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VEGETABLE SUBSTANCES:

MATERIALS OF MANUFACTURES.

Society for the Diffusion
of Useful Knowledge, London

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VEGETABLE SUBSTANCES:

MATERIALS OF MANUFACTURES.

CHAPTER I.

SUBSTANCES MORE PECULIARLY APPLIED TO WEAVING.

FLAX.

In almost every age and country some fibrous vegetable substances have been employed by man as materials for the production of interwoven fabrics, and of twisted cords.

In the earliest periods which history records, or even to which tradition alludes, we are told that the manufacture of woven fabrics, and particularly of those from vegetable substances, had attained a state of high perfection, altogether incompatible with the supposition of its being of recent invention.

So early as the time of Joseph, the Egyptians had acquired a considerable degree of proficiency in the art of preparing and weaving flax into fine linen cloths; constant mention is made of this material in those sacred records which contain the earliest history of the Jews. Solomon imported from Egypt flaxen yarn, which was woven by his subjects into cloth; and fine linen is continually enumerated among the ornaments of the temple of Jerusalem. It is supposed that the Grecians likewise obtained this material from the Egyptians, and that they were familiar with its use in very remote times. Herodotus (ii.) says that linen was imported from Egypt to Greece.

Subjects of such antiquity are necessarily enveloped in much obscurity, so that controversies have at times arisen even as to the meaning of many descriptive terms used in ancient languages. We may here state, that there exists no reasonable doubt that *linum* or flax, such as we now cultivate, is the identical material which the Egyptians produced in such great abundance, and manufactured with so much excellence. This fact has been proved by the examination of many Egyptian mummies. The most ancient of these which have been subjected to recent inspection, are found to be encircled with folds of linen cloth similar in material and in texture to that which we manufacture in the present day. An account was inserted by Dr. Hadley, in the 54th volume of the Philosophical Transactions, of the unwrapping of a mummy, on which, after the removal of the outward painted cloth, nothing appeared but linen fillets, of a fine quality, which completely enclosed the whole body. The indefatigable traveller, Belzoni, who carefully inspected a great variety of these strange relics of antiquity, has given us a similar account. "The Egyptians," he says, "were certainly well acquainted with linen manufactures equal to our own, for in many of their figures we observe their garments quite transparent, and among the foldings of the mummies I observed some cloth quite as fine as our common muslin, very strong, and of an even texture."

Captains Irby and Mangles, who in 1823 printed for private distribution a volume containing their researches in Egypt, Nubia, Syria, and Asia Minor, during the years 1817 and 1818, confirm the statement of Belzoni. In describing the great mummy-pits at Gournou, on the site of ancient Thebes, these gentlemen say, " Most of the bodies are enveloped in linen, coated with gum, &c., for their better preservation. Some of this linen is of a texture remarkably fine, far surpassing what is made in Egypt at this day, and proving that their ancient manufactures must have arrived at a great degree of excellence." In stating that *most* of the bodies were wrapped in linen, they do not imply that the rest were cased in cotton or any other cloth: on the contrary, they were naked. " Many of the bodies, probably of the lower orders, are simply dried, without any envelopement."

The great proficiency of the Egyptians in this manufacture, at a very early period, is celebrated by more than one writer of antiquity. Herodotus (iii. 47) records, that in the temple of Minerva at Lindus in Rhodes there was deposited a curiously wrought linen corslet, which had belonged to Amasis, king of Egypt, who lived about 600 years before Christ. Each thread of the corslet was composed of 360 filaments, and it was ornamented with cotton and gold. Some remains of this curiosity were still to be seen in the time of Pliny, who relates that those who beheld it, wishing to assure themselves of the truth of the fact, had by degrees reduced it to a very small relic. At the period in which Pliny wrote, flax was well known and extensively cultivated, not only in Egypt, but in several parts of Europe. It was in all probability known in Greece, and even cultivated there, many ages before Pliny. " A considerable quantity of flax," says Colonel Leake, " is still grown, as in former ages, in the plains of *Achaia* and *Elis*, for which the rivers furnish the means of irrigation *." The Roman natu-

* Travels in the Morea, vol. ii. p. 166.

ralist describes the different qualities of flax respectively produced by each country, with a particularity which argues that the manufacture of linen was already become an important branch of commerce to many nations. We learn from the same authority that the flax of Spain surpassed that of every other country in the fineness of its fibre, while it acquired a peculiar brilliancy by being steeped in the waters of the river which falls into the sea near Tarragona. It is curious to find how little the present manner of preparing flax differs from that described by Pliny. The linen manufactured from this substance was not in very general use as an article of clothing; but it appears to have been extensively employed in navigation. Pliny represents that ships were then "crowded with numerous linen sails, by which dangerous practice men courted death." At the present day scarcely any of the sail-cloth used in the Mediterranean is made of flax or of hemp, but of cotton.

The produce of flax was introduced into England by the Romans. It was subsequently discovered that the plant itself could be successfully transplanted to the British soil; but we may infer that it was not yet introduced into England at the time of the Norman Conquest, since it is not enumerated among the titheable articles of that period. Had it been then cultivated, there is little doubt that it would have been discovered by the clergy, and inserted by them in their tithe list. It was not until 1175 that flax and hemp were classed by the council of Westminster among the titheable productions of the earth *.

For a very long time the English government uniformly held out encouragement for the growth of flax and hemp, both in the mother country and in the colonies, with the view of supplying our manufac-

* Macpherson's Annals of Commerce.

tories from our own resources. But although it has been partially grown for a long period in England as well as in Scotland, we have always been supplied from foreign countries with the greater part of our demand. In 1531 a statute was enacted, requiring that for every sixty acres of land fit for tillage, one rood should be sown with flax or hemp-seed *. In later times the legislature attempted to promote the cultivation of these plants by promising rewards and advantages. Both these measures belong to the infancy of sound political knowledge, and were devised to avoid the imaginary evil of being dependant upon other countries.

Throughout the whole of the last century, bounties, with various modifications, were granted on the importation of undressed flax from the British colonies in America. For the encouragement of the home cultivation, an additional duty was laid, in 1767, on foreign linen, which yielded a revenue of £15,000, and this sum it was proposed to divide in premiums among successful cultivators of hemp and flax; but the English farmers were not incited to any immediate exertion by the hope of this reward, and for the space of fifteen years no candidate appeared to claim a premium. Flax is considered to be a great exhauster of the soil, and most probably the English agriculturists found that they could employ their land more advantageously than in raising this plant. It is, however, at present partially cultivated in several counties. In Lincolnshire, Somersetshire, and Yorkshire more especially, a considerable quantity is raised; it likewise continues to be grown in Scotland; and Ireland produces nearly all the flax it requires for its extensive linen manufactories, occasionally receiving small quantities from Holland. As the Irish cultivators do not preserve sufficient

* Macpherson's Annals of Commerce.

seed for the renewal of their plants, a very large quantity of foreign seed is annually imported from the United States of America, from Holland, Riga *, and other ports of the Baltic. Considerable importations are also obtained from Russia and Holland; the average annual amount for the last eight years being 908,009 cwt. These importations are admitted for home consumption at the merely nominal duty of one penny per cwt.

From "an account of goods exported in British ships from St. Petersburg, anno 1822," properly authenticated, and given by Captain G. M. Jones, in his Travels in Norway, Sweden, Russia, &c., it appears that in that year we imported from the Russian capital alone,

	Poods.
Of 12-head flax	190080
Of 9-head ditto	47129
Of a third quality	46227

Besides this we imported 5622 poods of flax yarn. In the same year, our imports of the different qualities of Russian hemp were as follow:—

	Poods.
Of clean hemp	1008870
Of outshot	77914
Of half-clean..................	192534

* Riga exports linseed, or the seed of flax for sowing, in large quantities. The seed is brought to that mart chiefly from Lithuania, Courland, and Livonia. "Thence," says a recent traveller, "it is sent in the autumn to the Hanse Towns, Holland, and Flanders. A small quantity is sometimes exported to England, and more to Ireland. As it is unfit for its purpose if stale, the sellers are called upon to make oath, that what they produce is the fresh seed of the year. All that is not exported before the winter, is sent to Holland to be crushed for oil."—(Journey from Riga to the Crimea, by M. Holderness.) Riga supplies both flax and hemp in great abundance. Hempseed is also among its exports. The last article is chiefly bought up for the great and admirable oil-mills of Holland, which will be described in the course of the present volume.

England, Scotland, and Ireland are of course included in this account*.

There is scarcely any plant which is found to be so little affected by difference of soil and climate as the flax plant, and accordingly one species, with all its characteristics unaltered, flourishes in the cold as well as the temperate regions of Europe, in North and South America, in Africa, and in Asia. By the Hindoos it is cultivated for its seed alone, from which oil is expressed and the stalks are thrown aside as useless†, but in every other country where it is raised its fibres are woven into cloth.

The common flax (*linum usitatissimum*) is an

Common Flax—*Linum usitatissimum.*

* One pood is equal to 36 pounds English. † Dr. Roxburgh.

annual plant which shoots forth in slender upright fibrous stalks about the thickness of a crow-quill. These stalks are hollow pipes surrounded by a fibrous bark or rind, the filaments of which, divested of all extraneous matter and carefully prepared, are the material of cambric, linen, and other similar manufactures. The leaves, placed alternately on the stem, are long, narrow, and of a greyish colour. When the plant has attained the height of about two and a half or three feet, the stem then divides itself into slender foot-stalks, which are terminated by small blue indented flowers: these produce large globular seed vessels divided within into ten cells, each containing a bright slippery elongated seed.

This plant will grow on almost any land, but it impoverishes the soil, and therefore it is deemed prudent to sow it on rich, rank ground, and never two years consecutively on the same spot. In Yorkshire old grass land is considered the most proper matrix for flax*.

A fine quality of flax is grown in the Crimea, and in the Russian territories near the Black Sea, on the rivers Dniester, Bog, Don, Dnieper, and in Kuban, where the soil is very moist and rich. The Crimea alone might be made to supply an empire; but its cultivation seems almost confined to the industrious Bulgarian colonists who merely raise enough for the use of their own families. This flax they prepare themselves, and their wives and daughters spin and weave it into clothing. Not to detail the numerous districts where this most useful plant is cultivated, we will merely add that in Egypt, whence, no doubt, it was first introduced into Europe, it is still grown, though now in infinitely less quantity than cotton. "Egyptian flax," says M. Savary, "formerly so renowned, has lost nothing of its ex-

* Marshal's Rural Economy of Yorkshire.

cellence: the fibres are long, soft, and silky, and would make beautiful cloth; but the spinners are so bad that their linen is very coarse."

Although flax is easy of growth, its quality depends very much on fitness of soil and situation. Low grounds, and those which have received deposits left by the occasional overflowing of rivers, or where water is found not very far from the surface, are deemed the most favourable situations for its culture. It is attributed to this last circumstance that Zealand produces the finest flax grown in Holland. Preparatory to the cultivation of this plant, it is not necessary that the ground should be very deeply furrowed by the plough, but it should be reduced to a fine friable mould by the repeated use of the harrow. Two or three bushels of seed are required for each acre of ground, if scattered broad-cast, but half the quantity will produce a better crop if sown in drills. Care is taken to distribute the seed evenly, and the earth is then raked or lightly harrowed over. When flax is raised to be manufactured into cambric and fine lawns, double the quantity of seed is sown in the same space of ground,—the plants growing nearer to each other have a greater tendency to shoot up in long slender stalks, and, as the same number of fibres are usually found in each plant, these will be of course finer in proportion.

The usual time for sowing the seed is from the middle of March to the end of April, and sometimes May. In some parts of the south of Europe the cultivators of flax sow part of their crop in the autumn: this is perhaps a judicious plan in low latitudes, but where the winter is severe, if this method were pursued, the tender shoots would be in danger of destruction from the frost. The plant blooms in June or July, and is considered ripe and fit for pulling towards the latter end of August. When the crop grows short and branchy, it is esteemed more valuable for seed than for its fibrous bark, and then it is not gathered until the seeds are at full maturity. But if the stalks grow straight and long, then all care of the seed becomes a secondary consideration, and the flax is pulled at the most favourable period for obtaining good fibres. Experience has shown that when the bloom has just fallen, when the stalks begin to turn yellow, and before the leaves fall, the fibres are softer and stronger than if left standing until the seed is quite matured.

It has been found from experience that most seeds, though not quite mature when gathered, ripen sufficiently after being plucked, provided they be not detached until dry from the parent plant; all the sap which this contains contributing towards farther nourishing and perfecting the seed.

The Dutch avail themselves of this fact with regard to their flax crop. After pulling the plants they stack them. The seed by this means becomes ripe, while the fibres are collected at the most favourable period of their growth. They thus obtain both of the valuable products from their plants, and supply their less careful neighbours with the seeds.

The plants which have been sown thickly are liable, if left without support, to be laid by the wind, and consequently to be spoiled; provision is therefore made to prevent this accident. Forked sticks, a foot and a half or two feet high, are fixed in the ground in rows three or four feet asunder. Poles from ten to fifteen feet in length are then laid horizontally on the sticks, and long branchy brushwood is placed across these parallel rows of poles: this is laid very thick, and the vacancies are filled up with smaller brush. Oak brushwood is never employed for this purpose, as it is found to tinge the flax. Thus the whole forms a support and shelter to the plants, which, as they grow, find an effectual prop in the hanging brushwood. Another more simple and equally efficacious plan is pursued by some cultivators. Small ropes are extended both across and along the fields intersecting at right angles, and fastened at their points of intersection: the whole is propped up by stakes fixed in the ground, and forms a kind of netting.

After the plants have been pulled and sorted, they are either laid regularly across the field in handfuls raised a little aslant, or are tied loosely in sheaves and set upright upon their roots. The general practice is to leave the plants in the field twelve or fourteen days after they have been gathered in order to dry them. This method does not meet the approbation of intelligent cultivators, who consider it most judicious to dispense with the drying altogether. When we come to treat of hemp, sufficient reasons will be given for this opinion. In some parts of France it is the custom to lay the flax on the ground for only a day or two. In Yorkshire the sheaves are immediately taken to the watering place. Flax intended for cambric is never so much dried previously to watering, as that which is employed in the making of lawn, lace, or thread.

An experienced flax-raiser is careful to sort his plants after pulling them, putting together those only which are of the same size and quality, as each kind requires a different treatment in the subsequent preparation.

The first operation which flax undergoes is called rippling, and this can be performed equally well whether the plants be green or dry. This is done to free the stalk part from the leaves and seed-pods called *bolls.*

The ripple is a kind of comb consisting of six, eight, or ten long triangular teeth, set in a narrow piece of wood, so that their bases nearly touch each other. This being firmly fixed on a beam of wood, two persons sit, one at each end, and taking up the handfuls of flax draw them repeatedly through the ripple; in a very short time each handful is by this means entirely divested of all its leaves and pods.

If the seed of the plants under operation is to be preserved, a large cloth is spread on the ground to receive the pods as they fall; these are then spread out in the sun, and when dry and hard the seeds are carefully sifted and winnowed from the husk. Those which separate spontaneously are reserved for sowing. The second and inferior sort is extensively used in the arts, and is known under the name of lintseed or linseed. The manner of obtaining the oil will be noticed in another part of this volume.

The delicate fibres of flax intended for cambric would be injured by the use of the ripple, and therefore the stalks are in that case divested of their seed, pods, and leaves, either by beating them with a wooden mallet, or by cutting them off with a wooden knife.

The flax, after being rippled, is placed in water to dissolve the gummy sap, by which the bark adheres to the ligneous stalk; to cause maceration by promoting a slight fermentation of those parts which are not fibrous, and consequently to promote the more easy disengagement of the useful from the useless portion. This is called *water-retting*. A difference of opinion exists as to the superior efficacy of a running stream or a standing pool for the purpose. It is said that a running stream wastes the flax, while on the other hand it gives to it a greater degree of whiteness.

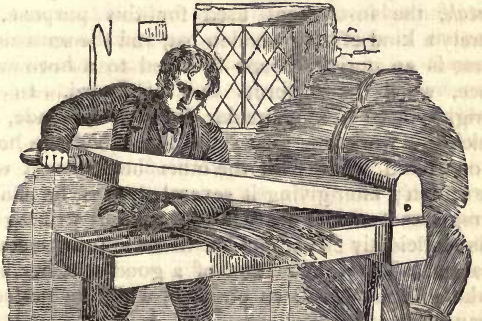
Hemp and flax impart somewhat of a poisonous quality to the water in which they are immersed. It was for a long time asserted that if there were any fish in the water they quickly died, and if cattle were allowed to drink of it the draught proved fatal. This may be the case where a very great quantity is soaked in a small pool, but where the volume of water employed is at all considerable no such effects are produced. The exhalations proceeding from hemp and flax when under maceration are indeed very noisome. The great quantity of hemp soaked every summer in the lake of Agnano, in the south of Italy, is even said to increase the malaria of the immediate neighbourhood; but it has never been known to poison the fish or the frogs, or any other animal drinking of that water. An act was passed in the reign of Henry VIII. forbidding the watering of flax and hemp in any river or common pond, and this act still continues in force. Canals are therefore generally dug for the purpose. A canal of four feet in depth, forty feet long, and six broad, is found of sufficient extent to water the plants produced in one acre.

The bundles of flax are placed in regular layers in the pond, and loaded with large pieces of wood unti the whole is immersed in water. Ten days is about the usual period of their remaining in this situation, but sometimes a fortnight is required. The proper time depends on various circumstances; the state in which the flax was pulled, whether green or approaching to maturity, the quality and temperature of the water, all have an effect on the length of time required for watering. It can only be known by trial when this operation is completed: if the flax feels soft to the touch, and if the rind separates easily from the stem, it having become brittle, then all that was required from the action of the water has been accomplished; the plants are consequently removed, spread thinly on heath or a stubble field, and turned about once a week until completely dry. In this manner of steeping, the flax soon gives to the water an inky tinge, and imbibes it again so strongly that much labour is required in its bleaching, and therefore many plans have from time to time been proposed to obviate this objection. It has been recommended as a much better method to subject the flax to the action of boiling water, or even to boil it for an hour or more, by which every advantage would be obtained of macerating the reed or *boon*, and separating the juices, while the bad effects attending long immersion in stagnant pools would be avoided.

The water-retting for very fine flax is more carefully performed, and in this process the advantages of running and still water are endeavoured to be combined. The pit into which the water is introduced for this purpose is made three or four month before it is wanted. A pure stream from a soft spring or a small rivulet is always gently running through; the pit having only two small apertures at opposite sides for the ingress and egress of the water. This receptacle should be about five feet deep, narrow, and of a length proportionate to the quantity of flax under process. Poles with hooks attached to them are driven in along the sides, the hooks being rather below the surface of the water; a long pole the whole length of the pit is fixed into these hooks. The flax is then made into narrow bundles of about two and a half feet long and four feet high, and these being wrapped in straw are immersed in the water, where they are kept securely by means of horizontal cross poles, which are then introduced between the long pole and the hooks.

For many ages it was the universal practice to separate the flax from the useless parts by hand-machinery, either by beating with mallets, or by the use of an instrument called a *break*. Even now in those countries where flax is most cultivated the hand-break is still used.

This instrument is a block of wood about seven or eight feet in length, and seven or eight inches in breadth and thickness. Deep grooves are made in the wood extending through its whole length, about an inch wide at bottom, and increasing in width in such a manner that the divisions thus formed may present rather sharp edges on the surface. Over this block of wood another block is fitted, one end of it being made fast by means of a hinge, and the other shaped into a handle. This upper block has two longitudinal edges, so shaped as to enter and fit into the corresponding grooves of the under part of the machine.



Flax-breaking.

The person who is to perform the operation of breaking takes a quantity in his left hand, while with his right hand he holds the handle of the upper jaw of the break. The flax being put between the upper and under part, the former is raised up and let down several times with all the force of the operator; this breaks the reed without injuring the fibres which surround it, and at the same time effectually separates these from the cellular texture which united them, and which together with them formed the bark. By putting the flax between the two jaws the bruised refuse is partially separated from the fibres.

Some of the smaller particles still remain entangled among the flax; to get rid of these, another operation is required which is called *scutching*. The *scutch*, the instrument used for this purpose, is merely a kind of long wooden bat, and the scutching-frame is an upright board fastened to a horizontal piece, which latter forms the foot-board. In the upright piece a semicircular incision is made, on which the workman places the flax which he holds in one hand, while with the other he strikes it with the scutch; after giving it several strokes, he shakes it, replaces it on the board, and continues striking till it is sufficiently clean, and the fibres appear tolerably straight. The qualification of a good scutcher is to make as little waste as possible, while he perfectly cleanses the flax.

This manner of breaking and scutching the flax is very tedious and laborious. About seventy years ago a more expeditious method was invented in Scotland, and it has been found so advantageous that the hand-break and scutcher are now seldom used in this country. The invention consists of a mill, having three indented cylinders placed in contact, and one above the other. The middle cylinder, by means of a water-wheel, or other motive power, is made to revolve with a quick motion, which is imparted to the other two through the intervention of cogs. The stalks are introduced between the upper and middle cylinders, a curved surface behind causes the flax to return again between the middle and lower cylinder, and this operation is continued till the *boon* is completely broken. The upper and under rollers are pressed against the middle one by means of weights.

The boon being now thoroughly broken, the fibres are freed from it likewise by means of the same mill, which gives motion to four arms projecting from a horizontal axle, and so arranged as to strike in a slanting direction on the flax, imitating as much as possible the action of the hand-scutcher.

It is evident that this process cannot wholly free the fibrous parts from the smaller pieces of the reed, or from the gummy substance which still adheres to the filaments. To effect the entire disengagement of all extraneous matter, and to disentangle the fibres from between themselves, recourse is had to another operation called *heckling*.

The heckle is a square frame of hard wood studded with rows of sharp-pointed iron pins about four inches in length, half an inch in circumference, and an inch apart from each other. The teeth are set in rows disposed in a quincunx order. By this arrangement they more effectually divide the flax than if they were placed square; the teeth in that case would scarcely produce a better effect than a single row. Coarse or fine heckles are employed according to the quality of the flax; a coarse one is generally first used to disentangle the filaments, and then a finer one gives to them the last degree of preparation.

The heckle is firmly fixed to a bench before the workman, who, grasping a handful of flax in the middle, draws first one side and then the other through the teeth till the whole is freed from all extraneous matter, and presents a series of smooth distinct filaments. Though this operation is apparently so simple, much practice and skill are required to perform it with little waste, and to produce even and continuous fibres.

Flax for cambric and fine lawn is dressed in a more delicate manner. After only slightly undergoing the process of scutching, it is not then consigned to the teeth of the heckle, but is merely scraped and cleansed with a blunt knife on a soft skin of leather,—thence it is carried to the spinner, who, with a brush made for the purpose, dresses each parcel previously to spinning it.

An account was published some years ago in Sweden, of a method used in preparing flax so as to superadd all the finer qualities of cotton to those of linen fibres. The plants were boiled for many hours in a mixture of sea-water, birch ashes, and quicklime; then washed in the sea, and, being subsequently rubbed and cleansed with soap, were laid out to bleach. By this process the flax lost one-half of its weight, but it is said that its superior quality more than compensated for the deficiency in quantity.

Berthollet likewise made experiments in bleaching flax, and succeeded in giving to its fibres the whiteness and softness of cotton. He subjected it to the action of chlorine, which indeed bleached it effectually, but at the same time injured its fibre; and although a thread was produced from it of considerable tenacity, yet this was a most troublesome operation in consequence of the shortness of staple.

It was found that this chemical bleaching process had the remarkable property of reducing the finest flax and the coarsest hemp alike to one uniform fineness of fibre and colour, and that even the refuse from rope-walks might thus be made into a substance valuable in the arts*.

The produce from the flax plant is extremely uncertain in quantity. It is affected by difference of soil and season, as well as by the degree of carefulness bestowed on its cultivation and preparation; these different circumstances causing a variation of from 280 to 980 lbs. per acre, but the average crop in the same area may be estimated at 560 to 700 lbs. of clean fibres available for spinning and weaving.

The quantity of seed produced from an acre of ground averages from six to eight bushels; sometimes, however, an acre yields ten or twelve bushels.

In the year 1810 a new method of dressing flax was proposed by Mr. Lee, who not only patented the invention, but obtained an act of parliament by which the specification of his invention was ordered to be deposited in the Court of Chancery, to be kept secret from the public for fifteen months, and then to be produced only by order of the Lord Chancellor, and by him to be examined whenever occasion required.

The ground on which this departure from the usual practice proceeded, was the necessity of securing to the state, in a time of war, the benefit of a most important discovery.

The inventor had ascertained by such experiments as were supposed to put the fact beyond all doubt, that when hemp or flax plants are well ripened, nothing more is requisite than to pull them up and spread them to dry in the sun, in a manner similar to that by which grass is converted into hay, taking care to lay the roots only in one direction in the ridge, so as to prevent, as much as possible, the breaking or entanglement of the stalks; when by these means

* Nicholson's Journal, 6th vol.

it had become sufficiently dry, the flax might be stored up either in ricks or in barns. Flax so treated was cleansed, without any previous water-retting, by machinery disposed somewhat differently from the breaking and scutching-machine in ordinary use. Since Mr. Lee's plan is now never employed, a particular description of it would be superfluous and uninteresting.

Messrs. Hill and Bundy, in the year 1817, likewise patented an ingenious machine for breaking and rubbing flax; but though this was said to have considerable merit as regarded its mechanical arrangement, the machine has not been found of greater practical utility than that of Mr. Lee. The expectations of advantages, held out by the proprietors of this new machinery, were met by the fact, that the thread produced by their method was, on sufficient trial, found to be so harsh and difficult of manufacture as not to pay the cost of spinning and weaving it into cloths. In consequence, after many attempts to introduce it into several factories, the machine has been universally rejected, and at the present time is entirely out of use.

The finest thread which has been produced in England by machine-spinning measures 12,000 yards spun from one pound of flax; though by hand-spinning the process has been carried as high as 36,000 yards to the pound.

The Siberian perennial flax is another plant of the same species, but of a much coarser fibre.

It has several strong upright stalks, rising to the height of four or five feet; the leaves are small, narrow, and of a dark green colour; they are set alternately on the stalk. The flowers are blue, and grow in large clusters; these appear in June, and the seeds come to maturity in autumn.

Siberian Flax—*Linum Sibiricum.*

The fibres of this plant are employed in the manufacture of coarse cloth. They are found to be very strong, but not so white or fine as those obtained from the common flax. The Siberian perennial flax has the advantage, however, as its name indicates, of having a root which continues for many years, annually shooting up stalks, and requiring no other care in its cultivation than that of merely keeping it free from weeds.

There are many other species of flax, or *linum*, but none of these are adapted to the purposes of spinning and weaving.

Chapter II.

SUBSTANCES MORE PECULIARLY APPLIED TO WEAVING—(*continued*).

COTTON.

It is impossible to assign even a proximate date to the period when the produce of the cotton tree or plant was first applied to the purposes of spinning and weaving. Goguet* endeavours to show that this material was coeval with the patriarchs. Pliny † describes the cotton plant as a small shrub growing in Upper Egypt, called by some *xylon*, and by others *gossypium*, the seeds of which are surrounded by a soft downy substance, of a dazzling whiteness, and which is manufactured into a cloth, much esteemed by the Egyptian priests. This clearly shows that, although known, it was not in extensive use among the Romans in the time of Pliny; and the date is comparatively modern when cotton stuffs became an article of clothing generally adopted by European nations.

It is a curious fact, that Herodotus, who wrote five centuries before Pliny, and had visited Egypt, does not describe the cotton plant there, but gives a vague account of it, as it was said to exist among the Indians. "They possess likewise," says the father of Grecian history, "a kind of plant, which instead of fruit, produces wool, of a finer and better quality than that of sheep; of this the natives make their clothes." His name for cotton, when describing

* 'L'origine des Loix, des Arts, des Sciences, et de leur progrès chez les anciens Peuples.'

† Lib. xix. cap. 1.

the corslet of Amasis, is "tree-wool;" the German name for cotton is the same. If the words of Herodotus have been properly understood, he says the Egyptian priesthood made use of linen garments, and none other, as well as the rest of the Egyptians. As he is more than usually particular on this head, mentioning how the Egyptian mode of weaving differs from that of the Greeks, &c., may we not conclude that cotton was neither used nor cultivated at that time in Egypt? The fact that no cotton has been found on any of the mummies, would go to confirm this hypothesis. And again, even supposing he has been misunderstood, and that in one or more instances we should read "cotton" instead of "linen," is it probable he would refer to India his description of the plant, if it were grown in Egypt? In this latter case, we should be led to suppose that the cotton stuffs were imported.

Whatever may have been the quantity of cotton used in the time of the Romans, it is certain that in the ninth century the Arabians, who were then masters of Egypt and the neighbouring countries, dressed almost entirely in cotton stuffs; for one of the first remarks of two Arabian travellers, who went to China at that time, was, that the Chinese, instead of wearing cotton, as they and their countrymen did, chiefly used silk stuffs for their garments. See the Abbé Renaudot's translation of the Travels of two Mohammedans in the ninth century—an authentic and valuable work.

Nowhere has cotton been found indigenous in Europe. In those ages when ignorance of the science of navigation rendered all intercourse between remote nations tedious, hazardous, and uncertain, the expense and risk attendant on distant commerce were sufficient obstacles to prevent the importation, to any large amount, of so bulky an article.

In later times, the cotton plant was transplanted and successfully cultivated in Asia Minor, particularly in the districts near Smyrna, in the islands of the Archipelago, in Malta, and Sicily, into which places it was introduced either from Egypt or Persia.

In Tournefort's time the beautiful island of Milo was celebrated for its cotton, but most of the Greek islands produced a good quality, though no great quantity. The cotton now very scantily grown in the Cyclades has the dazzling whiteness which Pliny attributes to the Egyptian.

It has been made a subject of controversy, whether the cotton plant is indigenous in the new world. The American colonists procured cotton seed from Smyrna, in the same manner as they supplied themselves with many other Oriental productions, before they had become acquainted with all the native plants of the west. To this they were incited by the naturally eager desire of giving to the country of their adoption every advantage of which, from its climate and soil, it appeared susceptible. A different species of cotton is, however, found growing wild in America.

Although it has been maintained that, at the time of the conquest of Mexico, cotton furnished almost the only clothing worn by the natives, its cultivation was neglected; while the art which had been so successfully practised by the Aztecs, of imparting to it the most brilliant hues, was entirely lost*. It might now soon become an article of extensive commerce to the Mexicans, as the tree propagates itself, and attention is only requisite to prevent the ground from being overrun with weeds.

The colonists of the southern parts of North America, at a very early period of their settlement, cultivated cotton. That found native was neglected,

* Ward's Mexico.

and the Georgians are indebted to the Asiatic seed, procured chiefly at Smyrna, for the excellence of their produce. This plant has flourished exceedingly well in Georgia, where it yields the best cotton in the world, for the length and fineness of its fibre.

The cultivation of the cotton plant in the United States has, according to Humboldt, increased in a prodigious ratio, and the production of cotton continues to be an object with the Americans of growing importance. "Sea Island" and "Upland" cotton are the terms used in commerce to designate the cotton which comes from Georgia. "These hieroglyphics in the Liverpool News," are fully explained in Captain Basil Hall's entertaining narrative of his travels in North America.

Near the Georgian coast are several small islands. It is on these insular spots that the finest cotton is grown, and from these it takes its name, which, however, is borrowed, in order to class under the same head cotton raised at various places on the main coast, and also in the swampy regions bordering on most of the great rivers. That which grows farther from the sea, and at a higher level, has acquired the name of upland cotton, and is of inferior quality.

The cotton-tree is cultivated in most of the West-India islands; and in South America this branch of agriculture has long been an object of attention. Until a very recent period, cotton formed one of the principal articles of exportation from Demerara; but its increased and cheaper production in many other countries has, notwithstanding the great and constantly increasing demand, lowered its price so considerably, that the Demerara planters have found it more to their advantage gradually to convert their cotton into sugar plantations. Much, however, is still grown in other parts of Guiana, and is known in commerce as Demerara cotton.

Among other nations, the Egyptians have, within the last few years, enormously increased the production of this article, and have become formidable rivals to other cotton cultivators. A very large quantity of an excellent quality is annually exported thence, to the great prejudice of the Smyrna and other markets. In 1825 more than a hundred thousand bags of cotton were exported from Egypt to Great Britain; and although the supply has not continued so excessive as in that year of excitement and speculation, yet the importation thence still continues much beyond that from the whole West-India islands. In the same year, and in 1826 and 1827, the exports of Egyptian cotton to France, entirely through the port of Marseilles, were immense. In 1828 and 1829 there was a glut. The immense department of the lazaretto of Marseilles, devoted to the reception of this and other products from plague countries, was then literally crammed with Egyptian cotton.

The cultivation of cotton is very extensively pursued in China; and in the time of Alexander the Great it was grown and spun in the Penj-ab. This valuable indigenous production did not become an article of commerce from the Indies to this country until many years after the British had possessed their widely-extending eastern territory. It must be remembered, however, that antecedent to this period, though the Europeans did not import raw cotton from the East Indies, they imported a vast quantity of muslins and other manufactured cotton stuffs, which were superior to what we could produce until we called in the aid of machinery.

When the enterprising French traveller Bernier was in Hindostan (about the year 1666), Bengal was the mart for these cotton goods. "There is in Bengal," says he, "such a quantity of cotton and silks, that the kingdom may be called the common storehouse for those two kinds of merchandize, not of Hindostan only, but of all the neighbouring kingdoms, and even of Europe. I have been sometimes amazed at the vast quantity of cotton cloths of every sort, fine and coarse, white and coloured, which the Dutch alone export to different places, especially to Japan and Europe. The English, the Portuguese, and the native merchants, deal also in these articles to a considerable extent*."

The first importation of raw cotton from the East Indies into England did not take place until the year 1798, and it was not even then imported by the chartered company, but by privileged merchants. The first cargo of this material which was brought to London was valued in India at £10,000, and it cleared the large sum of £50,000, having been sold at 2*s.* 2*d.* per lb. During the following year the price fell to 10*d.*; and the cotton of India is now the lowest priced that is brought to the English market. It can at present be purchased at 6¾*d.* to 7½*d.* per lb., while the best cotton from Georgia commands from 1*s.* 4½*d.* to 1*s.* 6*d.* per lb. Notwithstanding this very low price of East-India cotton, a considerable quantity is still annually shipped to this country, where, in 1832, more than 35,000,000 lbs. were retained for home consumption.

During the late war, when it was the policy of the French ruler to render his country independent of foreign commerce, efforts were made by him to introduce the cultivation of cotton into Italy, Corsica, and some of the southern parts of France. The attempt was attended by partial success, as long as other supplies were cut off; but as soon as the cessation of warfare happily restored freedom to commerce, the culture of cotton was gradually abandoned, since the product obtained could not at

* Travels in the Mogul Empire.

all compete with that of foreign growth, as regarded either price or quality.

The part of Italy where the cultivation of cotton was most successful was the kingdom of Naples, particularly in that fine plain which extends between Mount Vesuvius, the sea, and the Tifate mountains by Castellamare. Here a new and important trade was created, and carried on successfully as long as the continental system was in force, chiefly by French and Swiss merchants, who had establishments for the purpose at the neighbouring towns of La Torre dell'Annunziata and La Torre del Greco. These establishments closed with the coercive system that had produced them, and generally to the ruin of those who had largely engaged in them. Some small quantities of cotton are still produced there, but of late years it has only been used in the very limited manufactories of the Neapolitan kingdom, and not exported.

An eminent spinner of Manchester, in the year 1824, imported a small quantity of this Neapolitan cotton by way of experiment. The defect, as compared with the American cotton, was the shortness of its fibres. During the eruption of Vesuvius in 1822, some of these cotton grounds suffered much, from being covered to the depth of twelve or fifteen inches, by a dry, impalpable powder ejected by the volcano.

The Neapolitan cotton was known in commerce by the name of cotton of Castellamare. The agriculturists of the kingdom had also begun to cultivate cotton in some districts of Apulia, under very favourable circumstances of soil and climate, but had made no great progress when the system of Bonaparte fell. In 1824 all these Apulian cotton grounds bore wheat and Indian corn.

About the commencement of the present century the cultivation of the cotton-plant had been introduced with success into the southern parts of Spain, by Mr. Kirkpatrick, while acting as consul for the United States of America at Malaga. The environs of the village of Churriana, at the foot of La Sierra de Mijas, which before had been an uncultivated waste, was converted by him into a flourishing cotton plantation. Success in this apparently unpromising situation, caused the cultivation of the plant to be quickly extended from Motril to Almeria, along the coast of the Mediterranean sea; and the pursuit has become at once a beneficial employment for native industry, and a source of considerable foreign commerce.

When the French armies occupied the southern parts of Spain, in 1810, the exportation of cotton was so considerable as to lead the French government to suspect that the whole of that which went under the name of Spanish cotton was not the produce of Spain. Orders were therefore received by the military authorities to institute inquiries concerning the cotton plantations at Malaga, and to ascertain the quantity which these actually furnished.

Restricted in the exportation of his produce, the indefatigable Kirkpatrick transferred his energies to the erection of spinning factories, and 3,000 workmen were soon employed in a village, which only a few years before had been a miserable hamlet. But popular commotions, and the occupation by hostile troops, were not favourable to the continued prosperity of the peaceful arts; and so soon as the French troops had evacuated this part of Spain, the prejudiced populace, either instigated by a blind fury, or more probably incited by the agents of those who criminally indulged in political animosities, not only destroyed the factories, but even tore up the cotton plants, and thus, to all appearance, entirely dried up the source of prosperity to a place, which had only existed from the profitable employment furnished by this branch of industry.

Notwithstanding, however, its apparently total destruction, the cultivation of cotton had been found too advantageous to be altogether abandoned by those persons who had formerly prospered through its means; and as soon as the opportunity was offered by returning tranquillity, plantations again flourished on the coast of Granada, cotton being now produced in abundance and of excellent quality at Motril and through the surrounding country*.

There are many species of this plant, and their number is so constantly increased by the researches of botanists, that the varieties appear scarcely to have any limit. Linnæus enumerated only four kinds; Lamarck, in the Encyclopedie Méthodique, recognizes eight; Cavanilles, in his Sixth Dissertation on the Monadelphia class of Plants, adds two other species to this number; and Desfontaines, Poiret, and Rœusch have each described a new species.

Dr. Rohr, who resided during many years at the island of St. Croix, where he cultivated cotton with extreme care, and studied all the characteristics of the plant, describes thirty-four distinct species; but to these, much to the regret of the botanical student, he affixes only their popular names, and it cannot therefore be ascertained in what respects they agree with the different species which have been elsewhere described in botanical phraseology.

Mr. Bennet, a cotton cultivator in Tobago, who was an accurate and indefatigable observer of the plant, remarked more than a hundred varieties, and considered them as never ending. Of the species

* Dictionnaire Classique d'Histoire Naturelle.

already enumerated, it is most probable that some are only varieties occasioned by the different effects of culture, soil, or climate, on a plant which has been under cultivation for so many ages; and it is scarcely possible to determine what plants, so differing, can be regarded as forming separate species, or as being only simple varieties: while at the same time the information of the scientific man is so distinct from that of the practical planter, that it becomes a subject of no small difficulty to combine the knowledge obtained from each into one accordant whole.

Cotton—*Gossypium herbaceum.*

To the cotton planter it is a matter of much interest to become acquainted with all these distinctive varieties, as some are incomparably more valuable than others, in the quantity and quality of their produce. Some yield their downy harvest twice in the year, others only once. Some bear cotton of a long and delicate fibre, and of a beautiful whiteness, while others are found to be short and coarse, and of a bad colour. For want of this knowledge, so little regard is in general paid to the selection of the seed, and the improvement of the stock, that the

Cotton; showing a pod bursting.

careful cultivator in first forming a plantation is mortified at finding an endless variety among his plants, and can only hope to improve his plantation by his own personal experience, at the cost of much labour and many failures.

It would be tedious and unprofitable to the general reader to go into any minute particulars of all the varieties of the cotton plant, and therefore the distinctive characters, and the points of difference of those most in cultivation, will only be briefly noticed.

The *Gossypium herbaceum*, or common herbaceous cotton plant, is the species most generally cultivated. It is annual and rises scarcely to the height of eighteen or twenty inches. It bears a large yellow flower, with a purple centre, which produces a pod about the size of a walnut. This pod when ripe bursts, and exhibits to view the fleecy cotton, in which the seeds are securely embedded. It is sown and reaped like corn. This species is a native of Persia, and is the same which is grown in Asia Minor, some parts of the United States of America, in Sicily, at Naples, and in Malta.

The *Gossypium arboreum*, or tree cotton, is of much larger growth. If left without being pruned, to luxuriate to its full height, it has sometimes attained to fifteen or twenty feet. The leaves grow upon long hairy foot-stalks, and are divided into five deep, spear-shaped lobes. This shrub is a native of India, and probably the same as that described by Marco Polo, as existing at Guzzerat. "Cotton," says the Venetian traveller, "is produced here in large quantities, from a tree that is about six yards in height, and bears during twenty years; but the cotton taken from trees of that age is not adapted for spinning, but only for quilting."

Tree Cotton—*Gossypium arboreum.*

The *Gossypium Indicum*, or Indian cotton, is another species not very dissimilar to the last; it has not a ligneous stem, and its branches are more hairy, especially at their upper parts. The shape of the leaf likewise somewhat differs from that before described, this being divided into three convex lobes. The stem rises to the height of ten or twelve feet, and continues in full bearing during several years. It is sometimes called likewise Barbadense, or Barbadoes cotton—Barbadoes having been the first of the West-India islands into which it was transplanted from the East. This and the preceding species are both cultivated in the West Indies.

The *Gossypium vitifolium*, or the vine-leaved cotton plant, differs from the Indian, just described, in the form of its leaves, which resemble those of the grape vine. This is indigenous to the East Indies, and is cultivated at the Mauritius.

The *Gossypium hirsutum*, or hairy cotton plant, is another species; it has herbaceous stalks branching laterally, rising almost three feet high, and covered with a thick down; the foot-stalk and midrib of the leaf are likewise hairy, and the leaf is divided into three unequal lobes. This plant is biennial, or even perennial in the warmer provinces, but in colder climes it becomes an annual, which change is sometimes found to take place in regard to other objects of cultivation in those situations where the winter frost can attack the root of the tender plant, and cause it to lose its vegetating power. This species is said to be indigenous to South America.

Another species is distinguished by the name of *Gossypium religiosum*. No reason is assigned why Linnæus should have bestowed on it so singular a title. The solution of the question was thought to be discovered, on reading in Stedman's Surinam, that the negroes on the coast of Guinea have much veneration for the wild cotton-tree; unfortunately, however, on inquiring farther, we find that the tree associated with religion by the Africans, is the lofty bombax bearing no similitude to this diminutive plant, but resembling, though far surpassing our largest oaks in elegance and magnitude. The exalted

Shrubby Cotton—*Gossypium religiosum.*

dimensions and outspreading branches of the African bombax have ensured the favour and reverence in which it is held among a simple people, who, having "no long drawn aisle or fretted vault" raised for the observances of religion, have consecrated a natural temple under the ample shade of which their *gado-man*, or priest, delivers his lectures to the assembled audience. The little shrub called *G. religiosum*, only attaining to three or four feet in height, cannot therefore, by the most ingenious conceit, be made to show any connexion with the custom of the natives of Guinea, and we must consent to leave the origin of its present designation in obscurity. Lamarck calls this

Silk Cotton Tree—*Bombax ceiba.*

species *tricuspidatum*. Its stem is upright, of a slightly red colour, and very hairy. The leaves are sometimes entire, but more frequently divided into three or four not very deep lobes. The flowers grow in a similar manner to the others, but differ in colour, being first white, then changing to rose, and finally to red. It is not known of what country this is native. Lamarck believes that it is indigenous to the lowest latitudes of America. Cavanilles supposes that it comes from the Cape of Good Hope. It is cultivated in the Mauritius. There are two varieties of this species,—in the one the cotton is extremely white, in the other it is of a yellowish brown, and is the material of which the stuff called nankin is made; it may therefore be presumed that this species is a native of China, whence nankin cloths are obtained. The yellowish brown colour of Chinese nankins is therefore the natural colour of the cotton and is not imparted by dyeing. The name is derived from the city of Nankin, to which place the manufacture of these cotton stuffs was peculiar.

The colour of the nankins was long thought to be artificial, and Van Braam, who travelled in China with a Dutch embassy at the end of the last century, informs us, that the European merchants sent to request that the nankins for their markets might be dyed of a deeper colour than those last received. The fact was, the Chinese had made the last lighter than usual in consequence of a great and sudden demand, which obliged them to mix their common white cotton with the yellowish brown.

The various species of cotton just described have been distinguished according to their respective botanical characteristics. Dr. Rohr classes the species and varieties by the different appearances of the seed; other cultivators arrange the various kinds according to the facility with which the cotton is ginned, or divested of its seed; some again consider the distinctive difference to reside in the shape of the seed-pod, the number of its divisions, or the manner and time in which the cotton is retained in its place after the bursting of the pod; while others believe the only circumstances worthy of attention in the classification to be those which regard the staple or fibre.

Very white cotton is not considered the best; a slightly yellow tinge, when not the effect of accidental moisture or of an inclement season, is indicative of greater fineness.

The number of seeds in one pod vary according to the different species; the pods of some containing only ten or twelve seeds, others as many as thirty; while in all there is a marked difference in colour, shape, and size.

The shrub which grows wild in many parts of the West Indies, especially in low and marshy grounds, has a rough black seed. The cotton of this is in colour a pale red, and is of so short a fibre that it cannot be spun; in consequence, it is scarcely worth the trouble of gathering, and what little is picked up is used for stuffing mattresses and pillows. Among other varieties, the Brazil and the Guiana cottons bear the same kind of seed as the wild species, differing slightly in shape; these are both nearly alike as to the quality of their produce. The Guiana is, after the "Sea Island cotton," the most esteemed in Europe, on account of its colour and fineness, and the length and strength of its staple and fibre; it is likewise extremely productive, as it furnishes two gatherings in the year. It is farther valuable as the seeds of this kind conglomerate, or adhere firmly to each other in the pod, and are easily separated from the cotton. This variety requires a moist soil, such as generally predominates in Dutch Guiana.

The Indian cotton has a dark brown seed streaked with black; this cotton is very white and finer than that of Guiana, but not so productive. Six other varieties bear nearly the same description of seed, among which is the Siam so noted in the West

Indies, as being nearly equal to silk in beauty and fineness. It is of a brilliant whiteness, and its fibres are very fine, long, and elastic. This variety produces twice in the year, but does not bear a great quantity. It is not much cultivated, because it cannot be cleansed without extreme difficulty: the seed being entirely covered with a kind of green moss or hair, cannot be separated from the cotton by any machine, and not even by the hand without much labour and care.

The cotton of Curaçoa and that of St. Domingo have small seeds, the surface of which is thinly covered with a few short hairs or a thin beard. This kind is of a very tolerable quality.

The seeds of the Jamaica cotton are perfectly smooth, but so brittle as to break in the process of separating them from their downy envelope. The fibre is coarse but strong, and this would be considered of a very useful quality if it could be better cleansed. Little or scarcely any cotton is at present grown in Jamaica compared to the quantity which was produced there a few years back; but it was always considered as one of the worst cottons in the English market, in consequence of the planters' persisting in the cultivation of a species which could not, without hand labour, be properly divested of its seed; it was always exported mixed with pieces of these, and was therefore known by the technical term *foul* cotton.

Of all the species of cotton the annual herbaceous plant yields the most valuable produce. The "Sea Island cotton," imported into England from Georgia, bears a price double to that imported from any other country. The Persian cotton has long been celebrated for its superior quality, and the concurrent testimonies of many travellers show, that where this species is cultivated in other parts of the globe it is equally excellent. But the additional labour and consequent expense attendant on its cultivation, as well as its not being equally adapted to all soils, afford perhaps sufficient reasons why it is not more generally adopted. This species is cultivated in China, but not in sufficient quantities for the home consumption, as they import this article largely from India*.

The quantity of cotton which each plant yields is as various as its quality. Accordingly, there are scarcely two concurrent opinions to be collected on this subject. The average produce per English acre is reckoned by different writers at various quantities, varying from one hundred and fifty to two hundred and seventy pounds of picked cotton.

The cotton-plant will grow in most situations and soils, and is cultivated with very little trouble or expense. According to Humboldt the larger species, which attain to the magnitude of trees, require a mean annual temperature of 68° Fahr.; the shrubby kind may be cultivated with success under a mean temperature of 60° to 64°, and may therefore be propagated as far as latitude 40°. This plant is indeed cultivated in the neighbourhood of Astracan, the latitude of which is 46°. Some species flourish best in the neighbourhood of the sea; others again are injured by this proximity. The Pernambuco cotton, which is the finest in Brazil, is of the latter kind, and the planters find that in proportion as they recede from the coast the quality of the cotton is improved; they are, in consequence, every year penetrating more into the interior, and they always obtain a ready market for their produce, as the dealers follow their footsteps and settle where they settle †.

Open situations and a strong soil moderately dry and warm are most congenial to some species, while others thrive better in a moist and deep soil.

In selecting seed for a plantation, therefore, care

* Staunton's Embassy to China.

† Koster's Brazil.

should be used to adapt it to the soil and situation in which it is to be cultivated. Previously to sowing them the seeds should be wholly divested of every particle of cotton fibre, and then steeped in water during some hours; they are afterwards rolled in sand or any light earth, in order entirely to separate them from each other. This process is considered very much to accelerate their germination. The time for sowing in the West Indies is usually from May to September, both months inclusive. The ground is well prepared and manured, and then holes are made some inches deep and about three feet apart from each other. Eight or ten seeds are generally dropped in each hole, because some of them are liable to be destroyed by a grub or worm, and others to rot in the ground; besides which, a superfluity of plants is required to replace the ravages which are sometimes committed by caterpillars on the tender shoots. The seeds being covered with earth, it is generally expected, and especially if there have been any rain to hasten the germination, that the plants will begin to make their appearance in about eight days. In some situations, when the weather has been very dry, a much longer time elapses. At about the end of six weeks the ground is carefully weeded, and those plants which are the weakest are drawn out, only two or three being left in each hole. When the plants are about three or four months old they are again cleaned and thinned, and the stems and branches are pruned, or, as it is called, *topped*—an inch, or more, of the plants being broken off from the end of each shoot. This is done to retard the growth in height, and to facilitate the development of the lateral branches. Some of the lower leaves are occasionally taken off. These cares should be continued, occasionally, till the period of flowering. The time of the seeds coming to maturity varies according to the climate and the species of the plant. When the season has been favourable, the cotton is generally fit for pulling about seven or eight months after it has been sown. This period is, however, well indicated by the spontaneous bursting of the capsule or seed-pod. The plantations at this time present a very pleasing appearance. The glossy dark green leaves finely contrast with the white globular forms profusely scattered over the plant. In the East the produce is gathered by taking off the whole of the pod. In other parts, and this is the more general practice, the seeds and cotton are taken away, leaving the empty husks. The first is, of course, much the most expeditious method, but it has a very serious disadvantage. The outer part breaks in minute pieces, and thus mixes with the cotton, which cannot be freed from it without much time and difficulty.

Whichever method is pursued, this work is always performed in the morning before sunrise, as soon as possible after the cotton displays itself; because long exposure to the sun injures its colour, by giving it a yellow tinge. The pods likewise which are ready for gathering expand in the heat of the day, and in some varieties the seed and its envelope are then detached from the pod, and falling to the ground the cotton becomes soiled and deteriorated.

In some countries the plant after yielding its produce is every year cut even with the ground; in others this operation is performed only once in two or three years.

The cotton shrub does not in general last more than five or six years in full or productive bearing; the plantation is therefore generally after that period renewed. The seeds may usually be preserved for one or two years, but in some varieties they should be planted almost as soon as they are gathered. The surplus seeds serve as food for cattle ; an oil is likewise expressed from them which is employed for many domestic purposes, as will be farther noticed in another chapter.

The annual plant is cultivated in the same manner as that just described; only that in sowing it more seeds are put into the holes, and these are placed nearer to each other. It comes to maturity much quicker, the seeds being sown in April or May, and the crop reaped in September; in some hot climates two harvests can be gathered in each year.

Another important consideration is, that the cotton should not be pulled immediately after rain, as this would render the drying process much more tedious and difficult; and should it retain any moisture when it is packed, it would ferment or become mouldy.

Immediately after gathering it is taken to a barn and assorted according to its quality; it is then laid on mats or hurdles, and exposed to the heat of the sun, or dried in stoves.

The separation of the cotton from the seeds is a very long and troublesome operation, when performed by the hand; for the fibres of the cotton adhere tenaciously to the seed, and some time is consumed in cleansing even a small weight of so light a material. In the greater part of India the use of machinery for this purpose is unknown, and all the cotton is picked by hand. A man can in this manner separate from the seeds scarcely more than one pound of cotton in a day. In some parts of India, however, they make use of a machine, which, though more simple, does not materially differ from the gin used in the West Indies. Dr. Buchanan describes it in 'A Journey from Madras through the countries of Mysore, Canara, and Malabar,' (vol. iii. p. 317). Mr. Clarke Abel also found precisely the same machine in China, at the village of Ta-tung, not far from Nankin. This is his description of it: "It consisted of two wooden cylinders placed horizontally one above the other, on a stand a few feet from the ground. The cylinders, very nearly touching, were put in motion by a wheel acted upon by the foot. The cotton, being brought to one side of the crevice intervening between them during their revolution, was turned over to the opposite; whilst the seeds, being too large to enter, fell at the feet of the workmen." Mr. Clarke Abel then describes the instrument used by the Chinese for freeing the cotton from knots and dirt: "This is equally simple, and is the same as that used, I believe, in most countries for the same or a similar purpose. It is a very elastic bow with a tight string. In using it the carder places it in a heap of the material, and having pulled down the string with some force, he suddenly allows the bow to recoil; the vibration of the string scatters the cotton about, and separates it into fibres freed from all knots and impurities*." A drawing of an instrument scarcely at all differing from this Chinese cotton-bow, is given by Sonnerat, in his 'Voyage aux Indes Orientales,' tom. i. p. 108†. Thunberg says, that in Batavia, he saw "the cotton cleansed from the seed, by being laid out on extended cloths, and beaten with sticks, till all the seed was perfectly separated from it‡." The use of the machine called a gin very much facilitates the process. This machine in general consists of two or three fluted rollers set in motion by the foot in the manner of a turning lathe, and by its means one person may separate and cleanse sixty-five pounds per day, and thus, by the use of a simple piece of machinery, increase his effective power sixty-five times. A still greater increase may be obtained by the employment of more complex engines. In the United

* Travels in China, p. 163.

† Upland Georgia cotton is frequently known as "Bowed," which name it acquired from the implement formerly used in cleaning it.

‡ Travels, vol. ii.

States of America mills are constructed on a large scale, and are impelled by horses, steam, or other power. Eight or nine hundred pounds of cotton are cleansed in a day by one of these machines, which requires the attendance of very few persons. The American mills are exactly on the same principle as the smaller ones, but are more complete in their appointments. A description of one of the larger sort will therefore comprise all the requisite details of a cotton gin. It consists of two wooden rollers of about an inch in diameter; these are placed horizontally parallel and touching each other. Over them is fixed a sort of comb, having iron teeth two inches long and seven-eighths of an inch apart. This comb is of the same length as the rollers, and so placed that its teeth come nearly in contact with them. When the machine is set in motion the rollers are made to revolve with great rapidity in opposite directions, so that the cotton being laid upon them it is by their motion drawn in between the two, whilst no space is left for the seeds to pass with it. To detach these from the fibres of cotton in which they are enveloped, the same machinery which impels the rollers gives to the toothed instrument above a quick wagging motion to and fro, by means of which the pods of cotton as they are cast upon the rollers are torn open, just as they are beginning to be drawn in; the seeds now released from the coating which had encircled them fly off like sparks to the right and left, while the cotton itself passes between the cylinders. The sharp iron teeth of the comb moving with great velocity, sometimes break the seeds; then the minute pieces are instantly hurried on, and pass between the rollers with the cotton. These stray particles are afterwards separated by hand, a process which is called *moting*. Entirely to cleanse the cotton from any remaining fragment of seed it is subjected to another process. This consists in whisking it about in a light wheel through which a current of air is made to pass. As it is tossed out of this winnowing machine it is gathered up and conveyed to the packing-house, where, by means of screws, it is forced into bags, each, when filled, weighing about 300 pounds. These are then sewed up and sent to the place of shipment, where they are again pressed and reduced to half their original size*.

Some manufacturers fancy that this wholesale machine tears and injures the fibres of the cotton, but it is perhaps an idle prejudice, since the best cotton which we import is from Georgia, where it is most expeditiously cleansed; and that which obtains the least price comes from the East Indies, where the hand is the only machine used.

Another description of gin, called a saw-gin, is likewise used for short staple cotton in the United States and in Brazil. This consists of one roller nine inches in diameter, having a series of circular saws fixed upon it parallel to each other, and at a distance of one inch and a half apart. Above this roller is a hopper, having the bottom formed of a grating of wire-work, through which the teeth of the saw project to a certain depth. In this hopper the cotton to be cleaned is placed, and, as the cylinder revolves, the projecting teeth of the saw come in contact with the cotton, and drag it through the wire bottom of the hopper, which being inclined at a considerable angle, the seeds, as they are disengaged, roll down, and are conveyed away through a spout in the machine.

The cotton is more quickly cleansed by this method than by the use of the cylinder gin, but at the same time it tears and injures the staple. It is usual in the Liverpool Price Currents to denote, as saw-ginned cotton, the cotton of Brazil cleansed by this process, which fetches a lower price in the market than the Brazil cotton not so operated upon.

* Hall's Travels in North America.

Before the invention of spinning machinery in 1787, the demand for cotton wool in England was comparatively small. In the seventeenth century we obtained our trifling supply wholly from Smyrna and Cyprus. In 1786-7 we imported 19,900,000 lbs., viz.: 5,800,000 lbs. from the British West Indies, 9,100,000 lbs. from the French, Spanish, Portuguese, and Dutch colonies, and 5,000,000 lbs. from Smyrna and the rest of Turkey. Shortly after that memorable period in the history of our national manufactures, the annual consumption of cotton increased six-fold, and it has been progressively augmenting ever since.

The average annual import for the six preceding years has been 777,372 packages—each bale weighing about $2\frac{1}{2}$ or 3 cwt.*

From all corners of the world does this raw material flow in upon us, and with expedition scarcely credible is converted into textures which are reconveyed to the countries of production.

The value of cotton goods exported from Great Britain during four years, stands thus:—

	Piece Goods.	Yarn or Twist.
1828....	£13,649,012....	£3,595,405
1829....	13,558,132....	3,976,874
1830....	15,294,923....	4,133,741
1831....	13,282,185....	3,975,019

All these are real mercantile values. The official value at the custom-house is nominal and invariable.

In 1792	the official value of cottons exported was		£1,892,329
In 1830	ditto	ditto . .	37,269,432

The quantity of manufactured cottons exported to the East Indies alone in 1828, stood thus:—

	Yards.	Value.
To the East-India Company's territories, Ceylon, and China . .	37,566,836	£1,394,681
To the East-India islands, Sumatra, &c.	4,680,370	153,238

* Some few packages come from South America of smaller weight.

Besides which there was exported the following quantity of cotton twist, or spun yarn :—

	lbs. weight.	Value.
To its East-India territories, Ceylon, and China	4,549,219	£390,344
To the East-India islands, Sumatra, &c.	37,836	2,790

To all which must be added an exportation of hosiery and small wares, making in value £44,482.

It forms no part of our present object to describe the processes used for spinning and weaving. We cannot, however, refrain from giving the following fact to exemplify the celerity with which manufacturing operations are now conducted in this country. The proprietor of a cotton factory in Manchester, having recently obtained an order for the shipment of some goods of a particular description, purchased ten bales of cotton of suitable quality in Liverpool. On their arrival in Manchester, they were received into the highest floor of his works, and thence proceeding regularly downwards, underwent all the intermediate processes of carding, spinning, and weaving until, in ten days from their reception, the finished goods into which they were converted were packed in bales and proceeding again to Liverpool for shipment.

When, in 1787, spinning machinery was first erected, one pound of Demerara cotton could be spun into yarn one hundred and sixty miles in length * ; since that period great improvements have been made in this machinery, and yarn is now spun having a still greater degree of fineness.

* Macpherson.

CHAPTER III.

FILAMENTS APPLICABLE TO SPINNING AND WEAVING.

SPARTUM—ASCLEPIAS—HOP-BINE—NETTLE—BEAN-STALK—MALLOW—BARK AND SHOOTS OF MULBERRY—OTAHEITAN CLOTH.

MANY productions of the vegetable world contain fibrous matter capable of being converted into useful textures; but the superiority of flax, cotton, and hemp over these render such substitutes of comparatively little importance.

The Greeks originally called by the name of spartum, a particular shrub, the pliant branches of which they not only interlaced to form baskets of various kinds, but they also prepared and manufactured its fibres into cloth and cordage. This plant is identified by botanists with the *Spartium junceum*, or Spanish broom, which grows wild in the Levant and the southern parts of Europe. Pliny*, by whom it is called *genista*, improperly confounds it with the Spanish and African spartum, a plant distinct from this, and which will be described in another chapter. M. Broussonet, in 'Mémoires d'Agriculture,' for the year 1785, recommends the cultivation of this plant under the name of *Genet d'Espagne*, and enumerates the many uses to which it may be applied.

It springs forth on steep declivities and sterile lands with a rapid growth. Its roots ramify through the interstices of the rocky soil, binding together and

* Lib. xxxix. cap. 9.

Spanish Broom—*Spartium junceum.*

retaining the scanty vegetable earth, which is thinly spread over the hills, and which the equinoctial storms would otherwise wash away. When cultivated it is readily raised from seed, which is sown in the high ground. There the plants are left for three years, at the end of which time the sprigs or young shoots are fit for use. January is considered the most favourable time for sowing, the ground having previously received a slight preparation. The young plants are cut in August: they are spread out to dry, and then beaten with wooden mallets. After being immersed in water for a few hours, they are conveyed to a shallow pit made for the purpose, and are there covered with fern or straw. Water is daily thrown on the heap, which continues in this situation for nine or ten days. At the end of this time the plants are washed, and the thin green outer rind being peeled off, the fibrous part remains. This is again beaten to cause the separation of the filaments, which are then spread upon stones to cause desiccation. When perfectly dry the fibres may be readily separated from the ligneous part: they are then combed and sorted, and spun into yarn. The inhabitants of the south of France weave this into cloth, which they appropriate to household uses as well as to apparel. Textures of several qualities are manufactured of this material, from the coarse canvas of which sacks are formed, to stuff for clothing; and it is said that were it to be as carefully prepared, it would equal hempen or linen cloth in fineness and durability. The peasants of some departments are acquainted with only this description of cloth: none is, however, made for sale, every family preparing its own, proportionate to its wants or ability.

The *Asclepias Syriaca*, or Syrian dog-bane, bears a light thin seed-pod, which opening when it is ripe, discloses a silken fleece enveloping the seeds. The fibres of this beautiful down are not more than an inch or two in length, and are therefore extremely difficult of manufacture. Notwithstanding this objection, however, the plant has been successfully applied to useful purposes, both in Russia and France. In the latter country velvets and satins, as well as stockings, hats, and various other articles for dress, have been manufactured with this material. Although native to the burning plains of Syria, this plant supports without injury much colder climates, and is cultivated so far north as Upper Silesia.

Its roots are perennial; the stem annual, new

Syrian Dog-bane—*Asclepias Syriaca.*

shoots coming forth abundantly in the spring. It is very easy of propagation, either from seed or by parting the roots. When the latter plan is pursued, the plants should be placed at least five feet apart, as the roots spread very fast; and in three or four years, unless means be taken to prevent their too rapid production, the ground will be completely covered with stems growing too closely together

They thrive most luxuriantly in light soil, but they will flourish on any poor land.

As soon as the pods are arrived at maturity, which is known by the bursting of their shells, they are gathered and dried. The seeds are then picked out, and the down enclosed in bags: without this latter precaution it would soon be wafted away, as when dry it is so extremely light that the least breath of air disperses it beyond recall. Within these bags it is exposed to the steam of boiling water, and when in a moist state is carded. This operation is usually and more readily performed with alternate layers of cotton, which gives to the down sufficient body for spinning.

It was only after many attempts that M. Lemaire succeeded in carding it alone, which he found to be a most troublesome task. The stuff manufactured with the mixture of cotton and this material has a very silky appearance; and it is said in other respects offers encouragement for the farther cultivation of the *Asclepias Syriaca.*

The peculiar produce of its pod is not the only useful part of the plant, as the fibres of the stem, prepared in the same manner as those of hemp and flax, furnish a very long fine thread of a glossy whiteness.

A strong kind of cloth is prepared in some parts of Sweden from the stalk of the hop plant. In the Transactions of the Swedish Academy for 1750, there will be found an account of the process used for this purpose. The hop plant is so well known, in its more common application to another wholly dissimilar use, that of flavouring and preserving beer by means of its bitter flowers, and it is so rarely employed for productions which relate to the present subject, that it would be out of place were we here to give any particular description of this plant. The hop is indigenous in many parts of Europe, and is to be seen sometimes in England, as well as in other countries, growing spontaneously in the hedges. In this state it clings to the trunks of trees: when cultivated it is trained to twine round poles placed for the purpose, and in a spiral form often reaches to the height of twenty or thirty feet. The fibres of these long stalks or bines are capable of being manufactured into strong serviceable cloth.

The Swedish manner of obtaining this material is thus described in the above-mentioned Transactions. A number of hop stalks, equal in bulk to the same quantity of flax plants as usually yield a pound of flax, were gathered in autumn. These were kept in water during the whole of the winter. In March they were taken out, dried in a stove, and prepared by a similar process to that which flax undergoes. The prepared filaments weighed nearly a pound, and proved fine, soft, and white: they were spun and woven into six ells of fine strong cloth.

The Society for the Encouragement of Arts, &c. some years ago turned their attention to this subject, believing in the practicability of converting a substance, now thrown aside as refuse, into a useful material of domestic consumption. To promote this desirable object, premiums were offered for the successful manufacture of cloth made from the stalks of this plant. In several volumes of their Transactions accounts of different preparations are to be found; one of the most successful of these attempts detailed in the ninth volume.

The stalks were cut in lengths of two or three feet, and put into a copper containing a ley, in which linen had been previously bleached. The pieces were boiled in the mixture till the rind separated easily. After this process the fibres were prepared in a manner similar to those of hemp and flax, but they were found very much more stubborn and harsh than either of those substances. The heckling was a very troublesome operation; and carding it in the manner of cotton was found a more advantageous method. A texture was produced, having the warp or longitudinal threads heckled, and the woof or cross threads carded, but it had the colour of tanned leather, and great difficulty was experienced in the attempt to bleach it. Specimens of this cloth are to be seen in the repository of the society: they are not such as to induce a hope that the pursuit will ever be conducted with any practical utility.

A coarse but durable cloth has likewise been produced from the stalks of the common nettle. This use of a seemingly insignificant and valueless plant has long been known to the Japanese. Thunberg informs us, that from two species of nettles (the *Urtica Japonica* and *Urtica Nivea*), which grow wild on the hills, "they spin threads so fine that even linen is made of them." As materials "for cordage and lines, even of the thicker kind, which may serve on board of vessels," he says, these nettles are still more valuable. He adds, that from the seeds of one of them, the *Nivea*, so called because its leaves on the under side are as white as snow, the Japanese express oil. Mr. Smith, of Brentwood in Essex, made many experiments to ascertain the relative merits of the fibres of the nettle compared with those of flax and hemp. For his exertions and inquiries on this subject he received a medal from the Society for the Encouragement of Arts, &c. in testimony of their approbation. We learn, as the result of this gentleman's observations and experiments, that those stinging nettles which produce the finest, longest fibres, and are obtained with least waste, are commonly found growing in the bottoms of ditches, among briars, and in shady valleys, where the soil consists of a blue clay or strong loam. Plants were obtained in such a situation which in general measured from five to nine feet high; some of the larger were selected, which were of an extraordinary size, being twelve feet high, and their stalk two inches in circumference. It is difficult to imagine that the stinging nettle, which we so carefully root out from our gardens ere it has attained many inches in height, can ever arrive at such gigantic dimensions.

This plant has a perennial root, and when the stalks are cut down others quickly shoot forth. The most favourable time for collecting these is in the months of July and August. The quantity of available fibres in a given weight of nettle stalks is far smaller than that obtained from an equal weight of flax stalks, and therefore it could never be made so profitable an article of cultivation, the more especially as much more attention is required in retting and otherwise preparing these for spinning. But as the nettle flourishes abundantly all over Europe in wastes where no other vegetation, save a few noxious weeds, will grow, this wild produce might perhaps be profitably converted into a material for clothing.

Some experiments in the preparation of linen and thread from the floss of nettles were made a few years ago in Ireland. The thread, in colour, strength, and fineness, was equal, if not superior, to that obtained from flax, and the linen had the appearance of common grey linen.

The common and the Siberian stinging nettle are both found abundantly in Russia, especially on the Ural Mountains. These plants are converted to profitable use by the Baschkirs, the Koibals, the Sagayan Tartars, &c., who prepare yarn and weave linen of them.

In other countries the fibres of the nettle are likewise thus applied: we are told that in France they have been converted into a very fine fabric, and the dead nettle is, according to Staunton, manufactured into cloth by the Chinese.

The bean stalk, which is thrown away by us as useless, can, in like manner, be made subservient to these purposes. Every bean haulm contains from twenty to thirty-five filaments running up on the outside, under the thin membrane or epidermis, from the root to the top. After maceration these fibres are readily separated from the stalk by slightly beating, rubbing, and shaking, and ultimately by the use of the heckle. The Rev. James Hall has made many calculations to show how advantageously these fibres might be brought into use. He found that on averaging the produce from a number of acres, about two hundred weight of fibres could be obtained from one acre of ground planted in beans. That there are at least 200,000 acres of tick, horse, and other beans planted in Great Britian and Ireland, and that therefore, from what is now disregarded as refuse, 400,000 cwt. of good fibrous material might be obtained, and that by means which would furnish healthy employment to the cottager's wife and children.

Several species of mallow, if macerated like hemp, will afford a superior thread for spinning, and are said to make textures surpassing in beauty those manfactured of flax.

The bark of a species of mulberry-tree, the same from which paper is made in Japan, and which has been noticed in the volume on timber trees in this series, is made not only to furnish cordage, but such a degree of fineness can be given to its fibres, that they are capable of being woven into a very beautiful description of cloth. M. de la Rouverie, who made many experiments with regard to the capabilities of this tree for manufacturing purposes, asserts that he procured from its young and tender branches a beautiful vegetable silk. The method which he pursued was to cut the bark during the time the tree was in sap, to steep it in water, and to beat it with wooden mallets. By this process he separated from the woody part, fibres which had an exceedingly silky appearance, and this they retained after being woven into cloth.

The fibres of the bark of many other trees have been made to render materials for clothing. In almost every country indigenous plants may be found which can be advantageously applied to this purpose. The pages of our voyagers and travellers fully reveal to us the vast riches of nature in this respect, and we shall find almost every people, whom civilized man, in the pride of his refinement, is pleased to call savage, exercising their ingenuity in converting vegetable fibres, with more or less of preparation, into articles of dress and domestic use. It is not our design to go into any minute enumeration of all the plants which might be made applicable to this purpose, nor even of those which are already used in various countries. One example taken from among the islands of the South Sea, may in some measure serve to show the nature of the expedients employed in making different fibrous substances subservient to the wants of the ingenious natives.

The Otaheitans make cloth of the bark of the paper mulberry-tree which has just been noticed. The materials for another kind, inferior to the first in whiteness and softness, is obtained from the bread-fruit tree. A third sort is made from a plant resembling a fig-tree. This is coarse and harsh, and of the colour of the darkest brown paper. Although apparently of an inferior description, it has a quality which renders it much more valuable in use than the others. This is its resistance to water, in which advantage the two first are deficient. This imperviousness to moisture renders it the most useful cloth, but it is likewise the most rare; when ornamented it usually forms the dress of the chiefs. Though the cloths manufactured from the bark of these several trees differ in quality, they undergo the same process.

The bark is not merely stripped off the trees, as they grow in wild luxuriance, but they are carefully cultivated for the purpose of producing good and even bark. The lower leaves with their germs are taken off wherever they give any indication of producing a branch, as it forms the excellence of trees to be thin, straight, tall, and without lower branches. The proper time for using them is when they are about six or eight feet high, and somewhat more than an inch in diameter. The plants are then drawn out of the ground, and stripped of their leaves and branches, after which the roots and tops are cut off, and the bark being slit longitudinally, is readily separated from the stem. It is then placed in running water, and secured in this situation by placing heavy stones upon it. When sufficiently macerated, the inner bark is separated from the green outer rind. In performing this operation the women sit in the water, and placing the bark on a smooth board, scrape it, while yet immersed, with a shell, as the fibres are found to separate more readily when surcharged with moisture, and the useless parts are washed away at the moment of their disengagement. This work is continued until nothing remains but the fine fibres of the inner coat.

The fibres thus obtained are not, however, spun and woven in the manner of flax. The Otaheitan cloth is produced by so very different a process, that perhaps a brief description of the method pursued may not be wholly uninteresting.

The cleansed fibres are spread out on plantain leaves to the length of about eleven or twelve yards; these are placed on a regular and equal surface of about a foot in breadth. Two or three layers are thus laid one upon the other, much attention being paid to make the cloth of a uniform thickness: if in any of the layers the bark happen to be thinner in one particular part, a piece somewhat thicker is laid over that part in the next layer. This being completed, the cloth is left to dry during the night, when great part of the moisture with which it was saturated, on first laying out, being evaporated, the several layers are found to adhere together so as to allow of the whole being raised from the ground in one piece. It is then laid on a long smooth plank of wood prepared for the purpose, and beaten with a wooden instrument about a foot long and three inches square. Each of the four sides has longitudinal grooves of different degrees of fineness, the depth and width of those on one side being sufficient to receive a small packthread, the other sides being finer, in a regular gradation, so that the grooves of the last side would scarcely admit any thing coarser than sewing-silk. A long handle being attached to this instrument, the cloth is beaten first with its coarsest side, and spreads very fast under the strokes: it is after this beaten with the other sides successively, and then is considered fit for use. Sometimes, however, it is made still thinner by beating it, after it has been several times doubled, with the finest side of the mallet, and it can thus be attenuated until it becomes almost as thin as muslin. The cloth will sometimes break while under this rough process, but the fracture is very readily repaired by applying a piece of the bark, which is made to adhere by a glutinous substance prepared from the root of one of their plants. This can be done with so great a nicety that the part which has been repaired can scarcely be distinguished from the rest. The fabric thus prepared, particularly when made from the bark of the mulberry-tree, becomes extremely white by bleaching: it is tolerably durable, and has a very good appearance*.

* Hawkesbury's Voyages.

CHAPTER IV.

FIBRES APPLICABLE TO CORDAGE.

HEMP.

THE extent and consequence of our maritime power have long rendered improvements in making cordage an object of national importance. The greatest strength of material and the best manner of twisting the fibres have, accordingly, been thought subjects worthy of scientific inquiry, holding in this respect a very different rank in the estimation of the moderns, than was accorded to them in that of the ancients.

In the earliest stages of society vegetable fibres were not generally applied to this purpose; and in the inauspicious climes, where these are not of spontaneous production, the inhabitants continued to a very late period to employ materials which were naturally brought more within their own limited sphere of observation.

Thongs of leather formed the naval cordage of the rude ages. So late even as the third century the Scotch retained their use; and it was not until the ninth or tenth century that the countries to the north of the Baltic first adopted more commodious rigging. It is said that most of the inhabitants of the western isles of Scotland even to the present day reject the use of vegetable fibres in the formation of their ropes, and that the primitive unsophisticated farmers are still to be found yoking their horses to the plough with strips of the untanned skin of the seals which they have killed, or with the salted hides of their dead cows; while they manage to dispense with hemp altogether, by twisting thongs of leather into ropes of considerable strength and length.

The inefficient employment of leather for cables was early superseded among some of the more northern commercial nations by iron chains*. But in the refined countries of the south, leathern thongs had long prior to the time of Cæsar given place to the use of vegetable filaments, while the art of combining them for strength was practised with considerable ingenuity.

The cordage of the Romans was made of these materials at the period of their invading Britain; and the Roman settlers in this country no doubt soon applied our native rushes or *junci* to a similar use. An evidence of this is retained in the term *junk*, by which British sailors are wont even now to distinguish old cables and worn-out ropes.

Hemp, as being now the most used, as well as being the most efficient and valuable material for cordage, claims our first attention among those vegetable substances which are applicable to the purpose. But although its application is of the greatest consequence, and its use the most extensive in the formation of cables, ropes, and cords of all descriptions, the utility of its filaments is still more universal. The sails and the ropes that form the rigging of a man-of-war or a merchantman are alike made from this plant. Hemp forms the material of every description of canvas, which is the corruption of its Latin name *cannabis*. The Italians have very slightly changed its name: they call it "*canape*." Cloth,

* This invention of ancient times has recently been found far superior to cables made of any vegetable fibres. Cables formed of iron chains of a particular construction have within the last twenty years been introduced with so much advantage as to have become of almost universal adoption throughout the royal and mercantile navy of Great Britain.

though not so fine as that made from flax, is manufactured from hemp; it is considered very much stronger than linen, and its colour, though not so good when new, improves through continued exposure to the light in wearing. The strength and greater durability of the Russia hempen sheeting causes it, though much coarser, to be often preferred to Irish linen. In Suffolk, where hemp is much grown, cloth manufactured from it is generally worn by the peasantry and the small farmers.

There is little doubt that hemp was indigenous in Europe. We have records of its growth here for nearly two thousand five hundred years. Herodotus (book iv. 74) says, " Hemp grows in the country of the Scythians, which, except in the thickness and height of the stalk, very much resembles flax; in the qualities mentioned, however, the hemp is much superior. It grows in a natural state, and is also cultivated. The Thracians make clothing of it very like linen cloth; nor could any person, without being very well acquainted with the substance, say whether this clothing is made of hemp or flax. A person who has never seen hempen cloth, would certainly suppose that this, of which I am speaking, is made of flax." The Scythians of Herodotus lived in Europe, north of the Danube, and bordering on the Black Sea.

The shirts worn by the peasants (when they have any such covering), in the greatest part of Russia, are made of hempen cloth. The rest of their simple costume is soon described. They wear very large full breeches of the same coarse material, a large pair of boots, or very thick stockings, with shoes made of the bark of the linden, or lime-tree, (another useful vegetable substance); their coat is a sheep-skin, with the wool inside, and over this, when the weather is very cold, they throw another coat, made of extremely coarse woollen cloth, which is generally furnished with a hood to be drawn over the head; their cap is a compound of coarse cloth and sheepskin. Thus covered, they can brave the utmost inclemency of the northern winter; and we are assured on good authority, that their occasional deaths by cold are owing to their immoderate use of ardent spirits, which overpower their faculties, and set them to sleep.

The hemp plant was well known to the Romans as a material for cordage in the time of Pliny. This naturalist describes its culture and the preparation to which it was subjected, in order to obtain its fibres, classing these in two different qualities. The filaments nearest to the outer bark and to the reed were considered inferior to those growing in the middle, and were distinguished by the name of *mesa*. But in consequence of their supposed greater liability to be damaged by exposure to moisture, hempen cords, and particularly cables, were not so highly esteemed at that time as were those made from spartum, which were thought to be better qualified for resisting the injurious action of water.

Pliny eulogizes the root, juice, and other parts of this plant, as possessing wonderful medicinal virtues, for which it appears to have obtained a higher value in those days than for its excellent adaptation to the manufacture of cordage—an application at present considered so important as to cause its other properties to be almost entirely disregarded*.

Hemp is now almost universally cultivated, finding a congenial soil in nearly all parts of the world. As it is but a short time in the ground, it may be cultivated in any place that is habitable by man†.

* Nat. Hist. lib. xix. cap. 2 and cap. 10. Lib. xx. cap. 23.

† Traité de la Fabrique des Manœuvres pour les Vaisseaux, ou l'Art de la Corderie perfectionné. Par M. Du Hamel.

It is grown in Persia, Egypt, and various parts of the East Indies; in Africa, in the United States of America, in Canada, and Nova Scotia. Marco Polo mentions that hemp and flax, as well as great quantities of cotton, were cultivated in his time in the neighbourhood of Kashgar in the lesser Bucharia, and in the province of Khoten in Chinese Tartary. According to Mr. Clarke Abel, in China proper, though the *Xing-ma* (*Sida tiliæfolia*) is preferred for cordage, the *Gĕ ma* (*Cannabis sativa*, or hemp) is also cultivated and manufactured into ropes. At Tung-chow, that distinguished naturalist saw the *sida* and *cannabis* growing together, the first in long ridges or in fields like the millet, the second in small patches.

Dampier was told that the Spaniards at Leon in South America, near the Pacific Ocean, made cordage of hemp, but he saw no manufactory. Thunberg, on a journey from the Cape of Good Hope into the interior of Africa, found the Hottentots cultivating hemp (*Cannabis sativa*). "This is a plant," says he, "universally used in this country, though for a purpose very different from that to which it is applied by the industrious Europeans. The Hottentot loves nothing so well as tobacco, and with no other thing can he be so easily enticed into servitude; but for smoking he finds tobacco not sufficiently strong, and therefore mixes it with hemp chopped very fine."

Hemp is cultivated in Great Britain and Ireland, but not very abundantly. The counties of England in which it is principally grown are, Suffolk, Yorkshire, Somersetshire, and the fens of Lincolnshire; in Norfolk and Dorsetshire some few hemp grounds are likewise to be seen. Hemp is likewise raised in various parts of France, Spain, Denmark, and Sweden, in Wallachia and Moldavia, and in several of the Italian states; but with the exception of Italy, which affords a trifling export, and of Wallachia and Moldavia that supply the Turkish fleet with cordage, none of these countries produce it in sufficient abundance for their own consumption. Among the Italian states the kingdom of Naples is very productive of this useful vegetable substance.

A very considerable quantity is grown in the Terra di Lavoro and the districts in the immediate neighbourhood of the capital of that kingdom. In 1827 there were many fields of immense extent lying a little in the rear of the swampy shore, that extends between the mouth of the river Volturnus and Cape Misenum, devoted to this produce. On account of the very disagreeable effluvia proceeding from the hemp while macerating, and from an idea that it is noxious both to the water and the atmosphere, the Neapolitan government has appointed the Lago d'Agnano (a small lake beautifully situated, about a mile in circumference, and between three and four miles from the city of Naples) for this purpose; nor are the growers allowed to steep their hemp in any other place. Those who happen to raise the plant in thinly inhabited places where there is water at hand, as near the swampy shore we have mentioned, put it through the process of maceration on the spot; but the prohibition by law extends to all places within a circuit of many miles, except the Lago d'Agnano. To reach that lake the greater part of the hemp has to pass through the city of Naples, and as the cars on which it is transported are of great magnitude, and many streets of the capital are narrow, and all of them crowded, the cars are not permitted to enter the town until one or two hours after midnight. Every person who has resided at Naples during the summer must have been made sensible of the very considerable quantity of hemp grown in the neighbourhood, by seeing, day after day, the long lines of cars laden with it stationed at three of the four great avenues to the city waiting the appointed hour; and by having his rest broken night after night by the rumbling noise made by these numerous and heavy vehicles as they roll over the lava-paved streets of the town towards the grotto of Posilippo and the lake. In the long subterranean road or tunnel of Posilippo, through which also they must of necessity pass, there being no other communication, the noise they make is astounding. What with going and returning after the hemp has been macerated, the inhabitants of a considerable part of the city of Naples are regaled with this nocturnal music for more than two months every year.

The grand mart however for hemp, as an article of commerce, is Russia, where it is grown in immense quantities and of the best quality. The principal places of its cultivation are in the southern and western provinces bordering upon Poland, and in the provinces of Poland which belong to Russia. The plant even grows wild in some parts of Russia. In Siberia and about the river Volga it is found flourishing in natural vigour near spots where towns have formerly stood. The Cossack and Tartar women gather it in considerable quantities in autumn, when it has shed its seed and begins to die away. It is not, however, collected by them for its fibres, but is used, as by some other eastern people, as an article of food, for which it is prepared in various ways *.

Much anxiety was evinced some years since in this country that we should obtain supplies of hemp from our own dependencies, and its cultivation was very much encouraged in Canada. The attention of the planters being strongly called to it, several samples of hemp of Canadian growth were sent home.

* Pallas' Travels, tom. i. p. 356, tom. iii. p. 266.

These were placed under the examination of the best judges, by whom they were considered defective, rather from the faulty mode of preparation than from any inferiority in the material itself. Some was found to be of as great a length as the Italian hemp, which is longer than that from the Baltic, but the whole was mixed together without any regard to length or quality. The Petersburgh hemp, on the contrary, is always carefully assorted into different classes, distinguished in commerce as "Clean, or best staple hemp," "best shot," which is rather inferior to the first,—and "half clean," which is much inferior. These classes of course obtain very different prices in the market. It was supposed that the Canadian planters would have readily attained to better methods of preparing and assorting, but they have not yet been able to compete with the Russian cultivators, who still exclusively supply our market. At the latter end of the last century, in consequence of our extensive warfare, the importation of this article into England very much increased. For the five years ending with 1776 the average annual quantity was 246,573 cwt.; in the same number of years ending with 1799 the annual average is found to be more than double that quantity, being 573,358 cwt. It is calculated that the sails and cordage of a first-rate man-of-war require 180,000 lbs. of rough hemp for their construction. During a time of peace the demand for hemp is much less than in a period of war, and accordingly we find that the average importation of the last five years is very nearly the same as that in 1799; but an average taken after the lapse of so many years, if the circumstances of each period were perfectly similar as to our foreign relations, should show a great increase in accordance with the rapid progress of population and manufactures.

We learn from the Annals of Agriculture, that in the year 1785 the quantity of hemp exported from Petersburgh to England alone, amounted to 353,900 cwt.; and assuming that it requires five acres of ground to produce a ton of hemp, the whole space of ground requisite for raising the above quantity would amount to 88,475 acres. Since that period it has been much more extensively grown in Russia. We find that in 1799 about* 600,000 cwt. were exported in British ships from St. Petersburgh.

Riga, as we have already observed, also exports hemp and flax in large quantities. Hemp and hemp-seed, the produce both of Poland and Russia, are carried thither on the river Dvina, and warehoused or shipped at once for foreign ports, according to circumstances. Persons sworn to that office sort the hemp according to its different qualities, and regular prices are fixed before it is brought into the market. It generally arrives at Riga about the middle of May. Polish hemp is, for many purposes, preferred to Russian, being softer and of a more tender nature. Riga also exports some hemp grown in Livonia, which, though inferior to the best Polish and best Russian, is sometimes valuable to the exporter, as it is carried by land, and is sure to arrive, whereas that brought by water is liable to be detained beyond time by the freezing of the Dvina.

"The bringing together the produce of such an extent of country at the mart of Riga," observes an intelligent traveller, "is well worthy of attention. . . . . . The produce of Poland from Kiev northward, around the shores of the Dvina, are sent to this place. After the operation of thrashing the different grain is performed, and the frost set in, so that the ice on the rivers will bear, the peasantry are engaged in constructing the raft which is to float these

* Tooke's View of the Russian Empire, vol. iii.

cargoes to their destined port. These vessels are formed with much ingenuity and little expense, being put together without the use of a nail, and merely pegged with wooden pegs, and stuffed with tow (*made from hemp*) to make them impervious to the water. They carry from 200 to 500 tons burden, and are from 200 to 400 feet in length, being formed of large trees split into rough boards. The rudder is a single fir-tree, at which ten or twenty men preside, according to the strength required. The most valuable part of the cargo, which is wheat, hemp-seed, &c. is stowed in the centre of the vessel, a space being left around the sides for the package of those goods which a little wet will not materially injure, such as hemp, hempen cordage, &c. This being completed, the vessel is ready to take advantage of the earliest part of the navigable season. As soon as the ice is broken up and clear, the vessel floats with the strong current which succeeds to the removal of the ice, and thirty or forty of the peasants, sometimes with their wives and families, take their passage upon it. The owner or his steward meets the cargo at Riga, where it is either sold to the merchants or warehoused. The vessel then is knocked to pieces, and sold for firing, or frequently for paling for the merchants' yards, and often fetches no more than from 100 to 200 rubles*."—(Journey from Riga to the Crimea, by M. Holderness. London, 1823.)

Hemp, or *Cannabis sativa*, is an annual plant, usually rising to the height of five or six feet. In some situations it is, however, capable of attaining to a much larger growth. Du Hamel relates, that in some parts of Alsace, hemp plants are found which reach twelve feet in height, and are more than three inches in diameter at the bottom of the stalk, having

* The average value of a ruble is about ten-pence English.

Hemp—*Cannabis sativa.*

such deep roots that the strongest man is not able, unassisted, to pull them out of the ground*. As in

* In 1826 there were some fields near the Lago di Patria, in the kingdom of Naples, where hemp had almost attained similar dimensions. The site where it grew had been for many ages a *pantano*, or swamp, and only drained and recovered the year

flax, the fibres of the bark comprise the useful parts of this plant.

The stalk is channelled, and hollow in the inside, containing a white, soft, medullary substance, enclosed in a very tender tube, chiefly composed of a cellular texture, and of some longitudinal fibres, commonly called the reed, or, technically, the *boon*, of the hemp. It is covered with a green bark, rough and hairy, which is formed of numerous fibres extending the whole length of the stem. These are not reticulated, but are placed parallel to each other, and united by means of the cellular texture.

A microscopic view of these fibres discloses that each single fibre is in itself a bundle of fibrils, or fibres of extreme fineness; these are twisted spirally, and after maceration may be stretched out to a considerable length. The leaves grow on opposite foot-stalks by pairs, and are at their base always accompanied by two stipules, or leaflets, a very common characteristic of many species of plants. The leaves are divided, as far as the foot-stalks, into four, five, or a greater number of narrow segments, pointed and deeply indented in the margin. They are of a darker green colour on the upper than the under side, rough and furrowed above, and ridged beneath. The flowers and fruit grow upon separate plants. Those bearing the flowers are called male hemp, those bearing the fruit or seed, the female. In general the male hemp is more slender and delicate than the female; the fibres of its bark are also finer and more elastic; the stem, which is single, divides itself at the extremity into several branches, terminating in thin pointed

before. The soil "*terra vergine*," as the Italians called it, was very deep, black, and unctuous. It was still very moist, and besides a small river and a lake (Di Patria) of some extent, there was an immense deal of marshy ground and stagnant water in the immediate neighbourhood.

spikes, while the female hemp is surmounted by tufts of leaves of a considerable size. The male and female plants are therefore readily distinguishable at a considerable distance. The flowers of the former grow near the summit of the stem; they are disposed in clusters, two of which generally hang at the insertion of each of the upper leaves on the stalk: a cluster bears nine or ten flowers.

The fruit grows in great abundance on the stem of the female hemp. This seed is not preceded by any corolla; a membranaceous hairy calyx, terminating in long points, encloses the pistil, the base of which becomes the seed.

The male is quicker in its growth than the female, and generally rises half a foot higher, by which provision of nature the farina from the stamina, or the fecundating dust which conveys fertility to the seed, is readily shed on the lower plant.

Either kind are produced indiscriminately from the seeds which grow on the same stalk, and the difference cannot be known until the plants are somewhat advanced in growth. When the seed is put into the ground it is therefore quite uncertain what proportion there will be of each.

Most soils may be made fit by good manuring for the cultivation of hemp, but rich moist earth is considered the most favourable to its growth. It seldom thrives on a stiff clay soil. A poor land will yield but a scanty crop, the quality, however, will be proportionably finer; while a strong rich land produces a greater quantity, but this will be coarse. Cultivators are therefore regulated in their choice of soil by the description of hemp which they wish to raise.

Sir Joseph Banks remarks on this subject, that "coarse hemp, such as is required for the manufacture of cables, hawsers, and other heavy rigging, requires every where an abundance of manure and land of the richest quality." The richest of the new moist lands in the south of Italy will bear hemp two, and sometimes even three years, without manure, but they are then much impoverished, and require it.

In Lincolnshire, where strong and heavy hemp is grown, the hemp gardens are small, and near the houses of the growers. These gardens absorb vast quantities of manure, and produce hemp every year, without any alternation of crop, or any change except that in years when the hemp is pulled early a few turnips are sown for a stubble crop.

In Russia the same mode of cultivating hemp on small patches of land, near the houses of the growers, prevails, from the facility of getting manure upon it. In Romagna, where the best hemp in Italy is grown, the inhabitants have a common saying—"Hemp may be grown every where, but it cannot be produced fit for use, either in heaven or earth, without manure *."

When the hemp is required for cordage, it should be sown in drills, as a stronger and coarser fibre will be produced.

When it is wanted for purposes of weaving, then broad-cast is the best method, as the stems rise more slender and fine in proportion to their proximity, provided they are not so near to each other as to choke and impede the growth. There should never be a smaller interval than a foot between each plant.

Three bushels of seed is the ordinary allowance for an acre, when sown broad-cast, this quantity being more or less, according to circumstances. If sown in drills, a bushel and a half is found sufficient.

When the seed is sown it is carefully covered with earth, either by means of a harrow or rake. But, notwithstanding this precaution, it is requisite to keep a constant watch over the ground, to prevent the

* Letter to the Committee of Lords of the Privy Council for the Affairs of Trade.

devastations of the feathered tribe, which, if left unmolested, would make sad havoc among the newly-sown grain. The seeds rise up out of the ground with their green shoots in the manner of French beans or lupins, and the birds, mistaking these for perfect seeds, tear them away with the young plants adhering to them,—thus the hopes of the planter may be destroyed as soon as they have sprung forth.

The farmers endeavour to frighten away these depredators with scarecrows, as well as by the clamour of children, who are set to watch the grounds. But these precautions are often found insufficient*, and the superior vigilance of men or dogs is required effectually to prevent the mischief. Fortunately the irksome occupation is but of short duration, for as soon the hemp has put forth a few leaves, it is no longer in danger from the attacks of its former assailants.

After this period, the hemp ground requires very little care or labour till it is fit for pulling. This plant is never overrun with weeds, but on the contrary, has the remarkable property of destroying their vegetation. The cause of its producing this effect is attributed by some cultivators to a peculiar poisonous quality residing in its roots; by others it is considered to be so great an impoverisher of the soil as to draw off all the nourishment, which would otherwise contribute to the growth of weeds.

Agriculturists sometimes take advantage of this well-known fact, and by sowing a crop or two of hemp on the rankest soils, they subdue all noxious weeds, and entirely cleanse the ground from these troublesome intruders. One of the greatest difficulties attending the clearing of the ground alluded to at page 73, the swamp near the Lago di Patria, was to rid it of an exuberant growth of *canne*, or

* Wissett on Hemp.

reeds, that rose considerably above the head of a man on horseback. The sowing of hemp was found to be by far the most efficacious means. After hemp, Indian corn was very successfully sown in some of the fields.

It is said that this plant has likewise the peculiar property of destroying caterpillars and other insects which prey upon vegetables; it is therefore very usual, in those countries where hemp is much cultivated, for the peasantry to secure their vegetable gardens from insects, by encircling the beds with a border of hemp, which in this manner proves a most efficient barrier against all such depredators.

The male hemp comes to maturity three weeks or a month earlier than the female. It is known to be ripe by the flowers fading, the farina falling, and the stems turning partially yellow. This period is usually about thirteen or fourteen weeks after sowing.

It is the frequent practice to pull these before they are quite ripe, for after having arrived at their full maturity, the fibres adhere so tenaciously to the reed as not to be readily separated without injury. The Suffolk cultivators gather both male and female plants at the same time, reserving a small part for seed. In Lincolnshire and on the Continent they gather the male plant a month earlier than the female, and therefore small paths are made at intervals through the field, in order that the persons employed may pluck the plants which are ripe without trampling down those which are to remain.

The ripeness of the female hemp is known by the same indications as that of the male, and also by the calyx partially opening and its seed beginning to change colour. They are both less injured by pulling too soon than too late, but when very young, though the fibres are more flexile and fine, the ropes which are made with them are found not to be so lasting as when the plants are gathered in a more matured state.

Hemp is never suffered to remain ungathered till the seed is perfectly ripe, as at this period the bark becomes woody, and so coarse that no subsequent process can reduce its fibres to a proper degree of fineness. Some plants should therefore be preserved for seed. These require no particular cultivation, but the male hemp is likewise left rather longer than usual that it may attain to maturity and shed its farina upon the seed-bearing plant. The most careful cultivators, however, generally plant out a piece of ground for the purpose of raising seed, as it proves much more prolific when the plants are set at a greater distance from each other.

This has been fully ascertained by the experiments of M. Aimen, who found that forty plants raised in the common way yielded only a pound and a half of seed, whereas from a single plant which grew by itself seven pounds and a half were obtained.

When the hemp is pulled it is taken up by the roots, and before the plants are taken from the field, the leaves and flowers, and sometimes the roots, are taken off with a wooden sword; these are left on the ground, as they greatly contribute to enrich it for the succeeding crop. The stalks are then arranged as nearly as possible in equal lengths, the root-ends being laid all on the same side of each handful or bundle, which is then tied round with one of the stalks.

When the hemp is gathered from which seed is to be preserved, it is exposed eight or ten days to the air, after which the heads are cut off and the seed is thrashed and separated in the same manner as linseed.

The processes to which the hemp is subjected before it is rendered marketable and in a state fit for spinning are very similar to those practised with flax. The same end is required to be attained —that of separating and cleansing the fibres from the woody and gummy matters which adhere to it, and the means used are therefore the same,—the time and degree of each operation being proportionate to the different nature of the two fibres.

The plant is generally dried previously to being watered, but this is objected to by some of the most intelligent cultivators. Mills, in his work on husbandry, gives some very excellent reasons for dissenting from the general practice; he observes, "Those that are for drying it first, say that the hemp thereby becomes stronger than when it is steeped, without having been previously dried. For my part, I confess that this drying seems to be a needless trouble; for as it is necessary in the steeping of hemp that a certain degree of putrefaction should arise sufficient to destroy the texture of that glutinous substance which connects the fibres to the woody part of the hemp, it certainly is advisable to lay the hemp in water as soon as can be after it is pulled, because the more there is of the natural moisture left in this glutinous substance the sooner the putrefaction would begin. If either by design or by accident the hemp has been dried, the putrefaction comes on more slowly and unequably, and the fibres contract a hardness which the steeping will not afterwards easily correct *."

Marcandier † is of the same opinion as the writer just quoted, and farther adds, that hemp newly gathered requires only four days immersion in water, but if it has been previously dried, eight or ten days will scarcely suffice to produce a similar effect, and if the water be hard or of a very cold tem-

* Mills's Husbandry, vol. v. p. 197.

† Traité de la Culture du Chanvre.

perature, a fortnight or three weeks may be found necessary.

Mere exposure to the air is sometimes substituted for the water-steeping; this is called dew-retting. The hemp to be so treated is stacked and covered during the first part of the winter, and in January and February is spread upon meadow land and whitened with the frost and snow. The fibres of the plants thus treated are, however, always much inferior to those which are retted by water, and they are fit only for the coarser yarns.

In the cold regions of some parts of Russia and Sweden the snow which falls so abundantly is made the means of separating the fibres from the useless part of the plant. The hemp previously dried instead of being steeped in water, is, after the first fall of snow, spread on the ground to receive a fresh accession of snow upon its surface; and this, when dissolved in the spring, leaves the hemp in such a state that the fibres are readily disengaged. In some parts of Livonia a more complicated method is pursued, which it is said enhances the value of the hemp twenty-five or thirty per cent.

A spot where there is a fall of clear water is selected, and five or six basins of about two feet deep are made, one beneath the other; they are divided by slight banks of clay and communicate with each other by means of a small aperture in each, which can be stopped at pleasure. The plants are steeped in the lowest basin for two or three days, and so on successively to the highest; the first basin as soon as emptied always being filled again with fresh plants; at each time these are supplied, the water is renewed in the top basin, and the apertures being unclosed, an exchange of water takes place throughout all the vessels.

It has always been supposed that some improvement might be introduced in this preliminary part of the preparation of hemp. M. Brulles, an old curate of the department of the Somme, influenced by this opinion, occupied himself for several years with various experiments on the subject. Encouraged by his government, he at length, in 1803, discovered a much superior method, and offered it to the inspection of those interested in promoting the improvement. Napoleon, in the midst of his ambitious schemes and stupendous projects, still gave his attention to this minute point of domestic advantage, and directed that trials should be made of M. Brulles' plan under the superintendence of Berthollet and other scientific and competent persons. These experiments were carefully pursued for six months, and the result proved highly satisfactory.

The process is wholly different to the usual water-retting wherein so much time is consumed, and in which a situation near a river is almost indispensably necessary for the supply of the canals with soft water. This is M. Brulles' process: Soft soap being dissolved in water it is heated to nearly boiling temperature, the hemp stalks are then entirely immersed in this soapy mixture, the plants and fluids bearing the relative proportion in weight of 148 to 650; the boiler containing the whole is then closed, and the fire extinguished. After being subjected to this maceration for only two hours, the hemp is taken out and covered with a layer of straw, that it may cool gradually without losing its humidity.

As soon as one parcel of plants is taken out of the cauldron, fresh ones are put into the same water, care being taken to add a quantity of the soapy mixture equal to that which had been absorbed by the preceding plants.

By then crushing and beating the fibres, they were found to separate more readily than after the common method of retting, and with much less waste, producing in the proportion of four ounces from one pound of plants, while in the ordinary way only three ounces were obtained. On the other hand, the utensils required, and the soap and fuel consumed, might be adduced as countervailing objections, which, however, were believed not only by the inventor, but by those who investigated the method, to be more than compensated by the great advantages attendant on this process *.

After watering or macerating the hemp, it is sometimes dried in the same manner as flax, but this operation is more usually hastened by means of an oven or kiln. In this case the heat must be very carefully applied, as too great a degree will injure the fibres by drying up the oil which they contain, leaving them harsh and brittle. Combustion is so easily excited in dry hemp, that when a kiln is employed, great care is taken that no fuel is used which can blaze or sparkle; coke is therefore considered most proper for the purpose.

The drying place is sometimes a kind of cavern, so situated as to be sheltered from the north and north-east winds, and open to the south, that it may receive the full benefit of the sun. About four feet above the floor, bars of wood are fixed across this cavern, on which the hemp is laid six inches thick. Under the hemp so placed, a small fire is kindled, which is usually fed by the fragments of the reeds of plants, which have been already peeled; this is tended by a careful person, who must always be on the alert to replenish the fire, for the fuel used quickly consumes, and a constant and regular heat should be kept up in the cavern or oven, while very great caution is required

* Nichol. Jour. 11th vol.

to prevent the flame from reaching the hemp. During the process this is turned from time to time, that it may be equally dried throughout.

After it is dried the hemp is usually broken by the hand-break or by mills; when the former is used it is reckoned that one woman can break twenty or thirty pounds during the day. Some cultivators adopt another method for separating the fibres. This is done by simply breaking off a piece of the stalk at the lower end and peeling the bark from the reed in ribands. It is so simple of performance, that the children, the aged, and the infirm, can be advantageously employed in the task; and where there is a large family, and some hands which would be otherwise useless, this method may be pursued with a good result, but it would be very unprofitable work for an active labourer. Besides which it is not as effectual as the use of the break in separating the fibres. The peeled hemp comes off with much of the useless membranes adhering, and it is not disengaged from any of the dirt, which it may have contracted in the stagnant pools where it has been watered; these circumstances render the after processes with the peeled hemp more difficult than with that which is broken.

The Abbé Brulles * recommends another manner of accomplishing the same thing, and which he terms reeding the plant. For this purpose a trough is provided, twelve or fourteen inches deep, and somewhat longer than the hemp under process; to this trough are fitted two pieces of wood, a foot in length, set on one side with brass-wire teeth. The trough being filled with water, and the hemp laid evenly along, these pieces of wood are placed over the hemp, one

* The Mode of cultivating and dressing Hemp, by the Abbé Brulles.

at the end and the other in the middle of the stalks, serving thus the double purpose of keeping them straight and of retaining them in the water.

Immediately that the hemp is found to be sufficiently macerated, it is transferred to the trough without any previous drying; there it is gently rubbed, to promote still farther the separation of the bark from the reed. The bark is then disengaged from the stem at the root end; keeping the hand and the reed under water, and laying hold of the stem, it is readily drawn out from the bark, like a sword from its scabbard. In this way a skilful operator may draw out six or more reeds at once. Should any of the reeds be broken, then the board is taken off at the upper end, and the remaining pieces are drawn out at that side.

When the fibres are thus freed from the reeds they are readily disengaged from the remaining parts now macerated into a jelly, which is removed by washing and rubbing, care being taken not to twist or displace the threads.

After the fibres have been disengaged by either of the foregoing methods, the operation of scutching commences; this has been already described. The usual allowance for waste in Russian hemp, under this process, is estimated at four pounds per hundred weight. A good workman can scutch from sixty to eighty pounds of hemp per diem. Those fibrous parts which are beaten out are carefully collected and scutched separately, and the smaller pieces which are shaken out form the coarse tow used for caulking ships, making flambeaux, mops, and various other articles.

Before the hemp is heckled it is usually made to undergo a previous operation called beetling. This is performed by beating it with heavy wooden mallets in order still more completely to separate the fibres, and to make them finer and softer. The motion is given to the mallets either by hand or by water, or by other motive power. When a machine is used, the hemp is constantly turned by a boy, in order to change the surface, that every part in turn may receive the strokes. It is then consigned to the heckle.

The heckles used for hemp are somewhat coarser than those for flax. The teeth of the coarsest are usually about an inch in circumference at bottom, diminishing gradually to a sharp point, and they are set about two inches apart from each other.

The produce of an acre of land sown with this plant usually averages from four to five hundred weight of cleansed hemp, and from sixteen to twenty-four bushels of seed. The culture of hemp is considered to be very profitable, and therefore, as we have observed when treating of flax, many attempts have been made to encourage its farther growth in England; but a great prejudice formerly existed against this crop, and it was supposed to exhaust the land to such a degree that many landowners inserted in the leases granted to their tenants, covenants prohibiting its cultivation.

Hemp is admitted from all countries under a nominal duty of one penny per cwt.; its present price, varying according to its quality, is from £21 to £28 per ton.

CHAPTER V.

FIBRES APPLICABLE TO CORDAGE.

SUNN—PAAT—CHINESE HEMP—NEW ZEALAND FLAX AND GRASS, &c.

ALTHOUGH the hemp plant has been cultivated in India from time immemorial, it has never been employed by the natives in the manufacture of cordage or of cloth as in Europe.

It is cultivated in small quantities in every part of Hindostan for its narcotic properties*: the flowers of the male, and the leaves of the female plant, are the parts in most general use. Other nations as well as the Hindoos apply this plant to the same purpose. The *Madjoon* of Constantinople, which the Turks eat in order to produce excitement†, is composed of the flowers of the hemp plant, ground to a powder, and mixed in honey, with pulverized cloves, nutmegs, and saffron.

The Hindoos call this plant *Ganja*, and the intoxicating drug prepared from it is designated *Bang*.

No difference can be discovered between the Hindoo *ganja* and the European hemp, and it is believed that if properly prepared, the former might be applied with equal advantage to every purpose for which the latter is employed. It would, however, require rather

* We have shown at page 67, on the authority of the Swedish traveller, Thunberg, that the Hottentots cultivated hemp for the same purpose, and mixed it with tobacco for smoking.

† Travels in Palestine, &c. by R. R. Madden, Esq.

a different mode of cultivation than that practised by the natives. They sow it very thin, and the young plants are afterwards transplanted to about nine or ten feet distance from each other. The plant, in consequence of this kind of culture, grows to a great size, and the fibres become too harsh and ligneous to be prepared for cordage. It was supposed that with due encouragement the Ryots might be induced to cultivate this or some other of their native plants according to the European manner; but their inveterate prejudices render the task of introducing any thing new a work of almost hopeless difficulty, while few of the plants themselves are perhaps of a nature to be improved by our modes of preparation. Some hemp is annually imported into this country from India, but whether produced from other native plants, or from the *cannabis sativa* itself, it is of a very inferior quality, and does not command half the price of the best Russian hemp.

There are, however, numerous productions to be found in India which might form materials for cordage. Dr. Roxburgh made many interesting experiments as to the relative strength of different fibres; but although he pointed out and described many valuable substitutes for hemp, the result of his inquiries sufficiently shows that none are superior or even equal to our European plant.

Sunn, or *Crotalaria juncea*, approaches nearest to hemp in the manner of its growth and cultivation, and is in most general use in the hotter parts of Asia. It produces a material so similar to hemp, as to be often confounded with it; and the plant itself has in consequence been frequently considered of the same species. It is, however, quite distinct in its botanical characteristics from the *cannabis sativa*.

This plant is so easy of culture and so productive,

Sunn—*Crotalaria juncea.*

that many years ago the East-India Company were induced to direct their inquiries towards it, in the hope of cultivating it so successfully in their oriental dominions, as to convert it into a lucrative branch of commerce.

It has long been cultivated by the Hindoos for the purposes of cordage, but their manner of preparation was believed to be susceptible of improvement, and many attempts were made to introduce a process more conformable to the European method of dressing hemp. Pursuant to these views instructions were transmitted to every residency for promoting the more extensive cultivation and better management of the plant.

In complying with the directions, the several residents had as usual much difficulty in contending with the preconceived notions of the Ryots, who, attached to their own mode of cultivation and preparation, could not be convinced of the superior advantage of the new method, however strenuously recommended: everywhere objections were raised, and even in those places where the natives had consented to adopt the method prescribed, this was so partially and so inadequately pursued, as not to be considered a fair trial. In some places they most peremptorily declined going out of the beaten track of their forefathers; and at Dumroy especially, the report of the resident records that the natives manifested a most inflexible obstinacy. Although a European was employed to instruct them in the new method, they turned a deaf ear to his lessons, exclaiming, "You may imprison our persons, you may strike our necks, but never will we make sunn according to the advertisement."

In this case perhaps the Hindoo abhorrence of change was not quite so unreasonable as it too often proves. The result showed that it was not very judicious to require persons blindly to adopt a process which a different plant underwent in a different clime and country. It was found that the sunn was a much more delicate plant than hemp, and could not bear the rough treatment to which the other was subjected. The drying previously to steeping was found decidedly injurious to the plants, while immersion in water for even a few hours only beyond the time absolutely required for separating the bark, had a pernicious effect on the fibres, and these being of a much more brittle nature than those of hemp or flax, they as well as the reed were cut by the application of the hand-break.

In consequence of many failures, as the result of their own experiments, several residents at length gave it as their decided opinion, that the mode practised by the natives was preferable, and recommended that they should be allowed again to pursue their own plan without farther molestation.

Two species of sunn are cultivated in India, distinguished by the names of *Phool* and *Boggy*. The first of these is the most esteemed. It grows about four feet high, and produces the strongest and most durable fibres. The *boggy* attains to a much greater height, and its fibres are much darker coloured. A rich light soil is most congenial to it, but it will grow on land so sterile as to be unfit for any other crop. Much previous preparation of the soil is not necessary, and after being sown, it requires no farther care till it is in a fit state to be pulled. The time for putting the seed in the ground varies in almost every district: the commencement of the rainy season is considered the most favourable. Sunn is sufficiently ripe for gathering in about three, or sometimes four months after seed time. The natives believe that the thicker it is sown the better fibre is obtained. They say that the plants should grow so close together as to prevent the air from passing between them; the stalks then shoot up straight, without throwing out any branches, the fibres of which are short and much inferior to those of the principal stem. The time when the blossoms begin to fall is considered the most proper for gathering. The plants are in some parts of the country cut down close to the roots, and in others are drawn up entirely in the manner of pulling hemp. They are then immediately placed in shallow water, standing on their root ends; and not more than one-third of the plant being immersed, the next day they are wholly covered with water; thus the thicker and more woody part of the stalk is steeped longer than the thinner, which is apparently a judicious practice. When the plants have been macerated three or four days, the dresser, standing in the water, takes up a handful of the plant, breaks it in the middle, and strikes each part successively on the water until the fibre separates from the reed. When this is accomplished the filaments are hung up to dry. If intended for fishing-nets, or other small lines, they are afterwards combed; but for common use they are merely separated a little with the fingers, made up into bundles, and considered fit for sale.

Rope made of this material has the property of becoming much stronger when surcharged with moisture than when in a dry state. A dry cord broke in raising a weight of 148 lbs., which, after being soaked in water for twenty-four hours, and while yet wet, sustained 222 lbs. weight without breaking.

Paat, or *Corchorus olitorius*, or *Bhangee*, is another plant whose fibres are used for the purposes of making cordage in India. It is an annual plant, flowering in the autumn, and growing wild in many parts of India, but carefully and extensively cultivated in Bengal. Its fibres, for cordage, are known in commerce by the Bengal name *Jute*. Under cultivation, its stem is round and smooth, its height from three to four feet. When wild, it is short and ramous. It has been called Jew's mallow, because the Jews in India boil and eat its leaves with their meat. But this particular use of it is not confined to the Jewish people, for both Hindoos and Musulmans cook and eat its leaves. This seldom attains a greater height than four feet, and shoots out many lateral branches, which renders it a difficult task to separate the fibres from the woody parts. It is in consequence not considered very profitable for cultivation, and is only partially grown on small plots near the houses of some of the natives, and this more for the leaves and tender shoots, which are used by them as an article of food, than for the value of the fibres they produce. In preparing these filaments, the plant requires much longer steeping in water than hemp, a fortnight or three weeks being scarcely sufficient for its perfect maceration.

The gunny bags in which sugar and other similar commodities are brought from India to this country are made of this material.

The *Æschynomene cannabina*, or *Dooncha* of Bengal. This plant is never found growing wild in India, but is cultivated there. The hemp made from its fibres, though coarse, is much employed. When Calcutta port was blockaded by Admiral Suffrein, masters of ships were reduced to use cables of *dooncha*, which proved perishable, and many ships are said to have been lost from this circumstance. It is, however, considered in India as more durable in water than sunn or jute, and is employed for the drag-ropes of fishing-nets.

The *Sanseviera Zeylanica* is a perennial plant, which grows wild under bushes in the jungle. It is very abundant, and flowers from January to May. Its leaves, three or four feet long, contain fine, strong, white fibres through their whole length. The natives prepare it by placing the leaf on a smooth broad table, holding it down by putting their great toe on one end of it, and then scraping it with a thin piece of hard wood held in both hands. Forty pounds of leaves thus scraped will render one pound of clean dry fibres. The material is recommended, as excellent, by Dr. Roxburgh, who thinks the "China grass," used by the Chinese for fiddle-strings, fine fishing-lines, &c., is nothing else than this plant. It is sometimes called

"Bowstring," because it is used by natives of the Circars for the purpose of stringing their bows.

Another species, *Sanseviera guineensis*, found wild in great abundance on the west of Africa, has lately been brought into competition with New Zealand flax, to which it is said to be superior.

The Chinese hemp, or *Corchorus capsularis*, is a plant growing in India as well as China, and which is capable of affording serviceable fibres for cordage. It is an annual, and cultivated in Bengal for food as well as for cordage. It was generally supposed, a few years ago, that this plant, as its English name imports, was a superior kind of hemp, but it has been found to be not even of the same species; and Dr. Roxburgh affirms that of all the numerous varieties of seeds he from time to time obtained from China, he never saw any of the *cannabis sativa*, nor could he, from his most extensive inquiries, learn that any existed there. It has, however, been since ascertained that the *cannabis sativa* is cultivated in the northern provinces of China. At Tung-Chow (as we have shown in our account of hemp) Mr. Clarke Abel saw it growing with *sida*.

It was supposed that the *corchorus capsularis* was much superior to European hemp, and attempts were made to introduce it into England. An account of the particulars of the different trials made of the cultivation of the Chinese hemp is given in the 72d vol. of the Philosophical Transactions. We learn thence that seeds of this plant were sowed in England, and produced plants fourteen feet high and nearly seven inches in circumference. In consequence of this success more seed was procured from China, but notwithstanding the care and attention which were bestowed on the cultivation but few produced mature seeds. Some plants were raised by Dr. Hinton, but they were so sickly and unpromising that they were abandoned, and the field sown with another crop. One or two chance plants, which had escaped the general extirpation, were discovered among the new crop, and the seed of these, contrary to all calculation and expectation, came to maturity. They were carefully preserved and sown the ensuing season, when they were found to produce a crop of good hemp by one-third greater than was ever known to be obtained in England. For this successful experiment, Dr. Hinton received a medal from the Society for the Encouragement of Arts, &c., but it does not appear that any general good results followed this solitary instance of success, and nothing farther is heard of the Chinese hemp in this country. Subsequently these fibres were found, by Dr. Roxburgh, to be very much inferior to those of hemp, as regards both strength and durability.

In the fifth volume of this series ('the New Zealanders') is a cut and description of the *Phormium tenax*, growing in New Zealand, and used by the inhabitants for the same purposes to which we apply hemp and flax, and therefore called by the English New Zealand flax. It would be superfluous to enter here into any lengthened notice of this plant and of the manner in which the natives prepare its fibres, since the account has been already given in the above volume.

The leaves of the *phormium tenax* resemble those of the flag, but its flowers are smaller and more numerous. With very little preparatory process the filaments of these leaves are formed into clothing and cordage, the latter is beyond all comparison stronger than any which can be manufactured from hemp. Another preparation likewise produces from the same plant long slender fibres beautifully white and lustrous as silk*. Of these the natives make their

* Hawkesbury's Voyages.

New Zealand Flax—*Phormium tenax.*

most choice garments. Fishing-nets, which are sometimes of an enormous size, are formed of the leaves split into strips and tied together.

It may readily be supposed that many attempts have been made to propagate this valuable plant in England. But all the seeds which were brought home by various voyagers were found to have lost their vegetative powers, or at least, if in one solitary instance some sickly plants were raised, this partial success led to no good result. Government, however, was so fully impressed with the importance and superiority of this material in making cordage for our shipping, that every possible encouragement has been given to render it an article of commerce from Australia, and by admitting its importation free of duty, before the removal of the duty from European hemp, the legislature endeavoured to rouse the Australian settler to this branch of commerce with the parent country. The culture of the *phormium tenax* has been pursued in Australia, and some of the prepared fibres are occasionally imported thence, but as yet more as an object of experiment than as a useful article of export. A much greater quantity is received through Sydney from New Zealand; but however the missionaries may encourage the collection of this valuable plant among the natives, the supplies obtained from an uncivilized people must of necessity be very precarious, since no uniform industry or co-operative design for any continuous period animates them to lengthened exertions, or actuates them in the pursuit of any one object. The quantity imported into this country is therefore so small and fluctuating that it has hitherto been wholly out of the reach of private individuals, and very insufficient for the contracts which the government is desirous of making for a supply of so valuable a material in the rigging of ships. There is now, however, every hope that it will be obtained more abundantly, and we notice that a factory for the manufacture of cordage from the *phormium tenax* is already established at Grimsby in Yorkshire, on the race-course of which place, on May 11, 1831, the first stone was laid of a series of buildings for a manufactory of rope and canvas from this material. The establishment is to be conducted on a very extensive scale, and when in full operation, will, it is said, give employment to from two to three hundred workmen. While it has been a subject of much interest to obtain the *phormium* from the country in which it was first discovered, and to promote its culture in Australia, and while the constant and repeated failures of the imported seed have been matter of regret, the identical plant has been recently discovered flourishing luxuriantly in the south of Ireland.

It appears that this plant was brought to Ireland by Mr. Underwood in the year 1798, where it has been cultivated as an ornamental plant ever since. Mr. Salisbury *, of the Botanical Garden, Chelsea, found in his researches six years ago, that the *phormium tenax* was then growing in the open ground in gardens in Waterford, Cork, Limerick, Louth, Dublin, and Wicklow counties, it being a perfectly hardy plant; on one estate it has been cultivated for thirty years successively, during which time it was only once or twice triflingly affected by frost in the tops of the leaves. Some of these plants are likewise growing at the seat of Lord Cawdor in Pembrokeshire, and at several places near to Exeter. It is not yet cultivated to any extent in Ireland for purposes of utility, but since the climate has been proved to be so congenial to it, there can be little doubt that public spirited individuals will be found who will promote the home production of so valuable a plant.

Mr. Salisbury gives, as the result of his experiments and observations, many useful hints for its culture and preparation. He found that plants of three years old will, on an average, yield thirty-six leaves, besides a very considerable increase of offsets, which leaves being cut down in the autumn others spring up anew in the ensuing summer. Six leaves have produced one ounce of dry available fibres, having been previously scutched and cleansed; at which rate an acre of land cropped with these

* Trans. of the Society for the Encouragement of Arts, &c. 42d vol.

plants, growing at three feet distance from each other, will yield rather more than sixteen hundred weight per acre, a great produce compared with that of either flax or hemp. It has likewise the farther advantage of being cleansed with very little labour or trouble. The leaves are cut when full grown, and macerated for a few days in stagnant water; they are then passed under a roller machine properly weighted. By these means the fibres separate, and if then washed in a running stream will instantly become white.

Two or three years back some of this material which had been obtained from the Colonial Office was woven into cloth by the pauper children of St. George's workhouse, Little Chelsea. It was soft to the touch and of a good colour. From other trials, however, which have been made, it is supposed that this material does not produce very durable cloth, and that it is not well adapted to the purpose of weaving, but every test has proved its superiority for the formation of cordage.

The leaves of this plant grow in Ireland to five, six, and even eight feet high; it is propagated by offsets which should not be parted till the parent root is four years old; May is the most favourable season for this work of husbandry.

Experiments have likewise been made at Portsmouth in the application of another product of New Zealand to the manufacture of large and small ropes. A favourable report has been given of the result of these trials. The new material is a strong pliable grass, very silky in its nature, and of very rapid and luxuriant growth, three crops being obtained in one year. It may be brought into this country at the estimated price of £8 per ton, which is now about one-fifth of the price of hemp of the best quality.

CHAPTER VI.

FIBRES APPLICABLE TO CORDAGE.

AGAVE AMERICANA—OTHER SPECIES OF AGAVE—BROMELIA—BOWSTRING CREEPER—CALOOEE—MAHO-TREE—EJOO—COIR—BARKS OF VARIOUS TREES—ESPARTO—OTHER FIBRES.

THE leaves of the American aloe, or *Agave Americana*, are advantageously applied to the production of cordage. Their fibres are coarse and harsh, but they are found to be stronger than hemp, although not so elastic, and when made into ropes these are more liable to be affected by the weather. They are, however, extremely tenacious and durable, and consequently of great utility in those countries where the plant is found in abundance. The aloe, which flourishes in the south of Spain, differs very little from the American, and that which ornaments our green-houses is the same plant in miniature *.

The growth of this plant is slow, but when arrived at maturity its leaves are of a gigantic size, usually from five to eight feet in length, some considerably exceed even this dimension. The aloe attains a size quite equal to this in Sicily and Calabria, where, though not commonly, cordage and mats are made of its fibres. The great use to which the aloe is applied in those countries is to form hedges or fences. As each strong leaf of the gigantic plant terminates

* In 1770, when Thunberg was at Amsterdam, there was in the Botanic Garden of that city "a great American aloe (*Agave Americana*) which was in full blossom, and shown every day for money."—Travels, vol. i.

in a hard sharp point (as sharp as a needle), about half or three quarters of an inch in length, and in appearance not unlike the nails of a beast of prey, a hedge of this sort properly made is utterly impenetrable by cattle, and indeed by man, unless he have recourse to a hatchet or some other instrument, or to fire. The same sort of aloe grows and is turned to the same uses in the south of Spain. In many parts of Calabria and Sicily, geraniums of a great size and myrtles grow spontaneously in these hedges, mixed with aloes. The effect produced when the geraniums are in flower, both on the senses of sight and smell, is delicious beyond description. Mr. Bullock * measured several of the leaves of this plant growing in Mexico, and found them ten feet long, fifteen inches wide, and eight thick. When in bloom its flower stalk is twenty feet high, "expanding like a rich candelabra, its arms clustered with yellow flowers." The time of flowering is very uncertain; the generally received belief, that this plant vegetates for a century ere it blooms and dies, is now considered to be erroneous. The period very much depends on the climate in which it grows. It is brought to maturity much more rapidly by the vivifying heat of the tropical sun than when under the influence of a colder temperature. In Mexico the time of flowering varies from eight to eighteen years. The fibrous parts of the leaves are made into strong twine or thread in that country, and made up into rope which is most commonly used in the mines; and on the western coast it is employed as rigging for ships. This plant is indigenous to Mexico, and is likewise an object of extensive cultivation there; but the large plantations which abound in that country are not reared solely for the sake of

* Six Months in Mexico.

its leaves, although their fibres are made applicable to cordage.

When the aloe is arrived at maturity, by tapping the stem a spirituous liquor is obtained, which is a favourite beverage of the lower classes, called by them *Octli*, or *Pulque.* A good plant yields from eight to fifteen pints of liquid per diem during two and often three months. A full account of the manner of drawing off this pulque * may be found in Mr. Ward's work on Mexico.

The agave or aloe is deemed by the Mexicans to be one of the most valuable productions of nature. The aborigines applied this plant to a great variety of purposes; from it they made their paper (pieces of which of various thickness are still found covered with curious hieroglyphic writing), their threads, their needles (from its sharp points), and many articles of clothing and cordage. The thick fleshy fibrous leaves of most species of aloes contain filaments of considerable strength, and which may be drawn out and separated from the other parts of the leaf by a very simple and speedy process.

We learn from travellers that those growing in Africa, and especially that of Guinea, are employed in making very good ropes, which have the superior advantage of not rotting in the water.

The *Agave vivipara* and *Cubensis* are two species of aloe produced in great abundance among the

* Mr. Ward observes, that "although the plant is found wild in every part of Mexico, no attempt to extract pulque from it is made, except in the districts which are within reach of the two great towns of La Puebla and Mexico; where, among the lower classes of the inhabitants, the consumption is enormous. Before the revolution the revenue derived from a very small municipal duty exacted on the pulque at the gates of these towns, averaged 600,000 dollars, and amounted, in 1793, to 817,739 dollars, or about £170,000 sterling."—Mexico in 1827, vol. i. p. 55.

rocks and barren hills in the island of St. Vincent. Specimens of twine made from the fibres of the leaves have been sent to England by Dr. A. Anderson, with the view of converting this material, if approved, into an article of commerce *.

The silk-grass plant of the West Indies is likewise a species of aloe (*Agave yuccæfolia*) ; this grows wild in the woods in great abundance. The leaves are indented and prickly, and contain, longitudinally, very strong and fine fibres. To obtain these the leaf is laid upon a flat piece of wood, and scraped on each side with a wooden knife, until the filaments appear in straight threads, extending the whole length. With these the negroes manufacture hammocks, ropes, and fishing-nets; and it is said that this material is capable of being worked up into a much finer merchandize. Stedman says, "This kind of hemp is so very much like white silk that the importation is forbidden in many countries to prevent imposition by selling it for the same, and the fraud is more difficult to be detected when it is artfully mixed with silk." We are told by the same author that ropes are made of this material stronger than any in Europe, but it is discovered that they are sooner liable to be damaged by immersion in water than hempen cordage.

We shall have to speak of some other species of aloes applicable to other purposes in the course of this volume, but we may mention here that Thunberg found aloe-hedges made in Southern Africa, and on a journey into the interior from the Cape of Good Hope discovered a species (*Aloe dichotoma*), "the stem of which, when of a proper thickness, is hollowed out, and used by the Hottentots as a quiver for their arrows †."

* Trans. of the Society, &c. 26th vol.

† Travels, vol. ii.

Excellent twine for ropes may likewise be obtained from the leaves of several species of *Bromelia*, the same genus of plants as the pine-apple. The Caroa, or *Bromelia variegata*, which grows abundantly in Brazil, is among the most valuable of these. The inhabitants of the banks of the river St. Francisco weave their fishing-nets of this material, and manufacture it likewise into very strong cordage.

Bromelia acanga.

This plant has no stem and the leaves are radical and few. The stalk bearing the flowers is about two feet long, flexuous, and almost spiral, with alternate scales without thorns. It blossoms in the months of July, August, and September. The fruit is an oval pointed berry, about the size of an olive. The leaves are from three to six feet long and composed of two segments, one exterior and convex, and the other interior and concave. The former is more compact, hard, and thick, than the latter; between them are numerous longitudinal fibres of the same length as the leaves, and embedded in a juicy pulp. These are separated from the rest of the leaf, either by maceration and beating, or by clipping with a knife the convex side at the bottom, and while holding it in one hand pulling out the fibres with the other. This is an operation which requires some strength and dexterity, and is more laborious and expensive than the first method, but the filaments thus obtained are better and stronger.

In Brazil, especially about Pernambuco, many leagues of land are covered with this plant, and in some places growing in such wild luxuriance as to overspread the ground and render it impassable.

Crauata de rede, or *Bromelia sagenaria*, another native of Brazil, is a plant which resembles the foregoing, in not having a stem and in having radical leaves, but these are more numerous and sometimes attain to a much greater length than those of the last described plant. The stalk which bears the flowers is a foot and a half long. It produces purple flowers which bloom in July and August, and are followed by one pyramidal fruit composed of a congeries of berries. The filaments of the leaves vary in length from three to eight feet, according to the relative fertility of the land. The shortest fibres are finer and softer than the longest.

The following circumstance is related in proof of the strength of the cordage made from this material. A rope thus composed had been in constant use during many years upon the wharf of the city of Paraiba, where it was employed for embarking merchandize, and it retained its strength unimpaired. On one occasion the heavy anchors belonging to a line-of-battle-ship were hoisted on board a vessel with this same old rope, after hempen cables of a larger diameter had been found inefficient for the purpose. This material is not so liable as most other vegetable fibres to be injured by constant immersion in water, being protected by a kind of resinous matter, with which the filaments are naturally covered*. Both these properties of strength and durability in this material, may be proved by inquiry, at the present time, in the Isle of Wight. A Portuguese vessel from Brazil came on shore some years since, and the fishermen obtained a good deal of rope which she had on board. It is still in use amongst them; and some, which is occasionally fished up, is as strong as that which has not been exposed to the action of the water. This property, which is well known to the natives of Brazil, causes it to be preferred by the fishermen for their nets, and they increase its power of resisting water by tanning the threads of their nets with the bark of some of their native trees,—a practice recommended by Dr. Roxburgh as a preservative to cordage, and recently fully proved to be of great efficacy.

A process for tanning ropes has just been made the subject for a patent in this country.

Mr. W. Roxburgh in an excursion among the Rajemahl hills observed the bowstrings of the

* A Dissertation upon the Plants of Brazil, &c., by Dr. Manoel Arruda Da Camera, as quoted from Koster's Brazil.

natives to be made of a remarkably strong and beautiful fibre. He learnt that these strings usually lasted five years though in constant use, and exposed to all the vicissitudes of the weather. His attention was awakened to the subject, and he was sedulous in his inquiries after the plant which produced this valuable material, uniting strength, durability, and elasticity. He found on examining the plant called *Jetee* by the natives, that it was a species of Asclepias, to which he gave the name of the bowstring creeper. It is a twining plant with few or no branches, having leaves growing opposite on hairy foot-stalks, and at a distance from each other. The fibres are obtained by stripping off the bark from the tender succulent shoots after they have been exposed to the sun for a day, in order to evaporate a milky juice which exudes from the cut stalk. The only implements which are then used to cleanse the fibres are the finger nails, and those persons who have been provident enough to keep these very long, expeditiously scrape the pulpy parts away, one man so provided being able to cleanse a considerable quantity of fibres in a day. According to Dr. Roxburgh the fibres of this plant are the strongest of any yet known.

A plant indigenous to Sumatra called Calooee, or *Urtica tenacissima*, produces material for excellent twine. It is very easy of cultivation and of most luxuriant and rapid vegetation, throwing up numerous shoots which may be cut and will be renewed three or four times in the course of the year. Its stem would become ligneous and covered with brown bark if suffered to attain to its full growth, while it would throw out many branches spreading considerably; but the young shoots are those which are used, and on the stem being cut down, numerous straight simple shoots spring up from one to eight feet, according to the season, quality of the soil, and other circumstances. These shoots being cut are dried and beaten to separate the fibres, but it is a tedious and troublesome operation, and unless some more easy process be discovered to disengage the filaments, the difficulty of the work must be a sufficient obstacle to prevent the extensive adoption of this material.

From a plant similar to this the inhabitants of the Friendly Islands make, it is said, the strongest fishing-nets in the world. They likewise manufacture a kind of seine of coarse broad grass, the blades of which resemble flags; these are twisted and tied together in a loose manner till a large net is formed, which is advantageously employed in smooth shoal water*.

The Maho-tree, or *Hibiscus tiliaceus*, is indigenous to, and grows abundantly in both the East and West Indies. The fibres of the inner bark are used for making cordage by the inhabitants of many of the South Sea Islands, and by the American Indians. The Otaheitans make a kind of fine matting from it, and likewise manufacture it into ropes and cords of various thickness, from the size of a packthread to an inch in circumference. It has a woody pithy stem, dividing into several branches towards the top; these branches are covered with woolly down; the leaves are heart-shaped. The flowers of a pale yellow colour, grow in loose spikes at the end of the branches. After being divested of the outer rind, or parenchyma, the fibres are readily drawn off either singly or in flakes, and are without preparation rendered available to each purpose for which they are used. Voyagers relate that these filaments are adapted to any kind of cordage, even for the rigging

* Hawkesbury's Voyages—Marsden's Sumatra.

of vessels, but rope thus made is not nearly so strong as that prepared from hemp.

The Ejoo is a species of palm-tree, which affords a fibre exactly resembling coarse black horse-hair, and which is capable of being made into ropes of great strength, not so elastic as those made of *coir*, which will be hereafter described, but stronger than hempen ropes. This tree is called the *arrow* in Marsden's History of Sumatra, where it is described as affording fibres ready prepared by nature, flexible, strong, exceedingly durable, and the most convenient for cables and cordage that can be desired. These fibres grow in a very remarkable and peculiar manner, being produced from the base of the foot-stalks of each leaf, and embracing completely the trunk of the tree, from which the fibres and leaves are easily removed without injuring its growth. These fibres are apparently bound to the tree by thicker filaments of twigs, of which the Malays make pens for writing; indeed there are many other important qualities in this tree which render it a very valuable production. It abounds in palm-wine, a liquid which flows from incisions made in the trunk, and is a very grateful beverage much esteemed by the Malays, who likewise make sugar from it. Sago also is obtained from this species of palm. Each tree throws out annually six large leaves, and each leaf yields an average produce of three-quarters of a pound of fibres fit for cordage.

The fibres of the husk of the Cocoa-nut are much esteemed for cordage throughout Asia. These fibres are called *coir*. The fruit has been already noticed in a former volume, and the use of its fibrous parts described. Mr. Henry Marshall, a medical gentleman for many years resident in Ceylon, has given in his 'Contribution to a natural and economical history of the Cocoa-nut Tree*,' a full account of this species of cordage.

"The husk or fibrous part of the nut," says that gentleman, "is employed to polish furniture, and to scour the floors of rooms, &c. Birds which build pendulous nests commonly construct them of this substance. Its chief use, however, is in the manufacture of coir, and for this purpose the nut ought not to be completely ripe. . . . To remove the husk, an iron spike, or sharp piece of hard wood, is fixed in the ground; the nut is then forced upon the point, which passes through the fibres, thereby separating the rind from the shell. In this manner a man can clear 1,000 nuts daily. Coir is prepared by soaking the rind in water for several months, and then beating it upon a stone with a piece of heavy wood. . . . Subsequently it is rubbed with the hand until the interstitial substance be completely separated from the fibrous portion of the husk. The rind of forty cocoas furnished Mr. Koster with six pounds weight of coir. The next operation is to twist the fibres into yarns, which are manufactured into cordage of all sizes. Coir is remarkably buoyant and well suited for ropes of a large diameter. Until chain-cables were introduced, all the ships which navigated the Indian seas had cables made of this substance. Sea-water is said to be rather beneficial than hurtful to it. Coir-cordage, when properly prepared, is pliable, smooth, strong, and elastic: it is very well suited for running-rigging, more especially where lightness is deemed an advantage, as in top-gallant studding-sail sheets, &c. On account of its elasticity, seamen consider it not well fitted for standing rigging." Dr. Roxburgh, in his observations on the comparative strength of English hemp and other vegetable fibres, (Transactions of the Society

* Edinburgh, 1832.

of Arts, vol. ii.) says, "Coir is certainly the very best material yet known for cables, on account of its great elasticity and strength*." "The natives of Ceylon sew the planks together which compose their boats with coir yarns. When twisted into yarns adapted for being manufactured into cordage, it is valued in Ceylon at about £2 per candy (500lbs.). Large quantities of this substance are exported to the different ports in India. Under the Dutch government about 3,000,000lbs. were annually manufactured in the island. The quantity of coir exported from Ceylon in 1813 amounted to 4048½ candies. Very lately a manufactory for the making of coir-cordage has been established on a large scale at Recif, near to Pernambuco, on the coast of Brazil.

"Coir is much used in India, in place of hair, to stuff mattresses, cushions for couches, saddles, &c. It is also employed to make brooms and brushes to whitewash houses."

That accurate observer Dampier informs us, that the Spaniards in the South Seas make oakum to caulk their ships from the husk of the cocoa-nut, "which is more serviceable than that made of hemp, and they say it will never rot." He adds, "I have been told by Captain Knox, who wrote the Relation of Ceylon, that in some places of India they make a sort of coarse cloth of this husk of the cocoa-nut, which is used for sails. I myself have seen coarse sail-cloth made of such a kind of substance †."

The *Theobroma augusta,* of the same genus as the cacao-tree, is found growing indigenously in various

* Ships furnished with cables of this very elastic material have frequently been known to ride out a storm in security, while the stronger made, but less elastic ropes of other vessels have been snapped like packthread.

† A Voyage Round the World.

parts of the East Indies and the South Sea Islands and likewise in Australia. This is a perennial of rapid growth. The bark of its young shoots prepared like the hemp plant is capable of being manufactured into good ropes. It produces annually two and perhaps three crops of shoots, in a proper state for cutting. Cords are likewise made from the bark of the *Sterculia villosa*, which are so tenacious that the natives of the eastern frontiers of Bengal use them to bind the wild elephants when first taken, and when it requires no small coercion to restrain the indignant rage of the entrapped animals.

The inhabitants of some parts of the West Indies apply the bark of a species of mangrove* to the purposes of cordage, whence this tree is distinguished as the rope mangrove. The bark, when green, is easily detached from the wood, by reason of the great abundance of sap which it contains. This bark is then bruised between stones until the ligneous and cortical parts are entirely separated from each other. The last is the useful and fibrous substance, which is twisted into ropes of all sizes. These are exceedingly strong, and have the great advantage of not being injured by moisture.

The natives of the Gold Coast make rope and thread of the leaf of the palm, and in some of the islands of the South Pacific Ocean a kind of thread is made of the filaments of the mid-rib and foot-stalk of the leaf of a species of plantain called the Pesang. Twine is also made of the bark of the Baroo-tree, another production of these islands.

According to Thunberg the bark of another tree, the Anthyllis, which is a native of Southern Africa, is also converted into ropes. "Of the bark of the anthyllis," says that accurate traveller, "the Hottentots have the art of making ropes, by means of

* This tree will be described in a future chapter.

which they ascend trees, as by a ladder, when they want to get honey out of them. For this purpose, they first tie a noose round the trunk, in which they put one foot, then they fasten another noose higher up, and when mounted on that, untie the former, and so on*."

The bark of very many trees is advantageously employed as material for cordage. Among these may be classed the Linden, or Lime-tree, of European production. Its inner bark is manufactured into elastic strong ropes, which are much used and valued in some parts of the continent of Europe.

Another plant of European growth used to be held in esteem by the ancients for the manufacture of cordage, but it has now fallen nearly into disuse, and except in the countries of its production is scarcely known even by name. This is the *Stipa tenacissima*, which grows in Spain and Africa, and is at present called there Sparto or Esparto. It is supposed by Beckmann to be identical with the spartum of the Latins as described by Pliny †, and which, according to him, was first applied to useful purposes by the Carthaginians in their first war in Spain. At that period, in the part of Spain called by the ancients Spartarius Campus, which includes the territory reaching from the confines of Granada to the city of Murcia, it was growing so abundantly that the mountains were covered with it, and it continues to be produced in the same district at the present time. This plant is found wild in so poor a soil and in places so barren as scarcely to produce any other spontaneous vegetation. The inhabitants of the country in which it is native formerly manufactured it into many useful domestic articles, mattresses, shoes, and even rustic clothing. Baskets,

* Travels vol. i. † Lib. xix. cap. 2.

ships' cables, and other strong ropes were likewise made of it, and when its fibres had been properly prepared, in a manner similar to those of flax and hemp, it was used for various fine works.

It was much prized by the Carthaginians for cordage, and there would appear to be good reason for esteeming it, even in the present day, since it has the valuable property of not being injured by constant exposure to moisture. The Romans were fully aware of the advantage attending the use of this material for the rigging of ships, and for other purposes; but the freight of so bulky an article was, in those days of imperfect navigation, too expensive to allow of its extensive adoption. At that time the commercial interchange between countries was necessarily limited to articles which bore a high value in proportion to their bulk, and we learn from Pliny, that the difficulty and cost of transport were sufficient obstacles to prevent the introduction of so useful a material into foreign countries.

At the present time the *Stipa tenacissima* is used by the Spaniards for various purposes, especially in the manufacture of a kind of shoe called *alpergates*, with which, according to Beckmann, "they carried on a great trade to the Indies, where they are found very useful on the hot rocky and sandy soil*." This foreign trade may have failed, but the peasants in a considerable part of Spain, at this day rarely use any other kind of *chaussure*. The *alpergates* is rather a sandal than a shoe. As worn by the Catalans (a fine-limbed race of men), it has a graceful and classical air, however rustic be its material.

The Sparto of Africa is very inferior. When this plant is wanted for use it is torn up by the roots, a labour which is found very difficult of performance. The person who is about to undertake the task pro-

* Beckmann's History of Inventions.

tects his legs and hands with boots and gloves, and then twists the stem round a stick in order to obtain a better purchase and power of pulling it up. The time in which this work is most easily accomplished is from the middle of May to that of June, which is the season of its maturity. After being thus pulled it is collected into bundles, which are formed into a heap, and left during two days. On the third day it is spread out and exposed to the heat of the sun until it is dry, is then re-made into bundles which are placed under shelter, and afterwards macerated in sea in preference to fresh water, if the former can be obtained. It is once more dried, again wetted, and afterwards beaten before it is in a fit state to be used.

In the Western Isles of Scotland, the mountain Melic grass is manufactured into cord for fishing-nets, which are remarkable for their durability.

Besides these vegetable substances applicable to the purposes of twisting into twine and ropes, there are many others, which Dr. Roxburgh and other writers have described as producing good and serviceable fibres; but it would be tedious farther to enumerate all the various plants which are used in different countries as materials for cordage; it has already been sufficiently shown how man, in every stage of civilization, avails himself of the inexhaustible gifts of nature so bounteously laid before him; how every part of vegetation—bark, stalks, leaves, and even the husks of fruit, are each in turn made to furnish fibrous materials, highly useful, not only as ministering to the wants and adding to the comforts of life, but as calling forth ingenuity and invention in their adaptation, and thus eminently assisting in the progress of civilization.

CHAPTER VII.

MATTING AND BASKET-MAKING.

THE art of interweaving rushes into a thick texture is one so simple and obvious, that it is found to be among the first attempts of the rudest people, while it is so useful and convenient that it still retains its place among the arts of the most civilized nations.

Matting, baskets, the bottoms of some chairs, and other useful articles, are made of bulrushes; these grow in this country, naturally but not very commonly, in deep slow streams. The demand for them is greater than the home supply, and a considerable quantity is imported from Holland.

The *Juncus acutus*, or sharp rush, is planted with great care on the banks of the sea in that country, in order to prevent the water from washing away the earth, a portion of which might otherwise be removed at every tide. The roots of these rushes strike very deep into the ground, and mat themselves near the surface in such a manner as to hold the earth closely together. Whenever, therefore, the inhabitants perceive that the roots of these rushes are destroyed, they are very assiduous in replacing them.

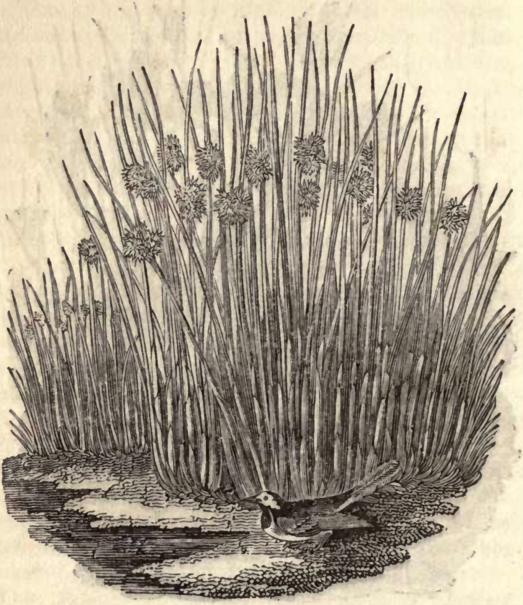
In the summer, when the rushes have attained their full height, they are cut and tied into bundles, which are dried and conveyed to the towns, where they are wrought into baskets and other useful articles.

Sharp Rush—*Juncus acutus.*

This sort does not grow so strong in England as on the banks of the Maese, where it sometimes is found more than four feet high.

Two species of *Junci*, the *conglomeratus* and *effusus*, are used as wicks for rushlights. The Romans applied different kinds of rushes to a similar purpose, as we learn from Pliny that the pith of *junci* was made into flambeaux, and formed the wicks of the wax-candles employed at funerals.

In Japan, where the floor of every house is covered with matting, this species of manufacture has attained



Hard Rush—*Juncus conglomeratus.*

great excellence and variety. To make the best of their mats, the Japanese employ the *juncus effusus*, which is plaited very closely, and the interstices are afterwards filled up with rice-straw.

These mats, which are at once the carpets and the only beds ever used by the Japanese, are soft, elastic, and often three or four inches thick. That the *juncus* of which they are chiefly composed may be of better quality, and grow to a greater height, it is carefully cultivated in certain low watery places; and in order that the mats may be of a whitish rather than of a

Soft Rush—*Juncus effusus.*

yellow colour, it is very common to bleach the rushes in the sun. Some sumptuary law probably regulates the size of these mats, for Thunberg says, that throughout the country he found them of precisely the same dimensions, viz. "two yards long and one broad, with a narrow blue or black border." It was only in the emperor's palace, at Jeddo, that the traveller saw mats larger than these.

Of the same rushes they make lighter matting, which serves as blinds to their windows, and protects from the rain the thin transparent paper with which the windows are furnished instead of glass.

The same ingenious people make an extraordinary use of another kind of rush; they manufacture it into shoes for their horses. We have not found a description of the plant, but have seen a drawing of one of these vegetable shoes. Its shape agrees with the hoof, it is somewhat hollowed, and at its edges there are four strings made of the same material, which attach the shoe to the horse's leg, above the pastern joint.

According to Dampier, the Tonquinese make great use of rushes in their religious ceremonies. He says, that in the outer room of all their houses "there is a table, and on one side a little altar, with two incense-pots on it; nor is any house without its altar. One of these incense-pots has a small bundle of rushes in it, the ends of which I always took notice had been burnt, and the fire put out." In another place he informs us, that when prayers are offered up to heaven these rushes are lit, and consecrated paper thrown in among them.

The comparative scarcity of bulrushes in this country, induced Mr. Salisbury to seek some substitute for this plant, and he attempted, with success, to apply the leaves of the flag, or great cat's-tail, to similar purposes. This plant (*Typha latifolia*) grows in great quantities in pools and swamps in all parts of the kingdom. Its stalks are six feet high, and the leaves three feet long; these are barely an inch broad, and are convex on one side; the amentum, or cylindrical club, which terminates the stalk, is of a dark brown colour, and about half a foot long. The modes of preparing these leaves and making them into matting are so simple that they may be acquired by a few trials.

The bags in which the sugar is imported from the Mauritius are made of a kind of matting, interwoven in broad compact strips; this is very thick, strong, and durable, and can be cleansed with soap and water without receiving the slightest injury. It is made of the leaves of one of the native trees, called there the vacoa. Sugar is now imported so abundantly from the Mauritius, that a large quantity of these bags are thus obtained in this country. They are washed and cut up into mats, and sold at so very cheap a rate, that the humblest housekeeper can afford to have a mat at his threshold, or to have his comfortless brick floor concealed by a warm, clean, and durable covering.

The inner bark of the linden-tree is employed very extensively in Russia for the manufacture of mats, both for home and for foreign consumption. The boors of that country almost universally wear mat shoes, made of the rind of the young shoots of the linden; and to such an extent is this custom carried, that it is calculated many millions of these shoes are annually platted and worn. The destruction of the linden-tree, in consequence of this constant demand for its bark, is immense; and the practice of the peasantry in employing so unsubstantial a covering for their feet, is very much deprecated by writers who treat on the internal resources of the Russian empire.

Mr. Tooke, in his work on Russia, has inserted a statement showing how many plants are thus yearly wasted. He observes, "The apologists for the practice of wearing the matted shoes bring as reasons,—1st, the poverty of the boors; 2dly, the quick growth of the linden; and 3rdly, that the making of them forms no insignificant occupation for their bye hours. The first is only in part well-founded, as the boors are not every where poor, and as these shoes, in many parts, stand them in more money than leathern ones would cost. The young linden-sticks grow undoubtedly the faster afterwards, but not in the same proportion with

Lime or Linden Tree—*Tilia europea.*

which they are cut down. To every pair of shoes from two to four young linden-stems are requisite. In winter the boor wears his platted shoes, it may be ten, but in the working season scarcely more than four days. In the whole year, therefore, he wears out at least fifty pair, to the making thereof, if we take a middle number, 150 young linden-stems are demolished. A fresh linden-shoot, in moist places, is not fit for peeling, to apply to the purpose of platting into shoes in less time than three years; on a firmer soil it takes longer. Accordingly the linden-wood is constantly diminishing faster than it grows. The benefit arising to the boors from the making of these mat shoes cannot be considerable, as they are very cheap in parts where there is linden enough. If the countryman would employ the time he spends in this in some other trades in wood, while he was benefiting the country he would be also increasing his private gains*."

The inner bark of the linden, known in this

* Tooke's View of the Russain Empire, &c. vol. iii. p. 126.

country under the name of *bast*, is largely used as a material for matting and cordage. The thick outer bark is likewise applied to useful purposes: this is made into boxes, trunks, coverings for cottages, baskets for carriages, sledges, and other purposes.

In England the osier willow, or *viminalis salix*, is recognized as a most useful plant for basket-work of all descriptions. The finer kinds of baskets are formed of the twigs of another species of willow; but what is called wicker-work is always made of osiers. These were largely cultivated by the ancient Romans for the same purpose, their commoner baskets being made of branches undivested of their bark; while for the better sort the bark was taken off, and the white pliant twigs were twisted and interlaced into a variety of forms. In the present day osiers are likewise used with or without their bark, according to the nature of the work to which they are to be applied. The demand for them is very great, and their cultivation is therefore very much encouraged in England. There is no plant which yields a surer profit, which entails less expense in its culture, or can better brave the vicissitudes of the seasons. A description and drawing of this useful plant are found in a former volume of the present series.

In the West Indies baskets are sometimes made of a kind of strong ligneous cord, which in part composes the bark of the lofty cabbage-tree, and which, as Dr. Bancroft describes it, consists of a web-like flexis divided crosswise in long hard polished threads, brown, and as tough as whalebone. These threads are drawn from it, and the filaments are applied to the same purposes as the more slender osier twigs are in England. It is said that nothing can be better or more beautiful for light and ornamental uses.

CANE AND BAMBOO.

Cane—*Calamus verus.*

Canes, which are used so abundantly as a material for forming the bottoms of chairs and other articles of furniture, are of eastern production.

The Indian cane grows straight and tall without branches, and is surmounted by a tuft or crown. Its bark is thickly beset with straight spines, but this being removed, the smooth cane is disclosed, having no marks of the thorns which grow on the outside.

Sumatra produces this plant very abundantly. The Dutch were formerly the exclusive importers of canes from that place into Europe, and we were accustomed to purchase them from this people, who studiously withheld all information concerning the plant from which they were obtained, fearing lest travellers should discover how plentifully they were produced in the woods, and that others beside themselves should divest the cane of its thorny covering, and appropriate it to useful purposes, without having recourse to their intervention.

Such a matter could not, however, long be kept secret. As our mariners found their way to the eastern islands, and different parts of the Indian ocean, they became well acquainted with the cane plant, and the great variety of uses to which it might be applied. At Java as well as at Sumatra,—at Japan, Malacca, Siam, Pegu, and many other places, the rattan was found in great abundance. The natives of Java cut the cane into fine slips, which they plat into beautiful mats to sit upon, manufacture into strong and neat baskets, or twist into cordage. With them it supplies the place of our string or twine, for all their parcels are neatly tied up with thin fibres of cane. The fruit it bears, which, when ripe, is roundish, as large as hazel-nuts, and lies in clusters, they sell in their markets as an article of food. They sometimes suck out the pulp by way of quenching their thirst, and at other times pickle the fruit. Here,as at Sumatra, and indeed throughout the eastern islands, vessels are furnished with cables formed of cane twisted or platted. This sort of cable was very extensively manufactured at Malacca. "Here," says Dampier, "we made two new cables of rattans, each of them four inches about.

Our Captain bought the rattans, and hired a Chinese to work them, who was very expert at making such wooden cables. These cables I found serviceable enough after in mooring the vessel with either of them; for when I carried out the anchor, the cable being thrown out after me, swam like cork in the sea, so that I could see when it was tight, which we cannot so well discern in our hemp cables, whose weight sinks them down; nor can we carry them out but by placing two or three boats at some distance asunder, to buoy up the cable, while the long-boat rows out the anchor*." In Japan the ingenious natives not only make all sorts of baskets of split cane, but work it up into cabinets with drawers, &c., which are woven in the neatest and most elegant manner.

That gigantic reed, the Bamboo, is applied to a still greater variety of purposes. Indeed, among the Chinese, it may be said to be used for almost every thing. Marco Polo informs us that in his time they had canes fifteen *passi* (thirty English feet) long, which they split in their whole length into very thin pieces, and then twisted them together into strong ropes 300 passi long, that were used to track their vessels on their numerous rivers and canals. M. De Guignes says, that in the course of his journey through part of the Celestial Empire, he often saw Chinese making this description of rope: the artisans were mounted on scaffolds twelve or fifteen feet high, and let the cord fall to the ground as it was platted: and M. Van Braam, another modern traveller, speaks of this bamboo cordage as being admirably light and strong. The sails of the Chinese junks, as well as their cables and rigging, are made of bamboo. The old Venetian also describes a pavilion of the Grand Khan, the roof of which was

* Voyages, vol. ii.

Bamboo—*Bambusa arundinacea.*

made of bamboo cane richly gilt and varnished. These bamboos, he says, were each three palms in circumference, and ten fathoms long, and being cut at the joints, were split into two equal parts, and laid concave and convex to form gutters. The missionaries inform us that not merely the roofs, but entire dwellings are constructed of bamboo: this is particularly the case in the southern province of Se-chuen, where nearly every house is built solely of this strong cane.

Moreover, almost every article of furniture—mats, screens, chairs, tables, bedsteads, bedding, &c. are all made of the same material. We shall presently show how this same curious people convert bamboo into paper: in short, as Van Braam remarks, "scarcely any thing is to be found in China, either upon land or water, in the composition of which bamboo does not enter, or to the utility of which it does not conduce*." The same extensive use of the hollow reed is made in Japan, nor is it much less employed in Java, Sumatra, Siam, Pegu, the Ladrone islands, and other eastern countries.

In a preceding volume of this series it has been shown how the Chinese extract an article of food from the young shoots of the bamboo; nor is this practice, any more than that of making candle-wicks from its fibres, confined to China: both obtain in Japan and some other neighbouring countries.

Although the bamboo grows spontaneously and most profusely in nearly all the immense districts included in the southern portion of their empire, the Chinese do not entirely rely on the beneficence of nature, but cultivate the gigantic reed with much care. They have treatises and whole volumes devoted solely to this subject, laying down rules derived from experience, and showing the proper soils, the best kinds of water, and the seasons for planting and transplanting this useful production.

* Account of an Embassy to China, vol. ii.

CHAPTER VIII.

MATERIALS USED FOR PAPER.

OF all the numerous vegetable substances which contribute to the nourishment or comfort of man, we are indebted to none more than to those which are convertible into paper, that most commodious, portable, and invaluable substance, which preserves and transmits *thought* through succeeding centuries, and to remote countries.

When the art of writing was first invented, the skins or hides of animals, the barks of trees, the broad, strong, and lasting leaves of the palm, or a plane surface of stone or metal, were most probably used. These were succeeded or accompanied, in some countries, by tablets of wood coated with wax, on which (and all writing was then performed by incision) the writer engraved his characters with a stylus or some other implement.

The first manufactured paper we hear of, was that made from the papyrus, a species of reed growing abundantly in the waters of the Nile. We have no means of judging whether the art of making it originated among the Egyptians themselves. The first paper of the sort, known to the Greeks and Romans, appears, beyond a doubt, to have been manufactured in Egypt. As the article became known and valued, it formed an important branch of commerce to the Egyptians, who exported it in large quantities. Either a deficiency in the supply, or, as it is more generally stated, a prohibition of the exportation to the kingdom of Pergamus, led to the invention of parchment in that part of Asia Minor*. Hence parchment was called *Charta Pergamena*, which is still the name for the substance in Italy.

Though parchment was thus introduced at Pergamus, about two centuries and a half before the Christian era, and though it afterwards became and remained for a considerable time the sole material for writing employed in Europe, it was very long before it superseded the use of papyrus.

In the Augustan age, when the Romans, who had hitherto been absorbed by war and conquest, devoted some of their energies to literature, papyrus was more extensively demanded at Rome, and the libraries formed then, and under succeeding emperors, were perhaps chiefly composed of books written on this Egyptian paper.

We can trace the general use of papyrus in Europe some centuries farther down. A heavy import duty was laid upon it by the Roman government, and this duty, we know, was abolished at the end of the fifth, or beginning of the sixth century, by Theodoric, the first Gothic king of Italy. His minister and favourite, Cassiodorus, has recorded, in one of his letters, this gracious act of the Goth, and congratulated "the whole world on the repeal of an impost upon an article so essentially necessary to the human race," the general use of which, as Pliny has remarked, "polishes and immortalizes man."

In the middle of the seventh century, the supply was interrupted by the Saracens, who conquered Egypt, the country of its production. Down to this period papyrus may have been scantily used, but it

* This prohibition was said to proceed from one of the Ptolemies, who was jealous lest Eumenes, king of Pergamus, should form a library as valuable as that at Alexandria.

appears, that at a date immediately subsequent, the priests and monks substituted parchment.

The Papyrus (*Cyperus papyrus*) is an aquatic plant; its roots are large and tortuous; its stem is triangular, gradually tapering as it shoots up gracefully to the height of fifteen or twenty feet, where it is very slender and is surmounted by a fibrous tuft of fine filaments, which are again subdivided into others, bearing small seedy flowerets; the whole of the umbel forming a beautiful flowing plume.

Paper was made from the inner bark of the stem of the papyrus, which was divided into thin plates or pellicles, each of them as large as the plant would admit. The plates obtained near the centre were the best, and each cut diminished in value in proportion as it was distant from that part of the stem. When carefully separated from the reed, and trimmed and smoothed at the sides that the pieces might meet equally, these plates or strata were laid close together, and touching each other, on a hard flat table; and then, other pieces, similarly cut, were laid across them at right angles. They thus formed a sheet of many pieces, which required adhesion to become one united substance. To promote this, the whole was moistened with the water of the Nile, and while wet pressed closely together for some time. After the pressure they were dried in the sun and the sheet was made.

It was long supposed that the muddy waters of the Nile had a glutinous quality which promoted the firm adhesion or incorporation of these separate strips; but this, it appears, is not the case, nor does the papyrus stand in need of any such aid, having a glutinous quality of its own, which suffices for the purpose.

Bruce states that he made paper from the papyrus, both in Abyssinia and in Egypt, and ascertained that the saccharine juice contained in the plant, and dissolved and diffused by the water, causes the immediate adhesion of the parts. In some cases, when the plants cut did not contain sufficient juice, or when the water did not dissolve the juice sufficiently, the strips of the papyrus were joined together with paste, made of fine wheaten flour mixed with hot water and a little vinegar. After being dried and again pressed, this paper was beaten with a smooth mallet, which rendered it still smoother and flatter.

The ancient Egyptians made some of these sheets of prodigious length, though, if we are to judge by those which have come down to our time, of no great breadth. The Earl of Belmore purchased one in Egypt and unrolled it himself, which was fourteen feet and a half long, by one foot broad: and that indefatigable Italian traveller, Belzoni, had a papyrus in his possession which was twenty-three feet long, by one and a half broad. "This last," says Dr. Richardson, "is the finest and the largest that I ever saw *."

The quantity of papyri used by the ancient Egyptians in their sepulture alone must have been very considerable. Near Thebes, these MSS. are not often found now with the body, because the men † there have been for ages in the habit of purloining them and selling them to strangers, who are not always anxious to encumber themselves with a whole mummy. Still, however, they are occasionally met with there, and in yet greater numbers in less frequented places, which, added to the heaps that have too often been scattered through the world from puerile curiosity and in heedless ignorance, and to those that may lie

* Travels round the Mediterranean.

† "While the men," says Dr. Richardson, "are employed in ransacking the tombs of the ancient Thebans (*their principal business for some months every year*), the females are engaged in the pristine occupation of tending the flocks."—Travels.

buried in mummy pits which have had the fortune to escape the intrusion and plunder of modern times, justify us in saying, as we have, that the quantity of papyri anciently employed in this way was excessively great.

These papyri found in the mummy cases of Egypt after so many centuries' interment, when not spoiled by the hurry and ignorance of those who purloin them and make a trade of them, are generally found in a very perfect state of preservation. According to Dr. Richardson, the fine one in the possession of Lord Belmore was every way complete, not a device or character wanting, or even obscured, but fresh and legible as the day in which it was written. They are always in compressed rolls. Sometimes their exterior is highly gilt, in which case they are greatly prized. When found with the body, they are generally thrust into the breast, or between the knees; occasionally they are enclosed in small wooden boxes or leather purses.

Additional evidence of the extensive use of the papyrus by the ancients is afforded by the fact, that there are now in the Museum of Naples nearly eighteen hundred MSS. written on paper of this description, which were all dug out of the lava that entombed the city of Herculaneum. A very small portion indeed of this city has been excavated; in other parts of it there are doubtlessly other libraries: and Pompeii, another city buried by different eruptions of the same volcano, was probably as literary and as well furnished with books as its neighbour. Unfortunately the volcanic matter that covered Pompeii was such as would destroy books; while, strange as it may appear, the melted lava that buried Herculaneum, cooling and becoming hard and compact as stone, tended to the preservation of the precious relics collected in the latter place.

These eighteen hundred papyri, which were dug, as it were, out of a quarry of lava, were all, like those found with the Egyptian mummies, in compressed rolls. A gentleman, who had frequent opportunities of examining them, has given the following description of them : "The ancients did not shape and bind their books like us, but rolled them up in scrolls. When these of Herculaneum were discovered, they presented, as they still do, the appearance of burnt sticks or cylindrical pieces of charcoal, which they had acquired from the action of the heat contained in the lava that buried the whole city. They seem quite solid both to the eye and touch, yet an ingenious monk discovered a process of detaching leaf from leaf and unrolling them, by which they could be read without much difficulty. When these manuscripts were first exposed to the air, a considerable number of them crumbled to dust. Our countryman, the late Sir Humphrey Davy, destroyed the integrity of a few by making unsuccessful experiments, which he fancied might produce a result that would supersede the slow and laborious process now adopted ; but about eighteen hundred still remain. Four of them have been unrolled, and fac-similes of them, with translations, published by the Neapolitan government *."

The same gentleman has just favoured us with the following description of the papyrus as he found it growing near Syracuse in Sicily, the only place in Europe where the beautiful plant flourishes in its natural state.

"The river Anapus, after flowing through an alluvial plain, which requires draining as much as any place I ever saw, being in many parts swampy and emitting the most unhealthy miasmata, falls into the sea at the west side of the magnificent harbour of Syracuse. We ascended the river for some

* Penny Magazine, No. 35.

distance in a flat-bottomed boat,—near its mouth the water was pretty deep, but muddy, and a little farther on we found it contaminated and obstructed by heaps of hemp which were steeping there. The current was scarcely perceptible, but our progress was impeded by aquatic plants and strong high rushes, which in many places so covered the river from side to side that we could scarcely see the water. In the winter season this is an admirable place for shooting wild ducks and other water-fowl; but we were there in the summer, when the river offered no sport except eels, which, with water-snakes, abounded prodigiously.

"At the distance of about an Italian mile from the mouth of the river, we first came in sight of the object of our search, the graceful papyrus plant, which we saw growing in little clusters and shooting above groups of water-lilies, on either side the river. A quarter of a mile higher up, we turned to the westward, and quitting the main stream, entered the Cyanean branch, which here forms its junction. This branch was still more covered with reeds and aquatic plants than any part of that we had come through, but unlike the Anapus, its water, when visible, was as clear as a mountain stream in Scotland. In proportion as we proceeded up this branch, which is very winding and deep, we saw the papyrus in thick groups, and as we laboured to force our way through the rich vegetable obstruction, which became stronger and stronger, the beautiful feathery tuft of the plant bending with its slim, elastic stem, frequently flapped in our faces. At a short distance from the fountain-head, the serpentine stream was so completely choked up with a vegetation of surprising tenacity, that having no men to tow us along from the banks, and indeed no assistance but such as a little boy from Syracuse could render us, we were wellnigh giving up our farther progress, for the present, in despair. Persevering, however, by cutting and tearing and forcing our little punt through or over this matting of plants and flowers, we at last shot into the clear basin of the Cyanean fountain, well bathed with perspiration and its own waters. This famous fountain, which, coming by the winding course of the stream that flows from it, may be somewhat more than half a mile from the Anapus, is a circular pool of from sixty to seventy feet in diameter. Its waters, though the bottom of the basin seems formed of black mud, are remarkably pure, and so transparent that you can see the fish (which swarm there) and any other object far beneath their surface, as clearly as if you looked through the medium of a clear atmosphere. According to our measurement the fountain was then thirty-two feet deep; it was fringed all round with the graceful *cyperus papyrus*. Nothing remained of the ancient temple of Cyane except some blocks of marble that had fallen or been thrown into the fountain. Even the name of Cyane was no longer known there, the Syracusans calling the fountain and the stream La Pisma.

"Few spots could be more solitary and still—the limpid water flowed without a ripple, nor were any sounds heard except the occasional twitter of a sort of reed-sparrow, and now and then the rustling of the high papyrus and other aquatic plants, as they were shaken by a breath of summer air, or agitated by the fish gliding among their roots. The papyri fringing the pool seemed literally to float upon its tranquil waters; their principal root, which is large and bulbous, running horizontally at the surface of the stream, and long slender filaments depending perpendicularly from it, like so many little cables to keep it at anchor. The shaft or stem proceeding from this root was frequently ten feet high, without measuring the flowering tuft in which it terminated.

"From some of them which we cut down and carried away with us, we easily made a sort of paper, though I cannot say much of the quality we produced, being hurried and without proper implements. We were obliged to fasten the strips together, to form our sheet with gum, which may have arisen from the Syracusan papyrus being deficient in the glutinous quality of those of the Nile, or, which is at least as probable, from our not dissolving it properly or not giving the strata sufficient pressure.

"Some manufactured papyri we saw in the house of a gentleman of Syracuse were certainly infinitely superior to our own, though even those would have been a poor substitute for our English writing-paper of the very worst quality. They were specimens of the result obtained by an antiquary called L. Cavalier Landolina, who, a good many years before, had endeavoured to revive the ancient manufacture, confidently anticipating that it would supplant paper, not only in Sicily, but in all Europe. It may however be doubted, whether paper produced from this substance, even when the ancient art was in its perfection, and the best papyri of the Nile employed, ever equalled the paper we now produce from linen rags, in any one quality save in durability."

We have already shown that in Europe at the middle of the seventh century, parchment superseded the paper made from papyri, and we have now to observe, that (as near as the date can be fixed) the use of parchment gave way to that of paper made from cotton at the beginning of the tenth century.

Previously to the introduction and sufficient supply of this new article the scarcity of materials for writing had induced the Greeks to pursue, what has properly been called "the almost sacrilegious practice" of obliterating the compositions of ancient authors, in order that they might themselves use the sheets on which they were written.

This paper produced from cotton was white, strong, and of a fine texture, but not durable or so well adapted for writing upon as the paper which is now made from linen rags. In consequence of some passages which occur in the authors of antiquity, disputes were once maintained as to the fact whether the art of making paper from linen was not merely revived in modern ages. The conclusion of these discussions seems, however, to prove that the art of converting linen into this substance was wholly unknown to the ancients, and that the *libri lintei*, or linen books, mentioned by Livy, Pliny, and other Roman writers, were pieces of linen cloth or canvas, prepared in the manner of oil-cloth.

The epoch is somewhat uncertain at which linen rags were converted to that substance, the extensive use of which has so importantly tended to the civilization of man, and which is the means of constantly diffusing knowledge, and therefore happiness throughout the world.

We find that in the year 1762 M. Mierman felt so much anxiety to ascertain this point, that he was induced to offer a reward for the discovery of the most ancient manuscript written on paper made of linen rags. Documents were produced in consequence, which induced him to fix the commencement of this manufacture as having occurred between the years 1270 and 1302. A specimen bearing a date prior to this period has, however, been subsequently discovered, and is preserved in the imperial library at Vienna. It is a charta seven inches long and three inches broad, written in the year 1243. Mr. Schwandner, an Austrian nobleman, who was principal keeper of the imperial library, affirms in an essay which he has written on the subject of this curious relic, that it is at least half a century older than any other specimen hitherto discovered*.

* Macpherson.

While some doubts have been entertained as to whom Europe is directly indebted for the introduction of so important a manufacture, it is quite certain that at a period anterior to the thirteenth century it was known and practised in Asia.

We have numerous and incontestible proofs that the Chinese possessed the art of paper-making at a very early period; from them their neighbours the Tartars received it, substituting *cotton*, which abounded in their country, for the bamboo, which was certainly the substance more generally used in China. At the commencement of the eighth century, when the conquests of the Arabs carried them to Samarkand, deep in the Scythian plains, they found the manufacture of cotton paper established there. The Arabs learned the art from the Tartars, as the Tartars had learned it from the Chinese, and in their turn substituted *linen* for cotton. To the Arabs therefore it appears pretty certain that we are indebted for the inestimable article, or paper made from linen; but whether the art of making it was introduced by the Italians of Venice, Gaeta, and Amalfi, who, during the eighth, ninth, and tenth centuries kept up a constant commercial intercourse with Syria and Egypt, or whether the Saracens—(Arabs under another name), who conquered Spain in the early part of the eighth century, made known the manufacture in that country, has not as yet been clearly ascertained. Mr. Mills reasonably supposes that the flourishing linen manufactories at Valentia suggested the idea of the substitution of linen for cotton in that part of Europe, as the cotton manufactories at Samarkand induced the Tartars to employ cotton instead of bamboo, &c. *

England was among the last European countries

* Andresi Storia generale delle Scienze; Hallam's Hist. of the Middle Ages; Mills's Hist. of Mohammedanism.

in which paper was introduced, it not having been used here till so late as the beginning of the fourteenth century*; and it is only one hundred and forty years since writing-paper became an article of home manufacture. Until 1690 there was scarcely any other paper made in England than that of a coarse brown description. The war with France at that time occasioning high duties to be laid on writing-paper, the English manufacturers were induced to attempt making the finer sorts, which they in course of time produced in great perfection. In 1720 we find that two-thirds of the writing-paper was of home manufacture; and very shortly after that period we became entirely independent of foreign supplies;—at the present time we export this article to a considerable amount.

The quantity manufactured in England alone in 1832 was 53,949,572 lbs.; in Scotland, 8,806,780; in Ireland, 2,179,303.

Paper is an article whence considerable revenue is drawn. In 1832 the excise duty on this manufacture amounted to £815,159. The rates of duty chargeable on different classes of paper are as under:—

	per lb.		
First class paper	£0	0	3
Second ditto	0	0	1½
	per cwt.		
Glazed paper, mill-board, and scale-board	£1	1	0
First class paste-board	1	8	0
Second class ditto	0	14	0

English writing-paper has now long been acknowledged by all Europe to be by far the best made; but in the production of that paper used for the printing of large engravings, we are inferior to France. Sensible of this inferiority, several individuals have turned their attention to the French pro-

* Macpherson.

cess,—French paper-makers have been brought over, and even the water used in France (on which it was supposed the quality might depend) has been imported, but hitherto without effecting any great improvement.

The art of making paper from vegetable fibres reduced to a pulp was not only known, but brought to a considerable degree of perfection in China in very remote ages. According to Martini, this manufacture was carried on among the Chinese at least 160 years before Christ. Nor do they confine themselves to any one particular material in this manufacture, but in each province judiciously avail themselves of that which is found of a suitable nature and in the greatest abundance. Cotton, linen rags, the bark of the mulberry and other trees, rice and wheaten straw, nettles, the leaves of a species of *artemisia* or mugwort, a particular kind of grass, the young bamboo, are each in turn employed in the formation of paper *.

In the time of Marco Polo (the thirteenth century) great use was made of the mulberry-tree. "The Grand Khan," says the Venetian traveller, "causes the bark to be stripped from those mulberry-trees, the leaves of which are used for feeding silkworms, and takes from it that thin inner rind which lies between the coarser bark and the wood of the tree. This being steeped, and afterwards pounded in a mortar until reduced to a pulp, is made into paper, resembling that which is manufactured from cotton."

At the same time (long before such a medium was thought of in Europe) a paper currency was established in China. The paper of the mulberry-tree was cut into pieces of different sizes, according to the value they were intended to represent; each piece

* According to the Jesuit missionaries, they even convert the *stem* of the cotton shrub into paper.

was signed by a number of government officers, and stamped with the emperor's own seal tinged with vermilion. This paper money was circulated in every part of the emperor's dominions, no person, at the peril of his life, daring to refuse to accept it in payment.

One of the substances mentioned above, the bamboo, a ligneous hollow reed of large growth, cannot perhaps be recognized as an eligible material for this manufacture; but the bamboo paper of the Chinese possesses some essential qualities in a superior degree to any that is manufactured in Europe. It is softer, smoother, and, not offering the least inequality in its closely united surface, is admirably adapted to the pencil, which the Chinese use in writing. On the other hand it is more liable to crack, more affected by moisture, sooner injured by dust, and more frequently destroyed by worms, than European paper.

The manner of transforming the harsh bamboo into so soft and delicate a substance is extremely simple. Young shoots, one or two years old, which have attained to only three or four inches in diameter, are generally preferred. The leaves are stripped from the stem, and the thin outer green rind or parenchyma is peeled off. They are then cut into pieces four or five feet long, made into bundles, and put into water for maceration. In about ten days they become sufficiently softened. After being washed in pure water they are put into a dry ditch and covered with slaked lime for some days; when taken out of this ditch they are again washed, then cut into filaments, and exposed to the rays of the sun to be dried and bleached. In this state they are boiled in large kettles, and subsequently reduced to a pulp in wooden mortars, by means of a heavy pestle with a long handle, which the workman moves with his foot. Thus prepared, some shoots of a particular plant called *koteng*, having been previously reduced to a glutinous substance, are mixed with the pulp in certain exact quantities, for on this mixture depends the goodness of the paper. The whole is then beaten together in mortars until it becomes a viscid liquor; this is poured into large receiving vessels. Forms of certain dimensions are then plunged into the semi-fluid, and each brings out sufficient for a sheet of paper. The glutinous substance, thus thinly spread, immedately becomes firm and glossy, and is detached from the form by merely turning down the sheet on the heap of paper already made, and without the interposition of a woollen cloth between each sheet, which is necessarily practised in making other paper. The forms or moulds which bring up this bamboo paper are also made of bamboo. Thin slips are selected and drawn successively through several holes in a steel plate, such as is used by our wire-drawers, until they are reduced to a fine thread. Of this thread the form is composed. In cold seasons, or in the more northern provinces, it is sometimes found necessary to dry the paper. This is done by an ingenious contrivance. A hollow wall, with the two fronts perfectly smooth, has a stove at one of the extremities; pipes communicating with this stove are carried in a circular manner through the whole inner space; the sheets of paper are laid on the surface of the wall, to which they adhere until dry, and are then readily removed with a soft brush. It is requisite to dip them in a solution of alum and isinglass to render them fit for the brush or the pencil.

"The consumption of paper in China," says father Du Halde, "is so prodigious that it is not surprising they make it of all sorts of materials; for besides the immense quantity used by the learned and students, and to stock tradesmen's shops, one cannot conceive how much is consumed in private houses: one side of their rooms is nothing but windows of sashes covered with paper; on the rest of the walls which are of plaster they paste white paper, by which means they preserve them clean and smooth; the ceiling also is made of frames covered with paper, on which they draw divers ornaments. If it has been justly said that the Chinese apartments are adorned with that beautiful varnish which we admire in Europe, it is also true that in the greatest part of the houses there is nothing to be seen but paper: the Chinese workmen have the art of pasting it very neatly, and it is renewed every year*."

We are informed by Mr. Barrow, that many old people and children gain a livelihood by washing the ink from useless written paper, which after it has been cleansed is beaten up, boiled to a paste, and re-manufactured into new sheets. Even the old ink washed from these written papers is not lost, for the economical and ingenious Chinese have a method by which they separate it from the water, after which it is put aside and preserved for future use. We learn from the same gentleman that the papermakers of China produce sheets of such dimensions, that a single one will cover the whole side of a moderate-sized room †.

The natives of Ceylon adopted a less artificial paper, and plucked from one of their trees tablets which have resisted for many ages the ravages of time. These are the leaves of the mountain palm, or *Corypha umbraculifera*, called by the Cingalese the talipot-tree. It attains to a great height, and is surmounted by many large palmated plaited leaves, the lobes or divisions of which are very long, and placed regularly round a long spiny foot-stalk, the whole exactly resembling a large umbrella.

* General History of China, vol. ii.

† Travels in China, p. 310.

Fan Palm—*Corypha umbraculifera.*

Some of their sacred records are graven on bronze plates which are neatly bordered with silver, but the books of importance in the Cingalese language, relative to the religion of *Buddhoo*, are written on laminæ of the leaves of this tree, the characters being engraved upon them with either a brass or an iron style.

Under the native government of Ceylon this gigantic leaf was made a distinctive mark of the gradations of rank, each person being allowed, according to his station, to have a certain number of the talipot leaves folded up in the form of fans borne before him by his servants. These leaves are likewise used by the common people as umbrellas, one outspreading leaf affording sufficient shelter for seven or eight persons. This gigantic production of nature is likewise adapted to many other useful purposes, being very substantial and durable.

The Japanese make an excellent paper from the bark of a species of mulberry-tree; an account of the process pursued by them for this purpose has been already given in the history of timber trees in this series. The Tonquinese manufacture paper from silk and from the rinds of different trees.

The Persians draw materials for their paper from a mixture of cotton and silken rags, which they manufacture into a smooth soft surface, and afterwards polish with a stone or shell. It will not bear ink without polishing.

The Aztecs or aborigines of Mexico prepared a kind of paper from the pulpy part of the leaves of the same aloe which yielded them a grateful beverage and afforded them a strong cordage. Their hieroglyphics were written on this paper, pieces of which of various thicknesses are occasionally found in that country *, whose unfortunate aborigines have been long exterminated, while there are thus still to be discovered vestiges of their advancement in the peaceful arts.

The widely spreading demand for paper throughout Europe renders the material from which it is manufactured a matter of no small importance. Some years back serious apprehensions were enter-

* Ward's Mexico.

tained lest the supply of white linen rags should become wholly inadequate to the growing demands of the different communities, and invention was consequently taxed to discover some substitutes by the employment of which the evil might be remedied. This pursuit was so far successful that numerous substances had already been found applicable to this manufacture, when happily an important discovery of modern chemistry rendered all this ingenuity unnecessary. It was found that by calling in aid the bleaching properties of chlorine, coloured prints and the coarsest canvas could alike be made available for the production of the finest paper; while from useless manuscripts and torn and soiled scraps the spotless sheet might again arise, destined, perhaps, again to receive effusions as short-lived as their predecessors.

The discovery of the advantages of subjecting the materials for paper to the action of this powerful agent was first made known by the French chemists, and thence it was gradually diffused and adopted in this country.

In the Transactions of the Society for the Encouragement of Arts, &c., numerous experiments are detailed of the manufacture of paper from various materials, and in their library is to be seen a book written in German, containing between thirty and forty specimens of paper made of different materials *. The author of this curious work was apparently one of those enthusiasts who become so enamoured of a particular pursuit as to cause every thing to be subservient to the one great end which they propose. However the more phlegmatic may sometimes be tempted to smile at the curious conceits and strange speculations of these characters, it is to such that

* Economical use of the Vegetable Kingdom in making Paper, by M. Schäffer. Ratisbon, 1765.

the world is indebted for many of the most useful discoveries and improvements which mark the progress of the arts and sciences. The same enthusiasm of character, the same tenacity of purpose, have alike been exerted in perfecting the magnificent conceptions of genius, as in increasing the material for that paper on which these are recorded. Let us not slight the indefatigable labourers who have pursued the less splendid, though no less useful objects of inquiry.

A minute detail of the numerous experiments made by M. Schäffer does not come within the scope of this volume. A slight notice, however, may not, perhaps, be wholly without interest, as it will serve to show what a boundless store is contained within the vegetable kingdom, convertible into this increasingly useful purpose.

M. Schäffer relates that his interest in the pursuit becoming well known, every body was anxious to supply some material, or to suggest some hint in furtherance of his views, and that the most heterogeneous substances were constantly presented to him with the question "Can you make this into paper?" His account of the causes which led him to many trials of different substances is confirmatory of the foregoing, while it illustrates the observation, that from the most trifling circumstances useful knowledge may be obtained by those who walk abroad with their senses and understandings alive to surrounding objects.

By this means, and by the zealous co-operation of those more immediately about him, M. Schäffer affirms that his catalogue was much increased: while he became so absorbed in the all-engrossing subject, that it would seem the whole world assumed to him the character of one vast mass of latent material for paper.

The bark of various trees, of the willow, the beech, the aspin, and the hawthorn, have been succcessfully formed into paper. That made from the bark of the lime-tree is of a reddish-brown colour, and so extremely smooth as to be peculiarly well calculated for drawings; the paper produce of this bark is not merely confined to the leaves of a book of specimens, but it is manufactured for useful purposes in some of the northern parts of the Continent. The wood, as well as the inner bark of the mulberry, is likewise capable of being made into this substance. A specimen of paper made from the down of the catkins of the black poplar is of a very superior quality, being very soft and silky. A paper similar to the last was likewise produced from the silky down of the *asclepias* with the admixture of a portion of linen rags.

The tendrils of the vine, after being subjected to putrefactive fermentation, can be converted into a tolerable paper.

The stalks of the mugwort, or *artemisia*, formed another material of nearly similar quality. This plant may almost be considered a weed, as it grows spontaneously on banks and on the sides of footpaths, and its roots spread and propagate very rapidly. The nettle is another weed from which two kinds of paper have been made; the one from the rind, the other from the ligneous part. The paper manufactured from this plant by M. De Villette was of a dark green colour; that produced by M. Schäffer is tolerably white.

The stalks of the common thistle as well as the down which envelopes its seed were both made available to this purpose. In relating the manner of manufacturing these stalks into paper, it is stated that the first experiment perfectly answered; a pulpy substance was produced which cohered in thin sheets, but on a second trial, vain were the maceration and subsequent manipulations, it refused to become a coherent mass, and paper could not be produced without the addition of linen rags. The same mysterious failure happened with regard to the burdock, another weed bearing a prickly head and a fibrous stalk. The disappointed experimenter endeavoured to discover the reason of so unexpected and vexatious a result, which he with much solemnity avers would by some superstitious persons be attributed to the intervention of witchcraft, exercised by some evil-minded persons; but he gravely disclaims for himself any belief in such influence. It is matter of surprise that at so late a period any cause should exist to warrant this self-congratulation on being exempt from so gross a popular prejudice. At a subsequent period, M. Schäffer was led to suspect that this want of success might possibly have arisen in consequence of the more mature age of the plants, which rendered them woody and less capable of being formed into a pulp.

The bark and stalk of bryony—the leaves of the *typha latifolia*, or cat's tail—the slender stalks of the climbing *clematis*—the more ligneous twigs of the branching broom—the fibrous stem of the upright lily—and the succulent stalks of the lordly riverweed, all were alike successfully brought into a pulpy consistence capable of cohering in thin and smooth surfaces.

Substances yet more unpromising did this persevering experimentalist endeavour to convert to his favourite object. Turf-tree, earth, and coral moss were successfully manufactured into paper. Even cabbage-stalks, wood-shavings, and sawdust were each in turn placed under process, and specimens of the result are to be seen in the above-mentioned book. Then the rind of potatoes was acted upon, and finally the potato itself; this latter substance proved a most excellent material, producing a paper extremely smooth and soft to the touch, while its tenacity approached nearer to parchment than any other vegetable substance thus employed, and caused M. Schäffer to esteem it as a valuable drawing-paper, which he recommended should be manufactured exclusively for that purpose, as he supposed that an edible substance might be deemed too valuable to allow of its extensive use except as an article of food.

A good and cheap paper was produced from "pine buds," which, from the description given of them, are the common fir-apples or fruit of fir-trees. These are well known as being hard woody cones, composed of scales overlapping each other. A singular accident led to the attempt with so apparently unappropriate a substance.

M. Schäffer's foreman had purchased a particular kind of bird whose natural food is the fir-apple. Soon after it had been provided with its first meal, the man remarked a considerable quantity of downy litter in the bird's cage, and supposing that it had been negligently introduced with its food, the careful owner cleansed the cage, and procured a fresh supply of the pine buds. After a time, the same appearance was again observed in the cage, and on watching the movements of the bird, it was found diligently tearing to pieces each scale of the cone, until at length the whole assumed the form of a ball of tow, and then it was in a proper state of preparation to be used as food by the feathered epicure. Profiting by this hint, its owner went joyfully to tell the wonderful labours of the industrious bird, and how it had converted the harsh fir cone into a material of which paper could be made. No time was lost in imitating the operations of the bird on the fir-apple, and paper was shortly produced extremely strong and serviceable, and fit for use as a wrapping-paper.

The stalks of the mallow, which grows in such profusion on the sides of hedges, having an upright herbaceous stalk, round leaves, and purple flowers, have been found by more than one individual to be well adapted to the production of paper. A few years back, M. De L'Isle presented to the Academie de Sciences a volume printed on paper made of this material. The celebrated chemists, Messrs. Lavoisier, Sage, and Berthollet, gave their testimony in its favour, considering it likely to prove of great utility as hangings for apartments; it having a natural hue much more solid than can be given by colouring matter, which might with advantage serve as a groundwork for other drawings.

Many attempts have been made from time to time to convert straw into a useful material for the manufacture of paper, and several persons have endeavoured to secure to themselves by patent the advantages which they considered likely to accrue from the discovery of a new process. So late as 1825 a patent was taken out for manufacturing paper from straw, but the plan pursued was extremely similar to those which had been previously adopted and which had failed. The paper hitherto produced from straw has always been extremely harsh, coarse, easily torn, and but little fitted for any useful purpose.

Judging from all the trials which have hitherto been made, there is little question that linen rags form the very best material for paper; those of cotton can indeed now be applied to the same purpose with nearly equal advantage: the vast quantity of these rags of all descriptions which are now available to the purpose, renders the adoption of any other material of little moment; but should any unforeseen circumstances hereafter cause a scarcity of linen and cotton rags for the production of this most essential article of civilized life, it is plain that we are surrounded by vegetable substances which are convertible into most valuable substitutes. That part of hemp and flax which is thrown away as refuse, because it is too rough and too short for spinning, and which in general amounts to a large proportion of the whole, may, if properly prepared and bleached, be made into as good paper as the most valuable part of the plant, after it has been converted into cloth and worn for years.

The bine of hops likewise makes a very good material for paper. It is calculated that the stalks of the hops grown in Kent, Sussex, and Worcester, and which, after the flowers have been plucked, are now thrown away as useless, would supply materials for the manufacture of all the paper consumed in England.

Paper has recently been fabricated in France from the liquorice root, or the root of the *glycyrrhiza germanica*. It is said that this paper is very white, and does not require any size in its prepartion, while it can be manufactured at a price much lower than that made from rags.

Many attempts have been made to convert the husk of maize or Indian corn to the same useful purpose. We are told of an excellent paper being prepared at Rimini from the husks of maize, and lately a patent has been obtained in America for a similar application of this material. Both the husks and flag leaves being mixed with certain proportions of alkali and of water, and exposed to a gentle heat for two hours, are converted into a pulp which is managed in every respect like the pulp of rags in the manufacture of paper.

Another patent has been recently taken out in

London for the fabrication of a coarse kind of paper, especially applicable to the sheathing of ships in the manner that tarred brown paper is usually applied. The material is a peculiarly soft kind of moss, which grows abundantly in ditches and the low grounds of Holland. In that country, and in several of the northern states of Germany, paper made from this plant is employed as a covering for the bottoms of ships between the wood and copper sheathing, and is found to be peculiarly serviceable in preventing leaks, as in consequence of its absorbent quality it swells up, forming a close and firm packing under the copper.

Chapter IX.

STRAW PLAT.

The culm or stalk of different species of grass is now so commonly applied in this country as a material for making hats and bonnets, that its introduction might naturally be supposed to be of ancient date. It is, however, scarcely half a century since the simple art of platting straws together was first practised to any considerable extent by our rustic population.

Immediately previous to the introduction of straw hats, those made of chip were usually worn by our fair countrywomen; and the first rude attempts of our own manufactories were then rejected by the higher classes for the more finished productions of Italy. The coarse British plat was, however, adopted by the more humble in the middle ranks of society, and the home manufacture gradually increased in importance.

This originated in Scotland, but a work in which even children could be profitably employed, and which they could soon learn to perform with considerable skill and dexterity, was quickly introduced into some of our English counties, and the wives and children of the peasantry of Buckinghamshire, Hertfordshire, and especially Bedfordshire, gradually became engaged in an occupation which required so little instruction. Dunstable plat soon became noticed as the best produced in England; it still retains its place, and continues to give its name to English straw hats of superior quality.

The first marked improvement in British plat consisted in interlacing straw previously split into fine and similar strips; the culm used for this purpose in the infancy of the manufacture having been thick and of unequal sizes, producing a very coarse and uneven plat. From that period this branch of domestic industry has increased rapidly in England. Many other great improvements have been made in the material and manufacture of this article since its first introduction; and many are the varieties of fancy straw plat which have, each in their turn for a brief period, been adopted by those fickle patronesses the votaries of fashion.

All plats must, however, give place to that of Italy, which is still considered superior to any other. Numerous attempts have been made, at various times, to equal the Italian plat; but although this manufacture is apparently so easy of imitation, yet perhaps neither the French nor English have ever produced any thing fully equal to the Italian hats of the best quality. These are well known in trade as Leghorn straw, so called from the port whence they are exported; but they are in reality manufactured throughout Tuscany, and more especially in the vale of Arno, where the female peasantry find full and profitable employment in this occupation. At every cottage door women and children are to be seen busily engaged picking and platting straws; and even when taking their walks they generally continue the easy work of platting.

Besides the great consumption in Europe of this well-known article, large quantities are sent to the North American states. An intelligent traveller has observed, on witnessing the Tuscan peasantry thus occupied, that " the work produces at every step the pleasing appearance of labour united to amusement,—of a toil in which childish play and childish gains form children to habits of industry without exhausting their strength or gaiety."

The women and children in nearly every part of Tuscany wear large straw hats, entirely prepared and made by themselves. These give them a very neat appearance; but altogether the peasantry of this state seem to be in a better condition than those of any other part of Italy. They owe this superiority rather to their own industrious, frugal habits, than to any material difference of government or taxation.

The material of which the plat is made is sometimes prepared from the straw of rice and of rye or darnel grass. But the straw principally used is the culm of a kind of red wheat, very commonly cultivated in the Tuscan states. It is a variety of spelt corn, or red wheat (*triticum spelta*), having somewhat the appearance of barley; the grains grow in the ears in a similar manner, but their shape is like that of other wheat.

Although apparently a very simple process, some skill and patience are required to prepare, split, and plat the straw, and to perform all the other operations without breaking so fragile a material. The wheat is allowed to grow till just ready to burst into ear. The straw is then pulled up by the roots, which, as well as the ear, is cut off from every stem; as soon as cut, it is tied in small bundles, immersed for a short time in boiling water, and spread out to dry. This being done, the knots are cut off, and the most slender straws are put aside to be platted whole, from which the best and most durable hats are made. The others are split longitudinally, with the point of a penknife, into two or three parts. These are again moistened and pressed flat for three or four hours, and they are then ready for platting. When hats of an extraordinary fineness are to be made, the straws are divided into a greater number of strips;

the point of a knife cannot, however, be depended upon in so minute a division. A row of very fine small needles are connected together at their heads with rosin, the distance from each other being regulated by the degree of fineness to which the straw is required to be divided. A flattened strip is then passed through these needles, which readily divide it to almost any degree of assignable exility. Another contrivance is used in England for dividing the straw. This is the frustum of a small hollow cone, the lesser end of which has a number of sharp teeth fixed in its opening. These cut the straw as it is pushed through the cone into strips more or less fine, according to the number and proximity of the teeth.

Some practice and a delicate hand are required to form an even plat with a number of these narrow strips, and to keep them disentangled and in their places without breaking them. Each plat is made with seven, nine, eleven, or thirteen slips of straw; it may therefore be supposed that some degree of nicety is required in its execution. It is not, however, in the plan of this work to enter into any description of the manner of performing the work. This employment is most usually assigned to females, as being more particularly appropriate to their habits. The Italian plat is considered fine when fourteen or more knitted together do not exceed four inches in breadth.

Leghorn plat has always been much esteemed in England, as being very superior to our home manufacture, and it has long formed an article of considerable importation, either as made up in the form of hats, or in the simple plat.

During the late war the importation of this article was attended with so much expense and difficulty, as nearly to annihilate this branch of foreign commerce. The home manufacture was, in consequence, very much increased and encouraged; its improvement likewise became an object of importance, and many attempts were made to render all foreign supplies unnecessary.

Mr. Corston, an eminent manufacturer of straw hats, was among the first who took active measures to promote this desired result, and at the beginning of the present century, he made strenuous exertions to obtain a successful imitation of the Leghorn plat in this country.

In prosecuting his endeavours with persevering energy, he appears to have been actuated more by the disinterested feelings of the philanthropist than by the petty views of the tradesman, and to obtain an increase of healthy and profitable occupation for his countrywomen in the humbler walks of life was the ruling motive for his exertion.

Taking an average of the ten years preceding 1804, he found that 78,000 Leghorn hats were imported annually into England, besides a quantity of plat, which, supposing five hats are made from one pound of plat, could be manufactured into two or three thousand more. From this and other data he calculated that if the foreign plat were superseded by that of English growth and manufacture, employment would at once be obtained for 5,000 young women and female children; and that 2,000 acres of very poor land, unfit for other purposes, might be brought into profitable cultivation.

For the furtherance of his object he instituted a school at Fincham, in Norfolk. On a poor and sandy soil rye-grass seed was sown, in the proportion of two bushels per acre. Each of these acres produced forty pieces of Leghorn plat of fifty-five yards in length, and employed for one week thirteen children to sort the straw, and eighty to plat it.

Three years were spent by Mr. Corston in bringing this manufacture to perfection, before his efforts were crowned with success. It appears that he was then rewarded with their gold medal by the Society for the Encouragement of Arts, &c. His exertions did not, however, meet with that success which had been anticipated. For when peace at length restored to Europe free commercial intercourse, the demand for, and the supply of foreign hats became greater than ever. Many attempts have since been made to induce the English ladies to wear straw hats of home production alone. But causes, independent of the influence of fashion, have hitherto prevented the exclusion of those of foreign manufacture. It is said that the quality of the foreign straw is superior to that of the English, the warm sun and more genial climate of Italy producing a material which cannot be equalled here. The Leghorn straw is more slender, and may therefore be employed entire in the production of the very fine articles, on which account the plat is rendered more even, pliable, and durable than that of equal fineness made of split straw; while it has the farther advantage that the spiral coil of Leghorn plat admits of its being joined by knitting the adjacent edges together, thus producing an imperceptible juncture and forming all the plats into one uniform whole. The nature of the English plat will not allow of this, and it is necessarily overlapped and sewed together in an unpleasing alternation of ridges and depressions, to effect which a considerably greater quantity of plat is likewise required.

To protect our domestic manufacture, and to encourage the importation of the Italian straw, a duty of £3. 8*s*. to £6. 16*s*. per dozen, according to their size, is levied on the importation of hats made of this material, a lighter one of 17*s*. per lb. upon plat not made up, and merely an ad valorem duty of 10 per cent. on straw not platted. Such, however, is the cheapness of labour upon the Continent, in comparison with its rate in England, that the best Hertfordshire straw has actually been sent to Switzerland, platted in that country, and returned to England, where, notwithstanding the import duty of 17*s.* per lb., it can be sold at twenty-five per cent. cheaper than plat made at home*.

In consequence of this difference of duty on the wrought and unwrought materials, a straw manufacturer a few years since imported a considerable quantity of prepared straw from Leghorn, and not succeeding in the platting, placed it in the hands of Mr. Parry, who first made himself a proficient in the Leghorn method of platting, and then taught it to other persons with so much success that in a short time he had above seventy persons, women and children, employed in this manufacture. On disclosing the particulars of the mode employed, he received an honorary reward from the Society for the Encouragement of Arts, &c., which society has at various times offered premiums for improvements in the home production and manufacture of straw plat, "influenced by the desire of thereby obtaining employment for the poor in the agricultural districts, by contributing to the revival and improvement of a manufacture at once healthful and domestic, and particularly valuable as accustoming children to habits of industry without the imposition of any hurtful degree of bodily labour."

At nearly the same time another candidate appeared claiming a reward connected with this subject, and which revived the desire of rivalling the Italians in their straw produce as well as in its manufacture. Miss Woodhouse, the daughter of a far-

* Trans. of Soc. for the En. of Arts, 40th vol.

mer residing at Weathersfield in Connecticut, sent to England a bonnet of very fine materials and manufacture, and which, on being submitted to the inspection of the principal dealers in such articles, was declared to be superior even to Leghorn in the fineness of the material and the beauty of its colour. It was manufactured from a species of grass growing spontaneously in that part of the United States, and popularly known by the name of tickle-moth. This grass is found abundantly in most of the meadow land, but more commonly in fields that have not been highly manured. Specimens and seeds of this grass were obtained in the hope of promoting its cultivation in England. But little of the seed, however, could be procured, as it is never sown in America, but springs up luxuriantly, and is cut from the time of its flowering until the seed is not quite matured. On being sown in this country, it germinated very successfully, both under cover and in the open air.

In the mean time many experiments were made by Mr. Cobbett and others on our English grasses, and Leghorn plat of a most excellent quality was produced.

The list of available grasses was continually increased by those persons who from time to time made experiments on the subject and presented specimens of the result of their labours.

A numerous class of grasses, like the common annual kinds of corn, have but few leaves; these gradually decay as the seed-stalks advance towards perfection, and wither, or fall off entirely, when the seeds are at maturity. The grasses which are applicable to the straw-plat manufacture are found in this class. Among these, the grasses which are proved to be the best suited to the purpose approach nearest in point of colour to the fresh pale green of wheat; for, in general, as the hue recedes from the yellow, and the blue tint predominates, the deeper and deader yellow does the straw become when dried. Other points, however, are to be considered as well as the colour, and these are not dependant alone on the particular species of grass. Mr. Parry found that the straw of grain grown upon clay soils is liable to become spotted, or otherwise discoloured, and apparently takes up a larger proportion of iron than usual, whereby it is rendered unfit to be used for the better kind of plat. When raised upon sandy soils, it in like manner seems to take up an undue proportion of silex, or flint earth, and thus becomes harsh and too brittle for fine platting; but when grown upon chalky soils, as well as being of a superior colour, it possesses the pliancy requisite for the best plat. The reputation which the Dunstable hats have so long enjoyed is attributed to this peculiarity arising from soil.

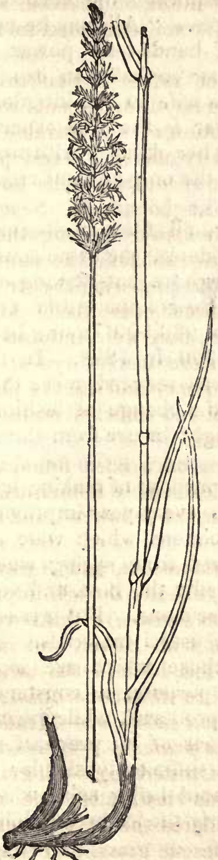
The manner of preparing the English grasses, as recommended by Mr. Cobbett, very nearly resembles the Italian method. The grass is cut as soon as it comes into bloom, it is then tied up in small sheaves, put into a shallow tub, and covered with boiling water. It remains in this situation during ten minutes, on being taken out it is spread thinly on soft grass for a week, being turned daily during that time. The only part used for platting is that portion of the stalk which is between the upper knot and the seed-branches. It is, however, found necessary in England to cut and bleach the whole plant, because if this part were taken off while green, it would wither away; but when the preparation is finished, this as being the only useful part is taken, and the rest rejected. The grass used by Miss Woodhouse did not require this precaution. In her process the upper part was taken off previously to scalding and drying, which operations it underwent in alternations, until the leaves which sheath the stem came off; it was then moistened in a solution of pearlash and soap, and in order to whiten it was subjected to the fumes of sulphur.

In consequence of the attention of agriculturists being called to this subject, many inducements were held out to further the promotion of so desirable an object. The Highland Society offered several premiums in 1825 and 1826, for encouraging the home manufacture in imitation of Leghorn plat. Several candidates appeared for the reward. Among these Messrs. Muir, of Greenock, gave a detailed account of their manner of cultivating and preparing the straw, which is very similar to that already described. After various experiments, however, they were induced to confine themselves wholly to the use of rye-straw, dwarfed by being grown on poor land in the Orkneys, and not suffered to attain to sufficient maturity for the production of good seed.

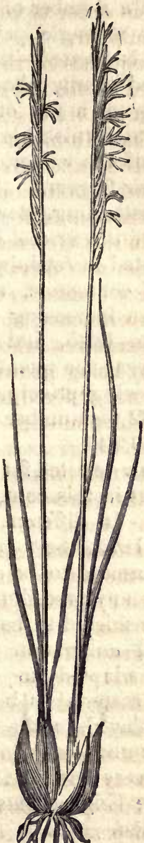
The English grasses which have been found appropriate to this purpose are extremely numerous.

Among these are—the fiorin, the yellow oat, and the brown-bent grass, the botanical names of which are *Agrostis stolonifera*, *Avena flavescens*, and *Agrostis canina*;—the ray or darnel, usually though improperly, called rye-grass (*Lolium perenne*); this is very commonly sown in England with clover, and in a rich soil grows to be four feet high;—the sweet-scented vernal grass, or *Anthoxanthum odoratum*;—Purple Melica grass, or *Melica cærulea*;—Meadow fox-tail grass, or *Alopecurus pratensis*;—Cat's-tail grass, or *Phleum pratense*;—Crested dog's-tail grass, or *Cynosurus cristatus*; this last, after the red wheat of Tuscany, was considered the best material for the purpose;—Sheep's fescue grass, or *Festuca ovina*;—Common mat grass, or *Nardus stricta*.

Mr. Cobbett has observed that the circumstance which recommended the inquiry especially to his



Crested Dog's-tail Grass—
Cynosurus cristatus.



Common Mat Grass—
Nardus stricta.

attention, was the great advantage that this manufacture possesses in not requiring the collecting together of a number of people. "All may be performed by a single pair of hands—no power of machinery is wanted—no other capital than can be commanded by any labourer's wife in the kingdom. The boiling of a pot of water is the sole expense necessary to furnish her and her children with work for a part of the winter, and the only engines requisite are their fingers."

Notwithstanding, however, all these well-meant exertions of the several individuals, the same causes long operated in retaining Leghorn hats among our articles of commerce, and their importation continued in an increasing ratio, 230,000 having been imported in 1825, and 384,000 in 1828. In the following year the quantity was reduced more than one-half, owing principally to a change of fashion; and in 1832 the number brought for use from abroad was only 60,830.

The straw selected for the purpose of making hats and bonnets in this country is every year improving in quality. In different specimens which were exhibited in 1825, those prepared from spring wheat were pronounced to be decidedly the best, and very superior to any preceding specimens. But grasses are still considered to be very useful materials. By the careful cultivation of those which are more peculiarly adapted to this purpose, a constantly improving material is being produced, while greater skill is displayed in the manner of its preparation. Straw may now be obtained sufficiently slender to produce a very fine plat without being split, which gives to the English hats nearly the same durability as the Italian.

Hats are likewise fabricated of chips or thin slips of wood. This manufacture preceded that of straw plat in England, though it would seem to be less obvious and natural.

The trees which are most appropriate for the purpose are the lime, the poplar, the willow, and some others, the wood of which is white without knots. While the wood is yet green it is divided into very fine chips; this operation is easily performed by means of a very simple instrument, a plane with two irons. The first of these is provided with several teeth, the width of which is proportionate to the required fineness of the chips; the second iron, which follows the first, has a common plain chisel-edge. On this plane being passed over the wood, it is evident that the shavings will be divided longitudinally into as many slips, and one more, as there are teeth in the first iron. That the teeth may be made to repass always over the same spot, the plane is pushed between two guides, by which means it is kept steady in one direction. Several machines have from time to time been invented for dividing these chips, but this double iron plane is the simplest, and perfectly answers the purpose for which it was intended.

The chips are whitened, either before or after manufacture, by steeping them in cold soapy water, coloured with a small portion of indigo; after which they are exposed for some days on the grass, where they are frequently sprinkled with clear water, as they must not be allowed to become dry.

Hats manufactured from this material recommend themselves by their extreme lightness, while they are sometimes made to assume a delicate and tasteful form; they are however at best but very fragile from their want of flexibility and firmness. The French have endeavoured to impart to them something of these qualities by the union of another substance, making hats composed of willow chips and whalebone. The warp of this texture is formed of whalebone and *willow chips*, one of the former and two of the latter alternately, and the woof is entirely composed of willow chips. Hats made of this mixture are found much more durable than those made wholly of wood shavings.

Platting of straws, grasses, and chips into hats, and different articles for wear, is far from being confined to Europe, or to civilized countries. The art is indeed found to obtain in different degrees of extent and excellence in nearly every part of the world. In the southern provinces of China, where, in summer, the population use no other head covering, and where the Mandarins wear these hats with tremendously wide brims, the quantity of straw platted is prodigious. In Japan, in proportion to the population, the consumption is almost equally great. "When on a journey," says Thunberg, "all the Japanese wear a conical hat, made of a species of grass platted and tied with a string." He also observed, that all the fishermen wore hats of the same material and shape. But in addition to this extensive use the Japanese hardly ever wear any shoes or slippers but such as are made of platted straw. "This," remarks the same excellent traveller, "is the most shabby and indifferent part of their dress, and yet in equal use with the high and the low, the rich and the poor. They are made of rice-straw platted, and by no means strong." They cost, however, a mere trifle; they are found exposed for sale in every town and in every village, and the pedestrian supplies himself with new shoes as he goes along, while the more provident man always carries two or three pair with him for use, throwing them away as they wear out. "Old worn-out shoes of this description are found lying every where by the sides of the roads, especially near rivulets, where travellers, on changing their shoes, have an opportunity at the same time of washing their feet*." In very wet weather they use wooden clogs, which are attached to their straw-platted shoes by ties also made of straw plat. People of very high rank sometimes wear slippers made of fine slips of rattan neatly platted.

The natives of Tonquin wear also broad-brimmed hats of platted straw or reeds, occasionally platting strips of the palmeto leaf for the same purpose. But not to enumerate many other comparatively civilized people, we find the wild Indians of both the Americas, the natives of the South Sea Islands, the Negros and Hottentots of Africa, and even the poor savages near the Polar regions, all acquainted with the art of platting strips of wood, grasses, or sea-weeds, and some of them producing, merely by hand, textures which we, assisted by all the agency of machinery, could scarcely rival.

A very pretty and endurable kind of straw plat, made in South America, is familiar to amateurs of cigars. "A fabric highly esteemed in all the Spanish possessions," says a recent traveller, "is that of a species of grass, which is bleached and platted into various articles, such as pouches and cigar-cases, of extreme regularity and fineness. Hats of the same material, but coarser, are exported in large quantities, and found well adapted to warm climates. I could obtain very little information respecting the raw material, farther than that it grew on the coast to the northward in great profusion †."

* Thunberg's Travels, vol. iii.

† Travels in South America, by Alexander Caldcleugh, Esq. vol. ii. p. 84.

CHAPTER X.

CORK-WOOD—TEAZLES—ULVA MARINA.

CORK is the bark of an evergreen oak, which has been already described in our account of timber trees. It grows in the southern parts of Europe and on the shores of the Mediterranean. This tree is to be seen in our English gardens, but bearing evident marks of its exotic growth.

Cork-trees are generally fifteen years old before they arrive at sufficient maturity to yield a supply of bark, and after this, at intervals of eight years, the bark is always sufficiently renewed to be again removed.

The cork is stripped off in large masses, from two to three inches in thickness, and retains the curved figure corresponding with that of the trunk of the tree. The only preparation required is to reduce it to a plain compact surface. In order, chiefly, to impart closeness of texture, it is scorched on both sides, and while still hot it is laid between flat heavy planks where it remains until cold.

The elasticity and the levity of cork cause it to be extremely useful wherever those properties are desirable. Since it can be readily compressed, and will expand again as soon as the compressing power is removed, it fills up very closely that space into which it had been driven by force; while its numerous pores are so minute that neither water nor any common liquid can escape through them, and even the more subtile particles of alcohol but very gradually, and that after a considerable space of time, penetrate through this almost impervious substance. A more compact wood, but having wider pores, affords a passage with greater facility to fluids. Cork is more buoyant in water than any other ligneous substance, its specific gravity being one-fourth that of water. It is readily inflammable, burning with a large yellow flame, which however soon dies away, leaving behind a bulky, soft, pulverulent charcoal.

The application of the bark of the cork-tree to useful purposes was practised by the Greeks and Romans. By the former it was called *Phellos*, by the latter *Suber*. Theophrastus and Pliny describe it under those respective names, and from the account of the latter there is little doubt that the Romans availed themselves of its peculiar properties in a manner similar to that in which it is applied at the present day. Fishermen, taking advantage of its buoyancy, then made floats to their nets with cork; this substance was likewise employed as anchor-buoys, while we learn from more than one Roman writer that the unpractised swimmer gladly derived support from the floating cork.

Although Pliny expressly states that it was used to stop vessels of every kind, this was not perhaps a very common application, or otherwise, as Beckmann justly observes, "cork-stoppers would have been oftener mentioned by the authors who have written on agriculture and cookery, and also in the works of the ancient poets. We every where find directions given to close up wine casks and other vessels with pitch, clay, gypsum, or potter's earth, or to fill the upper part of the vessel with oil or honey, in order to exclude the air from those liquors which it was wished to preserve. In the passages therefore already quoted, where cork is named, mention is made also of pitching. The reason of this, I believe to be, that the ancients used for their wine large earthen vessels with wide mouths, which could not be stopped sufficiently close by means of cork*." We may observe, that in the amphoræ,

* Beckmann's History of Inventions, vol. ii. p. 116.

or wine-jars, disinterred in such numbers at Pompeii, Nola, Cannæ, and other ancient places in Italy, the mouths are generally from five to ten inches in diameter. The average height of these vessels may be about four feet, and the diameter, at the thickest part, eighteen inches. Like our modern bottles they rarely vary in shape.

According to the accurate author last quoted, stoppers made simply of cork were not introduced until some time after the invention of glass bottles, of which there is no mention made before the fifteenth century. Ruellius * and Aldrovandi †, two authors who wrote in the sixteenth century, describe the purposes to which cork was at that time put, and they are both equally silent concerning that use to which it is now most extensively applied. We learn from Neumann that corks were not used by the apothecaries for securing the contents of their phials until the latter end of the seventeenth century. Before that period they employed waxen stoppers, which were not only much more expensive but required much trouble to render them efficient.

In the present day cork-stoppers are of universal adoption in Europe, and indeed throughout the civilized world, while the invention of modern ingenuity has introduced improvements to obtain these stoppers in the greatest possible perfection. In Italy, however, where many ancient practices still linger in defiance of modern improvement, the people often preserve their wine by pouring a little oil into the mouth of the bottle, and then tying up the mouth with oil-skin. This is always done with the Florentine wine, known under the name of Aleatico. The Neapolitans also practise the same with most of their wines, which are kept in very large glass vessels with wide mouths, called *perretti*. Sometimes, instead of tying up the

* De Natura Stirpium, p. 256.

† Dendrologia, p. 194.

mouth with oil-skin, they merely introduce a little tow into the neck of the bottle. In the Grecian islands another method recommended by the ancients still prevails. When the inhabitants do not keep their wine in skins (a very general practice), they secure the wooden or earthen vessels in which they put it with pitch and rosin, and thus impart to it a most unpalatable flavour.

Much difference exists in the quality of cork, either arising from variance of soil or of the trees themselves, or from the length of time which is allowed to intervene between two successive strippings of the bark. That bark which has remained the longest on the tree is naturally of a coarser and harsher texture, and has been more exposed to injury from the punctures of insects, but at the same time with its length of growth it has proportionally increased in thickness, and is therefore more appropriate for stoppers of large dimensions. The charring, however, which is then requisite to give it compactness and to render it impervious to liquids, produces an empyreuma which is often imparted to the fluids confined by stoppers made of carbonised corks. Wine-merchants, however careful in the selection of their corks, could not wholly prevent this evil, since the thickness of bark requisite to cut corks large enough for quart bottles could only be obtained through means which deteriorate its other qualities. A few years back this objection was entirely obviated by an ingenious invention. It was found that Vancouver's cement would securely cause the adhesion of two surfaces of cork bark when applied to each other, and stoppers could therefore be cut from the united thickness of two or more pieces of bark. Thus large corks of a very superior quality are made of the tender bark, the delicate pores of which require no charring for their farther contraction; while these stoppers are rendered still more efficient by a thin coating of caoutchouc on the upper part, which securely protects the cement from being acted upon injuriously, it having been found that the carbonic acid gas generated by the damp arising in wine-vaults has a tendency to decompose the cement and to cause a separation of the parts.

An instrument was invented some years ago to cut cork for stoppers by machinery. This was so constructed as to cut spirally, producing smooth, even, and nearly cylindrical pieces; but these not tapering sufficiently—there being scarcely any difference between the top and the bottom—and this defect not being remediable by any arrangement of machinery, the invention was found to be of little or of no practical utility.

Cork is admitted into England at an importation duty of 8*s.* per cwt., the price of the best being about £4 for the same quantity: 42,685 cwt. were imported into England in 1832.

The best cork is brought from France; that which we receive from Spain and Portugal being not more than a half or a third of the value of good French cork-wood.

Where the bark of the *quercus suber* cannot be obtained, many substitutes have been found to supply its place, among the spongy bark or woody substance of other trees. The bark of the black poplar is employed by the Cossacks for stoppers to their flasks. *Aeschynomene lagenaria* is applied to the same purpose in Cochin China, and the *hibiscus cuspidatus* in Otaheite. In many parts of the West Indies the wood of the alligator pear-tree is made a substitute for cork, which it resembles so much in its levity, and other properties, that it has likewise received the name of the cork-wood tree.

We may add to this short chapter a notice of several substances, which do not properly come under any of the general divisions of the preceding chapters.

THE TEAZLE.

Teazle—*Dipsacus fullonum.*

The Teazle, or fuller's thistle (*Dipsacus fullonum*), bears a prickly flower-head or bur, which is used in raising the nap on woollen cloths. It is cultivated for this purpose in many parts of the west of England.

The seeds, in the proportion of one peck per acre, are sown broad-cast on a dry soil; and when the plants come up, they are thinned to a foot asunder every way. The spring is the time for sowing: the ground is kept clear from weeds during the summer, and in the ensuing year the plants bear their prickly capsules: these are in a proper state for gathering in August, when they are cut, tied up in bundles, and dried. The largest and most pointed burs are esteemed the best: they are chiefly used in dressing and preparing stockings and coverlets. The smaller kind, properly called the fuller's, or draper's teazle, is used in the preparation of cloth.

When applied to the purpose of fulling, the heads are fixed firmly round the circumference of a large broad wheel, which is made to revolve, and the cloth is held against them, whereby the herbaceous prickles rub and raise up the nap without injuring the texture, much more effectually and securely than any artificial instrument which could be invented.

A species of moss (*hypnum crispum*), which abounds in Italy in every wood, growing especially on beech-trees, is found to be an excellent material for stuffing mattresses. It is little liable to decay, and does not retain moisture. This vegetable production is collected in August and September: it is then dried in the shade in order to preserve its fragrance, and after being beaten in the manner that flocks are prepared, it is fit for use.

Parmentier* strongly recommended the adoption of this material for mattresses in hospitals and barracks, as being much less liable to transmit contagion than those stuffed with wool or flocks.

A species of weed, used for stuffing mattresses, is also found in the southern states of America, and especially on the Mississippi.

ULVA MARINA.

A marine weed, collected on the coast of the Baltic sea, has been recently introduced into this country as a material for stuffing mattresses; it is known in commerce as Ulva marina. Its use is, apparently, attended with advantages which will cause its increasing and more general adoption. Bedding formed of this weed can be obtained at a much cheaper rate than that made of horse-hair, while it is equal to the latter in elasticity and softness.

The ulva marina belongs to that genus of marine plants which have no roots, and are found attached to stones on the sea-coast. It is imported into this country when dry, and the leaves in this state have the appearance of long narrow strips of a yellowish green colour.

* Annales de Chimie, 45 vol.

Chapter XI.

SUBSTANCES USED IN TANNING.

OAK BARK—CATECHU—MANGROVE—MIMOSA.

The art of tanning the skins of animals is of very remote antiquity. Pliny attributes the invention of leather to Tychius of Bœotia. But although of so ancient a practice, this art has, until a very recent period, been always carried on by persons wholly unacquainted with any thing concerning it save its practical processes, and who have pursued the routine of operations in which they have been instructed, without knowing the real cause of any of the changes produced.

Oak bark was for a long time exclusively used for this purpose in England, and after it had served its office in the tan-pit, it was rejected as useless, and supposed to be incapable of yielding farther advantage. It is said that our gardeners are indebted to William the Third for teaching them to apply this refuse of the tan-yard to horticultural purposes; he having first introduced the use of it for the purpose of raising orange-trees, as practised in Holland. Its useful qualities in producing artificial warmth for exotic plants were not however generally known or appreciated for many years afterwards, until in 1719 the cultivation of pine-apples was first attempted in England. It then came into general use, and has ever since been held in great estimation by gardeners. After coming out of the tanner's pit, if it be laid in a heap for a week or two, fermentation is induced, and if put into hot-beds properly prepared, it retains a moderate heat for three or four months. When it becomes useless for the hot-house, it can still be used with advantage as manure for some kinds of lands.

It was formerly supposed by English tanners, that the tanning principle resided in oak bark alone, but how or why its use was beneficial in the preparation of skins, was a mystery for which no one attempted to account. The scarcity of this bark, however, and its consequent high price, at length led to the investigation of its properties, and of its peculiar virtue in tanning, in the hope that similar qualities might be found to reside in other substances.

Oak—*Quercus pedunculata.*

Of every pursuit which has for its object the improvement of our domestic arts and manufactures, and the advancement of our colonies, the Society for the Encouragement of Arts, &c. has always been the zealous promoter, and accordingly we find it so early as 1765 offering premiums to any who should discover a substitute for oak bark. In that year the Society rewarded with £100 the person who first applied oak sawdust to the purpose of tanning; a discovery which was adopted in Germany, and has been continued with success. An attempt was likewise made to apply the oak leaf to the same purpose. The English tanners were, as they still are, slow to believe that any thing which did not belong to the oak could be efficacious in tanning. On inquiring, however, into the subject, it was found that in other countries many different substances were used. Heath pulverized, gall-nuts, and the bark of the birch-tree, were employed in different provinces of Germany. In some parts of Italy, myrtle leaves; in Russia, the bark of the willow; in Corsica, dried leaves of wild laurel, coarsely powdered; in the island of St. Kilda, tormentil root; and in the West Indies, the bark of the red mangrove tree.

In 1766 a method was discovered of tanning leather with heath boiled in a copper vessel, and applied to the leather blood-hot; and a reward of £700 was granted by the Irish parliament to the inventors *.

In order to prepare the oak bark for use, it was formerly ground down by a heavy stone-wheel, turned by a horse. Instead of this plan several persons now use cast-iron cylinders, between which the bark is passed, and it is thus more completely ground with less labour. In the ordinary method of tanning, the oak bark thus coarsely pulverized is put into a pit, in alternate layers with the skins to be prepared. M. Seguin found that much waste attended this method, by which the whole of the virtues of the bark could not be extracted, and that the using an infusion of the bark was a much more economical practice.

The experiments and discoveries made on this subject by that excellent practical chemist, were first pub-

* Macpherson.

lished in England in 1756, and at once opened a wide field to the researches of chemistry. He carefully analyzed the bark and the skin, both in the raw and the prepared state. The part of the bark which was found efficacious in tanning, he extracted from other extraneous matter, and gave to it the name of tannin, from the use to which it was applied. Previously to this accurate and scientific investigation, this vegetable principle had been confounded with gallic acid, under the name of the astringent principle. Tannin is a brittle substance of a brown colour; it breaks with a vitreous fracture; does not attract moisture from the air; and is extremely astringent to the taste.

The hides of animals, when divested of the hair, epidermis, and any fleshy or fatty parts adhering to them, consist wholly of gelatin, a substance capable of being dissolved in water, and forming with it a jelly which is well known under the name of glue. Tannin is likewise very soluble in water; but a union of the two forms an insoluble imputrescent compound, and hence the efficacy of tannin in the preparation of leather.

Since the discovery of M. Seguin, the first chemists, both on the Continent and in England, have made the art of tanning a matter of scientific inquiry. They speedily discovered that tannin abounds in the vegetable kingdom.

Sir Humphrey Davy, to whom the science of chemistry owes so many of its most splendid discoveries, after a careful investigation of the subject, was led to the conclusion, that in " all substances possessed of the astringent taste, there is great reason to suspect the presence of tannin; it even exists in substances which contain sugar and vegetable acids. I have," he adds, " found it in abundance in the juice of sloes; and my friend Mr. Poole, of Stowey, has detected it in port wine *." Various experiments have been made with a view of ascertaining the relative quantity of tannin in different vegetable substances.

Mr. Biggin † found that similar barks, when taken from trees at different seasons, differ as to the quantity of tannin which they contain. More than four and a half times greater quantity of tannin was obtained from oak bark, cut in spring, than from an equal weight of the same bark cut in winter. Sir H. Davy observed, that the proportion of the astringent principles in barks varies considerably, according as their age and size are different; these proportions are besides often influenced by accidental circumstances, so that it is extremely difficult to ascertain their distinct relations to each other.

"In every astringent bark," says this celebrated philosopher, "the interior white bark, that is the part next to the alburnum, contains the largest quantity of tannin. The proportion of extractive matter is generally greatest in the middle or coloured part; the epidermis seldom furnishes either tannin or extractive matter. The white cortical layers are comparatively most abundant in young trees, and hence their bark contains in the same weight a larger proportion of tannin than the barks of old trees. In barks of the same kind, but of different ages, which have been cut at the same season, the similar parts contain always very nearly the same quantities of astringent principle; and the interior layers afford about equal portions of tannin ‡."

An interesting account of a series of experiments, conducted by this eminent chemist, may be found in the work from which we have just quoted. It does not fall within the plan of the present volume to enter into any chemical details; but it would per-

* Phil. Trans. for 1803. † Ibid. for 1799.
‡ Ibid. for 1803.

haps be giving an erroneous view of the subject, if another agent in the process of tanning were not slightly noticed.

There is another vegetable matter, called by chemists extractive, which is absorbed by the skins together with the tannin, and which gives to them softness and durability; and therefore, in estimating the relative value of vegetable substances as applicable to tanning, it is necessary to take into account not only the quantity of tannin they contain, but likewise the quantity and nature of their extractive matter. The leather obtained by means of an infusion of galls, is generally found harder and more liable to crack than that prepared with the infusion of barks, from the circumstance of a less proportionate quantity of extractive matter having entered into chemical combination with the skin. Saturated infusions are found to contain much less extractive matter, in proportion to their tannin, than the weak infusions of the bark; and therefore, when skins are quickly tanned in a strong astringent solution, they absorb considerably less of extractive matter than when very slowly tanned in a weak solution.

The result of Sir H. Davy's examination of several vegetable substances, as applicable to the common uses of the tanner, shows that one pound of catechu would be nearly equal in value to two and a quarter pounds of galls, to three of sumach, to seven and a half of the bark of the Leicester willow, to eight and a half of oak bark, to eleven of the bark of the Spanish chesnut, to eighteen of elm bark, and to twenty-one of common willow bark.

Of all the plants here mentioned, that from which Catechu, or *Terra japonica*, is obtained, is the only one which is not noticed in other parts of this series. Catechu is a dry extract prepared from the wood of a species of sensitive plant—the *Acacia catechu.*

This tree is indigenous to Hindostan, flourishing abundantly in mountainous parts. It grows to about twelve feet in height, and about one foot in diameter: it is covered with a thick, rough, brown bark, and divides near the summit into many close branches. The leaves are doubly winged and placed alternately upon the younger branches. The single leaves, forming the winged leaf, grow in pairs opposite to each other. The flowers grow in close spikes, which arise from the insertion of the leaves. The seed-pods are brown, smooth, and lance-shaped, and contain six or eight seeds. It flowers in June. Short curved spines grow in pairs at the base of each leaf. The extract obtained from this tree is made from a decoction of the wood: it is a dry friable substance of a red colour externally, and within of a shining dark red brown.

As soon as the trees are felled all the exterior white wood is carefully cut away; the interior coloured wood is then cut into chips: narrow-mouthed unglazed pots are nearly filled with these, and water is added to cover them, and reach to the top of the vessel. When this is half evaporated by boiling, the decoction, without straining, is poured into a shallow earthen vessel, and farther reduced two-thirds by boiling. It is then set in a cool place for one day, and afterwards evaporated by the heat of the sun, being stirred several times during that process. When it is reduced to a considerable thickness, it is spread upon a mat or cloth, which has been previously covered with the ashes of cow-dung. This mass is divided with a string into quadrangular pieces, which are completely dried by being turned frequently in the sun, and are then fit for sale. Catechu is imported into this country from Bengal and Bombay.

Besides the trees already named, there are many other of our native trees which afford tannin. Among these are the elder, the plum, the sycamore, the birch, the cherry-tree, the poplar, the hazel, and the ash. The relative proportions which they each contain are given by Mr. Biggin.

Oak bark is still, however, generally used in England preferably to other substances. The demand for it in this country is so much beyond our home supply, that four-fifths of what is used is obtained from foreign countries. But so bulky an article is of very expensive carriage, and will not bear the cost of freight from distant parts: it is therefore imported into England only from Hamburgh, and the near ports of Holland, France, and the Netherlands. About 40,000 tons are annually imported into this country at a duty of eight-pence per cwt.; the present price varying from £5 to £9 per ton, according to its quality. The best is brought from Antwerp, the worst from Hamburgh. The supply has not, however, been kept up equal to the demand. The oak bark which we now obtain is yearly deteriorating in quality; and the time is evidently fast approaching when it must be sought in remoter countries, or the tanners must consent to adopt a substitute. Impressed with this conviction, some of the most enlightened among the leather-dressers have attempted to form establishments in Dalmatia and other distant parts, for making extract of oak bark, with a view of diminishing the expense of carriage, and enlarging the supply.

In like manner, in new countries, where timber is in such profusion as to be almost valueless, the extract of the bark might be obtained, and imported with advantage into the old countries. Much encouragement has been given to induce the adoption of this measure in America, and subsequently in

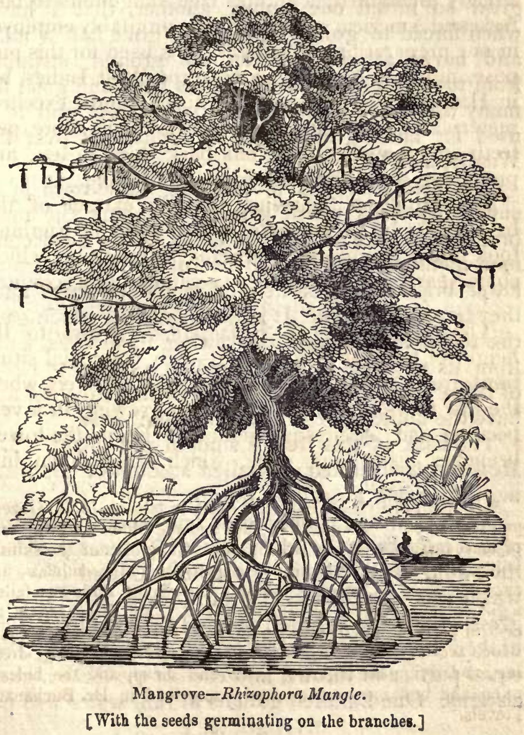
Australia, in the hope that this may eventually become an article of profitable commerce between England and her dependencies. It has been found that there are many different kinds of trees, both in the east and west, which produce a superior and stronger extract than that obtained from oak bark. The mimosa catechu has been already brought forward as an example. The red mangrove, which we have already mentioned, is another tree indigenous to both Asia and America, which might be profitably employed in our preparation of leather. It is used for this purpose, not only in many parts of the West Indies, but in Hindostan*; and it is said to be a most excellent material for tanning, performing its office more perfectly in six weeks than oak bark does in ten, and producing a leather more firm and durable.

Dr. Howison, believing that an extract of this bark might be advantageously employed in England, took much trouble in preparing a quantity, which, some years ago, he sent as a specimen to this country.

The Mangrove, or *Rhizophora*, grows to the height of forty or fifty feet: its only congenial situations are in water, and on the banks of rivers where the tide flows. It is an evergreen growing in a very peculiar and picturesque manner. From the lowest branches issue long roots, which hang down into

* In the time of M. Polo, and even so late as 1583, Guzerat and the country between that place and the Indus were the seats of considerable leather manufactories. They dressed the skins of wild oxen, buffaloes, rhinoceroses, goats, and other animals, and exported them to Arabia. Though the export trade has failed, a good deal of leather of different kinds is still prepared in the central parts of the Indian peninsula. The processes (some of which are very ingenious) used by the natives in tanning, dressing, and dying the skins of goats and sheep, and the hides of oxen and buffaloes, are minutely described in Dr. Buchanan's Travels.

the water and penetrate into the earth. Thus the whole has the appearance of a number of arcades from five to ten feet high, which serve to support the body of the tree. These branches are so closely entwined with each other that they form a kind of natural terrace. We may add Dampier's description of this curious tree, which (as usual with that extraordinary writer) is concise, spirited, and picturesque.



Mangrove—*Rhizophora Mangle.*

[With the seeds germinating on the branches.]

"The red mangrove groweth commonly by the sea-side, or by rivers or creeks.... It always grows out of many roots about the bigness of a man's leg, some bigger, some less, which at about six, eight, or ten foot above the ground, joyn into one trunk or body, that seems to be supported by so many artificial stakes. Where this sort of tree grows, it is impossible to march by reason of these stakes, which grow so mixed one among another, that I have, when forced to go through them, gone half a mile, and never set my foot on the ground, stepping from root to root. The timber is hard and good for many uses: the inside of the bark is red, and it is used for tanning of leather very much all over the West Indies*."

The natural way of propagating these trees is to suffer the seeds which germinate among the main branches to take root in the earth. The most common method, however, is that of laying the small lower branches in baskets of mould or earth until they have taken root. It is the mangrove which gave rise to the fable of oysters growing upon trees, since from its situation in the water it is a favourite resort of these shell-fish, which cling to its branches, and have the appearance of growing from them.

The bark of this tree is smooth and pliant. Dr. Howison transmitted a detailed account of the manner of forming an extract from it.

The apparatus consisted of four wooden cisterns, placed one above the other, so that by turning a cock the liquid in the higher one readily flowed into that which was immediately beneath it, and so on in progression. Four hundred pounds of mangrove bark, broken into small pieces, were divided into three equal parts, and thrown into each of the three highest cisterns. One hundred gallons of rain water was put

* Voyages, vol. i.

into the first cistern, this was allowed to remain for twelve hours. The infusion was then drawn off to the second, and after standing a similar period, into the third, and lastly into the fourth, which had been kept empty to receive the saturated infusion, to be farther concentrated by evaporation. The cocks of each cistern, when once turned, were left open to admit the liquid to drain off completely. The whole solution now collected into the evaporating cistern was exposed to the heat of the sun until concentrated to the consistence of a thick sirup, at which time the lixivium was reduced to about eight gallons; it was then drawn off clear from its precipitate into a copper vessel, in which it was boiled over a slow fire and kept constantly stirred until the extract acquired a consistence that would just admit of its being poured into the barrel, where, on becoming cool, it assumed the appearance of pitch.

A like extract was made from Myrobolans* and sent to England. The leather produced from this last substance was found to be similar in appearance to that which is obtained when galls are employed.

In the method of obtaining the extract as above described, the employment of more than two vessels does not appear to be requisite; the cisterns used were adapted to, and not made for the purpose. The process appears to have been extremely wasteful and defective. By the use of more simple means much better results might have been obtained; results so easily accomplished, that to those who only look on the subject scientifically, it is matter of surprise that the extract should not rather than the bark itself become an article of commerce, and that the advantage of obtaining the tanning principle at a

* Myrobolans will be farther noticed under the head of dyeing substances.

more reasonable rate, should not speedily lead to the universal practice of transporting it in a concentrated form. But a prejudice exists which hitherto has prevented its general introduction, and this can be only gradually overcome.

The quality of leather is estimated in the trade partly by its colour; the paler it is the higher value it obtains, for experience has shown that bark having been injured by fermentation produces a brown leather, which is brittle and of a bad quality; and since this hue has formerly been justly associated with inferiority, it still continues to be considered one of the criteria by which the quality of leather is to be judged. Both alder and larch bark make excellent leather, but being of a reddish brown colour it is very difficult of sale. The extracts of the barks give more colour to the leather than the unprepared oak bark, and although this darker tint does not appear to be attended with any kind of inferiority, it is from this circumstance alone considered of a lower quality.

When the results of scientific research are a little better known to practical men, the dislike of innovation will, no doubt, be removed. In the mean time constant discoveries and improvements are being made in this, as in every other branch of domestic industry, and the mode of preparation is, in consequence, much superior to that practised a few years back.

A tanner of Bern Castel, on the Moselle, has recently discovered that the *vaccinium myrtillus*, or whortle berry, is admirably adapted for the preparation of leather. It is cut down in the spring, and when dry reduced to powder. Three pounds and a half of this tan are said to be equivalent to six of oak bark, while at the same time the process of tanning is very much accelerated by its use.

A commission was appointed at Treves for examining the leather so tanned, and the report speaks strongly in favour of this new article in the preparation of leather. Shoes made of it were found much more durable than those for which common leather was used, while those parts of the skin most difficult to be worked by the ordinary tan becomes by the use of this as strong and elastic as the other parts. When cut, damp does no injury to this substance, whereas oak bark loses ten per cent. of its value by being wetted.

There is at present every prospect that the use of the extract of bark will at length be adopted, and that this substance will form an important article of commerce between this country and Australia. In the year 1823 the extract of the bark of two species of mimosa, which are cut down for the purpose of clearing the land, was imported from Australia, and was sold to some English tanners at £50 per ton, under the name of extract of wattle bark. It was found on trial to produce as much leather as between four or five times its weight of oak bark of fair average quality. It is not quite equal in strength to the extract of oak bark, but the importation price more than counterbalances this inferiority, and this will be the case, notwithstanding the distance of New South Wales, as long as mimosa-trees are cut down in clearing land for cultivation.

The bark was stripped from the trees in August, September, or October. The rough outward bark was taken off, and the inner bark while green crushed in a mill with fluted copper rollers like a sugar-mill. It was then put in a copper boiler containing clear water, 100 lbs. to 100 gallons, and boiled gently during two hours; the decoction was then strained through a sieve into broad flat copper pans, and evaporated to the desired consistence. One ton of bark produced 400 cwt. of extract when brought to the consistence of tar. If made hard as pitch, then only 300 cwt. would be obtained; but the evaporation if carried thus far will char the extract, which must on every account be avoided, since its tanning properties are then entirely destroyed. A ton of the best white oak bark produces 500 cwt. of extract, two-thirds of which is pure tannin; of the entire bark less than one-seventh of its weight is extract, half of which only is pure tannin. The mimosa is therefore rather less rich in tannin than oak bark, but where it so abounds this difference is not of any importance. Five tons of this extract sent from Van Diemen's Land were also favourably received. This extract was prepared rather differently, being boiled for twelve hours and then strained; then boiled for twenty-four hours and strained, and again boiled for an equal time and again strained.

The wattle bark, in its unprepared state, has been shipped to this country in small quantities, and the advantage arising from its importation in the form of an extract, has induced those persons interested in the subject to engage the attention of some of the first chemists in its examination and preparation. Professor Davy, of the Royal Dublin Society, has, in consequence, very recently prepared from the bark a dry extract by the employment of a new method of evaporating, by means of which the extract cannot by any possibility be charred. The adoption of this simple method in Australia would ensure the importation of the substance in a state uninjured for use; while in the solid form its transport will, in every way, be less expensive. The present price of mimosa, or wattle bark, is £7 to £7. 10*s*. per ton.

In the third volume of the Gardener's Magazine it is stated, that "*the pods of the Cæsalpinia coriaria,* known by the common names of Dividivi, or Libidibi, are used by the inhabitants of Curaçoa, Carthagena, and other places within the tropics for tanning hides, and might be advantageously imported into this country, and afforded to the tanner upon even cheaper terms than oak bark. The seed-pods of the dividivi are pounded in a mortar, and then steeped in water in large vats; when the water is well impregnated the hide is thrown into soak for four hours, and is then taken out to be rough-dressed and replaced in the vat for another four hours, and this process is repeated till the hide is well tanned, which is here the operation of a couple of days.

" Such is the rude process adopted in South America, which, though defective in many particulars, is found to answer the purpose proposed. By grinding the pods of the dividivi in the same manner as bark, and macerating them in warm water, by which the solution of the tanning principle contained in them would be rendered more complete and expeditious, an increased economy both of time and materials would be effected, and the process might by other improvements in the manipulation, which the experience of the tanner cannot fail to suggest, be abridged still farther and rendered more effectual, so as to reduce the present price of leather very considerably."

Chapter XII.

VEGETABLE OILS AND SIMILAR PRODUCTS.

FIXED OILS: OLIVE—RAPE—LINSEED—HEMP—COTTON—SESAMUM—RAPHANUS—ARACHIS—POPPY—NUT—BEECH—PALM—COCOA-NUT—BEN.

Vegetable oils are distinguished into two kinds, fixed or fat oils, from which no vapour is given off at the temperature of boiling water, and volatile or essential oils, which give off vapour at that temperature with water, or under 320° by themselves.

Those of the first class are obtained by expression principally, if not entirely, from the fruit or seed of plants. A variety of seeds are more or less oleaginous, more especially those of the nut kind, from all of which oil may be extracted. Many of the oils of this description are applicable to the arts, or are employed in combustion for producing light.

The vegetable oil most known and esteemed is that expressed from the olive. An account of this valuable tree has been already given in a former volume, where the extent of its cultivation and the manner in which it was prized by the ancients have been fully dwelt upon.

The olive, which now appears a native production of Italy, luxuriating in its genial soil and climate, is not however indigenous to that country. Pliny, who largely discourses on this tree and its produce, notices its first introduction, whence the historian of Rome remarks, "The olive in the western world followed the progress of peace of which it was considered as a symbol. Two centuries after the foundation of Rome, both Italy and Africa were strangers to that useful plant; it was naturalized in those countries, and at length carried into the heart of Spain and Gaul. The timid errors of the ancients, that it required a certain degree of heat and could only flourish in the neighbourhood of the sea, were insensibly exploded by industry and experience *."

Olive—*Olea Europæa.*

* Gibbon's Decline and Fall of the Roman Empire, chap. ii.

The olive and the cornel are the only trees from which oil is expressed from the pulpy part of the fruit and not from the seeds alone. The oil obtained from the kernel of the olive is supposed to become rancid sooner than that contained in the outer part, and therefore, in producing the best oil, care is taken that the stones are not cracked in the preliminary process of bruising the fruit, nor are they subjected to sufficient pressure to produce this effect at first when the best oil comes over. The press used for this purpose is of a very simple construction. The fruit is bruised by the action of a mill-stone, it is then transferred to the trough of a screw-press, and after as much oil is obtained as can be extracted by the degree of pressure given, hot water is poured on what remains in the trough ; the whole is then subjected to stronger pressure, and a coarser product is procured. When all the oil is entirely expressed the refuse is used as fuel.

The best soap is made of olive oil mixed with alkalis, but its preparation for this purpose is not so carefully conducted as when it is intended to form an ingredient in food. Spanish soap, known in England as Castile soap, is made with olive oil, which is also largely used for the same purpose at Marseilles, the merchants of which place carry on a large export trade in soap. The heavy duty charged on importing olive oil into this country, viz. £8. 8*s*. per ton, effectually prevents its application to soap-making in England, and we are consequently restricted to the use of an inferior article. The species of tree which bears the greatest quantity of fruit, and not that which yields oil of the best quality, is cultivated for this object. The fruit when gathered is laid up in heaps to produce a slight degree of fermentation, by which means a greater quantity of oil is obtained, but at the expense of its quality. The latter consideration does not deter some cultivators from employing this preliminary process in the extraction of the better kind of oil; a practice which, however, proves extremely prejudicial to the product, to obtain which, of the best quality, the fruit should be pressed immediately after it is gathered.

Olive oil when extremely good and pure can be preserved for several years, but such a quality is very rare, and in general olive oil deteriorates after being kept any length of time, losing its limpidity and becoming rancid. If the olive be not sufficiently ripe when expressed the oil will be bitter, if it be too ripe the oil will be thick and glutinous. The method of extracting the oil has likewise a great influence on its quality.

Olive oil becomes solid at 10° of Fahrenheit. Its specific gravity is ·913. It is never used in the composition of paints as it does not dry completely. The olive-tree produces oil abundantly, and a plantation of this in a favourable climate is always a certain source of profitable industry. "The young olive-plant bears at two years old, in six years begins to repay the expense of cultivation, even if the ground is not otherwise cropped. After that period, in good years, the produce is the surest source of wealth to the farmer, and the tree rivals the oak in longevity, so that the common proverb here is, 'If you want to leave a lasting inheritance to your children's children plant an olive.' There is an old olive-tree near Gericomio which last year yielded two hundred and forty English quarts of oil; yet its trunk is quite hollow, and its empty shell seems to have barely enough hold on the ground to secure it against the mountain storm *."

* Three Months passed in the Mountains East of Rome during the year 1819, by Maria Graham.

Four millions one hundred and fifty-eight thousand gallons of olive oil were imported into this country in the year 1831, very nearly one-half of which was retained for home consumption.

The following details respecting the olive and the oil trade have been communicated to us by a gentleman who lived a considerable time in the particular part of Italy referred to.

"All that part of Italy which may be called the heel of the boot is little else than one continuous olive grove. It forms an extreme point of the Neapolitan kingdom, and is divided into two provinces, viz. Bari and Lecce, or La Terra d'Otranto. Its principal ports are Bari, Brindisi (the ancient Brundisium), Otranto, Gallipoli (now the most important of them all), and Taranto (the ancient Tarentum). Starting from Gallipoli, as I have often done, and travelling to the Cape Santa Maria di Leuca, or to Taranto, or to Lecce, a very large city and the capital of one of the provinces, you literally are scarcely ever ten minutes out of the shade of olive-trees. The slight cultivation of grain, &c., which is not nearly enough for the consumption of that district, is carried on in the midst of olive groves. Before and behind you, on hill or in hollow, you see scarcely any thing but *oliveti.* I have stood on the terrace of an old baronial castle at the town of Parabita, and seen the olive grove spread around me on every side for many miles, like a dull sea of leaves. Though so much poetry is associated with this emblem of peace, the tree itself is certainly neither picturesque nor poetic; and travelling through them for such a length of time with scarcely any other object to relieve the eye, is excessively monotonous and tedious. Starting again from the city of Lecce to Otranto, or to Brindisi, you have olive groves nearly the whole of the way; or going on from Lecce to Bari, with short interruptions at the mountains of Ostuni and one or two other places, your road lies through the same continuous plantation of olives. The soil of these districts is very stony and waved into hills of slight elevation; it is in no part remote from the sea, whose contiguity is certainly favourable to the growth of this valuable tree. Though the long summer heats and the sirocco blowing from Africa are most oppressive at morning, mid-day, and evening, the narrow neck of land is generally refreshed by breezes from the open Mediterranean, or the Adriatic, or the Gulf of Taranto. These immense olive groves bear every year, but it is a well-known fact here, as in the south of Spain, Greece, and all the other oil countries I have visited, that they never produce the same, or any thing like the same quantity of fruit two years following. They have what the people there call a '*si e no*,' or a '*buon'annata*' and a '*cattiva annata*,' or a good year and a bad one, and this, in ordinary cases, in regular alternation; the groves bearing a bad crop this year, bearing a good one the next, and those highly productive this year being proportionably less productive the next year.

"I could not ascertain the precise time at which they cease to bear, but I have seen abundance of fine fruit taken from trees whose trunks were sadly hollowed and seemed altogether sapless, and which were known to have been planted a century and a half before the time of my observation. I believe, however, that after a hundred years the tree requires manure and more attention, and gradually decreases in its power of production. As the whole wealth of the country consists in olives and oil, and as all hands are employed or interested in this branch of agriculture, it is amusingly curious to observe what frequent allusions are made to it in the popular parlance. A man who is in a gay humour is said to be 'as merry as if he had *la buon'annata*,' or the good year of olives, and so on with the reverse when a man is in a bad humour. An improvident person who dies and leaves his family badly provided for, is said to have left '*un'eredità di oliveti antichi*' (a fortune of olive-trees past bearing), or they say he has consumed all the *buone annate* (good years) and bequeathed the bad ones.

"The oil throughout these two provinces, where the soil and cultivation vary but very little, is much the same at its production, but its quality is very considerably influenced by the nature of the wells or cisterns where it may be preserved afterwards. It is carried to Trani, Barletta, Bari, Molo di Bari, Molfetta, Giovenazza, Brindisi, Otranto, Taranto, and some other sea-ports, but its great *depôt* for some ages has been the town of Gallipoli, which gives its name to the oil imported in such great quantities by the English, French, Americans, and other nations, though, in fact, that oil is not produced exclusively in the country of Gallipoli, but throughout the two provinces I have described.

"Gallipoli owes this very advantageous preference not merely to its port, which, though bad enough, (as I have occasion to remember, having once been nearly driven from my anchorage upon some saw-like rocks,) is infinitely better and more accessible than any of the others:—but to the quality of the rock on which the town is built. This rock is a small island which is united to the main land by a bridge and entirely covered by the city, whose walls follow the shape of the low cliffs, and rise on all sides perpendicularly from the sea.

"This solid compact base is easily excavated; and in caverns thus constructed oil clarifies sooner, and keeps without rancidity much longer, than in any other place. Hence numerous oil-houses are established at Gallipoli, and a very considerable portion of the rock is cut into cisterns. A Gallipolitan oil-warehouse generally occupies the ground-floor of a dwelling-house, and has a low arched roof. Some are more extensive, but on an average they are about thirty feet square. In the stone floor you see four, six, or more holes, which are circular, about two feet in diameter, and like the mouths of wells. Each of these holes gives access to a separate *cisterna* beneath your feet, and when the oil is poured into them care is taken not to mix different qualities or oils at different stages in the same reservoir. One cistern is set apart for 'oglio mosto,' or oil that is not clarified, another for pure oil of the season, another for old oil, &c. I have seen oil that had thus been preserved for seven years in a perfect state, or, as the Gallipoli merchants' documents have it, '*chiaro, giallo, e lampante*,' words which I can never forget, for during some months I must have heard them at least a hundred times a day. I also many times verified the fact, that the *mosto*, or oil, in its turbid state, which arrived almost as black and thick as pitch, soon became bright and yellow in these excellent reservoirs without any help from man.

"All the oil, whatever may be its quality, is brought to the magazine in sheep or goat-skins, which are generally carried on mules, there being but few *strade rotabile*, or roads fit for wheeled carriages in these parts. In a good year, and at the proper season, I have counted in the course of an afternoon's ride as many as a hundred mules returning from Gallipoli, where they had been to deposit their unctuous burdens, to different towns and villages in the Terra d'Otranto or the more distant province of Bari. The quantity of oil required may be conceived when I state, that at one time (in the year 1816) I saw nine English, three American, two French, and six Genoese vessels (not to mention some small craft from the Adriatic), all waiting in the port of Gallipoli for entire or partial cargoes of it. When the oil is to be shipped it is drawn off from the *cisterne* into *uteri*, or skins, and so carried on men's shoulders down to a small house on the sea-shore. In that house there is a large open basin capable of containing a given quantity and of measuring the liquid, and into that the porters empty their skins as they arrive. A tube communicates from the basin to a large cock at the outside of the house. When the basin is full, well made casks of various sizes for the convenience of stowage are placed under the cock, which is then turned and the casks are filled. As the casks are closed up by the cooper the porters roll them down to the brink of the sea, where the sailors secure several of them together with a rope, and taking the end of the cord into the boat they row off to the vessel towing the oil casks through the water after them.

"Each porter being able to carry but a small quantity at a time, the number of men and boys employed to load a ship is very considerable; and as these are an active fine-limbed set of fellows, going with their legs and arms entirely bare, and running up and down and crossing each other with their oil-skins on their way to and from the town with great rapidity, and as they delight in singing as they work, and moreover, frequently sing very well in parts and concert, the scene presented on such occasions is often very animating and pleasing.

"The hilarity of the Gallipolitans when I first became acquainted with them might have been heightened by an agreeable contrast, for it was shortly after the fall of Bonaparte, whose system, whatever good parts of it may have done in the rest of Italy, was certainly most ruinous to the provinces of Lecce and Bari. Unable to export or to find any market for their produce, the proprietors in many parts of those provinces let the olives lie and rot upon the ground. For some years indeed the price of oil scarcely paid the cost of its preparation, to say nothing of transport and other necessary expenses. During the continental system the best '*chiaro, giallo, e lampante*' oil was sold at Gallipoli for eight Neapolitan ducats the *salma* *; in 1816 and 1817 it found a ready market at from sixty to seventy ducats per *salma!*

"Those who during the evil time had penetration enough to foresee better days, and that a system opposed to the general commercial prosperity of Europe could not last, and who had at the same time money enough for such objects by annually making their oil as usual, and by buying up the oil of others at the low current prices of the day, realized enormous profits when peace threw open the port of Gallipoli, and ships of all nations flocked thither as before.

"I have been in no part of Europe where the benefits resulting from the peace were so broad and tangible as here. At the end of 1816 these provinces had already partially recovered; those proprietors whom the war had left in debt were gradually paying off their obligations; those groves which had been almost abandoned were again looked to as a source of wealth, and the poor peasantry were restored to their ancient employment. In 1818 the improvement was much farther advanced, and though since that period, owing to the increased use of gas, the extended cultivation of rape for oil, and various other circumstances, the olive oil shipped at Gallipoli and other ports has declined considerably in price and somewhat in quantity, it may still be

* The salma is equal to 42¾ English gallons.

held as a valuable product, and Lecce and Bari, in regard to the condition of the rest of the kingdom they belong to, may be considered as two prosperous provinces.

"The olives of which the Gallipoli oil is made are never gathered, but allowed to drop in their maturity from the tree on the ground, where they are picked up chiefly by women and children and carried to the mill.

"The machinery employed in expressing the oil is of the rudest kind, and no doubt numerous improvements might be introduced, not only into this branch but into that of cultivating the olive-tree. The peasantry, however, and in the kingdom of Naples those who stand higher in the scale of fortune and rank, are too often but boors in intellect, are obstinate in their attachment to old practices, and are apt, when any of these are reprehended, to stop discussion by saying '*Faccio come faceva la buon'anima di mio padre, e ciò basta*' (I do as my father of blessed memory did before me, and that's enough).

"The poor people of the country make culinary uses of the same oil that is exported, and which in England is only used in manufactures or burnt in lamps; but in the houses of the gentry I have often tasted oil prepared with more care, which was truly delicious, being equal to that of Sorrento, Vico, and Massa, or even to the best oils of Tuscany or Provence."

Rape or Napus, a species of *brassica,* is very much cultivated throughout France and the Netherlands for its seeds, which yield an excellent oil for burning. It is likewise raised in large quantities in the isle of Ely and other parts of England.

This oil, which is principally used for lamps, is known in France under the name of Colza oil. In

Rape—*Brassica napus.*

the north of that country and in Belgium, particularly in the environs of Lille, much attention is given to the production of this useful seed. It is sown broadcast in the months of June and July; from six to eight pounds of seed are generally allowed to each acre of ground. Care is taken so to spread the seed that the young plants shall not spring up in patches.

In the month of September the plants are transplanted at the distance of twelve or fourteen inches apart from each other. The seed comes to maturity from July to September of the following year. The plants are then cut down with a sickle and spread on the ground to dry. The more careful cultivator shelters them immediately from the vicissitudes of the weather, and lays them to dry in some airy, but covered situation. When sufficiently dried, the seed is rubbed out on a large cloth prepared for the purpose. The straw and chaff on being burnt afford, it is said, excellent potash. The seed, as soon as collected, is taken to the mills, where its oil is extracted. If it be used in the manufacture of soap, no farther process is necessary, but if intended for lamps, means must be taken to discharge it of its impurities. M. Thénard recommends the following method of purifying the oil previously to its being used for this purpose: with one hundred parts of oil two parts in weight of concentrated sulphuric acid are mixed, and the whole is then subjected to considerable agitation. The fluid immediately becomes turbid, and assumes a dark green hue; the stirring is continued until the acid combines with the mucilage and colouring matter. In less than an hour these are seen to collect and gradually precipitate in flakes of a blackish-green colour. A quantity of water, equal to double that of the oil, is now added, and agitation is again applied; this is done to deprive the oil of any acid which may not have passed in combination with the impurities.

The whole is left for subsidence during several days, after which the oil, floating free above the water, is drawn off and put into tubs. The bottoms of these tubs are perforated, and the holes are filled with cotton, through which the oil filters into other vessels, when it is perfectly pure and limpid. This method of purification is equally applicable to all other seed oils. Another process has been recently recommended somewhat similar to the above, which consists in the admixture of dilute sulphuric acid, and the subsequent introduction of steam into the oil, whereby it is more entirely freed from all acid. This is said to be an improvement on M. Thénard's method.

Rape oil thus prepared has very little smell; it is of a yellow colour, and of rather a sweet taste. This oil has the advantage of remaining limpid at a much lower temperature than most other oils, which useful property causes it to be used in preference for street lamps.

It is of the same specific gravity as olive oil.

The very extensive cultivation of rape for oil, which has been made of late years on the Continent, has seriously affected the trade of Italy in olive oil. Besides in soap, rape-seed oil is now made to enter into several other manufactures, for which, until recently, Italian olive oil (chiefly from Gallipoli) was always employed. In consequence of this, in 1827, the value of those estates in the kingdom of Naples, whose main produce was oil, was very considerably reduced.

LINSEED OIL.

The oil drawn from the seeds of the flax plant or linseed is of very general application in the arts, especially in oil painting and in the composition of varnishes. Linseed oil as it is first extracted is of a dark brown colour. Many methods have been proposed for divesting it of this tint, which in some kinds of varnishes is an obstacle to its use. One process for bleaching it, is to add litharge in the proportion of two ounces to every gallon of oil, This mixture is well agitated every day for a fortnight; it is then allowed to subside for a day or two, after which it is poured into shallow vessels, and half a pint of spirits of turpentine is put to each gallon of oil. After three days' exposure to the heat of the sun it becomes as white as nut oil.

Linseed, before it is submitted to the mill, is sometimes subjected to the action of heat, for the purpose of getting rid of the mucilage which resides in the brown husk of the seed, and which absorbs a large proportion of the oil as it is forced out of the kernel. To this end it is placed in a large iron vessel shaped like a sand-bath, and fixed in a furnace; a moderate heat is applied, and the seed is constantly stirred that all may alike be roasted; but there is much hazard of burning some part, thus injuring the oil in the kernel, and giving it a greater tendency to rancidity. A larger quantity is, however, obtained in this manner.

HEMP OIL.

Hemp-seed likewise affords a very useful oil, similar in its qualities to linseed. It is of a green colour, and strongly impregnated with the peculiar odour of the plant.

In Russia this oil is produced abundantly from the vast quantity of hemp-seed obtained by the extensive cultivation of the plant for other purposes. From St. Petersburgh alone 150,000 pood (5,454,545 English avoirdupoise pounds) of hemp oil are annually exported *.

The boors for the most part extract the oil from the seeds themselves by means of little mills, in which the seeds are crushed by a small block-pestle worked by a horse. After being crushed, they are

* Tooke's View of the Russian Empire, vol. iii.

put into a large pan in a heated oven, and when thoroughly hot the bruised seeds are laid between coarse linens and subjected to pressure. Hemp-seed by this process commonly yields one-fifth of its weight in oil.

A duty amounting to a prohibition is laid on the importation of rape, hemp, and linseed oil from foreign countries; but they are allowed to be imported from British possessions at the trifling import duty of £1 per tun. Foreign seeds are subjected to only a small impost of 1*s.* per quarter. In 1828 we imported 428,905 bushels of rape and 1,996,414 bushels of linseed. The best of the latter, however, classed as flax-seed, is used for propagating the plant, and a small proportion is likewise abstracted for other purposes.

Numerous oil-mills are erected in this country for the purpose of extracting the oil from these seeds; but it is generally considered that the Dutch carry on the process in the greatest perfection. Their mills for expressing oils from oleaginous seeds are constructed on the best principles of economy in time, labour, and seed; while at the same time they combine the most careful and ingenious contrivances for the production of good oil.

The great oil cistern is divided into several chambers, by which means the different qualities obtained in each stage of the process are kept separate.

By one machine the seeds are in turn bruised, pressed, pounded, and stirred. They are first crushed by the mill-stones, when self-acting rakes successfully perform the office of "a hand directed by a careful eye and unceasing attention," constantly changing the surface of the seeds and scraping off the paste which adheres to the stones. When the bruising has been carried to the proper point, another motion, by means of an elbow joint, is given to one of the

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rakes, by which the paste is gathered together and pushed forwards to troughs placed to receive it. In the bottom of these troughs are perforations through which the oil drips, and is conveyed to a division of the cistern set apart for the first produce; this is considered the best, as having been obtained without pressure, and by the mere breaking of the parts containing it. After draining, the paste in the troughs is put into hair bags and subjected to pressure in another part of the mill. The oil thus yielded is considered scarcely inferior to the first, but another separate portion of the cistern is allotted to this second product. After the oil has been pressed out, what is left in the bags is one caky mass,—this is taken out, broken, and put into mortars; the pestles working in these are part of the machinery of the mill, and moved by the same power which actuates the whole. A simple contrivance puts them in or out of action, as occasion may require. The paste is now reduced to a fine meal, and in consequence the oil is freely disengaged from every vesicle. When sufficiently pounded it is conveyed to the *chauffer-pan*, or boiler, where it is heated to a certain temperature. This is not, however, ascertained by a thermometer; recourse is had to a less scientific, though perhaps equally efficient test—the heat required to melt bee's-wax is found from experience to be the most beneficial temperature, and this is made the criterion by which the operation is regulated and concluded. The contents of the boiler are constantly stirred with a wooden spatula, to which motion is given by some connection with the moving power of the machinery.

From the boilers the stuff under process is again put into hair bags, and twice more subjected to pressure; the oil which comes from the first of these pressings is considered the best of the second quality, and kept separate from that which is subsequently obtained.

At Picardy, Alsace, and most of Flanders it is the practice to put a small quantity of water among the paste in the chauffer-pan, by which the produce is increased, and after the second pressing, the oil-cake which is left is consigned to the farmers, and used by them for fattening cattle. The cake is, however, still moist, and more oil might by a farther process be extracted; the Dutch are, therefore, not content to yield it up, until they have wrung from it still more of its oleaginous matter. They mix no water in the paste the first time it is put into the boiler, as they consider this addition very much deteriorates the quality of the oil; but after the second pressing, they again break down the cake and submit it to the pestles and mortars again to be pounded into meal. It is then put into another chauffer-pan with a small quantity of water, and kept for some time at the heat of boiling water, the whole being stirred without cessation. The paste is then put in the hair bags for the third time and pressed, and though the oil thus obtained is of a very inferior description, it sells for a sufficient price to remunerate the miller for the extra labour. The cake is now as dry and as hard as a piece of board; but even in this state it is not wholly useless or worthless, as it is still found to afford nourishment to cattle.

That careful and industrious people, the Dutch, are so superior to all others in the manner of expressing the oil, that they even draw a profit from the wasteful practice of their neighbours, and some small mills in Holland are actually used solely for extracting oil from cakes purchased from the French and the people of Brabant, who have rejected them as being of no farther use in their own oil-presses. But the nicety and care by which the Dutch produce good seed-oils do not end with their mere extraction.

Notwithstanding all the precautions which are used in each operation, some particles of the vesicles of the seeds unavoidably find their way into the cistern, and these gradually subsiding, cause the fluid to be in strata of different purities. The pumps constructed for drawing off the oil are therefore made to work in pairs, the one bringing it up from the bottom, the other from about the middle: that coming from the latter is the oil barrelled up for sale, the other is conveyed to a deep narrow cistern, where subsidence again takes place and more pure oil is obtained.

The advantages of superior machinery and carefulness of process, cannot be more strongly exemplified than by instancing the Dutch oil-mills. The price of labour, as well as of materials for erecting machinery, are comparatively high in that country. Wind is generally made the moving power in these mills, and the complicated construction of windmills, and the keeping them in repair, are attended with enormous expense. Yet the Dutch are not only enabled by their superiority in this branch of industry to compete with other countries in so important an article of commerce, but likewise to send annually considerable quantities into the very provinces of France and Flanders, where they buy part of the seed from which it is extracted. The greater part comes from Riga. In the seigneurie of Lille alone, between thirty and forty thousand barrels of oil, each containing about twenty-six gallons, are annually made from seeds *.

The oil of several other kinds of seed is advantageously used as well as rape oil in many manufactories and trades. Among these are mustard and

* Nicholson's Operative Mechanic.

sun-flower seeds, both of which on expression yield a good oil. They are very little liable to dry by exposure to air, and are much employed as preservatives against the attacks of moths and other insects. There is a large consumption of rape and other seed oils for this purpose among wool and leather-dressers.

In America, cotton-seed is now made to yield a very good and serviceable oil; a machine having been recently invented there for hulling the cotton. The object of this operation is not to get rid merely of the hull or skin, but of the fibres of cotton which adhere to it, and which would absorb and retain a large portion of the oil under the press. Previously to this invention cotton-seed was treated as refuse, and served only for manure. Taking into consideration the quantity of cotton produced in the Southern States, and the relative weight of the seed which it surrounds, some estimate may be made of the vast produce of an article now found to be available for useful purposes.

After the seeds are hulled they are ground and pressed in a machine of the same construction as the Dutch oil-mills. Cotton-seed is much softer, and therefore easier to crush than linseed; the grinding-stones can accordingly be made smaller in proportion to the number of pestles used, than those of the linseed oil-mills. The oil thus extracted is refined by a simple and cheap process, so as to answer all the purposes of the best sperm oil; competent judges, who have carefully compared the two, being entirely satisfied of their equality.

After the oil has been expressed from the seed, the residue is a nutritive oil-cake; so that a planter who makes four bags of cotton, obtains by these means forty bushels of good food for his cattle, independent of the oil which may be produced.

"Not long since those who had cotton-gins felt themselves obliged by any neighbour who was willing to take the seed away, and what might have produced *millions* of dollars has been rejected as of no value *."

SESAMUM OIL.

The seeds of the oil plant, or *Sesamum orientale*, produce oil very abundantly. This is an annual plant indigenous to the coast of Malabar, the island of Ceylon, and other warm countries. It is also cultivated universally throughout Asia and in Africa, where the whole seed is valued as an article of food as well as the oil which is expressed from it. Though a native of the warmer climates, it may be successfully cultivated in the more temperate regions. It is grown in the southern part of Russia, and has been introduced into Carolina. In the West Indies it has found a congenial clime.

The sesamum has an herbaceous four-cornered stalk about two feet high, sending out a few lateral branches. The long oval leaves, somewhat hairy, grow opposite. The flower-stalks terminate in loose spikes of small flowers of a dingy white colour, and in shape like those of the fox-glove. The seeds are about the size of mustard-seeds. The culture of this plant is very easy, and the oil is readily obtained from the seeds by expression. Nine pounds of seed yield two quarts of oil, which is perfectly sweet †, and is used for the purposes of olive oil, while it has the great advantage of not contracting rancidity, though

* Franklin's Journal, May 1830.

† Marco Polo, who frequently mentions the sesamum oil, says, "it is better and has more flavour than any other oil." It was much used by the Tartars.

Sesamum—*Sesamum orientale.*

kept for years. This oil is made in Persia *, and exported thence in large quantities; it is known there by the name of *Kuntschuk.* The intelligent authors of 'Letters from the Caucasus' say, that the oil procured from sesamum cultivated on the side of that mountain is nearly equal to the best French olive oil.

When the seeds are used as food they are parched over the fire, then mixed with water and prepared with other ingredients, forming a pudding similar to that of rice or millet. This culinary mixture is called *benny* or *bonny* in Carolina.

* In the north of Persia, the oil chiefly used is extracted from walnuts and hazel-nuts.

In Japan, Thunberg informs us, "the *sesamum orientale* was cultivated in many places; and from the seed, although very small, a fine oil was expressed, which was in general use here, as well as in other places in India, for dressing of victuals and other purposes *."

The purposes he alludes to were medicine and varnish. In China, Cochin-China, and Siam, as well as in Japan, they take it as a resolvent and emollient, and mix it copiously with their beautiful and enduring varnishes. Herodotus mentions sesamum as growing in Assyria, and fears his veracity would be doubted if he stated the height to which it attains there:—he says, "The Assyrians had no oil but what they extracted from the sesamum." It is still grown in that country, as well as in Upper Egypt, Dongola, Sennaar, Abyssinia, and indeed through Africa generally. The African negros, who are fond of its seeds as food, first introduced it into America. The seeds have a warm taste not unlike weak mustard. When the oil is first drawn, this taste is disagreeably felt, but it soon wears off, leaving a pleasant oil admirably adapted for salads, and for all culinary purposes.

ARACHIS OIL.

The *Arachis hypogea*, or ground-nut of the West Indies, is now cultivated in the departments of Landes and L'Herault, in France, for the oil which its seeds contain. This plant was originally brought to Europe by the Spaniards from Mexico, and introduced into France from Spain. The seed yields most abundantly a very valuable oil, which French writers describe as being equal to that of olive for every domestic purpose, and much superior for that of illu-

* Travels, vol. iii.

mination. Trial was made of the relative degrees of their consumption in a lamp having a wick of one-eighth of an inch in diameter, when it was found that an ounce of the arachis oil burnt nine hours and

Arachis Nut—*Arachis hypogœa.*

twenty-five minutes, while the olive oil, under similar circumstances, lasted only eight hours. This oil, according to the same authorities, is preferable to any other in the manufacture of soap*.

A bushel of arachis nuts produces one gallon of oil, when expressed cold; if heat be applied, a still greater quantity is obtained, but the quality is inferior.

The arachis is indigenous to South America, and is very universally cultivated in the West Indies for its seeds, which formerly were used as an article of food among the negroes. It is an annual plant, with long stalks trailing on the ground; these are furnished with winged leaves, composed of four hairy lobes. The flowers, which grow singly on long stalks, are yellow, and of the pea kind. These are followed by oval pods, containing two or three oblong seeds. The manner in which the seeds come to perfection is very singular. As the flowers fall off, the young pods are forced into the ground by a natural motion of the stalks, and are so entirely buried as not to be discovered without digging for them; hence they have obtained the name of ground-nuts.

OIL OF POPPIES.

An oil is extracted from the seeds of the large white poppy, or *Papaver somniferum*, which is extensively cultivated for this purpose in France, the Netherlands, and various parts of Germany.

This oil is transparent, colourless, and, if well prepared, nearly tasteless, having only a very faint flavour of nut kernels: a considerable quantity is sold, either mixed or pure, as olive oil.

So early as the seventeenth century it was produced very largely for this purpose; and its sale gave rise to

* Nicholson's Journal, vol. vi.

great and lasting contentions, which took so serious an aspect as to call for the interference of the government of France to appease the opposing parties. It was supposed that as the poppy-head contains narcotic juices, the same soporific properties must necessarily reside in the seeds, and therefore that the use of its oil would be attended with dangerous consequences, and, like that of opium, would "finally obtund all the faculties of the soul." On the other hand, the advocates for its continued consumption asserted that long experience had proved this apprehension to be totally groundless.

The contending parties remained in this state, without any prospect of coming to an accommodation, when the severe winter of 1709 overtook the combatants still engaged in their angry warfare. The intense frost of that period damaged the olive, the walnut, and the other oil-producing trees, so much as to occasion a scarcity of oil. The poppy oil was then again brought forward in large quantities, and mixed in the proportions of one-quarter, one-third, or even one-half, with olive oil. It was sold without any active opposition; but when the vender, becoming bolder from this impunity, ventured to sell it in its pure state, violent clamour was again raised, and in 1717 the Lieutenant-General of the Police of Paris was obliged to take measures for quelling it. Reference was in consequence made to forty of the most celebrated medical practitioners, who reported, after various experiments, that nothing narcotic or prejudicial was contained in the oil. This decision was, however, considered unsatisfactory, and popular prejudice so far prevailed as to determine the legislative powers to pass a decree, in 1718, whereby the sale of poppy oil, whether mixed or unmixed, was totally prohibited, under a fine of three thousand livres for every offence.

Notwithstanding this penalty the clandestine sale of the article was encouraged, and gradually increased until 1735, when a still severer decree was issued against its employment; and its sale was interdicted most rigorously, unless the oil offered for sale had a previous admixture of a certain quantity of extract of turpentine to each cask, thus restricting its use to the painter and varnisher. This second enactment only served to annihilate all public sale; but the secret demand continued to increase, till at length, in 1773, an agricultural society undertook to re-examine the subject; and chemical investigations confirmed the opinion which had been pronounced more than fifty years before. The people, in the course of half a century, had become more enlightened, and the free sale of this oil was again permitted, without raising any formidable opposition. Since that period the prejudice has gradually been removed, and poppy oil is now in general estimation on the Continent. It has been ascertained that not only the oil which is expressed, but that no part of the seed, has any of the deleterious properties of opium; and in Brabant the oil-cake from poppy seeds is constantly used as food for cattle with obvious benefit.

This is an object of careful cultivation in some parts of the Continent, and its advantages have been held out to the attention of the British agriculturist, who, it is thought, might profitably engage in its production.

The time of sowing the seed is in March to the middle of April. About two pounds per acre is usually the quantity sown broad-cast. It would be superfluous to give any description of this well-known plant, which is so rapid in its growth and in coming to maturity. In August the full and ripe seed-vessels invite the hand of the reaper. The poppy-heads are cut as they stand in the field, the gatherers receiving them in their aprons, from which they are removed to bushel baskets, and conveyed to a large cloth spread out for their reception. They are then put in corn-bags, and are either trodden by men and children in sabots (wooden shoes) or well bruised by a mallet or a flail. By these means the heads are confined and cannot fly from the stroke imposed, while in being thus bruised their seed is not scattered abroad and wasted. The seeds being entirely separated are taken to the mill and expressed as soon as possible, since the fresher they are the more oil they yield. In extracting the oil it is of consequence that the mill, press, and bags be perfectly clean. From two pounds of seeds seven ounces of oil may be expressed. It is of the same specific gravity as linseed oil. This oil is more especially valuable to the varnisher, since it has no colour to injure the delicacy of his preparations, and has likewise the property of drying in a greater degree than most other oils. Those extracted from walnuts and from linseed are likewise what are called drying oils. In the northern parts of France this oil is very much used by soap-boilers.

NUT OIL.

The kernels of walnuts and hazel-nuts yield an oil very abundantly, which is extracted by means of a screw-press similar to that used for olives. This oil, as well as the oil of poppies, is much esteemed by varnishers from its being clear and colourless. It is likewise used for the mixing of flake white and other pigments, where the clearness of the colour is of great consequence, and would be injured by the brown hue of linseed oil. In the warm climate of the south of Europe the hazel and the walnut reach their full perfection, and will yield by proper management as much as half their weight of oil. The flavour of this, when fresh, is very agreeable, while it remains fluid at a much lower temperature than olive oil. Its specific gravity is somewhat greater, being from ·923 to ·947.

It is very generally used for culinary purposes in lieu of olive oil, at Geneva, in the Pays de Vaud, and other parts of Switzerland.

BEECH OIL.

Beech oil is another vegetable substance which is occasionally, though not very commonly, used in the composition of varnishes. This is extracted from the mast or fruit of the beech-tree, the kernel of which, being divested of its shell, is pulverized and then subjected to pressure. This nut does not contain oil very abundantly. In England the beech mast does not arrive at sufficient maturity to yield oil in a quantity sufficient to repay the labour necessary for extracting it. But in some parts of France and Germany the process is carried on to good effect, the kernels usually producing fifteen per cent. of their weight of a clear light oil, and twelve per cent. of a second-rate quality. Its specific gravity is the same as nut oil.

PALM OIL.

Palm oil is obtained from the fruit of some species of palm growing in several places in Africa, especially in Senegal. The two trees which principally produce this oil are the *Cocos butyracea* and the *Elæis*

Elæis guineensis, and *Cocos butyracea*.

guineensis. They both bear fruit abounding in oil. The first species, from which the oil is most commonly extracted, grows to the height of fifteen or sixteen feet, and flourishes most in shady places. The fruit or nut resembles a date stone. When ripe it is heated by fermentation, and then coarsely pulverized in hollow cylinders, by which its oily parts are separated; it is subsequently macerated in hot water, when the oil gradually collects on the surface, and cooling, concretes into a thick, unctuous cake, of a light lemon colour, with little or no taste, but having a rich perfume. At the ordinary temperature of the air this is not a fluid oil: at 69° Fahrenheit it begins to be slightly opake, at 62° it is of the consistence of honey, at 45° it is proportionably thicker, but still retains a degree of softness. It is heavier than most other expressed oils, its specific gravity being ·968. The oleaginous proportion of these palm-nuts is very considerable, one gallon of them usually producing a quart of oil. This is used as butter by the natives of the Gold Coast, forming part of all their culinary preparations, and when eaten fresh is a delicate and wholesome article of diet, differing as much from the palm oil imported into England, as fresh butter from that which is rancid. It is used in this country in the manufacture of a particular kind of soap, as well as in the composition of some pomades, and other perfumery.

The quantity retained for home consumption alone in the year 1830 was about 160,000 cwt. The import duty is 2*s*. 6*d*. per cwt., its price being about £1. 8*s*. for that quantity.

COCOA-NUT OIL.

The kernels of cocoa-nuts contain a considerable proportion of oil, which may be extracted and applied with great advantage to those uses in which other unctuous substance is employed. This oil congeals

Cocoa-nut—*Cocos nucifera.*

at the ordinary temperature of the atmosphere in England, and appears under the form of a white concrete substance. It was first introduced from Ceylon into this country at the beginning of the present century; and many exertions have been made by those interested in its introduction, to promote its extensive consumption. Cocoa-nuts are produced in so great profusion in Ceylon that the large quantities of oil which could be obtained from them, at a reasonable rate, might become a source of great profit to that island. When it was first imported here many trials were made of its quality. It was found that the soap-boiler could manufacture with this oil soap almost equal to that made with olive oil, and at a much lower price. For the same branch of manufacture it proved to be far superior to tallow, which it exceeded in cost only about ten per cent.

Mr. Marshall, whose notes on the cocoa-nut tree we have before referred to, says he has been informed that the glass-blowers of this country prefer this oil to all others in their ingenious operations.

Next to the purposes of bodily unction the greatest use the Cingalese make of this oil is that of illuminating their apartments. Their lamp also is furnished by the same bountiful tree, for they burn the oil in an open section of the cocoa-nut shell. The European settlers as well as the natives universally use it for lamp oil, and praise it for the pure beautiful light it emits; though even in Ceylon, at a certain reduction of temperature, it occasionally congeals and becomes inconvenient. An English officer on that station has informed us, that in the absence of a thermometer, and from long practice, he often judged of the state of the atmosphere from the condition in which he found his extinguished cocoa-nut lamp on rising in the morning.

It has been attempted to adapt this oil to the purpose of illumination in England, and some particular lamps were constructed in which the oil, as imported, could be burnt; but its appearance under a different form to the limpid fluid which is ordinarily consumed, and the management required in consequence for its equable combustion, caused its use in this way to be very circumscribed.

Recently, however, a discovery has been made of a method for separating the concrete matter from the liquid part of cocoa-nut oil—producing a pale, limpid, tasteless fluid, possessing the property of combustibility in an equal degree with the best sperm oil, while the solid unctuous substance is applicable to the manufacture of candles, and to other uses in which fatty matter is generally employed.

In the year 1815, and during a few succeeding years, considerable interest was taken in this country by mercantile houses connected with the island of Ceylon, to discover the most efficient manner of obtaining oil from the cocoa-nut; and accordingly many methods were pointed out, and machinery with directions for its use was shipped from England to that island.

The Cingalese, or natives, extracted the oil from the kernel of the cocoa-nut either by the process of decoction or by compression. The process of decoction rendered by far the best quality of oil, but it was slow and tedious.

The separation of the fluid and concrete parts of the oil is now produced in this country by pressure. The use of this process, and of the subsequent preparation of the solid part, is secured to the inventor by patent. The oil is obtained by putting the congealed cocoa-nut oil of commerce into strong linen bags; these are covered with thick sackcloth, and laid flat upon the horizontal bed of an hydrostatic press, leaving a small vacant space between the bags. Pressure is then given to them and continued until the oil ceases to flow through into a cistern fixed beneath. After the oil has remained a sufficient time at rest for the subsidence of its impurities, it is drawn off quite clear.

The residue in the bags is found to contain many impurities, such as fibre, mucilage, and other extraneous matter. It is therefore necessary to disengage it from these, for which purpose the whole is put into a tinned copper boiler, which is covered and immersed in a water-bath, to prevent the liability of an excess of heat. Two per cent. in weight of sulphuric acid of 1·8 spec. gra. diluted with six parts of water, is then added. The action of the acid, aided by heat, coagulates and precipitates the impurities, which may then be removed either by straining or filtering, while warm and in the fluid state; or by their being allowed to subside and become cold, when they are separated.

The substance thus obtained is of so firm a consistence as to form a very good material for candles, into which useful articles it is manufactured and sold at rather a higher price than those made of tallow.

The import duty on cocoa-nut oil is the same as that on palm oil. It can be bought at Ceylon at the rate of one shilling per gallon; and at this price a large quantity is annually sent to the different ports in India; but before the oil that we import reaches England, what with freight, waste, duties, &c. the price has generally been increased to four shillings the gallon. Should this manufactory meet encouragement in Ceylon, the islanders could augment its supplies to a great extent, by keeping the nuts for the oil-presses instead of exporting them, as they have been in the habit of doing, at the low rate of 3*s.* 6*d.* the hundred, or somewhat less than a halfpenny a piece. In 1809 the number thus exported, chiefly to India, amounted to 2,977,275. The cocoa-nuts sold in our shops are frequently brought from the West Indies by the captains of ships, who use them instead of wedges of timber, to fill up the vacuities between the casks and bales and other packages that compose their cargo.

BEN OIL.

Ben oil is obtained from the seeds of a tree growing in the Indies, Ceylon, and Egypt. Linnæus calls it *Guilandina moringa*, but Lamarck has changed it to *Moringa zeylanica* or *M. oleifera.* The fruit is a three-valved pod, full of three-cornered seeds, the size of large peas, and covered with a thin, soft, pale-grey shell. These seeds contain a white oleaginous kernel, of a very sweet taste.

After being decorticated, the oil of ben is extracted from them by expression. About a hundred pounds of the seed yield twenty-three pounds of oil. This oil is sweet, scentless, and scarcely under any circumstances does it become rancid. At a low temperature it separates into two parts: the one solid, the other liquid. The watch-makers use the liquid part, in preference to any other oil, for lubricating the wheels and other works in watches and clocks.

THE OIL PLANT, OR CAMELLIA OLEIFERA.

This beautiful shrub is a native of China, where it is cultivated in large plantations and produces much of the oil consumed by the Chinese. Its product being oil, and its appearance closely resembling the tea-plant, the Chinese give it the expressive and appropriate name of "the oil-bearing tea-plant." It frequently attains the height of a moderate-sized cherry-tree, and bears a profusion of large, single, white blossoms. "This circumstance," says one of our best travellers in China, "gave an interesting and novel character to the places which it covered. They often looked in the distance as if lightly clothed with snow, but on a nearer view exhibited one immense garden *."

A red, sandy soil, on which few other plants will grow, seems to be the best adapted to the *Camellia oleifera.* Its pure esculent oil is procured from the seeds of the plant by a very easy process. In the first place the seeds which alone contain the oil are reduced to a coarse powder. This is done by various methods: they are placed in a hollowed trunk of a tree shaped like a canoe, and there bruised by a wheel or mill-stone rolling over them; they are pounded in a large mortar by a heavy pestle at the end of a lever, set in motion by a water-wheel; or they are crushed by a horizontal wheel having small perpendicular wheels shod with iron fixed to its circumference, and acting in a groove also lined with iron. When sufficiently ground in either of these ways they are put into bags, transferred to a vessel containing a small quantity of water and slowly boiled, or rather stewed. From the vessel they are carried to a press of very rude construction, having a small opening through which the oil runs into vessels placed to receive it. This shrub, which is as beautiful as it is useful, was brought to England by some gentlemen of Lord Macartney's embassy. It was here considered as the *Camellia sesanqua* of authors, from which, however, Mr. Clarke Abel apprehends it is very distinct.

OIL OF THE ALEURITES CORDATA, OR ALRASIN.

From the seeds of this plant, the Japanese, who are inferior to few people in making the most of the gifts of nature, extract an oil for the purpose of burning in lamps. Thunberg thus describes the simple pro-

* Mr. Clarke Abel's Journey in China, p. 174; his volume contains a drawing of the plant.

cess:—" A press lies down on the ground; it consists of two blocks, between which the seed is put and crushed, and the oil expressed. One of the blocks composing the press is fixed and immoveable; and against this the other is forced by means of graduated wooden wedges, which, increasing in size at the foremost end, are driven in with a very long wooden club. At the side is an opening to let out the oil, which is received in a vessel placed underneath."

We might enumerate several other vegetable substances, affording oils of different qualities, but we have described the more important; the rest, for the most part, are scarcely known beyond the countries of their production, and have no place in commerce. Their existence is only interesting inasmuch as it shows the infinite variety of natural productions, from which, in spite of their dissimilarity, the ingenuity of man can produce the same, or nearly the same, beneficial results.

Chapter XIII.

ESSENTIAL OILS.

HUILE ANTIQUE—LAVENDER.

EMPYREUMATIC OILS.

BIRCH—TAR—PITCH.

While the grosser oils are extracted from the fruit and seed, essential oils are mostly obtained from the leaves and flowers or from the most odorant part of plants. In umbelliferous plants the oil is, however, found in the seeds. In the *geum*, or *avens*, the root affords it, and in labiated plants it is contained in the branches and leaves. The essential oils obtained from flowers are in general of a very delicate nature; and the odorous matter of some flowers is so subtile that it can only be obtained by impregnating another substance with it; in any attempts to secure it as an essence it diffuses itself, and will not be confined. Of this description of flowers are tube-roses, jasmine, honey-suckle, sweet-briar, and others of the same delicate nature, having strong scents, but which yield little or no oil by distillation.

Ben oil, as being perfectly inodorous and not liable to rancidity, is an excellent agent for retaining and imparting the perfume of the sweet-smelling flowers. L'huile antique, so designated as being produced by the method in which the ancients prepared their scented oil, is ben oil impregnated with the odorous matter of flowers. Cotton soaked in the oil is placed in alternate layers with the flowers whose scent is to be obtained; a close tin or pewter vessel is used for this purpose, which when thus filled has its cover screwed down. This is digested during twenty-four hours in a water-bath; during that time the oil will have imbibed the rich perfume of the flowers, and it is then disengaged from the cotton by pressure. Where ben oil is scarce, fine nut-oil is made to supply its place, but l'huile antique so prepared is not considered genuine.

Other essential oils may be obtained by distillation, water being added to the ingredients in sufficient quantity to prevent their burning.

In this manner essential oils are drawn from flowers, leaves, barks, roots, woods, gums, and balsams, with a slight alteration of circumstances, dependent on the nature of the substance under process. Lavender flowers and roses yield their oil by these means. The former is much more rich in oil than the latter. On being distilled with water, the oil comes over with the aqueous vapour and condenses with it in the receiver; then rises to the surface in a thin pellicle, which must be carefully separated from the water. This oil forms an ingredient in some varnishes, and is likewise used to dilute metallic oxides for painting on porcelain.

The use of the essential oils to the perfumer is too well known to require explanation. Some of these oils are employed in pharmacy and in chemistry—others are used in confectionary, but any particular notice of them would be here misplaced.

Empyreumatic oils obtained by dry distillation partake of the nature of volatile oils.

Birch oil is classed among these: it is prepared by the Tartars from the white bark of the birch-tree. For this purpose the bark is taken either from the trees growing in a wild state, or from those which lie rotting in the woods. The oil made from the bark of the trees in a putrid state is the most esteemed, because the inner part is then destroyed by putrefaction, while the external white bark remains uncorrupted for ages. Proofs of this indestructibility were found in some old burial places, and in the vaults of the very ancient castle at Moscow which had been covered with birch bark.

Birch oil is obtained by distillation in the following manner. Pits made in the form of inverted cones are prepared in a clay soil; these have a hole, like that of a funnel, at bottom, and a large wooden

Birch—*Betula alba.*

vessel for receiving the oil is sunk in the earth immediately beneath this aperture. This vessel or receiver has a wooden cover, with an opening in the middle and channels cut in it. The bark is gathered into a heap and pressed into these pits, and after being covered with turf is set on fire. The oil distilling through the hole at bottom drops into the vessel prepared for the purpose. After being thus obtained it is put into casks made of the hollowed trunk of a tree. The pure limpid oil which floats on the top is used in the preparation of leather, for which purpose it is in great request on account of its antiseptic qualities. To this oil Russia leather owes its peculiar smell*.

In woody regions, where the peasantry trade in birch oil, immense pits are made; the cover of the vessel placed at bottom is made distinct and independent of the vessel itself, in such sort that the vessel can be removed at pleasure without disturbing the cover. To this space beneath a subterraneous passage is made, into which the people can creep and place the vessels, and, when filled with oil, replace them with other receivers.

Tar, which is so extensively used for naval purposes, may likewise be classed with the impure empyreumatic oils.

It is distilled from the wood of the fir-tree, and produced in large quantities in the north of Europe and in North America. We receive it from Russia, Sweden, and America; that coming from Sweden being considered the best, and commanding the highest price.

Great part of that which is manufactured in America is made from old fir-trees, which have fallen down in the woods, and have their sap no longer

* Pallas's Travels—Letters from Scandinavia.

fluid. This is what is called light-wood, not with reference to its weight, as it is very heavy, but from its combustible nature, readily igniting and burning with so bright a flame as to serve the office of a candle. Only one particular species of pine (*pinus palustris*) becomes light-wood. Persons concerned in making tar immediately know it from the appearance of the concrete juice in the grain of the wood. When fir-trees are to be cut down for this purpose, those are most esteemed whose branches are distorted and full of knots; the sap which is thereby retarded in its circulation depositing a better kind, as well as a greater quantity of the resinous matter from which tar is distilled. Old trunks of trees, which have remained in the ground many years after their branches have been cut off, are likewise rich in that material. But the surest and best method of obtaining the greatest quantity of tar-wood, is to strip off the bark and branches in the spring from such firs as are destined for this purpose, and to leave them in that state until the year following. They should then be felled, and cut into small pieces as if for fagots. Being well dried, those billets which appear most oily and resinous are separated from the rest, and alone reserved for use; two-thirds or more of the tree will be thus retained, provided it was in a state of proper maturity previously to the stripping of the bark, and that after this operation it had been left sufficiently long in the ground. This is called tar-wood. The wood of the trees from which turpentine has ceased to flow is likewise made to yield tar. The faces over which the juice has flowed and partially concreted are split off, and from these is made what is called green tar, because distilled from green wood instead of dry.

When a sufficient quantity of wood is collected, a circle is marked out on the ground for the kiln.

The earth is then dug out a spade deep, sloping from the centre to the circumference, and is thrown up forming a bank round the circle. A straight pine, of sufficient length to reach from the centre some way beyond the bank, is split longitudinally and hollowed out. The parts are then put together again and one end is placed in the centre, being so supported on the ground that this end is higher than that which comes without the bank, where a hole is dug into the ground, into which the tar flows from the channel, and whence it is from time to time taken out and barrelled for market without any farther preparation.

After the kiln is marked out, the wood, being split up in small billets, is packed as close as possible with the inward ends sloping towards the middle, which is filled up with smaller pieces consisting of the knots of the trees, these yielding more tar than any other part of the wood. The kiln is built in such a manner, that at twelve or fourteen feet high it will overhang two or three feet, and appear quite compact and solid. After the whole of the wood is piled a number of small logs are placed round it, then a layer of turf, and so on alternately throughout the whole height; the top is then covered over with two or three layers of turf. After the whole is thus arranged, a turf is taken out in ten or twelve different places round the top, at each of which parts fire is applied, and the pile then burns downwards, till the whole of the tar is distilled from it. If combustion proceeds too rapidly, some of the holes must be stopped up,—if too slowly, others should be opened; practice enables a tar-burner to judge with tolerable accuracy as to the best measures to be pursued in this respect. Six or eight days are generally required to complete the burning of a tar-kiln of the dimensions here described.

Another method pursued is to place the tar-wood in a receptacle enclosed by an arch and walls, a small opening only being left near the bottom for the egress of the tar: a fire is then made round the arch in such a manner that the heat may communicate to the inside, and cause the tar to be distilled from the wood in the same way as if retorts had been used. This plan is perhaps more expensive than the first, and therefore less generally practised; the operation is, however, performed in much less time, and the quantity of tar produced from a given quantity of wood is greater than that obtained by the other method, while a very superior kind of charcoal is at the same time afforded from the wood thus carbonized. In the common way a cube of six feet of tar-wood yields from two to three, and sometimes four tuns of tar: burnt by this last described method, the same bulk of wood produces, in half the time, five or six tuns. An equal quantity of common fir-wood yields only about one tun, or one tun and a half.

In Norway, and other countries bordering on the Baltic sea, where the vast extent of their pine forests induces the natives to be less economical in the use of the wood, stacks of it are built on the slope of a hill, and covered with moss and turf: fires are then kindled in different parts; and the tar which oozes out flows through channels or spouts into barrels placed for the purpose at the bottom of the hill.

A more economical process for making tar is pursued in France and Switzerland, by which the wood is charred more equably, and the product is of a much more uniform, and probably also of a better quality. In the Valais the pines are felled the preceding year, that the wood may be sufficiently dry for use; and the outer bark and twigs being stripped off, the rest of the tree is cut up into billets of tolerably equal size. An oven is built of stone or brick in the form of an egg standing on its small end. On one side, about five inches from the lowest point, an aperture is made into which a tube is inserted. A large iron grating is laid at the bottom just above the opening for the tube, and on this the billets of wood are piled. This grating prevents the passage of any pieces of wood or other impurities, which would otherwise run out together and mix with the tar. The oven being filled with wood, a layer of dry chips is placed at the top, and the whole is enclosed, leaving only an aperture at the summit to act as a chimney: the chips are then kindled, and when the fire has spread downwards, and the whole is sufficiently ignited, the chimney is entirely closed with a large stone, and wet earth is heaped on this, more being thrown on whenever the smoke bursts out too strongly.

The general average product thus obtained is about ten or twelve per cent. of the weight of the whole charge.

The common method, as pursued in the north of Europe, though the least expensive of all, is attended, however, with great inconveniences. The management of the fire is extremely difficult and precarious, so that scarcely any workmen, who have not been long used to conducting the process, can be safely trusted with its superintendence, and the success even of these does not always answer their expectation. A much smaller quantity of tar is always extracted in this manner than that produced from an equal quantity of wood distilled in furnaces. The process by furnace is therefore always preferred by those tar-burners who have the means of pursuing it*.

* Descriptiou de la Maniere dont on fait le Goudron en Suede.

The quantity of tar retained for home consumption in 1830 was 5,205 lasts. It is admitted from foreign countries on a duty of fifteen shillings per last, an abatement of three shillings per last being made on that coming from British possessions. The price of tar varies from fifteen shillings to seventeen shillings per barrel.

Pitch, which is condensed tar, is obtained either by evaporation or burning. The process of burning is performed very simply. A hole is dug in the ground and lined with brick: it is then filled with tar, which is ignited and allowed to burn till the pitch is judged to be of sufficient consistency, which is ascertained by dipping a stick in it, and allowing the pitch adhering to it to cool. When sufficiently burnt the hole containing the pitch is closely covered, and the atmospheric air being thus excluded, combustion ceases. Five barrels of green tar are thus concentrated to two barrels of pitch, and two barrels of other tar make one of pitch*.

When pitch is evaporated in kettles it requires to be almost constantly stirred. The country people in Sweden, when they have no kettle for boiling their tar, in order to reduce it to pitch, put it into great wooden pails: into these pails they throw very large stones previously heated; the stones keep the tar almost boiling, and this process is continued until the fluid is of sufficient thickness.

A portion of the tar imported into this country is converted into pitch: the establishments for this purpose near London are conducted on a much more economical plan than that pursued abroad. Here no part of the tar which has any useful property is allowed to be wasted. It is evaporated in a still, and consequently the valuable volatile products are

* Trans. of S. for the En. of Ars., &c. 28th vol.

condensed and preserved. The oil, and acid and water, which distil over, do not mix, and may be easily separated by further distillation. The oil is an inferior oil of turpentine, which is useful in coarse painting. The acid is strong and empyreumatic, very closely resembling the pyroligneous acid obtained from the distillation of wood. By this method of converting tar into pitch, 600 gallons, or twenty barrels of tar, will produce ten barrels, or 2,200 weight of pitch, 176 gallons of oil, and about forty gallons of acid.

Besides the British-made pitch, 5,482 cwt. of foreign pitch were retained in 1830 for home consumption. It is admitted on a duty of 10*d.* per cwt. which is reduced to 9*d.* when coming from British possessions. Swedish pitch is the best: its price varies from 6*s.* 6*d.* to 10*s.* per cwt.

CHAPTER XIV.

OTHER INFLAMMABLE VEGETABLE PRODUCTS.

VIRGINIA MYRTLE, OR MYRICA CERIFERA—BRAZILIAN PALM WAX—ANDES PALM WAX—CROTON TALLOW—PINEY TALLOW.

THE experiments of the great chemist, Proust, led him to believe that the bloom which silvers the surface of plums and other stone fruits is wax, and that the property of resisting moisture, which resides in the leaves of the cabbage and some other plants, is caused by their surfaces being overspread with a similar substance.

There is no doubt that wax is to be found native in the vegetable world, without the intervention of its insect collector and manufacturer the bee.

The *tomex sebifera*, the poplar, the alder, and several labiated plants, afford a concrete inflammable matter by decoction, which more or less resembles tallow or wax.

Two species of the Virginia myrtle, or *Myrica cerifera*, yield a product in every way similar to wax, and in so great abundance as to have obtained for them the name of candleberry-trees.

The *myrica cerifera augustifolia* is a native of Louisiana. It is delicate, and can with difficulty be reared in an English green-house. In its general native clime it grows to the height of ten or twelve feet, with a crooked stem shooting forth into many irregular branches. The leaves grow without any

Virginia Myrtle—*Myrica cerifera.*

order, sometimes in pairs, sometimes alternately, and generally at unequal distances. Their upper surface is smooth and of a glossy bright green; the under side is of a more dusky hue. It has been erroneously supposed to be an evergreen, but the full-grown tree always sheds its leaves in autumn. The young plant, raised from seed, retains its leaves nearly throughout the winter, every year losing them somewhat earlier, until it arrives at its full growth. The flowers are small and brownish. The whole shrub has somewhat the appearance of the common myrtle, and its leaves on being rubbed emit a similar fragrance. The seed is a kind of berry about the size of a peppercorn; when ripe and fresh, it is white interspersed with minute rough black spots. This berry contains a small stone, nearly round, enveloped in a substance apparently similar to wax, differing only in being somewhat drier and more friable*. Toscan, in 'L'Ami de la Nature,' gives a minute description of the manner in which this vegetable wax is obtained by the Louisianians.

The berries come to maturity at the latter end of autumn, and are then in a fit state for the extraction of their wax. Those persons who make it their business to collect and prepare this substance, then proceed to a place on the sea-coast, or to some island, where they know, from experience, the tree is to be found in abundance. In these expeditions a man is generally accompanied by all his family, whom even to the youngest children he can make useful. As the occupation usually requires three or four weeks for its completion, he is obliged to go supplied with all that is necessary for the daily wants of himself and his companions during that period. He likewise takes care to furnish himself with a number of vessels, of suitable capacity and material, for the purpose of boiling the berries. With all these impediments to celerity, their progress is necessarily slow and prolonged. When, at length, the little troop halts at an eligible situation for gathering their harvest, the first care of the father is to provide a shelter for his family, for which purpose he diligently sets about constructing a hut with palm-leaves. While he is engaged in this preliminary labour, his wife and children are not idle: they are actively employed in gathering the berries, of which all the trees around are soon deprived. When the

* Annales de Chimie.

berries are collected, a certain quantity is thrown into the boilers, to which water is added in such a proportion as to rise about six inches above them. The whole is then boiled, and during this operation the berries are constantly stirred and pressed against the side of the vessel, in order to facilitate the separation of the wax: this soon rises to the surface in the form of oil, which is carefully skimmed off and strained through a piece of coarse cloth. When no more wax appears, the exhausted berries are withdrawn from the water, fresh ones are added, and they, in their turn, despoiled of their produce, give place to others, and so on in succession. During this process the ebullition is never checked, as boiling water is constantly supplied in proportion to the quantity lost by evaporation. The wax thus obtained is placed on a piece of linen cloth to be drained, and entirely separated from that portion of water which had been unavoidably removed with it. When dry it soon assumes the consistence of wax, and appears of a dirty green colour. It is then clarified and moulded into cakes, which are nearly transparent.

From each of the best shrubs seven pounds of these berries may be collected, which commonly produce a fourth of their weight of wax.

This substance, on being analyzed by M. Cadet, was found to be more consistent than the wax made by bees; it is drier and so friable that it may be reduced to a powder, and it is manifestly more oxygenated. It has the tenacity without the unctuosity of bees'-wax, and partakes in some degree of the brittleness of the resins. Water, whether cold or at a boiling heat, has no effect upon it; it likewise remains undissolved in alcohol at the ordinary temperature of the atmosphere, but when boiled in this a small proportion is taken up. Its specific gravity has been found, by different chemists, to be 1·015, making it somewhat heavier than water. The manner of obtaining it, by removing it as it rises to the surface of the water, would seem not to be in accordance with their relative weights. But this is readily accounted for by the fact of its expansion by heat, which causes it to become specifically lighter when in a state of fusion. It is heavier than bees'-wax, the specific gravity of which is ·96; it likewise fuses at a lower temperature; the fusing point of the myrtle-wax being 109°, and that of bees'-wax 142°.

This wax when made into candles burns with a peculiarly clear white flame, and gives a beautiful light, producing little smoke. When new the balsamic fragrance it emits is considered by the Louisianians as a powerful restorative to the sick.

Besides the wax, which is so abundantly obtained from this tree, it has other valuable qualities to recommend it to notice, and, as these have been recognized, it is a matter of surprise that it is not more generally cultivated. It affords gallic acid in considerable quantities, which might be applied with advantage to the arts; and it is said that a beautiful lake pigment may be obtained from the colouring matter of its berries.

Kalm, in his Travels in North America, when noticing this production, says, that in the country where the wax-tree grows they make excellent soap from it, which washes linen of a surpassing whiteness.

The *myrica cerifera latifolia* is another species of this plant which flourishes in Pennsylvania, Connecticut, and Virginia; it bears leaves shorter and broader, and seeds larger than that of Louisiana. It is of equal fragrance, and yields a similar substance. The former species rises to a greater height, but this is much hardier, and it is become perfectly naturalized in France. M. Deshayes describes it as flourishing with native vigour in his botanical garden at Rambouillet, where there are many of these trees which have attained to their full growth; and every year the numerous suckers proceeding from the roots of the large shrubs being planted out, produce a constantly increasing number of these valuable plants.

This species of *myrica* requires very little care in its cultivation; a light sandy soil somewhat moist is most congenial to it, and it may be successfully cultivated in regions much farther north than that to which it is indigenous. M. Cadet received from M. Thiebault the following interesting notice on this subject:—M. Sulzer, the author of a general dictionary of the fine arts, had obtained from Frederic the Great of Prussia an extensive piece of waste land on the banks of the Spree, at the distance of half a league from Berlin, in a place called the Moabites, and where there was a most barren soil, barely covered with thin poor turf on a bed of fine light sand. This unpromising spot was converted by M. Sulzer into a garden worthy of a philosopher. Among other remarkable things he formed a plantation of foreign trees, consisting of five long avenues running east and west. In these there were not two trees of the same kind near to each other. The avenues most exposed to the north were planted with none but the highest trees capable of withstanding the severity of the climate. Hence, proceeding from the north to the south, the first walk exhibited trees of about seventy feet in height, the second trees of from thirty to twenty-five, and so on in the form of an amphitheatre; so that all the trees had the benefit of the sun at least in part, and the weaker were sheltered by the stronger. "In the most southern avenue," says M. Thiebault, "I observed a sort of shrub which rose only to the height of two or three feet, and which M. Sulzer called the wax-tree. Every person visited this avenue in preference to the rest, on account of the delicious perfume emitted by the leaves." After describing the process for extracting the wax, he adds, "One taper of this wax perfumed the three chambers which composed M. Sulzer's private apartments, not only during the time it was lighted, but even for the rest of the evening." On this M. Cadet sensibly remarks, that "if it has been found possible to naturalize the *myrica cerifera* in the north, why should we neglect a vegetable production so valuable which would certainly thrive in our southern departments, and which requires less care than the tendance on bee-hives. The successful trials which have been made must excite the zeal of our agriculturists."

The heirs of the Prussian academician have sold the skilfully raised garden of their ancestor, but the wax-tree still remained in 1804: it had been planted in 1770.

The French government has encouraged the growth of this plant with a view to render its produce a lucrative article of trade. Plantations have been formed of it, and the nurseries at Orleans and Rambouillet contain more than four hundred shrubs.

This tree can be propagated in England from American seeds, by sowing them in boxes and protecting the young plants in a sheltered situation from the vicissitudes of our winter for two years, after which time they may with safety be transplanted into the nursery*.

Another wax-tree or shrub, called by Thunberg *Myrica cordifolia* flourishes in South Africa, and is subjected to precisely the same process as the American plant. The berries, which are covered with

* Philo. Mag. vol. xiv.; Nichol. Jour. vol. iv.

a bees'-wax-looking substance, are put whole into a pot of boiling water, to the surface of which, in due time, the wax ascends and is skimmed off. The Dutch settlers use the material for candles; but the Hottentots, who are very fond of it, eat it like a cake, with or without meat. It is somewhat softer than bees'-wax, and of a dirtyish grey colour.

Myrtle wax is not now an article of commerce to England, but it has been deemed of sufficient consequence to be included in the list of imports on which a duty is levied. The tax laid upon its importation is one shilling per lb.

CARNAUBA, OR CORYPHA CERIFERA.

This is a species of palm from which wax is obtained. It grows in the Brazils, rising to the height of thirty feet. The low lands upon the banks of some of the rivers are covered with these trees. The leaves are two feet in length, and while young are folded in the manner of a fan; when they afterwards expand they are nearly two feet in breadth. If they are cut from the tree as soon as they have reached their full growth, and are placed to dry in the shade, a considerable quantity of small light-coloured scales will be loosened from their surface. These fuse on the application of heat at 206° Fahrenheit, and thence take the appearance of wax. It is of a pale straw colour, and when cold is hard and brittle. Alcohol, unless heated, has no power of dissolving this wax; fixed oils, at the temperature of boiling water, cause its solution. The specific gravity of this vegetable product is ·980. It possesses most of the properties of bees'-wax, and, made into candles, burns well with a steady light. The addition of from one-eighth to one-tenth part of tallow is sufficient to obviate its brittleness without giving to it any unpleasant smell, or materially impairing the brilliancy of its flame. A mixture of

Carnauba—*Corypha cerifera.*

three parts of this wax and one part of bees'-wax also makes very excellent candles.

A specimen of this vegetable wax was transmitted to Lord Grenville from Rio de Janeiro, as a new production recently obtained from the northern parts of the Brazilian dominions, between the third and seventh degrees of north latitude.

That its properties might be scientifically investigated, it was submitted to Mr. Brande for analysis, and hopes were entertained that if it were found similar to bees'-wax, it might become an article of commerce between Brazil and this country.

A detailed account of the various experiments to which it was subjected, in order to ascertain its real nature, may be found in the Phil. Trans. for 1811. The trials which were made of its relative value, as an inflammable substance, proved highly satisfactory. When made into candles with wicks properly proportioned to the size of the candle, its combustion was in every respect quite equal to that of bees'-wax both in regard to uniformity and intensity.

The product of its leaves is not, however, the only useful part of the carnauba-tree. The fruit, when green, after being boiled in several waters, affords a nutritive food; the pith of the stem of the young plants, after being bruised in water, is likewise applied to the same purpose. The kernel of the fruit when ripe is covered with a layer of sweet pulp, and this is found to be wholesome food for cattle.

The leaves make a very durable covering for houses, and in such service will sustain every vicissitude of weather for twenty years without requiring to be renewed. The trunk of the tree is a useful wood for building houses, making fences, and a variety of other purposes.

From another species of palm, the *Ceroxylon andicola*, a substance somewhat resembling wax is obtained. This tree is a native of the Andes, towering in majestic beauty on mountains which rise many hundred toises above the level of the sea, and on the verge of perpetual snow. Humboldt describes the tree as attaining to the prodigious height of one hundred and sixty feet, while it differs from all the other species of palms in flourishing under a much colder temperature. The trunk of the *ceroxylon* is covered with a peculiar kind of varnish, possessing some of the properties of wax. Vauquelin subjected this product to chemical analysis, and found that it contained two-thirds of resin and one-third of wax; thus differing materially from the inflammable substances obtained from the *myrica* and the *corypha* just described.

The Tallow-tree, or *Croton sebiferum*, yields a substance very much resembling tallow in consistence, in colour, and even in smell. This tree grows abundantly in China, where the inhabitants convert its produce into candles.

Mr. Clarke Abel describes it as being one of the largest, the most beautiful, and the most widely diffused, of the plants found by him in China. He first saw it a few miles south of Nankin, whence it occurred in greater or less abundance all the way to Canton. "We often saw it," he says, "imitating the oak in the height of its stem and the spread of its branches. Its foliage has the green and lustre of the laurel. Its small flowers, of a yellow colour, are borne at the ends of its terminal branches. Clusters of dark-coloured seed-vessels succeed them in autumn; and, when matured, burst asunder and disclose seeds of a delicate whiteness *."

The seed-vessels are hard brownish husks, not unlike those of chesnuts, and each of them contains

* Travels in China, p. 177.

three round, delicately white kernels, resembling in size and shape our ordinary hazel-nuts, but having small stones in the interior. It is the hard white oleaginous substance surrounding these stones which possesses most of the properties of tallow; but on stripping it off it does not soil the hands. From the shell and stone, or the seed, oil is extracted, so that this fruit produces tallow for candles and oil for lamps. To obtain its useful extract, the Chinese subject the fruit of the tallow-tree to much the same process as the seed of the *camellia oleifera*, or oil plant. It is ground in a trunk of a tree which is hollowed out, shaped like a canoe, lined with iron, and firmly fixed in the ground. Lengthways within this hollowed trunk there moves backwards and forwards a mill-stone, whose axis is fixed to a long pole laden with a heavy weight to increase the pressure, and suspended from a beam. The pendulum-like motion is given by a man or boy who grasps the pole, and with very little exertion sways it from side to side. After the seed has been thus pounded it is thrown, with a small quantity of water, into a large iron vessel, exposed to fire and reduced by heat into a thick consistent mass. It is then put hot into a case consisting of four or five broad iron hoops, piled one above the other, and lined with straw, and then pressed down with the feet as closely as possible till it fills the case. It is then carried to the press.

Another, and perhaps a more generally adopted process is, merely to boil the bruised seed in water and to collect the tallowy matter that floats to the surface. A certain quantity of some vegetable oil, occasionally in as great a proportion as three pounds to every ten pounds procured from the tallow-tree, is mixed up with it*.

It is not so consistent as tallow, and therefore, to

* Du Halde; Clarke Abel; Alvarez Semedo.

promote the better cohesion of the material, the candles made of it are dipped in wax; this external coating hardens them, and preserves them from guttering. The combustion of these candles is described as being less perfect, yielding a thicker smoke, a dimmer light, and consuming much more rapidly than ours. These serious defects are perhaps attributable in a great measure to the unappropriateness of the wick employed, which is merely a little rod of dry light wood (generally bamboo), with the pith of a rush wound round it; the pores of this pith serving as a medium to convey to the wood the inflammable matter with which it is surrounded.

We learn from Father D'Incarville, in a letter written by him from Pekin, and published in the Philosophical Transactions for 1753, that almost all the candles sold in the southern provinces of China are made with tallow prepared from these berries. There are very few sheep in that part of the country; animal tallow is therefore very scarce, and this vegetable production is in consequence held in high estimation.

The Piney tree, or *Vateria Indica*, growing on the coast of Malabar, yields a substance very much resembling that of the *crotonse biferum*. The peculiar product of this tree is fully described in an interesting paper on the subject, by Dr. Benjamin Babington *, who, from many experiments, has shown that its inflammable properties admirably adapt it for the manufacture of candles, it being in every way superior to animal tallow.

The useful matter is obtained by simply boiling the pulpy fruit of the piney tree in water, when the fused vegetable tallow rises to the surface, and, on cooling, forms a solid cake. No farther preparation

* Quarterly Journal of Science, &c. vol. xix.

is necessary. This substance is generally white, sometimes yellow, unctuous to the touch "with some degree of waxiness, almost tasteless, and has an agreeable odour somewhat resembling common cerate." It takes a liquid form at the temperature of $97\frac{1}{2}°$ Fahrenheit, and consequently, generally remains solid in India, in which respect it differs from palm or cocoa-nut oil. Its specific gravity at the melting point, or $97\frac{1}{2}°$, is ·8965, and at 60° is ·9260.

A piece of this tallow enveloped in folds of blotting paper was submitted to strong pressure, and scarcely sufficient *elain*, or pure oil, was expressed to imbue the inmost fold. Its tenacity and solidity are so great, that the united efforts of two strong men were in vain exerted to cut a round piece of nine pounds weight asunder with a fine iron wire, and it was no easy task to effect a division even with the assistance of a saw. Dr. B. Babington likewise remarked that, "on a fracture being made, it exhibits a crystalline structure in small aggregated spheres, composed of radii emanating from a centre not unlike the form of Wavellite." Animal tallow, when melted into large casks and slowly cooled, has a somewhat similar appearance.

When piney tallow is manufactured into candles they come from the mould freely, differing in this respect from wax, which it is found difficult to cast. These candles afford as strong a light as those made of animal tallow, and have the great advantage of being free from the unpleasant odour of the animal substance.

Piney tallow readily unites in all proportions with wax, spermaceti, and tallow, forming, when mixed with spermaceti and wax, a compound which fuses at a temperature approximating to their mean melting point according to their relative proportions. A mixture with any of these ingredients has been found to form a better candle than when the pure and more fusible substance is alone employed. Dr. B. Babington made several experiments to discover its inflammability compared with other substances; and ascertained with tolerable accuracy, that the piney tallow approaches nearer to animal fat in its rate of combustion than to spermaceti or wax, and that, all circumstances being similar, a less weight was consumed of this in a given time than of either of the other substances.

The natives have never hitherto applied this vegetable product as the means of affording light. Its concrete form is probably the cause of their having neglected it; as a solid substance is never used in India for feeding the flame of their wicks, and candles are unknown there. Their lamps are supplied with many fluid vegetable oils, which their country yields in profusion. The product of the piney tree is, however, employed medicinally by the Indians, who consider it as an excellent application for bruises and rheumatic pains.

A resin, very nearly similar in its properties to that of copal, exudes from the same tree, and furnishes a very durable natural varnish. This resin, when mixed up with the tallow of the piney tree, is used as a substitute for tar in smearing the bottoms of boats.

The *Vateria Indica* grows very commonly throughout the western coast of the peninsula of India, as far northward as the extreme limit of the province of Canara. A plentiful supply might therefore be readily obtained, which could be imported into this country at one-fourth the price of wax. Although it may not possess all the advantages of that substance, it is still considerably superior to animal tallow.

CHAPTER XV.

ALKALIS.

ALKALI—SODA—BARILLA—KELP.

ALKALI is a term derived from *kali*, the Arabic name of a particular plant, from which, probably, an alkaline substance was first extracted. Its principal characteristic is that of combining with acids, to neutralize their activity, and produce neutral salts. It has likewise a great affinity for animal and vegetable oils, with which it unites and forms soap. Alkali is of most extensive utility in many manufactories. Itself an opaque substance, it combines with sand, which is also opaque, and from this union results perfectly transparent glass; a substance which, when considered with reference to all its various qualities, may be termed the most beautiful and the most wonderful production of the art of man.

The hue of most colours is altered by the addition of alkali, and it is therefore much employed in the different processes of dyeing. In bleaching, in calico printing, and in many other useful arts, it likewise holds an important place.

There is no doubt that the method of obtaining the alkalis from vegetable substances must have been known and practised by the Romans. A decisive proof of this was found among the ruins of Pompeii, in which a soap-boiler's shop was discovered, containing a quantity of soap which had evidently been composed of oil and an alkali. This soap has been described by those who have seen it as being still perfect, though more than seventeen hundred years must have elapsed since it was manufactured.

Potash and pearlash, which contain potass—and barilla and kelp, which contain soda—are the alkalis known in commerce and used in the arts. These are both obtained by the incineration of vegetables. Soda is produced from the ashes of marine plants, which growing chiefly in salt marshes, or on the sea-shore, are supposed to imbibe and to decompose the marine salt, separating it from its acid, partly by the power of vegetation in the plant itself, and partly by the burning.

Soda, moreover, is contained abundantly in many other situations; it is the base of sea-salt, which is found in immense masses under the earth's surface in many countries, particularly in Poland, Hungary, Spain, and England.

Soda is likewise found combined with carbonic acid gas in abundant quantities, in the natron lakes of Egypt, in the East Indies, and in various other countries. In summer, the water of the lakes being evaporated, a bed of natron or carbonate of soda is left generally two feet thick; this is broken up by wedges, and packed for the European markets. Natron is brought in large quantities from China and other parts of the east.

The two alkalis, potass and soda, are very similar in their general properties, though the variety of salts which they form in combination with the acids, generally exhibit a marked difference. Potass is more deliquescent than soda, that is, it dissolves more readily by the action of the atmosphere; it is likewise more acrid, and for this reason soda is preferred in most manufactories, as it does less injury to fibrous fabrics, and does not corrode or destroy in an equal degree the utensils used in its application.

The soft soap used in Great Britain is made with potash in combination with animal oil; but this alkali cannot be employed in the manufacture of hard soap, as by exposure to the air in damp weather, the soap thus made would become soft and unsaleable, in consequence of the moisture the potash would imbibe from the air.

Silex is found to fuse with more facility by the action of soda than potash, producing likewise a glass of greater hardness; soda is therefore gene-

Prickly Salt-wort—*Salsola kali.*

rally preferred by glass-makers who have made trial of both these alkalis.

Among the great variety of marine plants from the ashes of which soda is obtained, are the several species of glass-wort, or *salsola*, which yield it in great abundance. The kali which grows naturally in the salt marshes of England is one of this genus.

It is an annual plant not attaining above half a foot in height, having numerous branches extending on every side. The leaves are short, awl-shaped, and succulent, terminating in acute spines. Small flowers come forth from the sides of the branches, and are surrounded by short prickly leaves; the seeds which these produce come to maturity in autumn, soon after which time the plant decays.

The *rosacea*, a native of Tartary, is another species of salsola, very similar to kali; its flowers on their first opening are rose-coloured, but soon fade.

The *tragus* is indigenous to the sandy shores of the south of France, Spain, and Italy. It is likewise an annual plant, and very much resembles the two just mentioned, except that its leaves are longer and narrower.

The *vermiculata* grows naturally in Spain. This has shrubby perennial stalks, which rise three or four feet high. Its leaves, which are fleshy, oval, and acutely pointed, grow in clusters. The flowers come forth between the leaves, towards the extremity of the branches; they are so diminutive as to be scarcely perceptible, except on a close inspection.

The *salsola soda* has a perennial root. Its stem rises with herbaceous stalks, from one to three feet high; these are without thorns, and of a reddish brown colour. The leaves are long, straight, and thick, adhering to the stem; the flowers grow singly, at the insertion of the leaves; they are very small and followed by capsules, each of which contains only

Salsola soda.

one cochleated seed. This plant grows on the southern sea-coast of France.

The Barilla, or *Salsola sativa*, is an annual procumbent plant, with short leaves, like those of houseleek; it rarely attains to a greater height than four inches, each root, however, pushes out a vast number of little stalks, which again are subdivided into smaller sprigs, the whole forming together a spreading tufted bush. The colour is at first bright green, but as the plant advances towards maturity, its verdure gradually fades away, till at length it becomes of a dull hue, tinged with brown. Its flowers,

Barilla—*Salsola sativa.*

which are very small, grow in clusters of five or seven together.

There are three other marine plants, the Gazul, the Soza, and the Salieor, which in the early part of their growth bear so strong a resemblance to barilla, that they would deceive any but the nicest observers, or most experienced cultivators. Of these *gazul* bears the greatest affinity to barilla, both in appearance and the quality of its product. The principal difference consists in its growing on a drier, salter earth, and being consequently impregnated with a stronger salt. It rises only about two inches from the ground, spreading out into little tufts. The sprigs are much flatter and more pulpy than barilla. This is sown but once in three or four years, according to the nature of the soil.

Soza, the second of these plants, when of the same size, has exactly the same appearance as gazul; but at full growth it is much larger. The soil most congenial to its growth is a strong salt marsh, where it is found in large tufts of sprigs treble the size of barilla, and of a bright green colour, which it retains to the last.

The *salieor* is the largest plant of the three, growing upright and resembling a bush of young rosemary. Its colour is at first deep green, tinged with red, which latter hue becomes by degrees that of the whole plant. Its natural situation is on the declivities of hills, near the salt marshes, or on the edges of the small drains or channels, cut for the purpose of irrigation.

All these kinds are sometimes promiscuously used for obtaining their soda; but the barilla and the *salsola soda* are held in the highest estimation. The soda produced at Alicant is considered the best and purest of Spain, and these are the only two plants cultivated there, from which soda is procured in large quantities. Barilla contains less alkali than the others, but it is of a much better quality. It requires a richer soil than the *salsola soda*, but the manner of its cultivation is the same.

The land having been prepared by manure, and frequent ploughings, is sown at the latter end of the year with barilla. The seeds after being scattered on the ground are barely covered with earth; a day is chosen for this work, when the weather gives indications of being showery and unsettled, as such weather is most favourable to the early germination of the seed. At the first appearance of spring, the ground is cleared of weeds, and kept so throughout the summer. The barilla is in a fit state to be collected when it is in its decline, or after the greater part of the seed has arrived at maturity; and this usually happens in the month of September. It has very small roots, and is therefore readily torn up; after which it is dried in the same manner as grass is made into hay. It is sufficiently dry when so much of the succulent moisture is exhaled, that it will readily burn. A greater dryness, such as may be caused by a too long exposure to the sun in hot countries, is injurious to the barilla; as the combustion is in consequence too rapid, which not only lessens the quantity of alkaline salt, but likewise injures its quality.

About the middle of October the plants are burnt. For this purpose hemispherical holes are made in the earth, capable of containing about thirty hundred weight of soda. Two iron bars are laid across each of the cavities, and the plants mixed with straw and reeds are placed on these supports.

This process is never commenced on a day when the wind is high, lest it should cause a too rapid combustion; for when the plants are so quickly burnt, the barilla is less easily reduced to a solid mass. On the other hand, a perfect calm is not the most favourable to the operation, as the smoke is not then sufficiently carried off, and injures the purity of the alkali. The action of the fire fuses the soda which is in the plant, and it flows into the cavity beneath, in the form of a red-hot fluid mass. The combustion is continued until the pits are full, to accomplish which generally occupies a whole night. The alkali is then stirred once or twice to encourage the more intimate union of the parts; after which, being covered with earth, it is left to cool during ten or twelve days. At this time it is a concrete substance of a hard and somewhat spongy consistence; this is broken into large fragments, and is the article known in commerce as barilla. That which is produced from the barilla plant is of a bluish grey colour. The product of the gazul resembles it, but is of a deeper and more glossy hue when broken. The other kinds are nearly black within, and have a greater specific gravity. About a ton of barilla is generally obtained from plants sown on an acre of ground. The barilla cultivated near the sea-shore is of the best quality. It is, however, cultivated not only on the coast of Spain, but at a distance of forty leagues from the sea; the plants grown so far inland produce barilla of an inferior quality*.

According to Jameson, barilla contains from eight and a half to twenty-three per cent. of pure alkali. Parkes analyzed barilla of various qualities; from a very fine specimen he obtained thirty and a quarter per cent. of pure dry soda—this was an unusually large proportion.

Soda is likewise obtained by the incineration of a species of another genus of marine plants called Sea-wrack, or *Fucus;* the alkali thus procured is known in commerce under the name of kelp. This is of home production. An inferior kelp has for a very long time been made in Ireland. In the year 1730 this manufacture was introduced by Mr. Macleod from that country into the Scottish Isles, where kelp of a much superior quality was soon produced in large quantities. In consequence of the heavy duty on barilla, it could be procured only at so high a price that the manufacture of kelp was attended with great advantage, since this latter article, being unburthened with any imposts, could be sold at a much cheaper

* Pictet. Phil. Mag. 13th vol.—Lewis' Com. Phil. Tech.

rate. A given weight of kelp does not contain so much alkali as barilla, but a larger quantity in proportion to its inferiority could be sold at a good profit at a much lower price than the barilla with the duty attached to it. Although inferior to the foreign alkali, it could be used in the manufacture of glass and soap, and it therefore speedily became an article of great consumption.

This manufacture brought prosperity to the shores of the Orkneys. Small farms of £40 yearly rent speedily rose in value to £300; and it is said that Macdonald, Lord of the Isles, obtained a revenue of £10,000 from his kelp shores alone, which had heretofore been to his ancestors an unproductive, valueless possession.

The demand for, and profit on kelp was so great that every expedient was devised to increase the production of this now valuable weed. In addition to the natural rocks, on which it grows in great abundance about low-water mark, fragments of rocks were rolled into the sea, to encourage its growth on their surface, and these were soon covered with *ware*, as it is technically termed.

Sea-wrack, or *Fucus vesiculosus*, has a flat, radical, branching leaf of about two feet long. The branches are half an inch wide, having a flat stalk or rib divided like the leaf, and running in the middle of it throughout all its various ramifications. Hollow spherical, or oval air-bladders, hairy within, appear on the surface of the leaf, growing generally in pairs, but often single in the angles of the branches. The office of these air-bladders apparently is to buoy up the plant in the water. At the different extremities of the leaf there are one or two tumid vesicles, about three-quarters of an inch long, containing a clear viscid mucus.

Bladdery Fucus—*Fucus vesiculosus.*

This plant is useful for other purposes as well as for its alkaline properties. It is considered an excellent manure for lands, and in the islands of Jura and Skye it is a resource in winter as food for cattle. We are told that the poor cows regularly wander to the shores in that season, at the recess of the tide, to seek for that pasture which the fields deny them. Linnæus relates that the inhabitants of Gothland convert the *fucus* into a nutritive food for their hogs by the admixture of a little coarse meal or flour to the boiled leaves; and that in Scania the cottages are covered with it, while it is sometimes used as fuel. In the Hebrides the inhabitants dry their cheeses without salt, by covering them with the ashes of this plant.

For the purpose of obtaining the alkali which the sea-wrack contains, the plants are collected into heaps, to induce a slight fermentation ; they are then spread to dry in the air, and afterwards burnt to ashes in a manner similar to that just described in the making of barilla. The ovens in which kelp is made are generally of the rudest kind, being nothing more than excavations in the ground lined with rough unhewn stones. The alkali fuses, and on cooling combines into one solid mass ; when cold it is broken up with iron bars into large ponderous pieces, and in that state is offered for sale, under the name of kelp.

This is much inferior to barilla, inasmuch as it contains a large portion of neutral salts, a quantity of potash, and a much larger proportion of carbonaceous matter than is generally found in the foreign alkali. The proportion of pure soda contained in a given quantity of kelp is always very small ; but it is very variable in its quality, ranging in the proportion of between one and eight per cent. of pure alkali. It has been seen that barilla likewise varies in its quality, some containing a much larger proportion of effective matter than others. It is admitted on a scale of duties proportionate to the quantity of pure alkali which it contains. Formerly it paid one fixed duty, but some years back a considerable quantity of purified alkali was imported from France on payment of the same duty as that levied on barilla ; and Government then discovered the policy of altering the mode of taxing the article. In this manner the duty on the pure alkali amounted to much more than 100 per cent., and it yielded a revenue of £79,000 *.

The duty on barilla has however been very recently

* Sir Henry Parnell on Financial Reform.

lessened so considerably, that it can be sold at a price which renders the inferior article, kelp, no longer in so great demand; consequently the golden harvests of the proprietors of the kelp shores of the Orkneys have been interrupted. More than 250,000 cwt. of barilla were imported into, and retained in England for home consumption in the year 1831. Its price, without the duty, was about £10 per ton. The duty is now 2 shillings per hundred weight.

Chapter XVI.

ALKALIS, (continued).

POTASH—PEARLASH—AMERICAN POTASH—OTHER ALKALINE PLANTS.

Potash is said to be obtained from the ashes of almost every plant which grows at a distance from the sea. This distance, however, need not be considerable: in the *Maremme* of Tuscany, where the best potash is produced in great quantities, trees, brushwood, or underwood, growing close to the margin of the Mediterranean, are used for this purpose. In Sicily, Calabria, and other parts of the kingdom of Naples, potash manufactories are generally established near the coast, and supplied with materials growing on the spot. In some of these places fine forest-trees are reduced to ashes to furnish potash. This, as we are informed by a gentleman who has travelled in that rarely-visited part of Italy, was particularly the case on the coast near Viesti, in the district of Monte Gargano, where a Neapolitan proprietor, interdicted by the blind policy of his government from exporting the timber that grew on his estate, established a potash manufactory and consumed his trees to supply it. The directors of these works were Tuscans, who pursued the same plan as that followed in the Maremme. They burned down the wood where it grew, which was often very near the Adriatic, and removed the ashes in handbarrows.

Potash is obtained in other places besides the south of Italy, by the incineration of trees and other vegetable matters that are not species of marine plants. In the manner of pursuing the process necessary for the production of potash from these materials, much care and skill are required. When trees are burnt for the purpose, it is essential to the formation of good potash, that the whole of the wood be thoroughly reduced to ashes. Previously to being used, these ashes should pass through a wire sieve, where none but such as are completely reduced to dust can find a passage. Neglect of this precaution not only renders the evaporation more difficult, but deteriorates the potash. The alkaline salt is extracted from the ashes by means of water, which holds it in solution; the filtrated fluid, consisting of such salt and the water, is called a ley; the aqueous portion of which being evaporated, the alkali is obtained. The results of various experiments to ascertain the relative quantity of potash contained in different plants, show that weeds in general yield more ashes, and their ashes much more salt than an equal weight of wood; and in proportion as plants recede from the ligneous and approach to the herbaceous character, they are found richer in potash. Three times the quantity of ashes are obtained from shrubs, and five times as much from herbs as from trees. Equal weights of the branches of trees produce more ashes than the trunk, and the leaves more than the branches. Green vegetables produce more ashes than when dry, and herbs arrived at maturity are richer in their saline product than at any other time. Fumitory yields a greater proportion of potash than any other plant; it produces much more ashes than an equal weight of wormwood. With reference, however, to equal weights of ashes, those of wormwood are found to contain the most alkali.

The salt obtained from plants is not pure potass;

other salts are found mixed with it in small proportions. These are usually the sulphates and the muriates of potash and of lime, besides which a portion of earthy matter is likewise held in combination.

Kirwan furnishes the following directions for making potash from weeds. The weeds are cut just before seeding time, spread out, and when sufficiently dry, collected free from all extraneous matter. They are then burnt within doors on a grate. The ashes are gathered together as fast as they are produced, and any pieces of charcoal which may be found mixed up with them are rejected and again subjected to the action of the fire. This should be clear and brisk, a close smothered fire, though recommended by some, being prejudicial to the production of good ashes. The ashes when thus obtained are mixed with twelve times their weight of boiling water This hot water holds in solution the alkali, while the grosser and insoluble particles of the ashes subside; the supernatant liquor is then filtered off and evaporated to dryness in iron pans. Two or three vessels are used in the business, and when the evaporation has been continued until the lessened solution is more than saturated, as fast as the salt concretes it is passed from one pan to the other: thus time is saved as the water evaporates more quickly when less surcharged with the alkali. It is said that potash was so designated from the circumstance of its being prepared in pots.

The salt thus produced is of a dark colour, in consequence of its containing much extractive matter. To get rid of this another operation is required. The potash is placed in a reverberatory furnace, in which the extractive matter is burnt off, and much of the water is dissipated. It generally loses in the furnace from ten to fifteen per cent. in weight, but it gains greatly in quality. Potash after it has been subjected to this burning is the pearlash of commerce. This, when good, is perfectly white and bears a uniform appearance. In converting the potash into pearlash particular care should be taken to prevent its fusion, as the extractive matter would not then be perfectly consumed, and the alkali would form so intimate a union with the earthy particles that it could not readily be dissolved.

The numerous and vast forests in many of the Russian provinces have given rise to the manufacture of potash, which is pursued there to a great extent, it being a very ancient and considerable branch of industry in Russia. A large quantity of this alkali is annually exported thence. It is prepared principally from the ashes of the oak and all the species of pine. The consumption of wood as fuel is very great, and the ashes of this are collected and used in the manufacture of potash. Among the numerous fabrics erected for the purpose some belong to the crown; large works of this kind are established at Tolskoi-Maidan. The production of the ashes forms no part of the process carried on; these are purchased from the peasantry who deliver them at certain fixed prices. The works contain thirty-two ash-pits, four boilers, and a calcining furnace for making pearlash. In an establishment on this scale, the whole being in constant activity, three hundred casks, each cask containing twenty poods (720 lbs. Av.), are annually produced.

England is supplied with potash and pearlash principally from Canada, where the abundance of wood renders the manufacture a matter of little difficulty or comparative expense.

Besides the quantity of wood burnt for the sole and express purpose of obtaining their ashes, a large proportion of potash is produced, as in Russia, from the ashes of wood burnt in common chimneys for domestic uses. The kinds of wood chiefly employed are the hiccory, oak, beech, birch, elm, walnut, chesnut, and maple. No care is taken to keep these separate; they are burnt together indiscriminately, old and young, green and dry. The ashes of the wood thus consumed as fuel by the country people during winter are collected and laid in heaps under sheds, where they remain until May or June, when they are employed for making potash: summer is the most favourable season for carrying on this process, as the frost of winter would render the elixation impracticable. At the time of using the ashes they are at first moistened with water to prevent the dust from rising, and are then put in vats capable of containing from one hundred to a hundred and thirty bushels.

These vats or steepers are furnished with a kind of false bottom formed by a lattice work or grating of boards, dividing the bottom area into small compartments, having free communication by apertures made in each of the partitions at their lower part. The ashes are well pressed down, the surface being rather hollowed towards the middle for the reception of the water, which is then poured on the top as fast as it is absorbed and until no more can be imbibed. According to some accounts the water is suffered to stand for a week on the ashes *, according to others it is not retained at all but runs out as soon as it has penetrated the ashes in a small stream at the bottom. This liquid is of a dark brown or chocolate colour. After the first water has been drawn off, fresh water is put on the ashes from time to time, until it runs off void of taste or smell. This second ley is not mixed with the first, but is reserved to be

* In Tuscany they leave the water on the ashes for four, five, or more days.

poured on fresh ashes, in order that a greater proportion of salt may be obtained before the solution is subjected to ebullition.

The water strongly impregnated with alkaline matter is then evaporated in iron pots of from sixty to eighty gallons capacity. During the progress of the evaporation more of the ley is, from time to time, thrown into the boilers until they are considered to be sufficiently charged with alkali. The water being thus driven off by the action of fire the residue concretes into a hard substance, and adheres so tenaciously to the sides and bottom of the pot as to require much labour to separate it. This was formerly a most tedious and troublesome part of the process, and could only be accomplished by the use of mallets and chisels. Accident, however, discovered to the manufacturer a method of avoiding all this trouble by disengaging the potash when in a liquid form from the boiler. For this purpose, after the water is evaporated from the alkali, the action of the fire is increased until the boiler becomes red hot and the potash fuses; in this state it is conveniently taken out with iron ladles and cast on a dry floor paved on purpose. Before fusion the salt is brown; in fusion it takes various dark hues; indeed the potash thus produced is of a colour sometimes approaching to black: yet it is found that a solution of it is nearly colourless. The extractive matter, though not consumed, having been burnt to an indissoluble carbonized state, subsides, leaving the water impregnated with the salt.

For making potash of a superior quality the ashes are more carefully burnt and rendered sufficiently pure to produce a fine alkali. After continuing the intense fusing heat for some hours, the salt, which under fusion takes the appearance of a dark brown or blackish fluid, will at length concrete into a solid mass; or, if the heat be very great, into a paste-like substance of a whitish grey or marbled colour. This operation will frequently require twenty or twenty-four hours, and sometimes even more, for its completion, dependent on the purity of the ashes with respect to the proportion of extractive and other extraneous matter which they may contain. Recourse must in this process be had to the chisel and mallet to extricate the potash from the fusing vessel, and therefore no advantage is apparently derived from the fusion of the alkali, while it has the objection (which Kirwan cautions the operator to avoid) of being extremely difficult of solution. Though it soon partially liquifies it does not, unless previously pulverized, readily and wholly dissolve even by boiling in water.

It is calculated in America that a ton of potash is obtained from four to six hundred bushels of best ashes. The following table, taken from the first Supplement to the Encyclopædia Britannica, will show the relative quantities which different plants contain, as the result of the experiments of some of the most eminent French and English chemists:—

	Ashes.	Potass.
100 parts Sallow produce	2·8	0·285
Elm	2·36727	0·39
Oak	1·35185	0·15343
Poplar	1·23476	0·07481
Hornbeam	1·1283	0·1254
Beech	0·58432	0·14572
Fir	0·34133	
Vine branches	3·379	0·55
Common nettle	10·67186	2·5033
Common thistle	4·04265	0·53734
Fern	5·00781	0·6259
Cow-thistle	10·5	1·96603
Great river rush	3·85395	0·72234

		Ashes.	Potass.
100 parts	Feathered rush . . .	4·33593	0·50811
	Stalks of Turkey wheat	8·88	1·75
	Wormwood.	9·744	7·3
	Fumitory	21·9	7·9
	Trifolium pratense . . .		0·078
	Vetches		2·75
	Beans with their stalks .		2·0

Vauquelin found that one pound of the ashes of horse-chesnuts yielded nearly six and a half ounces of potash, and six ounces were obtained from the husk. The same chemist discovered that the greatest proportion of pure alkali is contained in the fruit of the Spanish lilac, or *Syringa vulgaris*, the ashes of which yield one half of pure alkali. M. Jacobson, the editor of the German Technological Dictionary, asserts that dried or withered leaves of the beech-tree afford the vegetable alkali in great abundance, insomuch that ten pounds weight of the ashes obtained from these leaves contain as much potash as thirty pounds of common wood ashes.

The ashes of different vegetable substances vary extremely in the proportion of other salts which they contain, but there is rarely any plant to be found the ashes of which do not yield an alkali. The tamarisk-tree, it is said, is a remarkable exception; its ashes yielding no alkali by lixiviation, but affording sulphate of soda in great abundance.

In some parts of Germany potash is obtained from the same parcels of wood of which charcoal is made. A number of tubes, made of plate iron or of copper, are so disposed in the pile of wood that the products which would otherwise be wasted in the combustion are collected in these tubes and pass on to reservoirs connected with them. The fluid thus obtained is the oil, acid, alkali, and aqueous and other juices of the plant. The oil being separated the remainder is boiled in iron vessels, and the residuum is converted by calcination into an alkali*.

The proportion of pure alkali contained in potash varies extremely. Four parts by weight of the best American potash should contain about three parts of pure alkali; some inferior kinds yield only two parts, the rest is made up of earthy matter and other salts. Mr. Dossie ascertained on analyzing potash of different qualities, that the proportion of earthy matter was always nearly the same, and that the specimens varied with respect to the admixture of other salts. Thus one pound of the best potash was found to consist

	oz.
Of pure alkali	12·5
Other salts	·9
Earthy matter	2·6
	16

While another pound contained

Of pure alkali only	8·3
Other salts	5·4
Earthy matter	2·3
	16

In one hundred parts of Dantzic pearlash the pure alkali amounted to somewhat above sixty-three. It is therefore not as strong as the best American potash.

In 1831 England imported from Canada for home consumption about 167,000 cwt., and from other parts 25,000 cwt. of pot and pearl-ashes. They are admitted duty free from British possessions; coming from foreign countries a duty of 6*s.* per cwt. is levied. The price of Canada potash is from £1. 11*s.* 6*d.* to £1. 15*s.* per cwt.; that of St. Petersburgh, with the

* Macquer's Chemical Dictionary, article Alkali.

duty paid, is about £1. 14*s.* per cwt.; Canada pearl-ash is from £2. 2*s.* to £2. 5*s.* per cwt.

The common fern contains a large proportion of alkaline juice, which in some parts of England is converted to useful purposes. This plant is well known as growing in common and waste lands, having an herbaceous, upright stalk, garnished with large winged serrated leaves, and attaining to the height of four or five feet. In the county of York many hundreds of poor weavers work at their looms at home, and when their pieces of cloth are finished take them to the public mill with their own scouring materials and there superintend the operation of *fulling*. This process is intended to make the cloth of a thicker and closer texture by continued beating with ponderous wooden hammers, causing the stuff to shrink and thus bringing the parts into more intimate union; but the desired effect will not be produced unless the cloth be entirely divested of all greasy matter; for this purpose an alkali is used, which is generally fuller's-earth, hard soap, potash, or soda. It is, however, not unusual for the poor Yorkshire weavers to save the expense of any of these ingredients by providing a cheaper substitute in fern. They send their wives and children to an adjoining common to collect this plant, which they throw into the mill with the pieces of cloth, where the alkaline juices are expressed and worked into the cloth, and as good an effect is produced as if potash or soda had been employed*.

Some plants abound in saponaceous juices, which are so easily separable from them as to be applicable to the purposes of cleansing in the manner of soap. There are plants growing in Arabia, which from time immemorial have been thus applied. Pliny † de-

* Parkes' Chemical Essays.

† Pliny, lib. xix. cap. 3.

scribes the Radicula, which furnishes a juice very efficient in the cleansing of wool, making it extremely white and soft. This is indigenous to Asia Minor and Syria, flourishing in rough and stony places, its most genial soil being beyond the Euphrates. Its stalk is slender and resembles that of fennel; the leaf is like that of the olive; it blooms in summer, and bears a very fine flower but without perfume.

This perhaps, or a plant very similar to the above description, is in the present day used for washing in the lower part of Italy and in Spain. It is called *Lanaria* by the Calabrians, and is known to botanists under the name of *Gypsophila struthium.*

Soap-wort—*Saponaria officinalis.*

Soap-wort, or *Saponaria officinalis*, is another plant of the same description, the roots of which contain a saponaceous juice. This grows in Switzerland and the north of Europe. It has a perennial root scarcely thicker than a quill; the stem is herbaceous and cylindrical, throwing out many branches, and attaining to about three feet in height. The leaves are lance-shaped, and attached to the stalk in pairs opposite to each other. From the axillæ of the upper leaves lilac flowers come forth, several grouped together but growing on separate footstalks; these bloom in autumn, and are succeeded by oblong capsules, enveloped in their calyx and containing numerous round, reddish brown seeds.

In the Helvetian Alps the sheep are washed with a decoction of the plant and root, previously to their being shorn. With a mixture of ashes this decoction serves for cleansing linen. The plant, even without being boiled, imparts to water its peculiar property; on being steeped for several days the infusion becomes viscid and soft to the touch, and by agitation froths almost like soap-suds *.

Marcandier recommends the employment of horse-chesnuts in conjunction with soap as a detergent, whereby a great saving in soap is obtained, as only a comparatively small quantity is required. For this purpose about twenty horse-chesnuts are rasped in five or six gallons of hot water, and with the addition of a very little soap this mixture is advantageously used in cleansing and bleaching hempen cloth and stuffs.

It is said that the juice of the leaves of the agave has a remarkably saponaceous quality, and which is well known and applied in the West Indies. The juice is expressed by passing the leaves through rollers; it is then exposed to the rays of a

* Dictionnaire d'Agriculture.

tropical sun in wide shallow vessels, until reduced to a thick consistence, after which it is mixed with ley ashes and made up into balls. In that form it may be kept for years, and is as effective as Castile soap in the process of cleansing linen, while it has a quality which renders it very superior to soap, that of mixing and forming a lather with sea-water.

CHAPTER XVII.

ACIDS.

TARTAR—CREAM OF TARTAR—TARTARIC ACID—OXALIC —PYROLIGNEOUS AND ACETIC—CITRIC—GALLIC.

AN acidulous concrete salt is disengaged from wines while kept in casks, and, adhering to the tops and sides of the containing vessels, forms a crust which hardens to the consistence of a stone. This substance is generally called tartar, but is known in commerce under the name of Argol. Its goodness depends rather on the repeated fermentations produced by a succession of new wines in the casks, than on the soil or climate where the wine is grown.

Less tartar is afforded by sweet than by sharp wines, and it is also less valuable. The tartar of Rhenish wine is better than that of any other; and in general those wines which have the most acid in them furnish the greatest quantity of tartar, and that too in the largest crystals. Argol brought from Germany is the best, because it is formed around those vats of immense dimensions and great durability, which are given as dowries to daughters, or descend as heir-looms from father to son. In these vast repositories the salt is left undisturbed until it comes to a hard consistence, which is one of the chie. qualities to be regarded in tartar.

Argol is either white or red, according to the colour of the wine from which it was produced. The white is preferred to the red, as it contains fewer impurities; but they differ in no other respect, their nature and properties being exactly the same. Good tartar is thick, brittle, brilliant, and contains but little earthy matter. It is used in dyeing, hat-making, gilding, and other arts.

Argol is distinguished in commerce as coming from Bologna, Florence, Naples, and Sicily, and from the Cape of Good Hope. After the German, that coming from Bologna is the best, its price averaging from 66*s.* to 70*s.* per cwt.; while that of Sicily, which is the lowest priced, obtains not more than 40*s.* per cwt. It is admitted at the trifling duty of 2*s.* per cwt., and from British possessions at only half that sum.

The average annual quantity imported during the five preceding years was 2,980 casks and cases, each cask weighing ten cwt., and each case from two to three cwt.

Tartar contains much extraneous matter, which is useless, or perhaps detrimental in the several uses to which it is applied. It is, therefore, for some processes in the arts employed in a purified state, and is then called cream of tartar. The following is the method of obtaining the cream as pursued at Montpelier. A saturated solution of tartar is made in boiling water; as this water gradually cools, some of the salt separates and forms into crystals. These crystals are then re-dissolved in another vessel, with the addition of a white argillaceous earth in the proportion of five or six pounds to each hundred pounds of the crystallized salt; the aqueous solution is then subjected to ebullition. After this boiling a very white salt is obtained by evaporation, and it is this salt that is known in commerce as cream of tartar.

According to M. Desmaretz, at Venice white of eggs and ashes are used instead of the earth; but it is said that this addition of ashes introduces a foreign salt which affects the purity of the product.

The Venetian cream of tartar, however, bears a higher price than the French in the market, the former being about £3. 16*s.*, and the other £3. 13*s.* per cwt. It is admitted at a duty of 4*s.* 8*d.* per cwt.

The average annual import for the five preceding years was 882 casks; each cask weighing 11 cwt.

Tartar, both in its crude and its prepared state, was long used in the arts before its component parts were separated and analyzed by chemists. It was then discovered to be a peculiar acid, combined with potash, in a greater proportion, however, than to form a neutral salt; hence the term *acidulous* tartrate of potash. The supposition that it was formed during the fermentation of the wine, was disproved by Boerhaave, Newmann, and others, who showed that it existed ready-formed in the juice of the grape. This peculiar acid, distinguished as tartaric acid, has been likewise found in other fruits, particularly before they are very ripe. It is contained in the tamarind, and also in sumac, balm, carduus-benedictus, and the roots of rest-harrow, germander, and sage.

The method of separating the tartaric acid from the cream of tartar was among the earliest discoveries of Scheele. He saturated the superfluous acid by adding chalk or carbonate of lime to a solution of this acidulous salt in boiling water till effervescence ceased; or till the carbonate of lime, which is a combination of lime and carbonic acid gas, had been wholly decomposed, the lime uniting with the tartaric acid and the carbonic acid gas now disengaged, escaping. The acid held in combination with the lime, was thus obtained under the form of tartrate of lime; this was again made to part with its acid by means of the sulphuric, to which the lime having a greater affinity combined, leaving the tartaric acid free. Thénard recommends another chemical process to obtain the whole of the acid from the tartar, some of which still remains combined with the potash, forming a neutral salt. In the solution of this neutral tartrate of potash, muriate of lime is added, which immediately decomposes the salt, the tartaric acid leaving the potash and combining with the lime. The tartrate of lime thus obtained is washed with abundance of water; three-fifths of its weight of strong sulphuric acid previously diluted with five parts of water are then added, by which means the whole of the tartaric acid is disengaged. Fourcroy pursued another process to obtain the same result, and this, as improved by Vauquelin, is considered a cheaper method. A hundred parts by weight of tartar, to thirty of quick, or forty of slaked lime, are mixed in boiling water. A caustic magma is obtained, which is evaporated to dryness by the application of a gentle heat. If this be now digested in water, the potash in its caustic state is alone dissolved, the whole of the tartaric acid with which it was combined having been taken up by the lime, forming tartrate of lime, which is an insoluble salt: the acid may be obtained from this by the equivalent quantity of sulphuric acid. Several other methods are likewise employed for this purpose. One of the simplest is to boil four parts of tartar in twenty or twenty-four of water, and to add, gradually, one part of sulphuric acid; by continuing the boiling the sulphuric acid will combine with the potash, and forming sulphate of potash will precipitate, leaving the acid free in the water. When the solution is reduced to about one-half by evaporation, it is filtered and again boiled; and if any more sulphate be deposited, it must be again filtered. When entirely freed from sulphate, the liquor is evaporated to a sirup. Crystals of impure tartaric acid are formed in cooling, which will be equal in quantity to half the weight of the tartar employed. By redissolving these and subjecting them to a careful evaporation, pure crystals may be obtained.

Tartaric acid is used in many of the arts, where the acidulous tartrate of potash could not produce the effect desired. It is employed in several processes in dyeing, especially in calico-printing, in which it is used to discharge false prints. This acid is extremely soluble in water, and is very safe in its application.

Oxalic acid is another vegetable acid, which is also much used in the arts. It is an article of great consumption in topical dyeing, both in the crystalline state and in that of super-oxalate of potash. It has been attempted to use the latter instead of citric acid; but it is so insoluble, that there is some difficulty in making solutions of sufficient strength. This salt is used for removing ink spots, and is an excellent test for discovering the presence of lime, for which substance oxalic acid has so great an affinity as to separate it from any of the other acids, forming with it a pulverulent insoluble salt, which is not easily decomposed, except by the agency of fire.

Oxalic acid, combined with potash, is found in the leaves of the wood sorrel, or *oxalis acetosella*, and in those of the common sorrel, or *rumex acetosa*. The expressed juice of the leaves of either of these wild plants is diluted with water, and set aside for subsidence: in a few days the feculent parts precipitate, and the supernatant liquor becomes clear. It is then strained off, evaporated, and placed in a cool situation favourable to crystallization; or sometimes the juice, as soon as expressed, is clarified with white of eggs, and being thus cleansed from its feculencies is at once evaporated.

The first product of crystals being taken out, the liquid is still farther evaporated and crystallized, until

Wood Sorrel—*Oxalis acetosella.*

no more crystals can be obtained. In this manner about nine drams of crystals may, according to Scheele, be procured from two pounds of juice, which is generally the produce of ten pounds of wood sorrel. Savary did not obtain so great a quantity; but he did not clarify the juice before he evaporated it, and was obliged repeatedly to dissolve and recrystallize the salt, in order to obtain it white, and probably wasted some in these different operations. This salt is collected in small, white, needle-like crystals, not alterable in the air. It is the acidulous oxalate of potash, or salt of sorrel, of commerce: it has usually been imported from Switzerland and the neighbouring countries, where it is prepared in large quantities.

Pure oxalic acid may be extracted from numerous substances, both animal and vegetable, by distillation with nitric acid. Bergmann was the first who obtained this acid from sugar, which affords it in abundance when treated with nitric acid. One ounce of lump sugar, coarsely pulverized, is gradually added to six ounces of nitric acid, in a stoppered retort; a gentle heat is applied during the solution, and the acid is distilled off, till what remains in the retort has a sirupy consistence; this will form regular crystals of oxalic acid, amounting to fifty-eight parts for every one hundred parts of sugar *.

Berthollet remarked, in the course of his experiments, that the quantity of oxalic acid obtained from vegetable matter, treated in a manner similar to the sugar, was proportionate to their nutritive qualities. Deyeux, having cut the hairs of the chick-pea, found that they gave out an acid liquor, which proved on examination to be an aqueous solution of pure oxalic acid. Proust and other chemists had before observed, that the shoes of persons walking through a field of chick-peas were corroded †.

Oxalic acid crystallizes in quadrilateral prisms; but if produced rapidly, the crystals take the form of small irregular needles. They effloresce in dry air, but attract a little humidity in damp weather. They are soluble in their own weight of hot water, and in double that quantity of cold water. Their acidity is so great, that when dissolved in 3,600 times their weight of water, the solution reddens litmus paper, and is perceptibly acid to the taste ‡. Oxalic acid acts as

* The acid may equally be obtained from raw sugar, but will, in this case, require some subsequent process for its proper purification.

† Ure's Dictionary of Chemistry. ‡ Ibid.

a violent poison when swallowed in the quantity of two or three drams.

A crude kind of vinegar is prepared for calico-printers by the distillation of wood: this is called Pyroligneous acid. The process used to obtain this product consists in subjecting wood enclosed in iron retorts to a strong red heat, by which means vapour is given off, which is conducted to, and condensed in a suitable apparatus. A series of these retorts, having a cylindrical form, each being about six feet long, and of four feet diameter, is built horizontally in brick-work, so that the flame of one furnace may play around two retorts. Both ends of each cylinder project somewhat beyond the brick-work; one end is effectually closed by a disc of cast iron, well fitted and firmly bolted. From the centre of this an iron tube, about six inches in diameter, proceeds, and enters at right angles the main tube of refrigeration, through which, when the apparatus is in operation, the vapour of the wood finds its way to a condenser, whence it flows in a liquid form into a receiver. The diameter of this tube varies from nine to fourteen inches, according to the number of cylinders used. The other end of the retort is open to receive the charge of wood, which, for a cylinder of the above dimensions, is about eight cwt. It is then closed by a disc of iron, luted round its edge, and secured in its place by wedges. The hard woods, such as oak, ash, birch, and beech, are alone used; fir is not considered to answer the purpose. When the cylinders are charged the furnaces are put into action, and an intense heat is kept up during the whole of the day: towards night the fire is extinguished, and the retorts are allowed to cool. Next morning the mouth of each retort is opened, the wood now reduced to charcoal is removed, and a new charge of wood is introduced. The average product of acid from eight cwt.

of wood is thirty-five gallons. Before the pyroligneous acid begins to distil over, there comes a peculiar fluid called pyroligneous ether, or pyro-acetic spirit, which is used, when purified by a subsequent distillation with lime and animal charcoal, for burning in spirit lamps, for the solution of shell-lac, and indeed for many purposes in which the use of alcohol was formerly required; but at present the greatest consumption of this spirit is in dissolving caoutchouc.

This impure acid is rectified by a second distillation, when from every hundred gallons twenty of a viscid, tarry matter are collected. The fluid is now become a transparent brown vinegar, having a considerable empyreumatic smell, and a specific gravity of 1·013. Its acid powers are superior to those of the best household vinegar in the proportion of 3 : 2. This was formerly called *acid spirit of wood*, and since pyroligneous acid. Fourcroy and Vauquelin showed that this acid was merely the acetic contaminated with empyreumatic oil and bitumen. The empyreumatic matter may be separated by saturating the acid with quick-lime, then evaporating this to dryness, and exposing it to gentle torrefaction. The acetic acid combines in this process with the lime, forming acetate of lime, while the separated impurities have been driven off. If this acetate be decomposed by sulphuric acid, a pure, perfectly colourless, and grateful vinegar rises in distillation.

It was discovered a few years ago that pyroligneous acid, previously to being thus purified, has the property of preventing the decomposition of animal substances. "Putrefaction," it is said, "not only stops, but retrogrades," on the application of this acid. The effect has been ascribed in part to the empyreumatic oil contained in the impure acid; and hence the agency of smoke has been accounted for in the preservation of some kinds of animal food.

This would have been a valuable discovery, but it is found that the empyreumatic taint which it imparts to any substance immersed in it cannot be quite removed by any subsequent culinary process.

The greatest consumption of this acid is in the business of the dyer and of the calico-printer. When purified it is used for pickles and other culinary purposes, where acid of great strength is required.

The peculiar acid contained in the juice of citrons, lemons, limes, and a variety of other fruits, is distinguished by the name of Citric acid. This is of very extensive use; and lemon juice, as well as its concentrated acid, is employed for a variety of purposes connected with the arts.

Lemon juice is exported in large casks from the south of Italy into Germany and the north of Europe, as well as into this country. Naples and Sicily furnish the greater part of these supplies.

Juice thus kept deposits much foot*, and if the clear liquor be racked off, it may be preserved for some time, especially if it be covered with a thin stratum of sweet oil and stored in a cool cellar. But there is some difficulty in obtaining the juice in a state for preservation from the country where it is produced. A writer from Sicily observes, "As soon as the country people press the juice it is brought into Messina for sale. The buyers do not afford it warehouse room, but roll the casks into the street, where it is exposed to the weather and the heat of the sun until an opportunity offers for shipping it. It is therefore not surprising that so much is imported that is musty and spoiled, and that the English merchants often find it so bad on its arrival in England as to create a difficulty in procuring for it even

* This is not entirely refuse, as a species of essence of lemon is distilled from it, and is used in confectionary.

the amount of the import duty." In the provinces of Calabria, in the same kingdom, the product is treated with the same carelessness; but at Sorrento small quantities may be procured of great excellence.

Lemon juice is imported into this country at a duty, if raw, of $\frac{1}{4}d.$, if concentrated, of $\frac{1}{2}d.$ per gallon; from British possessions the concentrated juice is admitted at the same duty as if raw. Lime juice is generally stronger in acid than lemon juice, but it does not obtain so good a price in the market, the first being from 1*s.* 3*d.* to 1*s.* 9*d.* per gallon, and the other from 1*s.* 6*d.* to 2*s.* per gallon.

The quantity imported last year for home consumption was 20,595 gallons*. The specific gravity of good lemon juice is from 1·0312 to 1·0625.

The juice can be procured with advantage only at one season of the year, and is likely to spoil if kept for any length of time without preparation. Besides this, there are many causes which may prevent its being received of a good quality. The fruit from which it was obtained may have been gathered in an unfavourable month, after the descent of the heavy periodical rains; or it may be deteriorated by the spontaneous decomposition which is occasioned by age; or it may have been designedly diluted with water by a dishonest vender. Independent of all these objections to the extensive importation of the crude juice, there is the increased freight in the bulk of the article, as compared with that of the citric acid which it contains, and which is the only part that is useful in the arts, the remaining, and by far the greater proportion, being made up

* A considerable quantity of lemon juice is consumed by the British navy as an anti-scorbutic. It is usual to put about ten gallons of brandy to every hundred gallons of juice; this precipitates the mucilage, which would otherwise during a long voyage throw the whole into a state of fermentation, when it would be entirely spoiled.

of sugar, water, extractive matter, and mucilage. These considerations caused it to be a matter of great interest with chemists to discover some method whereby this valuable acid might be separated and preserved in a state of perfect purity.

Alcohol was added by Scheele and other practical men, with the intention of precipitating the mucilage; but this preserved it very imperfectly, for although the mucilage was separated thereby, the extractive matter and the sugar were still held in combination. In 1774 M. Georgius, a Swedish chemist, published a process for separating the mucilage and concentrating the acid. The method proposed was to keep the lemon juice for a long time in a cool place in inverted bottles, and then expose it to a temperature below the freezing point of water. The water with the mucilage freezes, and this frozen portion is repeatedly removed, until at length the juice is reduced to one-eighth of its original quantity. It must not, however, be exposed to too intense a cold, lest part of the acid should also congeal with the aqueous portion; the temperature should therefore not be lower than 28° Fahrenheit. By this management none of the acid is lost, and when concentrated and purified, it may be kept for many years without sustaining any injury. This is at best but a very tedious process, which could not be easily practised in countries where the fruit grows, as the cold there would never be sufficiently intense*. The juice, after being subjected to this process, still has the extractive matter combined with it, and this prevents its crystallizing. The method was there-

* As far as regards Sicily and Naples, recourse might be had to ice, or rather congealed snow, which is preserved all the year round in caves or pits dug for the purpose on Etna, and most of the high mountains of that kingdom. But the whole process is perhaps too artificial for those parts, and, after all, is defective.

fore left open for improvement. Soon after this a French chemist published another process, the very reverse of the former refrigerating method. The juice was subjected to a slow degree of heat for a considerable time; the heat caused the mucilaginous matter gradually to thicken, and rise in a glutinous mass to the surface of the liquor; and this being removed, the remaining portion continued for a long time in an unaltered state. It was left however to Scheele, the great Swedish chemist, to add this to his numerous useful discoveries; and he was the first who obtained citric acid in a solid crystalline form, by the same method which he had employed long before for the purification and crystallization of tartaric acid. He separated the real acid by carbonate of lime, thus producing citrate of lime, which he decomposed by the intermedium of diluted sulphuric acid.

To pursue this process the juice is drawn off into a large open vessel, and neutralised by the gradual addition of carbonate of lime. The lime immediately combines with the citric acid in the juice, and disengages the carbonic acid gas, causing great effervescence: care is therefore necessary to prevent the overflow and consequent waste of the liquor, by supplying the carbonate of lime by very slow degrees: this is added till no more effervescence ensues, and until the liquor shows no signs of acidity on test paper. The citric acid, thus combined with the lime, produces an insoluble salt which precipitates at the bottom of the vessel. When the whole of this has fallen the supernatant liquor is drawn off, and the precipitate preserved for use, after being passed through a sieve, and frequently washed in warm water till any remaining mucilage or soluble impurity is entirely disengaged: this is ascertained to have been effected when, on leaving the whole at rest for some time, the water comes off clear and tasteless.

To obtain the citric acid this calcareous salt is now treated with dilute sulphuric acid. The quantity of carbonate of lime used in the previous process should have been accurately noted, and for every ten pounds employed, nine and a half pounds sulphuric acid of the specific gravity of 1·84, or 1·845, diluted with about fifty-six pounds of water, are added, the whole being poured gradually on the citrate of lime: the mixture is then well stirred for a considerable time with a strong wooden spatula that there may be no chance of any of the citrate remaining unbroken, and in consequence unacted upon by the stronger acid. Lime, having a greater affinity to the sulphuric than to the citric acid, immediately quits the latter and combines itself with the former, leaving the citric acid disengaged in a state of solution in the supernatant fluid. The insoluble part of the mixture is now sulphate of lime, and after allowing a sufficient time for its precipitation, the liquor is drawn off from it, and it is repeatedly washed in order that none of the citric acid may be left among it: the water in which it has been thus washed is mixed with the liquor, and the whole is concentrated by evaporation. This is performed in leaden vessels which are cased with wood, and heated by means of steam. When evaporated to about one-eighth in bulk, the solution is transferred to a vessel of a smaller size, wherein it is farther evaporated until it is reduced to the consistency of thin molasses. When a pellicle is seen gradually to spread itself over the surface, the mixture is immediately removed to other vessels and left to crystallize: there it remains undisturbed for three or four days, at the end of which time the mother-water is drained from the crystals. The crystals thus produced are most generally needle-formed, and nearly as dark as the brownest sugar, in consequence of the presence of mucilage; but if this have been previously well washed out from the citrate of lime, the crystals will be rhomboidal, and of a bright light brown. Citric acid in this state is found to answer extremely well as applicable to the arts, but for some processes in these it is desirable to have the acid quite pure; and this last condition is always requisite in medicine and domestic economy. To produce this purity the crystals are dissolved in clear water and boiled by steam heat, with the addition of animal charcoal: the solution is then passed through a flannel filter, and left for crystallization; very white and beautiful solid crystals in rhomboidal prisms will be thus produced.

In the autumn, the time when lemons come to maturity, 4,000 lemons are required to furnish about twenty gallons of juice: this juice, when good, generally gives eighteen pounds of dry citrate of lime, and these again give ten pounds of good white crystals of citric acid. When the juice employed has been but recently expressed from the fruit, it is stated that a gallon of lime juice yields from fourteen to eighteen ounces of pure citric acid.

The person who first prepared this acid in large quantities in England sold it at a high price, in the form of clear white crystals. The calico-printers were supplied with this for many years, until the demand becoming greater than the manufacturer's ability to comply with it, he began to furnish his customers with the brown crystals, that is, with the acid in the first or second stage of crystallization. These brown crystals he could of course afford to sell at a much lower price.

The discovery that citric acid could be used in its impure state in calico-printing, caused those engaged in that pursuit to turn their attention to the mode of preparing it themselves; and now most of the proprietors of large establishments buy the plain lemon juice, and use it in different states of concentration, according to the purpose to which it is to be applied. For most of the processes in calico-printing in which citric acid is employed, it is found that the impurities commonly found in lemon juice are of very little consequence, and that when concentrated by driving off its aqueous parts it very well answers for most purposes, superseding the use of the crystallized acid. In every large calico print-work there is always abundance of spare heat, and therefore the evaporation may be conducted without expense. There is, however, a large consumption of citric acid for a variety of other purposes, and it is therefore of consequence that this should be obtained as cheaply as possible. Fourcroy, in his 'General System of Chemical Knowledge,' recommended the expediency of sending proper persons to the French possessions in America, in order to collect the vast quantity of limes and lemons which were annually wasted there, to saturate the expressed juice with chalk, and after washing and drying the citrate, to send it home where it might be decomposed and the citric acid obtained pure.

Since his time several persons have gone from England to different parts of Italy for the purpose of making citrate of lime on the spots where the fruit is produced, and considerable quantities have been imported thence to Great Britain. As far back as 1808 an establishment of this sort was formed in the island of Sicily: an ample account of it may be found in Parkes' Chemical Essays. We are informed there that "the country round Messina consists of mountains of immense height rising one above another, and thickly covered to the very top with fruit-trees, chiefly olives and lemons, which render this place the very best in the world for procuring lemon juice." To this we may add that the opposite coast of Calabria, separated from Sicily only by the narrow channel called the Faro of Messina, is one continuous grove of oranges and lemons. When the establishment was first attempted, the Calabrias and all the rest of the continental dominions of the king of the two Sicilies were occupied by the French, and closed to us; but now, as integral parts of the same kingdom and from their contiguity, the most intimate intercourse subsists between them and Sicily. From the produce of its own hills, and from fruit obtained from Scylla, Reggio, &c. in Calabria, Messina with proper manufactories might almost supply Europe.

The time of pressing the fruit is generally in the latter end of November or December, for until that period lemons yield little or no juice. So great a quantity of lemons is required to obtain a comparatively small quantity of citrate of lime, that the expressing of their juice in the establishment in question was conducted on a large scale, presses being so constructed as to squeeze many thousand lemons at once. No difficulty was therefore found in saturating the chalk in any quantity; but to dry the citrate of lime sufficiently to be packed for exportation was extremely tedious and troublesome. It requires very hot and dry weather to produce this result, and sometimes it was spread out a whole fortnight before it was perfectly dry. In this manner it occupied so much room that the work was frequently stopped, because all the drying places were full; although the use of a vast terrace belonging to a neighbouring convent had been obtained for the purpose.

The conductor of this establishment for making citrate of lime remarked, that " he found as much difference in lemon juice as in wine, and both have more or less body according to the particular soil on which the fruit grows. When fresh squeezed all seems equally sharp and good. The hot weather, however, is its test, and there is much of the juice we buy which will not bear it: it often changes *very quickly*, and a mawkish acid remains. Though the early juice resists the heat the best, he can positively assert that with the utmost care there is no *certainty* of preserving its native sharpness in the hot months but by the addition of lime or some other similar agent *."

Besides the employment of citric acid in medicine, domestic economy, and calico-printing, there are many other arts in which it proves a valuable auxiliary. It is used in the preparation of the best Morocco leather; for improving that peculiar solution of tin applied in producing the most exquisite specimens of the scarlet dye; and for altering the hue of some colours which are exclusively used in the dyeing of silk.

Citric acid is extremely easy of solution; one ounce and a quarter can be perfectly dissolved in one ounce of cold water, while boiling water dissolves double its own weight. It is this solubility which renders it so useful to the manufacturer.

The juice of many other fruits besides that from limes and lemons, will afford citric acid either alone or mixed with other acid. The cranberry, the red whortleberry, the cherry, the berry of the night-shade, and the hep of the wild briar yield chiefly citric acid; while in the red gooseberry, the currant, the bilberry, the hawthorn, the black cherry, the wood strawberry, the cloudberry, and the raspberry, it is mixed with nearly an equal proportion of malic acid.

Gallic acid obtains its name from the gall-nut, the substance which yields it the most readily and in the greatest abundance.

* Parkes' Chemical Essays.

The existence of an uncombined acid in galls and various other astringent substances was suspected by Macquer, Lewis, Monnet, and other able chemists. It was not, however, well examined until 1772, when Morveau and the other Dijon academicians took the subject under consideration. These scientific men, however, brought forward no unanswerable proof, and the matter remained in this state until 1780, when Scheele put the question beyond all doubt, by publishing a method of separating the acid from the other constituents of the gall-nut.

Gallic acid is soluble in ten parts cold water, and three of boiling water.

This acid is used in the art of dyeing, especially in the formation of a black dye; and is employed to fix or improve several other colours.

CHAPTER XVIII.

VEGETABLE DYEING SUBSTANCES USED IN THE ARTS.

DYEING SUBSTANCES—INDIGO—WOAD.

THERE are many subtances which afford a durable colour, and which may therefore be applied successfully by the simplest people to the purposes of dyeing, without being subjected to any previous preparation. This application can scarcely be called an art. But to make permanent that which is evanescent in its nature, and not only to arrest the fugitive tints, but to give to them greater brilliancy, and by curious combinations to impart every varying hue, this may more properly be termed the art of dyeing.

It would be of little avail to search out passages, many of them obscure and contradictory, from various ancient sources, to assist our conjectures as to the origin of the art of dyeing, and with what success it was practised by the nations of antiquity. It may be sufficient to mention, that the practical methods of communicating various colours to stuffs was tolerably well understood at Rome; and we can trace some of the ingredients then used for this purpose, as retaining a conspicuous and useful place in the dye-houses of the present day.

We learn from the Italian chronicles that as early as the year 776, when Charlemagne, who had recently obtained possession of all upper Italy by conquering the Lombards, was at Pavia, with all his court, a number of Venetian merchants flocked thither and sold the Franks an abundance of brilliant silk robes, embroidered stuffs, and prepared furs. Charlemagne's dress at the time was nothing but a rude sheep-skin. In the course of the ninth and tenth centuries, dyed silks, &c. imported by the Italians from the East, mainly for the decoration of churches, are repeatedly mentioned by the same old authors. At the time of the crusades the Venetians and Genoese especially contrived to import many oriental productions and manufactures, which, by affording new means as well as new objects for imitation, contributed greatly to restore the arts.

For a long period Italy, and particularly Venice, possessed almost exclusively the art of dyeing; which was at length introduced into France. In the reign of Francis the First an enterprising individual, named Giles Gobelin, erected large buildings in the place which still bears his name, for the purpose of carrying on this trade. His undertaking was considered to be so rash, that the title of Gobelin's Folly was given to the establishment. Berthollet remarks, that the success which, contrary to their forebodings, crowned Gobelin's exertions, so astonished his fellow-citizens, that they believed he had entered into a compact with the devil.

The minister Colbert, whose enlightened mind was so indefatigably directed towards the promotion of those peaceful arts whereby the true happiness of society can best be fostered, turned his attention to the art of dyeing, with the desire of amending its processes and of removing frauds in its practice. With this two-fold view, he caused, in the year 1672, a code of instruction for dyers to be published, not only to inform, but to control this class of persons in their operations. While applauding the motive of Colbert, we cannot but be sensible that restraints of this kind, though they may prevent impositions on the public, must of necessity act as checks upon future experiment and improvement. It will be seen, when treating of some of the substances used in dyeing, how much the imposition of absurd restrictions, generally arising from unfounded prejudices, has prevailed among most European governments, and tended only to shackle the art, and to retain it in that state of ignorance of theoretical principles which kept it so long in its infancy.

The French government afforded, however, a countervailing advantage, by offering particular rewards for definite *desiderata;* and subsequently by appointing the most eminent chemists of France, in succession, to superintend and elevate the practice of the arts connected with chemistry, and more especially the art of dyeing. Accordingly that country became superior to the rest of Europe in this pursuit, and made great and striking improvements during the whole of the last century.

The practice of dyeing has been carried on for many years in England with tolerable success; but until recently very little progress has been made in investigating the theory on which the practice was founded. The Royal Society, soon after its institution in 1662, called the attention of some of its members to this subject; but it was not until many years after this recommendation was issued, that Lewis wrote his valuable remarks on dyeing. These were confined to only a few processes; but at length, towards the close of the last century, the works of Delaval, Henry, and Dr. Bancroft, besides many other excellent essays, rescued the English from the disgrace of borrowing wholly from the French all improvements in the art; and since that period the progress of the theory, as well as of the practice of dyeing, has been rapid in this country.

Dr. Bancroft distinguishes dyeing substances into two kinds, *substantive* and *adjective*, and thus explains the reason for adopting these terms. "Colouring matter seems to fall naturally under two general classes; the first including those matters which, when put into a state of solution, may be permanently fixed, and made fully to exhibit their colours in or upon the dyed substance, without the interposition of any earthy or metallic basis; and the second comprehending all those matters which are incapable of being fixed, and made to display their proper colours without the mediation of some such basis. The colours of the first class I shall denominate *substantive*, using the term in the same sense in which it was employed by Bacon, Lord Verulam, as denoting a thing solid by, or depending only upon, itself; and colours of the second class I shall call *adjective*, as implying that their lustre and permanency are acquired by adjection upon a suitable basis *." This beautiful and simple distinction, which is almost generally adopted among the English writers, has not been recognised by the French.

Adjective colours acquire permanency, and sometimes brilliancy also, by the interposition of substances which, having a considerable attraction for the colouring matter and the fibres of the fabric about to be dyed, combine with, and serve as a bond of union between them. These intermedia being usually some earthy or metallic substance, employed in a state of solution or combination with the acids, were, from that circumstance, denominated by the French, *mordants* (biters or corroders), and the term has been adopted also in English. Berthollet distinguishes under the title of alteratives those ingredients which are employed merely with a view of changing the

* Experimental Researches concerning the Philosophy of Permanent Colours, p. 78.

shade. Practical dyers, however, class these likewise under the title of mordants.

Almost all the metallic oxides have an affinity for the fibres of cloth, but only two are extensively used as mordants,—these are the oxides of tin and of iron. Solutions of tin in acids, sulphate of copper, acetate of lead and of copper, chloride of sodium (common salt in a dry state), alum, lime, tan. and tartar are the substances principally used as mordants.

Their effects in topical dyeing constitutes that "truly wonderful art," the art of calico-printing, or of communicating different colours to particular spots or figures on the surface of cotton or linen cloth, while the rest of the texture retains its original whiteness. This art originated in India, where it has been pursued, with little alteration, for more than two thousand years, it having been practised during all that period in a most elaborate manner by the Hindoos. The account given of the mere preliminary steps affords an example of the complicated and tedious processes in which these people love to involve their arts, while it will offer a slight specimen of the many subsequent operations needed for the completion of the work.

"The cotton cloths, on being brought from the weavers partly bleached, were worn next to the skin by the dyer, or some members of his family, during the space of eight or ten days, after which time the stuff underwent several macerations in water mixed with goats' dung, accompanied by frequent intermediate beatings, washings, and dryings in the sunshine. The cloth was then soaked for a considerable period in a mixture of the mucilaginous astringent fruit of the yellow myrobalans with curdled buffalo's milk; being thoroughly penetrated and impregnated therewith, it was taken out from the liquor and well squeezed, then dried by exposure to sunshine, and fterwards, by pressure and friction, made smooth enough for being drawn upon by the pencil with the different mordants *." The Egyptians, in the time of Pliny, had discovered or adopted from the Hindoos this mode of topical dyeing; as he describes them as painting or drawing on white cloth with certain drugs, which in themselves possessed no colour, but had the property of attracting or absorbing colouring matters. After these cloths had been drawn upon, they were immersed in a heated dyeing liquor, and though colourless before, and though the dyeing liquor in which they were immersed was of one uniform colour, yet when taken out of it they were soon after found to be tinged of different colours, according to the different nature of the several drugs which had been applied to the particular parts; and all of these colours were permanent.

To the uninitiated among the ancients this wonder-working process must have appeared like magic; and although the beautiful science of chemistry has laid open to the moderns so many mysteries and secrets of nature, yet even now it is matter of curiosity and admiration to behold a colourless texture, after being immersed for a short time in a certain preparation, drawn forth exhibiting figures of vivid and varied colours durably marked on its surface.

This art is comparatively of recent introduction in England. At the beginning of the eighteenth century it was scarcely known. No branch of domestic industry has risen to perfection with greater celerity. At present the elegance of the patterns, the beauty and permanency of the colours, and the expedition with which the different operations are carried on, are truly admirable.

Working dyers divide colours into two classes,

* Bancroft, chap. vii. p. 173.

simple and compound. Simple colours are those which cannot be produced by the admixture of other colours. They are blue, yellow, red, and black; to these is usually added that peculiar brown colour, with a cast of yellow, which the French call *fauve*, and which English writers translate either fawn or dun. This is in fact a compound colour, but is ranked among the simple, because it can be applied to cloth by a single process.

The various vegetable substances which produce the above five colours form the subjects of this division of our volume. From different combinations of these are derived all those beautiful shades of colour which present a never-ending variety.

INDIGO.

The real nature of indigo was not generally known in Europe until a long period after it had been obtained *direct* from India, the country of its production, and many erroneous notions existed as to its nature at a comparatively recent period. In the letters patent granted to the proprietors of mines in the principality of Halberstadst, not *many* centuries ago, indigo was classed among the minerals, to obtain which the works were permitted to be erected.

Marco Polo, indeed, who flourished in the thirteenth century, and who is the earliest European traveller into China and India on record, relates that he saw indigo made in the kingdom of Coulan, and describes the process by which it was prepared. "Indigo," says the old Venetian, "of excellent quality and large quantities, is made here (Coulan). They procure it from an herbaceous plant, which is taken up by the roots and put into tubs of water where it is suffered to remain till it rots, when they press out the juice. This, upon being exposed to the sun and

Slaves gathering Indigo

evaporated, leaves a kind of paste, which is cut into small pieces of the form in which we see it brought to us." This passage of the Italian ought at least to have prevented the Germans from considering the product as a mineral which they were to seek in the bowels of the earth; but illiberal ignorance had thrown discredit on Marco Polo and ranked him among those travellers whose lies were proverbial. At two other places in India, Guzzerat and Kambaia, Marco speaks of indigo as an article of extensive manufacture. Much curious information in regard to the trade in this article at the middle of the fourteenth century is contained in the works of Francesco

Balducci Pegolotti. At that time indigo was imported in leather bags and in chests in the same manner as at present. Although for more than two thousand years its value had been recognised in Asia, still its use was either prohibited or restrained for a considerable period in different European countries, under the erroneous belief that its colour was fugitive.

About the sixteenth century improvements in the art of dyeing were attempted in several European countries. Among the many new methods employed some gave greater brilliancy, others greater permanency to the colours. Some, however, though they might impose on the eye, gave but an evanescent beauty of tint; while others subjected the stuffs to pernicious chemical preparations whereby their texture was injured and they were found "to rot on the shelves of the shopkeeper." Governments were in consequence induced to interfere by legislative enactments, to prevent their subjects from being imposed upon by "these false and pernicious dyes;" and prohibited at once the use of all the new materials which produced only fleeting shades, and which contained, or were supposed to contain, any thing detrimental to the stuff under preparation. Now these governments to their mistaken views of domestic policy united an equally profound ignorance of chemistry, and listening to the reports of the uninformed or interested, sometimes laid under one prohibitory ban the useful as well as the hurtful. In Germany a decree of the Diet, held in 1577, prohibited under the severest penalties "the newly invented, pernicious, deceitful, eating, and corrosive dye called the *devil's dye*, for which vitriol and other eating substances were used instead of woad."

In the middle of the next century the use of indigo was found to interfere with the cultivation and sale of woad, which had hitherto formed a considerable branch of industry with the Germans. A prohibition was therefore issued against its use in Saxony, and in order to raise a prejudice against it in the minds of the people, and that they might be blinded by the imposition of a name, it was classed among those substances already prohibited as *devil's dyes*, and this prohibition was for some years enforced with great vigilance and severity. The people of Nuremberg, who at that time cultivated woad, went still farther. They made a law that their dyers should annually take an oath not to use indigo. Although the dyers do not scruple to avail themselves in the present day of the superiority of this colouring matter the oath is still enforced; and this strange unrepealed edict may be classed among those demoralising relics of defective government which take from an oath its sanctity, and prepare the minds of the people to dread the penalty rather than to abhor the crime of perjury. The use of indigo was likewise forbidden in France from 1596 to 1669, when Colbert showed more enlightened views on the subject and the prohibition was repealed *.

It was not until after the discovery of America that indigo was obtained in any very large quantities in Europe. The plant from which it is prepared was found growing wild in most of the tropical parts of the western hemisphere. Its application was likewise well known. We learn from the authority of more than one traveller, that the Aztecs, the unfortunate aborigines of Mexico, were well aware of its value as a dye, and that it was commonly employed by them in giving a beautiful hue to their cotton fabrics. During the last century the cultivation of indigo has been almost entirely neglected by the Spanish Mexicans, from the preference given in Europe to the indigo of Guatimala, or central Ame-

* Beckmann.

rica, and the failure of the native cotton manufacture in which it was principally used. Since the Mexicans have shaken off the Spanish yoke their commercial and agricultural prosperity has become a subject of more rational interest and attention. Attempts are now therefore being made to revive, among other branches of industry, the cultivation of indigo. A little is now grown on the western coasts, and it has been introduced into the valley of Cuautla. In some parts, which are hot and marshy, it is a natural production of the soil *.

The indigo of Guatimala was long prized as the best, and although this plant was cultivated in the West Indies and other parts of America, none ever approached to the excellence of that of Guatimala, which was long rated in commerce as of unrivalled quality. This plant was much cultivated in the French West-India islands, and the government of the parent country took so great interest in its improvement as to appoint scientific men to investigate its preparation and to point out in what manner it was susceptible of improvement. It does not appear, however, that these exertions were attended with any very beneficial results, and although much was suggested, perhaps no real, certainly no very important, improvements were introduced in the mode of preparing indigo. That prepared by the French still ranked lower, though next in quality to the produce of Guatimala.

This plant was for some time cultivated in great abundance in Jamaica, forming one of its principal articles of exportation; but a tax having been laid upon it, the culture of sugar became a more profitable branch of agriculture. *Indigofera* was found growing spontaneously in Carolina in the year 1747, and so abundantly that 200,000 lb. were shipped to

* Ward's Mexico.

England, and sold at a very good price, though it was not quite so well prepared as the French indigo; its farther cultivation in North America has not, however, been very extensively prosecuted.

In the year 1787 another source for the supply of indigo was opened by the French, who then began to import cotton and indigo from their settlement at Goree, on the coast of Africa. This dye was pronounced by the English dyers to be almost equal to that of Guatimala, and superior to every kind of West-India indigo.

England, though now occupying so commanding a position in the commercial and manufacturing world, was for a long time slow not only in originating inventions and improvements, but even in adopting those of other nations. A long period elapsed after the discovery of America before indigo began to take its rank among the most useful ingredients of the English dye-house. Richard Hakluyt, at the close of the sixteenth century, mentions it as an object deserving of inquiry, as at that time it was not known in this country what plant produced the indigo. Instructions were therefore given to discover whether "*Anile* that blue colour be a natural commodity, or, if it be compounded of an herb, to send the seed or root with the order of sowing *." The French name of indigo is *Anil;* it is known under that term, or simply *Nil,* in South America, whence it was adopted by the French and Portuguese. It is remarkable that *Nile* is the Arabic name of the same plant. The name by which it is designated in English is evidently a corruption of the ancient *indicum,* but on its first introduction into England from America it was usually known as anil. In Chinese it is called *Tien haam,* which signifies sky blue †.

* See Collection of Travels, &c. † Clarke's Travels.

Indigo from America was for a long period very superior to that obtained from the East; and although this dyeing ingredient was recognised in commerce as coming from the East Indies, it was imported thence in small quantities, and of so indifferent a quality, as not in any way to compete with the western production. Scarcely twenty years ago, this was the relative position of the indigoes from America and Asia. Since then the judicious and spirited exertions of a few enlightened individuals have shown that by careful cultivation and preparation its character might be essentially improved in the British possessions in India. At the present day this article ranks among the most important objects of our commerce with the East Indies, while its quality has been raised far above that received from South America.

Various species of *indigofera* grow spontaneously in China, Hindostan, Japan, Java*, and Madagascar, as well as in America; all more or less differing from each other. Three species are cultivated in America. *Ind. tinctoria* is not so hardy, nor is its pulp so good as the others, though it yields a greater quantity, and therefore is generally preferred. The Guatimala plant grows much higher, it is hardier, and affords a better pulp than the *Ind. tinctoria*. The third, *Ind. argentea*, or wild indigo, is hardier than either of the others, and yields the finest pulp, though least in quantity; its culture is therefore not so profitable to the grower, and it is seldom found in indigo plantations.

Indigofera is a knotty shrubby plant propagated by seed. The *tinctoria* has a root of about a quarter of an inch in thickness, and more than a foot in

* According to Thunberg the plant which grew wild every where in Java was the "*indigofera anil*." In his time it was in some small degree cultivated by the Chinese settled in the island.

length; the root has a faint smell somewhat resembling parsley. From this root issues a short bushy stem of nearly the same thickness; this stem rises about two feet from the ground; it is hard and almost entirely ligneous, and without any appearance of pith in the inside. The leaves are winged, or consist of small leaves ranged in two or three pairs on each side of a long foot-stalk, which is surmounted by an odd leaf; they are of an oval form, smooth and soft to the touch, furrowed above, and of a darker colour on the upper than the under side. From about one-third of the stem to the extremity, there are ears that are loaded with very small flowers from twelve to fifteen in number; these are destitute of smell; they are succeeded by long crooked brown pods, which contain small yellow seeds. The wild indigo has shorter pods and black seeds. The seeds of the Guatimala are green, and the stalks red. This plant requires a smooth rich soil, well tilled, and neither too dry nor too moist. Indigo is entirely the production of a warm climate; it has been observed, that "it is the child of the sun," and cannot be advantageously cultivated any where except within the tropics*. A higher temperature than 60° is absolutely necessary both for its vegetation and maceration.

The seed is sowed in little furrows about the breadth of the hoe, and two or three inches in depth. These furrows are made a foot apart from each other, and in as straight a line as possible. A bushel of seed is sufficient for five acres of land. Though it may be sown in all seasons, spring is mostly preferred for the purpose. Soon after sowing, continual attention is required to pluck the weeds, which would quickly choke up the plant, and impede its growth. Sufficient moisture causes it to shoot above the surface in three or four days, and it is usually fit for gathering

* Edwards's West Indies.

at the end of two months. When it begins to flower, it is cut with a sickle a few inches above its roots. The ratoons, or subsequent growth from the same plant, ripen in six or eight weeks. Sometimes four crops are obtained in one year from the same roots; but in North America and other parts where the heat of the sun is less fervid, the cultivator obtains but two, or perhaps only one crop. The produce diminishes fast after the second cutting, and therefore it is said to be absolutely necessary to sow the seeds afresh every year, or every two years at farthest *.

The Arabs in Egypt however sow the seed of this plant only once in seven years, and obtain two crops in the year †. The sun, which so rapidly improves and invigorates the plant, propagates at the same time an insect destructive to it. This is a species of grub or worm, which, becoming a fly, preys on the leaves and too often disappoints the planter's expectations, especially when the plant is grown a second year upon the same land. The only known remedy is to change the soil every year. This plant has not only to contend against the vicissitudes of the seasons and the ravages of the insect peculiar to it, but the leaves, which are its most valuable part, are liable to the depredations of caterpillars, myriads of which sometimes attack a plantation, and devour all the leaves in the short space of twenty-four hours.

The colouring matter is obtained from the whole plant. There are two modes used for its extraction —it is fermented, or it is scalded. The first method is universally practised in South America and the West Indies; and almost wholly by the English factors in the East.

In an indigo house, where the fermenting process

* Stedman's Surinam; Edwards's West Indies.

† Clarke's Travels.

is pursued, the chief apparatus consists of three wooden vats of different sizes, placed on different levels, so that the contents of the first may flow into the second, and those of the second into the third. The plants, on being cut, are laid in the first or steeping vat, in sufficient quantity to fill it without receiving pressure, and water is poured over them until it rises about three inches above the level of the top plants. A frame of heavy wooden bars is then laid on the vat to prevent the plants from rising when in fermentation. This state is generally induced in less than eighteen hours. The contents swell and foam; large bubbles of gas are formed, which on being disengaged appear of a lively green, and tinge the whole vat of the same colour. When at the highest, the fermenting mass is covered with a brilliant copper-coloured scum, which passes into violet towards the end, but the pulp and liquor remain green. The gas given off during the process is inflammable *. The heaving of the scum is so powerful as often to lift up the heavy wooden frame above mentioned. This fermentation is carried on for the purpose of extracting all the grain or colouring matter from the plant, and it is a nice point to ascertain the exact period when it ought to cease. If the fluid be drawn off too soon, much of the pulp is left behind, and if too late, the tender tops of the plant occasion putrefaction, by which all the dye is destroyed. Many plans have been suggested to discover to a scientific certainty the most advantageous degree of fermentation. Experiments were made at St. Domingo, when the French possessed that island, under the sanction and encouragement of the Chamber of Agriculture; but the unsatisfactory result only served to convince practical men that they could not with safety trust to any test save that of experience.

* Aikin's Chemical Dictionary.

In order to ascertain the state of fermentation it was recommended to dip a pen, at intervals of every quarter of an hour, into the contents of the vat, and to make with it a few strokes on paper: when the marks thus made are colourless, it is the proper period for arresting the fermentation. Much practical skill is required in seizing on this moment, in which the fermenting mixture assumes the appearance of a liquor, holding in suspension a distinct green pulp, which by slight agitation speedily and completely separates and falls to the bottom, leaving a clear gold-coloured supernatant fluid. The whole of the turbid green liquor is then discharged from the steeping vat, and passes into the second vessel. The first vat is then immediately cleansed, fresh plants are thrown in, and the work proceeds without intermission. The refuse matter is carefully removed from the house as soon as taken out. The noxious odour of this refuse occasions the peculiar unhealthiness incident to the occupation.

As soon as the liquor is received into the second vat, it is violently beaten by the repeated fall of wooden buckets, full of holes, and fixed to long handles moved by manual labour or other power. A more complicated mechanical contrivance is sometimes employed. This agitation of the parts, by checking any farther fermentation, prevents putridity, and especially promotes the separation of the grain, as it is technically called, or the dark coloured granular pulp, which is the indigo. The whole of the liquor and of the pulp change during the process from green to deep blue. A large quantity of air-bubbles are also expelled by the beating. Lime-water is most usually added at this time, as it greatly assists in the formation of the grain. When the grain, on being left in a quiescent state for a brief period, separates readily from the liquor which holds it suspended, the agitation is stopped, and the grain slowly subsides. The same degree of nicety is required to discover the exact point for the cessation of agitation as for determining that of fermentation. If too little beaten, the grain will not be sufficiently separated; if too much, a second fermentation would be excited, which would alter the dye, spoil its colour, and make what is called *burnt indigo*. From time to time, therefore, a little is drawn off and examined.

When the grain is precipitated, the liquor floating on the top is drawn off by means of cocks, and suffered to run to waste; care being taken to avoid mixing it with any brook or cattle pond, as it contains poisonous qualities which would be fatal to animals who might drink it. The thick pulpy matter is then discharged into the third or lowest vat, and after it is still more disencumbered of superfluous water, it is laded into common sacks. These are hung up that the water may drain off, the indigo itself being too thick to pass through. After draining it is transferred to small wooden boxes, where it is farther dried by exposure to alternate sun and shade.

In the indigo factories of Bengal, some part of the moisture is driven off by the direct application of fire heat. This is done after the colouring particles have been separated from the solution by beating. The indigo is then removed from the agitation vat into a boiler, the bottom only of which is of iron, while the sides are built up of solid masonry. Of course only this bottom can be exposed to the action of the fire, by which circumstance the efficiency of the vessel is importantly diminished; fuel is wasted, because that portion of the heated air which should apply to the sides, is prematurely drawn off into the chimney; time is lost, since the fluid will necessarily impart to the masonry a portion of the heat which it is made to imbibe; and, for this last reason, the liability of the indigo to the far greater evil of charring is much augmented. If a better arrangement were provided for this purpose, the process would be materially simplified, and might be carried farther than is now consistent with prudence.

When the indigo is brought by this means to that degree of consistence which is safely practicable, the thickened fecula is transferred to large cloths wherein the evaporation is further continued by exposure to atmospheric influence.

This intermediate operation of boiling is considered to be beneficial in arresting a second fermentation of the fecula, to which it is sometimes liable during the process of draining, while the farther advantage is obtained of holding in solution the gummy and other matter unavoidably extracted with the colouring matter. This extraneous part thus passes off with the water, and leaves the indigo in a purer state. The superior quality of the Bengal indigo is attributed to this method of preparation.

If dried hastily in the sun it is apt to become brittle. When all moisture is expelled, and the substance is quite solid, it is cut into square cakes. The process is not yet, however, completed. If exported in this state it would speedily become mouldy; a second fermentation is therefore necessary. To produce this the cakes are heaped in a cask and simply suffered to remain there for about three weeks. During this time they undergo a degree of fermentation; they become heated, moisture exudes from the surface, a most disagreeable odour is emitted, and finally the cakes are covered with a fine white meal. They are then taken out and dried in the shade for five or six days, when they are in a fit state to be packed for exportation.

The second method by scalding, instead of fermentation, was first proposed for adoption by Dr. Roxburgh, and its great advantages over the usual process were forcibly pointed out. The method of obtaining the colouring matter, however, by boiling the plant was by no means the invention of Dr. Roxburgh, although that gentleman has the merit of investigating scientifically the peculiar nature and properties of indigo, and of adopting and recommending a treatment of it in accordance with his more enlightened views on the subject. The Hindoos and the Egyptians both pursue this apparently more simple process.

In Egypt the plants are dried previously to being put into an earthen jar with hot water. They are then worked with a palm branch, in the manner of churning, until the whole of the colour is pressed out. The liquid is next strained through the bark of a tree into another jar. It is left there for eight or nine days, during which time part of the water escapes by trickling through a small aperture half way down the side of the containing vessel, leaving the sediment at bottom. This residuum is afterwards poured into a broad but very shallow hole formed in the sand, which absorbs the remaining liquid and leaves the indigo in solid cakes on the surface*.

The Hindoo method at Ambore is somewhat similar, though more elaborate. The plants are first boiled in earthen pots of about eighteen inches diameter, disposed in the ground in excavated ranges, from twenty to thirty feet long and one broad, according to the number used. When the boiling has extracted all the colouring matter ascertainable by the colour exhibited, the extract is immediately poured into another small jar fixed in the ground for its reception, and is then filtered through a cloth, and laded by means of small pots into a larger jar disposed in ad-

* A Journey to two of the Oases in Upper Egypt, by Sir Archibald Edmonstone, Bart.

joining higher ground. The contents of the larger jar, when three-quarters full, are agitated with a split bamboo extended into a circle, having a diameter from thirteen to twenty inches; this hoop is twisted with a sort of coarse straw, with which the manufacturer proceeds to beat or agitate the extract until a granulation of the fecula takes place. This operation occupies nearly three-quarters of an hour. A precipitant compound of red earth and water*, about four quarts, is poured into the jar. The whole stands during the night; in the morning the supernatant liquor is drawn off through apertures in the side of the jar, the lowest reaching to within five inches of the bottom, thus leaving just sufficient space to retain the fecula, which is taken out and dried in bags†.

The method by scalding has only been very partially adopted among the English in the East; the dyers of this country not reporting favourably of Indigo thus made. It is said that it contains much less colouring matter than that obtained by fermentation, and that the dye produced is not so permanent.

The indigo factories in the East Indies are conducted very differently from those in the West, on account of the dissimilar circumstances of the population of the two countries. In the West Indies the indigo plantations, and the works connected with its preparation, are all the same property and under the same superintendence. In Bengal and other of the British possessions in India the cultivation is exclusively left to the Ryots, or native farmers, who are provided with seed by the factor, and bound to deliver

* This red earth and water debase the indigo. In the northern parts of the coast of Coromandel the natives use a cold infusion of the bark of the jambolong tree *(jambolifera pedunculata)*, which is a very powerful astringent to precipitate their indigo. This indigo is of a very good quality.—Dr. Roxburgh.

† Asiatic Researches, vol. iii.

at a certain rate of price the whole of the plants produced from these seeds. The cultivators, in consequence of failures in crops, or other accidents, too frequently require advances from their employer; and thus, though nominally free, they are in reality subjected to him, and compelled to raise the indigo exclusively for the supply of his factory. These factories are generally on a very large scale, by which a much greater quantity of colouring matter is produced, than would result if natives were employed in its preparation as well as in its cultivation. It is calculated that in the European method one man can bring to issue one vat, containing fifty bundles of indigo plants, which, according to quality, will afford from ten to thirty pounds of indigo; whereas by the Indian method one man employed during the same time will produce only one pound of indigo*.

The extensive indigo factories are nearly always remote from the seat of the English presidencies. The superintendence of an establishment is seldom intrusted to any but one of its proprietors; who, entirely excluded from the society of his countrymen, consents to many privations, with the hope that in a few years he may reap sufficient wealth to ensure to his future life those enjoyments for whose possession he has been willing to sacrifice, as it were, a part of his existence. As soon as he has accomplished this end, he usually resigns his situation to a junior partner, who pursues the same course.

These expectations are not, however, always fulfilled. The profits of an indigo property are in some seasons greater than those afforded by almost any other investment. One acre of rich land, by proper cultivation and management, may be made to yield annually 500 pounds of indigo, and in some years indigo of the best quality has in England been as

* Asiatic Researches.

high priced as eleven shillings per pound. According to both Edwards and Stedman 300 pounds are produced on ordinary land, and the labour of four persons is required for the cultivation of five acres, and the subsequent preparation of the produce.

The large returns consequent on favourable crops, and the high prices of the home market for a few successive years, lead to the belief that the profits will always be thus excessive; and although the frequent and disastrous casualties which follow these periods of prosperity should excite doubts as to the realization of all the extravagant expectations which are so sanguinely indulged, yet the confidence which each person has in his own peculiar "luck," or superior management, too readily induces him to become a participator in the cares and hopes of an indigo factory.

It might be supposed that establishments thus superintended by persons who are deeply interested in their success, would be conducted in the best possible manner; while improvements would be continually suggesting themselves, by which favourable results might be attained with greater certainty. Surprise must therefore be excited when we find that very little scientific knowledge is engaged in the pursuit, and that the whole is arranged and conducted by means at variance with philosophical principles, a due attention to which might often produce totally different results.

Until within the last few years, since the appointment of Lord William Bentinck as Governor-General of India, Europeans were not allowed to take the land in their own hands for agricultural purposes, and they were therefore of necessity dependent on native industry for the produce of the soil. The cultivation of indigo was thus left to the care of the indolent and prejudiced Hindoo, who from age to age is found obstinately pursuing the same track, without deviation or improvement, making no attempt to discover the cause, or arrest the progress, of those ravages so often fatal to his whole crop, but which the superior intelligence of skilful European agriculturists might perhaps successfully combat.

The uncertainty of this production, though in the present day more known and felt in the East, was equally great in the West Indies during the time when its cultivation formed there an object of importance. In a statement of the comparative advantages of different crops, Mr. Edwards, after dwelling on the extreme productiveness of indigo, thus continues: "Unhappily, however, the golden hopes which speculations like these have raised in the minds of thousands have vanished on actual experiment like visions of the morning. I think I have myself, in the course of eighteen years in the West Indies, known at least twenty persons commence indigo planters, not one of whom has left a trace by which I can now point out where his plantation was situated, except perhaps the remains of a ruined cistern covered by weeds and defiled by reptiles. Many of them too were men of knowledge, foresight, and property. That they failed is certain, but of the causes of their failure I confess I can give no satisfactory account. I was told that disappointment trod close at their heels at every step. At one time the fermentation was too long continued, at another the liquor was drawn off too soon. Now the pulp was not duly granulated, and now it was worked too much. To these inconveniences, for which practice would doubtless have found a remedy, were added others of much greater magnitude,—the mortality of the negroes from the vapour of the fermented liquor, the failure of the seasons, and the ravages of the worm. These or some of these evils drove them at length to other pursuits where industry might find a surer recompense*."

To this melancholy statement may be added the fact, that of all the productions that have been made objects of great commercial speculation, not one has of late years so tended to swell the sad list of bankruptcy and ruin as "indigo."

The prepared indigo of commerce is usually imported in square, or oblong cakes, of an intense blue colour, approaching to black. The specific gravity of the best quality is small. It has a peculiar and disagreeable smell.

There is no article of commerce which fluctuates more in its price and is of greater variety of quality than indigo. It is distinguished according to its different shades of colour, arising from the manner of its preparation and the proportion of foreign substances with which it is mixed. The principal shades are blue, violet, and copper colour; the blue being the best quality. These are again subdivided into fine, good, and middling. The indigo which is imported from different countries is known in commerce by its relative value, and accordingly there are no less than twenty-four kinds in the English market, each bearing a different price, varying through all the intermediate proportions from 8*s.* 6*d.* to 2*s.* per lb.; Bengal is the best, and Manilla indigo the worst in quality. In 1831, 7,307,313 lbs. of indigo were imported into England. The duty on that coming from British possessions is 3*d.*, on other sorts 4*d.* per lb.

However carefully indigo may be prepared, there are always more or less of impurities mixed up with it. The relative quantity of these is ascertained by the specific gravity of the indigo, which is lighter in proportion to its purity. Bergmann found that the

* Quarto edition, vol. ii. p. 282.

best indigo which he could procure contained more than half of extraneous matter, being in these proportions:—

Pure indigo . .	47
Gum . . .	12
Resin . . .	6
Earth . . .	22
Oxide of iron . .	13
	100

Proust, on subjecting indigo to analysis, found it to contain a large proportion of magnesia*. This substance has very singular chemical properties. It is now well ascertained to be composed of the fecula of the plants combined with oxygen, to which it has so great an affinity that its transition from green to blue on exposure to the atmosphere is instantaneous. Pure indigo is insoluble in water, alcohol, ether, or oils; neither alkalis nor earths have any action on it, nor have any of the acids hitherto tried, except the nitric and sulphuric. Nitric acid converts its colour into a dirty white, and finally decomposes it completely. Sulphuric acid dissolves it, and causes it to acquire a more lively, though a less durable colour than it naturally possesses. This peculiarity has been taken advantage of by the dyers, and sulphate of indigo, under the name of Saxon blue, is a well known ingredient of the dye-house. Its application was first discovered and carried on in Saxony in the year 1740—whence its name. That powerful chemical agent, chlorine, instantly decomposes indigo.

This valuable dye has a strong affinity for almost every species of fibrous texture, whether animal or vegetable; it can therefore impart to all descriptions of stuff a very permanent colour, without the assistance of a mordant. By the superiority and richness of its dye, the facility with which it is worked,

* Nicholson's Journal, vol. iii.

and the other advantages attending its employment, indigo has nearly superseded the European woad as a first colour; woad being now rarely used except as an auxiliary. Indigo can only be applied as a dye in a state of solution, and must consequently be deprived of its oxygen, to be rendered again soluble in water. Ingredients therefore, having a strong affinity for oxygen, are mixed in the vat together with the indigo, whereby it is again held in a state of solution. To produce this effect, the dyers usually employ protoxide of iron, to deoxidize it, and lime-water to render it soluble in its yellow green state*. Bancroft considers that its colouring matter is somewhat injured by this process, and supposes that the very durable blue dyes of some nations, in different parts of Asia and Africa, are derived from the indigo plant employed when the colour is first extracted by steeping and fermentation. The Chinese are said thus to apply this dye, and the Africans use it in a way nearly similar. Mr. Clarkson has remarked that the dyes of Africa are superior to those of any other part of the globe. The blue produced there is so much more beautiful and permanent than that which is extracted from the same plant in other countries, that many have been led to doubt whether the African cloths brought into this country were dyed with indigo. It was believed that this vivid and permanent African colour, which obtained more lustre by repeated washings, must have been derived from some other plant, or extracted from some of the woods of the country celebrated for imparting beautiful colours. It has, however, been clearly ascertained, that the balls of indigo, prepared by the Africans, are simply the leaves rolled up. Two or three of these balls have been procured, and subjected to chemical examination.

M. Adanson, in noticing the indigo cultivated by

* Ure's Chemistry.

the negroes in Senegal, observes that these people do not take much trouble to draw the dye out of the plant. The leaves are gathered at any time in the year, and merely pounded in a mortar till reduced to a paste. This paste is made up into leaves in order to be preserved dry. When required for use it is dissolved in a kind of ley, made of the ashes of an unctuous plant which grows in the fields, and is called by the natives *rhemi*,—in this, the cloth to be dyed is immersed. It is supposed that indigo in this state will keep as long as that which has received the usual preparation; but the enhanced expense of freight caused by the much greater bulk of the article thus simply prepared, is perhaps a sufficient objection to its importation in that form.

Indigo is imported into England at a duty of threepence per pound for that grown in British possessions; the addition of another penny per pound is placed on that coming from foreign ports.

The average quantity of this substance annually imported, for the last five years, is 27,342 chests of East Indian, weighing from 2 to 3 cwt. each; and 3,151 serons, Spanish, weighing about 250 lbs. each; a considerable portion of which is re-exported to the continent of Europe.

Another species of indigo was discovered by Dr. Roxburgh, to which he gave the name of *cœrulea*, from the beauty of its colour. It is an erect shrubby species growing naturally in some parts of India on dry, barren, uncultivated grounds, to the height of from one to three feet, and still higher in a better soil. It mainly resembles the *indigofera argentea*, somewhat differing from that plant in the shape and growth of its leaves. A much finer indigo of a lighter colour was obtained from it, and in a larger proportion, than from the common plant. Eight pounds of these leaves gave two hundred and forty grains of indigo. Another species of indigo, called by Thunberg the *indigofera arborca*, was cultivated by the Dutch colonists at the Cape of Good Hope.

In the year 1792 Dr. Roxburgh transmitted home a sample of indigo prepared from the leaves of a species of rose bay, which he distinguishes by the name of *Nerium tinctorium*. From the excellent quality of this indigo, and other advantages attending its cultivation and preparation, it might have been supposed that the *nerium* indigo would quickly have become an article of commerce, and have been in much request among our dye-houses; but it has not yet taken its place among the imported eastern productions, though it should seem that the extensive cultivation of this tree would be attended with much less labour and cost, and offer a greater certainty of profit than the common indigo plant.

The *nerium* grows plentifully throughout the Carnatic, and in every part of the Circars where there are hills and mountains, being an extent of about a thousand miles in length. Near inhabited places it is so often cut down for fire wood, that in such situations it is always found in the state of a very small tree or a large bush. But when suffered to reach its full growth, it attains to the height of from eleven to fifteen feet up to the branches. Its trunk, which is of an irregular shape, is about a foot and a half, to two feet in diameter. Its bark when old is scabrous, but when young smooth and ash-coloured. The wood of this tree is remarkably white and close-grained, in appearance resembling ivory. The leaves are oval, pointed, tolerably smooth, and of a pale green colour; they are very numerous, and when full-grown, from six to ten inches long, and from three to four inches broad. To cause a greater production of leaves, it should be cut low as the mulberry-trees are for feeding silkworms, and like them the oftener it is cut down the greater is its disposition to increase. Many shoots issue from the old stumps, and in the space of one year these shoots grow to various heights—from one to ten feet, according to the nature of the soil and season. The leaves fall at the commencement, or during the colder part, of the year. In March, or the beginning of April, the young leaves together with the flowers first make their appearance. Towards the end of April, those which were earliest in unfolding attain to their full size. This period was found by Dr. Roxburgh to be the most favourable for gathering the leaves; about this time also it ceases flowering, and many of the seed-vessels become prefectly formed, though the seeds do not ripen until January or February. The leaves remain in a fit state for gathering until about the end of August, when they begin to acquire a yellow rusty tinge, and are gradually cast. The colouring matter resides in the leaves alone; all trials to extract any from the twigs proved unsuccessful. Indigo is prepared from these leaves in the same manner as from the indigo plant by the scalding process. The leaves of the *nerium*, unlike those of the common *indigofera*, will not yield their colour to *cold* water, but by *hot* water it is readily extracted. Hard spring water is found preferable in increasing the quantity and improving the quality of the indigo. After being exposed to the action of the fire for about three hours, the leaves begin to assume a yellow hue, then the scalding has been sufficiently pursued, and as the agitation and precipitation do not consume a longer time, the whole process is very speedily completed. From two to three hundred pounds of green leaves yield one pound of indigo.

Mr. Marsden, in his valuable history of Sumatra, informs us, that the inhabitants of that island have a kind of indigo which seems to be peculiar to their country. They call it *tarroom akkar*. Totally unlike the common indigo, it is a vine or creeping plant, with leaves four or five inches long, in shape like a laurel, but finer, and of a dark green colour. Its qualities are, however, precisely the same as those of the common indigo; there is no difference in their colours, they are prepared in the same manner, and used indiscriminately, no preference being given to one above the other, except that the akkar, by reason of the superior size of its leaves, yields a greater proportion of sediment.

The people of Sumatra do not manufacture either sort of their indigoes into a solid substance, as is practised elsewhere in the East, and in the West Indies. They merely soak and macerate the stalks and branches for some days in water, then boil it and work with their hands some quick-lime among it, with leaves of a species of fern, for fixing the colour. They then drain it off and use it in its liquid state.

The Japanese cultivate three other plants—the *Polygonum Chinense*, *barbatum*, and *aviculare*, for the same purpose, and procure from each of them a beautiful blue colour resembling that from indigo. They dry the leaves, then pound them and mix them up into small balls or cakes, which are sold in the shops ready for use. When they are to be used they boil these cakes in water, adding some ashes to the decoction. This liquid dye is equally available for linen, silk, and cotton.

WOAD.

Woad, or *Isatis sativa*, is a plant, probably, which from the earliest times has been used for the purposes of dyeing. The ancient Britons, when first invaded by the Romans, are described as having

Woad—*Isatis sativa.*

their bodies stained with the colouring matter of this plant. Pliny, in his description of the plant, while he notices its use by the dyers, chiefly dwells upon its medicinal qualities *.

Woad affords a substantive blue colour, extremely durable and substantial, which may not only be reduced to many different shades, according to the quantity employed, but is likewise of great use in dyeing and fixing many other colours.

* Lib. xx. cap. 7.

For many centuries it has been an ingredient of great importance with English dyers. So early as the year 1198 we find it in very extensive use, and it continued an article of increasing trade until the introduction of indigo, when, as it has been already observed, woad began to decline in consideration. Its natural colour is a deep blue, almost approaching to black. Indigo affords a much more lively and pleasing hue, while it contains, beyond all comparison, a proportionate greater quantity of colouring matter; but it is less permanent than woad, which is therefore still used in conjunction with that and other dyes, but now seldom employed by itself. Its price has been lowered by its lessened consumption, and consequently there is not so much inducement held out for its careful cultivation and preparation. The colour now sold is consequently much inferior to that formerly prepared; and it is supposed that a more careful management might be productive of great improvement in this dye.

Woad is cultivated in the Azores and the Canary Islands, in Italy, in Switzerland, and in parts of Germany and of Sweden. It is likewise indigenous to England, and is very extensively grown in Lancashire, where it is much used. This plant is also cultivated and prepared in various parts of France. That of the southern departments is the most esteemed, and is distinguished by the name of *Pastel*. Another species, the *Isatis lusitanica*, is grown in Portugal and Spain. This differs from the *Isatis sativa* in being of smaller growth, and having narrower leaves. A species of woad, apparently the same plant as that used by the dyers, is found growing wild in some parts of France, and on the coast of the Baltic sea.

This plant is biennial, having a large woody root, which penetrates deep into the ground. The stem is from three to four feet high, and about half an inch in diameter, dividing into several branches, which are loaded with many leaves of a lucid green colour, and sitting close to the stalk. They are thick, and of a long oval form, terminating in obtuse points, generally about a foot long, and half a foot broad in their widest part. The branches are surmounted by small yellow flowers, disposed in panicles; these appear in July, and are succeeded by seeds, which come to maturity in September. The soil in which this plant succeeds best is a gentle hazel loam, whose parts will easily separate; that is, a medium between a light, sandy, and a stiff, moist soil. Three or four crops are usually obtained in one year. The first when the stems begin to turn yellow and the flowers are about to appear; the others at successive intervals of six weeks, or more, according to the temperature of the climate. The two first gatherings render the best woad. The plants are mowed down with a scythe, and as soon as collected are washed in a stream of water, and dried in the sun. The desiccation must be rapidly performed: if the season be unfavourable, and the woad be exposed to rain, it will run the hazard of being spoiled. A single night is sometimes sufficient to turn it black. Immediately on being dried from the effects of the washing, it is conveyed to a mill, resembling the oil and tan mills, and is ground into a smooth paste. If this process were deferred for any time it would speedily putrefy, and emit an intolerable and unwholesome odour. This paste is laid in heaps, which are pressed close and smooth, and then covered to protect them from rain. A blackish crust is soon formed on the outside, which, if it happen to crack, is carefully reunited. Should this be neglected, little worms would be produced in the cracks, and the woad lose part of its strength. After remaining thus covered a fortnight, the heaps are opened, and the crust rubbed and mixed with the inside. This matter is then formed into solid balls, which are pressed into a compact substance in wooden moulds. These balls are dried upon hurdles; if exposed to the sun they turn black on the outside, but in a sheltered place they become of a yellowish hue. Dealers in this commodity usually prefer the first, though it is said that there is really no material difference between the two descriptions. Good balls are distinguished by their superior weight, and by exhibiting, on being rubbed, a violet colour within.

These balls require a farther preparation before they can be converted to the purpose of dyeing. They are first beaten with wooden mallets on a brick or stone floor, until they are reduced to a coarse powder. This is heaped up into the middle of the apartment to the height of about four feet, space being left to allow a sufficient passage round the sides; it is then moistened with water, which speedily induces fermentation, and thick fetid fumes are emitted. The heap is daily moistened and stirred about with shovels, for the space of twelve days, after which period it is moved less frequently, and without being watered. At length it is made into a heap for the dyer. Dr. Bancroft observes, that the proper mode of conducting the fermentation, and the exact time at which it ought to be stopped, still remain so uncertain that those who make it their business to prepare woad have no decided facts or indications to govern their management in this respect; and the goodness of any particular quantity can never be ascertained otherwise than by actual use. The powder thus prepared gives only brownish tinctures, of different shades, to aqueous, spirituous, or alkaline menstrua; rubbed on paper it communicates a green stain. If the powder be diluted with boiling water and allowed to stand for some hours in a close vessel, then, with the addition of about one-twentieth of its weight of newly slacked lime, on exposure to a gentle heat, with frequent stirrings of the fluid, a fresh fermentation takes place, a blue froth rises to the surface, and the liquor, though it appears itself of a reddish colour, dyes woollen of a green colour, which, like that from indigo, changes to a blue, as soon as exposed to the atmosphere. Its nature is very similar to that of indigo in every respect, and experiments have been made which prove the identity of their colouring matter. If the woad plant be prepared like the *indigofera*, indigo will be afforded, though in a much less proportion than that obtained from the exotic plant.

The average produce from an acre of land is about one ton of woad; in very favourable seasons sometimes one and a half ton are obtained. It requires change of soil; the best land is injured by being sown more than twice successively with woad. It is imported into England at rather a heavy impost duty of 3*s*. per cwt., its price being from 18*s*. to 20*s*. the cwt.

The number of vegetable substances used by us for dyeing blue is very cirumscribed, indigo and woad being the only two which are of extensive adoption. A few others may be enumerated, but these are of little importance.

CHAPTER XIX.

SUBSTANCES WHICH AFFORD A VIOLET DYE.

LOGWOOD—OTHER PLANTS.

ALL the intermediate shades of violet, purple, &c. may be obtained from the mixture of red and blue, varying according to the different proportions wherein these colours are applied. There are, however, some few vegetable substances which yield a violet or purple dye without being combined with another colour, and therefore a notice of these claims a separate chapter.

The most important of these is logwood which is largely used in dyeing, and more especially in combination with other ingredients to form a black dye; the natural colour it imparts is however violet, it cannot therefore be classed among those dyes which are wholly used in the production of a black colour.

Logwood, or *Hæmatoxylum campechianum*, is a native of the western world, having been first discovered in the bays of Campeachy and Honduras growing in the greatest luxuriance and abundance. It was known as a dye-wood as early as the reign of Elizabeth, but its use was forbidden by an act of parliament for "abolishing certain deceitful stuffs employed in dyeing cloths." The act sets forth "that logwood, or blockwood, of late years brought into this realm, is expressly prohibited to be used by dyers, the colours thereof being false and deceitful to the queen's subjects at home, and discreditable beyond seas to our merchants and dyers." The injunction against the use of this valuable dye was

Logwood Tree.

rigorously enforced, and all logwood found was seized and condemned to be burnt. The English were probably at that time ignorant of the manner of applying this dye with proper mordants. The prohibition was continued until the year 1661, the words of the act by which it was then repealed stating "that the ingenious industry of these times hath taught the dyers of England the art of fixing colours made of logwood, so that by experience they are found as lasting and serviceable as the colour made with any other sort of dye-wood."

Immediately after this repeal logwood became in great request, and adventurous individuals were induced to make exertions to obtain a supply. This tree is one of the productions of the province of Yucatan, where the possessions of the Spaniards for a long time consisted only of the port of San Francisco de Campeachy, and two other inconsiderable towns, Merida and Valladolid. These could boast of but few inhabitants, and the rest of the province was wholly desolate, without any indication of the abode of man. The English, from the north continent of America, in the year 1662, tempted by the desire of pursuing a profitable occupation, ventured to cut down some of the logwood-trees, which grew in great abundance on the uninhabited parts of the coast of Yucatan, and more especially in the bay of Campeachy. These persons soon formed a small colony in a spot remote from any Spanish settlement. They first raised their huts near Cape Catoche, and afterwards at Laguna de Terminos, which was found to be a more eligible situation. A few settlers thus continued to cut logwood unmolested by the Spaniards, but always with the feeling that they were intruders on the soil of other colonists.

After the treaty of Madrid in 1667, which was principally made for adjusting our commerce with Spain in Europe, British subjects were led to imagine that the respective interests of the two countries in the western hemisphere had also been accurately defined by the same treaty, and that the right of the English to cut logwood in those places of the Honduras, uninhabited by the Spaniards, was now clearly established. Many other persons were therefore in consequence induced to become logwood-cutters at Laguna de Terminos, so that in a year or two the number of settlers was greatly increased, and they transported large quantities of wood both to Jamaica and New England. The Spaniards for many years made no expostulations or complaints, and the English logwood-cutters continued to increase and flourish.

At first a sufficiency of wood was found near the coast, but when this, after a time, became exhausted, the settlers gradually penetrated farther into the country, where they planted Indian provisions, and built houses. The jealousy of the Spaniards was at length excited by this growing colony, and suddenly evinced itself very unceremoniously by the seizure of two English ships laden with logwood. The settlers of Laguna immediately made reprisals by taking possession of a Spanish bark. These mutual acts of violence were only the commencement of a series of hostilities, and after suffering much annoyance, the English settlers were, in 1680, forcibly ejected by the Spaniards from the island of Trist and from Laguna de Terminos. This triumph on the part of their adversaries was, however, but transitory, and in two or three months the English were again cutting their logwood, and trading in it more extensively than ever. Notwithstanding the continued opposition of the Spaniards the indefatigable settlers still contrived to increase their supply of that article, for whose possession they hazarded so much. Independent of the vexatious warfare by which they were constantly harassed, the lives of these poor wood-cutters were marked with hardship and privation; sometimes they worked up to their knees in water, and they were always tormented by the stings of innumerable insects.

We learn from Dampier that the commodities sent from Jamaica to procure a return cargo of logwood from Campeachy, were rum and sugar, "and very good commodities," says the sailor, "were these for the logwood-cutters, who were then (1675) about 250 men, most English." * * * "Neither was it long," he adds, "before we had these merchants come on board to visit us; we were but six men and a boy in the ship, and all little enough to entertain them: for besides what rum we sold by the gallon or firkin, we sold it made into punch wherewith they grew frolicksome. We had none but small arms to fire at their drinking healths, and therefore the noise was not very great at a distance, but on board the vessel we were loud enough till all our liquor was spent. We took no money nor expected any, for logwood was what we came hither for, and we had of that in lieu of our commodities after the rate of five pound per ton to be paid at the place where they cut it *."

This occasional festivity, a prospect perhaps of making more than by regular labour in the British colonies, and the entire freedom from all restraint, were circumstances likely to recommend the life of a logwood-cutter in spite of its frequent hardships. It had such charms to the adventurous Dampier himself that he soon returned and settled for ten or twelve months at Campeachy, and left that place with the intention of again returning for a longer stay. He thus quaintly describes the manner in which the logwood men lived.

"The logwood-cutters inhabit the creeks of the east and west lagunes in small companies, building their huts by the creeks' sides for the benefit of the sea breezes, as near the logwood groves as they can, removing often to be near their business: yet when they are settled in a good open place, they choose rather to go half a mile in their canvas to work than

* Voyage to the Bay of Campeachy.

lose this convenience. Though they build their huts but slightly, yet they take care to thatch them very well with palm or palmet leaves, to prevent the rains, which are there very violent, from soaking in.

"For their bedding they raise a barbecue, or wooden frame, three foot and a half above ground, on one side of the house, and stick up four stakes, at each corner one, to fasten their curtains; out of which there is no sleeping for moskitoes. Another frame they raise covered with earth for a hearth to dress their victuals; and a third to sit at when they eat it. During the wet season, the land where the logwood grows is so overflowed that they step from their beds into the water, perhaps two foot deep, and continue standing in the wet all day till they go to bed again; but nevertheless account it the best season for doing a good day's labour in.

"Some fell the trees, others saw and cut them into convenient logs, and one chips off the sap, and he is commonly the principal man; and when a tree is so thick that after it is logged it remains still too great a burden for one man, we blow it up with gunpowder. The logwood-cutters are generally sturdy strong fellows, and will carry burthens of three or four hundred weight; but every man is left to his choice to carry what he pleaseth, and commonly they agree very well about it: for they are contented to labour very hard. * * * In some places, especially in the west creek of west lagune, they go a hunting wild cattle every Saturday to provide themselves with beef for the week following. * * * When they have killed a beef they cut it into quarters, and taking out the bones, each man makes a hole in the middle of his quarter, just big enough for his head to go through, then puts it on like a frock and trudgeth home; and if he chanceth to tire, he cuts off some of it and throws it away."

The hides of these wild cattle, and many which they killed merely for their hides, were another valuable article of commerce to these hardy adventurers. Many of these men made considerable sums of money; and Dampier remarks, generally, that those who had the advantage of some education were careful to improve their time, industrious and frugal; but that those who did not possess this advantage "would extravagantly squander away their time and money in drinking and making bluster."

As these settlements continued to be regarded with an hostile eye by the Spaniards, the introduction of the logwood-tree into Jamaica was attempted in 1715. Seeds were procured from Campeachy for this purpose, and the growth of the plants was found to be so rapid, that in three years they attained to the height of ten feet. In a comparatively short period this tree flourished abundantly in the island, large plantations were formed for the purpose of cutting, and the tree has so multiplied that in the course of years it has become completely naturalized in Jamaica. The wood of Campeachy is, however, prized beyond that of Jamaica. The success attendant on its cultivation in that island, did not, therefore, by any means cause a cessation of the demand for Campeachy wood, and accordingly the cutters still continued to contend with the Spaniards for the right of cutting down these trees.

In the treaty of Utrecht, in 1713, the commercial relations of the two countries in America were not again neglected, and at length the privilege of cutting logwood was confirmed to the English in plain and express terms, so that it was supposed the question was set at rest for ever. It, however, still continued to be a subject of constant dispute between the parties, and, in 1717, the Marquis de Monteleone, then Spanish ambassador extraordinary at the court of St. James, delivered a memorial to the British government against the settlements in the isle of

Trist, and at Laguna de Terminos in the bay of Campeachy, declaring that if in the space of eight months these places were not evacuated, the inhabitants should be considered and treated as pirates. This document was submitted to the Board of Trade in England, which after much investigation, came to the decided opinion that British subjects *were entitled* to cut wood in the bay of Campeachy. Spain reluctantly acquiesced in this positive decision, and the settlement continued without being matter of farther dispute or treaty for more than forty years. During this long period the British settlers had not been idle. Fortifying themselves against the assaults of the Spanish Americans, their colony assumed a more important and imposing aspect, not only having the power to resist but to resent aggression.

These defensive measures were naturally viewed with alarm by the Spaniards, and in a treaty concluded in 1763, the two countries came to a compromise on this question; the English government consenting that the fortifications erected in the bay of Honduras, and other Spanish territories in America, should be demolished; while the Spanish government engaged that the subjects of Great Britain should not be molested in cutting or shipping logwood.

Notwithstanding the above treaty the Governor of Yucatan in the ensuing year gave great annoyance to the British logwood-cutters in Campeachy Bay, and even drove them from the place on the pretext that they had no certificate to prove them British subjects, and that, moreover, they made too free with the produce of the country. No time was lost in remitting a remonstrance to the Spanish court, which unreservedly disavowed and disapproved of the conduct of the governor. Positive orders were sent out to that man of office, and the English once more obtained their logwood without molestation. They were not, however, allowed to remain long undisputed occupiers of this coast. The French now attempted to supplant, or to share with them in this lucrative employment, and invaded their privilege by cutting logwood on those parts of the coast the productions of which had been assigned to the English by the last treaty. Although this had forbidden them to raise fortifications, it had at the same time not only given to them the right of cutting and shipping logwood, but of erecting houses and magazines, together with the privilege of a free fishery in the adjacent seas, on that part of the coast of the bay of Honduras, which was comprehended between the river Wallis on the south side, and the Rio Nuevo and the Rio Hondo on the north side, the sovereignty of the country still remaining with Spain. The privileged settlers of Campeachy of course treated the French as intruders, and were forced again to contend for the right of being undisputed wood hewers in a tropical morass.

The logwood-tree is of very rapid growth and easy of propagation, so that in a few years a flourishing plantation may be formed. It thrives best in marshy ground, but this ground must not be always under water. Trees of full growth are from sixteen to twenty-four feet in height, and sometimes five or six feet in circumference. The stems are in general very crooked and deformed; the bark is in young trees white and smooth, but blackish and rough in old ones; irregular branches armed with strong thorns shoot forth on every side. The shiny bright green leaves are winged, having three pair of lobes indented at the top. The flowers grow in clusters, springing from the wings of the leaves. They are of a very pale yellow hue, with a purple empalement. Dampier and others were struck with the resemblance the logwood-tree bears to our beautiful and fragrant hawthorn.

The logwood-tree grows abundantly throughout whole districts in Jamaica. Besides being cultivated as a dye-wood it is used for other purposes. It is found well adapted for making strong full hedges, and is constantly planted for this purpose, no other fences being seen in many parts of the island. It is excellent for fuel, and, according to Dampier, is advantageously used in hardening or tempering steel. The wood of this tree is very hard and heavy; it is of a deep orange red colour; it yields its colour both to aqueous and spirituous menstruæ, but the latter extracts it the most readily and copiously. A decoction of this wood is of a deep violet or purple colour, which after a time changes to a yellowish tint, and becomes finally black. Like that of Brazil-wood it is made yellow by acids and deepened by alkalis. Although an adjective dye, it can be made very durable by the judicious application of mordants. With alum and tartar it produces a violet dye. With acetate of copper, a fine blue. But its principal use is in dyeing black, to which it gives a superior lustre, and in the production of all the different shades of grey. It contains a large proportion of gallic acid, whence it is that in combination with acetate of iron, the black colour is produced.

Logwood is imported into England in large blocks, at the very small import duty of three shillings per ton; that brought from foreign countries is chargeable with fifty per cent. higher duty.

The average annual importation for the last five years has been 14,092 tons.

The average price for the best logwood during that time has been £8. 10*s*. per ton.

Several other vegetable substances are capable of producing a violet, purple, or claret colour. They are not used extensively, if at all, in modern manufactures.

CHAPTER XX.

RED DYES.

MADDER—BRAZIL-WOOD—BRAZILLETTO—SAPAN-WOOD—NICARAGUA-WOOD—CAM-WOOD—BAR-WOOD—RED SAUNDERS.

Madder—*Rubia tinctoria.*

VEGETABLE substances yielding red colouring matter are not very numerous, none of them affording substantive dyes. Among them madder ranks the first in importance. The colouring matter resides chiefly in the roots, and it is this part alone which is employed.

The Madder plant grows naturally in the Levant, in Italy, in the southern parts of France, and in Switzerland. It is much cultivated in Holland, but Macquer observes that the Dutch were first indebted to the Flemish refugees for their knowledge of the method of preparing this plant. Its culture has often been attempted in England, but always without success.

It will live in any soil, but will not yield in every situation an equally fine produce. Dry ground is not favourable to its growth, but it dies if it is flooded. It succeeds best in a moderately rich, soft, and somewhat sandy soil. The root is perennial, having an annual stalk, and is composed of many long thick succulent fibres, about a quarter of an inch in thickness. It is joined at the top in a head like asparagus, and runs very deep into the ground. Many side roots issue from the upper part or head of the parent root, and they extend just beneath the surface of the ground to a considerable distance. It in consequence propagates itself very rapidly, for these numerous side roots send forth many shoots, which, if carefully separated in the spring soon after they are above ground, become so many plants. These roots are covered with a black bark or rind, divested of this they are of a reddish colour and semi-transparent; a yellowish pith is found in the middle, which is tough and rather of a bitter taste. The whole has a strong and peculiar smell. From the roots spring forth many large square-jointed stalks; these are weak and unable to sustain their own weight; they rise in good land to the height of eight feet, but if not propped, they creep along the ground. They are armed with short herbaceous prickles, and round each joint are placed in a whorl six or eight spear-shaped leaves of about three inches in length, and in the broadest part almost an inch wide. The upper surface of these is smooth, but the mid-rib on the under side is armed with rough herbaceous spines. The branches which sustain the flowers proceed from the joints; they are placed by pairs opposite to each other, having a few small leaves growing in triplets towards the bottom and in pairs as they approach the top. These branches are terminated by loose branchy spikes of yellow flowers, which are cut into four parts, and resemble stars.

The madder plant does not bear flowers until the second or third year, when they bloom in June and are succeeded by berries which contain the seeds. It is propagated by shoots. In the beginning of August the land is ploughed in ridges, eighteen inches asunder, and a foot deep; the young plants are placed in these a foot apart from each other. They thus remain for two seasons, care being taken to clear them of weeds. At the latter end of September, when the leaves are fallen off, the roots are taken up and dried for market.

According to an experiment made near Tours, an arpent (48,000 square French feet) of ground produced eight thousand pounds weight of fresh roots of madder; but in general not more than four, five, or six thousand pounds are expected from the same space*.

As soon as the roots are dug up, they are taken to a place of shelter, so constructed as to admit the air freely from all sides.

The French distinguish two qualities of madder, that which is prepared from the parent root, and that from the side shoots; the first, when the roots are not too large, is considered the best. These two de-

* Elemens d'Agriculture, par M. Du Hamel.

scriptions of root are kept separate in the drying-house, where they are left for four or five days, being turned once or twice during that time, in order that they may dry equably, and that the earth adhering to them may be rubbed off. They are then conveyed to kilns constructed for the purpose, where they are still farther dried. When the roots are sufficiently dried outwardly they are removed to a floor made as clean as possible, and the outer skin is then separated by means of thrashing.

This skin is pulverized by itself and packed up in separate casks. It is known in commerce by the name of *mull*, and being extremely inferior to the other part, is sold at a comparatively very low price.

After the outer skin is thus separated, the roots are again conveyed to the kiln and subjected to a greater degree of heat than before. That this heat may not be injurious to the roots, they are frequently turned and a current of fresh air is blown through the kiln, to carry off the noxious exhalations of the plant, which would otherwise injure the colour. When the roots are sufficiently dried, they are conveyed to the pounding-house to be reduced to powder.

In warm climates madder is prepared without the application of artificial heat. It results from this difference of preparation, and perhaps also from the variety of the plant, that two kinds of madder are distinguished, which differ in their dyeing properties *.

The roots are ground either between mill-stones or under knives similar to those of a tan-bark-mill. After the first milling the impurities are separated by means of boulters or fanners. In this state it is so partially cleansed that the French call it *non-robée*, —the residuum consists of earthy matter, epidermis, and bark.

* Berthollet.

After a second milling what is separated is called *mi-robée*, and finally, after a third milling, the madder *robée* (signifying cleansed from the husk) is obtained, and which is of the best quality. This substance is employed as a red dye, and also as a first tint for several other colours. The madder used for dyeing cotton in the East Indies is in some respects different from that of Europe. On the coast of Coromandel it has the name of *chat*. It grows wild on the coast of Malabar; the cultivated kind is obtained from Vaour and Tuccoun, but the most esteemed is the Persian *chat*, called also *dumas*.

The madder imported in considerable quantities from Smyrna is more esteemed than the best Dutch madder, which ranks the first of that grown in Europe. The madder produced in the lower part of the Rhine is considered by Berthollet as not inferior to that of Zealand.

This is an adjective dye, but affords a permanent colour to cloth which a few days previously has been boiled for two or three hours in a solution of alum and tartar. The colour which it imparts is not so beautiful as that obtained from kermes or cochineal, but being much less expensive, it is extensively employed for common stuffs. Linen takes this dye with more difficulty than cotton. It is seldom used for silk, but is one of the most valuable dyeing drugs for a variety of purposes. It is an agent for dyeing many colours, and is therefore peculiarly adapted to the process of calico-printing, since by the use of different mordants, a variety of hues may be produced by immersion in the madder bath. One mordant in combining with it precipitates the colouring matter red, another purple, another black, and so of every possible shade from lilac to black, and from pink to deep red. If a portion of weld or quercitron be added to the madder, every shade from brown to orange may be produced*. Tin, iron, and aluminous bases, as well as other mordants, are used for this purpose, dependent on the colour required. It is a matter of doubt and speculation with chemists whether these various colours are produced by the combination of the colouring principle of madder with the different mordants, by which a chemical change takes place, or whether several colouring matters are not really contained in the substance itself, and severally precipitated or retained by the varying action of the different agents to which it may be subjected. It is, however, certain that it contains at least two distinct colouring matters, a fawn and a red, and that the admixture of the former with the latter very much injures its clearness and beauty. In consequence of this, two kinds of red are obtained from madder. The first is simply called madder red, which contains the whole of the colouring matter. The other possesses far more lustre, and is much more valued; it is called Turkey red, because first obtained from the Levant. Its superior brilliancy is imparted in consequence of the red colouring matter being alone preserved; and while the tint communicated excels in brightness, it has the additional and great advantage of extreme durability.

The manner of producing this desirable effect was for a long period of time a subject of much interest and inquiry, the process used in Turkey being enveloped in mystery. The industry of the French artisans was stimulated by the interest which their government took in the discovery. Yet attempts at imitating this beautiful dye were long fruitless, and when at length they proved successful, this success was limited to one or two dye-houses. It was only by very slow degrees that it became more diffused, and then each individual who acquired the know-

* Parkes' Chemical Essays.

ledge jealously guarded his own peculiar secrets which he had introduced in the process.

At length the Abbé Mazeas published the result of his experiments on the subject; and in the year 1765 the French government promulgated all the information which had by its direction been diligently collected. These instructions were entitled 'A Memoir containing the process for the incarnate red dye of Adrianople on cotton yarn.' Berthollet, Vitalis, and other eminent chemists, have likewise subsequently given an account of the course of procedure. All nearly agree in the detail, whence it appears that the process is most elaborate and tedious. Many different ingredients are used previously to applying the madder. Oil, sheep's dung, calf's blood, gall-nuts, soda, alum, and subsequently a solution of tin are employed, and the yarn undergoes seventeen distinct operations before it is finally imbued with its rich colouring. Many of these materials are considered by Dr. Ure as unnecessary, and his opinion has received the confirmation of an eminent calico-printer, who assured him that oil and alumina are the only essential mordants in the process *.

It is said that a dilute super-sulphate of potass is now used with success in France for separating the two colouring matters.

It was not until the year 1790 that the art of dyeing the Turkey red was introduced into our country. At that time M. Papillon, a Frenchman, formed an establishment at Glasgow for carrying on the process. He obtained a premium from the commissioners and trustees for manufactures in Scotland, on the condition of communicating his secret to Dr. Black; it being stipulated on the

* Note to Berthollet's Elements of the Art of Dyeing, translated by Dr. Ure.

Doctor's part that it should not be divulged for a certain term of years, during which period M. Papillon was to have the sole use of, and the benefit accruing from his process. The term being expired, the process pursued was published, and found to be very similar to that already given by the French chemists.

Another species of madder has been cultivated in France by M. D'Ambourney, who found it growing wild among the rocks of Oissel in Normandy. On trial it yielded a dye as beautiful as that of Smyrna madder, and he was therefore induced to prosecute its culture. This plant is rather different from the madder grown in Holland. Its roots are more slender and of a less bright colour. They are furnished with few fibres at their joints, and those joints are farther apart; the stalk is not so thick, and the leaves are narrower and of a paler green.

In consequence of the impossibility of drying his roots without fire, M. D'Ambourney was induced to use them fresh after being well washed and cleansed. It is estimated that the root of the madder loses seven-eighths of its weight when dried and reduced to powder. But four pounds of the fresh root were found to be as efficacious as one pound of pulverized madder; therefore, by this plan, twice as much effective colouring matter was obtained: besides which advantage there were many others,—the expense of erecting sheds and kilns for drying was rendered unnecessary—there was no danger of injuring the substance by improper drying, nor was the cost of a mill for grinding required. Lastly, the roots did not evaporate or ferment, as in the case with powdered madder if not speedily used; but they might be preserved fresh during several months, by laying them in a hole three feet deep, in alternate layers of roots and of earth*. Roots are now im-

* M. Du Hamel.

ported in large quantities into England, and obtain a proportionate higher price than the prepared madder.

In 1804 the gold medal of the Society for the Encouragement of Arts, &c. was voted to Sir H. C. Englefield, for his discovery of a pigment prepared from madder. He obtained a fine lake by many different processes, and found that the colour produced from the Smyrna was of a deeper and richer tint than any prepared from the Dutch madder. In pursuing his experiments he discovered that the colouring matter might be extracted from fresh madder, and thus not only all the expenses and difficulty attendant on the process for prepared madder might be avoided, but the cost of carriage would be one-fourth less than for the roots; while separated from these the colouring matter might be kept for any length of time without danger of being spoiled. A further advantage would also arise in the quantity obtained, as *all* the colouring matter could be extracted; while in the manner which the dyers use the roots, a very considerable part of the colour is left in the refuse matter, and consequently wasted.

The following is a slight sketch of the method proposed for obtaining this extract. A given quantity of the roots ground into a pulp is put into a woollen bag. This is then triturated in large vats filled with a certain relative proportion of water; the friction is continued until the colouring matter is entirely washed out of the madder; the water thus loaded with colour is boiled,—an iron vessel must not be used, as a chemical change would take place and the colour would be spoiled. After being boiled it is poured into an earthen receiver, and a solution of alum is mixed with it in given quantities. Then a certain proportion of a saturated solution of mild vegetable alkali is added, which causes effervescence, and the colouring matter is immediately precipitated, from which the supernatant liquor being drawn off, the colour is readily dried for use.

The colouring matter of this plant has a very remarkable affinity to the bones of animals, those eating of the root having their bones dyed of a red colour. This fact was long known to the practical dyer; but, as it did not fall in with any of his pursuits, it excited no interest and was disregarded by him, or taken as a matter of course. In the present day, perhaps, this class of persons are somewhat more enlightened, and their minds are not wholly chained down to the immediate objects of their particular avocation.

The average annual importation of prepared madder in England for the last five years is 67,525 cwts. Of madder roots 46,272 cwts. The former pays a duty of 2*s.* per cwt.; the latter only 6*d.* for the same quantity. The average price of the best madder for the five preceding years was 83*s.* per cwt., and of the best roots 48*s.* per cwt. It is imported from Holland, France, and Turkey.

An inferior kind of madder, known in commerce under the name of *munjeet,* is at present imported from the East Indies into this country. The average annual import for the five preceding years is 28,826 bales, each bale weighing 20 lbs.; the average price during that time being 34*s.* per cwt. for the best.

A plant called *raye de chaye*, chaya root, or colour root, gathered on the coast of Coromandel, is used as well as madder in India for dyeing red, orange, and purple; it is so similar to the latter plant that it is often confounded with it. The *raye de chaye* is by some botanists called *oldenlandia umbellata.* It has a weak jointed stem, with the leaves growing round the knots, from which opposite branches issue. It is not of so large a growth as madder. A few small white flowers grow on slender foot-stalks on the tops of the branches. These roots are preserved without injury, and even improve by keeping.

Brazil-wood.—*Cæsalpinia crista.*

The Brazil-wood tree, or *Cæsalpinia crista*, is an American production, commonly supposed to have been thus named because originally from Brazil. This tree is, however, likewise indigenous to other parts of the world, and was known by the name it at present bears many years before the discovery of Southern America; that portion of the continent which bears the name of Brazil having received that designation in consequence of this tree being found profusely scattered there *.

The Portuguese government soon recognized the value of this production, and it was made one of the objects of royal monopoly, being imported into Europe on account of the crown. From this circumstance it is known in Brazil as *Pao de Rainha*, or Queen's wood. It commonly grows in dry places and amid rocks. Its trunk is large, crooked, and full of knots; at a short distance from the ground innumerable branches spring forth, and extend in every direction in a straggling, irregular, and unpleasing manner. Trees of the largest growth attain to thirty or forty feet high, but they are rarely met with of so great dimensions. The branches are armed with short, strong, upright thorns; the leaves are small and never appear in luxuriant foliage. The flowers are of a beautiful red colour and emit a fragrant smell.

When first cut the wood is of a pale red, but becomes darker by exposure to air. It is variegated with irregular and fantastical black spots, which has obtained for it among the French the name of *bois de lettres* †. The bark of this tree, which is extremely thick, and the white pithy part, are both useless; the heart being the only valuable portion, and when both within and without are cut away it is diminished to nearly half its bulk. It is a very hard and dry wood. The thickest pieces with a close grain are considered the best. It is sometimes used in turnery, and is susceptible of a good polish, but its principal use is as a red dye. The colour which it communicates is however very fleeting. It is an adjective dye, and generally applied in combination

* Southey's Brazil, vol. i.

† Stedman.

with a mordant of alum and tartar, but with different mordants it may be made to assume all the shades allied to red. The most permanent colours produced from this dye are those in which the natural purple red is changed by acids to an orange or yellow colour. Brazil-wood is often used in dyeing silk of a crimson hue, but it cannot be made so durable as the cochineal crimson.

Red ink is made of a decoction of this wood in beer, wine, or vinegar, to which a portion of alum is added, to render its colour less fugitive.

Brazil-wood boiled in water communicates to it a fine red colour, while the wood itself becomes of a darker colour, and if the ebullition be continued long enough the residuum will be black. Paper tinged red with this decoction is altered to a violet colour by the action of the alkalis, and to a yellow by most of the acids. The action of sulphuric acid gas renders it quite white. M. De Bonsdorff, in the 'Annales de Chimie et de Physique,' details many phenomena of the effects which this colouring matter has on different acids. It is an excellent test to detect the presence of sulphuric acid in vinegar. In pure acetic acid it receives only a violet tinge, but the admixture of only one two-hundredth part of sulphuric acid will give the stained paper a yellowish instead of a violet hue.

In two decoctions made with equal weights of madder and of Brazil-wood, only half the quantity of chlorine gas, which will destroy the colour of the madder, is required to produce a like effect on the Brazil-wood. More colour is extracted from this wood by alcohol than by water. Warm marble stained by the spirituous tincture assumes a purplish red colour, which, on the heat being increased, changes to a violet hue. If the stained marble be covered with wax and considerably heated, the colour changes through all the shades of brown and at last becomes fixed of a chocolate hue.

A fine crimson red lake is prepared from this colouring matter by precipitating it when in a state of solution with alum. The average annual quantity imported for the last five years is 950 tons. Its price has very much fallen off, differing from £65, in 1826, to £35 per ton in 1830. A duty of £2 per ton is charged on the importation of Brazil-wood.

A species of this tree grows in the West Indies, the wood of which is known in commerce as Brazilletto. It is of the same kind, but of very inferior quality to the Brazil-wood. The duty charged on its importation from British possessions is only 3*s.* per ton, and in consequence it can be obtained on much cheaper terms than that from South America. Some years ago the demand for it was so great that it was cut down with unsparing hand, and scarcely any of the large trees were left in the British plantation. This species is known to botanists as *Cæsalpinia vesicaria;* it never attains to so large a growth as the *Cæsalpinia crista.* Its branches are slender and full of small prickles; the flowers are white, growing in a pyramidal spike at the end of a long slender stalk.

Sapan-wood is another dyeing substance obtained from another species of the same genus. It is distinguished as *Cæsalpinia sapan.* The flowers of this and the *vesicaria* have ten stamina; those of the *crista* have only five. There is scarcely any consumption of this wood in England; very few tons being annually imported. Its price averages from ten to sixteen pounds per ton, and it is admitted on a duty of fifteen shillings per ton.

The same duty is charged upon Nicaragua or Peach wood, which is another kind of Brazil-wood. It dyes a bright fugitive red, called fancy red. Though not so rich in colouring matter as the Brazil, it yields a colour which is brighter, more delicate, and more beautiful.

It takes its name from the Gulf of Nicaragua in America, opposite to Providence Island, whence it was first imported into England. Dampier says this was the only place on the Atlantic where he saw the tree; but that on the South-Sea side of the American continent it grew abundantly.

In his time Nicaragua-wood was sold at £30 per ton, being double the price of logwood.

The average importation for the last five years is much more considerable than that of Brazil-wood, being 1765 tons. The price of the best is about £15.

Cam-wood is another red dye-wood, obtained from the Brazils, and also from Africa. It once grew commonly in the neighbourhood of Sierra Leone, and was found at Tonquin and other parts of Asia. This wood is of a very fine colour; it is principally used in turnery for the formation of handles of knives and other similar articles. A very small quantity of cam-wood is imported into this country, averaging annually not more than 400 tons. It is admitted at the same duty as the sapan. Bar-wood is also liable to the same duty, and is not brought more abundantly into England. This is likewise a red dye-wood of Africa.

Red Saunders, or *Pterocarpus santalinus*, is a native of the East Indies, growing chiefly on the coast of Coromandel. It is a solid compact wood, which is imported in large billets. On the outside it appears of a dull muddy red, almost approaching to black; within it is of a brighter red, but becomes brown on exposure to the air. This wood is never employed without being pulverized. It is slow of imparting its colour to water, but yields it readily to alcohol. It does not produce much colouring matter when used alone, but this is a permanent dye. Its colouring matter is found to dissolve much better when mixed with astringent substances, such as walnut-peels, sumach, or nutgalls. With a solution of this in dilute spirit and on a tin mordant, Volger produced a poppy-red; on alum, a scarlet; on sulphate of copper, a crimson; and on sulphate of iron, a deep violet colour.

A very trifling importation of this wood is now received into England. The duty charged upon it is 1*s.* per ton. Its price varies from £18 to £19 per ton.

The people of Sumatra, who have great skill in extracting and imparting dyes, and who are in possession of a vegetable black dye, which is said to be much wanted by us, derive good red colouring matter from several other trees and shrubs.

From the outer parts of the root of a tree (*Morinda citrifolia*), by drying, pounding, and boiling them in water they procure a red dye, to fix which they employ the ashes yielded by the burning of the stalks of the fruit and mid-ribs of the leaves of the cocoa-nut tree.

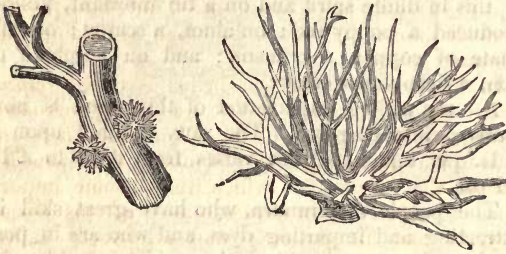
Oobar is a red wood which they use in colouring their fishing-nets. It resembles the logwood of Honduras, and, in the opinion of Mr. Marsden, might be substituted for that product.

Mr. Marsden remarks, that the Sumatrans are acquainted with no purple dye, nor apparently are any of the Indian nations, though the art is most ancient among them, and some others of their colours are of unrivalled beauty.

Chapter XXI.

RED DYES, (continued).

ORCHELLA—SAFFLOWER—ST. JOHN'S WORT—OTAHEITAN DYE—TURNSOLE—ALKANET-ROOT.



Rocella tinctoria.

Orchella, or *Rocella tinctoria*, is a white moss, growing in some parts of the Archipelago, and in the Canary and Cape de Verd Islands. It is likewise sometimes found on the rocks of Guernsey and the Isle of Portland.

Pliny * notices this substance as growing on the rocks of different islands, especially those of Crete and Candia; and mentions that with this moss dyers gave the ground or first tint to those stuffs which they intended to dye with the costly purple.

The manner of preparing this plant for the purpose of dyeing was, however, lost to western Europe for many centuries. At the beginning of the fourteenth century the peculiar properties of the orchella were accidently discovered by a Florentine, who had been called by his mercantile pursuits to the Levant.

* Lib. xxvi. c. 10.

He immediately took advantage of the fortunate circumstance which had revealed to him this valuable dye; and making many experiments to ascertain all its virtues, was soon in a situation to convert it into a most profitable source of wealth, not only enriching himself, but making it a branch of commerce extremely advantageous to his countrymen. The Florentine carried on his art of dyeing wool with orchella to a great extent, and for a considerable time kept the practice an exclusive secret, but subsequently he made known the process by which he obtained his colouring matter.

In the Greek islands this lichen is called *respio*, and in Spain *orciglia;* but it was totally unknown among the Italians, and the Florentine therefore gave to it a name somewhat resembling the Spanish; a name, the adoption of which was of some importance to him, as, in remembrance of his discovery, he and his posterity were afterwards called Oricellarii, which by being pronounced short, and a little mutilated, was changed into Rucellari, and lastly into Rucellai *, a name still found among the first families in Florence, and which has been borne by many statesmen, as well as men of letters.

Throughout the last century there has been a great and increasing demand for this lichen. The Canary Islands produce it in large quantities. In the islands of Teneriffe, Canary, and Palma, this production is considered of sufficient consequence to be claimed as the property of the crown. It is in great request in London, Amsterdam, Marseilles, and throughout all Italy. It was extremely scarce in London, and obtained a very high price, the increasing demand con-

* Giornale de Letterati d'Italia, tom. xxxiii. parte 1, p. 231, as quoted by Beckmann.

tinuing beyond the supply, when, in 1730, the captain of an English vessel discovered it growing in the Cape de Verd Islands. It was found in so great abundance that in a few days 50,000 pounds of moss were collected from only two of the islands. This orchella was larger, longer, and richer in colouring matter than that of the Canaries, perhaps in consequence of its having grown undisturbed, while the other was exhausted by being collected every year. A few years after this time Mr. Adanson found the orchella lichen in Magdalen Island, near Senegal, where the rocks were covered with the prolific plant.

The orchella lichen grows upright, either in single or double stems of about two inches in height. These are cylindrical, and internally white. When old, the plant is crowned with a round, or sometimes flat button. Its colour varies from white to a dark grey. It is imported as it is gathered, without receiving any previous preparation. In the different countries to which it is imported it undergoes some process before it can be employed as a dye. The manner of preparing this in Florence, as described by Mecheli, and quoted by Hellot, is, first to reduce the plant to a fine powder, which is passed through a sieve ; a chemical preparation of soda and other ingredients is then added. The mixture is daily stirred until it assumes a dove colour. It is then put into a wooden cask, and lime-water, or a solution of gypsum, is poured upon it until its surface is covered, in which state it is preserved. After a preparation nearly similar to this, the French make it into a kind of paste, which they designate *biseille en pâte*. The colour which is obtained from it in England is evaporated to dryness, and assumes the form of a deep red powder, known in the shops under the name of cudbear. Prepared orchella usually is known under the general name of archil. An infusion of this is of a crimson colour, bordering on violet. It is seldom used by itself, on account of its high price and the evanescent nature of its beauty, but it is chiefly employed to give a bloom to other colours. This is done by passing the dyed stuff under process through hot water, slightly impregnated with the archil. The hue thus communicated vanishes upon long exposure to the air. Hellot found that by the addition of a small quantity of the solution of tin it became a durable dye, approaching to the colour of scarlet. Archil dissolved in water gives a durable stain of a beautiful violet colour to marble. M. Du Fay relates that he has seen pieces of marble which had preserved their colour, without any sensible change, after having been stained with it for more than two years. It sinks deep in the marble and renders it more brittle.

Archil very readily gives out its colouring matter to both water and alcohol. Spirit thermometers are usually tinged with this colour, which circumstance has made manifest a remarkable property of archil, that exposure to, and a total exclusion from air, alike destroy its colour. Its fugitive beauty soon flies from the fabric on which it is sought to be fixed, while in a tube hermetically sealed it also vanishes.

Spirit coloured with this substance, enclosed in large thermometers, in a few years becomes entirely colourless. The Abbé Nollet observed * that this colourless spirit soon resumes its colour upon breaking the tube, and this for a number of times successively. An aqueous tincture enclosed in a tube lost its colour in three days. In an open, deep vessel an infusion becomes colourless at bottom, while at top it retains its colour.

Orchella is imported into England at a nominal duty of 3*s.* per cwt.; its price averaging from £14 to £7. 10*s.* per cwt., according to its quality. It is

* Memoirs of the French Academy for the year 1742.

distinguished in commerce as Canary, Cape de Verd, and Madeira; the first being the best, and the last the worst in quality.

The quantity retained for home consumption in the year 1830 was about 700 cwt.

An inferior colour is prepared from another species of lichen, called *Lichen perellus*, which grows on the rocks of Auvergne.

A beautiful red colour is obtained from the flowers of the Safflower, or *Carthamus tinctorius*. This plant is a native of Egypt and the warmer climates of Asia. It is likewise cultivated in the Levant and the southern parts of Europe. The Chinese have long known its use, and produce from it their finest red. The colour called by them *bing*, which is used by the Japanese ladies as a cosmetic, is made from it, and kept in little round porcelain cups. "With this," says Thunberg, "they paint, not their cheeks, as the Europeans do, but their lips. * * * If the paint is very thin, the lips appear red; but if it be laid on thick, they become of a violet hue, which is here considered as the greatest beauty *."

We obtain it from the East Indies and from Turkey, that from India being considered the most valuable. It is cultivated with success in the gardens of France, but not as an article of commerce.

The *Carthamus tinctorius* is an annual plant, with an upright, firm, smooth stem, of a colour approaching to white, and of about three feet in height; this stem is divided at top into several branches, bearing leaves of an oval form, and edged with small spines. Each of the branches is terminated by a large flower-head, composed of several flowerets, all of which are furnished with stamina and pistils. The flowers are of a deep red colour. This plant is pro-

* Travels in Japan.

pagated by seeds, which are sown early in the spring, in drills, at about the distance of two feet and a half asunder.

In about a month the young plants are expected to appear, and they are allowed to remain undisturbed for another month. They are then hoed and thinned, each plant being left about half a foot from the other. A second and third hoeing are given before blossoming. In rich land the flowers seldom appear till late in autumn, while in a poor dry ground the plants bloom at an earlier period, but the flowers of these are smaller and yield a less portion of colouring matter. A moderately dry and well manured soil is considered to be on the whole best adapted to the culture of this plant, especially if the seed be sown early in February.

The moment the flowerets which form the compound flowers begin to open, they are gathered in succession without waiting for the whole to expand, since when allowed to remain till fully blown the beauty of the colour is very much faded. As the flowers are collected they are dried in the shade. This work must be carefully performed, for if gathered in wet weather, or badly dried, the colour will be much deteriorated. These flowers contain two kinds of colouring matter,—the one yellow, which is soluble in water; the other red, which being of a resinous nature, is insoluble in water, but soluble in alkaline carbonates. The first is never converted to any use, as it dyes only dull shades of colour: the other is a beautiful rose-red, capable of dyeing every shade, from the palest rose to a cherry-red. It is therefore requisite, before these flowers can be made available, to separate the valueless from the valuable colour; and since the former only is soluble in water, this operation is matter of little difficulty.

The flowers are tied in a sack and laid in a trough through which a slender stream of water is constantly flowing; while, still farther to promote the solution of the yellow colouring matter, a man in the trough treads the sack and subjects every part to the action of the water: when this flows without receiving any yellow tinge in its passage the washing is discontinued, and the safflower, if not wanted for immediate use, is made into cakes, which are known in commerce under the name of stripped safflower. It is principally used for dyeing silk, producing poppy-red, bright orange, cherry, rose, or flesh-colour, according to the alteratives employed in combination. These are alum, potash, tartar, citric acid, or sulphuric acid.

A smaller variety of the *carthamus* is cultivated in Egypt *, where it forms a considerable article of commerce. Hasselquist, in his 'Voyage d'Egypte,' describes the manner in which the Egyptians prepare the *carthamus* for use. As soon as the flowers are gathered, they are squeezed between two stones to extract all their moisture; they are then washed several times with pit well-water, which in Egypt is naturally brackish. On being taken out of the water they are pressed between the hands, and then spread out on mats upon terraces; they are covered during the day lest the drying should be too quickly completed, and they are exposed to the dews of night. Every part is turned over from time to time, and when found to be dried to the proper point, the whole is taken up and preserved for sale.

The colouring matter from the stripped safflower is obtained by the application of an alkaline carbo-

* "The dyes the Egyptians use," says Volney, "are probably as old as the time of the Tyrians, and they carry them at this day to a perfection not unworthy that people; but their workmen, jealous of the art, make an impenetrable mystery of the process."—Travels in Egypt and Syria, vol. ii.

nate. On being soaked in a weak solution of barilla it speedily colours the fluid of a deep red. When the whole of the colouring matter is thus extracted and held in solution by the alkaline menstruum the infusion is strained. It now remains to precipitate the colour, for which purpose acid is added in sufficient quantity to saturate the alkali employed. Citric acid or fresh lemon juice is generally chosen, because it renders the colour more lively than when in combination with any of the other acids. The carbonic acid gas, which is disengaged during the saturation of the alkali, of course produces considerable effervescence, and therefore care must be taken that the acid be added gradually, and that the dimensions of the vessel are such as to allow of the ebullition without the liquor running over. The colouring matter extracted from the safflower being only kept in solution by the action of the alkali, it is of consequence separated, as this becomes neutralized by the acid, and it fixes on the sides and bottom of the vessel. Most generally, however, carded cotton is introduced into the fluid previously to the application of the acid, and as the colouring matter has more affinity for the cotton than for the surface of the vessel, it fixes upon that as it separates from the alkali. It is scarcely possible wholly to separate the yellow colouring matter in the first washing, and the part which remains renders the shade of colour given to the cotton rather dull, but this is easily removed by repeated washings. If no cotton is employed the precipitate appears in the form of a fine powder. The supernatant liquor is then decantered, the colour washed and distributed upon saucers, where, as it dries, it acquires a coppery tinge; the rose-red colour is produced as soon as this is wetted. The resinous part may also be preserved in a mass by merely drying the precipitate. It is then called

India or China lake. It does not communicate any colour to water, but produces a beautiful red tincture when alcohol is poured upon it. This colouring matter, mixed with French chalk, or talc, finely pulverized, is the substance known under the name of vegetable rouge.

To render this substance efficient for dyeing it must be again held in solution by an alkaline menstruum, in which the stuff to be dyed is immersed, and by the application of the acid the colouring matter is precipitated on the fabric under process, in a similar manner to that by which it was retained on the carded cotton.

Safflower is imported into England from India and Turkey: the Indian is very much superior, bearing nearly double the price of the Turkish. It is admitted at the trifling duty of 1*s.* per cwt. The average annual importation for the last five years has been 2,942 bales, each weighing one cwt. The average price of the best during that time was £8. 17*s.* per cwt.

The tops and flowers of a plant called St. John's Wort contain a resinous juice, which may be usefully employed for the purposes of dyeing.

This plant grows naturally in many parts of Great Britain, and can be easily propagated by layers or seeds. It has a shrubby stalk about two feet high. The branches grow in pairs, shooting forth in opposite directions. The flowers grow at the ends of the stalks, and bloom in July and August. These are succeeded by globular berry-like capsules of a black colour.

The juice expressed from the tops and flowers is perfectly soluble in water, alcohol, and vinegar; a solution in the two former affords a blood-red colour, in the latter, a fine bright crimson; when combined with other acids it exhibits a yellow colour, which proves that it contains two colouring matters, capable of separate solution in different menstrua. If alum, combined with a certain portion of potash, be used as a mordant, a bright yellow dye is obtained; by increasing the quantity of the mordant the colour somewhat inclines to green, and by the addition of a solution of tin in nitro-muriatic acid, according to the proportion used, rose, cherry, or crimson hues, all of a fine lustre, will be produced.

This juice can be made to assume a concrete form by being exposed in shallow dishes to the moderate heat of an oven. If then it be reduced to powder, it will readily combine by trituration with turpentine. The resin, thus saturated with the juice, can be mixed with olive oil, and forms the oil of St. John's wort, sometimes used in pharmacy. Incorporated with linseed oil, and with the addition of a small portion of oil of turpentine, a fine red varnish is produced, which may be advantageously employed for coating articles of furniture made of wood *.

An exceedingly beautiful red, surpassing our scarlet in intensity and brilliancy, is, it is said, produced in Otaheite, by a process which argues some advancement in the knowledge of domestic arts. This red dye is obtained by the admixture of two vegetable juices, neither of which separately has the least tendency to assume that hue. One of these juices is produced from a species of fig, the fruit of which is not bigger than a very small gooseberry. The stalk being broken off very close to the fruit, each fig produces one drop of a milky liquor resembling the juice of common figs. This liquor is collected and mixed with a very small quantity of cocoa-nut milk.

* Annales de Chimie; Nichol. Jour. vol. vi.

Some leaves of the *Cordia sebestena*, called by the natives *etow*, are wetted with it, and then laid on a plantain leaf. They are turned about till they become flaccid, and are then gently squeezed, gradually increasing the pressure, but not sufficiently to occasion fractures. As the liquor is imbibed more is applied, and in about ten minutes the leaves are fully saturated. The fluid is then squeezed from them, and strained into small cups made of the plantain leaf; it is then ready for use, and imparts a vivid red colour *.

Turnsole, prepared from the *croton tinctorium*, can scarcely be classed among dyeing substances; but it is used as colouring matter and is an article of commerce, and therefore claims some notice. The *croton* grows in the neighbourhood of Montpelier, and is called there *maurelle*.

It is an annual plant producing a round herbaceous branching stalk with many leaves, standing upon long slender foot-stalks. It seldom exceeds nine inches in height. The flowers are produced in short spikes from the sides of the stalks at the end of the branches. They appear in July or the beginning of August, which is the proper time for collecting them. At this time the peasants assemble from the distance of fifteen or twenty leagues round, and each gathers, on his own account, the flowering tops of the plants. These are immediately bruised in a mill, and the dark green juice is expressed into stone vessels. It is then, without loss of time, poured over pieces of canvas or linen provided for the purpose. These first appear of a lively green, but afterwards change to a red-purple hue. Thus prepared, they are packed and sold by the French under the name of *tournesols en drapeaux*. These shreds are employed to colour

* Hawkesbury's Voyages.

several articles in domestic economy. The Dutch buy up large quantities, which are used by them to colour wines and the rinds of cheese *.

When infused with distilled water they afford an excellent test. Litmus, well known to chemists as a test for detecting alkalis or acids, is prepared from this plant. The former changes its colour to blue, the latter to red. Persons who formerly prepared the litmus purposely concealed the source whence it was derived, pretending that it was extracted from the *heliotropium tricoccum*, in order to mislead others and restrict the preparation to themselves. It is now, however, well known that croton is the plant from which litmus is obtained.

Alkanet-root is another colouring drug, which is not very much used as a dye. It is the root of a kind of bugloss, or *anchusa tinctoria*, a native of the Levant, and the warmer parts of Europe. France, particularly about Montpelier, produces it in the greatest abundance. Our chief supplies are drawn thence; for though it is raised in England, the roots are much inferior to those of foreign growth. It is a hardy plant, growing with a branchy stem, having oval leaves set alternately on the branches. The flowers come forth from the summit in long spikes, growing grouped together like the tiles of a house. It is propagated by seed, sown in beds in either spring or autumn; when sufficiently advanced the young plants are transplanted at intervals of two feet from each other. The colouring matter is confined to the bark of the roots, and therefore the small roots, having more bark in proportion to their bulk than the large ones, afford the most colour, and are considered the best.

Alkanet-root is insoluble in water—an aqueous

* Beckmann.

decoction being of only a dull brownish colour; but this substance imparts a deep red colour to alcohol, oils, wax, and all unctuous substances. In consequence the principal use made of it is in colouring oils, unguents, and lip-salves. Wax tinged with it imparts a flesh-coloured stain when applied to warm marble, which by an infusion in alcohol is stained of a deep red colour.

Its consumption is considerable in this country, in comparison with the apparently trifling uses to which it is applied; 55,374 lbs. were retained for home consumption in 1830. The import duty is 2*s.* per cwt.; its price being about £2. 10*s.* per cwt.

CHAPTER XXII.

YELLOW DYES.

WELD—QUERCITRON BARK—FUSTIC—YOUNG FUSTIC—HICCORY—CHICA—ARNATTO—TURMERIC—SAFFRON, &C.

Weld—*Reseda luteola.*

THE vegetable substances employed for dyeing yellow are extremely numerous. They differ from each other in the relative quantity of colouring matter which they contain—in the different shades of colour which they impart, and in their degree of permanence. Our own native weld first claims our attention. No substance in either the vegetable or mineral kingdom is known which produces a finer yellow than that obtained from weld or wold, or, as it is sometimes called, dyer's weed.

This plant is well known throughout Europe. It is cultivated near Paris and other parts of France; it is likewise indigenous to England, and is found growing spontaneously in many parts of the country on uncultivated wastes. "It thrives," says the author of the Journal of a Naturalist, "in all our abandoned stone quarries, upon the rejected rubbish of the lime-kiln, and waste places of the roads, apparantly a perfectly indigenous plant. Unmindful of frost or of drought, it preserves a degree of verdure when nearly all other vegetation is seared up by these extremes in exposed situations." The wild weld does not, however, abound with as much colouring matter as that which is cultivated, although it grows larger and higher. This plant is therefore cultivated for its colouring produce in several of our counties, especially in Kent, Herefordshire, and about Doncaster in Yorkshire. It is not an object of careful husbandry, as it will grow on the worst soils, without the aid of manure.

Weld, or *Reseda luteola*, is a biennal plant. Its root consists of only a few ligneous fibres. Radical leaves spring forth from this of about four inches long and half an inch wide, spreading circularly near the ground; they are soft to the touch, and of a lively green colour. In good soils the stem which springs up from amidst these leaves is often branchy and furnished with narrow leaves like the radical ones, but smaller in proportion as they approach the flowers. It attains to the height of about three feet before blooming. The stems are cylindrical, hollow, and furrowed, terminating in long spikes of yellowish green flowers, like those of mignonette; these expand in the months of June or July, and are succeeded by globular fruits of the same colour, terminating in three points, and enclosing small brown spherical seeds, which come to maturity in September.

The more slender the stalk the more it is valued. This plant is commonly sowed with or immediately after barley or oats, no other additional care being required but the application of a bush harrow to cover in the seeds. It makes so little progress during the first year, that the reaping of the grain does it little or no injury. In the ensuing summer it is fit to be pulled. The more careful cultivator, however, devotes a piece of ground solely to its propagation. The seed is then sown in the month of August, in about the proportion of one gallon per acre; at the end of two months it is hoed and thinned, the plants being left about half a foot apart. The hoeing is repeated twice more, and at the end of June in the ensuing year the flowers appear in full bloom and vigour; in a short time the seeds form, and the stalks then acquire a yellow tinge. This is the most favourable period for gathering; the performance of which, previous to these indications, or some time after they are exhibited, would alike be detrimental to the colour of the dye. At the proper time for pulling the plant the seed is not sufficiently mature for propagation, some plants are therefore reserved for this purpose, and left in the ground until September. The plants, after being gathered, are carefully dried, and then tied up in bundles of from thirty to fifty pounds, and sold to those who prepare the colour from them, or to the dyers who sometimes use them without preparation.

It is generally supposed by the cultivators that the colouring matter is contained in the whole plant, but some assert that the valuable part resides in the seeds alone, and they therefore consider it a very injudicious practice to reserve the whole plant for sale, as the seeds are much wasted, not only by being shaken while the stalks are formed into bundles, but subsequently in the transport of these from one place to another. Nor is this the only disadvantage; the carriage of so bulky an article very much enhances its cost, while if the seeds alone were an article of commerce, their transport from one place to another would be comparatively trifling. The plants occupying a space of six cubic feet would not yield more than half a peck of seeds *. This simple fact might be ascertained without much difficulty, and if the seeds were found to be really the only useful part, surely the dyer would be loath to encumber himself with the whole plant. It is, however, still put into the dyer's pot, occupying one hundred times more space than the quercitron bark, containing an equal quantity of similar colouring matter. This is one of the strongest grounds for preference that has been brought forward by Dr. Bancroft in favour of that bark.

The beauty of the weld colour, however, notwithstanding the great bulk of the article, as compared with other dyes, causes it to be much used by dyers, calico-printers, colour-makers, and paper-hanging manufacturers. It is as adjective colour, but tolerably permanent when used with alum and tartar as a mordant.

In the year 1773 the sum of two thousand pounds was granted by act of parliament to a Dr. Williams, as a reward for his discovery of a fast green and yellow dye on cotton yarn and thread. This sup-

* Philosophical Magazine, vol. xiii.

posed fast colour was given by the combination of weld with a certain mordant, the composition of which the patentee was permitted to conceal, that foreigners might not enjoy the benefit of his discovery; while he, on his part, engaged to supply the cotton and thread dyers with his dye at a certain fixed price. The mordant used was supposed by chemists to be a solution of tin alone, or of tin and bismuth, which gives to weld yellow the power of resisting the action of acids and of boiling soap-suds, though it is not proof against the continued action of the sun and air. This defect, however, was not easily discoverable, in consequence of the ingenious method which, according to Dr. Bancroft, the inventor employed to obtain a favourable testimony of the dyers on the subject. He caused his specimens of dyed yarn to be woven into pocket-handkerchiefs, and gave them to be worn in the pockets of those who were afterwards to attest to the goodness of his dye; and as handkerchiefs enclosed in pockets are not exposed to the sun and air, this want of permanency of colour was not discovered until some time after the reward had been paid, for an invention which proved of little or no value.

A water-colour, called weld yellow, is much used in paper-hanging manufactories. This pigment, as it is usually prepared in London for sale, is the extract of the plant, and is in the form of hard lumps, which must be ground into powder previously to being used. Every colour is in some degree injured by that operation. Messrs. Collard and Fraser, therefore, use a process by which the necessity for subsequent grinding is avoided, the colour being obtained in the form of a fine powder. To produce this desirable result equal quantities in weight of carbonate of lime and soft water are put into a copper vessel; the mixture is raised to the boiling point, and stirred until it becomes of a uniform consistence. Then, to each pound of carbonate of lime, three ounces of pulverized alum are added; this is gradually mixed in, and as carbonic acid gas is by this means disengaged, the operation must be carefully performed, lest the effervescence which takes place should cause the mixture to overflow from the boiler. When the effervescence has subsided this part of the process is completed, the fire is withdrawn, and the mixture may remain any length of time without injury. Meanwhile the weld plants are placed with their roots uppermost in another copper vessel, into which soft water is poured in just sufficient quantity to cover every part containing seed. These plants, after being boiled for a quarter of an hour, are removed to a tub, where they remain until the liquor is drained from them; the water in which they have been boiled, added to these drainings, are then passed through a flannel filter, to intercept the seeds and fecula. The quantity of plants required for a given quantity of carbonate of lime cannot possibly be ascertained with accuracy, for some bundles contain three times as much colouring matter as others; but should too much of either mixture have been prepared, it can be kept in earthen vessels for many weeks without being in any way deteriorated.

When the weld liquor has been thus prepared, a fire is again kindled under the boiler containing the basis to which the weld liquor is added. The proper degree of colour required can only be obtained by trial. When the mixture is found to have a due proportion of each, it is raised to a boiling heat and the process is completed. The contents of the vessel are then put into an earthen receptacle, and the colour precipitates in the form of a powder. The next day the supernatant liquor is drawn off, and the residuum placed on large pieces of chalk, which in a few hours absorb the moisture, leaving the colour dry and fit for use. The liquor poured off from the colour is, with the addition of water, used again; the old plants are likewise boiled a second time previously to the addition of fresh ones, so that no colouring matter is lost. Iron vessels must not on any account be used in this process, for the gallic acid, which is extremely abundant in weld, would instantly dissolve the iron, and "the smallest particle of that metal is fatal to the delicacy of the weld yellow*."

Although cultivated in the parts of England we have mentioned, a sufficient quantity of weld is not produced for our home consumption, and we consequently draw it from foreign markets. Some writers have recommended the extension of its cultivation, and argued that it would thrive and render a handsome profit on some of our poorest lands, which for any other purpose are not worth ten shillings per acre. Marshal, in his 'Rural Economy of Norfolk,' says, it prefers a good soil, but others assert that it becomes stalky in a rich soil; and the author of 'the Journal of a Naturalist' supports the opinion that very poor land is the best for the purpose. "With us," he says, "it grows luxuriantly (i. e. in its wild state), three or four feet high, on a thin, stony, undressed soil, *apparently the very station it prefers.*"

QUERCITRON BARK.

Quercitron bark, though long in common use in those countries where it is indigenous, was not introduced into England until the year 1785, when Dr. Bancroft first applied it to the purpose of dyeing, and obtained a patent for its exclusive use. The *Quercus tinctoria*, which produces this dyeing substance, has already been described in the account

* Phil. Mag. vol. xiii.

of timber trees, any farther description here would therefore be superfluous. The quantity of colouring matter contained in this bark is very great compared to its weight; while the beauty of the colour it imparts is nearly equal to that of weld, and its durability is superior. According to Dr. Bancroft, it is capable alone of producing more cheaply all, or very nearly all, the effects of every other yellow dyeing drug. Its value is now fully appreciated, and a large quantity is annually imported from America into this country.

The epidermis, or exterior blackish coat of this bark, affords a yellow colour, but less pure than the other parts of the bark; it is therefore separated from these, being shaven off with a sharp instrument. The cellular and cortical parts which remain are then ground in a mill, some falling into a light fine powder, and the rest into stringy filaments; this last yields only half as much colouring matter as the powder. These are seldom separated from each other, however, but are used together as a dyeing substance. In this state the bark yields as much colour as about eight or ten times its weight, and one hundred times its bulk of the weld plant. The colouring matter is readily extracted by water, at a temperature of 100° Fahrenheit. This decoction is of a brownish yellow colour, which alkalis deepen and acids brighten. All the different shades of yellow may be produced by varying the quantity of colouring matter. It is an adjective colour; the mordants used are nitro-muriate of tin and acetate of alumina. Drab colours are obtained from the same dye, with a mordant of sulphate of iron and carbonate of lime, and olive shades by a mordant of sulphate of copper and carbonate of lime. An extract may be made from the bark amounting to about one-twelfth of its weight, but its colour becomes injured by the application of boiling heat, and therefore the extract cannot be used with advantage in dyeing. It would indeed be a most valuable desideratum if the colouring matter obtained from distant countries could be brought in the form of extract, thus concentrating all their virtues within the least possible space. But hitherto all colours are found to be injured while undergoing this process. The chemist would render an acceptable service to the arts who should discover means whereby this purpose might be successfully accomplished.

Quercitron bark is imported into England under an impost of 8*d.* per cwt.: its price is about 9*s.* per cwt.

The average annual importation for the last five years is 2,214 casks, containing ten cwt. each.

The wood of a species of mulberry or *Morus tinctoria*, yields a yellow colour, and is much used by dyers.

This tree is of spontaneous growth in Brazil and in many of the West-India islands, where it attains to a considerable height.

The precise period of its introduction into Europe as a dyeing substance is not exactly known, but it was certainly soon after the middle of the seventeenth century, as at about that time we find it noticed among the dyeing drugs in use. It is now in very extensive demand in our dye-houses under the name of *Fustic.*

This wood, which is of a sulphur colour with orange veins, abounds with colouring matter; it may be used substantively and is tolerably durable, but it can be made extremely so when in combination with the same mordants as are employed with weld or quercitron. Though a permanent dye, it is seldom used for pure yellow, as the colour which it imparts is dull and muddy; it is therefore chiefly employed in compound colours. It goes much farther than weld, but is not of so economical a use as quercitron. In equal weights, quercitron yields four times as much colouring matter as fustic, and their relative prices render the bark a cheaper dyeing material. This wood is, however, found more efficient in some mixtures of colours. It is much employed in combination with indigo, to dye what is called Saxon green. With an iron basis it dyes drab, and with an aluminous basis olive colours. This colouring matter is never applied to calico-printing, since the English dyers have hitherto been unsuccessful in producing from it any thing like an equal degree of clearness or brightness with that of weld or quercitron. Chaptal gives a simple method of obtaining a more lively colour from fustic. It consists in merely boiling in a decoction of this wood shavings of skin, glue, or other animal matter. The stuffs dyed in this preparation will, according to that eminent chemist, take a beautiful and most intense colour*.

Fustic is imported into England in large quantities, chiefly from Cuba and Jamaica. That from Cuba is very superior, and usually obtains fifty per cent. higher price than that from Jamaica. It is admitted into England at the nominal duty of three shillings per ton from British possessions, and of four shillings and sixpence from other countries. The average annual import for the last five years was 6,104 tons. The average price of the best is from £7 to £14 per ton.

Venetian sumach, or *Rhus cotinus*, is a shrub growing principally in Italy and the south of France. Both the root and the stem, when deprived of the bark and chipped, are employed for dyeing a full high yellow, approaching to orange, upon wool or cloth prepared with nitro-muriate of tin. But the colour obtained in this manner is extremely fugitive, neither

* Mem. de l'Institut, tom. i.

is it so bright as the yellow, which can be more cheaply obtained from quercitron bark. Four pounds of this chipped wood affords no more colouring matter than one pound of quercitron. This dye-wood is seldom used alone; it is employed merely as an accessary colour to heighten cochineal and other dyes, and to give them an approach to a yellow tinge.

Venetian sumach was long distinguished in France by the name of *Fustet*, and, with the wood, the name somewhat altered into *fustic*, was introduced into England. The wood of the *morus tinctoria* was subsequently brought from America, and likewise employed for dyeing yellow; destitute of a name, the American wood also acquired that of fustic, as being like it a yellow dye-wood. A confusion having consequently arisen to distinguish them, the wood of the shrub was called *young* fustic and that of the large American tree which is always imported in the form of large blocks or logs, *old* fustic. Many persons have in consequence been misled so far as to conclude that two very distinct dyeing drugs were the same, differing with each other only in point of age.

The wood known in England by the name of green ebony possesses a species of colouring matter very similar to that of *morus tinctoria*, and is sometimes employed in its stead in dyeing.

Among the American trees which yield a yellow dye, the Hiccory, or *Juglans alba*, may be enumerated. This is a species of walnut-tree producing nuts somewhat similar, but very inferior in every respect to the common walnut. The bark, the green leaves, and the rind of the nuts yield an adjective yellow colour. This dye is similar to that produced from quercitron, differing only in containing about one-third less colouring matter in a given weight. The grinding of

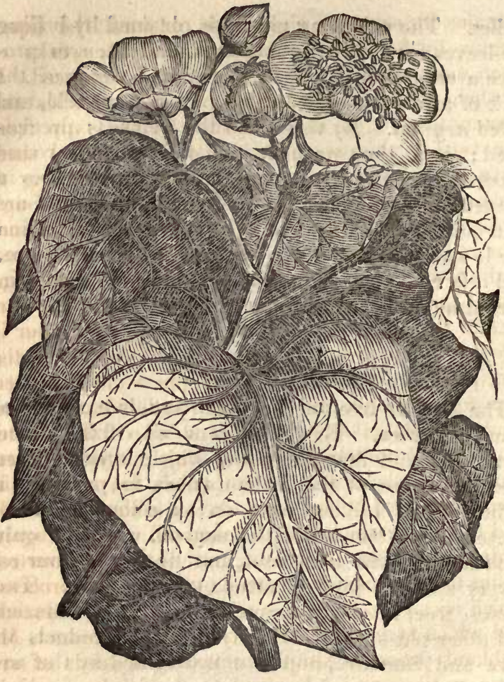
Hiccory—*Juglans alba.*

the bark is, however, attended with much greater difficulty and expense on account of its superior hardness and toughness, and therefore quercitron has almost entirely superseded the use of the hiccory bark.

A colour is extracted from a plant growing on the banks of the Orinoco. This plant is called by the natives *Chica,* and with its colour they paint their bodies. The colouring matter is obtained by boiling the leaves for a considerable time, and then to produce a separation of the fecula, adding pieces of the bark of a tree common to that part of the world, and called *aryana.* By this mean the fecula is precipitated; it is then washed, and formed into round cakes about two inches thick and five or six inches in diameter; these cakes are afterwards dried, and are then considered fit for use. In this state the chica dye is now occasionally to be met with in commerce, and it is coming into use for the purposes of dyeing. It communicates to cotton a fine orange colour.

ARNATTO.

The Arnatto tree, or *Bixa orellana*, is a native of South America. The Europeans who first visited America found that the berries which it yields were used by some of the Indian tribes to paint their bodies. The brilliant and showy colour soon attracted the attention of the settlers, who not only applied it to their own uses, but likewise converted it very speedily into an article of commerce. The arnatto tree is also extremely common in Jamaica and other parts of the West Indies. It abounds in Java and Sumatra, and is much valued by the natives of those islands on account of its colouring matter, which they skilfully extract. It seldom attains to more than twelve feet in height. The leaves are of a deeper green on one side than on the other, and are divided by fibres of a reddish brown colour; they are four inches long, broad at the base, and tend to a sharp point. The stem has likewise fibres, which in Jamaica are converted into serviceable ropes. The tree produces oblong bristled pods, somewhat resembling those of a chesnut. These are at first of a beautiful rose-



Arnatto—*Bixa orellana.*

colour, but as they ripen change to a dark brown, and bursting open display a splendid crimson farina or pulp, in which are contained thirty or forty seeds, in shape similar to raisin stones. As soon as they have arrived at maturity these pods are gathered, divested of their husks, and bruised. Their pulpy substance, which seems to be the only part that constitutes the dye, is then put into a cistern with just enough water to cover it, and in this situation it remains for seven or eight days, or until the liquor begins to ferment; sometimes, indeed, weeks or even months elapse before this effect is produced. It is then strongly agitated with wooden paddles and beaters to promote the separation of the pulp from the seeds; this operation is continued until these have no longer any colouring matter adhering to them. The turbid liquor is then passed through close cane sieves, leaving the refuse seeds behind. The mixture is now very thick, of a deep red colour, and of an extremely unpleasant odour. On being boiled the colouring matter is thrown up to the surface in the form of scum, or otherwise the colour is allowed to subside; in either case the scum or the precipitate must be boiled in coppers until reduced to a consistent paste. It is then suffered to cool and made up into cakes, which are dried in the shade. The liquor from which the colouring matter has been removed is preserved under banana leaves until it becomes heated by fermentation; it is then re-boiled, and the scum which rises is taken off. It then again undergoes similar treatment, until no more colour remains to be extracted. Instead of this tedious process, which occasions diseases by the putrefaction induced, and which at best affords only a spoiled product, M. Leblond proposes simply to wash the seeds of arnatto until entirely deprived of their colour, which lies wholly in the pulpy part, and to precipitate the colour by means of vinegar or lemon-juice, and then to boil in the ordinary manner*.

The experiments of M. Vauquelin made on some arnatto berries imported by M. Leblond, confirmed the efficacy of the process which he proposed, and the dyers ascertained that arnatto obtained in this manner had at least four times the value of that which was procured in the ordinary manner. It was

* Ann. de Chimie, tom. xlvii.

reported to be more easy to work, to require the addition of less solvent material, to give less trouble in the dyeing vessel, and to furnish a purer colour. Guiliche recommends that the application of heat should be avoided in the preparation of arnatto. There can indeed be no question that this substance is very much injured in its preparation; as all vegetable extracts, when exposed to the direct action of fire, have their properties lessened, or even altered, by partial charring; an accident which never fails to occur in a greater or less degree. In the country of its production, we are told that this colouring matter is much superior when used, as by the aborigines, fresh from the trees. The Brazilians, by another method of preparation, produce a permanent crimson colour from arnatto. The Spanish Americans mix the berries after having undergone a particular process with their chocolate, to which, in their opinion, it not only gives an excellent tint, but imparts valuable medicinal virtues.

The arnatto of commerce is moderately hard, of a brown colour on the outside, and a dull red within. It is seldom employed in England but as a dye for silken stuffs, or as an auxiliary in giving a deeper shade to the simple yellows. Its colour is a bright orange, but this is extremely fugitive, fading very fast on exposure to the air. It however powerfully resists soap and the action of the strongest acids. Dr. Bancroft, in making experiments on this substance, found that pieces of linen and cotton dyed in the usual way with arnatto, and subjected to the action of chlorine, not only retained their colour, but, on the contrary, bore exposure to the atmosphere longer than those pieces similarly dyed which had not been so treated. Arnatto is acted upon with great difficulty by water, to which it imparts only a pale brown tinge. When made into a dye-bath, alkali is therefore always added, which facilitates its solution and produces a better colour. The liquid sold in the shops under the name of "Scott's Nankin dye" is nothing but a solution of arnatto in potash and water. Arnatto is perfectly soluble in alcohol; it is much used in this state for lacquering, and for communicating an orange tint to the yellow varnishes.

It is likewise employed in large quantities as a colouring ingredient for cheese, to which it gives the required tinge, without imparting any unpleasant flavour or unwholesome quality.

Arnatto is imported into this country in cakes of two or three pounds weight, wrapped up in large flag leaves, and packed in casks. In this form it is a kind of paste, the evaporation not having been carried on to absolute dryness. Another kind, the roll arnatto of commerce, is of a much superior quality, being a hard extract, and containing a much greater proportion of colouring matter.

The average annual importation for the five preceding years was 1,074 casks, each weighing from three to four and a half cwt.

Turmeric, or Indian saffron, is a yellow dye obtained from the roots of *Curcuma longa.*

This plant is indigenous to the East Indies and other parts of Asia, and to Madagascar. It has likewise been cultivated with some success in Tobago; samples of turmeric sent to England from that island having been found superior to that usually imported. It does not, however, yet form an article of importation from the West Indies. Our supplies are brought from the East Indies, China, and Java; of these the Chinese turmeric is the best. The island of Sumatra might also furnish supplies, for it is much cultivated there, and principally used by the natives to give that yellow tinge to their rice and other food of which all

Turmeric—*Curcuma longa.*

eastern people seem so fond. The East-Indians make the same use of it.

The roots of the *curcuma longa* spread far under the surface of the ground; they are long and succulent, and about half an inch in thickness, having many circular knots, from which arise four or five spear-shaped leaves, standing upon long foot-stalks. The flowers grow in loose scaly spikes, surmounting the foot-stalks which spring from the larger knots of the roots, and attain to about a foot in height. The flowers are of a yellowish red colour, shaped somewhat like those of Indian reed.

These roots are externally of a colour inclining to grey, but internally of a deep lively yellow. They are very hard, and not unlike either in figure or size to ginger. The roots are reduced to powder previously to being employed as a dye. Turmeric is very rich in colour, but it possesses no durability, nor can any combination of mordants give to it this quality in a sufficient degree. Chloride of sodium and muriate of ammonia are the substances which best fix the colour, but they spoil its beauty by deepening its hue almost to brown. It is sometimes employed to impart a golden cast to yellow made from weld, or to give an orange tinge to scarlet, but the shade which it imparts is very evanescent, and soon vanishes on exposure to the air.

In Europe it is sometimes employed as a substitute for saffron to heighten the colour of certain culinary preparations. It is very often used as an ingredient in yellow varnishes.

Sixteen thousand and sixteen bags of turmeric were imported into England in 1830, each bag weighing from one to two cwt.

That received from our own possessions is subjected to an import duty of 2*s*. 4*d*. per cwt.; coming from foreign countries the duty is quadrupled. The price of Bengal turmeric is from 22*s*. to 24*s*. per cwt., and of the best Chinese 32*s*. per cwt.

French or Avignon berries are known in commerce as a yellow dye. They are the unripe berries of a species of buckthorn, the *Rhamnus infectorius*, which is an evergreen shrub, a native of Spain and southern France. It grows to the height of ten or twelve feet, sending forth many branches from the bottom.

A particular variety of this plant grows in Candia and other parts of the Levant, yielding berries larger than those which are brought from the south of France. They are distinguished by the name of Turkey berries, and are preferred to the French. Both kinds yield a very beautiful, but remarkably fugitive colour. No mordant has yet been discovered with sufficient affinity to this colouring matter to render their combination permanent. It therefore cannot be used with advantage to the consumer, except where a fine but very transient colour is required. These berries are, however, of very common use in our dye-houses.

Three thousand four hundred and twenty-five cwts. were imported in 1831. They are admitted on a duty of 2*s.* per cwt. Their average price for the last five years was 68*s.*

Yellow berries of another description are brought from Persia, and from some parts of Asia Minor; these are much superior to the French berries. They are very soluble in salt water. A gentleman on a passage from Smyrna on board a ship that carried a few bags of these yellow berries, observed that when a leak was sprung and the pumps applied, the water brought up from the hold was almost immediately of a bright yellow colour. This curious effect, which gave to the deck of the vessel the appearance of a dye-house, continued for two whole days, or until the circumstances of the navigation allowed the sailors to remove that part of the cargo from the action of the sea-water.

The well-known pigment, sap-green, is simply the concentrated juice of the ripe berries of buckthorn.

Common saw-wort, or *Serratula tinctoria*, is a perennial plant indigenous to England, growing in woods and in pasture grounds, where it flowers in the month of July. A decoction of its leaves produce a yellow dye, which is chiefly used for the coarser woollen cloths, and as an ingredient with other dyeing drugs. Applied in combination with indigo, a very good and durable green colour is obtained. This is an adjective colour, but with alum as a mordant it becomes a permanent dye. The decoction is of a brownish yellow hue: on being diluted with water it is changed to a brighter tinge; by adding a solution of pure potash it acquires a darker shade. The addition of a small quantity of muriate of ammonia converts the colour into a reddish brown; which may again be rendered of a golden tint by the addition of pure water. Poërner observes, that alum and gypsum, the latter forming the deeper shade, appear to be best calculated for extracting a fine colour from this plant.

In the neighbourhood of Rochdale in Lancashire, and in some parts of Yorkshire, the clothiers make use of common heath for their yellow and orange dyes. This well-known plant abounds in many uncultivated spots. It is taken from the moors and unenclosed land, and mowed down when in full bloom. It is then spread out, and treated in the same manner as grass for hay; when dry it is laid up in barns or ricks. In combination with a tin mordant, it is said that this plant produces a more beautiful colour on woollen cloths than either weld or quercitron. But, though more bright and intense, it is not so permanent *.

The branches or twigs of the Dyer's Broom (*Genista tinctoria*) afford an adjective lemon-colour. This plant was used by the Romans for dyeing, and is described by more than one ancient writer. It is still applied to the same purpose in some of the Gre-

* Parkes' Chemical Essays.

cian islands. The correct old traveller, Tournefort, describes the simple process as he saw it performed at Samos. "To dye yellow they throw into boiling water the extremities of the broom: after several boilings they add a little alum to the decoction; then they plunge into it linen, woollen cloth, leather, or whatever they wish to dye, and removing the cauldron from the fire, leave the material to soak all night. The yellow imparted is tolerably fine, and no doubt more skilful operators might make a more perfect colour of it. This Grecian plant differs from that which grows on the coast of Provence only in having its leaves narrower and longer*."

It is a native of Britain, growing abundantly on dry and hilly grounds. The height to which it attains is about three feet; its shrubby stalks are terminated by several spikes of yellow flowers succeeded by pods; the leaves are spear-shaped, and placed alternately on the branches. The colour produced by a decoction of these branches cannot be compared in beauty with that of weld or saw-wort, but it acquires sufficient permanency by means of mordants. It is sometimes used for inferior woollen goods, in combination with alum or tartar, and sulphate of lime.

Though yellow colouring matter is profusely scattered through the vegetable world, there are scarcely any plants to be found which yield a permanent yellow without the aid of certain intermedia to unite it to the stuff to be acted upon. Dr. Bancroft has remarked, that no substantive vegetable yellow has been ever extensively employed for dyeing in Europe, though there are accounts of plants growing in distant countries which seem capable of affording such yellows with advantage. None of these, however, have been introduced into our dye-

* Voyage du Levant, tom. ii.

houses since this observation was made, which therefore applies equally to the present day.

Mr. Clarkson, in his Essay on the Impolicy of the African Slave Trade, has related, that a gentleman residing on the coast of Africa, ordered some wood to be cut down for the purpose of erecting a hut. While he was witnessing the process of the work, some of the juice which was expelled from the bark reached him, and stained one of the ruffles of his shirt yellow. He found that the spot became of a much more bright and beautiful colour by the application of soap and water, and that it gained in lustre with every subsequent washing. Pleased with the discovery, he sent home a small sample of the bark, which produced a valuable yellow dye, far beyond any other ever in use in this country. In the mean time the gentleman unfortunately died, and with him the knowledge of the species of tree that had produced this bark, which still remains undiscovered.

The manner in which the double process of tanning and dyeing yellow is carried on among the Arabs of the desert is so curious as to deserve our notice. It is this:—" To render the camel's skin yellow (no other skin is ever dyed), they cover it with salt, which is left upon it for two or three days; they then steep it in a liquid paste made of barley-meal mixed with water, where it remains for seven days; then they wash the skin in fresh water, and clear it easily of the hair. Next they take the peels of dry pomegranates (a fruit which they purchase in the Syrian towns, or from the Menadhere Arabs, or from the Fellahs on the Euphrates), pound them, and mix them with water; they let the skin remain in that mixture three or four days; the operation is thus completed, the skin having acquired a yellow tint. They then wash and grease the leather with camel's fat to render it smooth. If pomegranates cannot be obtained, they use the roots of a desert herb called *oerk;* this is about three spans long, and as thick as a man's finger; the outer skin serves as a substitute for the pomegranate peel, but dyes the leather red. Of leather so prepared, the *rawouye*, or large water-skins, are made; these are sometimes soaked a second, and even a third time, in the mixtures above described, a month after the first dyeing. For some time the *rawouye* imparts to the water an anstringent, bitter taste; this, however, the Arabs like *."

Many different plants are capable of affording green colours, but these are of little practical use, as they are all fugitive, and hitherto neither science nor experiment has succeeded in discovering any artifice by which they may be rendered more lasting. D'Ambourney, indeed, after many trials, supposed that he had extracted a durable green from the berries of the *rhamnus frangula*, or berry-bearing alder, when the substance to be acted upon had been previously prepared with tartar, nitric solution of bismuth, and chloride of sodium. But either this has never been put to the test among practical dyers, or it has been found not to possess an advantage which would have rendered the discovery so valuable.

Among those plants which yield a fine, though evanescent green, are the field broom-grass, or *bromus secalinus;* the chilca, or *cestrum;* wild chervil; purple clover; and the common reed.

Saffron is not properly speaking a dyeing drug, being too expensive to be so applied in England; but it is an ingredient so rich in colouring matter that it should not pass wholly unnoticed, especially as it is occasionally employed in the dye-houses of some

* Buckhardt's Notes on the Bedouins and Wahabys.

places on the Continent. Saffron is a drug well known in pharmacy, is employed as a colouring tincture, and likewise in some peculiar culinary preparations.

The plant which produces saffron is the *crocus sativus*. It is cultivated in England as well as in France and Spain. English saffron is most esteemed, but it is not grown here in sufficient quantities for our own supply; we therefore import some from France and Spain. In 1830, about 3,500 pounds weight were brought into England for home consumption; it is admitted at a duty of 1*s*. per lb., its price varying from 20*s*. to 30*s*. for that quantity.

The *crocus sativus* has a bulbous root about the size of a small nutmeg, a little compressed at bottom, and covered with a brown netted skin. The flowers issue from the upper part of the root, and, together with the young leaves whose tops just appear, are closely wrapped about by a thin spatha or sheath, which parts within the ground and opens on one side. The tube of the flower is very long, arising immediately from the bulb without any foot-stalk, and at the top dividing into six equal oval obtuse segments of a purple colour. The germen, situated at the bottom of the tube, supports a slender style, which rises to half the length of the petal, and is crowned with three oblong golden stigmata, spreading asunder each way. Three stamina rise to the height of the style and are terminated by arrow-pointed summits. This plant flowers in October, but it never produces any seeds in this country; the leaves continue to grow throughout the winter. The only valuable parts of the flower are the stigmata, which when dryed are called saffron. A saffron ground is seldom above three acres or less than one in extent. It should be well exposed, and neither a poor soil nor a stiff clay, but a fine hazel earth on a substratum of chalk should be chosen for the purpose. The ground is carefully prepared during two or three months previously to planting by manuring and frequent ploughings. The time of planting is commonly in the month of July. The manner this work is generally performed is for one man to make a small narrow trench, throwing up the earth at one side; two persons follow with roots, which they place about three inches from each other; another trench is then made at the same distance from the first as the roots are from each other, the preceding one being filled up with the mould dug out of the second, and so on, till the whole field is planted. About 128 bushels of roots are in this manner planted in one acre. In September they begin to vegetate, they are then weeded, and in the next month the flowers appear. These are gathered before as well as after they are full blown. The most favourable hour for gathering them is early in the morning. The whole of the flowers are plucked and thrown by handfuls into a basket. When carried home the stigmata are picked off, and the rest of the flower thrown away as useless. The next labour is to dry the saffron. For this purpose a kiln of a particular construction is used, by which the delicate article under process is protected from the accession of too much heat. Over the mouth of the kiln is placed a hair-cloth, or net-work of iron wire, and above this several sheets of white paper, upon which the fresh saffron is spread about two or three inches thick. This saffron is covered with other sheets of paper, over which is placed a coarse blanket folded five or six times, or a canvas pillow filled with straw. After a fire has been for some little time lighted underneath, the whole is covered with a weighted board. No fuel should be used that emits smoke, as this would injure the colour of the saffron. When heat has been applied for about an hour, the board is raised, and the papers with the saffron within them are turned and then covered as before. The same operation is repeated every hour for the first three or four hours, and subsequently every half hour for four and twenty hours; the saffron is then thoroughly dry and fit for use. About five pounds of wet saffron yield one pound of dry. The quantity produced at a crop is very uncertain. Sometimes five or six pounds of fresh sigmata from one rood of ground; sometimes not above one or two, and at others not so much as is sufficient to defray the expense of gathering and drying. When the roots are planted very thick two pounds of dry saffron may at a medium be allowed to an acre for the first crop, and twenty-four pounds for the two remaining ones, the third being considerably larger than the second. The roots are never allowed to remain in the ground for more than three years, and, in the midsummer after the third crop has been gathered, they are taken up either by means of a forked hoe or a plough. The roots, being thoroughly cleansed from all extraneous matter, are either transplanted immediately, or may be kept some time without danger of spoiling. The quantity of roots taken up is very uncertain, but at a medium 192 bushels of clean roots fit for planting may be obtained from each acre.

The best saffron is that which has the broadest blades; it is by this that the English is distinguished from the foreign. It should be of an orange or fiery red colour, and yield a dark yellow tincture. That brought from Spain is very inferior, in consequence, it is said, of oil being mixed with it for its better preservation.

CHAPTER XXIII.

FAWN COLOURS.

SUMACH—WALNUT-PEELS—HENNA.

IT is observed by Berthollet that almost all vegetables contain more or less colouring matter capable of affording fawn (*fauve*) hues inclining to yellow, brown, red, or green. The colouring matters vary with reference to their quantity and quality, according to climate and the age of the vegetable. Great diversity of shades may therefore be procured, by modifying the peculiar brown colour natural to vegetables, by means of different mordants.

Sumach, or *Rhus coriaria,* abounds in this colouring matter.

This tree is a native of Syria, and is diligently cultivated in Spain and Portugal, and in some parts of Italy and Sicily. The stems are ligneous, dividing at bottom into many irregular branches, attaining to the height of eight or ten feet. The bark is hairy, and of an herbaceous brown colour. The leaves are winged, having seven or eight pair of jagged lobes, and terminated by an odd one. They are hairy on their under side, of a yellowish green colour, and placed alternately on the branches. These are surmounted by loose panicles of flowers, which are of a greenish white colour, each panicle being composed of several spikes of flowers, sitting close to the foot-stalks.

The shoots of this tree or shrub are cut down every year close to the root, and after being dried are reduced to powder by means of a mill. An infusion of this yields a fawn colour bordering on green. It is a substantive colour, but may be altered and improved by the judicious application of mordants. The principal use, however, of sumach in dyeing is the production of black, by means of the large quantity of gallic acid which it affords.

The different kinds of sumach known in commerce are the Sicily, Malaga, Trieste, and Verona; the first of these being of the best quality. Its import duty is 1*s.* per cwt.; and its price averages from 12*s.* to 15*s.* per cwt. The average annual importation for the five preceding years is 100,101 cwts.

The colouring matter of the husks of walnuts forms an excellent dye for wool, both by itself and as a basis for other colours. This dye is much used and esteemed among the French dyers, because it gives agreeable and very durable shades without the assistance of mordants. In consequence only one simple and not expensive operation is required, while the softness of the wool is preserved. But though a substantive colour, an alum mordant may be used with advantage, as it increases the density of the dye and makes it somewhat lighter in colour.

When the walnuts have attained to maturity they are gathered, and the outer peels are preserved for dyeing. For this purpose they are put into large casks or tubs, and water is poured over them. In this state they may be kept with advantage for one or two years. They then furnish much more colouring matter than when fresh, but it emits a very unpleasant putrid odour. The root of the walnut-tree gives the same shades, but to produce an equal effect a greater proportionate quantity must be employed.

The decoction of this substance consists almost entirely of pure tannin and gallic acid. All barks of trees contain these matters in greater or less proportions, and therefore by the use of an iron mordant may be made to give all the gradations of shade, from a yellow-brown to a black.

Among others, the bark of the Birch-tree (*Betula alba*) affords a decoction of a clear fawn colour, which becomes speedily turbid and brown by exposure to the air, and which may be made to produce many shades of colours.

Sir William Jones relates, that in the island of Hinzuin or Johanna he observed a very elegant shrub, about six feet high, not then in blossom. On inquiry he learnt that it was the celebrated Henna-tree, of which he had read so much in Arabian poems. He, in imitation of the heroes of oriental poesy, had his nails stained with a preparation of this plant, and thus obtained sufficient evidence of the durability of the colour; his fingers remaining discoloured until the substance of the nails changed by growth. This plant is much esteemed in the East and in Africa for this strange purpose; and the toilet of the Asiatic or African beauty is deemed incomplete, unless her charms are heightened by this potent auxiliary, the dark tints of which, to European eyes, impart no very becoming lustre. The use of henna is not, however, wholly confined to staining the nails and skin, as it is employed in the East for dyeing ordinary stuffs. It produces a reddish brown substantive dye. There is evidence that the ancient Egyptians made a similar application of this colouring matter, as in the envelopes of their mummies the henna dye is still observable.

The shrub whence it is obtained was known to the ancients under the name of Ciprus. It is the *Lawsonia inermis* of botanists, and in English is called Egyptian privet. It is indigenous to, and is cultivated throughout India, Egypt, Palestine, and Persia. The flowers generally come forth from May to August. The leaves are the only part used ; these are gathered, and after being hastily dried and bruised to a pasty substance, are made to yield by boiling the rich colouring matter in which they abound.

Many British plants produce a brown colouring matter, but not in sufficient quantities to render their use extensive.

The juice of the stems of hops affords a very durable brownish red colour. Sloe-juice imparts a pale-brown tint, which washed several times with soap, and then moistened with an alkaline solution, becomes of a deep red-brown. On boiling sloes their juice changes to a red colour, and the dye which it imparts to linen, when washed with soap, is converted into a bluish colour, which is permanent.

Chapter XXIV.

BLACK DYES.

GALL-NUTS—VALONIA—MYROBALANS.

Several substances are found in the vegetable world which produce a permanent substantive black dye, but these are of little importance in the dye-house, since they cannot be collected in sufficient quantity to be employed with advantage, the necessities of the art requiring a much larger supply of black dye than could thus be obtained. This dye is, therefore, in England always the result of artificial combination. Among the different colouring matters already described, the application of some in the formation of a black dye has already been noticed, and these, with different mordants, are most usually employed.

The Gall-nut is one of the principal ingredients used in dyeing black and various kindred colours: it is employed in large quantities in our dye-houses, besides which it is an essential component in all black writing-inks.

Gall-nuts are the produce of a prickly cupped oak, *Quercus infectoria*, a small timber tree, that grows wild in almost all the countries bordering upon the Mediterranean, and in some of the southern provinces of Germany. Some notice of this tree is to be seen in the volume upon timber trees, in the present series. Galls are generally supposed to originate from a puncture made by an insect of the genus *cynips*. An authority, however, of much weight in the scientific world would lead us to doubt

Oak Galls.—*Quercus tinctoria.*

whether this insect really produces the excrescence by wounding the bark, or whether it preys upon the fruit of the tree. Mr. Aikin observes, " that notwithstanding the concurrent testimony as to the origin of the gall-nut, any person who will give himself the trouble to break half a dozen *sound unperforated* Aleppo galls may readily convince himself that this is one of those vulgar errors which are repeated and believed from generation to generation, because in philosophy and natural history it is easier to believe than to examine *."

The gall-nut consists of four distinct parts, having every characteristic appearance of some other kinds

* Aikin's Chemical Dictionary.

of nuts, which are well known to be the fruit of trees. The external or *cortical* covering is of a dense fibrous texture, and of a pale dull yellow colour; this is very thin, and separable without much difficulty from the part which it encloses; to the taste it is highly astringent, with a slight and sometimes a scarcely perceptible bitterness. Immediately beneath this is what "we shall call the *resinous* part," and which constitutes by far the greater portion of the gall-nut. The colour of this is a dark yellowish brown, having a fibrous texture and a glimmering resinous lustre. It is very brittle, astringent to the taste, and nauseously bitter. The central cavity of the gall-nut is lined with a very pale yellowish brown shell, adhering pretty firmly to the resinous part. It is of a fibrous texture without lustre, and to the taste almost wholly insipid, like common ligneous fibre. "Within the shell is the kernel, a small egg-shaped body, sometimes considerably flattened, and a quarter of an inch or more in length. It is of a brown cream colour, and has an even and very minutely granular fracture like a common hazel-nut, breaking down between the teeth, like all the oily farinaceous seeds when dried. It is often found mouldy, and then it is of a bright chocolate colour. This kernel no doubt it is, which invites the depredation of insects *."

Though gall-nuts can be very readily subjected to the examination of any person who prefers ocular demonstration to description, yet it is a difficult matter to find *sound unperforated* nuts in this country; and specimens can rarely be found in agreement with the above description, in consequence of the absence of the kernel.

Perforated nuts, which are those most generally found in commerce, have the small cavity within hollow and unoccupied, without any appearance of a

* Aikin.

kernel; this may already have been devoured by the insect, who has pierced its way back to liberty. The gall-nut is certainly very different to the excrescence called the oak-apple, found on oaks, and which is apparently produced from the puncture of an insect.

All galls present a tuberculous, uneven, globular surface, but they differ very much from each other in size and colour; some not being larger than the smallest hazel-nut, and others about the size of a walnut, from which however they differ in shape. Their colour varies, some having a tinge of blue, some of green, and others of a pale yellow approaching to white. They are known and distinguished in commerce by these different colours, blue-galls being the most esteemed. The best of these are now brought from the East Indies, which obtain a higher price than those received from Turkey. The average annual importation for the five preceding years was 1,936 bags and chests; each of the former weighing 1 cwt. and of the latter from 2 to 3 cwt. The average price of the best, during that period, has been £4. 15*s.* per cwt. They are admitted at a duty of 5*s.* per cwt.

The constituent parts of galls, wherein their usefulness in the arts consists, have been noticed when treating of tanning and of the acids.

The cups of the acorns of the Velani oak, or *Quercus ægilops,* are found to partake of the nature of the gall-nut, and are much used in this country as a less expensive substitute. In China they have been long applied to the same purpose *, and Olivier remarks that other Orientals and the Italians likewise are acquainted with their use, but that the French have hitherto neglected to employ this substance.

* Staunton's Embassy to China.

The Velani oak grows in the Dardanelles, on the western coasts of Natolia, in the islands of the Archipelago, and indeed throughout all Greece and the maritime parts of Asia Minor. Tournefort describes it as growing to the size of our common oak, but Dr. Clarke was never able to discover one which was beyond the growth of a shrub. "However," he observes, "the accuracy of such a writer as Tournefort is by no means to be disputed upon a point that he was so peculiarly qualified to determine *." The intelligent and indefatigable traveller we have just quoted endeavoured to propagate this tree in England, and for this purpose collected with the utmost care some Velani acorns, which he conveyed home and caused to be sown in the botanic garden at Cambridge, but they did not produce a single plant.

The leaves of this tree are of a bright green, and of a long oval form, with serrated edges. The acorns are short and thick, and a little hollowed at the top. The cup is very broad, and closely beset with oblong scales. This tree grows more commonly in the plains than on the mountains. The cups of the velani, known in commerce as *valonia*, form an important article of export from Smyrna and its neighbourhood.

This is an article of great and increasing consumption, being beyond all comparison greater than that of galls. The last year (1830), 2,297 cwt. of galls, and 86,538 cwt. of valonia, were retained for home consumption. Most probably valonia has not nearly as much proportionate useful part in a given quantity as the gall-nut, but the average price of the best is only 18*s.* per cwt., which is less than one-fifth the cost of galls.

* Clarke's Travels, vol. vi.

In the five preceding years, 3,268 tons have been on an average annually imported into this country. It is admitted on a duty of 1*s.* 6*d.* per cwt.

A patent was taken out in 1826 for applying the shells of chesnuts as a substitute for galls. It is however well ascertained that the gall-nut is so much richer in gallic acid and tannin, as to be not only much better but more economical.

The fruit of the *Terminalia chebula*, or *Myrobalans*, is much used by the Hindoos as an excellent substitute for galls, all the useful properties of which it is found to possess. It is called in Bengal *Hurrah phul*, the largest distinguished as *Burrah hurrah*, and the smallest as *Choota hurrah*, and it is commonly sold in the bazaar of Calcutta. Myrobalans are equal in value to about half their weight of galls. In appearance they are of an irregular shape, and when fresh are of a pale yellow colour. They become darker by age, until they are of a deep brown, or nearly black, resembling dried plums. If the pulpy or outer part were divested of the stone, which is entirely useless, this substance would then be more valuable than an equal weight of galls, and it is probable might become a highly useful article of commerce. With the fecula of iron it produces an excellent black colour, and with weaker solutions of sulphate of iron a fine brown; in combination with alum a buff colour is obtained, which is the chintz painter's best yellow. Mixed with iron filings and water, it communicates a strong black dye to leather, and in every respect produces a similar effect to that of galls.

Chapter XXV.

RESINS.

TURPENTINE—CHIAN—STRASBURG—VENICE—COMMON TURPENTINE.

Turpentine is a resinous juice which flows from several trees. The manner of collecting it has been briefly described in the account given of the pine-tree in a former volume of this series, but the substance is of too extensive use in the arts not to claim a further notice in this portion of the work.

The Chian turpentine is that which was most anciently known. It is so called because the island of Chios (Scio) was formerly famous for this resinous product, the quality of which is much superior to that of common turpentine. In the present day Chian turpentine is very rarely to be met with in commerce. The tree whence it flows is commonly known as the turpentine-tree: it is called by botanists *Pistacia terebinthus.*

The tree grows to the height of twenty-five or thirty feet; the bark is very thick, and the wood is hard and resinous. The leaves are winged, composed of small single leaves growing in pairs opposite to each other and terminated by an odd one; these are serrated and spear-shaped. The flower is succeeded by a calyx, nearly round and resinous to the touch, enclosing a nut which contains a kernel of a slightly acid taste. This tree is an evergreen, but if exposed to an ungenial climate the leaves turn somewhat brown in autumn. It is native to Scio, and grows likewise in some of the southern provinces of France.

Chian Turpentine-tree—*Pistacia terebinthus.*

The turpentine which comes from it is a yellowish white fluid, having a slight tinge of blue. This flows from incisions made in the trunk and larger branches, first in the lower parts, and by degrees, as these become exhausted, others are cut above.

A very white limpid and fragrant essential oil is obtained from the fluid by distillation.

The resin formerly known in commerce by the name of Strasburg turpentine is a juice of the consistence of a fixed oil; it is of a yellowish white colour, a bitter taste, and a more agreeable smell than common turpentine. It flows from the yew-leaved fir, which is very common in the mountains of Switzerland. This juice is collected in blisters, which appear beneath the bark in the strong heats of summer. The peasants pierce these vesicles with the point of a small horn which becomes filled with the juice, and this is from time to time emptied into a larger vessel *.

The juice which flows from the larch, or *Pinus larix*, is called Venice turpentine, but it is improperly so distinguished, since it is produced in some parts of Germany, in the neighbourhood of Lyons, and in the valley of St. Martin, near Lucerne in Switzerland. This turpentine is much prized in the arts, and is very superior to that produced from the fir-tree. The manner of obtaining this juice is to make incisions in the trunk of the tree about two or three feet from the ground; narrow troughs twenty inches long are fixed in these, having their lower ends hollowed out in the form of a ladle, through the middle of which a small hole is bored, which affording a passage to the turpentine, this runs into a receiver placed below. The people who gather it visit the trees morning and evening, from the end of May to September, to collect the turpentine out of these receivers. The juice flows out of the tree as limpid as water, but when kept it thickens and becomes of a citron colour. The turpentine flowing naturally is called *bijon*, and is a kind of balsam, which, it is said, is not inferior in virtue to Peruvian balsam.

The common turpentine is obtained chiefly from

* Chaptal's Elements of Chemistry.

the *Pinus sylvestris*, or Scotch fir. It is produced largely in the pine forest in the south of France, in Switzerland, in the Pyrenees, and in Germany; it is likewise obtained most abundantly in many of the southern states of North America, where it forms an important branch of commerce, and whence it is imported into England. Several attempts have been made to obtain it from our own fir-trees, but hitherto without success.

The age of the tree when first operated upon

Scotch Fir—*Pinus sylvestris*.

should be at least twenty or thirty years. A hollow, about three inches square and an inch deep, is then cut into its trunk at half a foot from the ground, and the bark is stripped off to a foot and a half above, exposing the sappy wood. Some of the trees are cut on two sides, leaving only two longitudinal strips of bark of about four inches in breadth to convey the sap necessary for the support of the tree. The turpentine flows from the trees sometimes six or seven, but more usually only during four years; every year the bark being cut away higher and higher until the juice will flow no longer. Some trees die in consequence, but others continue to thrive, and do not appear to be much injured by the exhaustion of their juice. It is considered a good day's work for one man to *box* * sixty trees a day. About once a week it is found necessary to take off a thin piece of wood from the barked part, as otherwise the resin dries, and forming a coating prevents the free flowing of the juice; this operation is also performed after rain, which checks the running of the turpentine.

The hard concrete turpentine, which forms about the incisions of fir-trees while exuding, is a brittle and opaque resin called by the French *brai-sec.*

Turpentine, as first obtained from the trees, is loaded with impurities from which it is freed by two distinct methods; one consists in enclosing it in a cask perforated at bottom, when by exposure to a hot sun it becomes so fluid as to filter through, which gives the finest and most valued turpentine. The other method is to heat it moderately in a large copper until it is quite liquid, and then filter it through a strainer, made of rows of straws laid close

* For the meaning of this term, and also for farther particulars concerning turpentine, we refer the reader to page 82, of the volume on Timber Trees in this series.

to each other. After this preparation it appears of a golden colour.

The quantity of turpentine retained for home consumption in 1831 was 317,895 cwts. It is subjected to a heavy duty of 4*s.* 4*d.* per cwt., and if of greater value than 12*s.* per cwt., a farther duty of 1*s.* per cwt. is exacted. Its present price is about 12*s.* 6*d.* per cwt., making the value of the turpentine only 8*s.* 2*d.* per cwt. as imported.

Turpentine is not used until it has undergone the process of distillation. When distilled with water it yields a considerable quantity of a subtile penetrating essential oil, commonly termed spirit of turpentine. The advantage of distilling with water was made manifest by Neumann, who found that sixteen ounces of Venice turpentine when mixed with water and subjected to distillation produced four ounces three drams of oil, and that the same quantity distilled without water yielded with the heat of a water-bath only two ounces. About six pounds of essential oil is obtained from 25 lbs. of good common turpentine. After distillation with water a yellow substance remains in the still—this is the common resin of the shops.

If this be now subjected to a greater heat a thick balsam of a dark reddish colour, called balsam of turpentine, is distilled over, and the residuum, which assumes a blackish hue, is called black resin or colophony. A patent has been recently granted for the production and application of this balsam. Common resin being procured it is distilled in the manner above described, and the product is known under the name of resin oil. This oil being decomposed by a similar process to that pursued with the animal oils, is made like them to produce olefiant gas for the purpose of illumination.

Another patent has likewise been obtained for the procurement of this illuminating gas direct from the resin without any intermediate distillation. This latter plan is now partially pursued.

Oil of turpentine is of essential use in varnish-making. It forms the great solvent for all resins, and being extremely volatile when exposed to the air, it quickly separates from the varnishing substance, leaving this fixed to the surface whereon the mixture has been applied.

The most extensive use by far to which oil of turpentine is put, is that of diluting oil colours to such a consistency that they will flow freely from the painter's brush. For this purpose it is admirably fitted by the same volatile quality which renders it useful to the varnisher. Without some substance which could be made temporarily to combine with, without acting upon oil colours, liquefying them to the necessary degree, and leaving them again quickly after their application and consequent exposure to the air, it would be impossible to avail ourselves of the great advantages attending the use of colours ground in oil. With the exception of turpentine, there is not any substance known that would fulfil these offices, and which could at the same time be obtained at a price that would render them practically useful.

Turpentine, previous to its distillation, dissolves totally in alcohol, but the essential oil is very difficult of solution in a spirituous menstruum. One part may be dissolved in seven parts pure alcohol; but on standing a while, the greatest part of the oil separates and falls to the bottom. Oil of turpentine is a limpid white fluid of a peculiarly powerful smell. It is highly inflammable.

Its boiling point is 316 degrees of Fahrenheit's scale.

Chapter XXVI.

RESINS, (continued).

MASTIC—SANDARACH—DRAGON'S BLOOD—ANIMI—ELEMI—COPAL—JAPAN VARNISH—BENZOIN—LABDANUM.

Although the general name of resin is used to designate that alone which is obtained from turpentine, there are a considerable number of similar substances obtained from other sources, which are classed under the common term of resin. These are distinguished as being solid, brittle, inflammable, and somewhat transparent substances, of vegetable origin, totally insoluble in water, but soluble in alcohol, volatile oils, and sulphuric ether. When these solutions are evaporated the resin is restored unaltered; if thinly spread on any surface the alcohol or other solvent will speedily evaporate, leaving the resin behind, to cover the body with a smooth, shining, transparent coat, which cannot be washed off with water. This process is called *varnishing.* Resin is with difficulty acted upon by acids. Alkalis combine with it, but their combination is not easily effected.

Resins are considered by chemists to be nothing but volatile oils rendered concrete by their combination with oxygen, and this belief is confirmed by the results of several experiments.

Mastic is a resinous substance collected in the form of tears; it is of a very pale yellow colour, having but little smell, and scarcely any taste. It forms the basis of several dyeing varnishes, is one of the ingredients used in fumigations, and is considered to be efficacious in promoting a healthy state of the mouth: for this latter purpose it is held in much esteem by the Turks, Greeks, and all the people of the Levant, who constantly chew it. Hence it takes its name; mastic being derived from *masticare*, to masticate. The women of Scio, Smyrna, and Constantinople have almost always a piece of it in their mouths.

This is the most celebrated production of the island of Scio, and of so much importance is it considered there, that the inhabitants of the villages that furnish it, had, when under their Turkish masters, many peculiar privileges. They acknowledged no other chief than the *aga* or lord who farmed that production; they were exempt from contributing their labour gratuitously on public occasions, being obliged only to convey the mastic to the town, and to furnish beasts of burden to this aga when he travelled about the villages in order to collect it. "We had an opportunity," says M. Olivier, "of seeing the aga on his tour, preceded by military music, followed by several *tchocadars,* and surrounded by a greater number of villagers, eager to attend on him. Had we not been previously informed, we should much rather have taken him for a military commander than a simple farmer of taxes *."

The tree which produces the mastic is the Lentisk, or *Pistacia lentiscus.* It usually grows to about the height of twelve or fifteen feet. It is more like a shrub than a tree, scarcely acquiring seven or eight inches in diameter. The leaves are composed of two or three pair of spear-shaped lobes, and terminated by a single one: the outer lobes are the largest, the others gradually diminish in size. It is an evergreen, but the leaves lose their bright verdant look towards

* Olivier's Travels in the Ottoman Empire, chap. vi.

Mastic Tree—*Pistacia lentiscus.*

autumn. At Scio a few slight varieties are to be found bearing larger leaves, which are the consequence of culture, and which are perpetuated by layers and graftings.

In order to obtain the mastic, numerous incisions are made in the trunk and principal branches of the lentisk, during five days in the middle of July. A liquid juice gradually exudes from these incisions; this thickens by exposure to the air so immediately as mostly to adhere to the tree in the form of drops, but when very abundant it falls to the ground before it becomes a concrete substance. The former kind is most esteemed; it is detached from the bark with a sharp iron instrument: those persons who are careful in collecting it spread cloths on the ground under the trees, that the juice which falls may not be injured by coming in contact with the earth. The first gathering lasts during eight successive days, after which fresh incisions are made in the tree, and they are untouched until the 25th of September. Then the second gathering begins, and it is not allowed to cut the trees any more that season, but the mastic which continues to run is gathered until the 19th of November, on the Monday and Tuesday of every week; after which time it is forbidden to gather this production.

The culture of the lentisk is simple, and attended with little trouble; it consists much more in cleansing than in turning the soil. The cultivators do not prune this tree, but, on the contrary, endeavour to prevent the stem from growing in a handsome form, as it has been found from experience that the lentisks which trail yield much more mastic than those the stems of which are straight and shooting.

It may readily be imagined that all the Greeks in the island would gladly have become cultivators of the lentisk, by which they would gain exemption from the petty and harassing tyranny to which others were constantly subjected; but while it was prohibited under the severest penalties to offer the mastic for sale to any but the aga who farmed it, the cultivation of the lentisk was forbidden out of the limits traced by the government.

A Turk had recourse to an ingenious stratagem by which he evaded the law, and hoped to obtain some of the advantages acquired by the cultivation of mastic. He grafted the lentisk on young turpentine trees, and had the satisfaction of finding that these grafts succeeded perfectly well. To his astonishment, however, a few years afterwards, on making incisions in the trees a liquid flowed, which combined with the odour and other qualities of the mastic, the unchanging fluidity of turpentine *.

The quantity of mastic imported into this country, and retained for home consumption, in 1830, was 13,644 lbs. It is admitted under a duty of 6*s.* per cwt.; its present price varying from 4*s.* 6*d.* to 5*s.* 6*d.* for the same quantity.

A small quantity of inferior mastic is brought from Egypt.

Mastic, like all other resins, is soluble in alcohol and oil of turpentine, and is scarcely acted upon by water; it becomes by mastication soft and tough like India-rubber. A small part of it does not dissolve in a spirituous menstruum, and this portion much resembles caoutchouc in its properties.

Sandarach is a dry and hard resin, usually met with in transparent granules of the size of a pea. When good, it is of a bright yellow colour, of an acrid and aromatic taste, and diffuses a very pleasant smell while burning. It has all the characteristics of the other resins, being almost totally soluble in alcohol, with which it forms a very white varnish which speedily dries, and which is much esteemed for delicate work. It is likewise used as pounce to prevent the running of the ink in any parts of paper rendered defective by being deprived of its smooth surface.

This resin was at one time universally supposed to be derived from the *Juniperus communis*, and most European writers who notice it, describe sandarach as a resinous juice residing between the bark and wood of the juniper. M. Schousboe has however proved

* Olivier.

this to be an error. The juniper is not indigenous to Africa, and sandarach appears to belong exclusively to that part of the world, it being brought into Europe from the southern provinces of Morocco.

The tree which produces it is a species of *Thuia*, or *Arbor vitæ*. It rises to a considerable height, and produces valuable dark-brown heavy timber, from which planks two feet across can be sawn.

This species of *Thuia* is distinguished from the two which are cultivated in our shrubberies, by its form and manner of growing: it has a very distinct trunk, and the figure of a tree; but the branches of the other varieties rise from the root, which gives them the appearance rather of bushes than of trees. Its branches are also more articulated and brittle. Its flowers, which are not very apparent, show themselves in April; these are succeeded by fruit of a spherical form, which come to maturity in September. When a branch of this tree is held to the light a multitude of transparent vesicles are apparent; these contain the resin. In the summer months they burst, and then a resinous juice exudes from the trunks and branches, as is the case with other coniferous trees. Sandarach is an article very difficult to be adulterated, but the Moors who collect it contrive sometimes to mix sand with it previously to carrying it to the ports whence it is conveyed to Europe.

It is admitted into England at a duty of 19*s*. per cwt., its present price being about £4 for that quantity: 314 cwt. were imported for home consumption in 1830.

Dragon's blood is a resinous substance brought from the East Indies in the form of oval drops, which are imported wrapped up in flag leaves. It derives its compound name from the redness of its colour and from the name of the tree which yields it, and which some botanists describe as having the figure of a dragon finely represented under the rind of its fruit; but this is mere fiction. This resin is the product of a large tree called *Pterocarpus draco*, which grows in Africa and America as well as in Asia; it is also collected from some other plants, particularly the *Calamus rotang*. The juice exudes in drops, which are collected and wrapped up in the leaves of reeds. It is of a dark red colour, which lightens to a fine crimson when pulverized, without smell or taste, and very readily fusible; its texture is compact, and it breaks smoothly and easily; it quickly ignites, burning with much flame and emitting a slight fragrant smell. Like other resins it is insoluble in water, but perfectly soluble in alcohol, and, with the assistance of heat, in expressed oils, to which it imparts a deep red colour. Dissolved in alcohol, it is used for staining marble, to which a red tinge is given, which penetrates more or less deeply according to the heat of the marble under application; but for fine designs, the marble should be cold, because the colour spreads while sinking.

Dragon's blood is likewise a medicinal drug.

Animi is a resin which affords a most excellent varnish, and is largely employed for this purpose. The tree whence it is obtained is native both to Asia and America; hence two kinds of animi are known, and distinguished from each other by the names of Oriental and Occidental. The former is dry, and varies very much in colour, some specimens having a green tint, some red, and others brown. That which comes from South America is of a pale yellow, partly in transparent and somewhat unctuous tears, and partly in larger masses which are brittle. Its taste is not very pleasant; it readily fuses, and burns with an agreeable smell, and like other resins it is totally, though not very readily, soluble in alcohol.

The *Hymenæa,* or bastard locust-tree, which yields this resin, grows naturally in some parts of South America and in Mexico. It attains to the height of sixty feet, and is about three feet in diameter. It is covered with a light ash-colour bark. The seeds are covered with a light brown saccharine substance, which the Indians scrape off and eat with great avidity, and which is very pleasant and agreeable to the taste. Besides the juice which exudes from the trunk and concretes in tears, the resin is also found collected in large lumps at the principal roots under ground.

A large quantity of this resin is now imported into England, some from South America, but the principal part from the East Indies and the Persian Gulf.

The quantity reserved for home consumption for the year 1830 was 96,981 lbs. It is distinguished in commerce as scraped and rough, the price of the first being, exclusive of the duty, from £7. 10*s.* to £12 per cwt., and that of the last from £2. 5*s.* to £5. 5*s.* per cwt. The rough is subject to a duty of 5*d.*, and the clean to 6*d.* per lb.

Another resin called *Elemi* is sometimes employed in the arts as an ingredient in varnishes; but it is a very scarce and expensive substance, and only a very small quantity finds its way into this country. It is said to be the produce of different species of *Amyris* found in the West Indies. It is imported in cylindrical cakes covered with palm-leaves. The whole is not soluble in alcohol; it is therefore not a pure resin, but contains other extraneous matter. Alcohol, when cold, dissolves only two-thirds; when boiling, it takes up more than four-fifths. Elemi is sometimes adulterated with the common resin of the fir-tree, but this fraud is easily recognised by its entire solubility in cold alcohol.

Copal is a singular kind of resin, said to be obtained from a species of sumach (*copallinum*). This tree is indigenous to some parts of North America, and can be successfully cultivated even in England; but it requires the heat of a tropical sun to perfect its juice and cause spontaneous exudation. This species of sumach does not grow nearly so high as the other kinds. In Britain it seldom attains to more than five feet in height, dividing into many branches, which are garnished with winged leaves composed of four or five pair of narrow leaflets terminated by an odd one. They are of a light green, but in autumn change to a purple hue. The flowers are produced in loose panicles at the ends of the branches.

Copal appears in the form of a hard, shining, transparent substance; it is mostly of a lemon colour, sometimes inclining to orange, but the best is of a very light hue. It agrees with the other resins in the property of combustibility, and all its external characters, as well as in being insoluble in water; but it cannot be dissolved in alcohol, the essential oils, or ether, without considerable difficulty. It holds in this respect an intermediate state between the true resins and amber; resembling the resins by being soluble in oily substances, which do not touch amber, and resembling amber by greatly resisting the action of alchol. It may be dissolved by digestion in linseed oil, rendered drying by quicklime at a temperature very little less than sufficient to boil or decompose the oil. This solution, diluted with oil of turpentine, forms a beautiful varnish, which, when properly applied and gradually dried, is very hard and very durable. The colour of the finest sort is so faint, that when spread thinly over any surface it is not perceptible, and only imparts a hard, smooth, transparent glazing.

Copal is one of the hardest of resins, but easily reducible to a fine powder; this union of hardness with colourless transparency makes it highly valuable as a varnish for pictures, white-wood works, and for a variety of other purposes, among others for snuff-boxes, tea-trays, and similar articles of domestic use or ornament.

Mr. Sheldrake has discovered that camphor has a powerful action on copal; pulverized and triturated with a small portion of camphor, it softens and becomes a coherent mass. Alcohol and oil of turpentine are both made solvents of copal by the addition of camphor, which is thus an essential auxiliary in the formation of copal varnishes.

Copal is brought to us principally from Africa; a very small quantity coming occasionally from the East Indies and South America. It is admitted into this country at the same rate of duty as animi; its price being from 1*s.* 3*d.* to 3*s.* per lb., according to its quality and description. The quantity retained for home consumption in 1830 was 22,893 lbs.

The beautiful black varnish of Japan, which the artists of Europe have in vain sought to equal, is a resinous juice exuding from incisions made in the trunks of certain trees. One of these trees is that whose fruit is sometimes brought into Europe as a medicinal drug, the *Semecarpus anacardium*. It grows wild in China as well as Japan, but improves by cultivation, and affords three times more of this valuable product than when in a wild state. The resin is extracted by incisions made in the bark in spring, and when the juice, which is received in shells, does not flow readily, several hog's bristles moistened with water are introduced into the wound, causing it to run anew. When the tree is somewhat exhausted, the upper part of it is wrapped in straw, which is then set on fire, causing the juice to precipitate to the bottom of the tree *, whence it flows from perforations made for the purpose. The persons whose business it is to collect the varnish, set out before day-break, and place beneath the apertures their shells, which are not left more than three hours in this situation, because the heat of the sun causes too great an evaporation of the juice. This, it is said, emits an odour prejudicial to the health.

Benjamin, or *Benzoin*, is the product of a tree growing in Asia, particularly in Siam and Sumatra. The tree whence it is obtained was formerly supposed to be a species of laurel, but it is now ascertained to be the *styrax benzoin*. This tree, according to Mr. Marsden, does not grow to any considerable size, and is never used as timber. Its leaves are rough, crisp, inclining to curl at the point, and yield a very strong scent, resembling that of turpentine more than of their proper gum. The flowers grow on short foot-stalks, and are disposed in clusters; these terminate the branches. According to the same valuable authority, in some places near the sea-coast of Sumatra, the natives cultivate large plantations of these trees, as the quickness of their growth affords them a probability of reaping the fruit or their industry. The seeds or nuts of the tree are sown in rice-fields, and afterwards require no other care than to clear away the shrubs from about them. Trees of six years' growth are deemed of sufficient age for affording their juice; at this period the trunk will have acquired about seven or eight inches diameter. The bark is then cut longitudinally, or somewhat obliquely, at the origin of the principal lower branches. The juice issues in a liquid form, but quickly concretes by expo-

* Chaptal's Elements of Chemistry.

sure to the sun and air; it is scraped off from the bark with a knife or chisel. The annual product from one tree rarely exceeds three pounds. Few trees sustain the effects of this continued exhaustion longer than ten or twelve years.

The purest of the gum, coming first from the tree, is white, soft, and fragrant, and is called head benjamin. This resin is moderately hard and brittle; on the application of friction or heat it yields a fragrant odour. It is totally soluble in alcohol, from which, like other resins, it may be precipitated by the addition of water. Its specific gravity is 1·092.

Benzoin is much used in perfumery and in fumigation, forming a principal ingredient in aromatic pastils. It is imported into England from the East Indies: 7,335 lbs. were retained for home consumption in 1830. It is imported of very different qualities, and classed 1st, 2d, and 3d, and varying in price from £5 to £45 per cwt. according to the class whereto it belongs. A duty of 2*s.* per lb. is levied on its importation into England.

Labdanum is another resinous juice used by perfumers. It is the product of a species of cistus, a well-known and beautiful evergreen shrub, with evanescent flowers, scarcely expanding before their petals drop and are strewed around. The particular species, the juice of which affords labdanum, is the *cistus creticus*, a native of Candia. Tournefort, in his voyage to the Levant, relates that when the air is dry the resin spontaneously issues out of the pores of the leaves, whence it is carefully collected. The more common way of obtaining it, as pursued by the peasantry, is to employ a staff with several leather thongs fastened to its end, with which the leaves are gently struck until the juice is thus caused to exude: this adheres to the leather and is scraped off with a knife.

The best labdanum is extremely rare; this appears under the form of dark-coloured masses, of the consistence of soft plaster, becoming still softer on being handled. That which is collected on the leather thongs is made up into long rolls, much harder than the first, and not so dark. It is often greatly adulterated by the admixture of black sand; indeed both kinds have of necessity a portion of fine sand in combination, without which, independent of designed abuses, they cannot be collected; for the dust is blown on the plant from the loose soil on which it grows, and is unavoidably retained by the tenacious juice.

Most of the resins above described are classed in commerce among the gums, and have usually this name affixed to them. They are, however, very improperly so termed, as it will be seen that resins and gums have very distinct and opposite properties.

CHAPTER XXVII.

GUMS.

ARABIC—SENEGAL—TRAGACANTH—KUTEERA—CAROB—STARCH.

GUM is a thick transparent tasteless fluid, which gradually hardens without losing its transparency. It exudes from certain species of trees, and from its adhesive quality is extremely useful in the arts. It is moderately hard and somewhat brittle, so that when cold it may readily be reduced to a fine powder. This substance is extremely soluble in water, but insoluble in alcohol, being exactly opposed in this respect to the resins. On the application of heat it swells and softens: it is infusible.

Gums are largely used in topical or calico printing to give a proper consistency to the cloth previously to the application of the mordants, by which means they can be evenly laid on the surface and are prevented from running and mixing with each other, and thus rendering the pattern indistinct and imperfect.

Gum Arabic is most extensively employed for this purpose. The common appearance of this gum is too well known to need a particular description; when of a pale yellow colour it is most esteemed.

It is obtained from the *Acacia nilotica*, or Egyptian acacia. This tree is not of very large growth, rising only to somewhat beyond twelve feet in height. The bark of the trunk is smooth and of a grey colour, that of the branches has a slight purple tinge. The leaves are double-winged, and placed alternately on the branches. The single leaves grow in pairs on stalks, which are likewise placed in pairs opposite to each other on the thicker stalk that grows out from the branches. Long white spines proceed from each side of the base of the leaves. The flowers are

Gum Arabic—*Acacia Arabica*,

of a globular form, and stand four or five together upon slender stalks, which arise from the insertion of the leaves. It blooms in July.

The fruit is a long pod resembling that of the lupin and contains many flattish brown seeds.

This tree is indigenous to Arabia, and found abundantly spread over the vast extent of Africa, but the gum requires for its production the intense heat of the torrid zone. It is said that in Lower Egypt the solar rays are never sufficiently powerful to produce this effect.

The gum exudes, in a liquid state, from the bark of the trunk and the branches of the tree, and concretes by exposure to the air in a similar manner to the gum which is often produced from the cherry and some other trees growing in this country. When the tree first opens its flowers the gum begins to flow, and continues to exude during the rainy season, until the month of December. It is then collected for the first time. In the month of March incisions are made in the bark, an operation rendered necessary, it is said, by the extreme dryness of the weather, and the gum issuing from these wounds is soon after collected.

Gum arabic is imported into this country from the East Indies, Turkey, and Africa. The East-Indian is the worst. It is distinguished in commerce by its colour, the lightest being most esteemed; its price is from £2. 2*s.* to £12. 12*s.* according to its quality. The quantity retained for home consumption in 1830 was 12,193 cwt. It is admitted under a duty of 6*s.* per cwt. from British possessions, the duty being doubled on that coming from foreign countries.

Gum Senegal is extremely similar to gum arabic, though of rather an inferior quality. It is the product of another species of *acacia.* The Senegal mimosa is a native of Guinea. Its flowers are yellow, globular, and fragrant; the pods are brown, rounder, and smaller than those of the *nilotica.* On incisions being made in the bark of the tree, the gum exudes but less plentifully than the gum arabic.

It is likewise not so transparent and is of a darker colour. This gum is much used for all those purposes to which gum arabic is applied. It is subject to the same rate of duty as gum arabic; its price is from £3. 16*s.* to £4. 4*s.* per cwt. The quantity reserved for home consumption for 1830 was 3,493 cwt. It is imported from Senegal and Barbary.

The *Astragalus tragacantha,* a small prickly shrub not exceeding three feet in height, growing in many

Astragalus Tragacantha.

parts of the Levant, affords a gum in some respects superior to either of the above. Though the native of a warmer climate, this plant can endure with impunity the colder temperature of England, refusing, however, to yield any of that juice which here it produces only sufficiently for its own nourishment. This gum is called tragacanth or adragant, and sometimes it is vulgarly termed gum-dragon. Tournefort tells us, that the naked hillocks of Mount Ida in Candia produce this plant abundantly. The gum exudes spontaneously towards the end of June and in the following months, during which period the nutritious juice of the plant, thickened by the summer heat, bursts most of the vessels in which it is confined. This juice coagulates in threads, which make their way into the pores of the bark, through which being pushed forward by fresh juice they issue forth, and are at length hardened in the air, either in irregular lumps, or in long vermicular pieces bent into a variety of shapes*. The best sort is white and semi-transparent, dry, but somewhat soft to the touch. It is extremely different in many of its properties to gum arabic; one part of this diffused in one hundred parts of water affords a fluid of the same consistency as one part of gum arabic dissolved in ten parts of water. Water is, however, but an imperfect solvent to it, not forming the same intimate union with it as with other gums. When tragacanth is put into water it slowly imbibes a great quantity, swells into a large volume, and forms a soft, but not fluid mucilage. On the addition of more water, and if the mixture be agitated, the gum will be more generally diffused throughout the liquor, which will appear turbid. If left at rest the mucilage will again separate and subside; the supernatant water appearing limpid, and holding only a very small portion of the gum.

This is more costly than gum arabic or senegal, but its employment is highly beneficial in topical dyeing, when the mordant is prepared with nitrous acid; since other gummy solutions are coagulated by the application of this active alterative.

In 1830 the quantity of tragacanth retained for home consumption was 29,725 lbs. It is admitted on a duty of 1*s.* per lb.; its price being from £16 to £18 per cwt.

* Voyage Du Levant, tom. i. p. 64.

A species of gum designated Kuteera was in 1802, and during a few previous years, imported in large quantities from India into Europe, under the mistaken opinion that it was gum tragacanth, which it so much resembled as to deceive many dealers. It was, however, at length ascertained that the kuteera was the product of the *Sterculia urens*, a tree abounding in several parts of Oude and the adjacent countries, but of quite a different species to the thorny bush which yields tragacanth.

It is found that this substance does not possess all the characteristics of gum, it being very imperfectly soluble and possessing little of a glutinous nature; it is therefore inapplicable to the purposes for which tragacanth is used. On this dissimilarity being discovered, of course this new gum was supposed to be valueless, and many tons were for a long time lying at the East-India Company's warehouse totally unsaleable. It might, however, be usefully applied to some other purpose. The natives of India make many uses of it besides giving it to their horses as a medicine.

A patent has been recently taken out in London for applying the mucilage extracted from the seed of the Carob tree, commonly called St. John's bread. This is of so strong a gummy consistency that one pound of this is said to produce an equal effect with eight pounds of gum senegal and nine or ten pounds of gum arabic.

The seeds after being divested of their skins by the agency of sulphuric acid are dried and then ground in a mill, and the powder thus obtained is the mucilaginous matter.

STARCH.

Starch is much used in what is called the dressing of some descriptions of goods after weaving, whereby they are stiffened and rendered of an apparently greater consistency. It is likewise, by a subsequent process, rendered applicable to the service of the calico-printer, by whom it is much employed.

Starch is prepared from wheat: this being well cleansed is steeped in vessels of water, which are exposed to the sun; the water is changed twice a day during the period of eight, or sometimes twelve days, according to the heat of the season. A slight fermentation is then induced, which is considered to have been sufficiently excited when the grain bursts freely under the finger. Thus softened, it is put into canvas bags, in order to separate the flour from the husks. This separation is performed by rubbing and beating the grains enclosed in the bags, while laid on a plank placed across the mouth of an empty vessel, which is to receive the flour, as mixed with water it runs through the bags.

Or, instead of being put into these bags, the grain is, from the steeping vessel, removed to a tub of water, and trodden upon. By this operation the starchy part is washed out, and, mingling with the water, gives to it a milky appearance. This fluid is then drawn off through a sieve into another vessel, called the sitting-tub. Fresh water is effused on the grains, and the same process is continued until the water in the treading-tub no longer becomes turbid. While the starch is subsiding in the sitting-tub, the water at the surface assumes a reddish hue; this should be carefully removed from time to time, and replaced by clean water, and the whole should then be stirred together. Sometimes it is again strained through a cloth, the starchy particles are returned into the vessel, and the water is entirely renewed. The starch now gradually precipitates by repose from the water in which it was held suspended,—during which, sometimes, and especially if it be a warm season, the mucilaginous saccharine matter of the flour held in solution by the water goes into the acetous fermentation. This causes the starch to become purer and whiter. If this fermentation does not take place, the starch is of a grey colour, but it is rendered white by steeping it in water, slightly acidulated, as the acid dissolves and carries off its impurities.

After the subsidence of the starch, some of the water is drained off by inclining the vessel; the remaining part is suffered to drip through linen cloths supported by hurdles, and upon which the wet starch is placed. When great part of the moisture has drained through, the starch is wrapped up and wrung or pressed between the cloths, that the whole of the fluid may be separated. It is afterwards cut into pieces, which are placed in an airy situation, on slightly burnt bricks, to promote the complete desiccation, partly by the free current of air, and partly by the absorbent quality of the bricks. Lastly, the outer crust is scraped off, and the whole is broken up into smaller pieces: it fractures into oblong irregular masses. Starch has scarcely any smell, and very little taste; when kept dry it continues for a long time uninjured though exposed to the air. It does not dissolve in cold water, but soon falls into a powder; with boiling water it forms a thick paste. One hundred pounds of wheat produce thirty-three pounds of starch and twenty pounds of bran, the remaining part being considered as refuse. The starch-makers are not allowed to sell this refuse, because it still contains some portion of starch, on which article there is an excise duty levied; and it is supposed, with how much reason it were vain to inquire, that the revenue might possibly be defrauded, if this strange prohibition were not enforced. The refuse matter is found to afford excellent nourishment for pigs; and therefore, that it may be profitably consumed on his own premises, every starch-manufacturer is in a manner compelled to combine with his own regular business, the some what anomalous calling of a swine-keeper.

Starch is found in the greater number, if not in the whole of the seeds employed as articles of food. A large proportion is extracted from potatoes,—about five pounds of these roots yielding one pound of starch.

If starch be placed in shallow pans within an oven, and exposed to a heat of about 600°, it swells considerably, becomes soft, and exhales a very powerful smell, first changing to a yellow and afterwards to a cinnamon colour. By this treatment starch loses all its amylaceous properties, and acquires those of gum; it is now soluble in cold water, and in this state is much used by calico-printers, as being in many respects an efficient substitute for foreign gum.

Many attempts have been made to draw from other sources of home production some mucilaginous substance, which might be applied to topical dyeing. Some of these substitutes have been advantageously, though not very generally, employed in different parts of the United Kingdom.

All the indigenous species of lichens contain a considerable portion of viscid matter, and this has been successfully converted into a gum, possessing all the properties of gum arabic or senegal. The lichens applicable to the purpose are generally found on trees growing on poor stiff soils. They attain to maturity in three or four years, so that a crop may be taken from the same tree every fourth year. Immediately under the external skin is a green resinous substance; the remainder is composed partly of gum, and partly of a fibrous matter, which is insoluble by the action of heat or of the alkalis.

To obtain the viscid matter, the lichen is scalded two or three times in boiling water; this separates the skin, together with the greater part of the resinous matter. The remaining portion is next mixed with water, in the proportion of one pound to two gallons of water, and put into copper vessels, in which the mixture is boiled for four or five hours; half an ounce of soda, or a proportionate quantity of pearlash, is then added to every pound of the vegetable matter which is under process: the ebullition is continued till the liquid acquires a tenacious consistence like that of a strong solution of gum. It is then strained through hair sieves, and the residuum is expressed in hair-cloth bags, by means of presses similar to those used by tallow-melters, that none of the mucilaginous matter may be wasted. The extract thus obtained is suffered to remain undisturbed for ten or twelve hours; after which it is filtered and evaporated in lead or tin vessels, placed over stoves moderately heated, either by steam or fuel, until it becomes of a proper consistence for block-printing.

If this gum is made with the intention of employing it in the manufacture of ink or paper, or in the stiffening of silks, crapes, or gauzes, no alkaline salt should then be employed in extracting the mucilaginous parts; but the evaporation should be prolonged with a moderate degree of heat, the gummy extract will thus be nearly colourless, and may be used in the most delicate works.

The late Lord Dundonald, in a circular letter addressed to the calico-printers of Scotland, greatly enlarged on the advantages accruing from this discovery, considering it to be a national benefit. It is said, indeed, to answer extremely well, and to be very economical in its use; while the collection and preparation of the lichen afford an easy and profitable employment for women and children.

Chapter XXVIII.

GUM-RESINS.

FRANKINCENSE—OLIBANUM—GAMBOGE—CAMPHOR —CAOUTCHOUC.

In tropical climates vegetation is so luxurant that the juices of various trees are produced superabundantly; this exuberance of production is thrown off from natural cracks in the bark, or from artificial incisions, and concretes, by exposure to sun and air, into irregular masses of various forms, which are therefore the juices of the respective plants as nearly as possible in their natural state. Some of these are of a mixed nature, having the characteristic properties which would be produced by a combination of gum and resin, and they are therefore called gum-resins. To the gummy part they owe their solubility in water; and they partake of the qualities of resin in being fusible, in igniting with much flame, and in giving by distillation a large portion of volatile oil, and some ammonia.

Some of these gum-resins emit a most grateful perfume on being burnt, and are used as incense on the altars of the Catholic chapels. On the continent of Europe the consumption of these aromatic ingredients is very considerable. They have always been much prized for this purpose, and from the earliest records we find in the temples of the ancients the wreathing smoke, rich in delicious odours, encircling and rendering more acceptable the sacrifices offered up to their gods; while in the writings of some moderns we find how much value was attached to their use, even in the Christian churches. Aubrey, in his Hermetic Philosophy, says, "Good spirits are delighted and allured by sweet perfumes, as *rich gums, frankincense, salts, &c.*, which was the reason that the priests of the Gentiles and also the Christians used them in their temples and sacrifices*." "It is a curious fact," observes Dr. Clarke, "that this superstitious notion respecting a fragrant gum should also exist in South America. The pastillas of Lima are considered by the priests to be efficacious in destroying the influence of evil spirits, and are always burnt on the altars during the solemnization of high mass †."

Frankincense is the concrete juice of a species of Juniper (*Juniperus lycia*), and has every characteristic of a gum-resin; it appears in the form of small irregular pieces, semi-transparent, and of a brown, or dirty yellow colour. The tree whence it exudes attains to the height of twenty feet; the leaves are pointed, and grow imbricated, or lapping over each other, in four rows; the berries are large, and when ripe of a black hue.

Frankincense was one of those articles of commerce which we have before noticed as being for many centuries wrapped up in fable and mystery.

The port of Moscha (Moscat), near the promontory of Syagros (Rasal-Gat) in Arabia, was a great emporium for the frankincense produced in the adjacent country. Vessels from Cané traded to this port, and those from Barygasa, on the opposite coast, or the more distant parts of India, when too late for accomplishing their voyages in the propitious season, were wont to pass their winter here, and exchange their calico, corn, and oil, for frankincense, the sale of which the king most vigorously engrossed to his own advantage. This monopolizing spirit is general

* Second edition, London, 1721, page 172, as quoted in Clarke's Travels, vol. v. p. 77. † Ibid.

Frankincense Trees—*Juniperus lycia.*

among the sovereigns of many oriental countries even to the present time.

Olibanum was another gum-resin, so similar to frankincense in its appearance and all its properties that they are generally confounded together; it is, however, the product of another species of juniper (*Juniperus lycia*). They are both classed as olibanum in commerce, and are brought from Turkey and the East Indies, but in the present time little or none finds its way into England. The price quoted is from £1 to £3 per cwt. exclusive of the heavy duty, which is £2 for that quantity.

Myrrh is another gum-resin which was much prized by the ancients and which partook of the mystery in which frankincense was shrouded. Even to the present day there is no certain accounts of the tree whence it is obtained. It is certainly the product of Ethiopia as well as of Arabia.

This gum-resin is now classed among medical drugs.

Gamboge is a concrete vegetable juice, having all the characteristics of a gum-resin. It is the product of the *Stalagmitis gambogioides*, a middling-sized tree, a native of Ceylon, Siam, and Cochin China. Deep incisions being made in the bark the juice issues out in a liquid form, and is afterwards inspissated by the heat of the sun; it is then made into large cakes or rolls. The best sort is of a deep yellow colour, divested of all smell, and has very little taste. The Siamese gamboge is in small tears formed by the concretion of the drops of the juice as they exude from the leaves, stalks, and young shoots, when they are broken off from the tree.

It is not, properly speaking, soluble, but is extremely diffusible in water, with which it forms an opaque yellow-coloured infusion. Alcohol is a more effectual solvent; this takes it up in large quantities and forms a clear gold-coloured fluid: if water be added, the solution becomes turbid. Its alcoholic tincture forms one of the ingredients of the gold-coloured lacquer which is generally spread over the surface of the smaller articles of brass-work. It is well known as a water-colour pigment, and is likewise used as a powerful medicine.

Gamboge is fusible and inflammable; when ignited it blazes, throws out sparks, and emits a dense black smoke.

This substance comes to us from the East Indies; 7,019 lbs. were imported for home consumption in 1830. Its price is from £7 to £22 per cwt., exclusive of duty, which is 4*s*. per cwt.

Several other gum-resins are known which are used only in medicine; the enumeration of them is therefore not within our province.

Although many trees thus yield compound concrete juices, it is seldom that from one tree both gum and resin are extracted as separate products. According to professor Pallas the larch-tree in Russia possesses this singular property; on wounding its

Larch.

bark the resin called Venice turpentine is obtained, while a gum similar to that of arabic or senegal spontaneously exudes from other parts of the tree.

Camphor, which is so much used for medical purposes, is likewise extensively employed in the composition of varnishes, especially in that of copal. It is the peculiar product of the root of a species of laurel (*Laurus camphora*), a tree growing in China, Japan, Borneo, Sumatra, and several parts of India.

Camphor—*Laurus camphora.*

The *Laurus camphora* grows to the size of our oak. The leaves of this plant stand upon slender foot-stalks, and have an entire undulated margin, running out into a point. Their upper surface is of a lively and shining green; the under part is of a yellower green, and of a silky appearance. A few lateral nerves curve towards the margin, frequently terminating in small warts or excrescences, a circumstance peculiar to this species of laurel. The foot-stalks of flowers proceed from the axillæ of the leaves, but they do not come forth until the tree has attained considerable age and size. The flower-stalks are slender and branch at the top, dividing into very short pedicles, each supporting a single flower. This is white, and succeeded by a shining purple berry of the size of a pea. It is composed of a small kernel enclosed in a soft pulpy substance, having the aroma of cloves and camphor. The bark of the stem of the tree is outwardly somewhat rough, but on the inner surface it is smooth and mucous, and therefore readily separated from the wood, which is dry and of a white colour, and in much esteem for carpenter's purposes, being easy to work, light, durable, and not liable to be injured by insects *. Some travellers affirm, that the old trees contain camphor so abundantly that on splitting the trunk it is found in the form of large tears so pure as not to require rectification. The usual method, however, of obtaining this substance is from the roots, pieces of which are put into an iron vessel furnished with a capital, or large head; this upper part is internally filled with cords of rice-straw; the joinings are then luted, and the distillation proceeded upon. On the application of heat the camphor contained in the wood sublimes and attaches itself to the straw within the head. The substance thus obtained is purified by mixing an ounce of quick-lime with every pound of the camphor, and subjecting

* Marsden's History of Sumatra.

it to a second sublimation in large glass vessels. The Dutch were the only people for a long time by whom camphor was exclusively refined. It is now refined in England and other parts of Europe.

Camphor is well known as a white friable substance, having a peculiar aromatic odour and a strong taste. Some chemists consider it as a concrete vegetable oil. It melts at a temperature of 288°, and boils at 400° Fahrenheit. Its specific gravity is less than that of water. It is very inflammable, burning with a white flame and smoke, and leaving no residue. Alcohol, ether, and oils dissolve it. The only indication whereby it appears that water acts upon camphor is that of acquiring its smell; it is said, however, that a Spanish surgeon has effected the solution in water by means of carbonic acid *. Camphor may be burned as it floats on the surface of water. The best kind is not altered or sensibly diminished by mere exposure to atmospheric air, but that coming from Japan, obtained by boiling the wood, is so extremely volatile that if, in warm weather, it is placed in an open vessel, it evaporates completely. Camphor of the best quality, obtained naturally in Japan, is not nearly so volatile. It has been found that a hundred pounds of this description of the drug loses only ten pounds by evaporating freely in the air, while in the same period of time the same quantity artificially obtained entirely evaporates away †.

Camphor has been found to exist in numerous plants, whence it may be obtained by distillation. Neumann and other chemists extracted it from the roots of zedoary, thyme, sage, the *inula hellenicum*, the anemone, the pasque flower, and other vegetables; and it is considered probable that it is contained, more or less, in almost all the labiated plants. Experiment has shown that the plants whence it is extracted,

* Ure's Dictionary of Chemistry.

† Journal des Connoissances, &c.

afford a much larger quantity of camphor when the sap has been suffered to pass to the concrete state by several months' drying.

This substance was very early known to the eastern nations, and was introduced into Europe by the Arabians.

INDIA-RUBBER, OR CAOUTCHOUC.

The substance called Indian Rubber, or Caoutchouc, was not known in Europe until the beginning of the 18th century. It was then brought as a great curiosity from South America. It usually appeared in this country in the shape of bottles, birds, or other fantastically moulded forms; and nothing could be learnt of its nature, or of the manner of obtaining it, except that it was of vegetable production. Europeans continued in this ignorance of its origin until a deputation of the French Academicians undertook a voyage to South America in 1735, for the purpose of obtaining the correct admeasurement of a degree of the meridian. These philosophers did not confine their attention to the one great object of their pursuit, but likewise enriched the scientific world by ascertaining many facts connected with natural history, and which had heretofore been hidden in obscurity. Among these subjects the manner in which that peculiar substance, caoutchouc, was produced, became an object of inquiry. These academicians discovered at Esmeraldas, in Brazil, trees called by the natives *hevé*, whence flowed a milky juice, which, when dried, proved to be what is called India-rubber, or caoutchouc. The hevé was likewise recognized as growing in Cayenne and on the banks of the Amazon river. It has since been discovered that caoutchouc may likewise be obtained from another species of tree growing in South America—the *jatropha elastica.*

If these trees are punctured, a milky juice flows

Trees from which Caoutchouc is extracted.

out, which, on exposure to air, thickens into a substance of a pure white colour, having neither taste nor smell. The hue of the caoutchouc of commerce is black in consequence of the method employed in drying it. The usual manner of performing this operation is to spread a thin coating of the milky juice upon moulds made of clay, and fashioned into a variety of figures. These are then dried by exposure to the heat of a smoke fire: another layer is then spread over the first, and dried by the same means, and thus layer after layer is put on, until the whole is of the required thickness. While yet soft it will receive and retain any impression that may be given to it on the outside. When perfectly dry the clay form within is broken into small fragments by percussion, and the pieces are drawn out through the aperture, which is always left for the purpose. The common bottle of Indian rubber, therefore, consists of numerous layers of pure caoutchouc, alternating with as many layers of soot.

The natives of those parts of South America to which these trees are indigenous convert the juice to a variety of purposes. They collect it chiefly in the rainy season, because, though it will exude at all times, it flows then most abundantly. Boots are made of it by the Indians, through which water cannot penetrate; and the inhabitants of Quito prepare a kind of cloth with it, which they apply to the same purposes as those for which oil-cloth or tarpauling is used here. This, no doubt, is similar to the cloth now prepared with this substance in England, the use of which promises to yield so many important advantages.

The South Americans likewise fashion it into flambeaux, which give a beautiful light, and emit an odour which is not unpleasant to those who are accustomed to use them; but Europeans are annoyed by the fetid smell which they diffuse. One of these, an inch and a half in diameter, and two feet long, will burn during twelve hours.

Since the discovery of caoutchouc in America, a similar juice has been obtained from several trees growing in Asia, and which likewise are natives of tropical regions. These are the *Ficus Indica*, *Artocarpus Integrifolia*, and *Urceola Elastica*

The fluid obtained from the latter plant is dried in a different manner, and constitutes the solid flat pieces which are known as white Indian rubber.

Caoutchouc possesses some peculiar and remarkable properties, which, from the earliest period of its being known in Europe, have been subjects of the diligent investigation of some of the most eminent chemists. It is the most pliable and elastic of known substances, and so tenacious that it cannot be broken without considerable force. It has always been a desideratum with chemists to dissolve caoutchouc by some means which would allow it to re-form, and to assume different figures with the same facility as they can be imparted when in its original state of fluidity.

Within the last few years two solvents, which can be abundantly and cheaply supplied, have been found for caoutchouc, which, when evaporated, leave it unchanged. By these means this substance is made to be of extensive application. A thin coating of the solution spread on any texture renders it impervious to air or moisture; while, at the same time, it can be folded in as portable a form as before it had received this preparation. Hence pillows and even beds are formed out of bags thus made air-tight; and these being furnished with a small tube and stop-cock, may be inflated at pleasure into soft elastic cushions. Cloaks having their inner lining of this material are found to be effectually water-proof.

Mr. Faraday, of the Royal Institution, has furnished an interesting paper in the 21st volume of the Quarterly Journal of Science, &c. detailing his experiments on some caoutchouc in its fluid state, which had been obtained from the southern part of Mexico, and was very nearly in the state in which it came from the tree; a slight film of solid caoutchouc had formed on the surface of the cork which closed the bottle. The juice was a pale-yellow thick creamylooking substance, of uniform consistency. It had a disagreeable acescent odour, something resembling that of putrescent milk. Its specific gravity was 1·01174, but when in a solid form it is specifically lighter than water. A small portion of this fluid, dried at the heat of 100° Fahrenheit, lost more than half its weight in assuming a solid form.

On mixing the juice with water, no other change than mere dilution took place; when suffered to remain at rest, a separation quickly ensued; a creamy-portion rose to the top, whilst a clear aqueous solution of the other matters contained in the juice remained beneath. In this manner liquid caoutchouc may be purified.

When poured on to a filter, the water passed through and the caoutchouc coagulated. Put on to absorbent surfaces, such as bibulous paper, chalk, or plaster of Paris, the aqueous portion was rapidly abstracted, and the caoutchouc almost immediately united into a mass retaining the form of the body on which it was cast. In this manner beautiful medallions have been formed of the juice.

More than fifty-two thousand pounds of caoutchouc were imported into England in 1830, being nearly double the quantity brought during the preceding year. The consumption for the year ending April 5, 1833, is stated at 178,676 lbs. Its price is from 1*s.* 6*d.* to 2*s.* 3*d.* per lb.; the duty upon it being 5*d.* per lb. This increase in the demand is to be ascribed to the application of the substance as an article of general utility.

THE END.

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