated rapidly to displace the water by the centrifugal force. From thirty handfuls placed in this apparatus twenty pounds of water are expelled in from three to five minutes, so that a few hours suffice to treat the contents of one vat, amounting to two tons of the flax straw. The flax is dried of its remaining moisture in the summer by spreading it upon the grass, but in winter it is spread thinly upon lattice shelves, protected by a shed that is heated by steam pipes; the shed should hold the contents of one vat daily; when dried the flax should be made up into small beets or handfuls suitable for feeding into the rollers of the breaking machine.

"Such an establishment can ret about ten vats per week, equal to twenty tons of straw, producing two and a half to three tons of fibre, thus making 120 to 150 tons of flax ready for market annually, the produce of 400 or 500 statute acres.

"The saving in time accomplished by this process is not attended by any depreciation of quality or loss of material in the manufactured article. This is thus corroborated by the Belfast Society. The doubts raised as to Schenck's process were, 1st, that the yield of fibre would be less than the ordinary mode of steeping; 2d, that flax so prepared would be weakened; and 3d, that linen made from it would not bleach properly. Experience has proved that the last two are altogether baseless. As respects the first objection, we are of the opinion that, either by the common method or by Schenck's, the yield of fibre will be lessened if the fermentation be allowed to proceed too far. The uniformity of temperature insured by the latter would induce the belief that the yield of fibre should be increased. This is borne out by two experiments. In the one conducted at Lisburne by Mr. Davison in 1847, 112 pounds of flax straw, after steeping and drying in the ordinary way, gave twenty pounds of scutched fibre; and 112 pounds steeped by Schenck's process and dried gave twenty-four pounds, an increased yield of twenty per cent. In another experiment 112 pounds of straw gave, by the old process, fourteen pounds five ounces, and as much, by Schenck's process, yielded seventeen pounds eleven and a quarter ounces, or twenty-three and a half per cent. in favor of the latter. As respects the quality of the fibre the result was equally favorable to the Schenck process. In the first experiment, the flax steeped in the ordinary way spun to ninety-six lea yarn, that by Schenck's spun to one hundred and one lea. In the second, the ordinary gave sixty lea, Schenck's seventy lea."

Watt's method.—The flax straw is delivered at the mill dry and with the seed. The seed is separated by metal rollers and afterwards cleaned. The straw is placed in cast-iron close chambers, laid upon a false bottom of iron, and when the doors are closed tightly steam is thrown among the straw. The first effect is to drive off certain volatile parts that, with the water, are caught in the condenser placed above, and returned upon the straw; as this fluid accumulates, with portions of the extractive matter from the straw, it is drawn off from time to time. After being thus treated from eight to twelve hours, during which the resinous matters are removed from the straw by the water, it is taken from the chamber and passed through rollers that separate most of the water and split it longitudinally and crush the boom. It is then dried and in a few hours it is ready for scutching.—*Condensed from Society's report.*

The chairman of the committee of the society for the promotion of the growth of flax in Ireland gives the following account of the result of his investigations:

"A quantity of straw was taken weighing 13¾ cwt. After removing the seed, which, when cleaned, measured 3¾ imperial bushels, the remaining straw weighed 10 cwt., 1 qr., 21 lbs. It was then placed in the vat and subjected to the steaming process for eleven hours; after steeping, wet-rolling, and drying, it weighed 7 cwt. 11 lbs., on being scutched the yield was 187 lbs. of flax fibre, and of scutching tow 12 lbs. 6½ oz. fine, and 35 lbs. 3 oz. coarse. The yield of fibre in the state of good flax was, therefore, at the rate of 13½ pounds from the hundredweight of straw, with the seed; 18 pounds from the hundredweight of threshed straw; 16½ pounds from the hundredweight of steeped and dried straw, equal, respectively, to 12, 16, and 14½ per cent. The time occupied in the actual labor in the processes after removing the seeds from the flax was 13½ hours, beside the eleven hours consumed in steaming and the time spent in drying. The scutching by four stands occupied six hours sixteen minutes. Thirty-six hours is supposed to be the time necessary to perform all the processes, reducing straw into clean fibre. When sent to the spinning mills to be heckled and valued it was declared to be quite satisfactory to the hecklers, and worth from £56 to £70 per ton.

"The committee conceive that the most prominent and novel feature of this plan consists in the substitution of maceration or softening for fermentation. In the steeping of flax, both by cold and hot water, the gum is separated by being decomposed, while on Watt's system the maceration simply loosened the cuticle and gum, which are further separated mechanically by the crushing, and which, after the drying of the straw, readily part with the wood in scutching."

The water from these vats is found to be nutritious instead of noxious, as is the case with common retting when it becomes putrid from decomposition. It is only an infusion of the gums, and is used with the chaff of the seed bolls for feeding swine, and thus may be returned to the soil in the manure they produce instead of becoming a nuisance.

The following is a statement of the amounts of labor and time occupied in the process:

Process.	Persons.				Hrs.	Min.
Seeding	4 men,		8 women		1	15
Placing in vat	3	do	4	do		15
Cleaning seed	1	do	0	do	3	00
Taking out of vat	2	do	3	do		30
Wet-rolling and placing in dry room	1	do	16	do	2	20
Rolling for scutching	0	do	11	do	1	8
Strieking for scutching	0	do	7	do	4	47
Total	11		49		13	15
Scutching	4	do	0	do	6	16

Professor Hodge stated to the British association for the advancement of science that—

"This new method which is in operation at the extensive works of Messrs. Leadbetter, Belfast, appears to offer striking advantages. It is peculiarly adapted for rendering the separation of the fibre a manufacturing operation. No disagreeable odors are evolved, and if experience confirms the expectation of the patentees with respect to the quality of the fibre obtained, and if the cheapness of the plan be demonstrated the new process will contribute largely to the extension of flax culture in this country. The utilization of the residual liquor is another argument in favor of Watt's plan."

Experiments as to the comparative value of fibre prepared by steeping in the old way, and by Watt's method, give the following results: Watt's process in one set of experiments gave forty-five per cent. more of scutched fibre, and was considered worth £10 more per ton. In another set of experiments the green straw yielded twenty per cent. more of scutched fibre; the dry straw yielded seventy-five per cent. more of fibre.

Breaking without retting.—The commissioners have found several machines that will break and clean the unretted flax straw, and they desire to say a few words upon this subject, as obviating the necessity of this troublesome and expensive process, would appear to be a great desideratum in the culture and production of fibrous plants. In a valuable paper upon this subject by O. S. Leavitt, in the Patent Office Report for 1861, the following statements occur:

"In 1812 Lee took out a patent in England for a machine and process for breaking and working flax straw in the natural or unretted condition; and so important did Parliament consider the invention that the peculiar privilege was accorded to the inventor of having his specification filed for seven years in the secret archives of the government. This plan contemplated making linens entirely by the dry process. The Irish linen board expended £6,000 in their endeavors to introduce it into the flax districts. In 1817 the same was patented by Hill and Bundy. Other similar attempts were made on the continent, and all failed for the following, among other reasons:

"1st. The breaking machines were very imperfect; greatly inferior to those which have been of late worked with better success in this country.

"2d. The flax, broken out and cleaned in the most perfect manner, in the unretted condition, is coarse, harsh, and totally unfit for fine yarns, on account of the great cohesive force of the glutinous matter connecting the filaments so firmly that no heckling, brushing, or other mechanical means can separate them sufficiently for fine numbers. What may, in this condition, appear to be but a single filament, will, upon close examination, prove to be a bundle of filaments, cemented together by the incrusting matter.

3d. It was found that in attempting to divide the harls sufficiently many were ruptured, making a far greater proportion of tow than by the retting process, while the tow was of a very inferior quality—merely wide harls, with more or less aahering shives. Many harls were torn off abruptly, making what the spinners call stumpy ends, and the whole very harsh, and only suitable for inferior rope-yarn.

4th. By neglecting, as many did, to boil their yarns or goods properly in an alkaline solution, the azotized incrusting matter, when exposed to moisture, would cause the goods to mildew and decay more rapidly than when made from retted flax; but this was not the main cause of failure in working unretted flax, as many have alleged."

With the improved brakes now in use we have seen unretted straw broken very nicely, though there is always an amount of tearing of the filaments that must damage the material for the preparation of long-line; even if the fibre be exposed to the solvent action of alkaline solutions, the amount of tow is necessarily increased. For some of the processes to which these fibres are now exposed in their preparation for spinning as shortened fibres, however, we conceive that these objections are overruled, seeing that our brakes are more perfect; the design is to prepare and to use shortened fibres; and in the later operations of disintegrating the filaments, the material is exposed to suitable solvents of the incrusting or interstitial matters which are entirely removed.

Mr. Ward gives an account of a mill at Trebolgan, Ireland, where seven hundred hands are employed, and where the flax is broken in the dry way.* The flax is first taken from the stack to the mill, where it is seeded, by passing the straw through rollers and then beating it against timbers. It is then dried in a room artificially heated, and passed through the breaking machine, which prepares it for scutching. When the shives have been separated by the scutcher, and the fibre is brought to the desired state, it is tied up in bundles. This is the largest mill in Ireland, using an engine of twenty-five horse-power. The tow is also cleaned by machinery and rendered marketable. The proprietor, Mr. E. B. Roche, has a great advantage in the combination of this factory with his farm, as all the refuse may thus be consumed. The corn-barn is attached to the mill so as to have the use of the steam-power for threshing and winnowing. Near the engine are arrangements for cooking food for the cattle, which is done with the waste steam, by means of which from ten to twenty tons of mangold wurtzel may be prepared at once. The condensed steam is saved to mix with the flax bolls, as a very rich food. The shives from the straw thus treated in the dry state without retting are not only useful as fuel, but are found to be nutritious, and are valuable as food in combination with the steamed roots, with which they aid digestion. An oil mill, in addition, is all that the establishment needs to make it complete.

*Condensed from Ward's treatise.

The Belfast society say in regard to this method:

"It is sufficiently obvious that so simple a mode of obtaining flax fibre as its mechanical separation from the stems of the plant must have been the earliest methods adopted when this substance was first used for textile purposes. It is probable that accident first made known the fact that by immersing the flax stems in water, when above a certain temperature, the fibre could be divested of impurities by the decomposition of the foreign matters, which, with the woody portion of the stem, are united to it. In 1815 the Irish linen board adopted the dry preparation, then brought forward by Mr. Lee, and their records show that its principle was almost identical with Donlan's. After expending £6,000, the board abandoned it on account of insuperable defects. In 1816 Mr. Pollard, of Manchester, proposed to make an article from flax by a dry method which could be spun on cotton machinery. This also fell to the ground. The committee state as their opinion 'that the fatal defect of the dry methods is the retention by the fibre of the gummy and resinous matter incorporated with it. This, being subject to fermentation at moderate temperatures if moistened, and to decomposition by alkalies and acids, is not only useless, but absolutely pernicious, if thus retained, since, in the process of manufacture, it is exposed to these agencies.' And further they state that the matter may be summed up thus: 'In the retted flax a nearly pure fibrous matter is produced, and the material is thus in the fittest state for spinning even yarn and making good linen. In the dry worked flax, along with the fibre is combined a foreign substance, which must be got rid of afterwards, to the detriment of the spun and woven fabrics.'"

The following very interesting view upon this subject is taken from the reports of juries at the London exhibition:

"During the last few years great efforts have been made to extend and improve the manufacture of this valuable fibre in various parts of the world. The increase under the last head in the preceding table for 1849 is chiefly due to the importation of flax from Egypt. It must be remembered that, in addition to the above-mentioned quantity of flax annually imported, the manufacturers of England have consumed rather more than a quarter as much again, cultivated in various parts of the British empire, chiefly in Ireland. This proportion has also considerably increased during the last twenty years, and a most marked improvement in the quality of the flax itself has also been produced; a change in great measure to be traced to the persevering and most praiseworthy efforts of the Royal Society for the Promotion and Improvement of Flax in Ireland. The value of flax depends, in part, on the climate and soil in which it is cultivated, and in part, also, on the mode in which the fibre is prepared, on the care and skill in which the process is conducted, and on the constant and vigilant attention which is paid to it through the various stages of the operation. According to its quality, its value varies from about 40 pounds to 180 pounds per ton.

Another circumstance which has given a considerable impetus to the cultivation of flax, and is likely to produce, ere long, even yet more marked effects, is the introduction of the late R. B. Schenck's new process of steeping.

"Many different modifications and peculiar modes of retting are followed in the various flax districts of Belgium, Holland, and France, and in different localities dissimilar modes of retting have long been in use, often involving very considerable variations in principle. Thus, at Courtrai, the flax crop is dried in the field and stored for some months in barns before it undergoes the process of retting in the river Lys. In the district of Waes it is retted immediately after being gathered, the green stems being at once thrown into pits of stagnant water. As, however, the whole operation, in every kind of water retting, depends on the amount of fermentation produced, (which must be enough to insure the decomposition of the glutinous matter, but not enough to cause any injury to the fibre,) the process is necessarily slow, tedious, and very uncertain, especially towards the close of the operation, because then the flax must be most carefully watched, in order to put a stop to the fermentation as soon as the desired effect is produced. A slight change of tempature, or a few hours' exposure, when the fermentation is complete, may produce the most disastrous effects, the fibre being, in fact, ruined. Dew-retting is, of course, even slower than water-retting, depending, as it necessarily does, on the nature of the season, and being greatly retarded by long continued dry weather. In the very dry autumn of 1810 it was found impossible to prepare flax by this method, and recourse was obliged to be had to other methods of retting."

"During the last half century various attempts have been made to effect the separation of the fibrous from the woody portion of the flax stem by chemical and mechanical means. In several cases the results at first appeared to be very promising; but in every instance it was soon found that there were insuperable practical objections, which more than counterbalanced the advantages. Among chemical agents solutions of sulphuric acid, caustic potash, caustic soda, quicklime, and soft soap were all in turn tried and discarded; and among mechanical processes the ingenious contrivances of Mr. James Lee and Messrs. Hill & Bundy shared the same fate.

"In 1817, and, therefore, before the publication of Lee's specification, Messrs. Hill & Bundy took out their patent for machinery for breaking and preparing raw flax and hemp. The rival claims of these two inventors were investigated in 1817 by a committee of the

House of Commons; but whatever may have been the comparative merit of the two processes in the course of a very few years both were relinquished and forgotten. Since that time various other ingenious mechanical arrangements have been devised, but hitherto they have had very little success.

"Schenck's process, for which he obtained a patent in 1846, is undoubtedly a very important improvement. It consists merely in steeping the flax stems in warm water, heated artificially to the temperature best suited to fermentation. By this simple means the operation is rendered rapid and certain, all uncertainty from fluctuations in the temperature and weather is avoided, and the whole process is entirely under the command of the manufacturer. The temperature best suited for this purpose is about 80°, or from 80° to nearly 90°; above this point the process proceeds too rapidly, and the fibre is almost sure to be more or less injured. The time required is from seventy to ninety hours.

"From the facts and evidence brought forward by various independent exhibitors, it appears satisfactorily proved that the warm-water steeping increases the percentage of fibre obtained from the flax stem over that obtained by the old modes of retting by nearly one-fifth; and that, whilst the fineness and spinning qualities of the fibre are increased, the strength is in no way weakened or diminished unless the process be permitted to proceed too far, an effect which need never happen, from the complete control over it which the manufacturer has throughout. Although there is no doubt as to the practical value of the use of warm water in flax-retting, yet the introduction of Schenck's process is far from removing all the difficulties of the flax manufacture. Much still remains to be effected, and it is by no means improbable that ere long a yet more perfect process may be devised.

"It is interesting to observe that the use of warm water in the preparation of vegetable fibre is not altogether new, it having been long employed by the Malays, and by the natives of Rungpoor, in Bengal. The process adopted at Bencoolen is stated by Dr. Campbell to consist in steeping the stems of the hemp in warm water, in which it is allowed to remain for two days and nights. The old German process called 'Molkenrost,' sometimes used in preparing the finer sorts of flax, is also, to some extent, an application of the same principle. In this mode of retting, the flax was steeped for four or five days in a warm mixture of milk and water, and thus the desired degree of fermentation in the flax stems was produced. This operation must be distinguished from the more modern one, in which sour milk was used in order to give a good color to linen, a process introduced by the Dutch towards the middle of the last century. The linen was boiled in a weak alkaline lye, and subsequently treated with sour buttermilk, for the purpose of aiding in removing the alkali, and dissolving the earthy impurities present in the fibre. Occasionally, also, salt of sorrel was used for the same purpose, and in 1775 Reuss states that sulphuric and muriatic acids might be used for the same purpose; but that being too costly, they had not as yet come into general use. Of course, all processes in which boiling, or even hot, water is used are quite different in their mode of action from those in which only warm water is employed. When boiling water is used it is with a view of dissolving and removing the useless matters which incrust the fibrous part of the plant, whilst, on the other hand, warm water is used to soften them, and to aid in their putrefaction or decomposition, through the agency of fermentation. In 1787 much interest was excited in Ireland by the publication of a plan for improving the retting of flax by the action of hot water. In this scheme it was proposed to scald the flax stems in boiling water to soften them, and to remove a portion of the extraneous vegetable matters which they contain, and it was conceived that after this treatment the subsequent retting of the flax would be more rapid, certain, and manageable, so that time would be saved, the noisome process of pond-retting be obviated, and the result be to yield a stronger and whiter fibre. The minute and careful experiments of Hermbstaedt, on the chemical principles involved in the retting of flax, (made about the beginning of the present century,) threw much light on the whole subject, and to some extent indicated the influence of temperature on the success of the operation."

Aid of chemistry.—Without the aid of chemistry it would have been impossible for textile fabrics to have attained their present development. The bleaching of cotton and linen was not much practiced in England until about a century since; before that time they were sent to Holland, where the operation of bleaching consisted in steeping them in potash for a few days, afterwards for a week in buttermilk, and then exposing them for several months on a meadow to the influence of the sun and moisture. A great improvement was made in Scotland, by substituting sulphuric acid for sour milk; and the immediate effect was to reduce the time from eight to four months. In 1785 a French chemist suggested the use of chlorine as a means of hastening the process, and in the last year of the eighteenth century a compound of this gas, with lime, was introduced by Tennant, of Scotland. The development of the cotton manufacture now became immense. By a happy adaptation of other chemical processes, in conjunction with the bleaching power of chlorine, the time required for the whitening of cotton and linen fabrics was at once reduced from months to hours, while the miles of outstretched calico, defacing the verdure of country districts, disappeared, the whole operation being carried on within the small space of an ordinary factory. The bleaching of calico now consists of a chemical operation of great precision.*

In the last edition of Ure's Dictionary of Arts and Manufactures we find this branch of the subject very fully handled. The writer does not recommend the use of mechanical means without retting, because of the loss that must ensue afterwards in the processes of bleaching, &c., and for other reasons. The brief abstract, of various attempts to break unretted stock, refers the first to Lee, of England, in 1815. Pollard, at Manchester, resorted to a similar plan in 1816 with no better success. In France and Belgium similar plans were tried, and found impracticable. In 1850 and 1857 Donlan revived the project, but the same fatal objections prevented success. The fibre was loaded with impurities that made the apparently greater yield, all of which had to be got rid of afterwards. It is admitted that the "dry separated" material may be useful in manufactures where no bleaching is required, and where strength is needed. To the remaining forcible objection that the elements of decay are present in the fibre, it is claimed that such material may be used in the preparation of coarse fabrics like tarpaulins, that are to be invested with a protecting coat of tar, or for such as may be subjected to the kyanizing process.

With all these facts before us, we could but look with hesitating approval upon the claims of Mallory & Sanford, that their machines could break unretted flax. The specimens before us were quite satisfactory, it is true, excepting that we found some breaking of the harls, and a harshness arising from the presence of the dry glutinous matter among the fibres; but the boon had been thoroughly broken up, and the shives were well separated from the fibre both in the contributions to the museum and in green unretted stock that was broken upon the machine before our eyes. The rupture of the filaments must result in an increase of tow in the scutching and heckling processes, and, moreover, the elements of destruction would, to a certain extent, still remain among the fibre, ready to cause a change whenever exposed to the requisite degree of heat and moisture, so that the use of flax from unretted stock appeared to be limited to a few subordinate branches of the arts. Our attention was next directed to the use of this material in some of the different modes of preparing flax cotton, and we are happy to be able to report most favorably upon the results so far as they have been reached, for it appears that the unretted fibre is much more easily treated in the processes of disintegration, and that the product needs no additional bleaching, whereas the blue or gray tint consequent upon retting is known to be very difficult to eradicate.

At the International Exhibition held at London, in 1862, the jury make the following remarks in their report upon flax and hemp: "These important fibres are exhibited on a large scale, and in many instances the samples show the results of admirable management. Both have been prepared by all the various methods which have been invented for separating the fibres, except the empirical one, which, in 1851, led a majority of the jury to award a medal to Chevalier Claussen."

Belgium stands first, with its beautiful flax fibres; then northern France, Italy, Russia, and Hungary. Hemp is best shown by Italy; next, Hungary, Russia, France, and Germany.

From Canada, (Toronto,) cold-water retted, middling quality, mill-scutched, and being ripened for seed, is not very strong.

From Newfoundland tolerably good, but much injured by a very injudicious operation, namely, dressing it with oil, a practice which is calculated to depre-

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* Watts's pamphlet.

ciate it rather than to raise its value in the eyes of those skilled to judge such materials.

New South Wales—*Linum angustifolium*, (native.)—The jury believe that at no distant period it may become an important product of the colony. Also from Tasmania, Queensland, and Victoria, the same.

Hemp.—Among the French hemps was one from Messrs. Leoni & Cobleng, who have introduced a practice of preparing it without retting, using mechanical means for disintegrating the stalk and separating the fibre from the bark and medullary matter. The hemp so prepared appeared to be of a very useful quality, but it requires long and extensive experiments to prove that the strength and durability of the fibre are unimpaired by this process.

Italian hemp ranks highest in the exhibition; irrigation used.

Garden hemp of Italy, fibre six feet long, the color light and bright, and the fibre beautifully soft and flexible.

They represent the product of the European provinces of Russia to be—flax, 165,000 tons; hemp, 103,000 tons.

Export of Russia, annual average, from 1846 to 1860:

	Tons.
Flax cleaned	55,777
Tow and codilla	10,747
Hemp cleaned	44,087
Tow and codilla	20,001
Hempen yarn for cordage	19,980
Total	150,592

200 tons go eastward.

The high character of this product is owing to water-retting, which is universal, and to hand-scutching; no machine process is used.

The finest flax has been produced in Russia, equal even to the Courtrai of Belgium.

	Tons.		Tons.
In Austria, in 1860, the amount of hemp grown	50,000	Flax	100,000
Excess imports over exports	2,400		3,000
Totals	52,400		103,000

Spain, very short staple.

They found that Schenck's process of steeping in hot water is employed with advantage in Silesia.

What generally struck the attention of the jury were the fibres, yarns, and cloth of attractive appearance and superior quality obtained from ordinary flax treated by the Belgian process of Lefebure. The fibres thus prepared keep the regularity, the brightness, and the strength which are characteristic of superior finished yarns. They are refined, divided, and prepared in such a manner that the yarns and cloth made from them are sufficiently white for partial bleach, without being creamed. The jury found some tow yarn as fine as 150 leas from France, and some English still higher. There were also some yarns 520 leas, very fine; 350 is limit of fineness, generally used for practical purposes. They report great progress in mill-spun products since previous exhibition, especially by the French.

In Courtrai they are superior in hand-spun yarns, reaching 800 and 1,000 leas, but these are only used for the most expensive laces.

M. Alcan, the reporter, on behalf of the jury, explains why the flax manufacture has remained almost stationary, while the manufacture of some other etxtiles has wonderfully increased:

"We notice, in the first place, that though flax is a material most easily adapted for spinning yarns, being produced by hand labor quite equal to silk in fineness, and though the raw material of flax in the state of fibre is about the same price as the better kinds of cotton, the yarns produced from flax by machinery, taken in equal length for the same weight of fibre, appear to cost the most of all. We must also acknowledge that it is with the greatest difficulty that flax-spinners have been able to produce by machinery yarns of an extreme fineness, though still inferior in this respect to the fineness of the cotton yarns. As a principle the fundamental operations for the spinning, except perhaps the preparation of the raw material, are the same for all fibrous substances. The combing or carding, the drawing and spinning, constitute, without any important distinction, these various operations, still such will cost much more for some one of these materials than for others, even though this material may not possess a nature deficient in spinning qualities.

"The cause of this difference is that the more costly fabric is produced from material which is worked with greater practical difficulty, and requires more effort to complete; this is especially the case with the flax, the machinery for which must be decidedly stronger than that used for cotton, and the whole flax-spinning system must also have much more steam power applied, in consequence of the flax fibre not being sufficiently purified and freed from all heterogeneous substances, which, of course, present an obstacle to the sliding or drawing, the base of all spinning operations. On the present occasion we shall endeavor to give some explanation on the subject of steeping flax, this being the principal process by which more or less softness or purification of the fibre may be obtained.

"The great fault of the flax fibre is the excessive quantity of gum, which is not extracted by the present steeping process; when a new process shall have been discovered to remove completely this objection, there is no reason why flax fibre should not be spun as easily and as fine as cotton. It is to be hoped, also, that by such improvement we may eventually obtain a class of yarns more elastic, and that the cloth made from them may weave more readily, and in the end give greater satisfaction and durability. If we pass from the flax fibre to that of hemp and other similar substances, we find the hemp inferior to flax in softness and minuteness of subdivision, making it more difficult to spin; we find also that China-grass has the same defect in a much higher degree, while it is also much more costly. If jute manufactures have made such rapid progress it can be easily accounted for by the low cost of material, combined with a considerable amount of spinning quality.

"We may remark, before concluding these reflexions, that great attention is now being given to the flax-steeping process, and in consequence the real cause of the difficulty of the fibre for spinning, as explained above, has thus become every day more generally known. We may hope, therefore, that at no late date the process of steeping will be improved to an extent equal to the great progress which the other manufactures, dependent on the aid of chemistry, have lately made. The Lefebure process, and the products thus prepared, as well as some other attempts in the same direction, constitute an important step, which causes us to anticipate some advantageous results from a more perfect and rational mode of steeping. Having so fully referred to the steeping process, the importance of which can scarcely be exaggerated, we may remark, in conclusion, that the greatly enhanced cost of flax during late years has caused a considerable advance in the cost of all kinds of pure linen goods, which fact has, without doubt, in some degree, contributed towards the want of advance in the linen trade, which has already been referred to. By extending the cultivation of the flax plant to some other countries, greater cheapness in the cost of the raw material may be attained. We believe the north of Europe is well adapted, by climate and by cheapness of labor, as well as inexpensive soil, for a greater extent of this cultivation, and can hope so desirable an object will not be lost sight of."

Letter from E. Towne.

UTICA, N. Y., *February* 22, 1864.

The sample marked 1 was manufactured from fine tow, as made by flax dressers, which contained nearly fifty per cent. of shives and dust; the latter were mostly separated by a machine called a willow, or duster, but leaving some shives so firmly attached to the fibre that it was next subjected to the picker, which removed most of the balance of the shives, and also broke or shortened the length of the fibres. The cleaned tow was then boiled in an alkaline ley for eight hours, then, after being well washed, was steeped in dissolved chloride of lime twelve hours, then drained, then put in sour liquor for two hours, then washed in clean water, then the boiling, steeping, &c., in new-made liquor repeated.

If, at this stage, the fibres be not found of desirable fineness, they may be further divided by soaking in a strong solution of bicarbonate of soda, and then in a sour liquor. It is deemed best not to divide the fibres too much in the earlier stages of bleaching, as thereby they would be weakened so much as to break more in bleaching.

After being dried, the matted fibres are separated by passing through a picker, or strong cards, made for the purpose.

The loss in weight by full bleaching clean dew-rotted tow, including the loss in dust and light particles, is about thirty-seven and one-half to forty per cent.

Valuing tow, as it comes from the flax-dressers, at five cents per pound, (which is as low as I have known it to be sold the past year,) will make the cost of No. 1 about thirty-three cents per pound; thus—

1,000 pounds tow (with the shives adhering,) at 5 cents per pound	$50 00
Cost of separating the shives (500 pounds net,) at 3 cents per pound	15 00
Bleaching 500 pounds clean tow	25 00
Picking and carding 300 pounds bleached tow, at 3 cents per pound	9 00
Cost of 300 pounds bleached tow, or flax cotton	99 00

Or 33 cents per pound. Numbers 2 and 3 are one-half bleached. This was done by dissolving and mixing together about equal quantities of soda ash and chloride of lime, say eight pounds each to one hundred pounds tow, and in the clear liquor steeping the tow (cleaned of shives) for three to four hours; it must then be soured and washed, dried and picked.

Cost of 100 pounds clean tow	$13 00
Cost of bleaching materials	72
Cost of labor and picking and carding	3 35
Result, 75 pounds half bleached tow (or flax wool) costing	17 07
Or costing per pound	$22\frac{76}{100}$

Numbers 3 and 4 differ only in length of fibre—the shorter is made by passing a second time through the picker.

It is easy to reduce the fibres so that none shall exceed a given length, but, from their structure, they are liable to be more or less broken by the subsequent rough treatment to which they are necessarily subjected.

A manufacturer of woollens has used a small quantity of No. 1, carding it with wool. He reports: "It worked in every respect as well as cotton, and in the finish was fully equal, while the color it receives is undoubtedly more durable than that of cotton." I regret the cloth was sent to market without a sample being taken.

From numerous experiments I have made I am satisfied there is no saving in expense or material in using non-retted flax. The matters removed by water or dew-retting are all removed in bleaching, but at the expense of additional quantities of materials. Goods made from non-retted flax and not bleached will be "slazy" when moistened, and liable to early decay.

The cost of Nos. 1, 2, and 3 is based on the present price of tow, as it falls from the second and third knives of the flax-dresser. Owing to the large demand for flax at prices of 18 to 22 cents, fine tow, in the rough, is salable at 5 cents.

I have spent much time, and been at no inconsiderable expense in experimenting. I intend pursuing the subject as I have opportunities for so doing, in the hope of realizing valuable results.

Very respectfully, yours,

E. TOWNE.

STATEMENT

I herewith beg to submit my treatment of converting fla into a cottonized substance:

I commence by taking the flax straw gathered *when fully ripe*, either *tangled* or *straight*, after the seed has been taken off. The straw, after being air-dried, is passed through a flax breaker, of Sanford & Mallory's make. By the operation of this machine the boon, or bark, is, to a considerable extent, separated from the fibre, and the stem loses about fifty per cent. of its original weight and reduced to one-half of its original bulk. After breaking it is put through a picker and duster by which a large portion of the adherent portions of wood are removed. The fibre is now ready for boiling. The boiling consists of the following process:

To every ton of the fibre add as much water as will well cover it, and afterwards introducing into it about five per cent. of a solution of caustic soda of the specific gravity 1.50°. (The caustic soda is made by adding caustic lime to a solution of soda ash in the proportion of two parts of lime, six parts of water, and two of soda, and twelve parts of water. This is the *concentrated* liquid.) The fibre is allowed to boil three hours, and then is passed into a solution of carbonate of soda of five per cent.; then into a solution of sulphuric acid of one and a half per cent.; then into a solution of soda ash, same strength as before. It is then partially split and ready for bleaching.

The bleaching liquid is hypochloride of magnesia, made by taking one part by weight of chloride of lime to twelve parts of water; and in a separate vessel, two parts of sulphate of magnesia to twelve parts water. Mix the two solutions together, the clear liquid is then diluted to 3° Twaddle, specific gravity 1°.015. When sufficiently bleached, is then removed to a solution of carbonate of soda, same strength as before, and left there half an hour; then passed into a solution of sulphuric acid, same strength as before, and allowed to remain there as long as any disengagement of gas is visible; then wash the fibre in a weak solution of oil soap. It is then dried by passing through a wringer and passed over heated copper cylinders to the picker and duster. It is then carded on a Dundee card, and is finished by passing through a 48-inch wool card. The time occupied in the operation of boiling and steeping process to the state ready for carding is six hours.

The expense of converting one ton of flax straw into flax-cotton is as follows:

One ton of flax straw	$10 00
Breaking one ton of straw	2 50
Picking and dusting 1,000 pounds	1 00
Boiling in caustic soda 570 pounds	2 50
Labor in steeping and chemicals	16 00
Washing and drying	2 00
Picking and dusting 354 pounds	50
Dundee carding	50
Carding on wool cards 291 pounds, producing 257 pounds	5 00
Total cost	40 00

Or less than sixteen cents a pound, exclusive of rent, interest, and insurance, which the bleached flax waste will cover. It has been sold to paper-makers at four and a half cents per pound. The shives and other waste are used for fuel under boilers.

Cost of machines and vats.

Breaker	$355 00
Picker	175 00
Duster, or willow	150 00
Picker for white stuff	250 00
Dundee card	750 00
Wool card for finishing	1,100 00
One boiling iron vat	150 00
Six wooden vats	300 00
	3,230 00

The recent advance in the price of chemicals has raised the cost of production.

I adopt the Claussen process, having purchased the right for the use of his patent for the United States, having practically experimented upon it, and fully demonstrated the most favorable results. In 1854 I commenced manufacturing flax cotton at Rocky Hill, New Jersey, and produced a sufficient quantity on a commercial scale to induce a number of gentlemen to form an organized company, with a capital of $200,000; but from the low price of cotton and wool at that time, and the unfavorable state of the money market, and the prostration of the manufacturing interest, and from the prejudices of manufacturers to use a new staple, they became discouraged, and from some of the shareholders not paying their full instalments of shares, the company disposed of their property after having produced about ten tons of flax cotton. Most of it was purchased by Messrs. Lawrence & Stone for their manufactory at Lowell.

I can prove from practical experience that flax and hemp can be converted into a fibre stronger than cotton or wool, and capable of taking better color than either; can be spun and wove on the existing cotton and woollen machinery at a cost below cotton or wool at any time, there being less waste. It will mix and felt with wool, having had it mixed with wool and made into cloth and hats, and I had them worn in my family and found them much more durable than all-wool.

There has been a great deal of prejudice against some portions of Claussen's process totally unfounded and misconceived. For instance, that it was not suitable for making long flax, but rather that *all*, long and short, indiscriminately, was converted into flax cotton: the fact is the reverse. No doubt the flax cotton is the greatest novelty, a new article of commerce, and so becomes the most prominent feature in the various inventions. The long flax, however, through Claussen's process, is produced in better condition than as at present for the manufacturer, and what is indifferent and not sufficiently well grown for long flax is quite suitable for, and is converted into, flax-cotton, also common tow, and such like stuff. By this process the flax, instead of being pulled in a green state, is allowed to ripen the seed, and can be cut with a mowing machine. The farmer by this means saves the great expense of pulling, and has the seed, which alone pays for raising the crop, and by breaking the straw with a hand machine, such as Sanford & Mallory's, he can return to the land nearly one-half the weight as manure. The shives contain silica, and by feeding his cattle the refuse seed and bolls, he also obtains a rich manure. In 1854 I had an agent in Washington exhibiting specimens showing the whole of Claussen's process, from the flax straw to the finished cotton, linen, and woollen fabrics, in a bleached, unbleached, and dyed state.

Yours, respectfully,

H. McFARLANE.

NEW YORK, *September* 4, 1863,
No. 242 West 20th street.

SIR: I find in this morning's paper a notice of the meeting of the board of commissioners appointed by the Commissioner of Agriculture to consider the subject of the use of flax and hemp as a substitute for cotton.

Desiring to lay before the commission some facts in relation to a discovery in the mode of curing flax so as to make it useful as such a substitute, I take the liberty of addressing myself to you, sir, as the chief commissioner.

As long ago as the year 1852, while residing at the Hague, and acting in the capacity of private secretary to our minister at the court of the Netherlands, Hon. George Folsom, I made the acquaintance of a Hollander who claimed to have made a great discovery in the preparation of flax for spinning. It was much talked of at the time, and the Dutch government made a proposition to the inventor to put his new method into practical use. Similar propositions were also made to him by parties in England, France, and Belgium. I read some of the letters which he received from these parties at the time. He declined them all, giving me as a reason for so doing, that he was afraid of being deceived by them, and cheated out of the profits which he believed he would ultimately derive from his discovery. Specimens of his flax were exhibited at the World's Fair in London, in 1852, for which he received a medal, &c., from the commissioners. It was just at the time when Claussen was sounding his trumpet through the public journals about flax-cotton, and the invention of my Holland friend was overshadowed by the umbrageous fame of the since unfortunate chevalier.

I was led, by some interviews I had with the inventor, to write to a friend in Boston on the subject, enclosing samples of the flax, and asking him to consult with Mr. Lawrence (Amos or Samuel, I think the latter,) upon the matter. The result of that correspondence, after receiving Mr. Lawrence's very sanguine opinion, was, that I entered into an agreement with the inventor, and sailed for New York with the identical samples of the flax which had been exhibited at the World's Fair. After a long and stormy passage, which culminated in shipwreck, I reached New York and proceeded at once to Boston, where I learned of the death of Mr. Lawrence. I visited several of the manufacturing towns of New England, and showed my samples to different manufacturers. They were taken by surprise by the appearance of the flax, and seemed incredulous of the statement concerning the short time required to bring the staple into the state in which they saw it, and also of the cheapness with which it could be done. After some fruitless endeavors to interest them in it (they being all cotton spinners) I abandoned the whole thing.

Last summer I was induced, by the interest I saw was taking hold of the public mind in the matter of procuring a substitute for cotton, to write to the inventor on the subject, and I received a letter from him written in London, where he had been residing for several years, practicing as a dentist, and carrying on his experiments with flax, hemp, and India fibres. He sent me some new samples, more perfect than the ones I had before seen. These samples I showed to Hon. Washington Hunt last fall, whom I met at our general convention, and who is interested in a manufactory for the dressing and spinning of flax in Lockport. He acknowledged them to be finer than anything they had as yet been able to produce, and expressed the wish that I would visit Lockport and talk with him further on the subject. It was not convenient for me to do so, however. I afterwards gave the samples to a friend, who showed them to some private individuals, who authorized me to make a proposition to my friend in London to come to this country and demonstrate what he could do. In reply to my letter, he wrote that he could not entertain such a proposition; but requested the gentlemen to send out a competent person, having a practical knowledge of the culture, curing, and spinning of flax, to investigate the merits of his process, and with powers to enter into a contract with him. The parties were not willing to do this, and I have not since made any exertion to interest others; only, at the request of a friend, I have allowed my specimens to be sent to the Hon. Addison H. Laflin, of Herkimer, N. Y., who is largely interested in a new invention for the manufacture of paper from wood.

The specimens that I have are of several different kinds—some being prepared for ordinary flax machinery, and others for spinning on cotton machinery. These latter samples I have received since my interview with Governor Hunt. They closely resemble cotton, both in texture and in the length of the staple, being wholly unlike either the Lockport, Penn Yan, or any other specimens I have ever seen, and entirely different from the Claussen flax-cotton. The time required to bring the raw flax, in the straw, into its cottonized state is one day. The Lockport process takes from three to five days. By our friend's process there is less waste than by the Lockport process, and the expense is no greater.

Since I wrote last to the inventor in London, giving him the answer of the parties here to his proposition, I have received from him a London paper containing an account of a meeting of manufacturers and others, presided over by an English earl, whose name escapes me at this moment, at which a statement written by my friend was read, (relative to the invention,) and a committee appointed to test the merits of the same. Several members of the meeting pledged themselves to furnish the funds necessary for that purpose, and also for the purpose of going into the manufacture of it, if found to be as valuable as it then seemed to them to be. I am sorry I have not the paper here to refer to. I have not yet learned the result of these investigations. I do not believe, however, that the inventor will divulge the secret of his invention; or that he will enter into any contract which will shut him off from bringing the thing out in this country, in case sufficient inducement should be held out to him within a reasonable length of time.

I have been induced to write you upon this subject in the hope that it may lead to an investigation of my friend's discovery, on the part of your commission, and that our country, and not England, may reap the profits of this invention, if it should prove to be as valuable as I have every reason to believe that it is. To promote this object I will do whatever lies in my power, and which may be consistent with my clerical duties and obligations. I will only add that I would be glad to meet here any of the gentlemen of the commission who may be visiting New York, and will endeavor to have the samples referred to in this letter returned into my possession next week.

I have the honor to be, sir, your obedient servant,

E. FOLSOM BAKER,
At Church of the Annunciation, New York.

Hon. J. MOREHEAD, *Pittsburg, Pa.*

FOURTH SUBDIVISION, OR MANUFACTURING STAGE.

A leading object of the appropriation having been to test the practicability of substituting the fibres of flax for cotton, on cotton machinery, and also of mixing them instead of cotton with wool, we have directed our attention particularly to such modes of assimilating these fibres to cotton as would, in our judgment, be likely to accomplish the desired results, and to such modifications of cotton machinery (wool machinery not requiring any changes) as would best adapt it to the production of yarn from such assimilated fibres. We have not deemed it necessary to give much time to the mechanical modes of long-line flax-spinning now in general use in European countries, as the raising of marketable flax for long-line imposes too many burdens on the growers, and is produced at too great a sacrifice of seed to warrant, at present, its extensive cultivation in this country. Both the raising of flax for long-line, and its manufacture by machinery where grown, seem to be better adapted to countries of humid climates, and of comparatively small areas for cultivation, subdivided among a dense population accustomed to cheap manipulating labor. There are very few mills of this kind in the United States, and most of these are using long-line for coarse fabrics, obtained to a considerable extent in the Canadas, whence it is imported free of duty under the reciprocity treaty. A member of this commission recently visited one of these mills at Braintree, Massachusetts, and was shown the various machines and processes for making coarse, long-line yarn and cloth. It is well known that the only mill of this class in our country fully equipped for spinning and weaving fine long-line yarns, (located at Fall River, Massachusetts,) was, after a great outlay of capital and immense exertions to operate at a profit, converted into a cotton mill at a heavy loss, in consequence of an insufficient home supply, the mill being precluded from using foreign stock by a practically interdictive duty.

After the most careful consideration of various modes of growing and treating flax to obtain the best results to the farmer, and an abundant supply to the manufacturer, we are of the opinion that the crop should be planted mainly for the seed, and incidentally for the fibre; that to insure the greatest profit to the grower from both these sources, there should be sown from four to six pecks of seed to the acre; that if the crop is designed for ultimate fibre, *i. e.*, flax-cotton, it should be harvested by machine cutting in the morning after the dew is off, when the seeds are sufficiently in the glaze to be of brown color; thereby securing the greatest supply of oil and the least rigid condition of fibre; that it should be exposed to the sun through the day, cocked towards night, and treated in other respects like grass cut for hay, avoiding as much as possible exposure to rain or dew; that the seed should be threshed in the cheapest and most convenient manner regardless of the tangled condition of the straw; that the latter should, for the effectual removal of the shives, be subjected to the action of approved power brakes, (we give the preference to Mallory & Sandford's twelve-roller kind,) located either on the farms or at convenient points for the neighborhood patronage; that in this form it should be rough-baled and sold to chemical disintegrating works, to be there further divested of dirt and shives by mechanical means, and exposed to high steam in combination with mild or strong alkaline solutions for disintegration, and in this finished form sold as stock for manufacturing into fine linen fabrics on cotton machinery. Flax cotton from such stock will be reliable for uniformity of strength, and be sufficiently white without bleaching prior to its manufacture into cloth.

But if the crop is designed for short stock to be manufactured on modified cotton machinery into coarse linen goods without chemical disintegration, we recommend retting the straw, and that on taking the flax from the brakes it be subjected to the further action of power disintegrating, shortening and cleaning machinery, to be located at convenient centres in flax-growing districts, and there be baled for the market.

We are aware there is an impression that unretted straw cannot be successfully divested of its shives by mechanical means. This impression is probably based upon the imperfect mode hitherto practiced in harvesting the crop. The straw, even if intended to be left in an unretted state, is generally permitted to lie more or less exposed to dew or showers a few days after cutting. This partial wetting and drying appears to have a tendency to crystallize the gluten or cellulose between the filaments and woody portion, which makes it more adhesive and harder to separate; but if the straw is harvested and dried without exposure to moisture, the crystallizing process not being developed, we think the shives will, under the action of properly constructed brakes, readily separate from the fibres. We have seen unretted, tangled, as well as straight straw, quite thoroughly divested of shives after passing twice through a single head of Mallory & Sanford's brake, with the horizontal, rotating and vibrating rolls, placed in sets one above another.

It is estimated that retted straw shrinks in weight about fifteen per cent., while the fibre loses very little of its weight. This is caused by the partial decomposition of the shives and a portion of the gluten or intercellulose; so that if the straw crop is sold in an unretted state a proportional allowance should be made for its extra weight, less the value of the unretted shives for cattle-feeding, which is said to be considerable, as their oleaginous properties make them quite nutritious. A ton of retted straw in good condition produces about 450 pounds of flax, while a ton of unretted produces only about 380 pounds. Good retted straw in ordinary times is worth, in flax districts, say eleven dollars per ton of 2,000 pounds, equal to 2½ cents per pound for the flax. This gives a proportional value of nine dollars per ton for unretted straw, equal to 2½ cents per pound for each kind of flax. The cost of labor, supplies, power, supervision and use of machinery and buildings for converting the straw into flax, is also about 2½ cents per pound; making the entire cost of the flax at the brake machines five cents per pound. This, if sold at seven cents, in ordinary times would give a liberal profit to the proprietors of such machines; but flax in this form will, of course, be subject to a diminution in weight when further divested of its glutinous substance, straggling shives and seed-ends, by the action of preliminary machinery for converting it into filaments and fibres of the requisite fineness and length to be spun into coarse yarn, which with the loss of short fibre in manufacturing, and tare of the bags and ropes, will be fully equal to twenty per cent. of its weight, thereby adding two cents per pound to the first cost; to which must also be added 1½ cent per pound for railroad and mill transportation and other expenses, making the entire cost of the stock in ordinary times at the consuming mills about 10½ cents per pound.

The same stock sold from the brake machines at seven cents per pound to the proprietors of mechanical and chemical disintegrating works, to be "cottonized" for yarn suitable to weave into print-cloths or shirtings, would be subject to a loss in the respective processes of about forty-five per cent. of its weight, thereby adding about 6½ cents per pound to the cost; to which must also be added 1½ cent per pound for railroad and works transportation and other expenses, making the cost at the works thus far fifteen cents per pound. The cost of cottonizing, including the preliminary mechanical operations at the works, will be about four cents per pound net weight, making the entire cost at the works in ordinary times, exclusive of any charge for profit, about nineteen cents per pound.

If any of the manufacturing trade should be apprehensive under this estimate that the difference in value between flax-cotton and cotton in ordinary times would discourage the use of the former, no matter how perfect the stock may be prepared, we would remind such, that if linen goods continue to maintain their supremacy in the market, print-cloths or shirtings made of flax-cotton would probably command a price that would leave a larger difference in favor of the manufacturer than the difference of cost between the two kinds of stock.

In the early stage of the effort to cottonize, there was a general belief among experts (including the Chevalier Claussen, and also Mr. Sands Olcott, of Pennsylvania, the pioneer in this country of flax-cotton, and who patented a flax-straw cutting machine in 1840) that it would be necessary to cut the straw into lengths comparing favorably with the length of cotton; but a critical and microscopic analysis of the constituent parts of the fibrous covering of the straw revealed the fact that the filaments of which it was composed were subdivided into cells or individual tubular fibres, of nearly uniform fineness, and somewhat variable lengths, cemented longitudinally by intercellulose, or gluten, which, while it would to a great extent resist the disintegrating power of machinery, could not maintain its cohesion against the liberating and dissolving power of tepid-water soaking, followed by long-continued boiling in mild alkaline solutions and subsequent exposure for a short time to high steam; or by boiling at a temperature of 280° Fahrenheit, with soda-ash or caustic solution, without any preliminary processes.

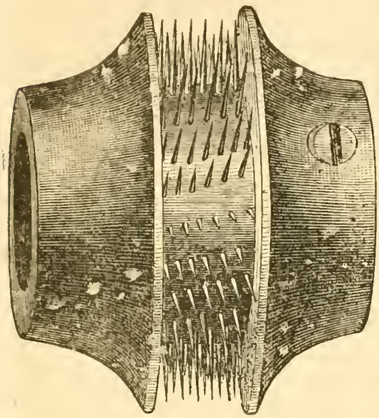
It then became a question to what degree of fineness and maximum and minimum lengths of fibre can flax be safely reduced by mechanical means only; and in what way can the product of such means be successfully spun into coarse yarn on cotton machinery? These questions have been met by the owners of a number of cotton mills in various parts of the country that have heretofore been employed in manufacturing the lower and coarse grades of cotton goods. Some of these mills, especially those that are located in flax-growing regions, began with tangled straw, and carried it successfully through draught-roller brakes, dusters, and wool and cotton pickers, thereby preparing their own stock; while others situated remotely from such districts have preferred purchasing their supply in bales, of parties residing there who have made the preparation of such stock a special business. The latter mode of obtaining it, besides being in accordance with the views of the commission, seems best adapted to encourage the alteration of this class of cotton mills into flax mills; and also for supplying flax disintegrating works with material to be transformed into flax-cotton for use by a higher class of cotton mills in the production of fine linen goods.

In determining the question of length of stock by means of preparatory machinery, it has been found impracticable to obtain, by any combination of machines yet employed, maximum lengths of fibre less than about three inches, without reducing the minimum lengths shorter than the fibres of cotton; and hence it became necessary to depend for the further reduction of the maximum lengths upon modifications of the machinery at the mills as arranged for cotton. To this branch of the subject the commission has given much attention, but as a report of our investigations is expected in time for distribution soon after the closing of the present Congress, we have reluctantly suspended our labors without obtaining as full results as the magnitude of the inquiry calls for, or as the light already obtained promises. We did not think it desirable at the commencement of our labors, while the manufacturers of both flax and cotton as well as ourselves were in a comparatively undeveloped state, to use the appropriation in crude experiments, or expenditures that might result only in loss. We preferred, as far as possible, to avail ourselves of the incipient efforts of those whom patriotism or hope of securing monopolies had stimulated to attempt the solution of the cottonizing problem. To this end, two of our commission visited in the past autumn nearly all the points in the western and eastern portion of the country, and in the Canadas, where particular attention had been given either to the growth or manufacture of flax. From these visitations and conferences, to which have since been added our own experiments, we have reached conclusions both in regard to the most promising modes of using flax cotton prepared exclusively by mechanical means for the manufacture of coarse goods, and by combined mechanical and chemical means for the manufacture of fine goods on cotton machinery, which we will now proceed to delineate, premising that if the unexpended balance of the appropriation is devoted to further discoveries by this or a new commission, the results might be given in a supplementary report at the first session of the next Congress. We think this course preferable to a lapse by "non-user" of the unexpended part, and much more likely to result in a larger contribution of valuable knowledge to the public upon this highly national investigation than a distribution of it in small sums to the many enterprising parties in different sections of the country who have so courteously responded to our call for information, and who have so generously sent specimens of their various productions for the museum of the Department.

Very good short flax stock is prepared from tangled straw for coarse yarn mills by Randall's, Clemens's, Smith's, and several other series of machines, but the cleanest and finest short stock that has come under our notice is that obtained from the Davies machine, made at Dayton, Ohio. This machine is composed of an iron or wooden frame, having a series of five open aprons, fluted feed rolls that rotate in iron shells, and wooden cylinders which have diameters of a foot each, and revolve about six hundred times per minute. The surface of the cylinders is perforated for the reception of square spring-tempered No. 12 wires, square at the ends, and inserted in the apertures in spiral rows converging from the heads towards the centres, and projecting from the surface about half an inch. The flax either in the straw (if retted) or in the form of crude tow is fed on a level apron through the feed rolls to the first cylinders, from which it is thrown on an inclined apron to be carried to the second set of feed rolls and the second cylinder, and then successively over the other inclined aprons, and through the other feed rolls, and over the other cylinders, until delivered at the end of the machine in bulk, when it is collected and baled in the same manner as cotton for the market.

In this form it is carried into cotton mills and presented first to the lapper, no preliminary operations being required, as it is to a great extent free from shives, dirt, or other extraneous matter. But as this stock, notwithstanding its comparative cleanliness and the ease with which it is made into laps, is too coarse and uneven for the carding process, without modifying the lapper beaters to adapt them for shortening the long filaments and fibres and making all the fibres finer, we added to each of the beaters another set of arms, and attached at the ends in lieu of knives wooden lags two and a half inches wide. The fronts of these were covered with strips of leather two inches wide, into which were inserted curved and pointed teeth of No. 14 wire, with their points on the same periphery as the knives on the other arms, and which, when in motion, rotate within about one-eighth of an inch of the periphery of the feed rolls. The speed of the beaters, arranged in this manner, should be about 2,000 revolutions per minute. When the beaters are so equipped, they not only distribute the grist evenly on the wire cylinders and lap rollers, but if the laps are doubled and carried through the lapper a second time, they disintegrate the filaments so thoroughly as to largely increase their number, and at the same time materially shorten those that were of too great length for the subsequent operations in the mill, without visibly shortening those that were sufficiently short in the bale. The laps so prepared are next carried to the carding machines, the carding power of which, in a great number of American mills, is in a main cylinder, doffer, and top-flats, all covered with fine chisel-pointed wire clothing, which, although well adapted for carding cotton, is considered insufficient for carding flax fibre. The insufficiency is caused by the fact that flax fibres have less elasticity and greater specific gravity than cotton, and are withal straight rather than curled like the latter, and hence do not rest easily upon the surface of the teeth, but are inclined to imbed themselves among the teeth, which makes it desirable to substitute needle-pointed clothing for chisel-pointed on the main cylinders and doffers, and also to substitute working, stripping, and fancy cylinders for the top-flats, which should likewise be covered (except the fancy) with needle-pointed clothing. This form of the teeth permits the workers and strippers, aided by the long and flexible teeth of the fancy, to act freely on the main cylinder, keeping the stock upon its surface and ready for delivery to the doffer. If the chisel-pointed clothing, however, of the main cylinders and doffers is in good condition, and the stock is well prepared, it can be used in connexion with the working, stripping, and fancy cylinders, but the two former kinds must have needle-pointed clothing. The latter is always covered with long, fine, and flexible clothing. The surface velocity of the fancy cylinder should be about twenty-five feet faster than the surface velocity of the main cylinder; the workers and strippers should run at the usual speeds; and one worker and one stripper are sufficient for one card. The cards should have screens of perforated sheet zinc under the main cylinders, and the licker-in cylinders (if there are any) about three-eighths of an inch from their surfaces, otherwise too much of the stock will be thrown off in the form of waste by the centrifugal forces developed in the rotation of these cylinders. The feed rolls should be heavily weighted, and their speed be increased about twenty-five per cent. The stock may be carded once or twice. We think once is sufficient. In either case, the fleece should first be delivered into a railway trough; and, if intended for a second carding, the product or sliver should be collected from calender rolls without being lengthened, and made into laps for the finishing cards, and from their railway should be drawn by means of a draught railhead from two and a half to three inches. This head should have three under rolls one and one-quarter inch in diameter placed about three and a half inches from centre to centre of the back and front rolls. The back and front rolls should be fluted or corrugated; the back top roll should also be fluted or corrugated, while the front top roll should be covered either with vulcanized rubber or gutta-percha, (the latter can be had at 153 Broadway, New York, of the Gutta-Percha Manufacturing Company,) and both rolls should be one and one-half inch in diameter. The middle under roll should be encircled by a spring gill, with collars at either end, rising an eighth of an inch above the points of the gill needles; the back top roll should be slightly weighted, and the front top heavily. The entire draught should be between the gill roll and the front roll. The shivers from this head should be collected in cans, and passed through either one or two heads of a drawing frame, with gills on the middle under rolls, and with top rolls fitted like the top rolls of the railhead, doubling the slivers at the draughts, which should not exceed one inch into four. From the drawing frame the stock should be made into condensed and untwisted roving on a Taunton speeder, arranged with gills on the middle roll, and with top rolls similar to the rail and drawing frame heads. The spinning frames may have either rings or flyers for twisting. As good yarn can be had from one as the other, it is indispensable that the frames should have large rings or flyers designed for coarse spinning only, as the kind of stock we are treating of cannot at present be made into finer yarn than numbers ranging from six to ten, (cotton gauge,) and it is wholly impracticable to think of spinning it on frames designed for yarn ranging between twenty and thirty-five skeins to the pound. The frames for this stock must be arranged with a draught not exceeding one inch into six inches, and should be fitted with spring gills on the middle rolls for each spindle, and with uncovered smooth iron back top rolls one and a half inch in diameter without weights. The front rolls should compare with the front rolls in the preceding operations. These spinning gills consist of twenty rows of tapering needles seven-sixteenths of an inch long and one thirty-second of an inch in diameter at the base, six in a row, one-sixteenth of an inch apart, and inserted obliquely through apertures in a brass hollow cylinder one and seven-sixteenths inch in exterior diameter, and projecting through the surface four-sixteenths of an inch, making the entire diameter of the periphery of the points one and fifteen-sixteenths inch, with brass collars at their ends one and six-sixteenths inch exterior, and fourteen-sixteenths of an inch interior diameter, and flanches to the same, one and nine-sixteenths inch in diameter, fitted with steady pins and set screws for attaching the entire gill to the middle roll. The gills cost three dollars each; the needles can be purchased at $2 50 per thousand. These gills, as well as the larger kind for railheads, drawing frames, and speeders, are made by Messrs. Lanphear, Levalley & Co., at Phenix Village, Rhode Island.

No. 1.



The yarn spun from this stock makes excellent twine, and can be woven into crash, osnaburgs, burlaps, and sugar cloths; and, when doubled for warp, it makes very superior grain bags.

Foremost among the cotton mills that have been altered substantially in the way we have described to make some of the above fabrics, are the Hope and Penn mills, of Pittsburg, Pennsylvania, owned by James H. Childs, esq., and others. The best flax grain bags in the country are made at these mills, and at the same mills are also made very superior stock for battings and for the use of upholsterers. Too much credit cannot be given to the proprietors of these mills for their patriotic and successful efforts to disenthral the north from entire dependence on cotton for these manufactures, and for the encouragement they have given to the owners of other mills to follow their praiseworthy example. The mills at Lockport, New York, owned by ex-Governor Hunt and others, are also producing excellent brown and bleached stock for upholstery, waddings, and coarse yarns, as well as twine of a very high grade. The Medina Flax Company's Works, at Medina, New York, are likewise producing goods of a similar character of superior quality. To this list must be added the mills of Governor Smith and others, in Warwick, Rhode Island, that are making grain bags of excellent quality, besides carpet warps, twine, and rugs. There are many other successful pioneers in this branch of flax manufacture obtaining most encouraging results, so that this department of substituting flax for cotton on cotton machinery may be considered no longer problematical, but a success.

Having thus portrayed what we conceive to be the best mechanical mode of disintegrating, shortening, and otherwise preparing flax for coarse yarn stock, and the best mode of carrying such stock through the various processes into yarn on cotton machinery for the manufacture of coarse linen goods, we will next present the results of our efforts, and the efforts of others as observed by us, to cottonize flax by combined mechanical and chemical means to the requisite fineness, evenness, and strength for being manufactured into print cloths, shirtings, or sheetings, on cotton machinery, either by an admixture of from fifty to seventy-five per cent. of the fibres with cotton, or by their exclusive use as flax-cotton. It is wholly impracticable to disintegrate flax into its ultimate fibre or cells without the intervention of a solvent for the intercellulose or gluten, as previously indicated. And we think it is equally impracticable to rely upon mere mechanical forces to separate the fibres after such disintegration, if they are allowed to become entirely dry before the application of such means. The undecomposed gluten is so unyielding in its nature that, if not partially wet, the separation will inevitably be attended with so much breakage of the fibres as to materially injure the stock. But if they are slightly moist, they readily slide apart into ultimate lengths through the agency of properly constructed pickers that will blow them into a dry atmosphere. It is also just as important, as we have shown, that flax-cotton obtained through chemical disintegration should be prepared exclusively from unretted stock. Some persons say that the filaments of unretted stock are more brittle than those from retted stock, and therefore more liable to abrasion in the preliminary mechanical operations of cottonizing. This, if true, would be incomparably less injurious to the fibre than over-retting, a fault of every-day occurrence in retted straw. Unretted stock will endure soaking, boiling, and steaming without injury, while retted, if over-retted, will be easily decomposed; and if it is not over-retted, and is not injured in passing through these operations, the cost of bleaching it, either before or after it is manufactured, will be much greater (besides being attended with more danger of injury) than the cost of bleaching unretted stock. Hence we recommend the discontinuance of further experiments on retted stock for flax-cotton intended for the manufacture of goods, for bleaching or printing, or goods that require the element of durability. We also recommend the postponement of bleaching unretted flax-cotton until it is manufactured into fabrics.

Specimens of bleached and unbleached flax-cotton, hemp-cotton, asclepias cotton, and China-grass cotton, have been sent by divers persons to the commission, some of them very nicely disintegrated; but three only of all the contributors who have responded to our call have accompanied their specimens with any explanation of the mode of cottonizing, viz: Mr. H. McFarlane, of Rocky Hill, New Jersey, who uses the Claussen process; Mr. Hugh Burgess, of Royer's Ford, Pennsylvania, and Messrs. Fuller & Upham, of Claremont, New Hampshire. Mr. Burgess has not experimented so extensively as the latter gentlemen, but the specimens of both are well disintegrated and separated, or cottonized. The contributions of Mr. Burgess were cottonized from flax of unretted, tangled straw dressed on Mallory & Sanford's 12-roller brake, in the presence of two of the commission, and also from flax of retted straw dressed and cleaned in his neighborhood. His process for short stock consists, after further cleaning by a suitable mechanical apparatus, in submitting it to the action of soda ash (or its equivalent in potash) in caustic solution, for an hour, in an iron boiler, (Keen's patent boiler preferred,) at a temperature of about 280° Fahrenheit, the boiler to be heated in any convenient manner, and the mass of flax to be kept under the solution while boiling. The quantity of alkali used is from one-quarter to three-quarters of a pound of dry soda ash to one pound of flax, according to the condition of the latter. After boiling, the mass is blown through the manhole under pressure into a tank, and then the solution is drained off, evaporated, and burned for repeated use. About eighty per cent. of the alkali is saved. The stock, after draining, is washed with hot water until all traces of the alkali disappear. It is then bleached by the use of bleaching liquid percolated through the mass, after which it is washed, squeezed, and dried. If long stock is used, it is formed into hanks and put into wire cylinders, which are then placed in the boiler, and, when boiled sufficiently in the solution, the latter is gradually drawn through an opening in the bottom of the boiler, and evaporated and burned as before. The hanks in the cylinders, on being taken from the boiler, are washed, bleached, and dried. After drying, both kinds of stock are to be separated by machinery. He has not yet constructed machinery (except models) for reducing the disintegrated fibres or cells to uniformity of length, or for separating them longitudinally, but is experimenting in that direction, and expects soon to accomplish the desired result. His process and product were patented in January, 1864.

The contributions of Messrs. Fuller & Upham were also cottonized from unretted, tangled straw (which they much prefer to retted,) dressed by one passage through Mallory & Sanford's brake. This brake, Fuller & Upham say, removes about ninety per cent. of the shives. These gentlemen, instead of depending on flax-disintegrating, shortening, and cleaning machinery located in flax-growing districts, take the stock from the brake and pass it through a shive-cleaning machine of their own invention, which consists of a series of card cylinders placed in a frame over each other. The stock is fed upon an apron at the bottom, and is carried from the first cylinder to the others successively to the top, where it is delivered from the machine. These cylinders act upon each other as workers and strippers. They are in a screen of zinc placed within three-sixteenths of an inch of the card teeth, having apertures for the discharge of the remaining shives and dirt by the centrifugal force of the cylinders. The latter are all enclosed in a case reaching below the cylinders that receives the waste, which is removed at the bottom. The stock is then placed in a vat with water kept at 90° Fahrenheit for twenty-four hours. The water is then drawn through a grate bottom, and the vat is again filled with water containing one barrel of soap to one thousand pounds of dry fibre, and boiled twelve hours by steam at 212° Fahrenheit, when the water is again drawn as before, and pure water is percolated through the mass the remaining twelve hours. There are two of these vats, that the soaking may be done one day, and the boiling and washing the next, in the same vat, without removing the flax until it is ready for the steaming process. The stock is next transferred in rail cars from the vat to a horizontal iron cylinder having an adjustable head and a perforated movable piston operated by a screw and gears. It also has a large escape-valve at the rear head near the top, and is supplied with steam from a boiler through pipes. It likewise has a pipe to draw off the water and extractive matter. The flax being placed in the cylinder, and the head screwed on, steam at ninety pounds pressure is let on for twenty minutes, when the perforated piston is run towards the head of the boiler, squeezing the stock into a compact "cheese." The water-pipe is then opened, and the water with the glutinous matter in solution, that has been pressed through the perforated piston, is blown off. The pipe is then closed, the piston is drawn back, and the escape-valve opened, which permits the steam to escape through the apertures in the piston, and out of the cylinder. Instantly this valve is opened, the steam in the fibres expands, overcoming the cohesion of the softened intercellulose, and filling the cylinder with disintegrated ultimate fibre or cells of the flax. The explosion is recommended to be only sufficiently powerful to disrupt the fibres and leave them measurably in parallel lines; for if they are entirely separated, many of them would be broken, and become, like immature cotton, too short to be profitably spun into yarn. The fibre is then taken from the cylinder, and, when partially cooled, is passed through a compound wringer, consisting of a cylinder eighteen inches in diameter and twelve inches in length, having several rubber rolls that revolve, with the flax passing between them and the cylinder. In connexion with the wringer there is a series of differently speeded drawing rolls that passes the stock between them, drawing it into a thin sheet to facilitate drying and to equalize the lengths of the filaments and fibres. The stock is then put into a box with a grate bottom, under which is a coil of heated steam-pipes. A rotary fan forces the air into the bottom under the pipes, and through the flax, thereby rapidly removing the moisture. When it is sufficiently dried by this arrangement to allow the fibres to slide apart without sticking to each other, it is passed through an opener which consists of a horizontal cylinder covered with needle-pointed card clothing, with workers covered in the same manner, and placed under the main cylinder, which makes about one thousand and four hundred revolutions a minute, and throws the stock into an adjoining room. The flax is then carried through ordinary gambril cards, and taken off by a railhead with large and strong-corrugated iron rolls, held together by rubber springs, to pull apart any remaining long filaments. It is then passed through a lapper and a fine gambril card, and baled for the market. The mode of preparing this stock, the steaming cylinder, and a considerable portion of the machinery used, are patented, and the entire apparatus is built by the patentees and their partner, Mr. Rice, at Claremont. The price of the apparatus (at present cost of labor and materials) for one thousand pounds of fibre per day is about fifteen thousand dollars. Parties who may desire to embark in the manufacture of linen goods from stock prepared under the patents of these gentlemen would probably do better, in the beginning, to buy their stock from the owners of disintegrating works.

There is a difference of opinion among those who have made microscopic examinations of the texture of flax fibres as to their composition. While all agree that they are cellular, and have transverse lines at variable distances, some think the lines are pores through which the interior moisture is evaporated in drying, and that the cellulose structure differs sufficiently from the structure of the intercellulose to allow the decomposition of the latter without injury to the former; others that the transverse lines indicate the growth of the cells, like cane joints; and that the composition of the cells is so nearly akin to the composition of the intercellulose, that both cannot be more than partially decomposed without so materially impairing the strength of the former at the marks, and intermediately, as to render them too weak for manufacturing. It is evident to us that the union of the cellular and intercellular matter is so thorough that while the former may be relieved from the tenacious hold of the latter, there should always be left enough of the intercellulose adhering to the cellulose after disintegration to keep the cells together until they are separated, if in a moist state, by sliding them apart through the intervention of pulling rollers; or if in a dry state, by the application of a picker to break them apart. The probability is that if the decomposition of the intercellulose is complete, or nearly so, the fibre would be much injured if not destroyed. Hence the absolute necessity, in cottonizing, of using unretted flax, which always has fibre reliable for strength in any high steam process of disintegration if properly prepared.

The opinion of the commission has often been asked upon the relative durability of goods made of long-line flax, or flax-cotton, and the relative strength of goods made of the latter to goods made of cotton. From such examination as we have been able to give the inquiry, we think that goods made from sound, long-line stock, when new, will be stronger than those made of well-prepared flax-cotton, in consequence of the excess of glutinous or intercellular matter in long-line yarns; but that as flax-cotton goods will be softer and less liable to crack when new than goods of long-line, while each ultimate fibre will be as strong, there is every reason to believe that they will be more durable, besides having the advantage of flowing more gracefully when made into garments; and as the fibres of flax-cotton are much stronger than the fibres of cotton, and much more soft and silky, fabrics made from them must not only be stronger when new, but more reliable for service than cotton goods.

In addition to the probable greater durability of flax-cotton fabrics over those made of cotton, is the important fact of their superior ability to receive and hold colors. This is supposed to be caused by the difference in the shape of the fibre of the two plants. We have remarked that both are tubular; but the wall of a flax fibre being thick, its tubular form is permanently preserved, while the wall of cotton fibre being thin, its tubular form in drying becomes flat spirally, like a twisted ribbon; consequently it presents only a flattened surface to receive and retain color; and hence it is always less brilliant, even when first dyed, than a flax fibre, the tube of which excludes the air, and by its transparency reflects the color strongly, while its closed condition shields the color from the fading influence of the atmosphere.

The flax-cotton of Messrs. Fuller & Upham has been spun on cotton machinery into about No. 24, (cotton gauge,) and also woven in the form of weft into print-cloth. To spin it successfully it will be necessary to alter the lapper and cards in the manner indicated for coarse yarns, and to reduce the number and draught of the drawing heads. One head with a draught of one inch into four inches will probably answer between the rail head and speeders. The middle top rolls of the rail and drawing heads and speeders must be relieved of a portion of their weights. The middle top rolls of the spinning frames must be wholly relieved of their weights, which can be done by substituting single saddles from the front top to the back top rolls for the double saddles generally used, unless the back top rolls are of smooth iron about one and a half inch in diameter, in which case the front rolls may be weighted with a hook and lever weights, and the back rolls be left without weights.

The preparation of flax-cotton is not yet sufficiently developed to enable us to predict decidedly its ultimate success. If more time be given this commission, or a new one for further investigation, greater progress will undoubtedly be made in the present year than has been accomplished during the entire period that has been given to the subject. The commission have specimens of unretted flax-cotton recently made by Messrs. Fuller & Upham, and also specimens of yarn made from this stock, and specimens in combination with cotton to the extent of twenty-five to fifty per cent. of the latter, together with the specimens of print-cloth previously referred to, in which the filling is of flax-cotton, all giving promise of early success.

Under every aspect of the subject, we believe it will be safe to alter one or more fine cotton mills (that are now idle) to give this stock a trial if the same can be purchased at encouraging prices; at first mixed with thirty-three per cent. of cotton, and if successful, to gradually reduce the percentage of cotton until by continued success they may be enabled to withdraw entirely the admixture and thereby demonstrate to the country the practicability of spinning fine flax-cotton yarn on cotton machinery.

The encouraging reports from those who have used machine-broken and disintegrated flax-cotton as a substitute for an admixture of cotton in coarse woollen goods, relieve the commission from the necessity of elaborating this branch of the subject. As an admixture in fine woollen goods in the form of chemically disintegrated fibre, there are at present no satisfactory results. The failure to obtain such results in this direction is probably owing more to the want of a supply of good material and to the general unwillingness of manufacturers of fine woollens to mix even cotton with wool, than to any intrinsic want of adaptability of flax-cotton for admixture. On the contrary, the peculiar affinity of flax for c lor, (it being equal to wool in this respect,) and its indisposition to excessive fulling, would seem to make it a much more desirable admixture for fine colored woollen goods than cotton. And it is not unreasonable to expect that when there is a sufficiency of supply of well disintegrated and separated refined flax-cotton, that it will be extensively sold for this purpose.

PECULIARITIES OF FIBRES.

When we examine minutely the construction of the several materials which are so useful in the arts as textile products, we shall be astonished to find that there is a great diversity in their characters, and we are admonished carefully to examine and consider these peculiarities, lest we may be induced to recommend certain articles for applications in the arts for which they are not by nature adapted.

All fibrous substances are composed either of cells or of cell bundles which constitute filaments and fibrils. There are three several classes of cells that may be usefully applied in the preparation of textile fabrics: first, the *endogenous* cells, and the filaments formed by their union; second, the *exogenous* or the true bast cells, which also combine together in nature to form fibrils and filaments; thirdly, the *capsular* cells, which, whether simple or branched, are still simple cells, each being naturally isolated from its fellows, and generally found as hairs, more or less intimately connected with the seeds of the plants which furnish them. Prominent among these is that wonderfully useful and admirable fibre known as cotton-wool, for an analysis of which the reader is referred to articles in the agricultural portion of the United States Patent Office reports for the years 1852 and 1853, prepared by Dr. George C. Schæffer, and in which the writer has given the results of his patient and extended microscopic investigations of these fibres. In this class we also find a large number of what are called vegetable silks that are not at all equally well adapted to economic application in the arts, but which are constantly thrust forward as presenting claims for usefulness, that are at once dissipated by a knowledge of their intimate structure. Though of good and even length, and though soft and silky in their appearance, these cells, which sometimes have an incrusting matter, are too even and smooth upon their surfaces to be possessed of good spinning properties Of this class are the silk weed, thistle down, cotton-wood down, and the epilobium.

Endogenous plants are so called from the manner of their growth. Instead of depositing annually concentric layers of woody matter, like our common timber trees, these plants are inside-growers, and the new cells are interposited among those previously formed, so that a cross section of the trunk presents a multitude of dots, but no regular concentric lines and circles like common wood. These are the ends of the filaments or cell bundles, among which all new formations have to be introduced instead of being laid on outside as with the other class of vegetation. On this account the wood of such trees may eventually become very hard, and the cells will be much compressed; but these filaments are not in so good a condition for textile purposes as the newly formed cell bundles found in the foliacious expansions, and in the leaf stalks of these plants, which parts, indeed, are the fertile sources of supply of this class of fibre. As a general rule, these bundles of cells, being often of great length and strength, are especially adapted to the preparation of ropes and cordage, or other coarse fabrics, but, if properly subdivided, some of them also furnish material for the most exquisitely fine tissues.

When we recollect that all the grasses belong to this great class of endogens we need not be surprised to learn that these strong fibres may be used without first being twisted into threads. All are familiar with the East India matting as a summer carpet for our floors; some have seen our native Indians weave strong mats with the rushes of the northern lakes, and the use of straw; and the strips of palmetto leaves in the manufacture of hats are familiar to every one; none of these are twisted. But few have observed that some very beautiful tissues made in the East Indies are composed of filaments that were separated from the plants just as they present themselves to us, and that these threads have never been twisted. In some cases, as is very apparent in the coarser tissue of the matting, the ends of the filaments have been tied together deftly so as to make a continuous woof for the weaver; in others, the ends have been brought together and agglutinated by using some adhesive substance that unites them into a continuous thread. The celebrated piña is of this character, and is composed of the fibres of the leaves of the wild pineapple, which is a native of our continent, and to be mentioned on another page.

The valuable fibres of all this class of plants are associated with other cells, particularly the pith cells interspersed between them, which must be separated and removed. This process in the hands of the native workmen is often a very simple matter, and is effected by beating, scraping, and washing, but it is slow and tedious, and as these are nitrogenous matters intimately associated with the fibres, a degree of fermentation may easily be set up to assist in the disintegration. In a hot climate it is necessary to guard this process very carefully to prevent the destruction of the valuable fibre.

In the other class of plants we find quite a different arrangement of the long fibres. In the *exogens*, or outside growers, the firm woody matter, which is composed of short and stiffer or firmer cells, is formed by the deposit of concentric layers which are successively placed upon the outside of those already formed. The bark of these plants, on the contrary, is composed of concentric layers also, but the last formed is deposited within its predecessors. Here we find the true bast cells, which are arranged in filaments that unite to form flattened ribbons of great strength, and, in many cases, of considerable length. They are very pliant, having very little ligneous matter in their composition, and they form the most valuable vegetable fibres of northern temperate regions. Many of the most remarkable fibres of this class, however, are of tropical origin.

The most valuable plants of this class, and those from which these bast fibres are most readily separated, are the annuals, because in them the woody matter is easily disposed of, and is thrown off from the fibre instead of our being obliged, as in the case of large trees, to peel the bark off from the woody matter. Flax and hemp are familiar illustrations of this, and their great value consists in the length, strength, and beauty of their fibres, which are associated with a very imperfectly developed woody tissue that is easily separated from them. There are many other plants, however, which have herbaceous stems that are as easily managed, and these will be mentioned in their appropriate place.

The ultimate cells of this class of fibres are found to vary in their lengths in different plants, and probably in different parts of the same plant; they are collected in bundles which are intimately connected with each other by intercellular matter, and by pith cells; similar foreign matters are associated with these fibrils and filaments, uniting them to one another, and this fact is one of the difficulties that attends their preparation. The ultimate cells are stated to be one twenty-five hundredths of an inch in diameter, and their length is variable. They have transverse markings, which are supposed to be pores, and these are somewhat spiral in their arrangement; still, the cells, like the fibrils, are nearly straight, and tapering towards the ends. Though often somewhat compressed and angular, they are entirely different from the cell of cotton, which, though originally cylindrical, with thin walls, on desiccation, becomes flattened irregularly. This gives it the character of a spirally twisted ribbon. Some of the cells are said to resemble a screw with several twists, and this form explains the remarkable spinning properties of this fibre.*

Dr. Ure very clearly sets forth the differences in the structure of textile fibres of cotton, silk, wool, flax, and hemp, and showed that, while the first three consisted of definite and entire filaments, not separable without decomposition, the latter were compound, and that they were further divisible after treatment with

*For very clear views upon the constitution of fibres, the reader is referred to Dr. Ure's Philosophy of Manufactures, p. 81 and seq.

alkaline solutions. He brought the microscope to his aid in this investigation, and was, perhaps, the first who demonstrated the structure of these substances satisfactorily, though he refers to the labors of others. He procured a fine instrument in Paris in 1833, made by Oberhauser, with which he made his examinations of flax and cotton and wool fibres, which he illustrated with engravings of the microscopic views; some of these have been reproduced as appropriate to this report, and giving very correct representations of the objects.

From what has been shown with regard to the peculiarities of the constitution and intimate structure of different fibres, as revealed by the microscope, it will be manifest that, how closely soever we may seem to have made the fibres of flax resemble those of cotton, there is still a radical difference between them; that, though these substances appear to be similar, they are structurally different. While the cell of a cotton fibre was originally a tubular sac when filled with moisture, upon desiccation, in the process of ripening, it becomes a spirally flattened tube with a certain amount of twist. It has a tendency, from its form, to unite with its fellows, and, when so combined and subjected to the moderate draught of the spinning machinery, it is constantly inclined to couple itself to them in unison, or in accord with the processes to which it is subjected. On the other hand, when we separate the long filament of flax, by any means in our power, into its ultimate, or nearly into its ultimate fibres, or into its original cells, we find these to be straight, without twist, or any means of making them adhere to one another. Moreover, the very walls of these cells, though similar in their ultimate elements, both being nearly pure cellulose, are very differently constituted. While the cell walls of a cotton fibre are of nearly uniform thickness, and, indeed, are quite thin, those of a cell of flax are of considerable thickness, and are formed by concentric layers deposited within the original sac. The result is, that while the cavity of the cell of cotton is relatively large, allowing it to flatten in drying, that of the flax is small, and the cell retains its plumpness and rigidity, and is only modified from its original round form by pressure against its fellows, which makes it somewhat angular and irregular on its edges. This thickening of the walls makes this fibre more rigid and less pliable, as well as more heavy, and this also accounts for the greater specific gravity and the higher conducting power of flax than of cotton. The latter property, so characteristic of flaxen tissues, will ever prove an objection to this material for wearing apparel with some delicately constituted persons, while, on the other hand, the coolness and cleanliness of these tissues, which are proverbial, commend them especially to others. The greater specific gravity of flax should be taken into the account in all calculations respecting its manufacture, to avoid errors in estimates of the cost of the materials.

Dr. Ure has bestowed great care in ascertaining the specific gravity of these substances, and the results of his researches are somewhat surprising. His process is very philosophical and simple, so that his data are probably very reliable, in view of the excellent precautions he has adopted to obviate the errors that would arise from the presence of air. After using great care, and proving his results by trial and corrections, he gives the following figures: Wool, 1.26; cotton, 1.47 to 1.50; linen, 1.50; silk, 1.30; mummy cloth, 1.50. Remarking upon these weights, he says: "As a bale of linen goods is heavier than a bale of cotton goods of the same size, it might be supposed that flax is a denser substance than cotton; but it should be considered that cotton is more elastic, and, therefore, less compact under similar pressure. It is only by weighing each matter, under immersion in a liquid, that its true density can be learned." He considers the density of cotton and linen the same, and suggests that silk and wool may also be equal, and that the vegetable fibres have equal density, and thinks that the timber fibres will be proved to have a density similar to that of flax; for he suggests that the porosity of wood causes a fallacious estimate to be made of the density of its substance.

The great impetus which has of late years been given to attempts to reduce flax to a condition similar to cotton, and the extended notoriety of the suggestions to cottonize flax, has induced many persons to think that this is a new idea, one of the characteristic events of the wonderful era of progress and invention in which we live. That the idea of cottonizing flax is not new, but that is has long occupied the human mind, will appear by referring to the history of the subject, as has been done by the very learned and intelligent jury of the great international exhibition of Great Britain, who give the following account, from which it will appear that nearly a century and a quarter ago it was proposed to convert flax into cotton by boiling in alkaline solutions. From whatever causes, all these various processes appear to have failed in the objects they attempted to subserve.

The statements with regard to the splitting and bursting of the ultimate cells, as claimed by Claussen, are not verified by microscopic investigations of the specimens presented to us.

The subjoined quotation is from the report of the jury at the international exhibition of Great Britain in 1851. An extract from the report of a later jury will also be introduced to show our progress in the arts during the intervening decade :

"Among the continental nations of Europe the northern have long been celebrated for the production of flax and its manufactures, Flanders being especially distinguished for the beauty of its fine goods, and Russia and Germany for the strength and durability of their heavy and other linens.

"It is a remarkable fact that so long as hand-spinning was the only known way of producing yarn, Great Britain and Ireland were not much noted for their manufacture of linens. The wonderful change, however, wrought by the invention of the "spinning jenny," and its application to cotton machinery, speedily led to the development of the same principle in making mill-spun yarn from flax and hemp. A numerous series of specimens were contributed by P. Claussen in illustration of his patent process of making flax-cotton. This process (patented August, 1850) consists essentially in boiling the cut and crushed stems of the flax, hemp, or other plant, in a dilute solution of caustic soda, containing about one two-thousandth part of alkali. The fibrous matter is then removed and plunged into a bath of dilute sulphuric acid, containing one five-hundredth part of acid, in which it is boiled for about an hour. It is next transferred into a solution containing about ten per cent. of carbonate of soda; and lastly, when it has remained in the latter for an hour, it is plunged into a weak solution of sulphuric acid, consisting of one part of acid to two hundred or five hundred parts of water. In this it is left for about half an hour, and the process is completed. The effect of these several processes is to divide and split up the fibre in a most remarkable manner, so as completely to alter its character. Flax thus treated is converted into a substance very nearly resembling cotton. It is probable that flax-cotton can be advantageously used in the manufacture of mixed fabrics, as it appears capable of being spun with wool, silk, and other fibres. It may, therefore, perhaps, hereafter lead to several new and important practical applications. For this ingenious process the jury awarded a prize medal.

"The idea of modifying the fibre of flax and hemp, so as to convert it into a kind of cotton, is by no means new. In 1747 Lilljikreuzes and Palmquist described a mode of converting flax into 'cotton' by boiling it for some time in a solution of caustic potash, and subsequently washing it with soap. In 1775 considerable quantities of refuse flax and hemp were converted into 'flax-cotton' by Lady Moira, with the aid of T. B. Bailey, of Hope, near Manchester. The full details of the process employed do not appear to have been published, but from Lady Moira's letters in the Transactions of the Society of Arts for 1775, it appears that the fibre was boiled in an alkaline lye, or a solution of kelp containing carbonate of soda, and subsequently scoured. The result of this was that 'the fibres seem to be set at liberty from each other,' after which it may be 'carded on cotton cards.' It appears that at this time flax-cotton was made and sold at threepence a pound, and Lady Moira states that she believes that it takes colors better than flax. It is curious to observe the fate of Lady Moira's scheme. She says: 'I have no reason to be vain of the samples I have sent you, they merely show that the material of flax-cotton, in able hands, will bear manufacturing, though it is my ill fortune to have it discredited by the artisans who work for me. I had in Dublin, with great difficulty, a gown woven for myself, and three waistcoats; but had not the person who employed a weaver for me particularly wished to oblige me, I could not have got it accomplished; and the getting spun of an ounce of this cotton in Dublin I found impracticable, and the absurd alarm that it might injure the trade of foreign cotton had gained ground, and the spinners, for what reason I cannot comprehend, declared themselves such bitter enemies to my scheme that they would not spin for me. Such is my fate that what between party in the metropolis and indolence in this place, (Ballynahynch,) I am not capable of doing my scheme justice. That it should ever injure the trade of foreign cotton is impossible.' Lady Moira states that the flax-cotton gowns which she had had made, and which were worn by the members of her own family, were exceedingly durable, and the specimens of these fibres, as well as of the flax-cotton prepared by her, which are still preserved in the Museum of the Society of Arts, and are highly remarkable for their beauty.

"Subsequently to this several attempts were made in Germany to convert flax into a fibre resembling cotton, which could be used, either alone or together, with cotton in the manufacture of cotton goods. In 1777 Baron Meidinger proposed to convert flax into a sort of cotton by the action of alkaline solutions, &c. In 1780 a factory was established at Berchtoldsdorf, near Vienna, for the practical working of this process; and similar plans were subsequently brought forward by Kreutzer in 1801, by Stadler & Haupfner in 1811, by Sokou in 1816, and by several others.

"At the factory at Berchtoldsdorf not only was flax converted into cotton, but likewise a useful cotton-like fibre was prepared from tow and refuse flax, and the same is said to have been done by Hoag near Pressburg in 1788, by Gobell in 1803, and Segalla in 1811. Whether these various plans failed from the effects of jealousy and opposition, like that which prevented Lady Moira from introducing her flax cotton, is unknown; but it does not appear that any of them were long persevered in."

In one of those excellent lectures which grew out of the international exhibition, Mr. Solly is reported to have said, "I must confess that I am not at all sanguine as to the benefits to be derived from this proposal, though I think it by no means impossible that it may hereafter lead to valuable and important improvements."*

The commission, though previously somewhat discouraged by the exhibition of many unpromising attempts to cottonize flax, now feel that they are upon the eve of realizing the valuable and important improvements suggested by this distinguished savan.

So far from flax-cotton being a new article, or prepared by a new process, Dr. Schæffer states, in his excellent article on vegetable fibre,† that a similar method has been used by the Chinese for centuries.

The method of preparing this substance, as patented by Claussen, has already been given; but we find many specimens that appear to have been prepared by other processes, and their exhibitors pretend to have secret methods which they are unwilling to divulge, or claim that they have patent processes for their modes of preparation. Many of these specimens are entirely worthless, and several of them have been ruined by the misuse of chemical substances. The expense attending some of the modes of preparation is a serious objection to them; those in which cutting the fibre is a part of the process it is apprehended will produce undue waste in spinning, and in all we find a want of such a perfect disintegration as to yield an approximate uniformity of length and thickness of the fibres. The most promising specimens are those which were prepared by hot alkaline solutions, and the bundles of cells mechanically separated from one another afterwards while still moist. These will be noticed in the chapter on manufactures.

The London jury at the international exhibition of 1862 do not appear to be even so favorably impressed, when they speak of the "empirical method which, in 1851, led a majority of the jury to award a medal to Chevalier Claussen, but which, after eleven years, is just where it was at that time—in the limbo of impracticable ideas. The so-called flax-cotton has been shown as a curiosity by its inventor, but every attempt to employ it practically has proved a failure. Flax still insists upon being treated as flax, and hemp as hemp, and nothing succeeds so well in the disintegration of the fibres as water-retting."

This sweeping clause we are not prepared to adopt at the present stage of our investigations, and with the very promising developments opening before us, as exhibited in the specimens presented by Mr. H. Burgess, of Royer's Ford, Pennsylvania, and by Mr. James B. Fuller, formerly of Claremont, New

* Lectures at the World's Fair, 1850: Professor Edw. Solly.

† United States Patent Office report for 1859, to which the reader is referred for much interesting detail.

Hampshire, but now engaged in putting his discoveries into practice at Norwich, Connecticut, we are led to anticipate the happiest results.

We have supposed that it was our duty to examine how far and in what way flax and hemp could be used as a substitute for cotton. This question has been pretty thoroughly investigated by the commission; its answer may already have been gathered from what has preceded, and the public may have drawn conclusions from the statements which have been made as to the radical differences between these fibres, that they can never really be substituted, because they are so dissimilar. And yet we should do wrong were we not to point out some of the many uses to which these fibres may be and have been applied to take the place which cotton has hitherto occupied.

As cordage and for twines, to which, in the cheaper days of cotton, that substance was extensively applied, hemp and flax still assume their pre-eminence and superiority. Even to the grocer's twine, which must be short and easily broken, these fibres have been extensively and profitably applied. Every variety of twine is now made of flax and tow in several establishments. Thread of the best quality for many purposes is also prepared from this material, and for some branches of the arts it has always been deemed superior to cotton. Coarse linen fabrics of every description, from bagging down through burlaps, crash, duck, diaper, &c., have all been successfully made of flax and hemp, where formerly the greater cheapness of cotton had caused that fibre to supplant its legitimate competitor. In the article of seamless grain-bags, which were formerly made altogether from cotton, we now have a much better article produced from flax. The nicely prepared battings of flax, whether bleached or unbleached, have taken the place, to a great degree, of the application formerly made of the dirty and refuse cotton for this purpose; but the greater weight of the flaxen material depreciates its value and usefulness when to be applied in this way, for a given number of pounds of flax batting will cover a space but half as large as an equal quantity of carded cotton.

It would not be consistent with the limits of this report to take up the discussion of the whole subject of paper-making, although its main feature depends upon the value of these very fibres we have been examining. As in its production, however, flaxen and hempen fibres may very advantageously be substituted for those of cotton, we may be pardoned for making some allusions to this matter. As before intimated, all of these several fibrous substances are composed of nearly pure cellulose, and thus, in their ultimate composition they are very much alike. It further appears that whatever materials be used for paper-making, their value will depend upon the amount of this proximate principle of cellulose which they contain, and whether the stock consist of solid wood, hollow straw, fresh fibre of bast cells from our flax fields, waste cotton from the factories, or worn-out clothing and old ropes, made from these different fibres, their value in every case depends upon the amount of pure cellulose which can be derived from them. The cellulose from the several sources appears to exist in nearly the same proportions, about fifty per cent., whether we take the wood or the straw for the raw material.

The union of these fibrous substances in the tissue of paper depends upon a peculiar condition which has been imparted to them by the action of the paper-machine, so tearing and breaking the cells and fibrils, and fraying their ends as to give them a sort of felting property—quite different, it is true, from what is described as felting, in another part of this report, but still enabling the ends of the fragments to unite with one another so as to form a tissue of more or less consistency, according to the nature of the materials used.

This will best be explained by an illustration taken from the Journal des Fabricants de Papier, vol. I, p. 180.

No. 2.

View of a shred of paper, in which are beautifully exhibited the cylindrical fibresof flax or hemp mingled with the ribbons of cotton fibre; also the confused mass of ruptured fibres completely comminuted. This drawing shows the condition to which fibres are reduced by the rag-engine, and explains the peculiar felting upon which the constitution of paper depends.

Besides the appropriation of considerable portions of the lint produced by our flax fields to the manufacture of paper, which, indeed, appears to be rather a waste, when we consider that old clothing is just as good as new fibre, there are several other applications of this material in the arts.

Considerable quantities of rough tow, such as is cheaply prepared from the tangled and inferior flax straw of crops that have been grown expressly for seed, is used in the stuffing of furniture.

But, it may be asked, when are we to have flax produced in such a condition and in such quantities as to be suitable to provide us with finer goods, like sheetings and shirtings and print-cloths? Even this we are about realizing, and we hope soon to be able to furnish some cloths of quite respectable fineness and finish, in which disintegrated flax fibres shall have been used either alone, or mingled with cotton. Though long discouraged by the failure of attempts to cottonize flax, on account of the injury done to the fibre, and the unsatisfactory results in attempting to reduce the long filaments to an average definite shortness suitable for cotton machinery, we now look hopefully for much more satisfactory products, as will appear in the appropriate place. The radical difficulties of the fibre remain in the less pliant and straighter cell, in the greater specific gravity, and consequently greater conducting power of the product; but the spinning difficulties appear to be in a fair way of being overcome by American ingenuity. (See specimens in museum.)

An application of flax as a substitute for cotton, which was little expected, presented itself in the formation of hard rolls for print-works and bleacheries. In the construction of these rollers it had been a desideratum to get a hard and elastic surface. This was first accomplished by disks of heavy paper closely applied to one another upon a shaft, firmly compressed and then turned into shape. Next cotton itself was used; but it is now found that flax fibre may be applied to this object with the most satisfactory results.

One of the greatest claims which flax presents to our notice is its ability to replace cotton, and with great advantage, too, in all the cases where that substance was formerly used in combination with wool in the production of mixed fabrics. Hempen and flaxen yarns are now resuming their original importance in the manufacture of carpets, both alone and when used as the warp only, of those useful tissues, in which cotton had entered as the leading article.

In the reproduction of the good old-fashioned linseys we are reminded of the healthy days of our boyhood and the infancy of our manufactures, when homespun goods were not yet wholly banished from the farmer's wardrobe by the introduction of the more flimsey cassinets from the power loom, which bore a deceptive finish, but did not furnish the desired resistance to the wear and tear of boyhood, in the rough-and-tumble plays of the school-house. The return to this substitution of flax for cotton will be hailed with acclamation by the boys, and may be equally relished by their careful mothers.

Kerseys and jeans are now produced of excellent quality, into the preparation of which flax enters largely in combination with wool, and there is scarcely a "boy in blue" who does not bear upon his body, in his uniform, fibres of flax, while he carries also a blanket largely composed of this material combined with the warmer fleece of the sheep.

There are beautiful samples of cloths upon exhibition in the museum, into the composition of which a considerable portion of flax has been made to enter. In the knit goods before us, and one garment of which has been subjected to constant use for some months, we find a beautiful merino stuff, in which the flax-cotton prepared by Mr. Fletcher, of Oswego, New York, has been used in combination with wool instead of the usual admixture of cotton. The service rendered by the garment in question has been in every way satisfactory and agreeable, and it appears to wear evenly and well, and has not been fulled up in the laundry.

FELTING.

There are on exhibition some very firm and well printed druggets, which have attracted great attention from visitors who have examined them. But we cannot advise any further experiments in the way of attempting to produce felted goods of mixed flaxen material, for it is manifest that the fibres of flax have no felting properties. To make this apparent it will be necessary to investigate the principles upon which felting depends, when we shall find that the necessary elements are not possessed by the smooth filaments of flax.

This may best be done by quoting from the popular writer of a work entitled "Useful Arts employed in the Production of Clothing," in which we find the following observations that throw great light upon the subject:

"If we hold a human hair firmly by the root and draw it gently between the thumb and fingers, it passes through smoothly and with hardly any resistance or interruption; whereas, if we reverse the motion, holding the hair by the point, and draw it from point to root, a very sensible tremulous resistance will be experienced, accompanied by a cracking sound. Again, if we place a hair loose between the finger and thumb, and then, by alternately bending and extending them, give them a backward and forward movement, the hair will be put in motion, and this motion will always be from root to point, whether the root be in one or the other position with respect to the two rubbing surfaces. A fibre of wool, likewise, under similar circumstances, always moves in one direction. Every schoolboy knows that an ear of barley, if put within the sleeve at the wrist, soon travels up to the arm-pit; he also knows that he can only rub a single awn of barley in one direction between his finger and thumb—that is, from root to point. The awn of barley is visibly jagged at the edge like a saw, the teeth pointing obliquely upwards, and this particular conformation is manifestly the reason why it is capable of motion in one direction, but not in the other. These facts lead to the explanation of the cause of felting.

"Wool is more crisped and spirally curled than hair; this may be seen by holding a small lock up to the light. This varies in the amount of the curl in the wool of different sheep, and is most perceptible in the fine wools. Those which curl most are best adapted for feltings. This twist aids in that arrangement of the fibres which enables them to unite thus together; it multiplies the opportunity for this interlacing, and increases the difficulty of unravelling the felt; but while assisting, it is not the principal agency concerned, which depends upon the ultimate structure of the particles.

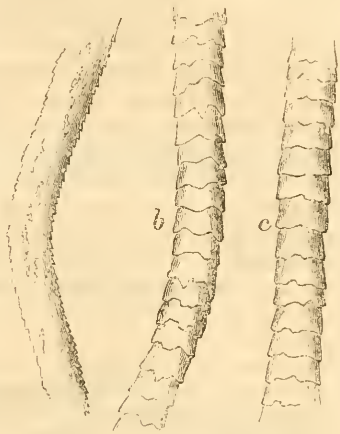
"Felting was formerly supposed to be owing to a kind of attraction or cohesion between the fibres. Dr. Young thought the cloth contracted in felting, because the fibres were unequally bent in the pounding received from the fulling-hammers, and that those most bent were prevented from returning to their original length by their adhesion to their neighboring fibres. This, however, does not apply to the common instances of felting, as in hat-making and the wearing of a woollen sock, for here the fibres are rubbed together and not beaten, as in fulling. Before Monge, the French philosopher, first discovered a satisfactory explanation for this process, a Mr. Plint suggested the following happy conjectures:

"'Respecting the application of the microscope to the examination of the fibre, I am decidedly of the opinion that a careful and minute examination of wools differing in their felting proportions would result in the detection of some specific difference of structure. This property is altogether inexplicable, except in the supposition that the surface of the fibre is irregularly feathered, and that, by compression, these feathered edges become entangled and locked together. These feathers must also point in one direction, from the root to the extremity of the fibre, and if we suppose the feathered edge, or, more properly speaking, the individual tooth or feather, to be of a finer texture, it is evident that one tooth being pushed into another would fasten like a wedge; and if we further suppose that the tooth or feather has a barb, similar to that on a harpoon, the phenomena of felting are explained.'"

How wonderfully these suggestions of Mr. Plint have been verified by the developments of science in the discoveries of the microscope; it has been found that wool has this very feathered or serrated structure. With an instrument of 300 linear power the filaments of wool show teeth resembling those of a fine saw, and different wools present different forms of serration. (See plate of wool magnified 200 times.)

No. 3.—Specimens of different wools. (Dr. Ure.)

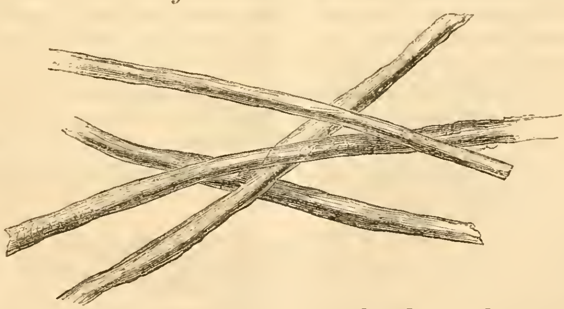
a. Leicestershire.
b. Finest Saxony.
c. Finest Spanish.



Dr. Ure tells us that, when viewed through a powerful microscope, the filaments of wool have something the appearance of a snake with the scales a little raised, so that the profile is serrated, the teeth being toward the point. Each fibre seems to be composed of serrated rings, imbricated over one another. These teeth and the intervening spaces differ in various samples, and these transverse lines resemble the rings of the earth-worm. This appearance has been compared to the effect of a series of thimbles with uneven edges inserted into each other. The existence of these serrated edges explains the reason why these substances may be felted, and it is known that in those which felt the best the serratures are most distinct.

DESCRIPTION OF THE PLATES AND THE FIBRES WHICH THEY REPRESENT.

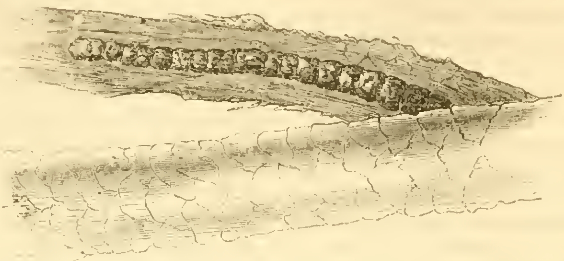
No. 4.—Silk, *from an East India handkerchief.*



The fibre of silk consists of a round or somewhat flattened, narrow, and structureless substance of indefinite length, quite solid—that is, without any internal cavity, and without any visible markings.

The original condition of these fibres, when first unwound from the cocoon, shows them in pairs, agglutinated by a secretion external to the fibre itself. The subsequent treatment separates these fibres more or less until they present the appearance shown in the figure. Silk is wound off from the cocoon, and its parallel fibres are afterward twisted. The broken fragments are carded, and then spun; the resulting fabric has quite a different appearance from ordinary silks.

No. 5.—Wool, *treated with dilute sulphuric acid.*



Wool, unlike silk, shows distinct structure, and is in fact made up of cells of two different kinds; the one kind on the outside (as seen in one part of the figure) being broad and flattened, overlapping each other, with their free edges pointing to the top of the hair; the second kind (as seen in the other part of the drawing) is nearly round in outline, and forms the so-called "pith" of the hair or wool.

The free ends of the external cells prevent the hairs from slipping past each other, and give the peculiar "felting" property to wool.

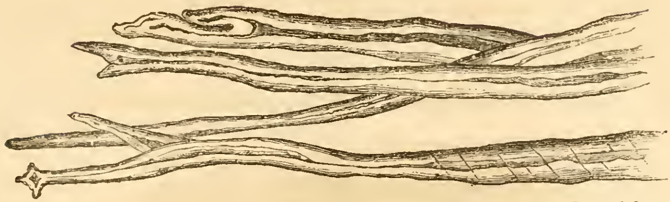
No. 6.—Flax, *from a fine Irish linen.*

Flax, like all vegetable fibres, is made up, as ordinarily used, of several cells forming a filament. The figure represents the separated cells.

The *bore* or internal cavity of the flax cell is not large; hence its greater strength as compared with cotton. The cross markings seen in the figure are not external, but are caused by "pores" passing from the inside of the cell to near the outside. These markings being internal, are not to be confounded with the serrated outline of wool, and do not give any hold of the cells upon each other. Their arrangement, however, has an effect upon the isolated cell; thus in the top one, shown in the figure, which is, however, a rather unusual form, there is to be noticed a greater flatness than in the others, together with a slight twist in the whole cell, which twist is mainly to be attributed to the oblique direction of the "pores."

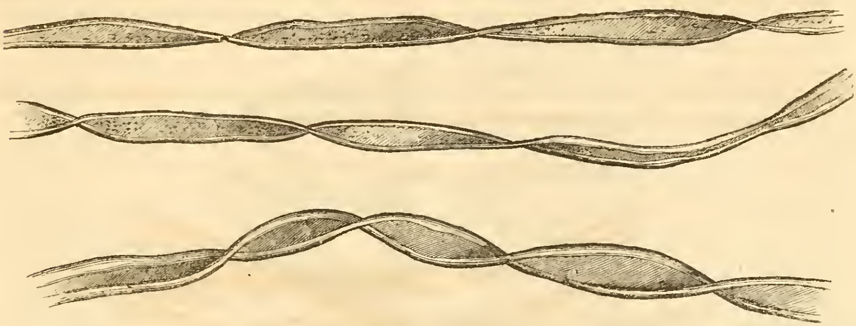
The specimen represented in the drawing has been spun by hand. When flax is spun by machinery there are always adhering substances derived from the remains of the short cells, which are removed by passing through the fingers in hand spinning. When flax is perfectly cottonized the cells should exhibit the appearance shown in the figure, with a smooth and unbroken outline.

No. 7.—HEMP.



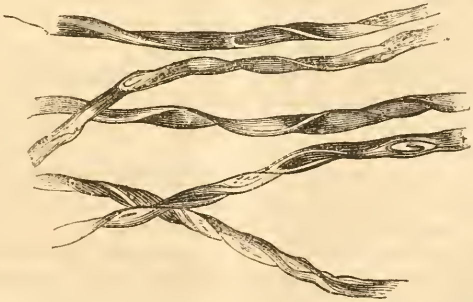
The figure represents the separated cells, which are somewhat like those of flax. Three of these cells are shown with forked ends, but this is by no means a constant character. The cross markings are shown as oblique in one cell, but even this is by no means uniformly found. In the specimens described in another place, it will be seen that while in Russian hemp the same obliquity is noticed, in American hemp the markings are almost exactly transverse. There are too few observations to show that this is a permanent and distinctive difference. *All of these figures represent the objects magnified two hundred times.*

No. 8.—COTTON.



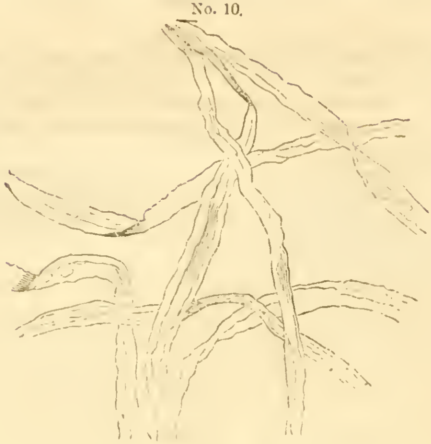
No. 8 represents portions of the separate cells of the cotton fibre as delineated in the beautiful drawing of Riessig. The original tubular or cylindrical character of the line cell is lost, and in desiccating, the walls have collapsed upon one another irregularly, which gives the peculiar spiral character to the fibres. This varies in different specimens, some being nearly like ribbons, while others have a regular twist like a screw.

No. 9.



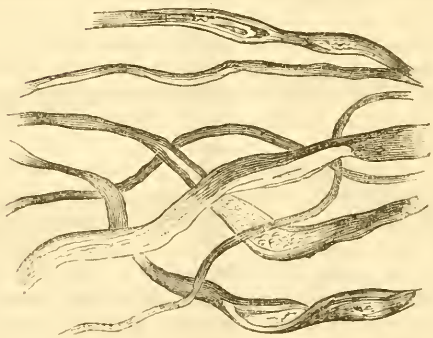
No. 9 from Dr. Ure, best sea island cotton, of which lace and fine muslin are made. Fibres one one-thousandth of an inch in diameter; tortuous semi-cylinders of uniform size.

No. 10.



Religious cotton, of which fabrics are worn by the Bramins; a very flimsy fibre. (Dr. Ure.)

No. 11.



Surat cotton, irregular ribbon form. (Dr. Ure.)

No. 12.

Flax fibres as mounted in balsam. (Dr. Ure.)

The commission is happy to be able to present the following results of a very careful microscopic examination of some of the preparations that have been presented for their investigation. For this purpose the services of an expert microscopist were secured, and he has rendered the following report upon the specimens submitted. The name of Professor G. C. Schæffer, who has been for many years engaged in similar examinations, is a sufficient guarantee of the value of his report upon these fibres.

EXAMINATION OF SPECIMENS OF FIBRE FOR THE FLAX-COTTON COMMISSION.

In making this report, it must be stated that I have confined myself to the description of the specimens as presented, without pretending to say what might have been done to them to make them different from what they are. By the words "cottonized fibre" we denote that condition given to an originally long fibre which may render it capable of being used in the ordinary cotton machinery. In general it is claimed that, by the process of cottonizing, the compound fibre is reduced to its single cells which then resemble cotton in this respect, as it also consists of single cells of nearly uniform length. The idea sometimes put forth that the individual cells are themselves split by this process is utterly fallacious, as I have ascertained by repeated examinations for many years.

The examination of these specimens, and of many others, has led me to suppose that persons, ignorant of the nature of the material employed, have frequently made their preparations under quite mistaken notions. It is known that cotton, to be profitably used, must have a certain length of cell or "staple," and one, too, of a reasonable degree of uniformity. But the ultimate cells of most basts (bark fibres) are, in general, much shorter than those of cotton; so that, when cottonized, they are not long enough for use. In this state, when mixed with cotton, they fail to combine with it in the proper manner, and are partly lost and partly found with projecting ends, giving an irregular surface to the thread formed. It appears, then, that, finding the complete operation yields a material too short for use, the idea has arisen that by an incomplete cottonizing a longer staple could be obtained. The result is, of course, as various as the treatment, but the end is nearly the same. The long fibre is broken up into shorter portions which consist of an indefinite number of cells, and, since these are arranged so as to break joint, the length of the filament obtained will be very variable. Hence the apparent length of staple is gained at the expense of great irregularity, while the free ends of individual cells projecting from the filament will interfere with the manufacture. The entirely free cells which may be found among the long filaments will be mostly lost in the manufacture. The arrangement of the bundles of bast cells in the plant is such, that a treatment which is not carried too far will give mainly a separation into smaller bundles by longitudinal division, turning out a long and fine filament, admirably adapted for long staple spinning. This process has been used with great success for centuries. But if the treatment is carried somewhat further, the fine bundles are themselves broken up into individual cells and compound filaments of varying length. This material, when treated like cotton, must be carded, and then becomes only a finer sort of *tow*, and the fabric formed from it will be a more or less fine *tow-cloth*. This may, however, be made quite fine in texture, and suitable for various purposes.

I do not intend speaking of the fitness of the cells of different plants for a process of manufacture similar to that used for cotton. I have enlarged upon this subject in an article in the Agricultural Report of the Patent Office for the year 1859, and generally the matter is so well understood that any repetition in this place would be useless. One thing, however, deserves notice, no matter how well the material may be fitted for cotton spinning, the fabric obtained will vary in character according to the structure of the cells employed. The cells of cotton have thin walls, are very absorbent of moisture, poor conductors of heat, and, for a given surface and thickness, produce a fabric lighter than that of any other material hitherto used

The cells of bast have thick walls and produce heavier fabrics, which are less absorbent, and are better conductors of heat than those obtained from cotton. In short, the cloth obtained from bast cells will always carry with it their peculiar character, and although manufactured as cotton, it will never be cotton-cloth. Of course there are many uses for which such cloth might be well adapted, but, as worn in contact with the body, it could never replace cotton.

Again, the action of colors upon cotton and bast fibres is quite different, and the treatment of colored goods from the different substances would be quite unlike. Indeed, it is doubtful whether the same results which are now so cheaply obtained from cotton could ever be produced from bast cell fabrics at an equal cost.

I shall now give the description of the respective specimens as examined by me under the microscope.

Each sample is denoted by a number which I have given for convenience of reference, and by the exact words placed upon the envelope as it came to me.

No. 1. "*Flax disintegrated, by H. Burgess.*"—The envelope contains two specimens—one bleached, the other unbleached. The fibres are of various lengths—appearing under the microscope to be mostly single cells—some quite long. One I found to be one and a quarter inch, with tapering ends. The cells have the usual character of flax. From the unequal lengths, I should be inclined to think that the cells of flax have no great uniformity in this respect.

No. 2. "*Asclepias cornuti cottonized, by Williams.*"—Imperfectly cottonized, and, of course, unequal in staple. Some single cells which could be drawn out were found to resemble flax in most respects, but differing in decided markings that form long spirals, and also in the diameter of the internal cavity which is less than that of flax, and also more irregular.

A specimen of this fibre, perfectly cottonized from Russia, which I have in my collection, shows that the cells will not average more than three-fourths of an inch, if so much.

No. 3. "*Russian hemp, by Burgess.*"—Not quite white. Not well cottonized, and, therefore, with filaments of unequal length.

As compared with American hemp the cells seem to have a greater diameter for the internal cavity, and the transverse markings are more oblique. I cannot say that this is a constant character, but it agrees very well with the drawing of Russian hemp given by Schacht, as will be seen on reference to the figure No. 4.

No. 4. "*Clansenized flax-cotton, Geo. Graham, Cincinnati.*"—Cream-white. Unequal in length; many single cells, but mostly filaments composed of four to eight. This shows that the process has not been carried to completion, as is also indicated by the adhering remains of short or pith cells.

No. 5. "*Green flax boiled in caustic soda, but not cottonized, McFarlane.*"—Yellowish white. Coarse to the touch; very long filaments, the finest containing at least six cells. The filaments are evidently too long and coarse to be treated as cotton.

As the action of caustic alkali is capable of separating the fibre into individual cells, it seems that this product has been obtained by a less prolonged action, or a weaker solution.

No. 6. "*Unretted or green flax, Claussenized by McFarlane.*"—One specimen in long slivers, the other bleached, the latter only examined. Some single and long cells, but many compound; no possible determination of average length. This has evidently been obtained from a flax having very long cells.

No. 7. "*Erolin or flax-wool: G. Davis, Cincinnati.*"—Unbleached; long filaments; seven to ten cells in each; also with adhering remains of short cells.

No. 8. "*By R. T. Shaw; his No. 2 cottonized flax.*"—Yellowish gray; staple *very* unequal; mostly short or broken single cells, some filaments with four or more. There is too much difference in this material to be wholly treated by one process of manufacture. The very great irregularity in length would prevent this. The whole mass is very closely matted. Some cells of extraordinary length were found; it must have been a remarkable flax to furnish such.

No. 9. "*Fibrilia wool, bleached: S. M. Allen.*"—Yellowish cream-white; mostly very long filaments, consisting of twelve or more cells, utterly incapable of being used on cotton machinery.

No. 10. "*Kentucky hemp, by H. Burgess.*"—Unbleached; very unequal filaments; some apparently single cells, or two or more slightly overlapping; very long compound filaments.

No. 11. "*Fibrilia hemp: S. M. Allen, Boston.*"—White (bleached) blue, and unbleached specimens. The bleached only examined. Very unequal compound filaments. The first drawn out containing about four cells.

No. 12. "*Hemp-cotton: R. T. Shaw.*"—This specimen consists almost wholly, if not entirely, of wool, as can be determined by the naked eye, and by the smell when burnt. This has, no doubt, occurred from some accidental confusion of the specimens exhibited to the commission, from which this sample was selected.

No. 13. "*Bœhmeria nivea. India. Urticaceæ. By L. W. Wright, Brooklyn, New York.*"—This specimen must have been presented as a mere curiosity. It shows this splendid fibre with its unrivalled length, but in a condition unfit for cotton manufacture; indeed, it is only in the state of the refuse tow obtained in the preparation of the long fibre which forms the well-known "grass-cloth" of the east. It was not exhibited as a cottonized sample.

No. 14. "*Jute by alkali: R. T. Shaw.*"—Yellowish white; coarse to the touch; unequal staple; single filaments of many cells.

No. 15. "*Flax: R. Fletcher, Oswego, New York.*"—White, bleached; staple very unequal; finer filaments of at least seven cells, many shorter; adhering remains. I am asked to determine if there are many broken cells. A bundle of the shorter part of the staple shows mostly single cells, some of them within broken ends. If this product is from flax cut into moderately short bits, it would seem that some waste would arise from the fragments which fall off in handling the specimen; but the quantity would be very trifling when compared with the waste from such equal staple.

No. 16. "*Fuller & Upham, Claremont, New Hampshire. Unretted and unbleached stock.*"—Grayish white; staple rather shorter than in most of the specimens, and more uniform, but still unequal. Some compound filaments with adhering remains. Seems to contain more flattened cells than are usually found.

The shorter compound filaments, which make the whole product more uniform in length, are to be noted. They may have been obtained by cutting the flax, as this would give a maximum length to the most complex filaments.

No. 17. "*Burgess. Hanks of retted flax, disintegrated, but not separated; also (a,) (b,) (c,) and (d.)*"—My attention has been called to the hank, (unbleached,) which has considerable tenacity when dry, but is readily separated into cells or smaller filaments when wet. The water swells and lubricates the parts, which then slip by each other; while, when dry, the natural arrangement of the cells gives too much friction to allow them to part, and, having been previously wetted, they have turned somewhat in drying, and so gained a hold on each other. Adhering remains of a yellowish color were found.

"*(a.) Retted; steamed with caustic soda and carded; same stock as (b.)*"—Gray; staple unequal, about one-half to one and a quarter inch in length. Mostly single cells, but with many adhering remains. Shows very well the inequality of the flax cells in length. In this specimen there are some cells of very large diameter.

"*(b.) Same stock as (a;) retted, steamed, and picked.*"—Staple shorter than in the last specimen; compound filaments; adhering remains abundant; some broken cells.

"*(c.)*"—No memorandum. Gray; not bleached. Staple unequal; many long compound filaments; also long single cells, as in No. 1.

"*(d.) Retted, and steamed with caustic soda. Crop of* 1862."—Gray; very long staple; many long single cells; still longer compound filaments of a few cells. Seems to be an extraordinary flax, as far as regards the length of the single cells.

No. 18. "*Epilobium; from Rutger B. Miller, Utica, New York.*"—Cream-white; silky lustre. Staple very short. Consists, like most seed-hairs, of single cells. Their walls are very thin; they make sharp bends, and seem to be brittle, without the least wind or twist, and, while resembling the down of asclepias, are of less length, with a rather strong longitudinal marking. Utterly useless for spinning. Even when mixed with other fibres, would fly off in the process of manufacture.

No. 19. "*Bœhmeria, sp. or Laportea? R. Chute, St. Anthony, Minnesota.*"—One specimen unbleached, the other bleached; both of similar character; rather harsh to the touch. On examination, the filaments prove to be compound and flat, consisting of more than five cells. There has evidently been no process used to isolate the cells, which hold together very tenaciously, and also have adhering remains. The smallest fragments that could be drawn out were still compound. A sufficiently prolonged treatment with alkaline solutions would separate the cells; but any mechanical means, or more rapid action of re-agents, only brought to sight portions of single cells from which their character might be determined. These appeared to be flattish, with rather thick walls, and long spiral markings. It is probable that the individual cells are quite long, judging from the appearance of the filaments.

GEORGE C. SCHÆFFER.

OTHER FIBRES.

In entering upon the consideration of any other fibrous plants than those mentioned in the act of Congress, we are aware that the commission may be said to have transgressed the bounds, and to have gone *extra limites;* but the deep interest that attaches to the subject, and the importance of some of these substances in the various arts of life, are thought to justify their introduction into this report.

In the preparation of this section we have been largely indebted to the reports of the juries of the international exhibition at London—a rare work, which is not generally accessible to our countrymen. Quotations are here made the more willingly in consideration of the eminence of the distinguished men who served upon the jury. They are the highest authority upon this topic, and we may do well to observe their dicta with regard to these substances, many of which are comparatively new to civilized life.

There are a great many fibrous plants in various parts of the country that present us with beautiful and strong fibres, which may be utilized in the arts. All of the mallow tribe are characterized by having bast-cells of great strength.

Many of these may be applied to useful purposes. The *sida abutilon* has been prepared many years since, and the fibres exhibited and declared equal to the finest flax. This is a common weed.

Another of this family is the *hibiscus*, or marsh mallow, of which there are several species that have attracted attention, and which have been brought into notice at different times.

The asclepias family are also remarkable for the beauty of the fibres furnished by their stems. Several specimens are exhibited in the museum. The silk attached to their seeds is not useful, though very beautiful. The *cornuti*, or *syriaca*, is a hardy perennial herbaceous plant, which has long been cultivated in Europe. It may be grown from seed, or by subdivision of the root. Planted at suitable distances, it would be easily cultivated, and, if close enough, would produce a heavy crop of tall, slender stems, well clothed with the fibre. This plant, being a perennial, would continue to furnish successive crops for many years without renewal, and would require very little culture. It affects low lands near streams, but may be grown on any tillable soil of moderate fertility. This substance has been attracting a good deal of attention lately in the public press. Other plants of the same family, and nearly allied to this, are also rich in fibre.

The *apocynum* on exhibition has a very fine and silky fibre, and its name, *cannabinum*, indicates that the botanists perceived its hempen characteristics. The Indians used these fibres in the construction of their bow-strings.

After considering the several other textile substances assigned to their investigation, the jury proceed, in their report, which was prepared by Mr. Alcan, to the examination of what are styled *miscellaneous fibres*, as appears in the following extracts:

"In the various collections of raw produce a very large number of other fibrous substances, used as substitutes for cotton, flax, and hemp, are shown; some of these are new, or but little known, and among them are several which, from their valuable properties, seem likely, ere long, to become important articles of trade, and not merely to form excellent substitutes for the substances already employed by manufacturers, but even in some cases to lead to the development of new branches of industry.

"An interesting series of hemp, flax, and other fibrous substances is contained in the Liverpool collection of imports. These include—

Name of fibre.	Name of plant.	Whence derived.	Amounts.	
			1849.	1850.
			Tons.	Tons.
1. Dutch flax	Linum usitatissimum	Holland	78	153
2. Egyptian flax	do do	Alexandria	------	270
3. Tow	do do	Holland	3	3
4. Hemp	Cannabis sativa	Canada	------	------
5. Jute	Corchorus capsularis	East Indies	8,660	12,216
6. Sunn	Crotolaria juncea	do do	------	81
7. Coir rope	Cocos nucifera	Bombay and Calcutta	470	1,100
8. Coir yarn	do do	do do	200	370
			Bales.	Bales.
9. China grass	Urtica nivea*	Canton and Hong Kong	150	320
			Tons.	Tons.
10. Picaba	Attalea funifera	Para	------	300
11. Manilla hemp	Musa textilis	Manilla	81	192
12. Brazil palmetto	Carnauba palm	Para	------	------
13. Brazil jute	Unknown	do	------	------
14. Spanish moss	Tillandsia usneoides	Brazil	------	------
15. Vegetable silk	Chorisa speciosa	do	------	------

* Bœhmeria nivea.

Among fibrous materials one of the most interesting is the "China-grass," of which numerous specimens are exhibited in various departments of the building, some of the most complete and valuable series being in the English gallery.

Although China-grass fibre is comparatively a new material in the hands of our manufacturers, yet it has been known to men of science for a very considerable time: but certain practical difficulties have hitherto prevented it from being usefully and profitably employed. China-glass fibre is obtained from *Urtica nivea*,* abundant in China and in various parts of the Indian empire, where it has long been used by the natives, who, by the simple maceration of the plants, obtain from them a strong and very useful fibre. Of the various fibres examined by Dr. Roxburgh, at the commencement of the present century, with a view to the discovery of some cheap and good substitute for hemp, one of the most promising was the "Callooee" hemp, "Kankhura," or the "Ramy," of the islands and Malay peninsula. This he found to be the produce of the Urtica, to which he gave the name of *Urtica tenacissima*. The plant was introduced in 1803, from Bencoolen to Calcutta, where it was cultivated for several years in the Botanic Garden, then under the charge of Dr. Roxburgh. A considerable quantity of Callooee hemp having been imported into England in 1814, its practical value was tested by some competent authorities, and as the reports were highly favorable as to its strength and other valuable qualities, the Society for the Encouragement of Arts and Manufactures awarded a silver medal to Captain Joseph Cotton, of the East India Company, for its introduction. The chief obstacle which interfered, however, with its use was the difficulty which was found to exist in the preparation of the fibre from the stems of the plants. None of the processes usually adopted with flax or hemp were found to be at all suitable to them, and the rude, wasteful, and imperfect means employed by the natives in preparing the fibre for the manufacture of twine, thread, and fishing nets, by the mere process of scraping. were wholly inapplicable on a large scale, and gave, besides, a very inferior result. When macerated or retted in water, it was found that the fibre itself was more easily destroyed than the glutinous matter of the stem. It was hoped that the introduction of the machines of Mr. Lee for breaking the straw unretted, and of Messrs. Hill & Bundy, already referred to, would have obviated this difficulty; but such did not prove to be the case.

During the last forty years various attempts have been made to devise a good and cheap process for preparing this fibre, but hitherto without much success; and consequently, till quite recently, the cost of the fibre was such as to preclude its being brought into the market as a substitute for flax. But recent investigations have shown that the *urtica tenacissima* and the *heterophylla* may be obtained, in almost unlimited quantities, in various parts of India; and a process which has lately been patented appears, to a very great extent, to have removed the practical difficulties which previously stood in the way of its employment by manufacturers, so that in a few years it is probable that the Callooee hemp will constitute an important addition to the fibrous materials employed in the arts.

The process of Messrs. L. W. Wright & Co., for the preparation of China-grass, &c., for which a patent was obtained in 1849, consists essentially in a very ingenious arrangement for boiling the stems in an alkaline solution, after they have previously been steeped for twenty-four hours in cold water, and for twenty-four hours in water of a temperature of 90°. The fibre is then thoroughly washed with pure water, and finally subjected to the action of a current of high-pressure steam till nearly dry.

The following table shows the comparative strength of several of these East Indian fibres, as ascertained by Dr. Roxburgh; but it must be borne in mind that in several instances the fibres had evidently been very rudely and imperfectly prepared: the experiments were made in 1804.

		Breaking weight.
1. Hemp (English)	Cannabis sativa	105 pounds.
2. Murga (Sanseviera)	Aletris nervosa	120 "
3. Aloe	Agave americana	110 "
4. Ejoo	Saguerus Rumphii	96 "
5. Donsha	Æschynomene cannabina	88 "
6. Coir	Cocos nucifera	87 "
7. Hemp (Indian)	Cannabis sativa	74 "
8. Woollet comal	Abroma augusta	74 "
9. ......do	Bauhinia	69 "
10. Sunn	Crotalaria juncea	68 "
11. Bunghi paat	Corchorus olitorius	68 "
12. Ghu nala paat	" capsularis	67 "
13. ......do	Hibiscus manihot	61 "
14. Flax (Indian)	Linum usitatissimum	39 "

* Bœhmeria nivea.

It is evident, however, that these experiments could not be regarded as giving at all accurate comparative results; they only proved that many of the fibres were very strong, and well merited further trials. In 1808 Dr. Roxburgh made a second series of similar experiments, the result of several of which was as follows:

		Breaking weight.
1. Bow-string hemp	Asclepias, sp	248 pounds.
2. Callooee hemp	Urtica tenacissima	240 "
3. ......do	Corchorus capsularis	164 "
4. Sunn	Crotalaria juncea	160 "
5. Hemp (Indian)	Cannabis sativa	158 "
6. Donsha	Æschynomene cannabina	138 "
7. ..do	Hibiscus strictus	128 "
8. Musta paat	" cannabinus	115 "
9. Bunghi paat	Corchorus olitorius	113 "
10. Plantain	Musa	79 "

Dr. Ure states that the relative tenacities or strength of several textile fibres has been experimentally found by suspending weights to threads or cords of them of a certain diameter, and the following results were obtained:

Flax	1000
Hemp	1390
New Zealand flax	1996
Silk	2894

The strength of cotton and wool, he adds, has not been so well ascertained, but it is much inferior to that of the preceding filaments. The New Zealand flax, which forms so strong a rope, is easily broken by any flexure, and therefore does not form a durable canvas.*

It is plain that the strength of all these fibres was ascertained under very unfavorable circumstances, and there is no doubt that they would have been found even yet more valuable had they been well and properly prepared. The principal vegetable fibres contributed from India are the following:

1. "Callooee," "Rhea," or "China-grass," the fibre of *Urtica tenacissima*, and one or two other varieties of *Urtica*, already mentioned as well known in commerce under the name of "China-grass." Strictly speaking, it is probable that China-grass and Callooee hemp are the produce of two distinct species of Urtica, though the fibre of the two is very similar, and, for all practical purposes, in fact identical. China-grass, as it is most commonly called, is the produce of the *Urtica* (*Bœhmeria*) *nivea* of Willdenow, whilst the Callooee, Kalmoi, or Rami, of Sumatra, is obtained from the *Urtica* (*Bœhmeria*) *tenacissima* of Roxburgh. It is from this latter plant, also, that the Rhea of Assam is procured. The plants yielding this beautiful fibre are very abundant in many parts of the empire, and may be had in almost unlimited quantities.

In the form of hemp, and when the fibre is well prepared, it is remarkably strong, and when thoroughly bleached, though the strength is then somewhat diminished, it acquires a most remarkably beautiful white silky lustre; unfortunately it is one of the most highly venomous of all the nettle tribe. It is stated that the Todawars prepare the fibre of this plant by boiling the stems in water, after which they readily separate it from the woody parts, and then spin it into a coarse but very strong thread. The Malays simply steep the stems in water for ten or twelve days, after which they are so much softened that the outer fibrous portion is easily peeled off.

2. "Yercum nar." The fibres of the *Calotropis* (*Asclepias*) *gigantea*, a plant which grows wild abundantly in various parts of the Bengal and Madras Presidencies, and is used by the natives in the manufacture of cord called "Lamb-dore," or "Toondee coir." The fibre is of very remarkable strength: from some recent experiments made by Dr. Wight, its tenacity, as compared with some of the other Indian fibres when made into rope, is as follows:

* Philosophy of Manufactures, p. 101.

		Breaking weight.
1. Yercum nar	Calotropis gigantea	552 pounds.
2. Janapum	Crotalaria juncea	407 "
3. Cutthalay nar	Agave americana	362 "
4. Cotton	Gossypium herbaceum	346 "
5. Marool	Sanseviera zeylanica	316 "
6. Pooley Mungu	Hibiscus cannabinus	290 "
7. Coir	Cocus nucifera	224 "

Specimens of the Yercum, or fibre of *Asclepias gigantea* (and of the Tongoos, and of the *Asclepias tenacissima*), or bow-string hemp of Rajemahal, are sent from Coimbatore and other districts in the Madras Presidency.

3. "Umbaree," or "Maestee pat;" the fibre of the Palungeo, or *Hibiscus cannabinus*, a plant common all over India, and cultivated in many parts for the sake of its fibre. The process generally adopted seems to be that of steeping the stems in water till putrefaction commences, when they are taken out, washed, and beaten until the fibre separates from the woody portion of the stem; this fibre is contributed from Madras.

4. "Marool," or "Moorva;" bow-string hemp, obtained from the *Sanseviera zeylanica*, a plant abundant in the southern parts of the continent of India, sent from Cuttack, Coimbatore and other districts in the Madras Presidency.

5. "Jute," or "Paat," &c., the fibre of various species of Corchorus, especially *C. olitorius*, well known in commerce, one variety of it having been formerly called Chinese hemp. Many different samples of this fibre are contributed from Calcutta and from Madras. From Rungpore, in the district of Moorshedabad, samples of three varieties of jute are sent, called Suffed Hemonty Pat, Lall Hemonty Pat, and Lall Petrie Pat.

6. "Sunn," "Janapam," Indian hemp; the fibre of the *Crotalaria juncea*, likewise well known in commerce. Good samples are contributed from Coimbatore, &c.

7. "Dhuncha," or "Dunche," obtained from the *Æschynomene cannabina*, used by the natives of Bengal to make fishing-nets; a remarkably strong, though rather harsh fibre, pretty well known in commerce. The plant is commonly cultivated in Bengal.

8. "Coir," the fibrous part of the husk of the cocoa-nut, *Cocos nucifera*, well known in commerce; good samples are sent from Calicut.

9. Nar, or aloe fibre, the produce of the *Agave vivipara*, and other allied species. A valuable and strong fibre is prepared in many parts of India from different species of aloe. A very interesting series of these fibres, which are obtained from the large Hill aloe, and from the small aloe, illustrating the preparation of the fibre, exhibiting some of the uses to which it is applicable, and showing the facility with which it may be dyed of various colors, is exhibited.

10. Specimens of aloe fibre are contributed from various parts of the Madras Presidency, Madras, Madura, Coimbatore, &c., and from Singapore.

11. Yucca fibre, obtained from *Yucca gloriosa*, is also sent from Madras.

12. Ejoo, or Gommuti, obtained from the *Arenga saccharifera* (*Saguerus Rumphii*) or Gummuttee Palm, much esteemed in the Eastern Archipelago for making ropes and cables, in consequence of its extraordinary elasticity and durability in water; unfortunately the value of this fibre is greatly diminished by its peculiar fragility. Very good samples of this fibre are contributed from Singapore.

13. Putwa or Mawal fibre, obtained from the *Bauhinia racemosa*, a plant common throughout the lesser hills of India, contributed from Bhaugulpore, in the division of Patna.

14. Talli Nanas, fibre of the pine-apple, *Bromelia ananas*, from various localities. Good samples are exhibited from Madras, Singapore, and from Travancore, &c. Some very beautiful specimens of fibre called "ananas flax" are exhibited from Java; the real source of this fibre does not seem to be very certain, for though from its name it might be supposed to be pine-apple fibre, it more closely resembles that of the Urticas, or Bœhmerias, already mentioned.

15. Plantain fibre and Manilla hemp, obtained from the *Musa textilis* and *M. paradisaica*, contributed from Madras, from Dacca, and from Chittagong. Excellent canvas and ropes are shown made by this fibre, which is extensively used in the government establishments at Ceylon.

16. Marsdenia fibre, obtained from *Marsdenia Roylii*, and contributed from Nepal.

17. Pulas, fibre of the Butea frondosa, used for making common cordage, from Beerbhoom, in the division of Moorshedabad.

18. Parkinsonia fibre, obtained from the stems of *Parkinsonia aculeata*, introduced from the West Indies, sent from Madras, said to be well suited for the manufacture of paper.

19. Roxburghia fibre, obtained from the *Roxburghia gloriosoides*.

20. Artocarpus fibre, obtained from an *Artocarpus;* this and the preceding fibre are contributed from Assam.

21. Trap fibre, obtained from the bark of the trap tree, a species of *Artocarpus*, contributed from Singapore.

22. Trophis fibre, from the *Trophis aspera.*

23. Daphne bark, the fibrous bark of the *Daphne cannabina*, used in the manufacture of Nepal paper.

Besides these, several other fibrous substances from different parts of India are exhibited, such as the fibres of the Palmyra leaf, *Borassus flabelliformis*, from Madras, the bark of the Sissi tree, and a series of vegetable fibres from Arracan, called Theng-ban-shaw, Pathayon-shaw, Shaw-phyos, Ngan-tsoung-shaw, Shaw-me, and Ee-gywot-shaw, &c.

Several of the Indian fibres, already mentioned, are also contributed from Ceylon. Good samples are shown, both as mere fibres, and also in the various states of thread, ropes, and coarse cloth; of coir, aloe, flax, and the fibre of the Plantain, Hibiscus, and Sanseviera. Specimens of aloe fibre are contributed from the Cape of Good Hope. Aloe fibre, obtained from *Agave americana* and *A. vivipara*, has been also sent from Barbadoes.

From St. Vincent, samples of the "Mahant" bark in its raw state, the fibrous part in the state in which it is employed in the manufacture of fishing-nets, and samples of lapeto, used also in the manufacture of common cord and coarse lines for fishing-nets, are exhibited.

Several interesting specimens of various fibres are shown in the collection from British Guiana; among these are specimens of silk-cotton obtained from the *Bombax ceiba*, from George Town, Demerara, said to be exported to the United States, and used in the manufacture of hats.

Plantain fibre, *Musa paradisaica* and *M. sapientum*, from Plantation Vigilance, East Coast, Demerara, and from Plantation Klein, Pouderoyen river, Demerara. It is calculated that about eight hundred weight per acre of this excellent fibre might be obtained; at present very little of it is used. It is worthy of remark that, in some of the first lists of premiums offered by the Society of Arts, about 1762, special attention was drawn to the beautiful fibre of the plantain: "Whereas the stem of the Asiatic and American fruit-bearing plantain affords three sorts of fibrous materials, which resemble hemp, hard silk, and cotton, all which have been experimentally found capable of being wrought into various sorts of manufactures; and among others, into cordage, fustians, lawn, knitting, gauze, blonde lace, and excellent candle-wicks, sundry specimens of which manufactures may be seen in the hands of the register of the society, &c." This advertisement was continued for several successive years, but as no candidate came forward to claim the offered reward, it was at last discontinued.

Silk-grass fibre, the fibre of the *Agave vivipara*, from Plantation Vigilance, East Coast, Demerara, and Fibiiri fibre, obtained from the Ita palm, *Mauritia flexuosa*, from the river Berbice, are exhibited.

Mahoe, or Mahoe fibre, *Hibiscus elatus* or *Thespesia populnea*, from Demerara, is exhibited; it is a very strong, but coarse fibre, used for making cordage, coffee bags, &c.

Some good samples of Yucca hemp, together with a leaf of the *Yucca serrulata*, from which it is obtained, and rope and cordage manufactured from it, are shown from Nassau, Bahamas; also specimens of the fibre of the Palmetto, and of rope made from it.

In the Trinidad collection are some specimens of the fibre of the pine-apple and aloe, and also of the fibre of the Mahagua, or Majagua, *Sterculea carribæa.*

Specimens of the leaf and fibre of the *Doryanthes excelsa* are contributed from New South Wales, as well as some rope made of the latter.

Some good samples of New Zealand flax, *Phormium tenax*, are contributed by various exhibitors. Among others New Zealand flax, cleaned and prepared by machinery.

In the Austrian collections specimens of fibrous wood, divided into very thin and slender strips, and used instead of straw in the manufacture of plaited work, are shown, from Zinnwald, near Köplitz, in Bohemia.

A good fibre prepared from the date palm, together with rope, string, nets and brushes made from the fibres, are contributed from Broulos, Ghizeh, and other places in Egypt.

Specimens of flax, cotton, pita, or aloe fibre, and mallow fibre, are contributed from Madeira.

A fine and very beautiful fibrous material called "Bejuco" is exhibited from the island of Luzon. This substance is very strong, and is used in the manufacture of plaited work, and a sort of cloth remarkable for its strength and softness.

Specimens of several of the textile fibres of Cuba are contributed, including the Daguilla, or fibrous inner bark of the *Lagetta lintearia*, together with cord made of it; cord and mats made of palm fibre; Magagna, the fibre of the *Paritium elatum*, and the fibre of the *Hibiscus cannabinus.*

Samples of a valuable grass, the *Macrochloa tenacissima*, much used for the manufacture of cord, &c., and which might probably be advantageously employed by paper-makers, are exhibited from Huesca.

Plantain fibre, prepared from the stem of the plantain, *Musa sapientum*, is exhibited from Puerto Rico; and Pita, the fibre of the wild aloe *Agave americana*, is shown from Murcia.

Other fibres, from Jamaica, by N. Wilson, who has named the species correctly.

Musk okra, Abelmoschus moschatus, six feet six inches. Common okra, A. esculentus, nine feet.
Abroma augusta, six feet six inches.
Abutilon graveolens, five feet.
Abutilon venosum, four feet three inches.
Adansonia digitata, three feet nine inches. Monkey bread.
Æschynomene cannabina, four feet six inches. Dunsha of India.
Agave karato, three feet six inches. American aloe or karato.
Alisma cordifolia, two feet six inches. Water plantain.
Alpinia nutans, four feet. Shell-plant of India.
Alpinia allughas, three feet six inches. Shell-plant of India.
Amomum sylvestre, four feet. Common wild ginger.
Ananassa sativa, four feet six inches. Pine-apple, black var.
Anona muricata, four feet. Sour sop.
Anona cherimolia, four feet six inches. Cherimoyer.
Anona palustris, five feet. Cork-wood or cow-apple.
Artabotrys odoratissima, five feet two inches.
Arum macrorhizon, nineteen feet—twenty-six feet six inches.
Arum funiculaceum, four feet six inches.
Arum funiculaceum, aerial root, ten and a half feet–fourteen and a half feet.
Arum funiculaceum, petiole of, two feet six inches.
Astrapœa Wallichii, two feet six inches.
Bambusa gigantea, six feet. Bamboo.
Bixa orellana, four feet. Arnatto.
Bœhmeria nivea, three feet eight inches. Rhea or China-grass.
Bromelia pinguin, five feet six inches. Pinguin.
Bromelia karatas, ten feet two inches. Pinguin silk-grass.
Calathea zebrina, two feet six inches. Petiole of zebra plant.
Canna indica, one foot six inches. Indian shot.
Carludovica palmata, ten feet. Yipi yapa for the Panama hats.
Carludovica peduncle, two feet six inches.
Carica papaya, five feet. Pawpaw.
Carolinia insignis, four feet six inches.
Cecropia peltata, petiole, two feet three inches. Trumpet tree.
Caryota urens, two feet six inches. Kitool fibre from a palm.
Caryota urens, from spathe, four feet six inches.
Corypha umbraculifera, petiole, six feet six inches. Talipot palm.
Costus afer, three feet six inches. African costus.
Cocus nucifera, coir. Cocoa-nut palm. One nut yields one pound fifteen ounces.
Cordia sebestena, four feet six inches. Scarlet cordia.
Cordia macrophylla, six feet. Broad-leaved cherry.
Cordia gerascanthus, three feet. Spanish elm.
Cordia collococca, five feet. Clammy cherry.
Corchorus olitorius, three feet six inches. Jute of India.
Corchorus siliquosus, two feet eight inches.
Cordyline heliconiæfolia, two feet.
Cochlospermum hibiscifolia, five feet.
Curcuma longa, three feet. Turmeric.
Cyperus elegans, four feet eight inches. Elegant sedge
Daphne tinifolia, five feet. Burn-nose bark.
Eriodendron anfractuosum, five feet. Silk cotton tree.
Guazuma ulmifolia, four feet. Bastard cedar.
Gossypium hirsutum, four feet two inches. Cotton shrub.
Glossospermum, six feet.
Hedychium longifolium, four feet six inches. Garland flower.
Helicteres jamaicensis, four feet six inches. Screw tree.
Helicteres isora, three feet.
Heliconia brasiliensis, six feet six inches. Wild plantain, Brazil.
Heliconia bihai, seven feet. Wild plantain of Jamaica.
Heliconia psitta corum, two feet six inches.
Hibiscus rosa sinensis var., five feet. Chinese rose.
Hibiscus liliiflora, four feet. Lily-flowered shoe-black.
Hibiscus radiatus, six feet ten inches. Purple shoe-black.
Hibiscus Sabdariffa, six feet six inches. Indian sorrel.
Hibiscus vitifolius, four feet.
Hibiscus lampas, five feet.
Ismene calathina, peduncle of three feet six inches. Gigantic lily.
Kæmpferia galanga, two feet six inches. Galingale.
Kleinhofia hospita, three feet ten inches.
Kydia calycina, four feet four inches.
Lagetta lintearia. Lace bark.

Malachra capitata, five feet. Wild okro.
Malachra urens, three feet.
Malvaviscus arboreus, six feet six inches. Wild mahoe.
Maranta sanguinea, two feet six inches.
Maranta arundinacea, one foot six inches. Arrowroot.
Momordica luffa. Vine strainer.
Musa textilis, six feet. Manilla hemp.
Musa violacea, five feet six inches. Violet-flowering plantain.
Musa coccinea, four feet six inches. Scarlet flowering plantain.
Musa sapientum, eight feet six inches. Banana.
Musa paradisaica, nine feet. Plantain.
Musa cavendishii, three feet six inches. Chinese banana.
Ochroma lagopus, eight feet. Down tree fifty–seventy feet.
Oncidium carthaginense, two feet six inches. Orchid epiphytal.
Pandanus spiralis, five feet. Leaves of screw pine.
Pandanus spiralis, three feet. Aerial roots.
Pandanus moschatus, leaves, three feet.
Pandanus moschatus, aerial root, three feet.
Pandanus variegatus elegans, five feet, leaves of.
Pandanus variegatus, aerial root of, five feet.
Paritium elatum, seven feet. Mahoe tree, fifty–seventy feet.
Paritium macrophyllum, five feet. East Indian mahoe.
Paritium macrophyllum, petiole of, one foot six inches.
Paritium tiliaceum, five feet. Sea side mahoe.
Pothos violacea, two feet six inches. Wild coco.
Pothos violacea, wild coco, new, two feet six inches. Substitute for straw plait.
Pavonia odorata, three feet three inches.
Pavonia racemosa, three feet three inches.
Sterculia carribœa, three feet six inches. Large tree.
Sterculia patens, three feet three inches.
Sanseviera zeylanica, three feet. Bow-string hemp.
Sanseviera guineensis, three feet.
Sanseviera cylindrica, three feet.
Sida mollis, five feet six inches. Broom-weed.
Sida hirsuta, four feet.
Sida jamaicensis, two feet three inches. A common weed.
Sida siliaris, three feet. A common weed.
Sida dumosa, six feet. A common weed.
Sida rhombifolia, two feet eight inches.
Sida ulmifolia, three feet six inches.
Thrinax parviflora, four feet six inches. Fan palm.
Theobroma cacao, eight feet. Cocoa.
Tillandsia serrata, four feet six inches. Wild pine.
Triumfetta semi-triloba, four feet six inches. Burr-weed, common.
Typha latifolia, four feet. Cats'-tail.
Urena sinuata, three feet three inches.
Urena typhalea, three feet nine inches. White-flowering burr-weed.
Uvaria pendulata, four feet eight inches. Large tree.
Veronia curassavica, four feet six inches. Black sage.
Zingiber officinale, three feet six inches. Ginger.
Yucca aloefolia, two feet. Dagger plant.
Yucca filamentosa, one foot six inches.
Yucca gloriosa, three feet.

The most valuable of these for cordage will be the Bœhmeria nivea, introduced from India, the mahoes, the sanseviera, the common and wild plantains, and the bromelias.

Silk-cottons are produced in great abundance in many tropical countries, but the extreme smoothness and roundness of their beautiful silky fibres render them utterly useless for spinning, and being very brittle and easily reduced to dust, they are not well adapted for stuffing cushions or bedding. They may be useful for gun cotton.

The Brazilian collection contained the following:
Down of the seeds of *Echites suberosa.*
Yellow down, (paina de pedra or amarella,) the silk-cotton tree seeds, a species of *Bombax.*
Down of the Imbiriçu, *Bombax carolinum.*
Silk-cotton, from seeds of the Cuba, a *Bombax.*
Silk-cotton tree (paina de paineira macho.) from seeds of *Chorisia pecholtiana.*
Down of seed (paina de abobora) supposed to be one of the *asclepiadaceæ.*
Down of the silk-cotton tree (paina tema,) *Chorisia speciosa.*
White down of a silk-cotton tree, supposed to be a *Bombax.*
Down of a climber (paina loura, or cipo de pennes,) *Stipecoma peltigera.*
Down of seeds of *Oxypetalum campestre.*

Down of seeds of *Asclepias curassavica.*
Down of seeds of *Aranja albena.*
Down of seeds of *Bombyco spermum.*
From Trinidad:
Ochroma lagopus.
Maniearia saccifera.
Tillandsia usneoides.
Bromelia karatas.
Agave vivipara.
Sanseviera guineensis.
Musa rosaceæ, M. textilis, M. sapientum, and M. paradisaica.
Mauritia flexuosa.
Apeiba Tibourbon, A. ulmifolia, and A. aspera.
Triumfetta semitriloba.
Guazuma ulmifolia.
Theobroma cacao.
Sterculia caribea.
Hibiscus rosa-sinensis, H. trilobus, and H. esculentus.
Paritium tiliaceum.
Malachra capitata.
Pavonia racemosa.
Urenna sinuata.
Sida cordifolia, and S. rhombifolia.
Courupita guianensis.
Lecythis adatimon.
Bauhinia megalandra.

These lists of tropical plants are the more valuable and interesting because many of them have been introduced from foreign countries, and are preserved in the government conservatories, where they may be studied in their growing state. It is truly surprising to observe in these collections so many valuable fibrous materials, and a new interest is at once imparted to the inspection of these exotics, when we find them possessed of so great utility.

The commission also refer to the very extensive and exceedingly interesting cabinet of fibres which was opened for their study by Dr. G. C. Schæffer of this city, among which were the following rare fibres:

ENDOGENOUS.

Agave americana.
Arum funiculaceum, (root.)
Pandanus spiralis.
Ananassa sativa.
Musa violacea.
Abroma augusta.
Malvaviscus arboreus.
Heliconia braziliensis.
Fourcroya gigantea.
(Pita cauca?)
(Madagascar palm?)
Ahauwa (Coricaceæ.)
Carica papaya.
Cocoa-nut, coir.
Musa paradisaica.
Musa sapientum.
Yucca gloriosa.
Pothos violacea.
Bromelia karatas, long and fine.
Carlodovica palmata.
Yucca aloifolia.
Bromelia penguin, very fine.

EXOGENS.

Tillandsia serrata.
Kydia calycina.
Helicteres jamaicencis.
Triumfetta semitriloba.
Sida jamaicencis.
Urena typhalea.
Sida mollis, very soft.
Hibiscus esculentus, coarse.
Cordea macrophylla.
Hibiscus liliiflora.
Ochroma lagopus.
Hibiscus subdariffa.
Cordia sebestena.
Eurena simulata.
Hibiscus elatus, 60 to 80 feet.
Kleinhoflea hospita.
Œnothera biennis.
Asclepias cornuti, very strong.
Asclepias tuberosa.
Lagetta lintearea.

Hibiscus rosa-sinensis.	Bœhmeria nivea, Java.
" rubroflore pleno.	Broussonettia, South Sea islands.

Flax and hemp from various sources, and many other fibrous substances.

CHINA-GRASS.

From the Asiatic continent we have some specimens of cloth made of China-grass. This article is no doubt, in its essential qualities and uses, a species of flax, and therefore properly comes under our notice. It has been produced for many years by the industrious and ingenious people of China. We have remarked that in the coarse kinds of cloth made from it the fibre appears to be split into lengths, and attached to each other at the smaller ends. In this simple state the pieces are put together with great dexterity. This is an interesting example of the position of this manufacture among one of the most ancient nations of the world.

Besides the coarser kinds of cloth, there are exhibited some beautiful handkerchiefs and other fine linens made from this material. At the present day China-grass is occasionally used in making colored fabrics, combined with other substances, such as silk and cotton; and from the peculiar brilliancy of the fibre it shows to much advantage in this way. It has not as yet entered into extensive use for plain goods ; but some very meritorious attempts to ascertain its utility for that purpose have been made and are still in progress.

The commissioners were very much pleased with specimens of this material contributed by Lemuel W. Wright, from Brooklyn, New York, which are remarkable for their beauty. They consist of the raw material, and of combed and cleaned fibres, some of which are beautifully dyed. There was also a portion of tangled fibres or tow which was examined by the microscope, though not presented as flax-cotton. The fibres of this material are made up of very long cells which would be ruptured in any attempts to cottonize it, and it should be used as long-line. The specimens of cloth presented in which this fibre was combined with wool were very beautiful. No description of processes and apparatus used in the preparation of this material was laid before the commission.

The admirable appearance of this fibre so attracted the attention of the commission that they at once investigated the history of the plant since its introduction into this country and propagation at the Congressional gardens. As will be seen by reference to the United States Patent Office reports for 1855, Mr. Smith succeeded in growing plants from seed sent him from the West Indies by Mr. Wilson. Mr. Smith propagated many plants, and we understand that they were widely distributed throughout the southern States, under the impression that the climate would prove well adapted to it. Our observations upon the plants that remain in the Congressional gardens, confirmed by the opinion of Mr. Smith and other botanists, induce us to believe that Washington is on the northern boundary of the region where this plant may be successfully cultivated.

Specimens of an allied species have been presented from the northwest, St. Anthony, Minnesota, which demonstrate that we have a native plant of great value, to which we desire to direct public attention. Unfortunately, the specimens of the dead plant were in too imperfect a condition to identify its botanical classification.

Dr. Schæffer, in the Patent Office report for 1855, notices the China-grass in the following paragraphs:

"Many exogenous plants are herbaceous—that is, grow with little strength to the stem for one year, and then die down to the ground Even the perennial plants of warmer climates may, in the milder regions of the temperate zones, become annuals. In the case of true annuals there is no need for any great hardening of the woody tissues of the stem, as the sole end to be attained is a sufficient support for the plant until it flowers and the seeds ripen. Herbaceous stems, which die down to the ground each year, are evidently designed for a similarly restricted end. In the case of perennials, which, in other climates, might at length become woody shrubs, a single year's growth is not enough to allow of much induration of the wood-cells, and hence they approach nearly to the condition of true annuals, although the tendency to produce firm wood is constantly shown. If, under either of these three heads, a plant is found which furnishes a long and useful bast, a common and well-known treatment can be economically employed for the separation of the fibre. The plant is exposed to the action of the air and moisture, with more or less of fermentation, until the different tissues become separated, and even until the different cells are loosened in their adhesion, by which the harder and shorter woody fibres are broken, and in part removed, while the pliability of the bast allows it to pass through the treatment without injury. At the same time, the short and more tender cells are also removed, the latter stages of the process differing for different plants, all contributing to the complete separation of the remains of the adherent and useless types.

"Two things, then, must concur to make a useful fibrous plant; for not only must the bast be long, pliant, and in bundles of the proper size, but the wood which is to be rejected must be brittle, with short cells, not much hardened, or not strongly adhering together. Flax and hemp are, in our own country, the best specimens of these favorable conditions, but we have other plants nearly, if not quite, as well adapted to the manufacture of useful fibre; and other countries show that nature has not been stinted in her supply of materials capable of meeting one of the first wants of mankind.

"Differences in degree, even in the same plant, under varying circumstances, must frequently occur. The wood may become harder and greater in amount, the bast weaker and less in quantity, and the necessary inference might be drawn that judgment and skill in the culture of the plants would favorably modify these conditions. Experience, in advance of anything like an accurate knowledge of plant structure, has shown that this is true, at least for our common fibrous crops. Single stalks of hemp, or other such plants, allowed to grow at a distance from each other, or from other plants, would furnish but sorry specimens of fibre, as a single plant invariably shows a hard woody stem, and a coarse fibre in the bark. But when a number of plants are grown in a small space, every one knows that they grow longer, and are more slender than when separate. In this way the strength of the wood is greatly diminished, and the fibre of the bark, if less abundant, is finer, and possibly longer. If the plant has a tendency to branch, this is thus advantageously prevented. The close cultivation of okra, cotton, and other plants, which we are accustomed to see separated from each other, would probably show a fibre in the bark far more capable of treatment by the ordinary process than would be suspected by most persons. A knowledge of correct principles is here of the greatest advantage, when new materials are concerned."

TROPICAL FIBRES.

Mr. Squier has presented a very pretty book upon tropical fibres, their production and economic extraction. It is based upon extensive observations made during his residence of some years in Central America, while acting as minister of the United States to that country. From this work we make some extracts and condensations.

He says he was struck with the number and variety of endogenous plants, such as agaves, pine-apples, plantains, and palms, which are characteristic features of the landscape. These plants all abound in valuable textile fibres, while many of them produce staple articles of food, oil, and refreshing as well as intoxicating drinks. The fibres are capable of being reduced to any degree of fineness, and are possessed of great strength, and are thus fitted for the most delicate tissues as well as for the strongest cables.

He very naturally asks himself, "Why are not all these fibre-bearing plants with which the country teems in some way utilized?" This question was soon answered when he came to observe the rude method by which the fibres were extracted. The natives slowly remove the pulpy and vascular portions of the plants with a triangular scraper, or a blunted knife, and thus procure but a few pounds of imperfectly cleaned fibres during a long day's toil. They have no machinery, and even in the Philippine islands, where ten million dollars worth of plantain fibres are annually produced, he learned that no machinery was yet applied.

The object of the book appears to be, to direct attention to some of these numerous and valuable plants, in the hope that Yankee ingenuity will succeed in producing and applying machinery by which a single man may extract a greater quantity of fibres, and in better condition, than one hundred men can obtain through the primitive modes now in use. This great desideratum, Mr. Squier thinks, we have obtained in some modification of Sanford & Mallory's flax and hemp machines.

The following tables are given of the value of these products:

Tropical fibres imported into the United States for the year 1860, (*custom-house valuations.)*

Kind.	Quantity.	Value.
Manilla hemp	347, 431 cwts.	$1, 631, 884
Sisal "	5, 630 "	25, 114
Coir, &c.	112, 585 "	163, 039
Gunny bags		287, 387
" cloth		1, 795, 256
Total		3, 902, 680

Tropical fibres imported into Great Britain for the year 1855, *(estimated real value.)*

Kinds.	Quantity.	Value.
Jute (gunny)	539, 297 cwts.	$2, 235, 835
Manilla hemp	92, 755 "	1, 443, 495
Other fibres	8, 591 "	51, 545
Total	640, 643	4, 730, 875

These quantities, however, he considers insignificant compared to the illimitable sources of supply.

Mr. Squier asserts that nearly all of these fibres are white while the plants producing them are in their green state, and that they become discolored by their exposure to the sun's rays while they are yet associated with the sap and its gummy and coloring matters. He also alludes to the danger from excessive fermentation to which vegetable tissues are exposed in attempts at rotting them in tropical climates. These gummy, coloring, and other extraneous matters of plants are said to be soluble in cold water, if the plants are treated while in a green condition, and may be removed by crushing the tissues, scraping and heckling and washing them simultaneously. The gum held in solution by plants, while in the growing state, becomes dried upon the fibres, and renders them harsh, brittle, and more or less unfit for textile purposes.

The pine-apple, *Bromelia sylvestris*, the wild species produces the silk grass of the British West Indies, the pita of Mexico and Central America. This plant is hardy and luxuriant, and produces an abundant and excellent fibre, which entitles it to a high rank among fibre-producing plants. All the bromelias yield a similar fibre. All varieties of the *musa* or plantain family produce good fibres; of these the *musa textilis* or Manilla grass, though a native of the east, flourishes in great luxuriance in tropical America and the Antilles. The agaves are peculiar to America, but the *Agave americana* flourishes in southern Europe and Algeria. The *Agave mexicana*, or maguey, and the *A. sisalina*, or *Hennequin* and varieties, are peculiar to America; the latter yields the Sisal hemp, which is said to be equally hardy with the *Bromelia sylvestris*, and grows in every variety of soil, even among rocks and in arid wastes where it produces an abundance of excellent fibres.

Dr. Henry Perrine attempted the introduction of some of these plants into southern Florida, under protection of Congress, granted in 1837, by which he acquired pre-emption to certain lands south of the 26th parallel of latitude. Among the plants he introduced from Central America were three or four species of the agave, the cochineal cactus, paper mulberry, date palm, &c.; all of which succeeded well until the occurrence of the Seminole war, which resulted in the destruction of the plantations and in the death of this patriotic citizen. Of some of these plants Dr. Perrine has written, that being "lighter, stronger, more elastic, and more durable than the cortical fibres of hemp or flax, and produced by perennial self-propagation, in stony, sandy, or swampy surfaces, with the easiest and cheapest cultivation, and the speediest and simplest preparation, the relative and positive prices and properties of the foliaceous fibres of the agaves and the plantain, insure their substitution for cortical fibres in the general consumption of mankind."

This prophecy has in great degree been fulfilled within our time in the increased consumption of this class of fibres, but we do not agree with Mr. Squier, who asserts that our agaves and bromelias supply better substitutes for flax and hemp than any of the Old World plants. We must admit that provident Nature has prepared special products for special uses, endowing them with peculiar properties, and varying forms in their ultimate structure, so that each is especially adapted to the several particular purposes to which the ingenuity of man in the course of centuries has applied it.

Mr. Squier reminds us that all vegetable fibres may be resolved into three great classes: the foliaceous, cortical, and capsular. The first are obtained from *endogenous* or *monocotyledonous* plants. Near the tropics this class of plants is largely represented by the yuccas, agaves, plantains, and palms, their fibres are imbedded in the cellular tissues and pulpy matter of their stems and leaves, and may generally be extracted by mechanical means.

The cortical fibres of this classification are obtained from the *exogenous* or *dicotyledonous* plants, containing the true *bast* fibres. They are often of great length, and but little hardened, some form great trees, while others are herbaceous. Among them we find the mallows, the nettles, the flax, and some of the bean family. In all of these there is also a woody tissue embraced by the bast, and constituting the stem of the plant, while the bundles of fibres are connected together, and with the stem, by a peculiar vegetable substance which needs to be separated in their preparation.

The third class, or capsular fibres, are obtained from the pods where they are associated with the seeds. Cotton is a familiar illustration of this class.

He quotes Mr. Dennis as speaking of the Sisal hemp thus:

"This gigantic plant delights in dried, rocky land containing an abundance of lime, and there are thousands of acres of land in this region, worthless for other agricultural purposes, on which a ton of clean Sisal hemp might be produced yearly, after the plant has reached an age to allow of cutting off its lower leaves, which would be in from three to five years, according to circumstances. Neither the growth of the plant, nor the amount of its product here, is any longer an experiment. Nor is there any longer a doubt as regards the value of the fibre, a number of tons of it having been collected and sent to market, where it readily brought within half a cent per pound as much as the best Manilla hemp, and that is about two hundred and fifty dollars per ton. A thousand plants should be set to the acre, and from the constant shoots which spring up it will be seen that the same land will not require replanting. After the plant is of sufficient growth, the lower leaves are cut off at proper times, leaving enough on top to keep it healthy. These leaves are composed of a soft, watery pulp, and are from two to six feet long, from four to six inches wide in the middle, and frequently three inches thick at the butt, having the general shape of the head of a lance. They contain a gum, which is the chief cause of their being rather troublesome in separating the fibre from the pulp. Neither the epidermis nor the pulp is more than a powder, after becoming dry, if the gum be entirely crushed or mashed out. This is a most important fact in relation to the means to be adopted to clean the fibres from the pulp. As these are continuous and parallel, and imbedded in the pulp, I feel certain that a system of passing the leaves through a series of heavy iron rollers, firmly set, something like those of a sugar mill, and throwing water on the crushed leaves, in jets or otherwise, in sufficient quantities to wash out the gum, (which is perfectly soluble in water,) will thoroughly clean the fibres without loss, so that when they become dry, and have been beaten to get out the dust, they will be fit for use. *At ony rate, the right plan for separating the fibres has not yet been discovered, although there has been enough done in it to show that they can be got out at a profit.* Here, the people either preserve the primitive process (which is practiced in Yucatan) of beating and scraping the leaves, or, after crushing them between a pair of rollers, steeping them in an alkaline solution for a few days and then heckling them. But both scraping and combing destroys too many of the fibres by breaking them, which would not be done by a system of rolling and washing out the gum. In Yucatan they sometimes ferment the beaten leaves in water or mud; but this stains and weakens the fibres so as to reduce their value, I believe, more than half. Even steeping the leaves in an alkaline pickle, although it may not much weaken the fibres, as the juice of the leaves is acid, nevertheless destroys the silky gloss which they possess when got out of the fresh leaves by aid of pure water alone, besides increasing the cost of extraction. I have some fifty acres of the plants under cultivation, and am increasing the quantity as I have opportunity."

Mr. Hermonds, of Indian River, Florida, informs me that the Sisal hemp grows well there, and has continued to thrive well for four years. He thinks that my estimate of a ton of fibre per acre is too low. The experiments which I have made during the past year, in getting out a number of tons of this fibre, prove that all the vesicles of the leaves are ruptured by crushing or rolling, and that the pulp or gum can easily be washed out by either salt water or fresh. The plan which I have found most successful was to wet the leaves, being careful to rupture all the vessels, then confine these crushed leaves in an open-work wooden frame or box, which I placed in such a manner that the tide forced the sea-water through them both at the ebb and flow. In this manner the gum and pulp were so far washed out, in from three to six days, according to the temperature of the air and water, that by beating the fibres a little they were fit for market.

Mr. Hermonds mentions, as a tested fact, that steeping the crushed leaves in boiling water, even for a few minutes, at once dissolved the gum and cleaned the fibre. This renders it almost certain that when a steam-engine is used to propel rollers and crush the leaves, the waste steam can be rendered effective to clean the hemp by blowing it off between the rollers, aided by a little water, in a jet, while the leaves are passing through.

Mr. Squier objects to the use of steam or hot water. The amount of Sisal hemp imported into the United States in 1854 was 925,900 pounds, valued at the custom-house at $64,516, but having a real value of upwards of $100,000.

Mr. Squier tells us that the Maguey is chiefly cultivated in Mexico for its juice. The plants are set in rows, about five feet apart. When the *hampe*, or central stem, which often attains the height of forty or fifty feet, is on the point of efflorescence, it is cut off, and a hollow scooped out for receiving the sap. This keeps running for two or three months, the reservoir being emptied three or four times a day. The yield from a vigorous plant is about four hundred English cubic inches per day, or, for the season, from two to three hundred gallons. This enormous product is all the more remarkable from the fact that the Maguey plantations are generally in arid grounds, and frequently on ledges of rocks scarcely covered with vegetable earth. The plant has firm and vigorous leaves, and is neither affected by drought, wet, hail, nor by the excessive cold which prevails in the higher Cordilleras of Mexico. It perishes after efflorescence, but an infinity of shoots then spring from the decaying roots. No known plant multiplies with greater facility.

The fibre of the Maguey is coarser than that of the *Agave sisilana*, but nevertheless of great utility and extensively used.

Agave americana.—This plant, which has been naturalized in the south of Europe and Algeria, is often confounded with the *Maguey* or *Agave sisilana.* Its flowering or central stem, when the plant is vigorous, rises to the height of forty feet or upwards, and throws out branches on every side, like those of a candelabrum, so as to form a kind of pyramid, each branch supporting a cluster of greenish red flowers. These give place to bulbous seeds, which, when planted, spring up rapidly and luxuriantly. The original plant, however, dies. The time of flowering varies with localities and climate. An erroneous notion is that it flowers only once in a hundred years. Hence the popular name of century plant. The fibres from its leaves closely resemble those from the Maguey. It is a hardy plant, and often covers rocky, barren eminences, where every other kind of vegetation fails to take root.

Bromelia sylvestris, or wild pine-apple, the *istle* of Mexico, but known as *pita* and *pcñnella* in Central America and Panama, and in the West Indies as *bromelia pinguin*, or *penguin*, can hardly be said to rank second to the *hennequins* in economic importance. It is widely diffused throughout the tropics, growing everywhere, in all varieties of soil. It is extensively used for hedges, for which its long, straight, and spiny leaves admirably adapt it, and may be cultivated with a minimum of labor and cost, and in unlimited quantities.

The leaves are from five to eight feet long, from one and a half to three inches wide, thin, and lined with a fine, tough fibre, the *pita*, equal in strength and beauty, and in other respects better than that of the *hennequin*. It is altogether a superior substitute for flax

This plant is self-propagating, and, left to itself in an open field, will soon cover the ground. In Central America, but particularly in Nicaragua, it is so abundant in the forests as to be a serious obstruction to the passage of man or beast.

Major Barnard, United States army, in his report on the isthmus of Tehuantepec, speaks as follows of the *istle:*

"Among the spontaneous products of the isthmus is *Bromelia pita*, or *istle*, which differs in some respects from the *Agave americana* of Europe, the *pulque maguey* of Mexico, and the *Agave sisilana* of Yucatan. Of this prolific plant there are numerous varieties, all yielding fibres which vary in quality from the coarsest hemp to the finest flax. It is indifferent to soil, climate, and season, and the simplicity of its cultivation, and the facility of extracting and preparing its products, render it of universal use."

In the year 1857, (January 14,) Chief Justice Temple, of Belize, or British Honduras, read a paper before the Royal Society of Arts of London, on the resources of that part of Central America. Among other objects of interest, he exhibited a quantity of the fibre of the plant under notice, as well as of the *Agave sisilana.* Of the former, or *Bromelia sylvestris*, he said:

"The plant called *Bromelia pita*, *istle* by the Mexicans, and *silk-grass* by the Creoles of British Honduras, grows spontaneously in the greatest abundance. The leaves are of a soft, dark green, from five to thirteen feet long, and from an inch and a half to four inches wide. Along the edge of the leaf, about six inches apart, are short, sharp, curved thorns. When the plant is cultivated, these gradually disappear. The fibre which the leaf contains is unquestionably of a very superior description, and, I have no doubt, could be used in every species of textile fabric. I have been informed by leading manufacturers that this fibre is equal to the best China-grass, superior to the New Zealand flax, and capable of being manufactured into the finest fabrics."

In the discussion which took place among the leading members of the society on the paper of Judge Temple, Mr. P. L. Simmonds, editor of the Mark Lane Express, said:

"I have to-day seen some of the indigenous specimens of the *penguin*, or *bromelia*, from Honduras, which have been operated upon by a new, patented process of Messrs. Pye Bros., of Ipswich, and am astonished at the remarkable improvement and high commercial value which have been given to the article. The main difficulty that has stood in the way of utilizing many of these fibres, and making them cheap and of universal use, has been the want of cheap and efficient machinery for preparing them, and getting rid of the gummy and other matters which surround them, without injury to the fibres. Such machinery is a desideratum of the age."

Mr. J. B. Sharp said:

"He could confirm all that had been said by those who preceded him. He had that morning submitted some of the fibres to a close microscopical examination, and had ascertained that each fibre contained from five to twelve, or more, fine filaments, held together by gummy matter capable of being dissolved by proper processes. Some of the specimens before them had been passed over the comb or hackles of a flax-mill, and had been pronounced by the most experienced flax-spinners of the country (England) to be greatly superior to Russian flax, and approaching the best descriptions of Belgian flax, in capability of application to the finest textile fabrics.

"He had no hesitation in saying that the three British colonies of Jamaica, Honduras, and Guiana were capable of furnishing fibres from the plants in question to the value of $15,000,000 per annum."

MUSA OR BANANA FAMILY.

The various members of this family rank only second to the *agaves* and bromelias in the quantity and value of their fibres. Several varieties are cultivated for food, yielding a delicious and nourishing fruit; and in such abundance that Humboldt estimates the product of a single acre as equal to the average product of 133 acres of wheat, and 44 acres of potatoes. An interesting and, for the purpose which we have in view, a most important fact, is that the tree or plant, whether plantain or banana, is almost universally cut down when the fruit is gathered. With proper machinery for extracting the fibre, the many millions of plants thus left to rot could be converted into articles of first utility for mankind, such as cordage, cloth, paper, &c.

Manilla hemp.—The fibre known to commerce as *Manilla hemp* is extracted from a variety of the banana, the *musa textilis.* It is a round, silky-looking fibre, nearly white. It is admirably adapted for cordage, and from the finer fibres obtained from the petioles of the leaves are made many of the delicate and celebrated muslins of India.

The stems of all the plants of this order or family are made up of the united petioles of the leaves. They contain such a remarkable abundance of spiral vessels that they can be pulled out by handfulls, and are sold for tinder. Each spiral vessel contains six or seven fibres, which when separated constitute the *Manilla hemp.*

The value of Manilla hemp in the English market is about $25 per ton more than the best Russian hemp.

M. Perronttel, botanist of the French government in Gaudaloupe, has given a very full account of the *abaca* of Manilla, and the mode of extracting its fibres:

'The *abaca* of the Philippines differs essentially from all the varieties of banana known. Its stem, which rises from a tuft of shoots, has a height of from fifteen to twenty feet, of a dark-green color, and very smooth on its surface. Its leaves are of the same color, long and straight, with strongly marked nerves both parallel and transverse. The fruit is small, triangular, resembling abortive bananas, and scattered here and there near the extremity of the fruit-stem. It is full of black seeds, almost round, and similar to those of the *gumbo.* These seeds fructify rapidly after planting, and the young plants are strong and vigorous, attaining the dimensions already indicated within the short space of eight or nine months. The plant requires a rich, humid soil, and rejoices in thick forests, at the base of mountains, where it acquires in a short time an extraordinary development. I have never seen it in such perfection as on the humid yet high grounds belonging to M. de Lacharriése (Guadaloupe,) notwithstanding its entire abandonment to itself in the midst of a jungle of other plants. Only two shoots were planted here, about seven years ago, yet now the whole valley is covered with them so as to resemble a forest. This fact proves sufficiently that the plant is robust and easily cultivated; indeed, that it can be propagated with a minimum of care to the greatest needful extent.

"No doubt, however, its regular cultivation would be beneficial in many respects, especially if the plants were kept at a reasonable distance apart, so as to permit their full development. In the Philippines the stems are cut down as near the ground as possible at the moment they evince signs of flowering—that is to say, about eight months after planting. The outer sheath or envelope is then stripped off, leaving the petioles that compose the stem proper. The stem is next split into two. and afterwards into four parts, after which the petioles or layers are stripped off, working from the exterior. Those composing the very interior or heart of the stem are thrown aside, as being destitute of fibres of sufficient strength for economic purposes. The reserved filaments or slips are now pounded with clubs of hard wood, first on one side and then on the other, until the transversal and cellular tissues and porous and gummy matters are expelled. After this the fibres are passed frequently through a coarse hackle, and washed many times in clear, running water, until perfectly free from all extraneous matters. They are then hung over ropes or poles to dry in the shade.

"As the fibres are not all of the same size, those being finest which come from the slips nearest the heart of the stem, they are carefully separated by hand; the coarsest being laid aside for cables, ropes, cords, &c., according to their relative fineness, while the finest are reserved for the more delicate tissues.

"In sending them to Europe for sale, the fibres are packed in bales of greater or lesser size. Those which are of fifteen feet in length or upwards are folded back on themselves three or four times, according to the length of the cases containing them; those of less length are folded two or three times, after which the cases are hermetically closed, in order to protect their contents from humidity on board ship.

"This is the manner in which the *abaca* of the Philippines is prepared, and it only remains to indicate the purpose for which it may be used in France.

"As already said, the coarser fibres are used to make cables, which have great solidity and durability. Ropes of great tenacity are also made from the stems, which are used in many ways, but particularly in rigging coasting vessels; of the finer sort, tissues or muslins of great beauty are made, which are very dear even in Manilla. I had a number of shirts made from this muslin, which lasted me a very long time, and were cool and agreeable in the use. But it is especially in France that tissues of this material are best made and of greatest beauty. They receive all colors with equal perfection. Veils, crapes, neck-handkerchiefs, robes, and women's hats, all of great beauty and high cost as well as of wonderful durability, are among the manufactures from the *abaca* fibres. Besides, they are used for various articles of men's wear, such as shirts, vests, pantaloons, &c.

"Ever since this precious fibre became known in France, our vessels have frequented Manilla, returning freighted in part with the article. The quantity imported, however, falls far short of the demands of the manufacturers, and its production certainly deserves the attention of all our southern colonies. Its cultivation, as we have seen, is easy, and as regards cost, next to nothing; and there is no reason why it should not become an important article of commerce throughout tropical America."

Mr. Jules Itier, special agent connected with a late French mission to China, made a report to his government on the productions and resources of that empire:

"The *abaca* cloth is almost transparent, somewhat rigid, light, and cool to the touch, and is used by the Tagals for napkins, handkerchiefs, shirts, &c., of various colors. The fibres are not spun or twisted, but the threads are used in their natural state, being only tied together at their ends. They are next wound into balls, soaked for a day in hot water, dried in the sun, and are then ready to be woven."

THE PALM FAMILY.

The *Gommuti saguere*, or Ejoo fibre, from the variety of palm known to science as *arenga saccharifera*, is produced by the splitting or decay of the leaf-stalks. To the natives of the tropics these naturally prepared fibres are invaluable, supplying them with materials for canvas, cordage, and a variety of economic purposes. It is best known as a product of the East Indies, but a similar article is also found under the tropics in America, where it is produced from a variety of palm known to science as the *attalea funifera*. The tree producing the *gommuti* fibre rises from twenty to thirty feet in height, and has a dense crown of leaves. The petioles are very stout, and it is at the base of these, completely embracing the trunk of the tree, where the horse-hair-like material, which co-operates to render this palm so valuable, is found. Cheaper, more durable, and stronger than *coir*, it has the additional advantage of resisting moisture, for which reason it is highly valued for ropes, especially cables, from their not being liable to injury when stowed away below, wet with salt-water. Underneath this naturally produced fibre the *gommuti* palm produces a soft, gossamer-like substance, called *boru*, used in place of oakum for calking, &c.

To the natives of the East Indies and the Philippine islands this tree is invaluable. Its juice, when reduced, produces sugar, and when fermented, an intoxicating liquor. From one hundred and fifty to two hundred pounds of sago may also be obtained from a single tree, which will furnish from four to seven pounds of fibre.

Piassava, monkey-grass, or Para-grass, and called by the natives *chiqui-chiqui*, is produced from a variety of palm (*attalea funifera*,) which abound on the Amazon river and its tributaries, in very much the same manner as the *gommuti* from the Arenga palm. The tree is one of the most elegant of its family. Its stem rises from twenty to thirty feet, straight as an arrow. From the top of this springs a tuft of pinnated fronds or leaves, often nearly twenty feet in length. Before the decay of the petioles the fibres become detached at the margin of their bases in large quantities, hanging down ten or twelve feet in tufts, whence comes the name *funifera*, rope-bearing.

Nearly all the cordage used on the Amazon is made from the *piassava* fibre, which is remarkably round, not very pliable, and often about the thickness of the small green rush. In 1851, eight hundred tons were exported from Para to England, where it is used for making brushes and brooms. The brushes of the street-sweeping machines of London are made from this fibre.

Coir, or cocoa-nut fibre, manufactured from the husk or outer covering of the common cocoa-nut, is nearly as strong as hemp, and is used in the east for cordage. The fibre is prepared by soaking the husks in water for a long period of time, not unfrequently for six months, and until they become soft. They are then dried and beaten until the woody part falls out like saw-dust, leaving only the fibres. The cordage made from *coir* is second to that from no other material. The amount of *coir* rope imported into Great Britain from the East Indies, for the year 1859, was 8,238,200 pounds, valued at $392,265.

Corosal, coyal, or Corajo palm, abounds in dry, arid, rocky ground throughout tropical America, but particularly in Central America, and in the interior of Cuba. It grows to the height of twenty feet, and the trunk is covered, from bottom to top—as are also its leaves—with long, narrow, *sharp*, and hard spines. It produces a large cluster of nuts with a hard shell, of the size of grape-shot, from the kernel of which is extracted an oil indistinguishable from that of the cocoa-nut. The woody exterior of the trunk covers a pulpy heart, saturated with a juice of a fresh, agreeable flavor, which may be obtained by incision, and which is called *vino de coyal*. When fermented, it becomes intoxicating, like the pulque of the *maguey*. In times of great drought, when vegetation is destroyed, this pulpous heart is often fed to cattle. The leaves of the *coyal* are lined with a long and excellent fibre, called, in Cuba, *pita de corojo*, from which ropes, cords, &c., are manufactured. The fibres are equal to those of the *hennequin*, from which they can hardly be distinguished.*

CATALOGUE OF CONTRIBUTIONS OF FLAX, HEMP, AND OTHER FIBRES.

RAW MATERIALS.

No. 12. GEORGE C. DAVIES, *Dayton, Ohio*.—5, flax-straw tangled; broken on Messrs. Sanford & Mallory's old machine.

" 17. STEPHEN ALLEN, *Boston, Massachusetts*.—13, 16, 17, flax-straw.

" 19. R. TENANT SHAW.—1, broken tow and flax.

" 45. JOSHUA S. COE, *Newton Square, Chester County, Pennsylvania*.—Flax retted, broken and heckled.

" 46. WILLIAM S. LOWRY, *Saratoga Springs, New York*.—Retted flax, good specimen.

" 55. LEMUEL W. WRIGHT, *Brooklyn, New York*.—China-grass in the crude state as stripped from the plant.

" 58. H. BURGESS, *Royer's Ford, Pennsylvania*.—1 and 3, raw flax; 6, Kentucky hemp; 8, Russia hemp.

" 59. J. W. SWAN, for the Medina Flax Company, *Medina, New York*.—Flax-straw, dew-retted.

" 60. J. D. LANG, *Vassalboro, Maine*.—Flax-seed and straw, well grown.

" 63. Captain C. W. PEDEN, *Parkersburg, Western Virginia*.—Flax-straw in the boll, good.

" 66. G. L. THOMPSON, *Wood Lawn, Maryland*.—Hibiscus esculentus, showing the fibre produced by this plant.

" 67. S. W. POND, *Shakopee, Minnesota*.—Urtica? or Bœhmeria, the species not identified.

" 68. *Apocynum species*.—Unknown, but believed to be A. cannabinum. Contributor unknown.

" 73. *Crude flax*.—Contributor unknown.

" 74. J. S. RITCHIE, *Superior, Lake Superior, A. D.* 1863.—Fire-weed, Epilobium angustifolium. See Dictᵉ. Histᵉ. Naturelle, Paris, 1819, page 74, where it is set forth that attempts had been made with this substance, which had proved unavailing.

" 77. JOHN H. MOORHEAD, *Ida, Ida County, Iowa*.—Wild flax, a native plant; the botanical identification of which could not be made out.

" 109. R. B. DEAN, *Waterford, Minnesota*.—Grass-down, of Eryophorum polystachyon; a very beautiful grass, but not applicable in the arts, so far as we know.

" 128. RUTGER B. MILLER, *Utica, New York*.—Epilobium angustifolium, a useless fibre which cannot be easily separated from the plant and collected in quantity.

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* Condensed from *Tropical Fibres*.

PREPARATIONS.

LONG FIBRES.

" 5. THOMAS H. QUERIAN, *Baltimore, Maryland.*—Specimens of jute, in the crude state as presented in commerce.

" 11. STEPHEN ALLEN, *Boston, Mass.*—12, prepared flax; 13, flax broken; 16, flax-straw retted; 17, flax-straw unretted

' 12. GEORGE C. DAVIES, *Cincinnati, Ohio.*—5, tangled flax-straw broken by Mallory's machine, shown as the stock from which he prepares his clean tow, called Erolin, or flax-wool.

" 15. JOSEPH LEA, *Philadelphia, Pennsylvania.*—Specimens bleached by Lea & Roth's process: 1, Dutch flax retted 50 minutes; 2, Dutch flax slightly done; 3, American retted one half done; 4, Dutch flax retted 50 minutes; 5 and 6, American retted, only half done; 7, American retted 65 minutes; 8, Riga flax retted 25 minutes; 9, Dutch retted 60 minutes; 10, unretted American; 11, unretted Irish, part bleached; 12, Friesland, bleached and unbleached 75 minutes; 13, American, unretted, bleached and unbleached; 14, old tarred rope, bleached; 18, samples of crude flax, same as made into yarn. These are beautiful samples of bleaching, and appear to be perfectly clear of chlorine.

" 17. GEORGE GRAHAM, *Cincinnati, Ohio.*—2, flax-straw broken; 6, cottonized flax; specimens of the Claussen product.

" 19. R. TENANT SHAW, *South Lansing, New York.*—7, long-line disintegrated and bleached; 8, long-line disintegrated and heckled; 10, jute treated; 13 and 14, "extract de Vlas" flax fibre; 15, tangled fibre; 16, from green straw as above; 17 and 18, tow as above; 19 and 20, jute by same process; 21, China-grass as above. These latter are prepared by a peculiar patented process, in which a ferment prepared from the flax itself is used to set up the fermentation.

" 41 & 81. C. G. GRABO, *Detroit, Michigan.*—Flax cut, to illustrate his apparatus for shortening the fibre; the cut ends are soft and even.

" 45. JOSHUA S. COE, *Newton Square, Pennsylvania.*—Flax retted, broken and heckled by hand; good flax.

" 46. WILLIAM S. LOWRY, *Saratoga Springs, New York.*—Dressed flax, very good specimen.

" 49. MARY MC CREARY, *Anderson, Ohio.*—Prepared flax, beautifully prepared.

" 51. AUGUSTE FEIJE, *Theresa, Wisconsin.*—Flax very beautifully dressed, soft and fine, and of good color.

" 55. LEMUEL W. WRIGHT, *Brooklyn, New York.*—Specimens of prepared China-grass, very beautiful illustrations of the silky character of this foreign fibre when properly treated. The process not disclosed.

" 56. LOCKPORT FLAX COMPANY, *Lockport, New York.*—Broken flax, heckled flax specimens of stock used at this mill.

" 57. ARNOLD WILKINSON, *Providence, Rhode Island.*—1, hemp whitened; 2, flax whitened; 3, flax "decolorized without caustic;" hemp from old rope whitened; 5, hemp baling rope. These specimens show what may be done in operating upon very unpromising material.

" 58. H. BURGESS, *Royer's Ford, Pennsylvania.*—3, raw flax and straw; 10, disintegrated in the straw; 6, hemp; 1, flax. The processes by which these are prepared is given in the chapter on manufacturing.

" 59. J. W. SWAN, for Medina Flax Company, *Medina, New York.*—2, flax broken by his machine; flax dusted by his machine; well prepared.

" 61. H. MC FARLANE, *Rocky Hill, New York.*—1, green flax cottonized; 2, green flax treated; 4, unretted flax treated; 8, hemp Claussenized; 12, China-grass prepared. See process and statement in the appropriate chapter.

" 62. Specimens lost and contributors unknown.

" 65. MARY ALLEN, *Pittsburg, Pennsylvania.*—Prepared flax brought from Antrim, Ireland, a very beautiful specimen.

" 68. Contributor unknown; 2, Asclepias cottonized; 3, Asclepias retted and broken.

" 69. C. C. WILLIAMS, *Oswego, New York.*—Cottonized tow by Neil Cook, a very good specimen.

" 70. JAMES Y. SMITH, *Delaware, Ohio.*—1, straight flax scutched by McBride's machine; 2, tangled tow.

" 73. Contributor's name lost; bleached flax.

" 83. JAMES Y. SMITH, *Providence, Rhode Island.*—1, flax from tangled straw, dressed on McBride's machine; 2, flax from retted straw grown in Delaware, Ohio, dressed as above; both good specimens of long-line.

" 103. JAMES E. MALLORY, *New York city.*—1 to 6, retted flax, well broken; 7, unretted flax, some shives; 8, Irish water-retted, beautifully prepared, elegant ribbons of fibre; 9, tangled straw not retted, some shives; 10 to 12, straight straw, well broken, and has some loose shives; 13, Missouri hemp, dew-retted, good. All broken on the Sanford & Mallory machines, and are good illustrations of their capability to break the straw.

" 105. Contributor's unknown, *Piqua*, *Ohio.*—1, flax tow.

" 107. CHARLES KEMPER, *Orange Springs*, *Snyder county*, *Pennsylvania.*—Asclepias fibre, strong and very promising for application in the arts.

" 113. ISAAC HEDGES, *Chicago*, *Illinois.*—Flax fibre prepared, very nice flax.

" 122. REUBEN HENDRICKSON, by Hon. John Law.—Fine flax, a good specimen.

" 129. A. BEEBE, 229 *Broadway*, *New York.*—1, two shades jute; 2, American hemp tow; 3, Russian tow; 4, dyed jute "lubricated."

" 130. R. CHUTE, *St. Anthony*, *Minnesota.*—1, fibres of a native Bœhmeria, long and strong; 2, tow of the same; 3, bleached fibre of the same plant. See microscopical examination and report in chapter on peculiarities of fibres.

SHORT FIBRES.

" 4. JAMES H. CHILDS, *Pittsburg*, *Pennsylvania.*—1, 2, flax-cotton; 3, cottonized hemp.

" 11. STEPHEN ALLEN, *Boston*, *Massachusetts.*—9, Fibrilia wool, bleached; 10, Fibrilia hemp brown, colored and bleached; 11, Fibrilia wool, natural. Shown as specimens of stock used in the production of the fabrics contributed.

" 12. GEORGE C. DAVIES, *Dayton*, *Ohio.*—1, Erolin, or flax-wool; 2, Erolin, blue; 3, Erolin, black; 4, Solferino; to show the capacity of this material for taking color.

' 14. CYRUS BACON, jr., assistant surgeon U. S. A., *Baltimore*, *Maryland.*—Cottonized flax, carded; cottonized Asclepias; nice specimens. For the latter see report of microscopist.

" 17. GEORGE GRAHAM, *Cincinnati*, *Ohio.*—3, flax-cotton; 4, 5, 5½, same.

" 19. R. T. SHAW.—3, flax disintegrated and retted; 4, tangled tow treated; 5, hemp as No. 4; 6, flax as No. 3; 9, flax-cotton: 11, tow bleached; 12, tow bleached chemically. These specimens are not so satisfactory as we should desire.

" 21. BRADLEY N. HOWELL, *Philadelphia*, *Pennsylvania.*—Flax-cotton, small hand specimen of good appearance.

" 36. L. YEOMANS, *Fulton*, *Oswego county*, *New York.*—Flax-wool for batting, &c.

" 37. JONATHAN KNOWLES, *Providence*, *Rhode Island.*—Flax-cotton, nice specimen. Process not communicated.

" 18 & 39. ROBERT FLETCHER, *Oswego*, *New York.*—1, flax-cotton to work with cotton; 2, flax-cotton to work with wool, beautiful specimens. See microscopic report. Process withheld by contributor.

" 43. THOMAS WILLIAMS, *Vernon*, *Oneida county*, *New York.*—Flax-cotton, good specimen.

" 50. L. BARDICK, *Espytown*, *Pennsylvania.*—1, flax-cotton bleached; 2, flax-wool unbleached, good.

" 52. E. TOWNE, *Utica*, *New York.*—1, 2, and 3, flax-cotton. Prepared in the dry way by machinery, not very promising for cotton machinery. See letter in chemical chapter.

" 54. UPHAM & FULLER, *Claremont*, *New Hampshire.*—1, flax-cotton; 2, flax-cotton fibres cut; 3, flax-cotton fibres cut to work with wool; 4, flax-cotton picked and carded, not cut. See later contributions and report of microscopist of these fibres; also, the section on manufactures.

" 55. LEMUEL W. WRIGHT, *Brooklyn*, *New York.*—Tow from China-grass. This does not pretend to be cottonized. See microscopic report upon it.

' 56. FLAX COMPANY, *Lockport*, *New York.*—1, flax-wool; 2, same; 3, flax-wool bleached. These are useful products for the upholsterer, and may be used with wool.

" 57. ARNOLD WILKINSON, *Providence*, *Rhode Island.*—Bleached tow, "no bleach used." Nicely prepared; process not stated.

" 58. H. BURGESS, *Royer's Ford*, *Pennsylvania.*—2, prepared flax of 1862; 4, same of 1863; 5, prepared flax and bleached of 1863; 7, prepared Kentucky hemp; 9, prepared Russian hemp; 10, flax disintegrated in stalk. See remarks in chapter on manufactures for estimates and description of processes.

" 61. H. MCFARLANE, *Rocky Hill*, *New York.*—3, green flax cottonized; 5, green flax treated; 6, flax-wool from green flax; 7, hemp cottonized; 10, 11, flax-cotton carded; 12, China-grass carded. A very interesting group of products. For processes see letter in appropriate chapter.

" 68. CYRUS BACON, *Baltimore*, *Maryland.*—2, Asclepias cottonized, a pretty specimen; 3, Asclepias retted and broken.

" 69. C. C. WILLIAMS, for Neil Cook, *Oswego*, *New York.*—Cottonized tow, very good.

71. CYRUS BACON, *Baltimore*, *Md.*—Asclepias cottonized, very pretty.

" 72. BAYARD TAYLOR.—Flax cottonized, from Russia.
" 75. JAMES WHITEHILL.—Flax cotton.
" 84. CHARLES BEACH, *Penn Yan, N. Y.*—Specimens not found.
" 105. ROBERT SANDERSON, *Piqua, Ohio.*—2, crude bleached and cleaned tow; 3, unbleached tow.
" 127. UPHAM & FULLER, *Claremont, N. H.*—1, Ohio seed flax broken and pickered; 2 is No. 1 steamed, pressed, exploded, and pressed; 3 is No. 2 once picked on wool cards pickered twice on fine picker; 4 is No. 3 carded three times on wool cards (breakers); 5 is No. 4 with ⅜ wool mixed; 6 is hemp tow; 7 is No. 6, boiled, pressed, exploded, picked twice, and carded three times on coarse wool cards; 8 is ½ wool and ½ flax, worked like No. 1 to No. 4.
" 131. Same party, as JOS. B. FULLER, *Norwich, Conn.*, again show: 1, from unretted flax, treated, picked dry; 2, same stock, picked, moist, carded with Gambrel card; 4, same stock bleached, not picked; 6, same stock bleached, picked, moist, and carded with ¼ American cotton; 9, same stock colored, also drawings and rovings; see description in chapter on manufactures.

MANUFACTURES.

" 11. STEPHEN ALLEN, *Boston, Mass.*—1, 2, 3, druggets, see remarks in chapter on peculiarities of fibres; 4, knit stuffs; 5, felted 33 per cent. fibrilia; 6, roving; 7, jeans and satinets; filling 40 per cent. cotton; 40 per cent. flax-cotton; 20 per cent. wool; 8, fibrilia yarn; 14, Canton flannel, ½ fibrilia and ½ cotton: 15, calicoes and prints; 18, papers referring to the above; 19, brake as represented in a plate.
" 15. JOSEPH LEA, *Philadelphia, Pa.*—15, St. Petersburg flax, bleached in the fibre, spun at Mechanicsville, N. Y., beautiful; 16, yarn spun as above, very good thread; 17, yarn, American Linen Company; Fall River, Mass., good, bleached in two hours and forty minutes; a piece of duck, very handsome goods.
" 17. GEORGE GRAHAM, *Cincinnati, Ohio.*—Union cloths and stuffs mixed with flax-cotton.
" 21. BRADLEY N. HOWELL, *Philadelphia, Pa.*—2, roving of flax-cotton.
" 37. JONATHAN KNOWLES, *Providence, R. I.*—2, flax roving; 3, flax thread; 4, thread.
" 39 & 82. ROBERT FLETCHER, *Oswego, N. Y.*—Knit stuffs, very good articles, see report of trial in wear.
" 45. JOSHUA S. COE, *Newton Square, Pa.*—Flax thread.
" 49. MARY MCCREARY, *Anderson, Ohio.*—Linen cloth.
" 51. AUGUST FEIJE, *Theresa, Wis.*—Flax thread, by hand, very fine.
" 55. LEMUEL W. WRIGHT, *Brooklyn, N. Y.*—4 and 5, specimens of cloth, China-grass and wool mixed; specimens of roving; specimens of dyeing China-grass, very beautiful products.
" 59. J. W. SWAN, for Medina Flax Co., *Medina, N. Y.*—7, flax combed; 8, flax warp; 9, twines; 10, calicoes and woollens; 11, brown wrapping-twine; 12, white wrapping-twine. A very interesting group of products; the twines are particularly good.
" 60. JOHN D. LANG, *Vassalboro', Me.*—Specimens of cloth and kerseys; very good.
" 61. H. MCFARLANE, *Rocky Hill, N. Y.*—9, stuff. Flax and wool.
" 76. M. KNOWLES.—Flax thread.
" 122. REUBEN HENDRICKSON, *Dale P. O., Spencer Co., Ind.*—2, flax thread.
" 132. J. B. FULLER.—3 yarn, No. 24, spun from fibre: No. 2 (see No. 131,) very promising; 7, yarn spun from No. 6, (see 131,) very good; 8, yarn half flax, half cotton, excellent product. See chapter on manufactures. Also print cloth, warp cotton, weft flax-cotton, good quality.