THE

TECHNOLOGIST.

A MONTHLY RECORD OF

Science Applied to Art, Manufacture, and Culture.

EDITED BY

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THE TECHNOLOGIST.

ON THE PHYSICAL SCIENCES WHICH FORM THE BASIS OF TECHNOLOGY.

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I have endeavoured to define the objects of Technology. I propose, on this occasion, to consider the physical sciences on which it is based. Yet at the outset I cannot but ask myself, which of these sciences does not lend support to Technology, and on what plea shall any be omitted from the list of its ministers? In reality, none can be. Technology is the sum or complement of all the sciences, which either are, or may be made, applicable to the industrial labours or utilitarian necessities of man. But though this be the case, certain departments of knowledge stand so much more closely related than others to the recurring urgencies of daily labour, that to them a pre-eminent importance must be assigned in any endeavour to number the scientific pillars on which Technology rests. And, in the first place, to narrow our horizon within limits that can be compassed, let me remind you that our science ministers only to the physical necessities of man. It does not acknowledge his imagination, or directly concern itself with his ascription of beauty to some things, and of ugliness to others. It does not acknowledge his heart, or take heed of his loves and his hates, his exultations and despairs. It does not acknowledge his conscience, or care about right or wrong, or affect any interest in his moral welfare. It does not even pay court to his intellect, or profess sympathy with his cravings after knowledge for its own sake, his impatience of ignorance, and longings for perfection. It knows him only as the paragon of animals, the most helpless, though most gifted of them all; and seeks only to meet his fleshly wants; to enlarge the practical empire of his senses; to make his arms stronger, his fingers nimbler, his feet swifter, and with help from Hygienics, his frame more stalwart, himself a more smoothly moving, well-ordered, living machine.

Putting aside, then, all questions of Beauty, Morality, or Philosophy, we are to consider where man can acquire the knowledge which will give his body the victory in the daily battle of life. The problem which he has to solve is a vast one; so vast, indeed, that instead of attempting to enumerate the items which make it up, I will say, in one word, that his capital to begin with is one wise head and ten skilful fingers; and with these he must build such a Crystal Palace as the world saw in 1851, and stock it with all its wondrous contents. To solve this problem, he must fall back upon the sciences which reveal the properties of matter, and the modes of altering it.

The sciences in question are familiarly divided into Natural History, on the one hand, and Experimental Physics, including Chemistry, on the other. Natural History, on this view, is the science of all those objects, phenomena, and laws, which physical nature *spontaneously* presents to our view; whilst Experimental Physics is the science of all the *additional* objects, phenomena, and laws, which our interference with nature enables us to bring under our scrutiny.

Such a twofold division, however, is not sufficient for us. All the sciences observe and register the phenomena and laws which nature presents within the circle allotted to each; and are therefore portions of Natural History, or *Naturalistic*. All the sciences, also, but Astronomy, experiment upon, or subject to trial, the objects presented by nature to each; and are therefore *Experimental*. The difference, accordingly, between the majority of the sciences which are observational, and those which are experimental, is one only of degree. A distinction of a much deeper kind lies in the fact, that the experiments which the one characteristically makes are simply more precise observations of what nature presents; whilst those which the other characteristically makes, imply the transformation or transmutation of natural objects, and the study thereafter of the results of such transformations.

In addition, however, there is a third class of experiments, neither simply observational nor transformational, but *registrative* and *directive*, in modes which I shall presently consider. And, further, Biology, the science of Plant-Life and Animal-Life, must have a place to itself, from the peculiarity of the subject-matter with which it deals.

I would arrange the physical sciences, accordingly, as related to Technology, in three groups.

I. Naturalistic, Observational, and Registrative sciences, of which the chief are Astronomy and Geology, including Meteorology, Hydrology, Physical Geography, and Mineralogy, as well as descriptive Botany and Zoology.

II. Experimental, Transformational, and Directive sciences, of which the chief are Chemistry and Mechanics, as well as Heat, Optics, Electricity, and Magnetism.

III. Organic sciences: namely, Functional or Physiological Botany, which treats of the plant-life of non-sentient organisms; and Functional or Physiological Zoology, which treats of the animal life of sentient organisms.

This complex, nominally triple arrangement, is essentially twofold, in its relation to Technology. The industrialist must study one class of the physical sciences, or rather one side of all physical science, to consider what gifts Nature offers him with her liberal hand. He must study another class of these sciences, or rather another side of all physical science, to discover how to turn those gifts to account. There is always, on the one hand, something to be had for the taking, a raw material, a physical phenomenon, a physical force. There is always a necessity, on the other hand, for expenditure of skill to effect the *transformation* of the raw material, the *registration* of the phenomenon, the *direction* of the force. To render this clear, I must enter a little more fully into details; and these may be discussed under three heads.

One of the greatest services which observational science is continually rendering to Industrialism, is the discovery of natural substances, mineral, vegetable, and animal, possessed of useful but latent properties. A service not less great is, then, rendered by transformational science pointing out how to modify this gift of nature, so as to call into active existence hidden, precious qualities. Thus, to take a complex but striking example. Through observational science we may discover a soil more or less fertile, all the world over; but transformational science must show us how to fence and till it, how to drain or irrigate, and manure it, before it can be made a fruitful field. Geology, striving ever to reach nearer to the centre of the earth, finds coal for us. Chemistry teaches us how to coke, *i. e.*, literally to cook, this raw material, and how to distil it into naphtha and gas. Mineralogy selects iron-ores for us; Chemistry converts them into steel; and Mechanics forges that into bars. Descriptive Botany plucks a wild currant; Physiological Botany changes it into a sweet grape; Chemistry ferments it into wine, and transforms that into ether. Descriptive Zoology lays its hands on a caterpillar; Physiological Zoology nurses it into a strong silkworm; Chemistry bleaches and dyes the silk which it spins; and Mechanics weaves it into velvet.

A second most important service which observational science renders to Industrialism, is by discovering striking natural phenomena, such, for example, as the eclipses of the heavenly bodies, the alterations in the pressure and temperature of the atmosphere, the motions of a loadstone suspended freely, and the like; which experimental science can so *register* as to make them guides of the greatest value in a multitude of practical labours.

Thus, there is perhaps no more familiar natural phenomenon than that the sun leaves in shadow that side of a body which is turned from him, and that this shadow changes its place in obedience to the apparent motion of the sun. And with no more than this fact of nature made over to him, even the barbaric mechanician constructs his useful sundial, and the day measures itself into hours. So also the bar of steel, which the experimenter has rubbed with a natural loadstone, becomes a compass-needle, and deserves its name, by threading the mariner's way through all the labyrinths of the sea. "The wind," said King Solomon, the greatest naturalist of his time, "goeth toward the south, and turneth about unto the north: it whirleth about continually: and the wind returneth according to his circuits." And the sailors of the ships of Tarshish had, like our sailors, their wind-vane and streamers, their anemoscopes and anemometers, though they did not so name them, to tell from what quarter, and with what force the wind blew. The complex and beautiful art of navigation abounds in examples of what I have called Registrative Science. The night-glass, the sextant, the thermometer, the barometer, the sympiesometer, as well as the compass-needle and the simple wind-vane, by the indications of which the sailor makes his ship go straight, as if on a railway, to the desired haven, are industrial instruments of the highest value. No one will doubt this who visits any of our fishing towns during the herring season, when the boats are at sea, and observes how the straining eyes of loving mothers and wives are fixed on the weathercock, and those of faithful fathers and brothers on the doubtful barometer. Here natural phenomena are not merely analysed into greater simplicity, which is the function of observational science; neither are they interfered with, which is the function of transformational science; but they are made, as it were, to prolong their existence till not merely the speculative philosopher, but also the busy workman, has been roused to their presence, and has had opportunity to profit by their warning. We hold, as we may say, the key down, and let the steam-whistle scream till all have heard the ominous note; we keep the signal flying that all may see that the wind has changed, and the fleet is weighing anchor. This cannot be done without instruments, which, if possible, should be automatic or self-acting; and such instruments are the fruit only of much and varied experimental trial; yet the experiments, as something more than observational, and as in no respect transformational, stand apart, and may, till a more distinctive place is found for them, be ranged under Registrative Science.

A third most important service which observational science renders Industrialism, is by discovering natural powers, forces, or energies, which in their spontaneous action work both good and ill to man; but when disciplined and controlled by what I have proposed to call directive science, become his unreluctant slaves and willing workmen.

Thus, meteorology reveals to us the laws according to which great currents are occasioned in the atmosphere; and then mechanics builds its windmill, and the most impatient breeze that tries to hurry past must stop, and, like a chained slave, take its turn at grinding corn or drawing water. "The wind," said He who spake as never man spake, "bloweth where it listeth, and thou hearest the sound thereof, but canst not tell whence it cometh, and whither it goeth;" but provided only it do not cease to blow, the mariner can turn his sail one way, and set his rudder the other, and make the wind carry him round and round the globe, whithersoever he will. These are achievements of Directive Science; multitudes more might be named. The clock, for example, moved by the falling weight; the hour-glass, with its noiseless shower of sand; the wheel turned by the stream of water, the mill wrought by the ebb and flow of the tide, the sea-salt crystallized by the heat of the sun, the boracic acid of the volcanic lagoon evaporated by the heat of the volcano; the direction and force of the wind noted down on paper by the anemometer, *i. e.*, by a pen put between the fingers of the wind itself; the photographic pictures which we compel the sun to draw with a chemical pencil of his own providing, as often as we choose to spread a tablet before him: those are but a few familiar examples of the office of Directive Science. Between it and Registrative Science it is impossible to draw a sharp line of demarcation. A balance or steelyard, for example, falls as much within the one category as the other; so do all kinds of chronometers. But where we avail ourselves of a natural agency, like the winds, as a mechanical motive power, or like solar heat, to induce chemical change, we may conveniently refer it to Directive Science; whilst where we employ such agency simply to signal to us a change in events, as when the sun-dial marks the passage of time, the compass-needle altered direction in space, or the thermometer altered temperature of the atmosphere, we may with equal propriety refer it to Registrative Science.

Again, as Registration is but carefully made, fully registered, or prolonged Observation, they must shade into each other. It is important, however, to keep them as distinct as we can in reference to Technology; and the essence of this distinction lies mainly in the different nature of the instruments which they severally employ. The object of the naturalist, using that term in its widest sense, is to separate the complex wholes which on every side Nature presents, into their simplest components. His chief implements, accordingly, are analytical, and are represented by such instruments as the telescope of the astronomer, the microscope of the botanist, the mining axe of the geologist, the hammer of the mineralogist, the scalpel of the anatomist, and the voltaic battery of the chemist.

The instruments of Registrative Science, on the other hand, are, in the simplest sense of the word, *significant* and *metrical.* They signal the occurrence of a phenomenon; they note the presence of a force, indicate the line of its action, and often also measure its intensity and quantity. Such instruments are the wind-vane, compass-needle, thermometer, barometer, chronometer, voltameter, and many more. These instruments are part of the armament of the Naturalist, who is free to use them all; but the disciple of Registrative Science is not equally free to use the analytical implements of the observer. I may compare the difference between the function of the registrars and the observers in science to that which subsists between the musicians of an army and its fighting men. The drums and trumpets of the band are at the disposal of any combatant officer who has lawful occasion to give a signal to the troops; but the bandmaster himself never meddles with those exceedingly analytical instruments, the guns and swords of the active combatants.

Thus, then, in all its departments, and at all times, Technology stretches forth both hands: with the one, receiving from the Observational Registrative Naturalist an organic or inorganic substance, a physical phenomenon, or a physical force; and with the other, receiving from the Directive, Transforming Experimentalist the means of changing that rude material into many a precious product; that terrestrial, or sidereal, or cosmical phenomenon, into a faithful watcher and measurer, that wild force into a patient, docile servant.

After this explanation, I shall fall back upon the familiar division of all the physical sciences, whether dealing with dead or living matter, into two groups, viz.:—

I. The Observational and Registrative, Natural History Sciences.

II. The Directive and Tranformational, Experimental Sciences.

Let us look more particularly at these contrasted groups. The sciences which illustrate the contrast best are astronomy on the one hand, and chemistry on the other. I shall commence with them.

Astronomy, the oldest, the grandest, and the ripest of the sciences, is, in relation to the physical objects which it considers, almost purely observational. When we study it, we are like men reading a book under a glass case, the leaves of which are slowly turned over by a self-acting mechanism, so that two pages only can be studied at a time. If we quickly exhaust the meaning of these pages, or tire of their perusal, we cannot hasten the period when the leaf will turn over; and if we miss their meaning, or wish to dwell upon it, we cannot arrest or delay the turning of the leaf, but must wait, it may be for a lifetime, till the cycle is complete, and these pages are opened again.

The magnificent clockwork of the heavens, with all its fiery glories, its stately movements, and faultless machinery, is far beyond and above our slightest interference. We cannot reach it, nor, if we could, dare we approach to touch it. The humiliating contrast which any comparison of the two brings to light, between the immensity and majesty of the heavens and the littleness and impotence of man, presses too heavily on the heart to allow us easily to contemplate with merely intellectual eyes the unapproachableness of the objects of astronomy. The greatest of modern astronomers have often with their lips, and always, I believe, with their hearts, uttered their amen to the star-loving king of Israel's confession, "When I consider Thy heavens, the work of Thy fingers, the moon and the stars which Thou hast ordained; what is man, that Thou art mindful of him? and the son of man, that Thou visitest him?"

But upon this moral aspect of the peculiarity of astronomy under consideration I have no desire at present to dwell. I would rather on this occasion forget it; for, in truth, if man has reason to feel proud of any one of his achievements, it is of his science of astronomy; and the limitations which restrict its study justify his pride the more.

Those limitations are great. Ages before the existence of scientific astronomy the question was put to the patriarch Job, "Canst thou bind the sweet influences of Pleiades, or loose the bands of Orion; canst thou bring forth Mazzaroth in his season? or canst thou guide Arcturus with his sons?" And when Job in his heart, if not with his lips, answered the Almighty, No, he answered for all his successors as well as for himself. Astronomical problems accumulate unsolved on our hands, because we cannot as mechanicians, chemists, or physiologists, experiment upon the stars. Are they built of the same materials as our planet? Are they inhabited? Are Saturn's rings solid or liquid? Has the moon an atmosphere? Are the atmospheres of the planets like ours? Are the light and heat of the sun begotten of combustion? and what is the fuel which feeds his unquenchable fires? These are but a few of the questions which we ask, and variously answer, but leave in reality unanswered, after all. A war of words regarding the revolution of the moon round her axis may go on to the end of time, because we cannot throw our satellite out of gearing, or bring her to a momentary stand-still; and the problem of the habitability of the stars awaits in vain an *experimentum crucis.* The only exceptions which may be made to the essentially non-experimental character of astronomy are furnished by the opportunity granted us to modify to the extent of our power the sidereal influences, such as heat, light, and actinism, and the sidereal bodies, such as the meteoric stones which reach our globe. The sidereal influences, however, have passed from the domain of Astronomy into that of Physics, before they come under our examination; and the meteoric stones are terrestrial minerals before we analyse them. Optics and Chemistry claim them from Astronomy.

The astronomer, accordingly, must be content to be the chronicler of a spectacle, in which, except as an onlooker, he takes no part. Like the sailor at the mast-head in his solitary night-watch, he must see, as he sails through space in his small earthly bark, that nothing escapes his view within the vast, visible firmament. But he stands, as it were, with folded arms, occupied solely in wistfully gazing over the illimitable ocean, where the nearest vessel, like his own, is far beyond summons or signal, and the greatest appears but as a speck on the distant horizon. His course lies out of the track of every other vessel; and year after year he repeats the same voyage, without ever practically altering his relation to the innumerable fleets which navigate those seas.

Astronomy is thus pre-eminently the Observational Science; and represents in its greatest purity that function of the physical sciences which consists in the investigation of the works of God, as untouched by man. Such investigation is the basis of all our knowledge and all our industry. And if our human pride ever tempts us to undervalue the astronomer as compared with his brother philosophers, because he is only a spectator, and not an actor, on the field which he cultivates, let us remember that the ever-changing spectacle which he witnesses is one which not only demands for its full appreciation the whole intellect of man, but far surpasses in grandeur the sights which open to the eyes of other students, even though they are free to add to the glories which God has made to shine forth from all His works, every hidden grace which human weakness can bring to view.

This superhuman character of astronomy was recognised from the first. As a bare scientific truth, it was implied in the declaration of the great Greek mechanician Archimedes, that *if* he had a place whereon to stand he could move the world. The ποῦ στῶ, the whereon to stand, has not been found. The greatest practical mathematician of antiquity incidentally proclaimed that, though man is free elsewhere to compel Nature to teach him the mysteries she seeks to conceal, and to submit to his interference with her, there is one territory of hers, and that her vastest, where she brooks no interference, and he cannot stretch her on the rack, or torture her secrets from her. We have no standing-place among the stars, no liberty to lay finger on them. What we know of them they have told us, spontaneously revealing at all epochs more than we are able or willing to receive. This thought, which was latent in the Greek philosopher's utterance, and in part proclaimed in the question already quoted as addressed to Job, was announced in all its fulness by the inspired Hebrew king—"The heavens *declare* the glory of God: and the firmament *sheweth* His handiwork. Day unto day uttereth speech, and night unto night sheweth knowledge."

Unconstrained and spontaneous though the revelations of astronomy thus are, their value to industrial science cannot easily be overrated. Our modes of measuring space and time, and in connection with both the art of navigation, are applications to the most useful purposes of truths which astronomy offers freely to all who have capacity enough to receive them. The phenomena, in truth, of which Registrative Science takes cognizance, are in great part furnished by this liberal giver, who has also taught us laws regulating many of the forces with which Directive Science deals. It is sufficient on this head to refer to the laws of gravitation.

Astronomy, further, is related to the Experimental Transformational Sciences in a very curious way. If imaginative men, needlessly fearing that the progress of physical science will prove fatal to poetry, rejoice that the sun is as dazzling to us as to our forefathers, and that we no more than they can wreathe our hands in the golden manes of his fiery coursers ; at least we can watch with more exulting delight the sparks which their pawing feet strike out of the starry pavement, and can see other than romantic reasons why they rejoice to run their race.

Daily the conviction deepens among those who have studied the matter, that with a few exceptions all the physical powers which man wields as movers or transformers of matter are modifications of sun-force. It was bestowed upon antediluvian plants, and they locked it up for a season in the woody tissue which it enabled them to weave, and afterwards time changed that into coal; and the steam-engine, which we complacently call ours, and claim patents for, burns that coal into lever-force and steam-hammer power, and is, in truth, a sun-engine. And the plants of our own day receive as liberally from the sun, and condense his force into the charcoal which we extract from them, and expend in smelting metallic ores. With the smelted metals we make voltaic batteries, and magnets, and telegraph wires; and call the modified sun-force electricity and magnetism, and say it is ours, and ask if we may not do what we like with our own.

And again, the plants which we cultivate concentrate sun-force in grass, hay, oats, wheat, and other grains and fibres, which seem only suitable to feed cattle and beasts of burden with. But by-and-by a Spanish bull-fighter is transfixed by this force, through the horns of a bull, and dies unaware of his classical fate, pierced to the heart by an arrow from Apollo, the Sun-God's bow. On English commons prizes are run for, by steeds which are truly coursers of the sun, for his force is swelling in their muscles and throbbing in their veins, and horse-power is but another name for sun-power. Nor is it otherwise with their riders; for they, too, have been fed upon light, and made strong with fruits and flesh which have been nourished by the sun. His heat warms their blood, his light shines in their eyes; they cannot deal a blow which is not a *coup de soleil*, a veritable sun-stroke; nor express a thought without help from him.

In grave earnestness, let me remind you, that as force cannot be annihilated any more than matter, but can only be changed in its mode of manifestation, so it appears beyond doubt that the force generated by the sun, and conveyed by his rays in the guise of heat, light, and chemical power, to the earth, is not extinguished there, but only changes its form. It apparently disappears when it falls upon plants, which never grow without it; but we cannot doubt that it is working in a new shape in their organs and tissues, and reappears in the heat and light which they give out when they are burned. This heat, which is sun-heat *at second hand*, we again seem to lose when we use plants as fuel in our boiler-furnaces; but it has only disguised itself, without loss of power, in the elasticity of the steam, and will again seem lost, when it is translated into the momentum of the heavy piston, and the whirling power of a million of wheels.

The second-hand heat of the sun appears equally lost when vegetable fuel is expended in reducing metals; but oxidize these metals in a galvanic battery, and it will reappear as chemical force, as electricity, as magnetism, as heat the most intense; and, in the electro-carbon light, will return almost to the condition of sunshine again.

This second-hand plant-heat appears equally lost when vegetables are eaten by animals, but in reality reappears in their so-called animal heat, and in the chemical, electrical, and other forces which act upon and within them. It reappears, also, I do not doubt, in their vegetable life, and changes into what we call vital force. Do not, however, misunderstand me, as going beyond physical force. Life, remember, is not mind. The immaterial spirit, the immortal soul, is far above the Sun. We know him, and we know ourselves, but he knows neither himself nor us.

Astronomy thus stands much nearer industrialism, in all its departments, than perhaps any of us fully realize. I cannot wonder that men, even practical men, were once astrologers. A dim sense of obligation to the heavenly bodies for something more than starlight was obscurely felt perhaps by all, and rested, as the stable foundation-stone of a worthless building, at the bottom of the fantastic erection which formed the astrology of the middle ages. And still more intelligible is sun-worship. Only by a fallen and a rebel angel could such words be uttered as " I add thy name, O sun ! to tell thee how I hate thy beams." The worst of men would recall that God " maketh His sun to rise on the evil and on the good ;" and across the chasm of centuries I own to a sympathy with the pagan who worshipped as a god the bountiful Sun.

If now we turn to Chemistry, as pre-eminently the Experimental Science, we shall find everything reversed. Were we to personify ancient chemistry, we should represent her as a speechless priestess of nature, sworn to silence, loving concealment, and the most grudging of givers. She persuaded mankind for centuries that there were but four elements, Air, Earth, Fire, and Water ; and so cunning a conjuror was she, that though in open day she was continually taking them to pieces before the eyes of all, they did not detect the trick, but pronounced each fancied element one and indivisible. She still stretches forth her hands, filled with truths the most wonderful ; but those hands are clenched, and you must borrow her strength before you can open them. Every substance under her control is a locked casket, with a concealed key-hole, and no key. You must first, if you can, find the key-hole, which a search for ages has often failed to find ; and then study as best you may the hidden wards of the lock ; and thereafter forge not a pick-lock, but a perfect key, which in a multitude of cases will open the lock for which it was made.

The characteristic attitude, accordingly, of the chemist is very different from that of the astronomer. It is true that the former, like the latter, and like all the students of nature, must deal much in simple observation. The colours, the odours, the tastes, the crystalline shapes, the densities, the melting and boiling points, and many analogous properties or phenomena presented by bodies, are carefully noticed and registered by him. In observing these, however, he is not doing his own work, but that of the physicist : his proper work begins where that of the latter ends. Whatever is brought him, whether meteoric stone from the realms of space, or mineral from the bowels of the earth, or essence of plant, or secretion of animal, crystal or liquid, or vapour or gas, he regards as coming in "a *questionable* shape." Is it a compound; and if so, what are its ingredients? Are they compound in a less degree, or in essence simple? Are there any bodies truly simple; and if so, how many? What new compounds is it possible to produce by uniting in ways which Nature has not followed the simple and complex substances which she supplies?

To act out in practice those queries and others, the chemist at all times must keep both hands busy. His arms may never be folded. No mighty panorama unrolls itself before his eyes, requiring only that he fix upon it an unwavering gaze. No mysterious strangers longing to unburden their bosoms of truths known only to themselves, seek his cell as a confessional, and whisper revelations into his ear. He must be likened to one of those grim inquisitors of the middle ages, whom no man willingly answered, and who believed in no man's answer unless he wrung it from him by torture. In truth, there is a wonderful similarity between the old drawings of the inquisitors putting their victims to the question, and the old drawings of the alchemists testing the objects of their suspicions. In both cases there is a dark subterranean chamber, with ominous fires lighting up the gloom. In both the presiding genius is a wasted old man, with a haggard look, and the pitiless, unsatisfied eye of a bird of prey which has often missed its quarry. In both, obsequious familiars stand ready to do the bidding of the senior, and strange machines and implements hang upon the walls and burden the floor. In both, to complete the picture, all eyes are fixed upon the doomed object of suspicion in the centre, from which, whatever truths mechanical pressure can crush, or fire and water melt or dissolve, will presently be gathered. The analogy is not a fanciful one, for unless history has wronged the mediæval Inquisition, it reversed the rule of English jurisprudence, and counted every object of its notice guilty, till he proved himself innocent: and such is certainly the law of the chemist, who, like the French terrorist, regards every substance as "suspect" of being something else than it seems, and puts a mark even upon those against whom nothing has been proved before his searching tribunal.

But this comparison illustrates only one-half, and that the less important half, of what distinguishes chemistry from the other sciences. It is not that it experiments, for all the sciences, excepting astronomy, experiment. Nor that it tries to analyse everything, for every science is analytical, none more than astronomy; and all to the extent of their power treat nature inquisitorially. Chemistry differs only in degree from the other sciences in this respect, although the degree of that difference is immense. But it may be said to differ in kind from the other sciences, in its power to modify or transform matter, and to effect the creation of new bodies. That it can separate substances into their simpler ingredients, perhaps into their veritable elements, is a legitimate source of pride; but in relation, at least, to the arts of life, a greater ground of exultation is, that it can unite those elements or ingredients so as not only to reproduce the compound from which they were taken, but to bring into being, for the first time, compounds new to man. No wonder, then, that Nature is jealous of her chemical secrets. She knows that we shall never try to rival her in lighting up suns and stars, in building granite mountains and digging volcanic craters, or in shaping blades of grass, and manufacturing from it fleeces of wool. For the making of these she has the patent which we cannot infringe. But from the moment that chalk was proved to consist of carbonic acid and lime, the patent for making it expired; and we can not only produce chalk at will, out of its components, carbonic acid and lime, but out of their elements, carbon, oxygen, and calcium, we can make novel compounds, and forestal Nature in her own market.

The chemist is thus pre-eminently a transformer, a transmuter, a maker; in one word, a creator, to the full extent a mortal can be. God has given him one world; and, in addition, has permitted him to make as many worlds from it as he can. And every day he is making a new, and still a newer globe, new metals, new earths, new alkalies, new acids, new foods, new drinks, new airs to breathe. Alexander the Great wept because he had not another world to conquer; but no chemist needs weep on that account, for he may be first creator, and then conqueror of world upon world. Since the century began, Davy gave us one new world; Berzelius gave us another; Liebig a third: many more are in store for us.

The ancient Chemistry, a mute priestess, has long confessed that her oracles are dumb, and herself listens to the revelations of her unresembling successor. Modern chemistry is an active, full-voiced workman, a daimonic blacksmith, like the Scandinavian Thor or the classical Vulcan; only I do not know that it is essential to our conception of personified chemistry that he should be represented lame. This blacksmith's chief tools are two hammers. The one of them he calls *analysis;* it is a *crushing* hammer. If you bring him anything, no matter how rare and costly, he begs you to lay it on his anvil and let him try it with his tool. There are not many things in the world that can bear uninjured its stroke. The few that can, he sets great store upon, puts aside with a certain reverence, calls elements, and distinguishes by names. Some sixty such elements are all that he has yet encountered; and, with an improved hammer, he hopes to break down many of these. The multitude of bodies that give way before his blows he continues to smite till they will break no smaller, and the grains that remain he separates according to their kinds, and puts into that parcel of the sixty invincibles to which each belongs.

His other hammer he calls *synthesis;* it is a *forging* hammer. Beneath its strokes any two or more of the sixty unbroken residues of his crushing work can be welded together, made to incorporate into new substances, and assume new forms. Two, ten, twenty, the whole sixty simplest bodies may be taken, in equal or unequal quantities, and from each of the endless mixtures a new wonder will take shape under the hammer.

So he stands with a weapon in each hand, for he is ambidextrous; and moreover, he can wield both weapons at once. Neither are these his only tools. Equipped with them and with others, the chemist is pre-eminently a transformer, from the fourfold force which he can bring to bear upon material things.

First: He can analyse or decompose them into their last elements, and avail himself of these, as he does, for example, when he extracts the sulphur and the metal of an ore, and uses both; or when he takes out of salt the chlorine, and bleaches with it; and the sodium, and makes soap with it. Or he can *partially* analyse them, reducing them from their native great complexity to perfect simplicity, step by step; doing this by steps of different length, and obtaining something useful at each stage. Thus, instead of at once decomposing sugar into carbon, hydrogen, and oxygen, he can stop short of this, and decompose it into charcoal and water; or into alcohol and carbonic acid; or into oxalic acid and carbonic acid; or into the acid of milk (lactic acid); or into the acid of butter (butyric acid); or into manna and gum; or into mixtures of various of these, and of other peculiar and highly-prized products.

Secondly: He can unite bodies, so as to obtain artificially compounds which are rare in nature or difficult to procure. Thus, instead of digging in Illyria for cinnabar, he heats together sulphur and quicksilver, and makes vermilion in England; instead of sending to the Italian volcanoes for alum, he makes it at home from clay and oil of vitriol; instead of burning sea-weeds in Shetland to get carbonate of soda, or sailing to India for saltpetre, he produces these at his own door, by uniting their constituent acids and bases. Further, out of the sixty elements he manufactures compounds of the greatest value to the industrialist, which are not to be found in nature at all, such as brass, gun-metal, cast iron, steel, percussion powder, bleaching powder, chloroform.

Thirdly: He can take certain constituents from a compound whilst he adds in their place others, so that analysis and synthesis proceed side by side. Thus he removes oxygen from iron ore, and replaces it by carbon, converting thereby the iron into steel. He begins with a carbonate, and replaces the carbonic acid in it by sulphuric, nitric, acetic, or other acids, so as to convert it into a sulphate, nitrate, or acetate. He takes carbon, nitrogen, and oxygen from alcohol, and adds chlorine, transmuting the spirit into chloroform. Such processes of substitution are perhaps the most common of all the transformative methods of the chemist, and they often imply complete exchange among all the elements of very complex compounds.

Fourthly and lastly: He can transform bodies, without taking ingredients from them or adding ingredients to them. By a new arrangement of particles, implying neither loss nor gain of weight or substance, one body may be converted into another of properties wholly different. Thus starch can be changed into gum, and gum into sugar, and sugar into wood-fibre. A neutral salt may become a powerful base; a volatile odorous liquid an indifferent crystalline solid. Chemistry looks in no direction more hopefully than in this for new triumphs over matter.

(To be continued.)

ON CHEMISTRY APPLIED TO THE ARTS.

BY DR. F. CRACE CALVERT, F.R.S., F.C.S.

A Course of Lectures delivered before the Members of the Society of Arts.

Lecture I.

Bones.—Composition of Raw and Boiled Bones. The Manufacture of Superphosphate of Lime. Application to Agriculture. Bone-black or Char, and its Use in Sugar-refining. *Phosphorus*, its Properties; Extraction and Employment in Manufacture of Matches. *Horn* and *Ivory*, their Composition and Application.

I shall not take up your time by making many preliminary remarks, but merely state that, though the heads of the subject on which I intend to speak are not inviting ones, still we shall find as we progress that the study of the various matters which I shall bring before you is full of interest and instruction. Further, it would be difficult to name subjects which better illustrate the ability of man to turn to profitable account the various materials placed in his hands, or to mention substances which have received more complete and skilful applications than those we shall treat of this evening.

Bones.—The composition of "green bones," or bones in their natural state, may be considered under two general heads, viz.:—the animal matters, consisting of a substance called osséine, and a few blood-vessels, and the mineral matters, chiefly represented by phosphate of lime and a few other mineral salts. The composition of bones has been examined by many eminent chemists, but the most complete researches are those published in 1855 by M. Fremy, who examined bones, not only from various classes of vertebrated animals, but also from different parts of the same animal; and to enable you to appreciate some of his conclusions, allow me to draw your attention to the following table* :—

* Annales de Chimie et Physique. Vol. xliii., pp. 79, 83, 84.

Composition of Bones.

Name of Bone.	Mineral Matter.	Phosphate of Lime.	Phosphate of Magnesia.	Carbonate of Lime.
Femur—Fœtus 6 months	63·0	58·9		5·8
„ Boy 18 „ ...	61·6	58·0	0·5	2·5
„ Woman 22 years...	60·1	59·4	1·3	7·7
„ Man 30 „ ...	63·2	57·7	1·2	9·3
„ „ 40 „ ...	64·2	56·3	1·3	10·2
„ Woman 80 „ ...	64·6	57·1	1·2	7·5
„ „ 97 „ ...	60·8	51·9	1·3	9·3
„ Lion (young)	64 7	60·0	1·5	6·3
„ Sheep	70·0	62·9	1.5	7·7
Sperm Whale	62·9	51·9	0·5	10·6
Ostrich	70·0			
Carapace of Turtle	64·3	58·0	1.2	
Codfish	61·3			
Stag's horn	61·9	58·1	traces	3·8
Cow's tooth Bone	67·1	60·7	1·2	2·9
„ „ Enamel.....	96·9	90·5	traces	2·2
„ „ Ivory.........	74·8	70·3	1·3	2·2
Scales of the Carp	34·2	33·7	traces	1·1

The first conclusion drawn by M. Fremy from these researches is, that he found a larger proportion of mineral matter than is generally admitted by chemists. Secondly, that there is no material difference in the composition of various bones taken from different parts of man, or of any one animal, but that age has a very marked influence on composition. Thus, in the bones of infants there is more animal and less mineral matter than in the adult, whilst in old age there is more mineral and less animal matter than in the middle-aged man. The mineral substance which chiefly increases in old age is carbonate of lime. Lastly, he could find no marked difference between the bones of man, the ox, calf, elephant, and whale; whilst in the bones of carnivorous animals and those of birds there is a slight increase in the amount of mineral matter. Allow me now to call your attention to a most interesting query. I hold in one hand the mineral matter only of a bone, which you can see retains perfectly its original form, and in the other hand I have the animal matter only of a similar bone, which also retains the form in which it previously existed, but is flexible instead of rigid. The question, therefore, arises whether the hardness of bones proceeds from these two kinds of matter being combined together, or are their respective molecules merely juxtaposed? The answer is, the latter; for, as you see by this specimen, the mineral matter has been entirely removed without deforming the animal texture. Further, in the fœtus it is found that the bones contain nearly the same proportions of animal and mineral matters as those of the adult. Also, it has been observed by Mr. Flourence and other eminent physiologists, that the wear and tear of bones during life is repaired by the formation of new bone on the exterior surface of the bone, while the old substance is removed through the interior duct, and that the composition of the new layer is the same as that of the original bone. Let us now proceed to examine the chemical properties of the various substances composing bones, and some of the various applications which they receive in arts and manufactures. The general composition of bones may be considered to be as follows :—

BONES.

Organic Substances.	Blood-vessels	1
	Osséine	32
	Fatty Matters	9
Mineral Substances.	Water...	8
	Phosphate of Lime	38
	Phosphate of Magnesia	2
	Carbonate of Lime	8
	Divers Salts	2
		100

The above-named animal matter, *osséine*, C 50·4, H 6·5, N 16·9, O 26·2, and which has been erroneously called gelatine, is insoluble in water, weak acids, and alkalies, whilst gelatine presents properties directly the reverse. But what has led to this popular error is, that osséine, when boiled in water, becomes converted into the isomeric substance commonly called gelatine. As I shall have to dwell upon this substance at some length in my next two lectures, I will not detain you now further than to state that osséine is obtained from bones by placing them in weak hydrochloric acid, which dissolves the phosphate of lime and other mineral salts, washing the animal substance, osséine, until all acid is removed, drying it, and treating it with ether to remove fatty matters. I cannot leave this subject without remarking on the extraordinary stability of this animal substance, for it has been found in the bones of man and animals after many centuries, and even in small quantities in fossil bones.

The fatty matter of bones is made useful in the manufacture of soap, railway grease, and other purposes ; it is obtained by taking fresh bones (as bones which have been kept a long time will not yield their grease easily) and placing the spongy parts, or ends of the bones (where most of the fatty matter exists), in large boilers filled with water, which is then carried to the boil, when a part of the osseine is converted into gelatine, and the fatty matter liberated rises to the surface, and is easily removed. The bones thus treated are called boiled bones, and receive many important applications. Benzine and bisulphuret of carbon have been used as substitutes for water in the above operation, but the advantages do not seem to have been sufficient to lead to their general adoption.

Mineral Matter of Bones.—These, as the foregoing tables show, are chiefly represented by phosphate and carbonate of lime. The immortal

Berzelius was the first to establish the fact that phosphate of lime was the only substance possessing the properties necessary for the formation of bone, owing to the extremely simple chemical reactions which cause the soluble phosphates to become insoluble. Let us trace shortly the sources from whence we derive the large proportion of phosphate of lime which exists in our frames. Several of our most eminent chemists have proved the existence of phosphorus in sedimentary and igneous rocks, and the important part played by phosphorus in nature cannot be better conveyed to your minds than by this extract from Dr. Hofmann's learned and valuable 'Report on the Chemical Products in the Exhibition of 1862 :'—"Large masses of phosphorus are, in the course of geological revolutions, extending over vast periods of time, restored from the organic reigns of nature to the mineral kingdom by the slow process of fossilization; whereby vegetable tissues are gradually transformed into peat, lignite, and coal, and animal tissues are petrified into coprolites, which, in course of time, yield crystalline apatite. After lying locked up and motionless in these forms for indefinite periods, phosphorus, by further geological movements, becomes again exposed to the action of its natural solvents, water and carbonic acid, and is thus restored to active service in the organisms of plants and lower animals, through which it passes, to complete the mighty cycle of its movements into the blood and tissues of the human frame. While circulating thus, age after age, through the three kingdoms of nature, phosphorus is never for a moment free. It is throughout retained in combination with oxygen, and with the earthy or alkaline metals, for which its attraction is intense." After these eminently philosophical views by Dr. Hofmann, I will proceed to call your attention to the application of bones to agriculture. Bones are generally used for manuring in one of these three forms:—1st. As ground green bones; 2nd. As ground boiled bones (that is, bones nearly deprived of their osseine by boiling under pressure, as I shall describe in my next lecture); 3rd. Superphosphate of lime.

Green or raw bones have been used on grass land for a long period, but their action is exceedingly slow and progressive, owing to the resistance of the organic matter to decomposition and the consequently slow solubility of the phosphate of lime in carbonic acid dissolved in water. What substantiates this view is, that boiled bones are far more active than the above. It is found that from 30 to 35 cwts. per acre of these will increase the crops on pasture land from 10 to 20 per cent. in the second year of their application. But the great advantage which agriculture has derived from the application of bones as a manure has arisen from their transformation into superphosphate of lime, especially applicable to root and cereal crops. To Baron Liebig is due the honour of having first called the attention of farmers (in 1840) to the importance of transforming the insoluble phosphate of lime of bones into the soluble superphosphate, rendering it susceptible of immediate absorption by the roots of plants, and of becoming at once available for their growth. These suggestions of Liebig were rapidly carried out on a practical scale by Messrs. Muspratt, of Lancashire, and J. B. Lawes, of Middlesex ; in consequence of the valuable results obtained by them, the manufacture of artificial manures has gradually grown into an important branch of manufacture in this country. The manufacture of superphosphate of lime is so simple that any farmer possessing a knowledge of the mere rudiments of chemistry can make it for himself, by which he will not only effect great economy, but also secure genuineness of product. All he requires is a wooden vessel lined with lead, into which can be placed 1,000 lbs. of ground boiled bones, 1,000 lbs. of water, and 500 lbs. of sulphuric acid, sp. gr. 1.845 (or concentrated vitriol), mixing the whole, and stirring well for about twelve hours. After two or three days a dry mass remains, which only requires to be taken out and placed on the land by means of the drill, or to be mixed with water and sprinkled on the land. When very large quantities of this manure are required, the plan devised by Mr. Lawes appears to me to be the best. It consists in introducing into the upper end of a slightly-inclined revolving cylinder a quantity of finely-ground boiled bones, together with a known proportion of sulphuric acid of sp. gr. 1·68. As the materials slowly descend by the revolution of the cylinder they become thoroughly mixed, and leave it in the form of a thick pasty mass, which is conducted into a large cistern capable of containing 100 tons, or a day's work. This is allowed to remain for twelve hours, when it is removed, and is ready for use. Most manufacturers find it necessary to add to the phosphate of lime of bones other sources of phosphates, such as coprolites, or the fossil dung of antediluvian animals, which have been found in large quantities in Suffolk, Cambridgeshire, and elsewhere, and contain from 36 to 62 per cent. of phosphate of lime, and from 7 to 38 per cent. of organic matter. Others employ a mineral substance called apatite, containing about 92 per cent. of phosphate of lime, and found also in large quantities in Spain, Norway, France, &c. Others, again, employ guanos rich in phosphate of lime, such as those of Kooria Mooria Islands, and Sombrero phosphates. The following is the average composition of the superphosphate of lime of commerce :—

Soluble Phosphate	22	to	25	per cent.
Insoluble „	8	„	10	„
Water	10	„	12	„
Sulphate of Lime	35	„	45	„
Organic Matter	12	„	15	„

Nitrogen 8·75 to 1·5 per cent.

The valuable and extensive researches of Messrs. Lawes and Gilbert, and Messrs. Boussingault and Ville, have not only demonstrated the importance of phosphates to the growth of cereal and root crops, but also that phosphates determine in a great measure during vegetation the absorption of nitrogen from the nitrates or from ammonia, as will be seen by the following table:—

Amount of Nitrogen fixed by Wheat under the Influence of following Salts:—

	Without Nitrogenated Compounds.	With Nitrogenated Compounds.
Phosphate of Lime and Alkaline Silicate ...	8.15	20.08
Phosphate of Lime	7·25	19·17
Earths and Alkaline Silicates..................	5·71	11·16
Earth	3·00	9.50

Bone-black or Char.—In 1800, Löwitz made the interesting observation that wood charcoal possesses the remarkable property of removing colouring matters from their solutions. In 1811, Figuier also observed that animal black has far greater decolorating power than wood charcoal, and bone-black has consequently become one of the principal agents in sugar-refining, and has been the means, more than any other substance, of producing good and cheap white sugars. To give you an idea of the extent to which bone-black is used at the present day for decolorating purposes in the refining of sugar, I may state that in Paris alone it is estimated that about 11 million kilogrammes of bones are used annually for that purpose. The preparation of bone-black is simple in principle. It consists in placing in cast-iron pots about 50 pounds of broken boiled bones, that is, bones which have been deprived of their fat—of most of their osséine, and piling these pots in a furnace, where they are submitted to a gradually rising temperature, during twenty-four hours, such as will completely decompose the organic matter, but not so high as to partly fuse the bones and thus render them unfit for their applications. But a more economical process is generally adopted. It consists in introducing the crushed bones into horizontal retorts, which are themselves in connection with condensers, the ends of which are brought under the retorts to assist by their combustion in the distillation of the animal matter. By this arrangement not only is char obtained, but oily matters which are used by curriers, and also ammoniacal salts employed in agriculture and manufactures. The extraordinary decolorating action of animal blacks may be considered as partly chemical and partly mechanical—mechanical because it is proved, by some interesting researches of Dr. Stenhouse, to which I shall refer further on, that the action is due to the minute division of the carbon and the immense surface offered by its particles to the colouring matter, char being composed of ninety parts of mineral salts to 10 per cent. of carbon. On the other hand, the action is proved also to be chemical, by the fact that water will not remove the colouring matter, whilst a weak solution of alkali will dissolve it. Dr. Stenhouse's valuable researches not only illustrate fully this fact, but also prove the possibility of producing artificially substitutes for bone-black. In 1857 he published a paper describing the production of an artificial black, called by him aluminized charcoal. This he obtained by mixing intimately, and heating, finely pulverized charcoal and sulphate of alumina, when he obtained a powerful decolorating agent containing 7 per cent. of alumina, and well adapted for decolorating acid solutions, such as those of tartaric and citric acids, in chemical works. He also prepared what he called coal-tar charcoal, by melting one pound of pitch in a cast-iron pot, adding to it two pounds of coal-tar, and mixing intimately with it seven pounds of hydrate of lime, then carrying the whole to a high temperature, allowing it to cool, removing the lime by washing the mass with hydrochloric acid, and then with water, when carbon in a high state of division was obtained, possessing powerful decolorating properties. The following series of experiments by Dr. Stenhouse perfectly illustrate the chemico-physical action of animal black as a decolorating agent. He boiled a certain amount of char and his two charcoals, with a solution of logwood, then treated each black separately with ammonia, when the following results were obtained: Aluminized charcoal yielded no colour. Bone-black but a slight amount. Coal-tar charcoal, large quantities. But it would be wrong in me to leave you under the impression that animal black can only remove colours from solutions. Purified animal black, that is to say, animal black deprived of its mineral matters by the action of muriatic acid and subsequent washing, has the power of removing certain bitters from their solutions. Thus Dr. Hofmann and Professor Redwood applied this property with great skill, some years ago, to the detection of strychnine in beer. Again, Mr. Thos. Graham, Master of the Mint, published a most interesting series of researches, in which he established the fact that purified animal black had the power to remove a great number of saline matters from their solutions, such as the salts of lime, lead, copper, &c.

Revivication of Bone Black.—After a certain quantity of syrup sugar has percolated through the cylinders containing bone black, the interstices become so clogged with impurities, that it loses its power of decolorating the syrup. Sugar refiners are therefore in the habit of restoring the power of their bone black, generally speaking, by submitting it to a process of calcination, which volatilizes or destroys the organic matter fixed by the char. It has been proved by experience that char may undergo this operation about twenty times before its pores become so clogged with dirt as to render it useless. [Here the lecturer described, with the aid of drawings, several of the various apparatus used in sugar refineries for the above process, alluding particularly to that of Messrs. Pontifex and Wood, by which a ton of char is revivified every twenty-four hours.] A new process, however, has been devised by Messrs. Leplay and Cuisinier, which as a whole deserves the attention of refiners, though I am aware that several of the details of their process have been used for some time. The char which has served its purpose in the cylinders, instead of being removed, is treated at once by the following processes. It is first thoroughly washed, treated by steam to remove all viscous substances, then a weak solution of alkali is allowed to percolate through the char, which removes saline matters and a certain amount of colouring matter, when it is further acted upon by weak hydrochloric acid, which in removing a certain amount of the lime salts liberates the colouring matters; the char is again washed with weak alkali to remove the remaining colouring matter, and lastly the decolorating power of the black is restored by passing through it a solution of bi-phosphate of lime. It is to be hoped that the high praise bestowed upon this process on the Continent may induce our manufacturers to try it, as they would obtain two strict advantages by its use. First, the economy of operating at once upon the black and restoring its properties without removing it from the cylinders. Secondly, the prevention of the noxious odours given off during the revivification of char by the ordinary methods. It is interesting to note one of the results of the different employment of char in this country and on the continent. In England the wear and tear in sugar refinery is constantly repaired by the introduction of fresh char, and there is no spent or old char for sale. In France, on the contrary, owing to the great impurities in their beet-root sugar syrups, and to the use of blood in refinery, the char becomes rapidly clogged with organic matter, and is so completely animalised, that its value as a manure exceeds what the char originally cost the refiner. The result is that French "spent" char is annually exported to the French colonies to the amount of 120,000 tons, and is there used as a manure to promote the growth of the sugar cane. So important is this article of commerce considered, that the French Government have appointed special analytical chemists to determine its value for the trade.

Phosphorus.—I am now about to call your attention to one of the most marvellous and valuable substances ever discovered by chemists. In 1660, Brandt, a merchant of Hamburgh, discovered a process for obtaining phosphorus from putrid urine; but though he kept his secret, a chemist named Künckel published the mode of obtaining it from this fluid. A hundred years later, Gahn discovered the presence of phosphorus in bones; and Scheele shortly afterwards gave a process to obtain it therefrom. The process devised by this eminent chemist was shortly afterwards improved upon by Nicolas and Pelletier, and their method was so completely worked out by Fourcroy and Vauquelin, that it is still the process used in the present day. The preparation of phosphorus consists of four distinct operations—1st, 80 parts of thoroughly calcined and pulverised bones are mixed with 80 parts of sulphuric acid, sp. gr. 1·52, to which is then added 400 parts of boiling water; 2ndly, after a few days the clear liquor, containing bi-phosphate of lime, is removed from the insoluble sulphate, and evaporated until it has the specific gravity of 1·5; 3rdly, this liquor is mixed with 20 per cent. of finely pulverised charcoal, and the whole is dried at a moderately high heat, when, 4thly, it is introduced into an earthenware retort, placed in the galley furnace, and on heat being slowly applied phosphorus distils, and the operation is continued at a high heat for two or three days. It is, however, necessary that the phosphorus thus obtained should be purified, and this is effected by melting the phosphorus under water, and pressing it through a chamois skin. It is then boiled with caustic alkali to remove other impurities : but what is still better is to heat the phosphorus with a mixture of bichromate of potash and sulphuric acid. The phosphorus thus purified is drawn through slightly conical glass tubes by the suction of a caoutchouc pouch, or is allowed to run by an ingenious contrivance into tin boxes. As will be seen by the following formula, the manufacturer only obtained from the bones one-half of the phosphorus they contain :

$2\ (PO_5,\ 3\ Ca\ O)$	÷	$4\ SO_3\ HO$	=	$2\ (PO_5\ Ca\ O,\ 2\ HO)$	÷	$4\ (SO_3\ Ca\ O)$
Bone phosphate of lime.		Sulphuric acid.		Acid phosphate of lime.		Sulphate of lime.

$2\ (PO_5\ Ca\ O)$	÷	$5\ C$	=	$PO_5\ 2\ Ca\ O$	÷	$5\ CO$	÷	P
Bi-phosphate of lime.		Carbon.		Pyrophosphate of lime.		Oxide of Carbon.		Phosphorus.

Consequently many attempts have been made to devise a chemical reaction by which the whole of the phosphorus might be secured. The most successful attempt of late years is that made by Mr. Cary-Montrand, whose process is based on the following chemical reaction :

ACTION OF HYDROCHLORIC ACID ON BONE PHOSPHATE.

$2\ (PO_5,\ CaO)$	÷	$4HCl$	=	$2\ (PO_5,\ CaO,\ 2HO)$	÷	$4CaCl$
Bone-Phosphate of Lime.		Hydrochloric Acid.		Acid Phosphate of Lime.		Chloride of Calcium.

ACTION OF HYDROCHLORIC ACID ON BI-PHOSPHATE.

$2\ (PO_5,\ CaO)$	+	$2HCl$	÷	$12C$	=	$2CaCl$	÷	$12CO$	÷	$2H$	÷	$2P$
Bi-phosphate of Lime.		Hydrochloric Acid.		Carbon.		Chloride of Calcium.		Oxide of Carbon.		Hydrogen.		Phosphorus.

He arrives at this result by treating calcined bones with hydrochloric acid ; the liquor is then mixed with charcoal, and the whole dried at a moderate heat. The prepared mass is then introduced into cylinders through which a stream of hydrochloric acid is made to percolate, and, as shown above, chloride of calcium, hydrogen, carbonic oxide, and two proportions of phosphorus are produced. (The process of Fleck was also described.) Phosphorus prepared and purified by the above processes is a solid, semi-transparent body, having a sp. gr. 1·83, fusing at 110·5° F., and boiling at 550°. It is so inflammable that it ignites in the open air at several degrees below its fusing point ; but Professor Graham made, some years ago, the interesting observation that this slow combustion of phosphorus could be entirely checked by the presence of certain combustible vapours. Thus he found that one volume of vapour of naphtha in 1,820 of air, or one volume of vapour of oil of turpentine in 4,444 of air, completely prevented the spontaneous combustion of phosphorus. Further, phosphorus presents the curious property, that if heated to 160° F. and suddenly cooled, it becomes black, and if heated to 450° or 460° for several hours, it becomes amorphous, and of a dark brown colour. This allotropic state of phosphorus, first noticed by Schrotter, has enabled it to render great service to society, owing to its not being spontaneously inflammable (as in fact it only becomes so at a temperature approaching its point of fusion), and also to its not being poisonous, so that it can be substituted for common phosphorus in the manufacture of matches with great advantage. Lastly, owing to this brown amorphous phosphorus not emitting any vapours, those employed in the manufacture of chemical matches now avoid the risk of the dreadful disease of the jaw-bone, called phospho-necrosis. Notwithstanding the great difficulties attending the manufacture of this valuable product, Mr. Albright, of Birmingham, has, with praiseworthy perseverance and great skill, succeeded in obtaining it perfectly pure on a large scale, and at such a price as to bring it within the scope of commercial transactions.

Chemical Matches.—Although I do not intend to enter at great length upon this subject, yet as it is a highly important one, I deem it my duty to lay a few facts before you. The first application of chemistry to the discovery of a substitute for the old tinder-box of our fathers was made in 1820, when the sulphuretted ends of matches were covered with a mixture of chlorate of potash, lycopodium, and red lead, and the matches so prepared were dipped into asbestos moistened with sulphuric acid. In 1836, lucifer matches were first introduced, and the explosive matches were soon followed by the non-explosive ones. The composition of these matches is as follows :

	Non-explosive.		Explosive.
Phosphorus	25 or 30	...	9 or 4
Red Lead	5 „ 20	...	16 „ 3
Nitre	0 „ 0	...	14 „ 10
Sand	20 „ 20		
Vermilion	1 „ 0		
Gum or Glue	20 „ 25	...	16 „ 6

The danger as well as the disease attendant on this manufacture was greatly mitigated by Professor Graham's discovery of the property of turpentine vapour already alluded to. Until lately the only successful application of amorphous phosphorus to lucifer matches was that of Messrs Coignet, Frères, of Paris, who caused a rough surface to be covered with it, and so prepared their matches that they would not ignite except when rubbed upon the prepared surface. Similar matches, under the name of "special safety matches," have also been introduced into this country of late by Messrs. R. Letchford and Co., who have also effected several important improvements in this branch of manufacture, in one of which paraffin is made use of to carry combustion to the wood instead of sulphur, which gives rise to the noxious fumes of sulphurous acid, and as the substitution is made by Messrs. Letchford without any increase of cost, the price of these matches is as low as that of the common ones. These gentlemen have also found the means of diminishing the amount of phosphorus used to a very considerable extent, so that the disagreeable smell of this substance is also avoided. But the greatest improvement that Messrs. Letchford have made is in what they call their hygienic matches, or lights, in which for the first time amorphous phosphorus is substituted for ordinary phosphorus, and in small quantities. The advantage of these matches cannot be overrated, for children can eat them with impunity, as amorphous phosphorus is not poisonous; they are not nearly so combustible, and therefore not so likely to cause accidental fires; and lastly, all source of injury to the health of those employed in the manufacture is removed. I cannot leave this subject without still drawing your attention to one or two important facts. Messrs. Hochstetter and Canouil, besides others, have lately introduced chemical matches free from phosphorus, which are stated to have the following composition:

Chlorate of Potash	10	10	10
Hyposulphite of Lead ...	26	26	20
Peroxide of Lead	...	9·8	...
Peroxide of Manganese ...	...	...	33·6
Chromate of Lead	17	4	8·8
Gum Arabic	4	4	4

An important improvement in the manufacture of chemical matches is the reduction of the proportion of phosphorus to a minimum. This is effected by reducing the phosphorus to an infinitesimally minute division, by which the manufacture is rendered more economical, and the matches, when ignited, have less of the unpleasant odour of phosphorus. This division is accomplished by using a solution of phosphorus in bisulphuret of carbon, by which a saving of 19-20ths of the phosphorus is obtained. Another invention is that of Messrs. Puscher and Reinsch, who have proposed the employment of sulphide of phosphorus.

Ivory.—The lecturer having given some details respecting the properties of ivory, said: I will now call your attention to the substitution of the following mixture for ivory tablets as applied in photography. Finely-pulverised sulphate of baryta is mixed with gelatine or albumen, compressed into sheets, dried, and polished; these sheets are ready for use in the same way as ivory plates. You are all doubtless aware that the nut of the *Phytelephas macrocarpa*, of the palm-tree tribe, has for many years been used in this country as a substitute for ivory for small articles, and it may be interesting to you to be made acquainted with the two following facts, viz., that the nut is composed of—

Pure cellulose	81	per cent.
Gum	6	,,
Nitrogenated principles ...	4	,,
Water	9	,,
Total..............	100	

and Dr. Phipson has recently published a method of distinguishing this vegetable ivory from the animal one by means of sulphuric acid, which gives a beautiful purple colour with the vegetable ivory, but none with the animal ivory.

Horn.—Horns of the best quality, and especially the beautiful ones obtained from the buffaloes in India and America, receive a great variety of applications at the present day, owing to their toughness and elasticity, as well as to their remarkable property of softening under heat, of welding, and of being moulded into various forms under pressure. To apply horns to manufactures they are treated as follows: They are first thrown into water, and slight putrefaction commences, by which ammonia is produced, when the horn begins to soften. To carry this action further the horns are transferred into a slightly acid bath, composed of nitric and acetic acids, with a small quantity of various salts. When the horns are sufficiently softened, which requires about two weeks, they are cleaned and split into two parts by means of a circular saw, and these are introduced between heated plates, and the whole subjected to an intense pressure of several tons to the square inch. The plates may be moulds, and thus the horn may be compressed into any required shape. A great improvement has recently been effected in this branch of manufacture, which consists in dyeing the horn various colours. To accomplish this the horn is first dipped into a bath, containing a weak solution of salts of lead or mercury, and when the horns have been thus impregnated with metallic salts, a solution of hydrosulphate of ammonia is rubbed on them, when a black or brown dye is produced. Another method consists in mordanting the horn with a salt of iron, and dipping it in a solution of logwood. Of late, very beautiful white fancy articles have been produced from horn by dipping it first into a salt of lead, and then into hydrochloric acid, when white chloride of lead is fixed in the interstices of the horn, which then simply requires polishing.

This lecture, as well as those which followed, were illustrated by numerous specimens and experiments.

NATAL FIBRES.

In a late number you call attention to Fibre Staples, and justly remark that they ought to take a high place amongst the future exports of the colony. A short notice, therefore, of the nature and peculiarities of a few of the fibrous plants indigenous to or introduced into Natal may be of interest to some of your readers, and perhaps may lead some of them to bring others into notice which may have escaped my own observation. If so, I am sure you will gladly aid us in our endeavours to gain a knowledge of these productions, as no doubt we shall profit by the information likely to be adduced. I am, &c.,

Botanic Gardens, Durban, April, 10, 1864. M. J. M'KEN.

FIBROUS PLANTS OF NATAL.

Hibiscus Cannabinus—Amaree, or hemp-like *Hibiscus.*—This plant is much cultivated in India for its leaves, which are used as a vegetable, and for its fibre, from which a kind of hemp is prepared.

Hibiscus Furcatus.—The bark yields abundance of strong white flaxen fibres.

Paritium Tiliaceum—Maho tree.—Produces a valuable fibre much used for ropes. It is little affected by moisture, and hence is chosen for measuring-lines, &c. The wood is white and light, useful for small cabinet woık.

Sida.—There are three species of this genus common here, the bark of which yields abundance of delicate flaxy fibres.

Crotalaria Capensis.—Yields a strong and tolerably soft fibre, but much inferior to hemp.

Sanseviera sp.—bowstring hemp.—The leaves of this plant abound in fibre, remarkable for fineness and tenacity.

Gomphocarpus and others belonging to the milkweed family, yield a large quantity of fine silky fibre.

In addition to the above, there are many others which yield fibrous material, as the *Grewia, Corchorus, Triumfetta, Urtica, Ficus, Hyphæne, Phœnix, &c. &c.*

CULTIVATED FIBRE-YIELDING PLANTS.

Agave Americana—American aloe.—The fibres from the leaves of this plant closely resemble those of Maguey, which is used in the manufacture of paper. Mayer, in his work on Mexico, observes : " The best coarse wrapping or envelope paper I have ever seen is made from the leaves of *Agav e Americana ;* it has almost the toughness and tenacity of iron.

Fourcroya gigantea.—Abounds in excellent fibre suitable for ropes, lines, or paper.

Pandanus sp. Vacoa—or screw pines.—The common sugar bags are made from the leaves of this plant. The leaves are composed of tough longitudinal fibres, white and glossy, and make excellent cordage.

Bromelia Pinguin.—Yields a strong fibre which is twisted into ropes, and manufactured by the Spaniards into cloth, of which they make hammocks, &c.

Ananassa sativa—or pine apple.—The fibre of this plant is extensively used in manufacturing the delicate fibre known to commerce as *Pina.*

Yucca Aloifolia—or Adam's needle.—Abounds in fibre of fine quality and strong in nature ; it is known as silk grass.

Phormium tenax.—New Zealand flax.

Plantain and banana.—Both the stems and leaves of these plants abound in fibre useful for textile or cordage purposes, while the tow which is separated in preparing the fibres forms an excellent material for the finest or toughest kinds of paper. Humboldt calculated that the same extent of ground, when planted with the banana, will support a far greater number of people than when planted with wheat. The productiveness has been found to differ with the mean temperature of the place. Boussingault has given the following as the produce per imperial acre of the raw fruit in three places :

	Temp.	Produce per imp. acre.	Dry food per acre.
Warm regions	81½	72 tons.	19½ tons.
At Canca	78.4/5	59 „	16 „
At Hague	71.2/5	25 „	6¾ „

—Professor Johnston is the authority for the last column, or that of dry food per acre, as he had, from his analysis, obtained 27 per cent. of nutritive matter from the banana.

Corchorus capsularis.—Jute hemp is produced from the bark of this plant; a kind of cloth called *chatee* is made from the same material, and gunny bags are made from it. The leaves are used in the East as pot-herbs.

Hibiscus esculentus, the Okkro, and *Hibiscus Sabdariffa*, the sorrel plant —abound in fibre of fine quality. The fruit of the first is used, when cooked, as a vegetable, as also to thicken soups. The seeds may also be added, like barley to soups, and have been recommended to be roasted as a substitute for coffee. The sorrel plant is cultivated in most gardens because its calices, as they ripen, become fleshy, are of a pleasant acid taste, and are much employed for making tarts, as well as an excellent jelly.

Bœhmeria nivera—China grass or grass-linen, sometimes called *Rheea.*—Hemp is prepared from this plant. The *rheea* is a perennial, and abounds in splendid fibre. Of the value of this fibre, no better evidence can be given than that of Dr. Royle, who states that, as imported into England, it has sold at from $300 to $400, and even $600 a ton. In respect of strength, it has been proved by numerous experiments that it sustains a weight always much greater than the best Russian hemp. The cloth made from the fibre known as "grass cloth" is not unlike silk in appearance, and has a softness and strength distinct from that of the fabric of any other fibre.

Besides the above plants in cultivation here, there are numerous others which produce fibres, but which it would occupy too much space to notice in detail. Among them may be mentioned flax, hemp, Jerusalem artichoke, oleander, bauhinia, common sun-flower, parkinsonia, the mulberry, &c. &c.

I have added the dietetical uses of some of the plants, in order to show that if cultivated on account of their fibre, they would also be useful for other purposes.

CHEMICAL ANALYSIS OF COFFEE.

Coffee has been analysed by several chemists, and though the results obtained differ in some slight degree, yet it seems pretty clear that the principal constituents to which its hygienic and medicinal properties are due are caffeine, a peculiar volatile oil generated in the roasting, and a kind of tannic acid.

The alkaloid caffeine, or theine, is found in one or two other plants besides tea and coffee. It occurs in the seeds of *Paullinia sorbilis*, a native of Brazil, and in the leaves of several species of holly, natives of South America, which furnish the Paraguay tea, or Yerba mate, so large an article of consumption in several of the South American republics. The leaves and young shoots, dried, parched, and pulverised, are used for a hot infusion. A kind of cake, called Guarana bread, is made from the seeds of the *Paullinia*, which is highly esteemed in Brazil and other countries when infused, like chocolate, for its nutritive and febrifuge properties, and is sold generally as a necessary for travellers, and as a cure for many diseases.

The nutritive and medicinal virtues of all these plants must certainly be attributed in a great degree to the presence of this chemical principle, and to the tannic acid which they also contain.

The use of coffee as a beverage has been considered in a chemical and physiological point of view by Professor Lehmann. The general results of his investigations are :

1. That a decoction of coffee exercises two principal actions upon the organism, which are very diverse in character, viz., increasing the activity of the vascular and nervous system, while at the same time it retards the metamorphosis of plastic constituents.

2. That the influence of coffee upon the vascular and nervous system, its reinvigorating action, and the production of a general sense of cheerfulness and animation, is attributable solely to the mutual modification of the specific action of the empyreumatic oil and the caffeine contained in it.

3. That the retardation of the assimilative process brought about by the use of coffee is owing chiefly to the empyreumatic oil, and is caused by caffeine when taken only in large quantities.

4. That increased action of the heart, trembling, headache, &c., are effects of the caffeine.

5. That the increased activity of the kidneys, relaxation of the bowels, and an increased vigour of mental faculties, passing into congestion, restlessness, and inability to sleep, are effects of the empyreumatic oil.

Professor Lehmann considers it, therefore, necessary to regard the action of coffee, and, in a less degree, that of tea, cocoa, alcohol, &c., upon the organism, as constituting an exception to the general law, that increased bodily and mental activity involves increased consumption of plastic material.

Caffeine, on careful analysis, has been found to contain in 100 parts, 49·80 of carbon, 5·08 of hydrogen, 28·83 of nitrogen, and 16·29 of oxygen. It is inodorous, but has a slightly bitter taste. The proportion in which this principle is found to be present in coffee varies between ¾lb. and 1¾lbs. in 100lbs. of berries.

The peculiar essential oil which is generated in coffee in the process of roasting, by the action of heat upon some yet unascertained principle contained in the berry, is also very similar to the volatile oil in tea; but the quantity of it in coffee appears to be comparatively very small; for whilst 100lbs. of tea-leaves contain 1lb. of volatile oil, it takes 500 cwts. of roasted coffee to give a similar quantity; and yet it is upon the presence of this oil that the flavour and value of the several varieties of coffee mainly depend.

The tannic acid is, by some chemists, also said to be generated only in the process of roasting; others maintain that it is present in the raw bean.

The chemical properties of the coffee-berry are altered by roasting, and it loses about twenty per cent. of weight, but increases in bulk one-third or one-half. Its peculiar aroma, and some of its other properties, are due to a small quantity of essential oil, only one five-thousandth part of its weight, which would be worth about 100*l.* an ounce in a separate state. Coffee is less rich in theine than tea, but contains more sugar and a good deal of cheese (casein).

Schrader has analysed raw and roasted coffee, with the following result:—

	Raw.	Roasted.
Peculiar coffee principle	17·58	12·50
Gum and mucilage	3·64	10·42
Extractive	0·62	4·80
Resin	0·41	2·08 (Resin and Fatty oil)
Fatty oil	0·52	
Solid residue	66·66	68·75
Loss	10·57	1·45
	100	100

"The examination of coffee" observes Dr. F. Knapp, "has led to interesting results, although they are still defective in pointing out the quantitative composition of the berry."

The following is the composition of the ash according to Live:—

Potash	50·94
Soda	14·76
Lime	4·33
Magnesia	10·90

Oxide of iron	0·66
Phosphoric acid	13·59
Sulphuric acid	trace
Chlorine	1·22
Silicic acid	3·58
	99·98

According to the analysis of Payen, the unroasted coffee-berry has the following composition :

Moisture		12·0
Glucose and dextrine		15·5
Nitrogenous matters		13·0
Chlorogenate of caffeine, &c.		3·5 to 5·8
Fatty substances		10 to 13·0
Cellulose and woody fibre		34·0
Mineral substances in ash		6·7
Essential oil	003	
		100·0

Or to define the percentage more closely, we may put it thus :

Water	12·000
Caffeine, or theine	1·750
Casein	13·000
Aromatic oil	0·002
Sugar	6·500
Gum	9·000
Fat	12·000
Potash, with a peculiar acid	4·000
Woody fibre	35·048
Mineral matter	6·700
	100·000

In another form this shows us :

Water	12·00
Flesh-formers	14·75
Heat-givers	66·25
Mineral matter	7·00
	100·00

As gluten is only very sparingly soluble in boiling water, in the usual way of making coffee the flesh-formers are thrown away with the dregs ; the addition of a little soda to the water partly prevents this waste.

The various components in one pound of coffee will be—

	Oz.	Grs.
Water	1	407
Caffeine, or theine . .		122
Casein, or cheese . . .	2	35
Aromatic oil . . .		1½
Gum	1	192
Sugar	1	17
Fat	1	402
Potash		080
Woody fibre	5	262
Mineral matter . . .	1	31

The part roasted is the albumen, which is of a hard, horny consistence ; and Lindley remarks that it is probable that the seeds of other plants of this or the stellate order, whose albumen is of the same texture, would serve as a substitute. This would not be the case with those with fleshy albumen.

Coffee loses in weight by washing, but gains in bulk in proportion to the heat applied.

Payen found the following amount of nitrogen in 100 parts :—

	Nitrogen.	Ash.
Martinique coffee . .	2.46	5·00
Bourbon	1·54	4·66
Mocha	2·49	7·84

The coffee from Martinique lost 11·58 per cent. of its weight by drying. This description of coffee also afforded the following results :

	Unroasted.	Slightly Reddened.	Chestnut-Brown.	Brown.
Loss in washing......	—	15 per cent.	20 per cent.	25 per cent.
Increase in bulk...	—	1·3 times	1·53 times.	—
Extract	40 per cent.	37 per cent.	37·1 per ct.	39·25 per ct.
Insoluble residue...	48·5 per ct.	—	—	—

Coffee, as ordinarily prepared for beverage, contains only two-sevenths of the nitrogenous or nutritive matter of the fresh bean, but two-thirds of the washed, and the mineral ingredients are all present.

M. Lebreton ("Agriculteur praticien") has estimated the loss of weight of coffee in roasting at 18 to 20 per cent., in Porto Rico, Rio, and Martinique coffee ; and at 16 to 18 per cent., in Malabar, Bourbon, Ceylon, and Guadaloupe coffees ; while in Mocha coffee it amounts to only 14 or 16. The loss of weight depends upon the time of roasting and the degree of heat. Damp or damaged coffee loses more than dry sound coffee. He considers that these substances have the capability of rendering the individual insensible of a certain deficiency of food, in virtue of their retardation of the assimilative process. He thinks it probable, likewise, that these substances have a direct nutritive value, especially coffee as drank by the Turks and Arabs with the grounds.

Professor Lehmann considers that the singular preference of one or other of these beverages by particular nations, as well as the Eastern custom of drinking coffee with the grounds, are not accidental, but have some deeper reason. This reason, he thinks, is to be found in the different effects of the coffee, tea, &c., and the various requirements of the nations by whom they are used, and instances the use of tea by the English, and of coffee by the Germans and French, as in accordance with this view. The diet of the former affords a larger supply of plastic material than that of the latter people ; and while, consequently, the retardation of the assimilative process is an important influence for the German, the proportionately greater nervous stimulus caused by tea is more desirable for the former. The use of coffee with its grounds has its analogue in the use of tea mixed with meal, milk, and butter among the Mongols, and other inhabitants of the Central Asiatic steppes.

M. Payen, from elaborate experiments, shows that coffee slightly roasted is that which contains the *maximum* of aroma, weight, and nutrition. He declares coffee to be very nourishing, as it contains a large quantity of nitrogen, three times as much nutriment as tea, and more than twice the nourishment of soup. Chicory contains half the nutriment of coffee.

NEW MATERIALS FOR PAPER-MAKING.

At the general meeting of the Paper-Makers' Association of Great Britain and Ireland, held at the Bridge House Hotel, London Bridge, on the 14th June, John Evans, F.R.S., in the chair, one of the speakers, Mr. Scott, of Sunnydale, thus spoke :

"It seems to me that if the paper trade is to expand as other trades do, and to become a great trade, we must either have full access to rags or we must find a new material : now there is a new material ; but it really appears to some not a very practical suggestion to talk about it, because of the time and money expended in finding out the proper materials. In experiments a great deal of time is lost one way or another before we can find a substitute ; but I beg to remind you to look at the progress which the Esparto fibre has made within the last two years. I know the Esparto fibre was tried about ten or fifteen years ago, and was found perfectly unfit for making paper that was marketable. I do not say that is the only fibre, for I cannot conceive that in all the resources of Nature there is not some fibre such as Esparto, and far more suitable if we could only get it. I should like to see the trade addressing themselves to some such expedient of getting out of the difficulty, because I am perfectly certain that Government will never do it for us ; and my suggestion is that a fund be set up for making inquiries, instead of spending our money in parliamentary expenses on one thing or another, to send a practical man abroad, to India or some other tropical climate, where fibre is in abundance, to find some new material."

The Chairman, John Evans, Esq., F.R.S., thus replied to these remarks :

"As to Esparto, to which Mr. Scott has alluded, the importations have increased from a very small quantity to something like 20,000 tons per annum, and even more than that ; and there is no doubt that to some extent the importation of Esparto has made up for the loss of materials which we have sustained in consequence of the failure of the cotton trade (hear, hear) ; but it must be borne in mind by this meeting, and by the trade generally, that any question as to new materials is, as it were, beside the question of free trade in rags. (Hear, hear.) You will bear in mind that it is only when rags are at a certain price that you can use those new materials at all, and if by the introduction of this new material to any great extent there is a fall in the price of rags in this country, a corresponding fall will take place in those countries where the export duties are levied. The result will then be that the foreign makers, instead of having an advantage, it may be of a percentage of twenty per cent. in the shape of export duties on their raw material, may have it to the amount of thirty per cent. For instance, if you have an export duty as now of 5*l.* upon rags costing 20*l.*, you have the present percentage; but if rags go down to 15*l.*, it comes to thirty-three per cent. upon the value of the rags ; therefore the introduction of this new material, though extremely desirable in every possible point of view, does not bear immediately upon the question of the grievance under which we are suffering. It is not a question as to the quantity of materials we can command, but a question of the relative prices at which we can procure them, compared with our foreign competitors.

"While Mr. Wrigley also opposed new materials, it ought to be remembered as a fact, and one which we should never lose sight of, that this new material in question has been the great *bugbear*—the thing which we have been taunted with constantly. We have been told to go and get new material. Now, in the first place it ought to be quite sufficient to consider that the trader has to buy the material offered. I admit the necessity and desirability of a new material to the fullest extent, in order to increase the base from which we have to work ; but then people talk about a new material, and always talk as though we were to have the exclusive advantage of that material. They speak of it as though we could go and get a lot of something or other and confine it to our own use; as though we could have the exclusive patent or power of getting it; as though the only possible operation of the intention which we have in getting new material should have the effect of reducing the price of rags. But nobody dreams or ever supposed that any new material that can be brought will exclude rags from use, or form a substitute for them. It may be very well to supplement them, but rags for all time to come will ever remain the sheet-anchor of the paper maker, simply because rags are refuse, costing nobody anything to produce, and without reference to the purpose to which they are applied, and are altogether irrespective of the law of supply and demand; therefore the only effect of introducing new material, whatever it be, is to operate upon the price of rags; but the unfortunate part of it is this, that in the introduction of a new material we do as much good to the foreigner as we do to ourselves, and still we shall always remain in the same relative position as we do now. If we bring in a material and reduce rags 2*l.* per ton, it ought always to be borne in mind that it is not the actual price of rags or the materials of which we complain, but the relative price as between ourselves and those we have to compete with abroad. (Loud cheers.) This is simply the plain mode of reasoning upon the question which I thought it necessary to put forth to supplement the statement made with regard to new material."

USES OF THE HORSE-CHESTNUT.

Of all the waste substances which might be profitably employed in domestic economy, there is none which has given rise to more discussion or on which so many attempts have been made as the fruit of the horse-chestnut, which contains a large quantity of starch. At various periods the utilization of this product has attracted public attention, and many speculators have essayed to make it an object of commerce.

When first introduced from Constantinople, the fruit of the horse-chestnut was considered edible; and Parkinson, writing in 1629, included it among his fruit-trees, and described the nut as of "a sweet taste and agreeable to eat when roasted." Very little use has ever been made of the nuts in this country; though in Turkey they are mixed with horse food, and are considered good for horses which are broken-winded. When ground into flour, they are used in some places to whiten linen cloth, and are said to add to the strength of bookbinders' paste. They contain, moreover, so large a quantity of potash, as to be a useful substitute for soap, and on the latter account they were formerly extensively employed in the process of bleaching. The nuts contain a great deal of starch.

In March, 1776, Lord Wm. Murray obtained a patent for extracting starch from horse-chestnuts, which was merely by peeling them, grating the nuts, washing the pulp several times, and baking it or drying it.

Various attempts have been made to utilize them by producing sugar and spirit from them; and on removal of the bitter principle, excellent edible fecula and maccaroni have been made from horse-chestnuts in France.

"Fecule de marrons d'Inde" is now made by H. de Callias, sold at twenty-two francs the kilo, 18 Rue de Bellevue, Passy, near Paris. The process adopted by this maker permits the purifying of the fecula without having recourse to the peeling which was formerly considered indispensable, and hence the extraction of the starch is as easy and cheap as that from the potato. The following is given as the cost:—

	Francs.
Collection of 20,000 kilogrammes of horse-chestnuts in the park of St. Cloud . .	400
Conveyance to the factory of the Abbey de Val (Seine et Oise), belonging to Mr. Becappe	280
Manufacture and total other charges . .	200
	880

Horse-chestnuts are much used on the Continent, especially in the Rhine districts, for fattening cattle and for feeding milch cows. Hermstadt gives the following analysis of a sample dried in the air, and with 21·8 per cent. of the shell removed:—

Starch	35·42
Flour fibre	19·78
Albumen	17·19
Bitter extract	11·45
Oil	1·21
Gum	13·54
Total	98·57

Pabet estimates that 100 lb. of dried horse-chestnuts are equal in nutritive value to 150 lb. of average hay. Another authority, Petri, makes them equal, weight for weight, to oatmeal.

The starch obtained from the horse-chestnut is white, and when thoroughly washed, perfectly free from any bitterness. They yield 29 to 30 per cent., and sometimes nearly 35 per cent., and contain besides a glutinous matter which, according to Liebig, possesses eminently nutritive properties, but, which experience proves, very inferior to the gluten of cereals. Adopting the analysis of M. Chevallier and M. Lefrage, 17 per cent. may be taken as the mean yield of starch with operations conducted on a large scale. And therefore in its starch produce the horse-chestnut may be taken to be equivalent to the potato, which root contains about 25 per cent. in the solid state, but after deducting the pulp rarely yields more than 18 per cent. of starch.

M. Mercandier, in the 'Journal Economique' for December, 1757, stated that horse-chestnuts furnish a soapy water, proper for bleaching linen. The same observer remarks that the pulp or residue of the starch furnishes an excellent food for the poultry of the farm-yard, and which can be employed as a fuel.

In 1780 M. Bon, President of the Royal Society of Montpellier, published a process founded on the use of alkaline leys "for softening horse-chestnuts and rendering them fit for fattening cattle in countries where acorns and pulse are not used for that purpose." About the same period an abbot of Anchin, in French Flanders, discovered a means of extracting from horse-chestnuts a good oil for burning, and obtained from their flour a weaver's starch, which was used subsequently by the weavers of Geneva.

In 1783 the 'Bibliothèque Physico-Economique' (p. 412) mentioned a means of thoroughly depriving the fruit of the horse-chestnut, by grafting and transplanting, of their natural bitterness, and thus obtaining from this tree chestnuts as sweet and palatable as those of Lyons.

At the same time the 'Decade Philosophique,' t. viii., p. 454, made known a process for removing, by simple washing in water, the bitterness and acidity of the flour of the horse-chestnut.

We find also in the 'Dictionary of Agriculture of Abbe Rogier,' t. vi. p. 442 (1785), that a M. du Francheville obtained from the horse-chestnut the farinaceous and nutritive part which the fruit contains, by applying the process used by the South Americans for making manioc or cassava.

"In August, 1794," observes M. Chevallier, "the Lyceum of Arts informed the National Convention that among the means of supplying the place of flour for the manufacture of paste, the Lyceum had found in the horse-chestnut materials admirably fitted for making the best pasteboard."

In another memoir the same Institution demonstrated that in burning the horse-chestnut potash could be obtained, and that 12½ ounces of ashes yielded 9 ounces of fixed alkali (potash) of the first quality.

In a publication issued in Silesia, 'Biblioth. Physico-Econom.,' 1806, p. 150, it was shown that it is possible to obtain from the fruit of the horse-chestnut oil, flour or meal for paste, and a black colour resulting from the carbonisation of the husk or envelope. These numerous citations are sufficient to prove that the idea of utilizing these fruits is by no means new.

It is stated by those well-informed, that a horse-chestnut tree of twenty years old will yield an hectolitre of fruit, and an adult tree three hectolitres. But this estimate is necessarily subject to variations according to local and climative circumstances. In France there are a large number of these trees, and in Belgium and other European countries it is quite possible to extend them where land is not valuable, or more profitably occupied.

In 1778, Parmentier, in the investigation which he set on foot at the request of the States of Languedoc, on the alimentary resources of France, placed the horse-chestnut at the head of the list of vegetable products capable of being utilized for the support of man.

Somewhat later, in 1795, Baumé directed also prominent attention to this fruit; and in the complete treatise which he published on the horse-chestnut, and its use as food, he proposed, for depriving it of its bitterness, first to peel them, and subsequently to treat the pulp by repeated washings in alcohol. But this could scarcely be employed profitably on a large scale and at the same time. Parmentier ('Cours d'Agriculture,' t. viii., p. 202) pointed out that water could be employed with equal advantage in the place of spirits.

The experience of M. Calmus, in a memoir presented to the Société d'Encouragement of Paris, also fully demonstrated that it was quite superfluous to seek to deprive the chestnuts of their bitterness by means of agents more or less costly than simple washing in water. M. Calmus, in the memoir alluded to, proposed to utilize the water in which the fruit had been washed for lixiviating and bleaching linen, the husk or perisperm for tanning, and the marc or residue for fattening poultry and domestic animals.

Notwithstanding these well-known facts, M. Flandin pointed out in 1849 ('Comptes-rendus,' tom. xxvii., p. 349) a method of removing the bitterness from horse-chestnut starch, by mixing with 100 kilogrammes of pulp one or two kilogrammes of carbonate of soda; then washing in several waters, and afterwards straining. The product thus obtained was mixed with other farinaceous substances, and constituted, according to M. Flandin, another food resource. It is probable that the employment of the soda was recommended by Hischermist, because in summer the washing water of the fecula acidifies very quickly, and leads to the formation of a certain quantity of dextrine, which involves a notable loss of starch.

But although the removal of this bitter principle is indispensable when the starch is intended for alimentation, it is quite unnecessary if the starch is to be used for industrial or manufacturing purposes. Parmentier, in proposing to employ horse-chestnut starch to supply the place of paste made with food grains, very justly remarks that it has the advantage of not being attacked by insects on account of its bitterness. And bookbinders and makers of pasteboard frequently mix in their paste some aloes, with the object of keeping off insects and mould. It has been suggested by Parmentier and others that the fruit might also be utilized for its potash. The chestnuts are dried and burnt, and the salt obtained by lixiviating the ashes. Or, if preferred, the ashes may be employed direct in bleaching linen. Mercandier, in his 'Treatise on Hemp,' states that in Switzerland, and in some parts of France, they employ the water in which horse-chesnuts have been boiled for bleaching hemp, flax, and other fabrics, and it also supplies the place of soap.

For a great number of years M. Klose, of Berlin, has operated on a large scale on the horse-chestnut, and obtained the following products :

1. From the burnt pericarp an alkaline ley.

2. From the skin or husk of the peach the episperm, a very fine charcoal, which forms the base of different printing inks.

3. From the amylacious pulp is extracted the fecula, which can be transformed into dextrine, glucose, alcohol, or vinegar, and which are all adapted to industrial use.

4. The fatty matter extracted serves to make a kind of soap, and to render certain mineral colours more fixed and solid.

5. A yellow colouring matter which serves for different purposes.

In 1833, M. Vergnaud, of Romagnesi, contributed a very interesting paper on the horse-chestnuts and its products to the 28th volume of the 'Recueil Industriel' of Paris.

Twenty-seven essays on the horse-chestnut were sent into the Belgian Commission in 1856, in competition for the premium for the best substitute for edible substances for starch for industrial purposes, but they contained very little new matter, and were for the most part a repetition of previous information and experiments.

The use of the horse-chestnut was commenced on a large scale in France in 1855 by M. de Callias, and is still continued. He operated, as we have seen, on more than twenty million kilogrammes annually.

WHAT PRECIOUS STONES ARE MADE OF.

Factitious and Real Diamonds.—The popular taste runs in grooves or channels sometimes, and fixes itself upon objects as diverse in character and nature as it is possible for any two things to be. In one period, not very long ago, Europeans ran mad upon tulips ; at another, respectable old housekeepers prided themselves upon rare china ; mahogany has had its day, and still later postage stamps, coins, and meerschaum pipes, have in turn occupied public curiosity for a brief hour. Just now all these favourites are deposed, and the diamond has obtained such a hold upon the purses and thoughts of a large portion of the public that lesser objects have no chance. It is not strange that such should be the case, for a real colourless diamond of large size is such a magnificent object that the eye never tires of gazing upon it.

"All is not gold that glitters," neither is every white and sparkling stone a diamond, as too many have found to their cost. Yet these precious stones are now apparently as common as garnets or cornelians. They may be seen sparkling upon the unwashed fingers of some sturdy Bridget, or blazing upon the breast of Patrick, attired for a holiday stroll. The shop boys and girls have them, and it seems almost as if some benevolent society had been formed for the purpose of "supplying every man with his own diamond."

Let not the reader with exclusive tastes, who is, perhaps, the possessor of a genuine stone, mourn over this parade. In the days when his jewel shall gleam untarnished and with renewed splendour, Patrick's shall fade away into a dull gleam. The spirit of his "stone" shall depart, and humbled, robbed of its glitter, the light plucked out, and the flame with which it once glowed quenched for ever ; it shall be cast aside as useless, and be without its place among men.

"Gew-gaws" correctly express the value which attaches to these paste imitations of the precious diamond—a stone which is the first among jewels, which has never been deposed, and it is safe to say never will be, whose fire rages within, and increases until the eye is dazzled almost beyond endurance ; whose gleam is hard, cold, and unsubdued. It fairly revels in its vicious glitter and seems to send out rays that pierce like the arrows shot from Diana's bow. Old as it is, its value is always great, and at the present time beyond the reach of persons of ordinary means. It is in some countries a standard of value, like gold, and it is said that persons in the United States are now purchasing them as investments which cannot depreciate or lose, except in the interest.

The paste imitations of the diamond are known by different titles ; sometimes as the "California diamond," "Australian pebble diamond," &c. ; but the basis of all of them is quartz or rock-crystal, pulverized and fused in combination with the oxides of certain metals. The paste is technically known as *strass*, after the discoverer, Strass, of Strasburgh, who, by a series of experiments in the seventeenth century, was very successful in making imitations of precious stones. Strass is composed of silex, potash, borax, red lead, and sometimes arsenic, in the following proportions : 300 parts silex (quartz, flint, or pure sand) ; 96 parts of potash ; 27 parts of borax (prepared from the boracic acid) ; 514 parts of white lead ; 1 part of arsenic. This mixture is put into a covered Hessian crucible and kept at a great heat in a pottery furnace for twenty-four hours. The longer the mass is kept, the clearer it will be when turned out.

Strass of this kind is used for imitating the diamond, rock crystal, and white topaz. There are many signs, however, by which this strass, or Californian diamond, can be detected by the experienced eye. These signs are its inferior specific gravity, its want of hardness, and the absence of coldness to the tongue-test, or when it is applied to that organ. Good strass is so hard that fire flies when it is rubbed on a file, but it is readily attacked by fine quartz-sand on a grinding plate. The small air-bubbles in the strass may be readily detected with a good magnifying glass, and the breath remains much longer upon it on account of its bad conducting power, than upon real gems.

The electrical power of jewels is also another test, for it is stated that genuine stones retain their electricity from six to thirty hours, whereas the false stones retain it scarcely as many minutes. The appearance of some "California diamonds" will deceive many persons, for they have a lustre and evanescent fire which is extremely beautiful. This is soon lost, however, by wearing; perspiration, moisture, and dirt, washing the hands, &c., soon destroy the appearance of this paste, and in a few days it becomes as dull and lack-lustreless as the eyes of a dead fish.*

The diamond is the ultimate effort, the idealization, the spiritual evolution of coal—the butterfly escaped from its antenatal tomb, the realization of the coal's highest being. Then the ruby, the flaming red oriental ruby, side by side with the sapphire and the oriental topaz—both rubies of different colours—what are they? Crystals of our argillaceous earth, the earth which makes our potter's clay, our pipe clay, and common roofing slate—mere bits of alumina. Yet these are among our best gems, the idealizations of common potter's clay. In every 100 grains of beautiful blue sapphire, 92 are pure alumina, with one grain of iron to make that glorious blue light within. The ruby is coloured with chromic acid. The amethyst is only silica, or flint. In 100 grains of amethyst 98 are simple pure flint—the same substance as that which made the old flint in the tinder-box, used before our phosphorus and sulphur-headed matches, and which, ground up and prepared, makes now the vehicle of artist's colours. Of this same silica are also cornelian, cat's-eye, rock crystal, Egyptian jasper, and opal. In 100 grains of opal 90 are pure silica, and 10 water. It is the water, then, which gives the gem that peculiar changeable and iridescent colouring which is so beautiful, and which renders the opal the moonlight queen of the kingly diamond. The garnet, the Brazilian—not the oriental—topaz, the occidental emerald, which is of the same species as the beryl, all these are compounds of silica and alumina. But the beryl and emerald are not composed exclusively of silica and alumina; they contain another earth called glucina—from *glukos*, sweet, because its salts are sweet to the taste. The hyacinth gem is composed of the earth, not so long discovered, called zirconia—first discovered in that species of hyacinth stone known as zircon. The zircon is found in Scotland. To every 100 parts of hyacinth 70 are pure zirconia. A chrysolite is a portion of pure silicate of magnesia. Without carbonate of copper there would be no malachite in Russia or at the Burra Burra mines; without carbonate of lime there would be no Carrara marble; the turquoise is nothing but a phosphate of alumina coloured blue by

* 'Scientific American.'

copper ; and lapis lazuli is only a bit of earth painted throughout with sulphuret of sodium.

The sapphire is one of the most precious stones, and inferior only to the diamond in hardness, the diamond being the hardest substance in nature.

It is of a very extensive suite of colours, passing from pure white to deep blue, to red, to yellow. Each variety bears a different name ; thus the blue variety is called sapphire, the crimson-red variety is ruby, the yellow oriental topaz. The foregoing colours occur from the palest to the deepest hue. The pure white is called Lux Sapphire. The violet-blue variety is occasioned by the blending of the red and blue colours in the same stone : it is generally called violet ruby. The sapphire is sometimes met with of a green colour and of a bluish grey, and of every modification of these principal colours pure and mixed, transparent and opalescent. In some specimens two colours occur in the same stone, as blue and red, white and blue.

The finest specimens of these stones are procured from Pegu, in Asia. From Ceylon the sapphire is very inferior in colour, being pale or streaked, the ruby being of a port-wine tint, whereas from Pegu the colour is of crimson or blood-red. It is also found in various parts of Europe, but of a very inferior quality. It is generally found in alluvial soil in the vicinity of the secondary or trap formation, also imbedded in gneiss, and in iron sand, with fragments of pirope and zircon.

Its primitive form is a six-sided pyramid, or a short six-sided prism ; the red or ruby occurs generally in blunt-edged, rounded, or rhomboidal grains ; the blue or true sapphire is much oftener of the regular form of the pyramid and prism. Its specific gravity is from 4. to 4·2. It is composed chiefly of crystallized alumina (*i. e.*, pure clay), its component parts being alumina, 92. ; silex, 5·5 ; oxide of iron, lime, &c., 2·5.

The value of these stones depends entirely upon the depth of colour and size. The ruby is very highly prized when of a fine colour, but it is never found of a large size. The sapphire is often found very large, but fine colour is very rare. There is also another description of sapphire and ruby having an opalescence at one end ; these stones, when cut elliptical in form, keeping the opalescence over the apex, produce the appearance of a star with six rays : these are called asteria or star stones, and are highly prized. Many of this description have been found in Australia, as well as several specimens of transparent sapphires of good quality ; it is therefore probable that specimens of all the varieties of colour abound in the colony, and might be discovered by any competent person acquainted with this gem, and prove to be highly remunerative.

If any doubt existed on the subject of Australia being a diamond-producing country, it is now removed. A successful digger named Williams, from the Yackandandah district, submitted to Mr. Crisp, jeweller, Queen Street, a collection of small stones which he had picked up while washing out gold. Amongst which was a diamond, the largest yet found in the colony, so far as is known, and the purest of water. Its natural facets are perfect; its colour is a pale green, but approaching much more nearly to the pure water of the East Indian diamond than the stone, was the subject of a conversation not long ago in the Legislative Assembly. The diamond weighs 2⅝ 1·32 carats, or nearly three carats. It was found at Wooragdy, near the Magpie, Yackandandah, in auriferous earth taken, about four feet deep, from a hill-side.*

Let us now turn, in conclusion, to the great diamond-producing country, Brazil. To give an accurate account of the value of this precious stone, exported thence to Europe, is a work of impossibility. Being essentially a secret trade, when once they reach Bahia, means are at hand not only to evade the export duty of one per cent., but also to ship them clandestinely.

The traffic with the diamond mines is, however, becoming daily of more importance, and is the one upon which now mainly depends the important import trade of the city of Bahia. From trustworthy information from the inland Drabre, Mr. Morgan, British Consul there, estimated the value of diamonds exported from Bahia in 1858 at 750,000*l.*, and the foreign merchandise sent up to the diamond mines at 800,000*l.* sterling. This traffic is but an imperfect idea of what it may yet become, were it possible to instil into the minds of the governing powers the necessity of opening proper roads with facilities for transit and transport of both men and merchandise, in order to reach the inexhaustible riches of that rich mineral region and its surrounding municipalities, bordering on that magnificent internal tributary the River St. Francisco.

The diamond district is known by the name of Serro do Frio; it extends sixteen leagues from north to south, and eight from east to west. It is surrounded by craggy mountains, as if Nature had been at some pains to conceal her treasures from man.

Every possible precaution is taken to prevent the inhabitants from carrying the diamonds, which are found in the auriferous sands beyond this natural wall; all the outlets are strictly guarded, and any person detected breaking the law is most severely punished. Offenders were formerly sent to the coast of Angola, which punishment was looked upon by many as severe as death itself.

It must not be supposed that diamonds are procured without great labour. They are sometimes found on the surface of the earth; but it is not unfrequently necessary to turn the course of rivers to obtain even a small quantity. Until the present period the river Jiquitihonha has furnished most of this kind of wealth. Large masses of that species of flint known in the country by the name of "Cascalhao" are found in

* For further information on the diamonds and other gems of Australia, see an article by Dr. Bleasdale—TECHNOLOGIST, vol. iv., p. 372.

it, which are submitted to a lavatory process in such a way as to prevent every opportunity of fraud.

The diamond is almost always enveloped in a ferruginous crust; therefore long practice is necessary to enable persons to distinguish them from the flints among which they are imbedded.

Nor are they procured without expense. It is calculated that every diamond obtained by the Government costs about eight dollars the carat! Though more than a thousand ounces have crossed the Atlantic since the discovery of the mines, the whole produce of Tejuco has not been put in circulation; because this would be a sure means of reducing the value of a precious stone, which, unlike others, has only an arbitrary price. The same policy has forbidden the opening of the mines of Goius and Matto Grosso, which are guarded by the Government from the incursions of adventurers.

At the time of the discovery of the famous diamond of the Portuguese Crown, South America was so tranquil, that it is looked upon as an important event. It was found in the brook of Abayti by three malefactors who had been banished, and carried to the governor of mines by an ecclesiastic.

Its size was so enormous, that repeated assays were made before they were convinced of its being in reality a diamond. It was then sent to Lisbon, where it excited universal astonishment, and procured the pardon of the criminals. Afterwards an exploring station was fixed on the banks of the Abayti, but without success; the diamonds found were of little value, and scarcely defrayed the expense of search.*

WOODS OF THE PHILIPPINE ISLANDS.

BY PROFESSOR BERNARDIN.

No. II.

Acre (*Mimosa acre*), Legum.—Tree of first rank, the wood of which, dark reddish, is of a solid texture, waved fibre, no sensible smell, breaks in long branches, shavings rude and somewhat twisted. Leaves twice alated, and the folioles eight by twenty centimetres. The branches have no spines. Employed for construction and boat-building. Abounds in all the islands.

Alintatao (*Diospyros piloshantera ?*), Guyacan, or Ebenac.—Several varieties, among them the *tugon* or *ébano*, the *zapote negro*, and the *camagon*. Tree of about 20m., stem of 8m. by 0.6 or 0.8 diameter. Wood reddish with black spots, easily receiving a beautiful polish; texture even and smooth; fibres compressed; pores small and nearly in-

* Dennis, 'Histoire du Brésil.

visible ; leaves alternate ; breaks short ; shaving fine, somewhat twisted and even. The principal employment is for fine furniture. Abounds in Luzon and Visayas.

Alupag Alopai (*Euphoria litchi*), Sapindac.—Tree which arrives to be of second rank ; wood yellowish, strong and fine texture ; fibres somewhat waved ; pores hardly sensible ; splits in large pieces ; shavings fine and twisted. Employed for posts. Abundant.

Ambogues, or Amogius (*Cyrtocarpa quinquestila*), Terebinthac.—Tree of second rank ; stem large ; leaves alated with impair ; wood dark reddish ; fibre long, compact, having pores and crevices of different sizes ; texture solid ; splits from the trunk ; shavings rather fine, smooth, and twisted ; suffers much from the *anay* or comegén (termites Neoropteræ). Nevertheless, this wood is much used for planking. Rather abundant.

Aninabla, or Aninapla (*Mimosa coriaria*), Legum.—Tree of second rank, 10 à 12m. high. Wood reddish, fibre longitudinal ; weak, and texture somewhat rough ; splits from the trunk ; shaving rough and much twisted. When this wood grows old, it becomes black. Employed in construction of houses, and particularly for its light weight and great durability in that of boats.

Anonang (*Cordia sebestenac*), Borragin.—Tree of 10 à 11m. The leaves are filled with caterpillars, and seem at first sight to have the same properties as the mulberry-trees. Wood clear red ; breaks in short and clean splinters. Serves for drums and musical instruments.

Antipola (*Artocarpus incisa*), Urtic.-artocarp.—Tree of first rank, rising to more than 20m. Wood yellow, light, somewhat spongious ; precious for shipbuilding, particularly for canoes. Also used for planking and for machines ; from the back of the trunk issues a kind of milky sap, from which is made glue ; splits in short splinters ; shavings fine, compact, and twisted.

Balibago (*Hibiscus tiliaceus*), Malvac.—Tree of 2m. in height, the leaves of which are one decimètre large ; its bark, which is very strong, is good for making rope and paper ; also employed for tanning leather ; wood used for machinery ; charcoal for making gunpowder.

Baliti (*Ficus indica*), Urtic.—Tree arrives to be of first rank. The wood is of little use ; the extremities of the branches extend in such manner that they touch the earth and take root, thus forming new trees. Gnarled roots are said to cure all kinds of wounds.

Baticulin (*Millingtonia quadripinnata*), Bignoniac.—Tree of 6 à 8m. and 4 decimètres diameter. Wood whitish yellow, very clear, odoriferous, and soft ; fibre amidst cellular tissue, long, and waved ; is worked easily, and serves specially for moulds of castings and for sculpture ; lasts long without damaging ; rather abundant ; splits in short splinters ; shaving rough, porous, and less twisted.

Banaba (*Munchaustia speciosa*), Lythrariac.—Tree of 10 à 12m. in the forests, and smaller out of them, with beautiful red flowers. The wood is much esteemed in every kind of work for its tenacity ; it resists very well to the action of air and of water; dark red, with longitudinal compressed fibres; large wide pores and crevices; splits short; shaving rough; a little twisted and porous.

Bancal (*Nauclea glaberrima*), Rubiac.—Tree of a fine aspect, with oval leaves of 0.06 by 0.12, and flowers in capitulæ; rises to 8 à 10m. and 0.7 diameter. Wood golden yellow and greenish yellow; longitudinal fibre, and texture somewhat like tow; esteemed for its tenacity and durability in construction of planking and carpentry; it is also used by shipbuilders, coopers, and even for making quays. Abundant; shaving somewhat tough, twisted, and strong.

Bitoc (*Myrtica* ?).—Clear, rosy wood; texture solid, compact; pores less visible; splits from the trunk and breaks in the splinter; shaving fine, strong, and less twisted; can be well employed for pieces that have to resist to tension.

Lauan or Sandana (*Dipterocarpus sandana*), Guttif.—Tree 12 to 30m. high, and trunk of 1m. or more diameter. Yields by incision a white, fragrant, hard resin, that is used as incense. Wood ashy colour; weak texture; longitudinal flat fibres; large pores. Abounds in Cavite, Bataan, Nueva Ecija, Bulacan, Mindoro, &c. Splits in long splinters; shaving rather fine and twisted; formerly much employed for sheathing of ships, because the balls do not break it in splinters.

Malacatlun (*Tetracera sarmentosa* ?), Dilleniac.—Shrub with ash-colour wood; texture towy and rough; fibres longitudinal, amidst a white marrow; not regularly employed; splits at the trunk, and shaving rough and disunited.

Malacintud.—Red wood, of solid texture; fibres longitudinal, waved, compressed; pores more or less large; splits short; shaving fine, twisted, and compact; can be used in every kind of construction, particularly when resistance to tension is wanted.

Malavidondas (*Mavindato ? niota*), Terebinthac.—Wood yellowish white; texture fine and longitudinal; less compact; pores imperceptible; splits at the trunk; shaving rough, not much twisted; used for assembling, and for every work that has to resist tension.

Malatalisay (*Terminalia mauritiana*), Halorag-combretac.—Tree with horizontal verticillated branches; excellent for public walks; 15m. high; trunk 3m. and 0m. diameter. Wood weak, white, or yellowish; rough; fibres flattened amidst a pithy centre; great elasticity and flexibility; of good use for assemblings of ships, &c. Splits at the trunk; shaving leathery, rough, and little twisted.

Malarujat, or Maladujat (*Myrtac* ?).—Wood red, dark brownish, or sometimes ashy; solid texture; fibres compressed, waved; pores puncturated and oblong. Abounds in Cavite, La Laguna, and other provinces. Splits in large splinters, and shavings somewhat rough, compact, and waved.

Melle, near Ghent.

Reviews.

COFFEE AND CHICORY: THEIR CULTURE, CHEMICAL COMPOSITION, PREPARATION, AND CONSUMPTION, &c. By P. L. Simmonds. E. and F. N. Spon.

IN this little handbook, by the Editor of the TECHNOLOGIST, is compressed a large amount of practical information on the culture and consumption of coffee and its adjunct, chicory. It contains numerous practical hints, useful both to the producer and consumer. We have republished in the present number the chapter on the "Chemical Analysis of Coffee." The book, we may further observe, is profusely illustrated with well-executed woodcuts.

MEMOIRS OF THE DISTINGUISHED MEN OF SCIENCE OF GREAT BRITAIN LIVING IN THE YEARS 1807-8. Compiled by Wm. Walker, jun. Second Edition. E. and F. N. Spon.

THE following extract from the introduction, by Robert Hunt, F.R.S., &c., conveys the best idea of the contents of this interesting little volume:—

"We have advanced to our present position in the scale of nations by the efforts of a few chosen minds. Every branch of human industry has been benefited by the discoveries of science. The discoverers are therefore deserving of that hero-worship which sooner or later they receive from all.

"The following pages are intended to convey to the general reader a brief but correct account of the illustrious dead, whose names *are* for ever associated with one of the most brilliant eras in British science. It will be remembered that, in the earliest years of the present century, the world witnessed the control and application of steam by Watt, Symington, and Trevithick; the great discoveries in physics and chemistry by Dalton, Cavendish, Wollaston, and Davy,—in astronomy by Herschel, Maskelyne, and Baily; the inventions of the spinning-mule and power-loom by Crompton and Cartwright; the introduction of machinery into the manufacture of paper, by Bryan Donkin and others; the improvements in the printing-press, and invention of stereotype printing, by Charles Earl Stanhope; the discovery of vaccination by Jenner; the introduction of gas into general use by Murdock; and the construction (in a great measure) of the present system of canal communication by Jessop, Chapman, Telford, and Rennie. During the same period of time were likewise living Count Rumford; Robert Brown, the botanist; William Smith, 'The Father of English Geology;' Thomas Young, the natural philosopher; Brunel; Bentham; Maudslay; and Francis Ronalds, who, by securing perfect insulation, was the first to demonstrate the practicability of passing an electric message through a lengthened space; together with many others, the fruits of whose labours we are now reaping.

"The following pages briefly record the births, deaths, and more striking incidents in the lives of those benefactors to mankind.

"'Lives of great men all remind us we may make our lives sublime.'—The truth of this is strongly enforced in the brief memoirs which are included in this volume. They teach us that mental power, used judiciously and applied with industry, is capable of producing vast changes in the crude productions of Nature. Beyond this, they instruct us that men, who fulfil the commands of the Creator and employ their minds, in unwearying efforts to subdue the Earth, are rarely unrewarded. They aid in the march of civilization, and they ameliorate the conditions of humanity. They win a place amongst the great names which we reverence, and each one

> "'becomes like a star
> From the abodes where the Eternals are.'"

Scientific Notes.

Minerals of Ceylon.—Plumbago is the only mineral of importance. In 1860 (an exceptional year in regard to this article), the export rose to 75,660 cwts., from 23,823 cwts. in 1850; but in 1861 it fell to 38,345 cwts., the average of the past seven years being 29,594 cwt.: but the export fluctuates exceedingly. It is generally of a coarse quality, fitted for the lubrication of machinery, and for use in the arts in the shape of crucibles for melting copper and the more precious metals. Some is fine enough to be compressed into parcels, but for this purpose the Ceylon plumbago is greatly inferior to that of the Somerset and Cumberland hills. It is found generally pretty near the surface. In the Western Province a royalty is charged by Government for plumbago digging at 7s. 6d. per ton. In the Southern Province a duty of one-tenth on the value of the article (usually reckoned at 4*l.* per ton) is levied, which is equal to 8*l.* per ton. These two provinces are the only two in the island which contribute any revenue on account of plumbago. The amount received in 1861 was 383*l.* Although occasionally a blue sapphire or a ruby of some value turns up in the zygnamies or localities worked, plumbago is the only mineral of any commercial importance. There are about forty-two localities where iron-stone is dug for native use. Most of the lime used is procured from coral and shells. The gneiss of Ceylon is seldom used for building purposes, cabook (latirite) being so mush easier worked. Sandstone is found on the sea-shore not far from Colombo. In the Northern Province coral lime-stone is the universal building material, and the roads are made with a species of lime-stone gravel. In other parts of the island the roads are metalled with a species of broken gneiss. Cabook is very common near Colombo, and is found valuable for building purposes. It is easily cut into blocks, and when well protected from the weather by lime or cement will last a long time. In house-building it is generally used for walls, with brick pillars between for the support of heavy roofs, &c. Cabook is paid for at the rate of 4s. a thousand when cut on crown lands, but little revenue is received from this source, as it is principally obtained on private property.

STARCH SUGAR has been converted into a sweet, hard, granular condition, in which it resembles ordinary sugars, by Mr. F. Anthon. He first treats the starch with sulphuric acid in the usual manner. The neutralized solution is then evaporated in a wooden vessel, allowed to rest and to solidify gradually. The mass of raw sugar is then removed and strongly pressed in a cloth, the syrup which is pressed out being reserved and boiled down in a fresh operation. After pressing, the sugar is melted and further concentrated in a water bath until the liquor reaches 43° or 35° Baumé. When this point is arrived at, the melted sugar is allowed to cool, with an occasional stirring. If it is desired to obtain the sugar in small granules, the stirring is continued. When this mass has cooled to 25° or 30° Reaum., it is removed and dried in a gently heated drying-room.

THE MEZQUIT-TREE (*Algaroba glandulosa*) belongs to the family of the Acacias. The leaves are delicate, the wood of a hardness that, did the tree attain a large size, would render it admirably adapted for turnery. The long narrow seed-pods are a favourite kind of food with horses and mules, and the beans are ground by the natives and made into cakes, either alone or with maize or wheaten flour. The name *Algaroba* is used by Decandolle for one division of the species *Prosopis*, but by George Bentham for a species belonging to the tribe *Parkiæ* of the natural order. The *Algaroba glandulosa* was first mentioned by Toney, and drawn and described in the 'Annals of the Lyceum of New York,' vol. ii., p. 192.

BLACK SALT.—The black salt of Madagascar is extracted from the ashes of the reed mace (*Typha communis*), called "Vundra," and which they have a habit of licking frequently.

RUSOT.—The yellow aqueous extract of the *Berberis lycium* of India is used as a substitute for bark.

PERIODICALS RECEIVED.

Paper Trade Review—The Paper-Makers' Monthly Journal—Journal des Fabricants de Papier—Le Technologiste (Paris)—Memoir upon the Improvement of the Sheep and Goats of Italy, by Saxe Bannister.

THE TECHNOLOGIST.

ON THE MECHANICAL NATURE AND USES OF GUN-COTTON.

BY JOHN SCOTT RUSSELL, C.E., F.R.S.

Gun-cotton is a new power coming under the same category as steam and gunpowder. It is highly dangerous to those who do not possess the necessary knowledge and skill; but, like them, it enormously extends human power, and like them, the skill to use it can be rightly and certainly acquired.

I. Is gun-cotton stronger than gunpowder? The answer to this is, Yes, sixfold stronger.

By this we mean that a given weight of gun-cotton, say four ounces, if we bore $1\frac{1}{2}$ inch in diameter and 3 feet deep, into hard rock or slate, in a quarry, and put four ounces of gun-cotton into it, it will occupy about 1 foot of its length, and the aperture being closed in the usual manner, and a match-line led from the charge to the proper distance from which to fire it; and if we next take 24 ounces of best gunpowder, bore a similar hole, and charge it similarly with gunpowder, and close it in the same way; it has been found that, on these being exploded, the 4 ounces of gun-cotton have produced greater effect in separating the rock into pieces than the 24 ounces of gunpowder. The answer is, therefore, that in disruptive explosion the strength of gun-cotton is sixfold that of good gunpowder.

But the disrupting or bursting power of gunpowder is not always the quality for which we value it most, nor the service we require of it. In mining rocks, in exploding shells, in blowing up fortresses, this property is what we value, and this work is what we require. But we do not want to burst our fowling-pieces, our rifles, our cannon. On the contrary, we want to use a force that shall project the projectile out of the gun without bursting the gun, without straining the gun beyond moderate given limit, which it shall be able to endure. We want, therefore, a service from gun-cotton which shall be the contrary of destructive to, or disruptive of, the chamber in which it does the work of giving motion to the projectile.

This moderated and modified work gun-cotton can also perform; and it is the modern discovery of General Lenk which has enabled us to moderate and modify gun-cotton to this gentler service. He discovered how to organise, arrange, and dispose mechanically of gun-cotton in such a way that it should be three times stronger than gunpowder. Accordingly, one of his charges of gun-cotton, weighing 16 ounces, projected a 12-pound solid round shot with a speed of 1,426 feet a second, while a charge of gunpowder of 49 ounces gave the same shot a speed of 1,400 feet a second. One-third of the weight of gun-cotton exceeded, therefore, the threefold weight of gunpowder in useful effect.

II. Is gun-cotton more convenient than gunpowder? This is a larger and more various question than the former, and divides itself into various subdivisions.

It is well known to sportsmen, to soldiers, to artillerymen, that gunpowder fouls a gun. A foul residue of soot, sulphur, and potash soils the inside of the gun after every charge. The gun must, somehow, be cleaned after a discharge; if not it fires worse, recoils more, and ceases to do its best. If the gun be a breech-loading gun, its mechanism is dirtied, and works less easily. Gun-cotton deposits no residue, leaves the gun clean and clear, and the utmost it does is to leave a gentle dew of clear water on the inside of the bore, this water being the condensed steam which forms one of the products of its decomposition. Gun-cotton is, therefore, superior to gunpowder in not fouling the gun, a result favourable both to quicker and more accurate firing.

It is further a matter of no slight convenience that gun-cotton makes no smoke. In mines the smoke of gunpowder makes the air unbreathable, and for some time after explosion the miners cannot return to their work. In boring the great tunnel of Mont Cenis through the Alps, the delay from smoke of powder alone will postpone the opening of the line for many months. After a properly-conducted explosion of gun-cotton, the workmen may proceed in their work at once without inconvenience.

In casemates of fortresses, gunpowder fills the casemates with foul smoke, and the men speedily sink under the exertion of quick firing. By using gun-cotton it was ascertained that the men could continue their work unharmed for double the quantity of firing. This is partly attributed to the greater heat, and partly to the foulness of the air produced by gunpowder.

But it is under the decks of our men-of-war that the greatest benefit is likely to arise from gun-cotton. Not only does the smoke of a broadside fill the between decks with hot and foul air, but the smoke of the windward guns blinds the sight, and hinders the aim of the leeward.

When there is no smoke, as with gun-cotton, the aim of every gun may be precise and deliberate. The diminished heat between decks will also tell powerfully in favour of gun-cotton. In our armour-plated ships also there is more value in breech-loading guns than in any other use of artillery. It is one of the necessities of breech-loading mechanism that it be kept clean, and nothing tends more to derange its perfect action than the great heat which gunpowder imparts to the gun from which it is fired.

That gun-cotton has the convenience of not heating the gun has been thus proved. One hundred rounds were fired in thirty-four minutes with gun-cotton, and the temperature of the gun was raised 90 degrees. One hundred rounds were fired with gunpowder, and triple the time allowed to cool the gun, which, nevertheless, was heated so much as to evaporate water with a hissing sound, which indicated that its temperature was much above 212 degrees. Under these circumstances the firing with gunpowder had to be stopped, while that with gun-cotton was comfortably continued to 180 rounds.

It is also a matter of practical convenience that gun-cotton, insomuch as it is lighter, can be carried more easily and farther than gunpowder; and it may be wetted without danger, so that when dried in the open air, it is as good for use as before.

III. We have now to ask—Is it cheaper? The answer to this question must be qualified—pound for pound, it is dearer; we must, therefore, judge of its cheapness by its effect, not by weight merely. But where it does six times as much work, it can then be used at six times the price per pound, and still be as cheap as gunpowder. As far as we yet know, the prices of gun-cotton and gunpowder are nearly equal, and it is only therefore where the one has advantages and conveniences beyond the other, and is more especially suited for some specific purpose, that it will have the preference. Effective cheapness will, therefore, depend mainly on which of the two does best the particular kind of duty required of it.

To illustrate how curiously these two powers, gun-cotton and gunpowder, differ in their nature, and how the action of gun-cotton may be changed by mechanical arrangements, we may take one kind of work that is required of both:—If a general want to blow open the gates of a city, he orders an enterprising party to steal up to the gate with a bag containing 100 lbs. of gunpowder, which he nails to the gate, and by a proper match-line he fires the gunpowder and bursts open the gate. If he nailed a bag of gun-cotton of equal weight in the same place and fired it, the gun-cotton would fail, and the gate would be uninjured, although the 100 lbs. of gun-cotton is sixfold more powerful than the gunpowder. Here, then, gunpowder has the advantage—both weight and effect considered.

But the fault here lies not in the gun-cotton, but the way of using it. If, instead of 100 lbs. of gun-cotton in a bag, 25 lbs. had been taken in a proper box made for the purpose, and simply laid down near the gate, and not even nailed to it, this 25 lbs. would shiver the gate into splinters. The bag which suits the powder happens not to suit the gun-cotton.

Gun-cotton is, therefore, a power of a totally different nature from gunpowder, and requires complete study to know its nature and understand its use. It appears that both gunpowder and gun-cotton have special qualities, and may be peculiarly suited for peculiar uses. It is the duty of a wise people to make use of both to the ends they each suit best, without prejudice arising from the accident of novelty or antiquity.

The nature of gun-cotton requires a double study, chemical and mechanical. It is not like steam, the same substance, whether in the form of ice, or water, or steam. It is one substance when as gun-cotton it enters the gun, and quite a different one when it explodes and leaves the gun. Not only are the solids which enter converted into gas, but they form totally new combinations and substances. So that the marvellous changes which the chemist effects by the magic of his art take place in an instant of time, and during that almost inconceivably minute period of time, in a laboratory intensely heated, old substances are dissolved, their material atoms are redistributed, each atom released selects by affinity a new partner, these new unions are cemented, and at the end of this prolific instant totally new combinations of matter, forming what we call new substances, issue from the gun. It so happens that of these new substances, formed out of gun-cotton, all are pure transparent gases, while in the case of gunpowder there remain 68 per cent. of solid residue, and only 32 per cent. are pure gases.

The mechanical application of gun-cotton may be considered to be due exclusively to Major-General Lenk, of the Austrian service. Pure gun-cotton becomes either a powerful explosive agent, or a docile performer of mechanical duty, not according to any change in its composition, or variations in its elements or their proportions, but according to the mechanical structure which is given to it, or the mechanical arrangements of which it is made a part. It was General Lenk who discovered that structure was quality, and mechanical arrangement the measure of power, in gun-cotton ; and in his hands, a given quantity of the same cotton becomes a mild, harmless, ineffectual firework, a terrible, irresistible, explosive agent, or a pliable, powerful, obedient workman.

The first form which General Lenk bestowed on gun-cotton was that of a continuous yarn or spun thread. Gunpowder is carefully made into round grains of a specific size. Gun-cotton is simply a long thread of cotton fibre, systematically spun into a yarn of given weight per yard, of given tension, of given specific weight. A hank of a given weight is reeled, just like a hank of cotton yarn to be made into cloth, and in this state gun-cotton yarn is bought and sold like any other article of commerce.

This cotton yarn converted into gun-cotton may be called, therefore, the raw material of commerce. In this form it is not at all explosive in the common sense of the word. You may set fire to a hank of it, and it will burn rapidly with a large flame ; but if you yourself keep out of reach of the flame, and keep other combustibles beyond reach, no harm will happen, and no explosion or concussion will result. If you lay a long thread of it round your garden walk at night, disposing it in a waving line with large balls of gun-cotton thread at intervals, and light one end of the thread, it will form a beautiful firework, the slow lambent flame creeping along with a will-o'-th'-wisp-looking light, only with a measured speed of six inches per second, or 30 feet a minute ; the wind hastening it or retarding it as it blows with or against the line of the thread. This is the best way to commence an acquaintance with this interesting agent.

Care must be taken not to become too familiar with gun-cotton even in this harmless and playful guise ; cotton dresses will readily catch fire from it, and it should not be treated with less care to keep fire from it than gunpowder. In one respect it is less liable to cause danger than gunpowder. Grains of powder are easily dropped through a crevice, and may be sprinkled about in a scarcely noticeable form, but a hank of gun-cotton is a unit, which hangs together and cannot strew itself about by accident.

The *second* form of gun-cotton is an arrangement compounded out of the elementary yarn. It resembles the plaited cover of a riding whip : it is plaited round a core or centre which is hollow. In this form it is match-line, and, although formed merely of the yarn plaited into a round hollow cord, this mechanical arrangement has at once conferred on it the quality of speed. Instead of travelling as before only 6 inches a second, it now travels 6 feet a second.

The *third* step in mechanical arrangement is to enclose this cord in a close outer skin or coating, made generally of india-rubber cloth, and in this shape it forms a kind of match-line, that will carry fire at a speed of from 20 to 30 feet per second.

It is not easy to gather from these changes what is the cause which so completely changes the nature of the raw cotton by mechanical arrangement alone. Why a straight cotton thread should burn with a slow creeping motion when laid out straight, and with a rapid one when wound round in a cord, and again much faster when closed in from the air, is far from obvious at first sight ; but the facts being so, deserve mature consideration.

The cartridge of a common rifle in gun-cotton is nothing more than a piece of match-line in the second form enclosed in a stout paper-tube, to prevent it being rammed down like powder. The ramming down, which is essential to the effective action of gunpowder, is fatal to that of gun-cotton. To get useful work out of a gun-cotton rifle, the shot must on no account be rammed down, but simply transferred to its place. Air left in a gunpowder barrel is often supposed to burst the gun; in a gun-cotton barrel, it only mitigates the effect of the charge. The object of enclosing the gun-cotton charge in a hard strong pasteboard cartridge, is to keep the cotton from compression and give it room to do its work.

It is a *fourth* discovery of General Lenk, that to enable gun-cotton to perform its work in artillery practice, the one thing to be done is to "give it room." Don't press it together—don't cram it into small bulk; give it at least as much room as gunpowder in the gun, even though there be only one-third or one-fourth of the quantity (measured by weight). One pound of gun-cotton will carry a shot as far as 3 or 4 lbs. of gunpowder; but that pound should have at least a space of 160 cubic inches in which to work.

This law rules the practical application of gun-cotton to artillery. A cartridge must not be compact, it must be spread out or expanded to the full room it requires. For this purpose, a hollow space is preserved in the centre of the cartridge by some means or other. The best means is to use a hollow thin wooden tube to form a core; this tube should be as long as to leave a sufficient space behind the shot for the gun-cotton. On this long core the simple cotton yarn is wound round like thread on a bobbin, and sufficiently thick to fill the chamber of the gun; indeed, a lady's bobbin of cotton thread is the innocent type of the most destructive power of modern times—only the wood in the bobbin must be small in quantity in proportion to the gun-cotton in the charge. There is no other precaution requisite except to enclose the whole in the usual flannel bag.

The artillerist who uses gun-cotton has, therefore, a tolerably simple task to perform if he merely wants gun-cotton to do the duty of gunpowder. He has only to occupy the same space as the gunpowder with one-fourth of the weight of gun-cotton made up in the bobbin as described, and he will fire the same shot at the same speed. This is speaking in a general way, for it may require in some guns as much as one-third of the weight of gunpowder and seven-tenths the bulk of charge to do the same work; a little experience will settle the exact point, and greater experience may enable the gun-cotton to exceed the performance of the gunpowder in every way.

The *fifth principle* in the use of gun-cotton is that involved in its application to bursting uses. The miner wants the stratum of coal torn from its bed, or the fragment of ore riven from its lair; the civil engineer wishes to remove a mountain of stone out of the way of a locomotive engine; and the military engineer to drive his way into the fortress of an enemy, or to destroy the obstacles purposely laid in his way. This is a new phase of duty for gun-cotton—it is the work of direct destruction. In artillery you do not want to destroy directly, but indirectly. You don't want to burst your gun, nor even to injure it; and we have seen, in order to secure this, you have only to give it room.

The fifth principle, therefore, is, to make it destructive—to cause it to shatter everything to pieces which it touches, and for this purpose you have only to deprive it of room. Give it room and it is obedient; imprison it, and it rebels. Shut up without room, there is nothing tough enough or strong enough to stand against it.

To carry this into effect, the densest kind of gun-cotton must be used. It must no longer consist of fine threads or hollow textures wound on roomy cores. All you have to do is to make it dense, solid, hard. Twist it, squeeze it, ram it, compress it; and insert this hard, dense cotton rope, or cylinder, or cake in a hole in a rock, or the drift of a tunnel, or the bore of a mine; close it up, and it will shatter it to pieces. In a recent experiment, 6 ounces of this material set to work in a tunnel not only brought down masses which powder had failed to work, but shook the ground under the feet of the engineers in a way never done by the heaviest charges of powder.

To make gun-cotton formidable and destructive, squeeze it and close it up; to make it gentle, slow, and manageable, ease it and give it room. To make gunpowder slow and gentle, you do just the contrary; you cake, condense, and harden it to make it slow, safe for guns, and effective.

To carry out this principle successfully, you have to carry it even to the extreme. Ask gun-cotton to separate a rock already half-separated, it will refuse to comply with your request. Give it a light burden of earth and open rock to lift, it will fail. If you want it to do the work, you must invent a *ruse*—you must make believe that the work is hard, and it will be done. Invent a difficulty and put it between the cotton and its too easy work, and it will do it. The device is amazingly successful. If the cotton have work to do that is light and easy, you provide it with a strong box, which is hard to burst, a box of iron for example; close a small charge, that would be harmless, in a little iron box, and then place that box in the hole where formerly the charge exploded harmless, and in the effort it makes to burst that box, the whole of the light work will disappear before it.

The first trial of English-made gun-cotton was made at Stowmarket in the spring of 1861. A charge of 25 lbs. not only destroyed a tree-stockade, but shattered it into matchwood.

It is, therefore, the nature of gun-cotton to rise to the occasion and to exert force exactly in proportion to the obstacles it encounters. For destructive shells this quality is of the highest value. You can make your shell so strong that nothing can resist its entrance, and when arrived at its destination no shell can prevent its gun-cotton charge from shivering it to fragments.

These are the main principles in the mechanical manipulation of gun-cotton which will probably render it for the future so formidable an instrument of war. Resistances too great for gunpowder only suffice to elicit the powers of gun-cotton. On the other hand, in its elementary state as the open cotton yarn, it is playful, slow, gentle, and obedient; there is scarcely any mechanical drudgery you can require of it that it is not as ready and fit to do as steam, or gas, or water, or other elementary power.

In conclusion, I may be asked to say as a mechanic what I think can be the nature and source of this amazing power of gun-cotton. In reply let me ask, Who shall say what takes place in that pregnant instant of time when a spark of fire enters the charge, and one-hundredth part of a second of time suffices to set millions of material atoms loose from fast ties of former affinity, and leaves them free every one to elect his mate, and uniting in a new bond of affinity, to come out of that chamber a series of new-born substances? Who shall tell me all that happens then? I will not dare to describe the phenomena of that pregnant instant. But I will say this, that it is an instant of intense heat—one of its new-born children is a large volume of steam and water. When that intense heat and that red-hot steam were united in the chamber of that gun and that mine, two powers were met whose union no matter yet contrived has been strong enough to compress and confine. When I say that a gun-cotton gun is a steam gun, and when I say that at that instant of intense heat, the atoms of water and the atoms of fire are in contact atom to atom, it is hard to believe that it should not give rise to an explosion infinitely stronger than any case of the generation of steam by filtering the heat leisurely through the metal skins of any high-pressure boiler.

THE RICE-PAPER OF FORMOSA.

BY ROBERT SWINHOE, H.M. CONSUL AT FORMOSA.

THE plant that produces the so-called rice-paper is the *Arabia papyrifera* of botanists, a low shrub with large leaves, in form not unlike those of the castor-oil plant (*Ricinus communis*).

This plant has as yet only been procured from the northern end of Formosa, where it grows wild in great abundance on the hills. It is of very quick growth, and the trunk and branches, which are lopped for use, are not unlike those of an old alder in appearance. The cellular tissue or pith attains its full size the first year. The trunks and branches are mostly procured from the aborigines of the inner mountains in barter for Chinese produce. They are rarely straight throughout their length, and are usually cut into pieces of about nine inches long, and with a straight stick inserted at one end and hammered on the ground the pith is forced out with a jump at the other end. The pith is then inserted into straight hollow bamboos, where it swells and dries straight. If too short to form the required breadth of paper, several bits are inserted into a hollow bamboo, and, by rods inserted at both ends of the bamboo, pressed together until dry. By this process the short bits are forced to adhere together and form one long straight piece of the required length. Thus paper of almost any size may be procured. The knife used in paring the pith into paper is in shape not unlike a butcher's chopper. It is well sharpened on a stone, and, when not used, kept with the edge in a wooden groove held firm to it by two strings round the wood and the knife. Before using it, the edge receives a fresh touch upon a small block of wood, usually a piece of the timber of *Machilus ramosa*, shaped like a large hone. The block on which the pith is cut consists of a smooth brick or burnt clay tile, with a narrow piece of brass or a rim of paper pasted at each edge, on which the knife is laid, and is consequently a little raised above the tile itself. The block is laid flat on a table, and the dried pith rolled on it with the fingers of the left hand, and then the knife laid on the brass rims with its edge towards the pith, its handle being held by the right hand. As the knife is advanced leftwards by the right hand, the pith is rolled in the same direction, but more slowly, by the fingers of the left. The paring thus goes on continuously until the inner pith, about a quarter of an inch in diameter, is left, resembling somewhat the vertebral column of a very small shark, and breaking into similar concave-sided joints. This is used by the Chinese as an aperient medicine. The paring produces a smooth continuous scroll about four feet long, the first six inches of which are transversely grooved and cut off as useless. The rest shows a fine white sheet. The sheets as they are cut are placed one upon another, and pressed for some time, and then cut into squares of the required size. The small squares made here are usually dyed different colours, and manufactured into artificial flowers for the adornment of the hair of the native ladies, and very excellent imitations of flowers they make. The sheets most usually offered for sale, plain and undyed, are about three inches and a quarter square, and are sold in packets of one hundred each, at rather less than one penny the packet, or a bundle of five packets for fourpence. The large-sized paper is made to order, and is usually exported to Canton, whence the grotesque but richly tinted rice-paintings have long attracted the curiosity of the Europeans. Some of us tried our hands at paring, but made most abortive attempts, producing only chips, though the operation looked so easy in the hands of the apprentice. The term of apprenticeship to the trade is three years, during which time the man receives no pay, but only board and lodging, from his master, and has to give his services as general attendant besides to his employer. When the three years are completed, the apprentice is required to work other four months in place of paying premium. He then receives a certificate of capability, and can either set up on his own account or demand wages for hire.

ON THE MACHINERY FOR THE MANUFACTURE OF PLATE GLASS.*

BY GEORGE H. DAGLISH, ST. HELEN'S.

WITHIN the last ten years the production of plate glass in England has been quadrupled, whilst in the same time the price has been diminished fully one-half. The present extent of the manufacture in this country is about 85,000 square feet per week, whilst about 12,000 square feet per week of foreign plate glass is imported. The foreign glass has obtained a preference from its superior lightness of colour, which arises from the greater purity of the materials that it is made of, particularly with regard to the sand, of which the foreign makers have an abundant supply, of great purity and light colour, as seen from the specimens now exhibited of English and foreign sand.

Under the influence of competition, the English manufacturers have lately commenced an extensive course of experiments with the view of improving the quality of the plate glass made in this country, and also reducing the cost of manufacture; and in some instances very decided success has thus far been the result. In order to accomplish these objects, the sand employed at the British Plate Glass Works, at Ravenhead, near St. Helen's, is now imported from France; and every precaution is adopted to insure as far as possible the chemical purity of the other ingredients of the glass. At these works also two of Mr. Siemens' regenerative gas furnaces have been erected for melting the materials for the plate glass; and from the absence of smoke and dust in them, and the facilities they afford for regulating the heat, these furnaces have contributed greatly to the desired results. Under these altered circumstances, the glass now manufactured is fully equal in every respect to the best samples of the French production.

As time is money, any improvement which tends to expedite the manufacture of glass is of importance. This is strongly exemplified in the process of annealing. After the materials have undergone the process of melting in the furnace, and are considered in a fit state for casting, the pot containing the melted mass is taken to the casting table, and its contents are poured out on one end of the table in front of a large cast-iron roller; the material is then spread out over the surface of the table by passing the roller over it, the thickness of the plate of glass being regulated by strips of iron placed along each side of the table, on which the ends of the roller run. As soon as the plate of glass is sufficiently solidified to bear removal, it is introduced into an annealing oven, there to be gradually reduced in temperature or "annealed," until it is fit to be exposed to the atmosphere without risk of fracture. This process of annealing used formerly to occupy upwards of a fortnight, but from the improved arrangement and construction of the annealing oven it is now completed in four days; thus three times the quantity of

* Read before the Institution of Mechanical Engineers, Birmingham.

glass can now be annealed in each oven, compared with what was formerly considered possible; and consequently a large outlay in building and in space has been saved, since only one layer of plates can be placed in the oven at one time, no method of piling the plates being considered practical, or even safe. The chemical difficulties and manipulation in producing the raw material have thus been very satisfactorily overcome; but the problem of carrying out the necessary improvements in the subsequent mechanical operations has not, perhaps, been so completely solved, though considerable strides have been made in that direction also.

The plates of glass, when taken from the annealing ovens, are exceedingly irregular, particularly on the surface which has been uppermost in the process of casting, that surface being undulated or wavy after the passage of the roller over it whilst in a semi-fluid state; the lower side, too, is affected by any irregularities on the surface of the casting table, and also to some extent by the floor of the annealing oven; and both sides of the plates are also covered with a hard skin, semi-opaque. The plates vary in size, the largest being about 17 ft. long by 9½ ft. wide; and the thickness varies according to the size from 3-8ths to 5-8ths in. The first process to which the plates are submitted is that of grinding, to take off the hard skin and reduce the surface to a uniform plane, which is performed by the application of sand and water. The second process is that of smoothing, which is a continuation of the first process, but performed with emery of seven different degrees of fineness, so as to prepare the surface of the glass for the final process of polishing. This last process is affected by the use of oxide of iron employed in a moist state.

The machine in general use for grinding is that which was originally employed at the commencement of the glass manufacture, and is believed to have been designed by James Watt. It is known by the name of the "fly frame" machine. It consists of two benches of stone, sufficiently large to hold a plate of glass, and placed about 12 ft. apart; on these benches the plates of glass are fixed by plaster of Paris. Each bench has a runner frame made of wood, about 8 ft. long by 4½ ft. wide, shod on the underside with plates of iron about 4 in. broad and ¼ in. thick, and provided with a strong wrought-iron stud on the upper side, by which it is moved about over the surface of the glass. The gearing for driving these two runner frames is placed between the two benches, and consist of the square cast-iron fly frame, with two flat bars hinged to it on opposite sides, extending over each bench, and suspended from the roof by long chains, so as to allow them to radiate freely in every direction; this is called the "fly frame," from the peculiar motion given to it, and each of the runner frames is connected to it by a central stud, working loosely in the slot between the bars. The fly frame receives its motion from an upright spindle, which is driven from the main line of shafting by a pair of level wheels with a friction clutch for throwing in and out of gear. On the top of the spindle is a wrought-iron arm or crank carrying a movable stud, which works with a bush in the centre of the fly frame. Round the centre spindle are also four other spindles equidistant from the centre spindle, and from one another, each carrying on the top a wrought-iron arm or crank with movable stud, similar to the centre one; these studs severally work in bushes at each corner of the fly frame. Hence, when motion is given to the centre spindle, the fly frame is carried round by the stud on the crank arm, while its sides are always kept parallel to their original position by the four corner cranks. The two runner frames being connected by their central stud to the arms of the fly frame, receive the same circular motion as the fly frame; but at the same time they are left free to revolve round their own centres, which they do in a greater or less degree, according to the varying friction of the grinding surfaces. The grinding motion being thus obtained, sand and water are constantly applied, until the surface of the glass is found upon examination to be free from all defects; the sand is then washed off the glass, and the first stage of the smoothing process is commenced on the same machine by substituting the coarser qualities of emery in place of the sand. The plate of glass is then removed from the bench, turned over and replaced on the bench, and submitted to the same process on the other side. The speed at which the fly frame is driven is about forty revolutions per minute. As the runner frame is not sufficiently large to act upon the entire surface of a large plate of glass at one time, it is therefore necessary to divide the operation, and shift the position of the runner frame as the work requires it, by inserting the centre stud of the runner frame into a different portion of the slot between the fly frame bars.

Until the last few years the principal part of the operation of smoothing was effected by manual labour, the operation being performed by rubbing two pieces of glass together, and applying emery powder between them. Great care is requisite as the work approaches completion, that no scratching shall take place; and it is on this account that hand labour is considered absolutely necessary for finishing the process, the slightest scratch being immediately felt by a practised hand, whilst a single stray particle of grit on a machine would spoil the whole surface before it was perceived. About 1857 Mr. Crossley introduced a machine for smoothing the plates of glass, which so far succeeded that the nicety of the hand touch is only required for the final part of the operation. This smoothing machine is exceedingly simple and inexpensive, consisting of a long wooden bar connected at one end to a crank, or an upright spindle, and extending over the stone bench on which the plate of glass is laid: two runner frames of wood are attached to the bar, and on the underside of each frame is fixed another plate of glass; these are then laid upon the glass on the bench. In this case the runner frames are only allowed to partake of the motion given to them by the bar, and are not left free to revolve round their own centres as in the grinding operation previously described. The centre of the bar between the two runner frames is kept in position by a radius rod secured to a fixed bracket on one side of the bench, at right angles to the direction of the bar. The crank being set in motion, the bar and runner frames receive a movement somewhat similar to the figure 8, which is very similar to the motion given in manual labour. One advantage of this machine is that two surfaces of glass are finished at one operation. The space between the two runner frames is found very convenient for applying the emery, and also ascertaining the progress of the work, without having to stop the machine.

The machinery used in the polishing process remains the same in principle as that originally constructed for the purpose. Each machine consists of a strong cast-iron frame, about 18 ft. long by 10 ft. wide, containing a series of small rollers, upon which is placed a wooden table with two racks on the underside; suitable gearing is connected to these racks, to give the table a slow alternate lateral motion so as to bring every part of the plate of glass under the action of the rubbers. The plates of glass are fixed upon the table by plaster of Paris, and the ends of the table move between side blocks secured to the main frame, so as to prevent the action of the rubbers from displacing it. The rubber blocks are pieces of wood covered with felt, and provided with a central spindle and adjustable weights to regulate the amount of friction; a number of these blocks are secured to two movable bars running on rollers at each end of the table, and driven by a short shaft with cranks at the ends set at right angles to each other. The rubber blocks are thus worked transversely to the motion of the table; and by applying the polishing powder in a liquid state, the surface of the glass is gradually brought up to the requisite degree of polish, both sides of the plate successively being subjected to the same operation.

About 1857 experiments were commenced at the British Plate Glass Works, at Ravenhead, with an entirely different class of machinery for grinding and smoothing plate glass, with the object of increasing the production, reducing the cost, and also completing the process of smoothing upon the same machine on which the glass is ground, so as to obviate the necessity of a separate machine for smoothing, and also save the expense and loss of time in removing and refixing the plates of glass. The new grinding and smoothing machine consists of a revolving table 20 ft. diameter, fixed upon a strong cast-iron spindle, and running at an average speed of twenty-five revolutions per minute, driven through an intermediate upright shaft from the main line of shafting by a pair of bevel wheels, and friction cone for throwing in and out of gear. This arrangement of gearing for driving the table was made by Mr. Daglish, and was adopted in order to obtain a long spindle for the table, of a length equal to the semi-diameter of the table, and at the same time to keep the main line of shafting continuous, for driving a series of tables in one room. Over the top of the table a strong timber bar is fixed, about 10 in. from its surface ; and on the two opposite sides of this bar are bolted two notched plates of cast-iron, one on each side of the centre of the table. The notches are for receiving the centre studs of the runner frames, which are very similar to those used on the old class of machinery ; and the runners can thus readily be moved nearer to or further from the centre of the table, as circumstances require, by shifting the stud into a different notch. The only motion which these runner frames have is round their own centres, and this is given to them by the excess of friction on the side furthest from the centre of the table over that on the side nearest to the centre, this excess being caused by the greater velocity of the portion of the table further from the centre. It is evident that the amount of grinding action is considerably greater on this machine than upon the old one, both from the increased velocity of the runner frames themselves, and also from the double amount of movement obtained by the revolution of the table and the runner frames. The idea of driving the runner frames themselves, as well as the table, was conceived at an early stage of the experiments ; but on being put to the test, it was found that the unaided movement of the runner frames adapted itself to the work to be performed far better than any compulsory motion could do. It has also the advantage of leaving the surface free and unencumbered with any machinery, and consequently facilitates the operation of laying and removing the plates of glass ; the whole of the driving machinery is also covered over, and thus protected from the injurious effects of the sand and water thrown off from the edge of the table in working.

This machine has been found to answer equally well for smoothing as for grinding ; and this is perhaps its most successful feature in a commercial and economical point of view. Both these processes are now completed on it at the Ravenhead Glass Works, the finishing portion of the smoothing operation alone being effected by manual labour for the reasons before stated. The plates of glass being generally oblong in form, it was found that the machine in its original shape, having a circular table for carrying the glass, entailed considerable waste in filling up the area of each table for grinding ; and it was then determined to alter the shape to that of an unequal-sized octagon, or square with the corners taken off. No difficulty has been experienced in the process of grinding from this alteration in form, whilst the amount of waste in making up the tables has been considerably reduced, and greater facilities are obtained for grinding large plates. The amount of wear and tear on this machine has been found to be very small in comparison with the old machines, owing to the small number of working parts, the large extent of bearing surface, the smoothness of the motion, and the complete balancing of the table. The quantity of glass finished upon one of these machines per week is 1,200 to 1,500 square feet, which is about one-third more than the old machines are capable of doing, due allowance being made for the difference of area in them.

The first point to which attention should be directed for working out further improvement is the method adopted in casting the plates of glass, and the machinery employed to carry out the process. It has been stated that the plates of glass in their rough state are very irregular, so much so that about forty per cent. of the glass is ground away in the subsequent processes, which is a serious waste of material, and entails a great expenditure of time and material in the process of grinding; it is therefore worthy of consideration, whether some improvement may not be carried out in this direction by obtaining the plates of glass smoother in the first instance. The grinding and smoothing operations are believed to be now improved upon the previous practice, though there is no doubt room for further practical suggestions and appliances. The polishing process has been tried to a limited extent on the revolving table last described, but without any practical advantage: the present system is no doubt theoretically correct, as the action of the rubbers is regular and uniform over the whole surface of the glass, thus keeping up a uniform temperature; but some motion producing a continuous movement of the rubbers, instead of the present alternate movement, would no doubt reduce the wear and tear and require less power, and would probably also be found capable of a higher velocity, resulting in an increase of production, provided the other requisite conditions of the process were complied with.

In the course of the discussion which followed, Mr. F. J. Bramwell observed that reference had been made in the paper to the highly satisfactory working of Mr. Siemens' regenerative gas furnace as applied for melting the materials to make the glass at the Ravenhead Works: he had, as engineer to the company, recommended the adoption of that furnace for the purpose, being convinced of the great advantages that would be found to attend its use, and the first furnace on that construction had now been in constant work for fifteen months, and a second and larger furnace had been erected in May last, which had also been in constant work since that time. These furnaces he believed left nothing to be desired as far as regarded the melting; but in other respects he thought the process of making plate glass was at present in a most unsatisfactory position, and some improvements seemed to be much wanted in the mechanical contrivances used in the manufacture, though he must admit it was more easy to make that assertion than to show how the improvements were to be effected. A serious objection to the present arrangements was the great amount of handling that the plates of glass had to undergo in the several processes, which was evidently an important point when it was considered that the large plates fetched a higher price per square foot than smaller ones, and therefore it was desirable to avoid the risk of having to cut up large plates into smaller sizes on account of fractures. Under the present methods, however, the risk of fracture was great, from the number of times the plates were handled. On leaving the annealing oven the plate was handled once in conveying it to the grinding machine and bedding it there, and afterwards a second time in turning it over for grinding the second side; and similarly it had to be twice handled for each of the subsequent processes of smoothing and polishing, making six times of handling altogether before the plate of glass was finished on the machines, after which it had still to be twice handled in the final operation of hand cleaning. All these processes, he considered, ought to be effected without more than twice laying the plate at all, by working on both sides of it simultaneously; and in this respect, therefore, he thought there was a wide field open for improvements in the plate glass manufacture.

The revolving grinding table that had been described was a decided improvement upon the old fly-frame grinding machine, since in all mechanical operations it was better to get rid of a reciprocating action, wherever practicable, and replace it by a continuous circular motion. The new construction of grinding table was preferable to the old grinding benches, on account of its protecting all the machinery below it, so that the working parts and bearings are not exposed to injury from the grit thrown off profusely from the grinding table. A further advantage was the large size of the table, 20 ft. diameter, which afforded room for working on the whole surface of a large plate of glass at once.

A serious cause of loss at present in the manufacture was the very large proportion of the glass that had to be removed in the process of grinding in order to obtain a level surface of the glass. The undulations on the surface of the plates before grinding could not, he considered, be produced by the roller on the casting table, as had been suggested, because the roller was of great weight and was moved forwards steadily, running at each end on a smooth strip of iron laid along each side of the casting table, by which the thickness of the plate of glass was determined; the surface of the glass appeared level before the plate was put into the annealing oven. The undulations after annealing were not in parallel furrows across the plates, but were in the form of hills and hollows; altogether irregular in size and position. It therefore appeared that the glass in annealing must contract irregularly, causing this unevenness of the surface, particularly on the side which had lain uppermost in the annealing oven, in consequence of which so large a proportion of the glass had to be ground away as waste in order to obtain a level surface. In the old annealing ovens the plates had to be left a long time till the oven had cooled down of itself; but the ovens were now built with air channels under the bed, through which a current of cold air passed, so that the heat was reduced as quickly as practicable without injury to the glass, whereby a great saving of time was effected. No method, however, had yet been devised for laying the plates one on another in the annealing oven, and consequently a large area of surface was required in the ovens in order to lay them all separately, some of the ovens being as much as 50 ft. long for the purpose of annealing six large plates of glass at a time; the ovens were well designed for uniformity of heat in all parts, notwithstanding their great size.

Mr. R. Pilkington observed that the great cost of importing foreign sand for making plate glass was a heavy expense in the manufacture. The French sand cost about 21s. per ton, as compared with only 3s. per ton for English sand, including cleansing by washing; but the latter when washed clean of impurities was good enough for the manufacture of sheet glass.

Mr. J. Silvester inquired whether the use of iron plates laid upon the upper surface of the glass had been tried for flattening the glass in the annealing oven: these were used successfully for flattening sheet steel, which was rendered necessary by the tendency of the sheet to buckle in hardening, but if made perfectly flat during the process of tempering it remained so afterwards, and he thought the same plan might answer for flattening plates of glass.

Mr. F. J. Bramwell thought there would be a good deal of difficulty in employing iron plates as covers for keeping the plates of glass flat in the annealing oven, on account of the large size of plates that would be required, 180 in. long, by 80 to 100 in. wide. He remarked that in grinding the emery that was used for smoothing and polishing the plates of glass, it had formerly been customary to grind it dry under edge runners; but recently a valuable improvement had been made by grinding it in a stream of water, the whole apparatus being otherwise the same.

Mr. W. E. Newton remarked that for separating substances having different sizes of particles there were two methods that might be employed, the wet and the dry. The former had already been described in the case of separating the particles of emery by streams of water running at different velocities; in the dry method the separation was effected by a blast of air. The latter plan was devised and employed by Mr. Bentall, of Weybridge, for separating into different degrees of fineness the coal dust which he used in his foundry for making castings, whereby he obtained castings much superior to those generally produced for agricultural purposes. The coal was crushed by edge runners to a great degree of fineness, and an air blast from a fan blew the dust into a long covered box or chamber about 30 ft. long, the bottom of which was divided into four lengths or compartments: the finest dust was carried to the extreme end of the chamber and deposited in the furthest compartment, while the coarser and heavier particles fell into the nearer compartments, according to their respective sizes, the coarsest falling nearest to the grinding apparatus. The process was found most satisfactory in producing a distinct and accurate separation of the different sorts of coal dust; and he had himself examined with a microscope the particles of dust deposited, and found them very uniform in size at any one part of the long chamber. In this process also the ground coal dust was removed immediately from the grinding apparatus by the air blast, instead of remaining there to clog the grinding. The same method would, he thought, be applicable for separating emery into its different degrees of fineness for polishing glass, if it were preferred to separate it dry instead of employing water for the purpose.

The Chairman thought it was matter of regret that no means had yet been arrived at for making the best plate glass from home sand, instead of foreign sand : and he suggested that some mechanical mode of bleaching the sand might be discovered, to render the English sand as good for the purpose as the foreign sand : the application of heat might perhaps be tried, as that was known to produce a great difference in the colour of many materials, such as clays and other earths.

With regard to the origin of the waviness on the surface of the glass plates after leaving the annealing oven, it had been stated that this unevenness did not exist when the roller left the surface of the glass on the casting table, but that it became developed during the gradual cooling of the plate in the annealing oven ; and it occurred to him that possibly the glass at the time of casting might be in a viscid or plastic state, like gutta-percha, instead of being completely and uniformly liquified throughout the entire mass, the result of which would be that it would yield under the roller, but the rolled plate would be irregular in density and would thus become uneven during annealing by swelling up again at various parts. If, however, the unevenness could be prevented by packing the plates of glass between iron plates in the annealing oven, as had been suggested, he thought the saving effected by the smoother surface in the subsequent grinding process might make up for the additional expense of the iron plates in the first instance : and the number of iron plates required would be only one more than the number of glass plates to be laid between them, if they were laid in a continuous pile.

The particulars given in the paper regarding the increase in the manufacture of plate glass during the last few years afford another and a very clear illustration of the effect of cheapening any article in causing a great extension of its use.

ON *MYROXYLON TOLUIFERUM*, AND THE MODE OF PROCURING THE BALSAM OF TOLU.*

BY JOHN WEIR.

[Previous to his departure for New Granada, Mr. Weir received instructions to make inquiries respecting certain interesting medicinal plants growing in that country, especially the *Balsam of Tolu* tree and *Sarsaparilla*, and to obtain, if possible, seeds and specimens. In accordance with these instructions, Mr. Weir has communicated the following interesting notice of his proceedings.]

From inquiries made during the voyage out, and immediately on landing in this country, I learnt that a good deal of the Balsam of Tolu was brought down the river Magdalena annually to Barranquilla, whence it is exported to Europe. I therefore thought that the best way of reaching the country where the tree grows, was to go up the river to one of the ports I was informed the drug came from, where I hoped to be able to procure specimens and collect the desired information concerning it. At all events, I was told that by going to one of the ports on the lower Magdalena, I could cross the country to the valley of the Zinú quite as easily as I could reach the mouth of that river from Cartagena by sea.

Following up this plan, I took a passage to Mompox by the first steamer up the river after my arrival at Barranquilla. On arriving at Mompox, I found that no balsam was gathered there (although I had been assured to the contrary in Barranquilla), and that the people generally did not know the tree; a negro was recommended to me, however, as having a wonderful knowledge of all kinds of "*hervas y remedios*," and who said he knew where some of the balsam-trees grew. With this man I started in a canoe for a place called Espino, about three leagues distant from Mompox, and situated on the margin of one of the large swamps called "*ceinigas*," so common on the lower part of the river.

On reaching this place we entered the forest; and after having toiled through it for a couple of hours, during which I was gradually losing faith in the probity of my guide, he suddenly pointed out a tree which he assured me was the balsam-tree. This confirmed the opinion I had been forming—that he knew nothing about it, for the tree was certainly not a *Myroxylon*, nor anything like one.

I returned to Mompox in disgust. The gentleman who recommended the black was much disappointed on learning the result of our excursion, but said he had found another man, who would undertake to guide me to a place where the tree was to be found. I went with him a few days afterwards, but with no better success.

I have no doubt that the tree occurs within perhaps a day's journey

* From the Proceedings of the Royal Horticultural Society.

of Mompox, but not in its immediate vicinity ; for the ground for leagues around that place is low and swampy ; indeed, it was nearly all under water when I arrived there, and I afterwards found that the tree is never found in the low tracks adjoining the river, but in the higher rolling ground beyond, where the soil is dry.

Finding that the tree was not known in Mompox, I left for Plato on the 17th December. Taking the steamer to Las Mercedes, I went from thence to Plato in a canoe. Las Mercedes is the port of El Carmen, and it consists only of a large storehouse for the tobacco brought from the interior, and the imported goods received in exchange. It was here I first saw the balsam. In the store were upwards of thirty tins full of it, ready for exportation ; most of the tins contained ten pounds of the balsam, but there were also a few of a larger size, each containing an arroba of twenty-five pounds. The storekeeper told me that that lot of balsam had come from Plato only a day or two before, and that he expected some more that evening from the same place. The drug, he further informed me, was also exported from Teneriffe, Pinto, and Santa Anna, all small ports on the right bank of the river, but that most came from Plato. At Corozhl, he said, none was now gathered, although the tree exists there, as also at El Carmen.

I was glad to find that I had got on the right track at last, and waited patiently for the canoe from Plato, by which I hoped to get a passage to that place. It arrived about six o'clock in the evening, started on its return an hour later, and by nine of the same day that I left Mompos, we were in Plato. This place is about a league further down the river than Las Mercedes, and on its opposite side, near the outlet of one of the numerous branch streams the river forms in its course. Luckily for me, the "Jefe Municipale" of Plato, Frederico Alfaro by name, came in the canoe with me, and this man showed me much disinterested kindness during my stay there.

I had great difficulty in getting animals for the journey into the Montana,—not a horse nor a mule was to be had, and it was only after waiting two days that I was able to hire two donkeys, one for my guide and the other for myself ; a third for baggage I could not get,—and indeed it was considered quite unnecessary, as it is the usual custom here to travel on donkeys loaded with eighty or ninety pounds of cargo besides the rider.

During the two days I had to wait at Plato, I found a species of *Myrospermum* growing plentifully in the neighbourhood of the village, and gathered specimens of it both in flower and fruit. This I take to be *M. frutescens*, Jacq. : it grows to a height of about fifteen to twenty feet. Some trees are now in flower, while on others the fruit is already of a good size. The trees bearing flowers or fruit are generally destitute of foliage, and it is only barren individuals that are in full leaf.

On the morning of the 21st, having got the donkeys and guide assembled and everything ready, we started for the Montana. On one side of my own donkey was hung a bundle of paper and boards for drying specimens, and on the other my "estéra" (mat for sleeping on), blankets, mosquito net, and a change of clothes; that of the guide carried some provisions for the journey and his own things. I started on foot, feeling almost ashamed to mount an animal not much bigger than myself, which seemed to be already well loaded; but, before the day's journey was done, I had been glad to take occasional lifts on the poor donkey. We made about eighteen miles before we halted for the night, and my guide, a man twice my weight, rode every foot of the way. What with the burning sun, the thermometer at 89° in the shade, and the heavy load, I did not much envy his poor "burro."

We passed some balsam-trees in the afternoon, each with a lot of calabashes stuck on its trunk to catch the drug which trickled from the wounds in its bark. I picked up a few of the fruit under one of these trees, and on asking him what they were, he said they were "ojos de algo palo de la Montana." He did not know them, although he told me he had been accustomed to gather balsam since his boyhood.

Our second day's journey was not so long as the first,—I think not more than about twelve miles. The balsam-trees occurred occasionally during the whole way. We stopped at a hut in the forest surrounded by a small clearing, the owner of which, like all the inhabitants of the Montana, makes part of his living by gathering balsam. The trees were very plentiful here, and generally of a large size. Their average height is about seventy feet, and the trunk is sometimes upwards of two feet in diameter a yard from the ground, and generally rises to a height of forty feet without branching, so that it is impossible to get at either foliage or fruit without cutting down the tree. On the day after our arrival, I got the man's permission to have a tree felled; he did not charge me anything for the tree, but stipulated that I should pay two of his sons a dollar each for felling it. I selected an old tree, nearly two feet in diameter. There was a sprinkling of pods upon it, but it was not by any means loaded. The pods are so loosely attached to the branches and so brittle in themselves, that nearly all of them were shaken from the tree and many broken to pieces by the shock of the fall. I found them to be approaching maturity, the seeds being fully developed, but, I am afraid, not ripe enough to grow. I had another smaller and more vigorous tree cut; the foliage of this was much larger than that of the older tree, and also a little different in form, but it bore no fruit. The specimens I send will sufficiently show the difference in the foliage of the two trees, and it is also sufficiently explained by the greater luxuriance of the younger.

As I have already said, it is impossible to reach the foliage of any of the trees unless by felling them; but I examined the leaflets of many trees from specimens picked up from the ground, but saw nothing to induce me to believe that the balsam is produced here by more than one species. The young trees have always larger foliage than the old ones;

but the difference was constantly the same as it was in the individuals I had felled. The trees never make a very dense head of branches and foliage; but in the old ones, which have been much bled, it is very thin. Many of the small twigs are dead, and the living ones are covered with lichens.

When a tree is about to be bled, two sloping notches are made in its trunk quite through the bark, and meeting in a sharp angle at their lower ends, leaving thus a point of bark between them untouched. The bark and wood is hollowed out a little immediately under this point, and the calabash cup is inserted under it. The process is repeated all over the trunk at close intervals, up as high as a man can reach; I have seen as many as twenty cups on a tree. The piece of bark and the cups I have sent will show the process better than I can describe it. When the lower part of the trunk of a tree is too full of scars and wounds for any fresh cuts to be made, a rude scaffold is sometimes made round the tree, and a new series of notches made higher up.

From time to time, as may be necessary, the balsam-gatherer goes round the trees with a pair of flask-shaped bags made of raw hide, slung over the back of a donkey. Into these bags the contents of the calabash cups are successively poured, and the cups are re-inserted under the point of bark and left to be again filled. The balsam is sent down to the ports on the river in these hide bags, where it is transferred to the tins.

I could not learn which were the best months for the flowing of the balsam,—one person saying that it was in July, another in March, and so on, scarcely two agreeing; but the bleeding goes on during at least eight months of the year, from July to March or April. When the balsam is flowing well, I was told that "one moon" sufficed to fill the cups.

Respecting the time of the flowering of the tree, individuals differed as widely as they did about the best time for the production of the balsam. I think I was told that it flowed in every month of the year, each person asked giving a different month; and several asserted that it did not flower at all.

I could not get any one to recognise the name "*Balsamo de concolito.*" I tried individuals with it at Cartagena, Barranquilla, Mompox, Las Mercedes, Plato, and the Montana, but none of them knew what I meant. The balsam is certainly not known by that name at any of these places, but is always called *Balsamo de Tolu.**

I remained a couple of days in the Montana, and returned to Plato. We travelled part of the way with a man going down to the port with a

* "The balsam is not distinguished in this region [Carthagena] by the name of *Tolu*, but is known by the name of *Balsamo de concolito*,—*concolito* being the native name of the small calabash used for collecting it."—*Letter from the late Sutton Hayes to D. Hanbury*, April 23, 1862.

quantity of balsam. He had three donkeys loaded with it, each carrying four arrobas, or 100 lbs. weight. The quantities of the drug I saw on its way for exportation at Las Mercedes, Plato, and on the road from the Montana, must have amounted to at least 1,500 lbs., which proves that the tree must be very plentifully scattered through the forest.

I returned to Mompox in a canoe, and arrived there on the 29th ult. On the 4th of the present month I left Mompox by the steamer up the river, and landed here on the 7th. This place is called Barranca Vermeija, and is situated on the river side, about two leagues further up than the place where the village of Bojorques formerly stood, for it is not now in existence, the river having carried all the houses away. This being the nearest point to Bojorques I could land at, I came here hoping to find *Smilax officinalis*, H.B.K., but after several days' unsuccessful searching for it, I am afraid I must conclude it is not here ; but I will go to Bojorques in another day or two, and perhaps I may find it there.

The Rhatany, I was told at Barranquilla, came from the neighbourhood of Bucaramanga, and as I intend to go up the river Sogamoza to that place when I leave Bojorques, I hope to be able to procure specimens of the plant that produces it there.

Barranca Vermeija, on the River Magdalena, New Granada,
January 13th, 1864.

DEVELOPMENT OF COLONIAL RESOURCES.—SAWING MACHINERY.

Perhaps there are few countries in the world so well provided with timber suited to the purposes of man as New South Wales, and certainly nowhere until within a very recent period was so little effort made to turn natural capabilities to account. Three or four years since almost all the window sashes, doors, flooring, and other carpenters' and joiners' work used in the colony were imported, as well as most of the ordinary articles of furniture and cabinet-maker's goods. Now, on the contrary, owing to colonial enterprise and ingenuity, almost every article of this kind is made in Sydney, and at a much lower price than it can be imported for. Two years since, the market was glutted with imported doors, sashes, and furniture, since then no articles of the former description, and very few of the latter have been introduced; and owing to the adaptation of machinery to cabinet-making and carpentry, there does not now exist the slightest chance of the revival of such an anomalous state of things, as a colony producing the finest timber in the world, importing inferior articles manufactured from inferior timber, from a country thousands of miles distant. It is all the more gratifying that this change has been brought about, not by absurd protective duties, not by excluding by legislative enactment the products of the industry and commerce of other countries, but by colonial energy and capital acting in open competition with the world; and, for that very reason, certain to be the more permanent in its effects and successful in its operations.

We think it due to those to whom the colony is mainly indebted for producing the beneficial change alluded to, that attention should be drawn to their efforts; and we feel sure that a notice of the machinery used, and a description of the process by which a log of wood is changed into doors, bedsteads, or packing cases, will be read with interest.

There are several establishments in Sydney for machine-sawing and the manufacture of woodwork, but by far the most extensive is that of Messrs. Moon and Co., at the foot of Bathurst street, and to a description of this we shall at present confine ourselves. The premises occupied in the operations of this firm covers several acres of ground, and the number of persons in their employment is upwards of 150. Their machinery is driven by three steam-engines, and all their engineering work and machine making is done on the premises. Most of the machines used were not only made under the direction of Mr. Nicolls, their engineer, but several of the most important are of his own invention. To understand perfectly the operation of the various mechanical appliances, it will be necessary to watch the progress of a log of wood—say of cedar or pine, for nearly all the timber used is the produce of the country—from the time it is drawn from the water at the foot of Liverpool street, until it is changed into chairs, bedsteads, and tables, ready for the purchaser. The log of timber is drawn from the water up an inclined plane by machinery, and placed on the movable frame of an engine, called a breaking-down machine. This is the invention of Mr. Nicolls, and is one of the most powerful sawing-machines in the world. It is remarkable for the simplicity of its construction, and works very much on the principle of Nasmyth's steam hammer. The blade of the saw is a mere extension of the piston-rod, so that its action is perfectly direct. It is capable of sawing a log eight feet in diameter, with as much ease as a man would cut with a handsaw through a plank of an inch in thickness. After being broken down, as it is called, by this machine, the timber is sawn into thinner portions by other more complicated ones. For this purpose there are two perpendicular sawing machines, each capable of carrying from eight to sixteen vertical saws, according to the required thickness of the planks. The perfect truth and smoothness with which these machines turn out their work is admirable. We may remark that it is necessary that wood intended to be planed, grooved, tenoned, and morticed by machinery, should be perfectly square and true, and of a uniform thickness throughout. All these conditions, which could not be obtained by hand sawing, are incidental to machine work.

As soon as the log has been broken down, and cut into boards of the requisite thickness, it is, if wanted for immediate use, placed in the seasoning house. This is a steam-tight building, constructed of riveted iron plates, in the same manner as the boiler of an engine. It is fitted with steam-pipes, and it is by the action of the steam that the wood is seasoned,—a few hours being sufficient to produce the same effect by this process as would require months in the ordinary way. When seasoned, it is handed over to the department by which it is intended to be worked up.

There are separate buildings, each having its necessary staff of workmen, for the manufacture of each description of article. One set of men make nothing but bedsteads, another only chests of drawers, a third packing cases, a fourth doors, a fifth sashes, a sixth chairs, and so on. The wood for each kind of article is sawn out by the machinery, and stacked separately. It may give some idea of the amount of work produced in this establishment by this division of labour, when we state that a thousand bedsteads are undergoing the process of manufacture at once ; that a single boy, with a morticing machine, is capable of morticing one hundred doors in a day ; that, on an average, four hundred pairs of sashes are sent out, glazed and ready for use, every week ; that the wood consumed annually in making soap, candle, wine, and other cases, alone, amounts to four million feet, and that the value of this single article of production is over 6,000*l.* annually.

The rapidity and ease with which the circular saws, working on rack benches, reduce heavy pieces of timber into boards is something startling. A log, say fifteen inches square, and fifty or sixty feet long, is reduced into strips as easily, and almost as rapidly, as a lady could cut a sheet of paper with a pair of scissors. These rack-benches are among the most expensive machines used. They were made on the premises, at a cost of about 1,500*l.* each. The men attending them have little else to do than look on, and supply the machine with fresh timber as often as required.

Another very ingenious tool, and one peculiar to this establishment —the invention of Mr. Nicolle, and made on the premises—is a machine for cutting laths. It is capable of producing ten thousand laths per day, and is said to be superior to anything of the kind ever before invented. To enumerate all the purposes to which steam machinery is here applied would be tedious. In addition to the large sawing machines there are others for planing, for cross-cut sawing, for grooving and tongueing, for morticing, for cutting tenons, for moulding, and for various other purposes.

The consumption of timber amounts to 80,000 feet of cedar and 40,000 of pine weekly. No imported wood is used unless, from some unusual circumstance, colonial cannot be procured,—as the latter is deemed preferable on many accounts. The stock on hand usually amounts to about 2,000,000 feet. The consumption in 1862 was upwards of 4,000,000 feet, and is fast increasing. A considerable export trade is rapidly springing up to Victoria, Queensland, and other places. The

Sydney made articles are fast driving the American out of the market in the other colonies, as they can be produced much cheaper than foreign goods can be imported, and are very superior in finish and general quality.

It is somewhat surprising to know that, notwithstanding the enormous quantity of goods manufactured, and with all the facilities at their command, Messrs. Moon and Co. are unable to supply orders fast enough. The demand is always in advance of their powers of production, although new adaptations of machinery are constantly offering greater facilities for the supply of the goods which they manufacture.

We may mention, in order to show the facilities afforded by machinery, that a boy can mortice 100 four-panel doors daily, at a cost for wages of 3s. 4d., and that this work, if performed by hand-labour, would cost about 10*l.* That is, perhaps, an extreme instance, but the difference in the cost of making mouldings, &c., if not quite so great, is sufficiently remarkable. Most persons not acquainted with the facts are under the impression, when seeing packages of doors and sashes being taken into the interior from Sydney, that they are imported American goods. This used to be the case, but it is not so at present. We are assured that very few sashes and doors have been imported during the last two years, and that they cannot now be introduced for less than about 50 per cent. over the Sydney manufacturers' prices.

ON THE PHYSICAL SCIENCES WHICH FORM THE BASIS OF TECHNOLOGY.

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THERE are thus four means of inducing chemical change, resembling familiar arithmetical processes. The first, a process of simple subtraction; the second, a process of simple addition; the third, a process where certain figures are annexed and others removed; the fourth, a process where, without altering the total number of figures, the value of each and of the sum total is changed, by changing their relative decimal places.

Astronomy and Chemistry thus stand at opposite poles; although no one who studies both can fail to perceive that the stars of the one science are represented by the atoms of the other, and that it is felt to be as natural to speak of the atmosphere of an atom as of the atmosphere of a star. The ancient vague alliance between astrology and alchemy has not been repealed, but only by wise restriction and enlargement made the modern explicit and intelligible bond between astronomy and chemistry. They agree in being observational and analytical, but differ inasmuch as, of the two, chemistry alone is synthetical, synthetico-analytical, and transformational. And although as a science chemistry is not more essentially analytical than astronomy; all the sciences, as already urged, being, according to the limits of their domain, equally analytical; as an applied science, *i.e.*, as an art, its powers of analysis give it pre-eminence. In popular language, this word "analysis" is understood to signify chemical analysis; nor need the analysts of the other sciences complain of this. It is the utilitarian value of the material products of such analysis, not the fact or mode of its performance, that chiefly leads to the appropriation by chemistry of the term. The analysis by the telescope of the milky way into a firmament of stars; of nebulæ into clusters of them; of one evening star into a Jupiter with four moons; of another into a Saturn with rings; of a third into a double star, with each twin differently coloured, are performances as wonderful as the analysis of water into oxygen and hydrogen, or of vermilion into sulphur and mercury. But the moons of Jupiter have no industrial applications, and the rings of Saturn do not alter in market value; the milky way has not become more nourishing since the gods vanished from the sky; nor is a double star of more use than a single one. Microscopic analysis, anatomical analysis, crystallographic analysis, yield results as curious and as important as any yielded by chemical analysis, but they have little interest for the industrialist. It matters not to the manufacturer of phosphorus what the microscopic characters of a bone are, but a great deal what its chemical composition is. It matters not to the farmer what the shapes are of the fossil infusoriæ in the soil he tills, but a great deal what the chemical constituents of that soil are. It matters little to the gunpowder maker what the crystalline forms of sulphur and saltpetre are, but he attaches the greatest value to the question of their chemical purity.

There is another reason why the word "analysis," unless qualified, should be so generally understood to be chemical analysis. Chemistry, alike as a science and an art, does not merely separate the complex material wholes with which it deals into their simpler and simplest ingredients, but completely detaches each of these from the rest, and handles it apart. We do not merely know that water consists of hydrogen and oxygen, but these themselves are ours, to examine as minutely as we please. The solitary exception presented by the element fluorine, which chemical science can logically analyse out of its compounds, but which chemical art cannot concretely isolate and exhibit, makes the contrast in all other cases the more remarkable. No doubt our means of chemical analysis and isolation are very great, as geology, mineralogy, anatomy, and physics generally illustrate. Their modes of application, however, and their results, are less numerous, and far less striking than those of chemical analysis. The mechanical part, for example, of metallurgy, with its minings and diggings, its crushings and sortings, its siftings and washings, which are all processes of analysis and isolation, makes no such impression on us as the chemical part of metallurgy, where the blast-furnace resolves iron ore into oxygen and iron ; and the clay-still resolves cinnabar into quicksilver and sulphur ; and the cupel extracts silver from a mixture of metals. The greater impressiveness of chemical as compared with mechanical analysis largely depends upon the great rapidity with which the former can be executed, and its results rendered visible. You let fall a drop of oil on the liquid chloride of nitrogen, and on the instant it is resolved into its component gases. You strike a fulminating crystal, or heat a lock of gun-cotton, and in a moment every element in either is set free. You expose a salt of silver for a second to the sun, and silver appears. You add a little green vitriol to a solution of gold, and the gold is at once deposited. You plunge the poles of a galvanic battery into water, and torrents of hydrogen and oxygen instantly rise from the liquid. No science but chemistry can show such things ; and if the practical chemist does not analyse quite so swiftly as such feats would imply that he might, he nevertheless always analyses swiftly. But skill to analyse forms, as we have seen, but one-fourth part of the chemist's power. He can build up as well as pull down ; he can do both at once, and he can transmute without doing either, and all as swiftly as he analyses. This fourfold power and this immense energy place chemistry at the head of the experimental transformational sciences, and render it as an art so mighty in effecting useful changes upon matter. It is the type of the one group of industrial sciences, as astronomy is of the other.

Astronomy is severely observational as a science, and passively registrative as an art. At best it lifts up its hand only to warn, and stretches forth its finger only to point. Chemistry is inquisitorially scrutinising as a science, and actively changeful as an art. It lays its hand upon everything within its reach, and is never content till it has made some alteration upon it. The symbol, accordingly, of astronomy is an eye ; the symbol of chemistry is a hand : not that astronomy is handless, or chemistry eyeless, but the power of the former is in its eye ; the power of the latter is in its hand. The symbol of industrial science is a hand with an eye in the palm, and the fingers free. Let this be the crest of the Industrial Museum.

The other physical sciences rank between those two, standing nearer to the one or the other, as they are predominantly observational or experimental. Nearest to astronomy stands geology. The magnitude of the objects with which it deals, small though they are compared with those which concern astronomy, places them in greater part beyond human interference. And the same influence which illimitable space exerts in astronomy, by lifting the stars to heights inaccessible by us, immeasurable time exerts in geology, by enlarging her almanac, so that less than a line suffices for all the generations of the most ancient race.

Yet geology is visibly an experimental science, which astronomy is not. Our experiments upon the earth have indeed been more frequently incidental than designed, yet human feet have not trod the globe for thousands of years without leaving footprints upon it. And although with all our mines, tunnels, canals, bridges, roads, railways, breakwaters, and harbours, we make no greater change on the crust of the globe than the earth-worms do on the soil of our gardens, or the sea-slugs on the sand of our shores, still, like them, we do leave behind us an impression which is not only immense, as tried by human standards, but sufficient, we may believe, permanently to distinguish our planet from all others. Such determinations, also, as those of the heights of mountains, the depths of oceans, and the limits of our atmosphere: such observations as those of the size, and the shape, and the weight of the earth: such bold questions, boldly answered in the affirmative, as—"Is the sea open to the four winds of heaven? and may we sail upon it whithersoever we will?" "Is there a great continent to the west of Europe, behind the arch of the sea; a land of gold, near the setting sun?" "Is the ocean a sphere as well as the land, and may we let loose from our sea-rock without anchor on board, and measure the great circle, floating every day on new waters, till we moor beneath the white cliffs of our sea-rock again?" Such achievements, although a strict logic must refer them solely to observational science, inasmuch as they imply no transformative power over the objects with which they deal, yet include in the instruments with which they are effected so many fruits of transformative experiment, and are wrought out so thoroughly in its spirit, that we cannot easily reconcile ourselves to calling their heroes simply observers. They plainly deserve a middle place. Geology is half of the heavens: half of the earth. She stands an imperial queen, with her head among the stars, and her tresses are white with the snows of ages; but her feet, graceful and quick, are beneath the young grass, and are wet with the dews of to-day. Her hands are often raised to shade her eyes, as she gazes through space to exchange greetings with each sister-presence in the worlds around. But her fingers are as often busy with homely cares, and with bended forehead she traces for the tenant-lord of her estate the best track for his railway and channel for his canal, and shows him where to find coal and iron, and how to dig for gold. The geologist, indeed, is so essentially a miner, a quarryman, a rock-blaster, a stone-breaker, a hill-climber, and leveller, that we do not realize him without such tools in his hands as to the imagination appear more potential than mere instruments of observation. Geology thus forms a link between the contrasted groups of sciences. It is to some extent experimentally transformational, and will slowly, as the ages roll on, become more possessed of this character. *Registrative* it scarcely is at all. It does not, for example, warn us of earthquakes, but only tells us when they are past; and we can scarcely call it *Directive*. It is of the greatest importance, however, to industrialism, in its purely observational character, as dealing with the globe as a great store-house of mineral matters of the highest value. I need but name building stones, metallic ores, the constituents of glass and porcelain, coal, and lastly water.

Next to Chemistry, as an experimental science, wielding immense transformative power, stands Mechanics. I include under this term the science of force, not only as determining the rest and sensible motion of masses or particles of matter, but also as determining all structural or molecular changes in bodies, whether solid, liquid, or gaseous, which are not produced by chemical alterations, or by the vital agencies at work in plants and animals. Were this identity between mechanical force, and all molecular force which is not certainly either chemical or vital, made the ground of positive deductions in natural philosophy, it would be liable to the gravest objections. But, regarded simply as an assumption, awaiting refutation, verification, or correction, as knowledge progresses, it will involve us in no speculative error, whilst it greatly simplifies our study of many of the practical applications of science. There are few technical processes, for example, more important than the tempering of steel, the annealing of glass, and the crystallization of salts; yet how far the structural or molecular changes which it is the object of those processes to produce imply only a mechanical, or, as is most probable, also a chemical change in the relative arrangement of their particles, is unknown. As, however, no loss or gain of element or ingredient, or any other *sensible* chemical change occurs, whilst a very appreciable mechanical alteration happens, it is convenient to disregard in technological discussions the possibility of the former kind of transformation occurring, and to recognise the occurrence only of the latter. The relation of vital to mechanical force will be considered hereafter.

The transformative power of mechanics over matter comes before us as industrialists in a threefold way. First: As furnishing a motive power which can be directed on masses both large and small, so as to throw them into motion. Second: As furnishing a means of inducing change by alterations in the external configuration of bodies. Third: As furnishing a means of inducing molecular change in a mass without alteration of its external configuration or production of sensible motion.

So far as the first is concerned, I need scarcely remind you that there is scarcely an industrial art which does not in some of its departments require a motive power. A steam-engine is scarcely wanting from a single utilitarian establishment. Places so unlike each other as a farm, a dye-work, a cotton factory, a stone-cutter's yard, and a wood-cutter's shop, have alike this indispensable engine, or some substitute. This necessity is curiously illustrated by the same word *mill* being applied to industrial establishments of the most opposite character. We speak, for example, of a flour-mill, a cotton-mill, a gunpowder-mill, and a sawmill. As examples of the application of motive power to the production of mechanical transformation, I shall content myself here with referring to the conversion of wool, silk, flax, and cotton into woven fabrics, and of rags into paper.

So far as the second aspect of mechanical force is concerned, namely, as an inducer of alterations in the external configuration of bodies, it will be sufficient here to refer to the arts of the stone-cutter and wood-carver, and to those of sculptors, carvers, and engravers of all kinds.

As for the third aspect of mechanical force, namely, to induce internal molecular change, such processes as the tempering of metals, the annealing of glass, and the baking of porcelain, in certain of its stages, may serve as illustrations.

In contrasting mechanical with chemical transforming force, it is curious to notice how in one respect the former is the more imposing, in another the latter. Mechanical force, when exerted as a motive power, can be employed by man on a much grander scale than the similar power of chemical force, except in the case of explosives. Artificial chemical processes, again, on however large a plan they are conducted, are, with few exceptions, such as that of the iron blast-furnace, striking only in their results. But the movements of massive pieces of machinery, even though moving aimlessly, still more when working for a purpose, always awaken in us the idea of power; and often also create emotions of awe and sublimity akin to those which are begotten by the spectacle of great natural phenomena. The sweep of a railway train across the country, and the dash of a war-steamer against the waves with which it measures its strength, never become paltry pageants, even though we are ignorant of the errands on which these swift coursers are bound. Still more striking are those actions of machinery which involve not only swift irresistible motion, but also transformation of the materials on which the moving force is exerted. Take, for example, a cotton-mill, which some never tire of representing as dreary and prosaic. In the basement story revolves an immense steam-engine, unresting and unhasting as a star, in its stately, orderly movements. It stretches its strong iron arms in every direction throughout the building; and into whatever chamber you enter, as you climb stair after stair, you find its million hands in motion, and its fingers, which are as skilful as they are nimble, busy at work. They pick cotton and cleanse it, card it, rove it, twist it, spin it, dye it, and weave it. They will work any pattern you select, and in as many colours as you choose; and do all with such celerity, dexterity, unexhausted energy, and skill, that you begin to see what was prefigured in the legend of Michael Scott, and his "sabbathless" demons (as Charles Lamb would have called them), to whom the most hateful of all things was rest, and ropemaking, though it were of sand, more welcome than idleness. For my own part, I gaze with untiring wonder and admiration on the steam Agathodæmons of a cotton-mill, the embodiments, all of them, of a few very simple statical and dynamical laws; and yet able, with the speed of race-horses, to transform a raw material, originally as cheap as thistledown, into endless useful and beautiful fabrics. Michael Scott, had he lived to see them, would have dismissed his demons and broken his wand.

Yet magnificent as the scale is on which many mechanical transformations occur, they are to a great extent undervalued because there is nothing mysterious about them. However great the difference between the raw material and the finished product, we can follow each step in the transition from the one to the other. The Portland Vase, for example, is as different, in one respect, from the ball of vitreous jelly out of which it was elaborated, as in another, that jelly is from the sand and alkali and metallic oxides, which were melted together to produce it. Rarely-gifted hands and nice tools were needed to furnish the mere outline of that beautiful vessel; still more to carve the exquisite shapes which are sculptured upon it. Its materials, on the other hand, are of the cheapest; and the most ignorant slave had skill enough to melt them together. Yet we can realize each step in the mechanical workmanship; and some lookers-on; if none others, the artists themselves, saw the whole grow into beauty under their eyes, like Aphrodite rising from the glassy sea. But no one saw or can see the sand and alkali change into glass, or can realise what happens during the transmutation. The most critical part of the process is effected *per saltum;* and, as with children trying to watch themselves fall asleep, our eyesight and consciousness fail us at the very moment when the mystery lies bare, and the secret is open to view. It is so with every chemical process: bleaching, dyeing, fermenting, ether-making, reducing of metals, firing of gunpowder. The substances taking part in each reaction are like masqueraders crossing a bridge, the crown of which is hidden by clouds. You trace them, letting no movement escape you, as they climb from one side leisurely towards the elevated centre, and enter the shadowing cloud, but though it seems quite transparent, its entrants grow suddenly invisible, and when you next catch sight of them descending on the other side, they are transfigured and totally changed.

This occult character of chemical force appeals not only to that vulgar wonder which holds *omne ignotum pro magnifico*, but provokes the chastened curiosity of the philosopher, who cannot divine what or how many unexpected figures may emerge from each enigma, and alter the value of all his calculations.

The mechanical powers are like stalwart giants of Northern blood, standing erect and naked to the waist, with their ponderous tools beside them, and their fair, frank faces, ignorant of guile, opening their blue eyes calmly upon us. They possess only strength and skill, and obedience to laws so few and simple that they can be made plain to any intelligent child. We respect and admire them; but we feel that we can measure their height, and take the girth of their arms, and we are not afraid to calculate the horse-power, immense though it is, which lies in the bend of each of their little fingers.

The chemical forces are like supple Eastern jugglers, with swarthy brows and lustrous, unfathomable eyes, who never look you straight in the face, or measure glances with you. They are robed in gauze, which seems transparent like glass ; but when you try you can see nothing through it. The instruments in their girdles are like children's play-things ; and the lighted lamp, which they always keep near them, has nothing to distinguish it from ordinary lamps. You may be indifferent when they stretch forth their slender arms, and ask you for the stone beneath your feet ; but you are startled when, after some sleight-of-hand, you receive in its stead a steel blade or a sphere of crystal ; and you tremble when you see the cunning fingers close for one moment over a little harmless charcoal and water, and open the next to offer you the deadliest poison. These subtle conjurors, secret as the grave, have we know not what of angelic, what of demonic, power at their command ; and we are continually tempted to put a higher value upon their mysterious legerdemain than upon the open handiwork of the mechanical powers. In so far, however, as the artificial modification of matter is concerned, we almost invariably require the services of both, and they work willingly together. It may be well to have one word, as *transmutation*, to indicate chemical molecular change, and another, as *transformation*, to indicate mechanical molecular change ; but, as industrialists, we must hesitate to marvel more at the one than the other. How cheerfully they labour to a common end, like twin brother and sister ; the one strong by measurable strength, the other by immeasurable fascinating power, we see in the case of that great world-changer, that emblem of war and minister of peace, gunpowder. It needs the strong brother to fell the oaks, and with a hint from his twin sister to burn them into charcoal. It needs his stout arms to quarry the sulphur, and bring the saltpetre from India ; to crush them into grains, and grind them together ; but it also needs his weird sister, in whose palm he lays the innocent dust, to breathe upon it before the Alps are tunnelled, or Sebastopol lies in ruins.

It is not necessary, after the division I have made, to make special reference to heat, light, electricity, and magnetism as sciences of transmuting and transforming force, since, without deciding on the essential nature of the agencies which they represent, we may, as industrialists, divide them between mechanics and chemistry. Thus heat may be equally partitioned between them, as alike remarkable for mechanical and chemical alterative power. Electricity and light may be given in larger part to chemistry, and magnetism in larger part to mechanics. On the other hand, also, mineralogy, as a lesser geology, may be ranked along with it.

We may suppose all the sciences related to industrialism arranged in the form of a crescent. At the tip of the one horn stands astronomy, next it is geology, and next to that mineralogy. At the tip of the other horn stands chemistry, next it is mechanics, next to that heat, light, electricity, and magnetism. In the centre of the crescent stands the remarkable science which we have still to consider—namely, biology. It includes botany, the science of plants and plant life, and zoology, the science of animals and animal life. These sciences, in popular estimation, alone constitute natural history, and are often referred to as if they were solely observational and analytical; but they are transformational in a remarkable way, and furnish the industrialist with most important instruments for effecting changes upon matter. After death, plants and animals furnish to the botanist and anatomist endless subjects for the observation and analysis of peculiarities of form, structure, and function. To the practical chemist also and the mechanician they supply the raw or *genetic* materials, such as wood and wool, of a thousand industrial arts. During life they are likewise objects of observational science; and in one respect are as much removed beyond direct human interference as the objects of astronomy. Life builds up a barrier round plants and animals which we may not overpass, except at a few places. We cannot experiment on them in the way we can on dead objects; for interference with them, to any considerable extent, either sacrifices life, or so alters its conditions, that a dead or diseased thing is left in our hands. Nevertheless, every living plant and animal is for the industrialist a machine or apparatus, possessed of remarkable transforming and transmuting powers, which, to a very considerable extent, may be controlled, directed, and even modified by him. And if living organisms cannot be wielded as tools or weapons in the same way as inorganic machines can, there is this great compensation in the fact that, to the extent an organism can be wielded by us, it enables us to add to the transforming and transmuting powers of mechanical and chemical force, which alone are available in the dead machine, the metamorphosing power of vital force. Differences of opinion may exist as to the essential peculiarity of this force, but there can be none as to the practical advantage of regarding it as distinct from mechanical and chemical force. I will go further, and apply the term *metamorphosis* to the kind of change which vitality specially induces in matter, so that, accepting the confessedly arbitrary employment of terms which I have proposed, we shall speak of a mechanical *transformation*, a chemical *transmutation*, and a vital *metamorphosis*.

Looked at from this point of view, biology yields to none of the sciences in industrial importance. Translated into practice, it gives us agriculture, an art so peculiar and extensive, that, like medicine, it demands all the energies of an entire profession. It is not my province to discuss agriculture, but there are certain industrial aspects of the biology on which it reposes requiring notice here.

Animal force is of immense importance to all the useful arts; first, as a motive, secondly, as a transformative power. In these days of railways and steam-engines we are apt to think too lightly of our horses and other beasts of burden, forgetting that without them we could not construct the engines which to some extent are supplanting them, and that they themselves are the best of engines for many purposes. James Watt and George Stephenson, I am sure, respected even a donkey; and were the last of its race to die, we might all join Sterne in weeping over the dead ass. We do not sufficiently remember that all other machines are the offspring of living machines. A steam-engine is the literal as well as the metaphorical embodiment of so much horse-power. A railway viaduct is the petrifaction of so much animal force. A power-loom, after its last improvement, remains still a hand-loom. Archæologists tell us, that in far separate regions of the world, you find stamped on the monuments of forgotten races the impression in red of a human hand. But we need not go to distant lands and the works of extinct races for this mysterious signature. The mark of the red hand, red with the blood which toil has wrung from it, will be found on every industrial instrument and product, and the print of a horse's hoof is generally near it. A horse's shoe, indeed, might be nailed up on many a door besides the blacksmith's, to keep away the evil spirit of idleness, if we are afraid of no other demon.

It is only the sentient organism, the animal, that has motive and transformative powers of the kind we have been considering; and it is only the paragon of animals that is able to direct them at will. But a transmuting and metamorphosing power of another kind, and not less important to industrial art, is common to plants and animals, and in some respects characterises the former even more than the latter. The plants and animals which as agriculturists we care for, may be regarded as skilled labourers, who, in return for food, wages (which must be paid in kind), and a certain liberty of action, agree to collect or manufacture for us a multitude of useful substances. We employ them, and many wild plants and animals also, as collectors or amassers of certain bodies, because, although we could collect these ourselves, we could not do it half so well. We employ them as manufacturers, because they keep their processes secret and have a monopoly of the manufacture.

Look first at their skill as collectors. As soon as the seed we sow has germinated, it begins to extract from the soil, or water and air around it, various matters, among others the mineral alkali, potash. Now this alkali is of great industrial value, and it is in our power to procure it from the sources which yield it to plants. To procure this, however, is a tedious, costly, and laborious process, for all the free alkali to be found at any moment in a moderate weight of soil is exceedingly small, and could not profitably be extracted by any artificial method. But a growing plant day by day appropriates to itself an almost infinitesimal amount of potash through its roots, and, like a miser, hoards it all, or nearly all, so that if at the close of a season we burn it entire, we find in the ashes all the gathered potash of the year harvested to our hands.

The sea, in like manner, is the great fountain of a rare and prized substance, iodine, but were we compelled to take it directly from the ocean we should require to evaporate tons of water to keep a single photographer supplied with it, and it would be more costly than gold. But the seaweeds employ it as well as the photographers, and have long anticipated the physicians in taking it internally. Day by day they sip a homœopathic dose of iodine and retain it, and by-and-by we burn them into kelp, and extract iodine and much else that is valuable from the ashes.

To take another example, phosphate of lime, a minute constituent of all fertile soils and of most waters, is of great value to the ivory turner, the manure-maker, the potter, the silver-assayer, the drug-manufacturer, the dyer, and the lucifer-match maker. It reaches all of them in the shape of the bones of dead animals; dead cattle from our farms, dead horses from the Pampas of South America, dead walruses from the arctic icebergs, dead whales from the Pacific Ocean, dead men even from fields of battle. Land and sea plants have, as it were, milked this essential constituent of their frames, drop by drop, from the breast of Nature. Animals of all classes, from the lowest to the highest, have robbed plants of their hard-gotten gains, and made their bones strong with the precious substance. Finally, the chartered robber man has robbed them all, claiming even the relics of his brethren, and obtaining in a handful of bone-dust the phosphate of tons of rock and water.

The industrial importance, however, of plants and animals, as collectors and harvesters of valuable mineral matters, is insignificant compared with their value as manufacturers of bodies whose worth depends much more on their construction or composition than on their raw material. In their former capacity, living organisms resemble simply filters with apertures of different fineness, and fitted to arrest and detain certain substances in themselves valuable. In the latter, those organisms resemble highly complex machines, able to convert the most familiar things into substances precious almost solely from the workmanship bestowed upon them.

Take for example that important substance, wood. Its chief ingredients, charcoal and water, are uncostly and abundant; but in themselves they are useless to the carpenter, and he cannot change them into timber. So he calls to remembrance that his great grandfather planted an acorn, which has turned its first small capital to so excellent account that now it is a timber merchant on a large scale, and will contract with you to build a ship of war out of oak of its own making. It is with other trees as with this ancestral oak. Each, with its republic of industrious roots and leaves, is a joint-stock company with limited liability, engaging to furnish you with pine-stems for masts, fir-wood for planking, logwood for dyeing, cork bark for tanning, walnut for tables, rosewood for picture-frames, willow for cradles, mahogany for wardrobes, ebony for will-chests, elm-tree for coffins.

Those trees form the Worshipful Company of Woodmakers, an ancient guild. But there are others as old. A peaceful army of flax plants protects the monopoly of linen-weaving. Whole battalions of cotton shrubs watch over calico. No one may infringe the patent of the indigo plants for blue dye ; none may borrow the multitudinous crimsons and purples of the madder root ; none may rival the elastic fig in manufacturing caoutchouc ; or learn from the trees of the Eastern Archipelago how to produce gutta-percha. The roses of Damascus keep the secret of their otto to themselves ; and the acacias of Arabia and Africa alone deal in gum arabic.

Each of those plants has a monopoly of its manufacture, and sells, at a price settled by itself, all that it produces. The charge is entirely for work, not for materials. You may bring these, indeed, yourself, and have them made up for you ; and nearly the same materials will suit all the manufacturers. The cane will return them as sugar, and the vine as grape-juice, the olive as oil, and the poppy as opium ; keeping only to themselves such a percentage as is needed to maintain their workshops, and multiply their buildings. The day *may* come when the patents of these monopolists will expire, and their secrets be published recipes open to all ; but that day is distant, and chemistry as yet has discovered only so many of their devices as serve to whet to a keener edge her unsatisfied envy of their unapproachable powers. Plants are thus, in virtue of their amazing ability to convert the simplest and commonest ingredients of air, earth, and water into the most complex and precious compounds, of as much value to the industrialist, considered simply as pieces of apparatus, as the most elaborate engines he has constructed. Nor is it otherwise with animals. They do not work with so simple a raw material as plants do : they use plants, indeed, directly or indirectly, as their raw material ; but they convert them into products raised in industrial value by the additional workmanship bestowed upon them. We have thus the silkworm, whose calling it is to turn mulberry leaves into silk ; the bee, who turns sugar into wax ; the coccus, who turns cactus-juice into carmine ; the oyster, who turns sea-chalk into pearls ; the turtle, who turns seaweeds into tortoiseshell ; and the whale, who turns sea-jellies into oil and whalebone. The birds are the only makers of quills and feathers ; the hogs of bristles ; the elephant, the walrus, and hippopotamus of ivory ; the sheep of wool, not to speak of fat and mutton ; the ox and his congeners of undressed leather ; the beaver and his brethren of hat-felt ; and myriads of wild creatures of land and sea of furs and skins. I have barely alluded to one animal, as supplying us with food ; although, as I need not remind you, the most important industrial relation of many others is their power, as machines, to convert weeds of various kinds into beef, mutton, venison, milk, butter, eggs, the flesh of birds, and beasts, and fishes.

Two points call for special notice in connection with living plants and animals, as industrial apparatus and machines. Firstly : It is impossible ever to say too much regarding their amazing transforming, transmitting, and metamorphosing powers. Into the question how far their functions, as modifiers of matter, depend upon their vital, as distinguished from their mechanical and chemical endowment, it is unnecessary to enter here. It is sufficient to notice that the power which every blade of grass and green leaf possesses to resolve carbonic acid into charcoal and free oxygen, and thereby to build up the most solid vegetable tissues, chiefly out of air, is beyond the rivalry of all our engines ; and this is but one feat among the thousands which plants unconsciously perform, and in vain bid us repeat. Within the more complex region of animal life, we are equally compelled to be mere spectators of changes of matter which we very imperfectly understand, and cannot effect by our machines. We can scarcely, accordingly, rate too highly the importance of living organisms, as working for us and with us. Secondly : Although we cannot construct machines to rival sugar-canes and silkworms, or any other plants and animals, we have a singular power of modifying these, so as to alter their actions as machines.

At every agricultural show, prizes are given to the exhibitors of vegetables and animals, which differ as much from their protoplasts as Watt's steam-engine does from Savary's or Newcomen's. So much has cultivation changed our most highly-prized cereals, that it is matter of dispute from what forgotten weeds wheat and barley, as we now see them, have been elaborated. Our apples and pears were once sour crabs ; our plums austere sloes ; our turnips acrid radishes. We have as truly created such fruits and vegetables as the chemist has created ether or chloroform. The physiologist, no doubt, is much more limited than the chemist as a creator, but he is as truly one. Both work under that aphorism of the *Novum Organon*, which teaches us to conquer Nature by obeying her.

The creating power of the physiologist is still more striking as exerted upon animals. Our dogs, and horses, and cattle we have *made*, as truly as we have made glass, or bronze, or porcelain. Nature yields no pointers among dogs, or race-horses among steeds, or short-horns among cattle. Food and climate, regimen and temperature, domestication and training—above all, pairing in special ways—have given us endless and important varieties of every creature we have cared to subdue ; and whenever the whim prompts us to make pets of pigs, or rabbits, or pigeons, we show through how many phases we can induce our playthings or victims to pass.

We do not generally call this *creation*, because we quickly realize that we are but evolving certain germinal tendencies latent in the plants or animals whose offspring our interference renders so unlike themselves ; but we do no more when we call into existence glass or ultramarine ; for unless the elements of these compounds had inevitably tended to produce them under the conditions which we secure, the securing of these conditions would no more have produced them than the mating, under certain restrictions, of particular vegetable or animal pairs would have given us the grapes of Portugal or the race-horses of England.

But whether we choose to call it creation or not, it is transformation of a kind as important, industrially, as that which mechanics has effected on many a machine. Ask a baker if he sets the same value on samples of wheat differently derived and grown, and he will offer you twice the sum for one that he will give for another. Ask a brewer the same question regarding barley, and you will receive the same answer. The sugar-planter carefully classifies his beet-roots or sugar-canes, the perfumer his lavender and orange-flowers, the wine maker his grapes, the tea merchant his teas, the dye broker his indigos and madders, the pharmacologist his poppies and cinchonas. The plants in which those industrialists have an interest may, by variation in stock, in soil, latitude, climate, mode of cultivation, degree of manuring, and the like, be made abundant or deficient in starch, sugar, azotised nutritive principles, mineral salts, odorous essences, colouring principles, and medicinal or poisonous alkaloids.

It is the same with animals. A cattle-dealer will give you one calf which shall certainly in course of time prove a bountiful yielder of milk and cream ; another which shall as certainly be a fatted ox when three years old ; a third which shall by-and-by be a match for a horse at the plough.

A jockey may at first stun you with what seems his unintelligible slang about blood, and bone, and wind, and bottom ; but by-and-by you discover that these are his technical phrases for certain structural and physiological peculiarities, which he can exalt or diminish in a particular animal by due selection of sire and dam, and fit treatment, and training of foal ; so that if you are not very difficult to please, and, moreover, are not in a very great hurry, he will contract *to make* you a horse according to the pattern you select, as an engineer will to make you a steam-engine.

So also : The Yorkshire broadcloth-makers choose by preference the long stapled wool of sheep fed plentifully upon artificial grasses, turnips, and the like. The Welsh blanket-makers, on the other hand, prefer the shorter wool of sheep cropping the natural grass of the hills, whilst the Scotch tartan shawl-weavers work only with Australian or Saxony wools.

In like manner the comb-makers will tell you that the farmers are injuring them, by multiplying breeds of cattle which quickly fatten, and are, in consequence, killed before their horns are well grown ; and those same industrialists will curiously distinguish between the tortoise-shell from one region of the sea and that from another.

I should never end, were I to pursue this matter. Let those illustrations suffice to show that living organisms are not only industrialists like ourselves, and in many cases more skilful artists, but are also machines and apparatus which, within certain wide limits, we can wield at will.

Such, then, is the scientific basis of industrialism, a platform broad as the whole earth, and reaching even to the stars. Although to biology we give a special place, because it deals with the inscrutable mystery of life, yet after all we can find room for it in the twofold division of physical sciences which arranges them, as each in part passively observational, in part actively transformational. Our whole work, as industrialists, resolves itself into observing and transforming, and whether we labour as observers or transformers, we have noble work to do. In either case, an edifice rises before us as the fruit and memorial of our labour. In the one case, this edifice is like a Nineveh recovered from oblivion ; in the other it is like a Crystal Palace, for the first time given to the world. When we work as naturalists, though we do no more than bring into view objects which, from the moment of their creation, have been within reach of our senses, we are, nevertheless, like those skilful excavators who read a new lesson to the modern world, when they recovered to the light of day the long-buried and forgotten wonders of Herculaneum and Pompeii ; or like those unwearied explorers who displaced the sand under which Egyptian temples had been concealing, untarnished and unworn, the paintings and sculptures bestowed upon them centuries before. The same kind of interest which attaches to Belzoni, Denon, and Lepsius, as uncoverers of the sand-hidden pyramids and sphinxes of Egypt ; and to Young, Champollion, Rossellini, and others, as decipherers of the hieroglyphics upon them ; or to Layard, as a revealer of the disinterred wonders of Babylon and Nineveh ; and to Rawlinson, as an interpreter of the Cuneiform inscriptions upon their buildings ; attaches to the naturalists of all classes. The most ancient book, it has been finely said, is published to-day for him who reads it for the first time. Herculaneum, Thebes, and Nineveh were as great novelties on the day of their re-discovering as if they had been cities of the Mormons, built yesterday. Hieroglyphics and Cuneatics are, for the novice who encounters them, marvels as astounding as the new language can be, which a tribe of native Africans are asserted (I fear on doubtful authority) to have recently constructed for themselves. And so, although Galileo only discovered the moons of Jupiter, we often and unconsciously think of him as if he had been their creator, and had first set them to play their untiring game of hide-and-seek round the stately planet ; and so also in no irreverent spirit we call the laws which Kepler divined to regulate certain movements of the heavenly bodies, "Kepler's Laws," although he disclaimed the title, grandly affirming that God, whose laws they were, had waited some thousand years before one man, even Kepler, had discerned them. And so again, notwithstanding our conviction that the star Neptune has been shining in the sky since what I shall be content to call "the beginning," and that all the tiny planets which have so rapidly been added to our astronomical catalogues are probably as old as the sun, we cannot help feeling as if Adams, Leverrier, Hinds, and their brethren, had just planted those lights in the sky, and that midnight should be sensibly less dark because of their addition to the heavens. I have taken these illustrations from the most observational science, astronomy; but any other science would have yielded illustrations as striking. The mastodons and megatheria of geology pass with us for creatures more recent than the elephants and camels which were the largest quadrupeds known to our fathers. Coal we think of as a newly invented, not as the oldest fuel; aluminium we deliberately call a new metal, although we know none older; and gutta-percha is a new "gûm." After all, however, the naturalist is but a disinterrer, his tool is a spade, and his newest things are generally Nature's oldest, and have taken longest to find, because they were buried first and deepest.

When we work as transformationalists we are like sculptors, not evolving a pre-existent statue from a concealing mass, but bestowing a statue on a block of marble. The hollow screw is Archimedes' screw; the condensing steam-engine, Watt's engine; the railway locomotive, Stephenson's locomotive; the electric telegraph, Oersted's telegraph; the Crystal Palace, Fox and Paxton's palace. Yet as implied in what has been already said, we treat discoverers as if they were inventors, and to make amends we call inventors discoverers. And although, in strictness of speech, it is inadmissible to speak of Watt, as accomplished men are frequently found doing, as the *discoverer* of the steam-engine, and only Sancho Panza thought of invoking blessings on the man who first *invented* sleep, still the popular confusion between the discoverer and the inventor shows how difficult it is to assign the one higher praise than the other. It is better to decline answering, or to leave each person to answer according to his taste, such questions as, Is the world more indebted to Layard, who recovered Nineveh, or to Paxton, who created the Sydenham Palace? Whether industrialism is more indebted to the naturalist or to the experimentalist, is a problem best disposed of by the logic of the child who, when asked whether he would have an apple *or* an orange, held out each hand and replied he would have *both*.

ON THE "NARDOO" PLANT OF EASTERN AUSTRALIA.

BY DAVID MOORE, M.R.I.A.

CURATOR OF THE ROYAL DUBLIN SOCIETY'S BOTANIC GARDEN.

In the paper which I have now the honour to read before this sectional meeting of the Royal Dublin Society, my object will be to convey some idea of the nature and appearance of the plant which produces the food called "Nardoo" by the Aborigines of Australia, the position which it occupies in systematic botanic arrangement, and point out the parts of it which contain the nutritive matter.

The Australian mail which brought the sad tidings of the fate of the last exploring party, brought at the same time two small packets of the "Nardoo," which formed a portion of that taken from Cooper's Creek to Melbourne by the party who rescued King, the only survivor. Valentine Hellicar, Esq., to whom we are indebted for one of the packets, sent it to his sister, Mrs. Ball, of Granby Row, with a request that it would be sent to me for the Botanical Garden, which that lady immediately complied with, and at the same time enclosed a short abstract taken from an article published in the 'Ballarat Star' newspaper, giving a brief description of the plant. The fact of the fruit of a cryptogamous plant containing a sufficient quantity of nutritive substance to support human life during a lengthened period, at once struck me as being a very remarkable circumstance. It has been long known that the thallus of some, and the rhizomes of others, contain nutritive matter, which leads to their being occasionally used as food by the natives of various parts of the world ; but this I believe to be the only instance on record of the fruit of any of them being employed for that purpose. Several specimens of Lichens and Algæ afford examples of cryptogamous plants which have the thallus nutritive, whilst Ferns have nutritive rhizomes. Among the latter, *Pteris esculenta* is largely used by the natives of New Holland, and *Cyathea medullaris* by the New Zealanders. Mr. Backhouse, in his work on the former country, speaking of Pteris, says : "Pigs feed on this root when it has been turned up by the plough, and in sandy soils they will themselves turn up the earth in search of it. The Aborigines roast it in the ashes, peel off its black skin with their teeth, and eat it with their roasted kangaroo, in the same manner Europeans do bread. The root of the Tara-fern possesses much nutritive matter, yet it is to be observed that persons who have been reduced to the use of it in long excursions through the bush have become very weak, though it has prolonged life." Now, this last sentence has an important bearing on our present subject, affording as it does strong presumptive evidence that the nutritive matter in the rhizome or stem of the Fern and that contained in the fruit of the "Nardoo" are similar substances. Poor Burke and his companions were able to subsist on the latter during a considerable period, but they also died on it, with the exception of King, who was reduced to a mere skeleton when found by the relief party. I am not sufficiently acquainted with chemical substances to give a definite opinion on the matter, but I believe I am pretty safe in assuming that the nutritive properties contained in the thallus or rhizomes of Cryptogamic plants depend chiefly upon the presence of an amylaceous substance, analogous to gelatine, which occurs in the form of pure starch, or amylaceous fibre, which is also the case in the fruit of the "Nardoo." But, before observing farther on the nutritive parts of this plant, I shall state the position it occupies in the great section of plants to which it belongs.

Whatever doubt exists relative to its species, happily there is none respecting the genus. It is a Marsilea, and of the natural order Marsileaceæ, which Berkeley, in his 'Introduction to Cryptogamous Plants,' places between Lycopodiaceæ and Equisetaceæ. I shall not here state the botanical characters which serve to separate this order from its allies, but simply observe that it includes four genera, according to that author, which contain a considerable number of species, all of an aquatic nature, growing in shallow pools and ditches liable to be occasionally dried up, and in geographical distribution extending over a considerable portion of the surfaces of both hemispheres. Our Irish Flora contains only one example of the order—namely, the Pillwort (*Pilularia globulifera*), a singular little plant, which, like the "Nardoo," creeps along the bottoms of shallow pools of water, producing its round pill-like involucres or spore cases. In general appearance, the "Nardoo" plant bears a great resemblance to some dwarf species of Trifolium, or Clover, in its leaves; whilst the hard, horny involucres might be mistaken at first sight for the legumes of that genus. When growing, it sends out long rhizomes, or stems, which lie flat on the surface of the mud, producing leaves and involucres at intervals from above, and roots from the under side. When the pools become dried up, the leaves wither and decay, leaving the hard involucres on the surface, which the natives collect as required for consumption. It appears, from King's narrative, that the preparation consists of pounding them between stones, and baking into cakes as we use flour, or simply boiling.

The genus Marsilea is one of the highest orders of Cryptogams, inasmuch as the prothallus is confluent with the spore, and does not form a distinct expansion. Besides, when vegetating, a root and frond or leaf are developed at the same time, similar to some monocotyledons, or even dicotyledons—for example, the Water-Lilies, Nymphæaceæ.

The involucre of Marsilea being a metamorphosed leaf, is a further indication of their approach to Phænogamous plants. The microscope shows it is composed of parallel series of tough vascular tissue, which is probably unrollable vascular fibres, lying among the cellular mass, and giving form and consistence to the two valves. When examining this part of the plant, hot water was applied to soften it, which caused it to swell considerably, when the table of the microscope was covered with exceedingly minute roundish granules, which were tinged slightly of a brownish colour by iodine. I think it therefore probable that the mucilaginous valves of the involucres contain one of the elements of nutrition, though not, in my opinion, the principal one. When they open, their contents consist of two distinct spore-like bodies, sporangia and antheridæ, which are differently shaped, and perform very different functions. In fact, they are analogues of the ovules and anthers of flowering plants. Esprit Fabré regards them as such, and states that the latter " consists of a membranous sac, very thin and transparent, in which you see numerous pollen grains ; and when crushed beneath the microscope, spermatic granules of extreme smallness are seen to come out." On the other hand, according to Dr. Lindley, Messrs. Brown and Griffith each regard both sorts of bodies as sporules. I have examined them carefully, and have studied the germination of the plant during the last month, when my observations tend to the confirmation of Fabré's views. The sporangial bodies have in a good many instances produced plants, whilst the antheridæ after the germination of the former became putrid and decayed. But the most convincing proof of the distinctness of the two bodies is their great difference in chemical composition, which I am not aware of having been previously pointed out.

The body which germinates and produces the future plant is filled with well-defined and very large starch granules, which have been taken even by some good Cryptogamic botanists for reproductive bodies. I applied the test of iodine to them, which speedily turned them a violet-blue colour, thus revealing their true nature, and at the same time affording evidence of the principal source of nutrition in the "Nardoo." The antheridæ were scarcely altered in colour by the application of iodine—if any, it was a very slight tinge of brown.

Having now, I trust, shown pretty clearly what the nutritive substances are, and the parts which contain them in this sensitive plant, I shall only further make a few brief remarks on the progress of germination.

The involucres were split and laid on the surface of the mud, covered slightly with water, on the 13th of January, when they were afterwards placed in a warm house, where they speedily softened. In this state, the large oval sporangia could be seen lying among a mass of nearly globose antheridæ, about one-eighth part the size of the former. They were without any cord, or attachment to a central cord, and were surrounded by a gelatinous fluid. The first young frondlet was seen to be protruded from the nipple end of the sporangia on the ninth day after sowing, when a radicle was at the time pushed into the soil. On the fourteenth day several others were visible, and on the sixteenth day the second frond or leaf was produced, which had a spathulate point. At this period the antheridæ were again carefully examined, and found to be breaking up in form and decaying ; whilst the sporangia, which had not vegetated, retained their perfect form, unaltered in consistence. The progress of the young plants does not authorise me to make further observations on them at present; but on some future occasion I hope to be able to state with certainty which species of Marsilea is the "Nardoo" of Cooper's Creek, when the plants become fully developed. If *Marsilea quadrifolia*, which Dr. Harvey informs me is common through east and middle Australia, it has been cultivated at Glasnevin for a number of years ; but if it be the large species gathered by Drummond in the Swan River district, and so kindly lent by Dr Harvey for this occasion, it will prove a valuable and interesting acquisition.

The following description was published in Australia :—

"The Nardoo belongs to that class of flowerless plants which have distinguishable stems and leaves, in contradistinction to that in which stem and leaves are undistinguishable—as seaweed, fungi, and lichens. The part used for food is the involucre sporangium, or spore case, with its contained spores, which is of an oval shape, flattened, and about an eighth of an inch in its longest diameter, hard and horny in texture, and requiring considerable force to crush or pound it when dry, but becoming soft and mucilaginous when exposed to moisture.

"It is the same substance that sustained Macpherson and Lyons when they were lost, in 1860, between Ellenindie and Cooper's Creek, a fruit of it serving them a day. They pounded it, in the manner of the natives, between two stones, and made it into cakes like flour. The spores vegetate in water, and root in the soil at the bottom, where the plants grow to maturity. After the water dries up, the plants die and leave the spore cases on, in many instances quite covering the dried mud, and it is then that they are gathered for food. On the return of moisture, either from rain or the overflowing of rivers, the spore cases are softened, become mucilaginous, and discharge their contents to produce a fresh crop of plants.

"The foliage is green and resembles clover, being composed of three leaflets on the top of a stalk a few inches in length. This order contains five genera and twenty-four species, all of which are inhabitants of ditches or inundated places. They do not appear to be affected so much by climate as by situation, and have been detected in all the four quarters of the globe, chiefly, however, in the temperate latitudes. Their uses are unknown to European botanists. If the Nardoo grains are carefully opened without crushing them, the spores can be readily perceived, of a regular oval form, with the aid of a magnifying glass of small power."

Correspondence.

THE CHEMISTRY OF COLOUR.—RESTORATION OF VIOLET.

TO THE EDITOR OF 'THE TECHNOLOGIST.'

Sir,—Your readers may probably be interested in the following description of a process for restoring the colour to violet silk, after its extraction by acid. It is well-known that spirits of hartshorn will act upon black under similar circumstances, but I am not aware that any chemical agent has hitherto been put forward, as a restorer of violet; and I claim to be the originator of the experiment, with the result of which I am very well pleased. After applying to several chemists and druggists on the subject, and failing to hear of anything that would answer the purpose, it occurred to me to try the "iodine process," which is employed for the purpose of obliterating blots of marking ink from linen; although the process is doubtless well-known to most of your readers, it may be as well to describe the plan adopted :—First, brush with tincture of iodine the portion of fabric affected; after a few seconds well saturate the spot with a solution of hyposulphite of soda, and dry gradually in the air; the colour will then be perfectly restored. I should be very glad if any of your correspondents who may try the experiment would give the result through the medium of your columns.

I am, Sir, yours obediently,

M. A. B.

P.S.—I should have stated that I was induced to try the experiment described above, in consequence of my knowledge of some of the chemical properties of iodine, and its relation to the colour in question; indeed, it is well-known that "iodine" derives its name from the violet vapour which it exhales when volatilized.

Scientific Notes.

New Artificial Fuel.—At a meeting of the Franklin Institute recently held in Philadelphia, Professor Flenny exhibited samples of new artificial fuel and gas material, the invention of Mr. Wm. Gerhardt. This invention consists in preparing porous bricks, balls, or otherwise shaped fire-proof material, which are fully saturated with gas-tar, coal-oil, or any other hydrocarbon of a similar nature. These bricks are afterwards dried and used for the purpose of producing illuminating gas or fuel. The oil having burnt out, the material is used over again; it leaves no ashes, and preserves its porosity. The use of fuel that is free from sulphur is of the highest importance in the manufacture of steel, iron, glass, &c., and it is claimed that artificial fuel is well adapted for these purposes, as well as for other uses, because the price of manufacture is not so high as the present price of coal.

SEAWEED IN PLACE OF HAIR.—It is becoming quite a common practice in New York to use seaweed in place of curled hair for upholstery, cheap furniture, and the filling of mattresses. Quite an extensive business is carried on from Long Island in the seaweed line, and vessels often leave the wharves bound for New York freighted with this article of merchandise, where it is sold to upholsterers and others, bringing a higher market price than a like quantity of the very best hay. On the shore where this seaweed is gathered, it is spread out and dried, and then pressed and baled the same as hay. In this condition it is sent to the metropolis, where it is at once converted into hair mattresses, used for sofas, chairs, &c. The best articles of this kind are stuffed with seaweed, hair sufficient being used to conceal the former and avoid detection. This branch of business is now carried on extensively, and the profits accruing therefrom are of no inconsiderable amount. [*Ulva marina* has long been used for upholstery purposes in England and on the Continent.—EDITOR.]

NEAT'S FOOT OIL.—The process of obtaining this kind of oil is very simple, and many farmers often throw away enough feet annually to furnish oil sufficient to keep all their harness, shoes, and leather machine-belts in the best condition. By breaking the bone of the leg of a fat bullock or cow, it will be found full of an oily substance which often appears as rich and edible as a roll of excellent butter. This is neat's foot oil, and it is sometimes surprising to see how much a single foot and leg will yield when it is properly treated. In order to extract the oil, wash the hoofs clean, then break up the shin bones, the finer the better, and cut the hoofs and bones of the feet into small pieces. Then put them in a kettle of any kind, and pour in water enough to cover the bones. The kettle should never be filled so full that the water will boil over the top of it. The finer the bones are broken, or cut, or sawed, the sooner the oil will be driven out. Now let the kettle be covered as tightly with a lid as it can be conveniently, and boil the bones thoroughly all day. Of course, it will be understood that more water must be poured into the kettle as it evaporates. The object of covering the kettle with a close lid is to retain the heat as much as possible, and thus expel the oil from the bones. The hot water and steam will liquify the oil and expel it from the bones, when it will immediately rise to the surface of the water. Therefore it is very important that the water should not be allowed to evaporate so low that the oil that has risen to the surface of the water comes in contact with the dry hoofs and bones, as much of it will be absorbed by them, and will be lost unless it be again expelled by boiling. When there appears to be oil enough on the surface of the water, pour in a pailful or two of cold water to stop the boiling, or let the fire burn down. Now dip off the oil into some clean vessel, and boil the bones again until there is oil enough to be dipped off again. The oil that is obtained by the first boiling is purer than that which is obtained at the second or third boiling. There will be some water among the oil which must be evaporated; therefore, put the oil in a clean kettle and heat it just hot enough to evaporate the water, and the oil will be ready for use. Great care must be exercised in heating the oil, so as not to burn it. As soon as the oil begins to simmer a little, the oil may be removed from the fire, as the water has evaporated. Water in oil, heated to the boiling point, will be converted into steam almost instantaneously, as may be seen by allowing a few drops to fall into boiling oil or hot lard. (This occurs from the difference of temperature at the boiling point of the two liquids, that of linseed oil being 597°.) Let the oil be kept in a jug corked tightly, and it will be ready for use at any time for years to come. In very cold weather, however, it will require a little warming before using it.

TEASELS (*Dipsacus fullonum*) are the dried heads of a biennial plant which is extensively cultivated in the woollen manufacturing districts and on the Continent, for its uses in raising the nap upon woollen stuffs, which it does by the rigid hooks of the heads. Without this plant, our woollen manufactures could hardly have made such progress. It appears, from many attempts, that the objects designed to be effected by the spiny bracts of the teasel cannot be so well supplied by the mechanical contrivance of metallic wire "cards," and successive inventions have been abandoned as defective or injurious. The dressing of a piece of cloth consumes from 1,500 to 2,000 teasels. They are repeatedly used in different parts of the process. The largest burs, and those most pointed, are esteemed the best, and are called "male teasels;" they are mostly used in the dressing and preparing of stockings and coverlets. The smaller kind, properly called the "fuller's, or draper's teasels," and sometimes the "female teasel," are used in the preparation of the finer stuffs, as cloths, sateens, &c. The smaller kind, sometimes called "linnet's heads," are used to draw out the nap. The dealers give them peculiar names, according to their size and shape, &c., as "Kings," "Queens," &c. The teasel heads are set in a long frame of iron bars, when used for carding. Although not specified in the official trade returns, upwards of twenty millions of these teasel heads are imported annually from France.

THE TECHNOLOGIST.

ON CHEMISTRY APPLIED TO THE ARTS.

BY DR. F. CRACE CALVERT, F.R.S., F.C.S.

A Course of Lectures delivered before the Members of the Society of Arts.

Lecture II.

Gelatine, Glue, Bone-size, Chondrine: their Preparation, Chemical Properties, Nutritive Value, and Application to Arts and Manufactures. Artificial Tortoise-shell. *Isinglass:* its Adulterations and Adaptations to the Clarification Fluids. *Skins,* and the Art of Tanning.

There are four distinct gelatinous substances obtained on a commercial scale from animal tissues and bones, viz., *Osseine,* which I mentioned in my last lecture, *Gelatine, Chondrine,* and *Isinglass.*

Osseine, as already stated, is the animal matter existing in bones, and no doubt it is the same substance which also exists in skins, both during life and when recently removed from the animal. It is characterised by its insolubility, its inability to combine with tannin, and, lastly, the facility with which it undergoes a molecular change, and becomes converted into gelatine—slowly, when boiled with water at 212°, rapidly, when boiled under pressure at a higher temperature, and very gradually under the influence of putrefaction.

Gelatine is a solid semi-transparent substance, which absorbs water in large quantities (40 per cent.), becoming thereby transparent. It is very slightly soluble in cold water, but very soluble in boiling water; and this solution has the characteristic property of forming a jelly on cooling. So powerful is gelatine in solidifying water, that one part of gelatine will form a jelly with 100 parts of water. It has been observed that gelatine loses this valuable property if boiled for a long time at ordinary pressure, or if carried to a temperature above 223° F. Before examining the interesting action of acids upon gelatine, allow me to mention, that whilst solid gelatine resists putrefaction for a long time, its solutions have a tendency to putrefy rapidly, but I have the pleasure to inform you that a few drops of a substance called carbolic acid will prevent putrefaction for a long period. Gelatine dissolves readily in acetic acid, of moderate strength, or vinegar, and this solution, which is used as glue, has the useful property of remaining fluid and sound for some time. But a Frenchman, named Demoulin, has introduced of late years in Paris a solution of glue which is superior to the above and to that in common use, because it does away with the trouble of constantly heating the glue-pot. His process consists in melting one pound of best glue in one pound of water, and adding gradually to the two one ounce of nitric acid of sp. gr. 1·36, heating the whole for a short time, when the fluid glue is prepared. The action of concentrated nitric acid on gelatine is most violent, giving rise to several compounds, amongst which may be cited oxalic acid. The action of sulphuric acid on gelatine is important in a scientific point of view, as an alkaloid called leucine is produced, as well as a sweet substance, called glycocolle, or sugar of gelatine. Gelatine is distinguished from other organic substances by the following chemical reactions :—it gives a white precipitate with alcohol, also with chlorine, none with gallic acid, but one with tannin, or tannic acid. The properties of this precipitate are most important to us, as it is on the formation of it in hides that we ascribe their conversion into leather. The relative proportion of these two substances (gelatine and tannin) in the precipitate varies with the respective proportions brought in contact, but precipitates containing as much as 46 per cent. of tannin have been examined. It is insoluble in water, and presents the invaluable character of not entering into putrefaction. Beautiful fancy ornaments have recently been introduced in Paris by M. Pinson, called artificial tortoiseshell, which he obtains by melting, at a moderate temperature, gelatine with a small amount of metallic salts, running the whole into moulds, staining the mass with hydrosulphate of ammonia, so as to produce an imitation of the grain of tortoiseshell. The objects so produced are then polished and ready for sale. Before entering on the manufacture of various qualities of gelatine, I should wish to state that there can be do doubt, from the researches of Magendie, as well as from the Report of the Commission appointed by the Netherlands Academy of Sciences, that gelatine as food possesses no nutritive value whatever. Allow me now to give you a rapid outline of the methods followed in the manufacture of various qualities of gelatine. The first quality of gelatine is prepared by taking the clippings, scrapings, and fleshings from the tanyard, treating them with lime water or alkali, to remove any smell and certain impurities. They are next washed and left in contact for a day or two with a solution of sulphurous acid. They are then placed in a suitable apparatus, with water, and heated, when the osseine is converted into gelatine. This is run into a second vessel, and a little alum added, to throw down any impurities that may be in suspension. The liquor is now ready to be run into another pan, where it is concentrated to the necessary consistency, so as to become solid, when it is run into wooden moulds. Eighteen hours afterwards the gelatine in turned out of these moulds on to a wet slab, where it is cut into slices by means of a copper wire ; these slices are placed on wire gauze frames, and left in a drying shed until they are perfectly dry and ready for the requirements of trade. The second quality of gelatine is prepared by placing bones in large cylinders, and allowing high-pressure steam to arrive at the bottom of the cylinder, which rapidly converts the osseine of the bones into gelatine, and the removal of this is facilitated by allowing a stream of hot water to enter the upper part of the cylinder. The solution of gelatine thus obtained is evaporated, and is usually employed for the preparation of glue. A third quality is prepared by treating bones with hydrochloric acid (as referred to in my first lecture), and submitting the osseine thus obtained to the action of steam. Lastly, a fourth quality of gelatine, called bone-size, is manufactured by boiling more or less decayed bones as imported from South America and elsewhere, the flesh of dead animals, &c., and concentrating the solution to the consistency required for the various applications it receives in commerce. [The lecturer then described the mode of obtaining the beautiful thin coloured sheets of gelatine used in photography and other fancy purposes, and also the characteristics which distinguished good from bad glues.]

Chondrine, or cartilage gelatine, first noticed by Messsrs. Müller and Vögel, jun., is interesting as possessing qualities not only different from those of gelatine, but such as injure the quality of the latter when mixed with it. In fact, it gives precipitates with acetic acid, alum, persulphate of iron, and other salts ; and as gelatine is often used in connection with these substances, it is easy to foresee how these precipitates may interfere with its application. On the other hand, the quality possessed by this peculiar gelatine may, I think, render it serviceable in the art of calico printing, for fixing colours, or as a substitute for albumen or lactarine. Thus, the solution of chondrine and acetic acid may be mixed with any of the new tar colours, and the whole printed, allowed to dry, and steamed ; the acetic acid will be driven off, leaving the colour fixed by the chondrine on the fabric. Chondrine is prepared by submitting to the action of heat and water the cartilaginous tissue of animals or the bones of young animals.

Isinglass is obtained from the air-bag, or swimming-bladder, of several kinds of fish, especially those of the Sturgeon tribe ; and although imported from various parts of the world, the principal supplies are from Russia, from whence the best qualities come, which bear the names of Beluga, Volga, or Caspian Sea leaf. Brazil, New York, the East Indies, and Hudson's Bay, also supply various qualities of this valuable substance. It also reaches this country in different states, viz., in leaf and in honeycomb, that is, the bag is cut open, cleaned, and dried ; and the quality called snow-bleached is enhanced in value by having been buried in the snow on the banks of the Volga for a long period, by which the isinglass is whitened. Pipes, purses, and lumps are bags which have been cleared but not opened; and a quality called ribbon is made by rolling the bag and cutting it into strips before shipping it to this country.

I shall now endeavour to explain to you how the beautiful preparations before you, for which I am indebted to the kindness of Mr. James Vickers, are obtained. The leaf bladder is first softened in water, and rolled out, under high pressure, into thin leaves, which may extend to several feet long; these in their turn are drawn under a number of revolving knives, making 1,000 revolutions per minute, by which 6,000 of the well-known fine threads are produced in every minute. This quality is chiefly used for culinary purposes. For commercial uses the purses or lumps, above mentioned, are chefly employed. These are soaked in water for two or three days, cut open, certain useless parts removed, further softened, rolled, and cut into various dimensions, according to the requirements of trade, their chief use being the clarification of beer and other alcoholic fluids, for which gelatine cannot be employed, because it dissolves in water, whilst isinglass merely swells. The result is that the highly-swollen and extended mass, when poured into beer, wine, or other alcoholic fluids, is, on the one hand, contracted by their alcohol, and, on the other hand, it combines with their tannin, forming an insoluble precipitate, which, as it falls through the liquor, carries with it the impurities in suspension, and thus clarifies the fluid. As isinglass is very slow in swelling out in the water, brewers employ an acid fluid for the purpose, but, strange to say, instead of using pure acetic acid, many of them take sour beer, and thus run the great risk of spoiling their sound beer. I have known instances of great losses occurring in this way, acetous fermentation having been thus spread through an entire brewery during the summer months. As a large quantity of gelatine, cut into shreds, in imitation of isinglass, is sold at the present day, it may be useful to know that detection is very easy by the following method:—Place a small quantity in hot water, in which gelatine will readily dissolve, whilst isinglass will do so very slowly. I cannot conclude the examination of this interesting class of substances without drawing your attention to the fact that osseine, gelatine, chondrine, and isinglass present marked differences in their textures and general properties, although their chemical compositions may be considered identical, thus:—

	Osseine.	Gelatine.	Chondrine.	Isinglass.
Carbon . : .	50·4	50·0	50·61	50·56
Hydrogen . .	6·5	6·5	6·58	6·90
Nitrogen . . .	16·9	17·5	15·44	17·79
Oxygen . . .	26·2	26·0	27·37	24·75

Esculent Nests.—I must not omit to mention, in connection with this interesting class of substances, these curious gelatinous products, which are not only considered great delicacies in China and other parts of the East, but even in Europe, where they realize from 3*l.* to 7*l.* per pound; some are occasionally imported into England. It has long been a disputed question what is the chemical nature of the substance composing these nests, which are the product of a peculiar kind of swallow; but Mr. Payen, by his recent researches, has left no doubt in the minds of chemists that it is an animal, not a vegetable matter. In fact, it is a peculiar mucous substance, secreted by the bird, and composed of carbon, hydrogen, oxygen, nitrogen, and sulphur. Further, it is insoluble in cold water, but soluble in boiling, and differs from gelatine and isinglass in that it does not gelatinize as it cools.

Skins.—Skin consists of two principal parts, one a mere film, called the epidermis, and the other constituting the bulk of the skin, and called the dermis. There are, also, found in skin a large quantity of blood-vessels, and a small quantity of pigment cells, which hold colouring matter. Further, the skin contains a small amount of nerves and a number of glands, among which may be cited the sebaceous glands or follicles, which are intended to secrete the unctuous matter constantly accumulating upon the skin, and keeping it soft and pliable; then there are perspiratory glands, which play a most important part in the physiological construction of the skin. These are so numerous that Mr. Erasmus Wilson has calculated that there are 3,528 of them in a single square inch of human skin, so that in an ordinary-sized body there are no less than 2,300,000 of these pores. But still the most important part of the hide for us is that called the "dermis." The skins of animals are commercially divided into three distinct classes. The hide is the name given to the skin of full-grown animals, such as oxen, horses, and buffaloes; and these are further sub-divided into fresh hides, that is to say, those which are obtained from animals slaughtered in this country; dry hides, that is hides which have been stretched in the sun, and which are principally imported from South America; dry salted hides, principally from the Brazils, where they are salted and then dried in the sun; and salted hides, which are preserved at Monte Video and Buenos Ayres by salting them, and are then shipped, imbedded in salt, to this country. The composition of a fresh hide may be considered to be as follows:—

Real skin	32·53
Albumen	1·54
Animal matters soluble in alcohol .	0·83
Animal matters soluble in cold water .	7·60
Water	57·50
	100·00

A second class of hides is that called kips, which are skins flayed from the same kinds of animal as the foregoing, only when young. Thirdly, the term skin is applied to those of small animals, such as the sheep, goat, seal, &c.

I will now endeavour to give you an idea of the preparation which hides undergo to fit them for the art of tanning. These operations are four. The first consists in washing off the dirt from the hide, softening it, if a dried one, or removing the salt, if salted. The second has for its object the removal of the hair, which is effected by two or three different methods. The most usual plan is to place the hides in large vats, containing a weak milk of lime, for two or three weeks, care being taken to remove and replace them every other day, after which time the hair is sufficiently loosened to be removed. A second plan consists in piling up the hides, allowing them to enter slightly into a state of putrefaction, and then placing them in weak milk of lime, so as to complete not only the loosening of the hair but also the swelling of the hide, for lime also possesses that property. Another process, which is called the American plan, is to hang the hides in pits for two or three weeks, keeping them at a temperature of 60° and constantly wet, when the hair can be easily removed. Weak alkalies are sometimes substituted with advantage for lime in the above processes, and this plan is certainly the best, as it does not leave in the hide any mineral residue, as is the case with lime, either in the form of an insoluble soap of lime or of carbonate, both of which are highly objectionable in the subsequent process of tanning, as they act on the tannic acid of the tan, facilitating its oxidation, and thereby rendering it useless. Depilation of hides is sometimes effected by the employment of weak organic acids; thus the Calmuck Tartars have used from time immemorial sour milk for that purpose. In some parts of France, Belgium, and Germany, the unhairing of the skins is also effected by an acid fluid, produced by the fermentation of barley meal, which gives rise to acetic and lactic acids. To carry out this process, generally speaking five vats are used. In the first the hides are cleaned; in the second they are softened, and the hair and epidermis prepared for depilation; and the third, fourth, and fifth are used to swell and give body to the hide. This operation, which is called white dressing, does not work so well as lime for heavy hides, as it swells them to such an extent as to render them unfit to prepare compact leather. When the hair can be easily pulled off, the hides are placed on a convex board, called a beam, and scraped with a double-handed concave knife, which not only removes the hair, but a large amount of fatty lime-soap and other impurities from the hides. The third operation consists in fleshing the hides, by shaving off all useless flesh, fat, and other matter by means of a sharp tool. The fourth operation is called swelling or raising the hide, the purpose of which is the following:—First, the removal of any lime or alkali which may remain in the hide; and secondly, to swell or open the pores of the hide, so as to render them better adapted to absorb the tannic acid of the tanning liquors. This is effected by dipping the hides in weak spent tanning liquors, or liquors which have lost the tannic acid, but which contain more or less of gallic acid, for not only do all tanning matters contain gallic acid, but its proportion is greatly increased during the operation of tanning, by a process of fermentation which goes on during that operation, and which converts tannic acid into gallic acid and a peculiar sugar.

The Tanning of Hides.—The old process of tanning consisted in placing layers of wet tan and of hides alternately, and after two or three months removing the whole from the pit and replacing the old by fresh tan. These operations were repeated until the hides were tanned, which took from eighteen months to two years, owing to the difficulty of the tannic acid reaching the interior of the hide. Of late years the process of tanning has been greatly shortened by treating the bark with water, and steeping the hides in the liquor, first weak and afterwards strong. By this means good leather can be obtained in the space of eight or ten months. More rapid tanning, but probably giving inferior leather, is effected by employing, in conjunction with, or as a substitute for, bark, a decoction of divi-divi, valonia, myrobalan, catechu, terra japonica, or gambier, &c. Many efforts have been made of late years to apply the laws of hydraulics, as well as several physical and physiological principles discovered by eminent philosophers, with the view of shortening the period of tanning; but as I believe that none of them have received the general sanction of the trade, I shall confine myself to giving you an idea of the most successful ones. The first attempt to accelerate the process of tanning consisted in forcing the tanning fluids into the substance of the hide by means of hydraulic pressure. Mr. Spilbury, in 1831, employed a process which consisted in packing the hides into sacks, and plunging them into a tanning liquor, and as the fluid percolated through the skin into the interior of the bag the air was allowed to escape. By this means a certain amount of time was saved in bringing the tanning liquor in contact with the various parts of the skin. Mr. Drake soon followed in the same direction, his plan being to sew hides together, forming bags, which he filled with a solution of tan; and to prevent the distension of the skins by the pressure of the liquid within, they were supported in suitable frames; as the pores became gradually filled with tannin, artificial heat was applied to increase the percolation of the fluid. Messrs. Chaplin and Cox's process is also very similar to the above, the difference being that the tanning fluid is placed in a reservoir, and allowed to flow into the bag of hides through a pipe, the fluid being thus employed at pressures varying according to the height of the reservoir. The bag of hides is at the same time plunged into a solution of tannin to prevent excessive distension. Messrs. Knowles and Dewsbury have recourse to another principle to compel the percolation of the tanning liquor through the hide. To effect their purpose they cover vessels with hides, so as to form air-tight enclosures, and, having placed the tanning fluid they employ on the hides, the vessels are exhausted of air, and atmospheric pressure then forces the fluid through the skins into the vessels below. Mr. Turnbull's process, being an imitation of that used for tanning morocco leather, need not be described. Attempts have been made from time to time to mineralize, that is to say, to substitute for tanning, mineral salts, as will be described in my next lecture, when speaking of the art of tanning skins. The processes which have attracted most notice in this branch of the art of preparing leather are those of Messrs. D'Arcet and Ashton, M. Bordier, and M. Cavalier. M. Bordier's plan is that of dipping hides in a solution of sesqui-sulphate of iron, when the animal matters of the hide gradually combine with a basic sesqui-sulphate of iron, rendering the hide imputrescible, and converting it into leather. M. Cavalier's method is to dip hides first into a solution of proto-sulphate of iron, and then into one containing alum and bichromate of potash. A chemical action ensues by which the proto-sulphate of iron is converted into a persulphate, combining with the animal matter, and by its preservative action, together with that of some of the alum, the hide is converted into leather. I think, however, that I shall be able to satisfy you, from the results of many examinations of leather and hides which I have made, that there are good and sufficient reasons why most of these processes have necessarily failed. Inventors have been led to believe, by the statements of many eminent physiologists (as can be proved by reading some of the most recent works on that science), that skin is composed of blood-vessels, glands, &c., plus gelatine, and that if by any mechanical contrivance the tanning liquor could be brought into contact with this gelatine, the leather would be tanned; and many ingenious schemes have been devised, and much money expended, to obtain that result. The fact, however, is that there is no gelatine in skin, for if there were, when hides were placed in water, the gelatine would be dissolved and washed away. But what is supposed to be gelatine in the hides is in reality the isomeric substance called osseine, or one greatly resembling it. The great discovery to be made in the art of tanning, therefore, is that of a chemical or fermentative process, by which the isomeric change (that of the osseine into gelatine) may be rapidly produced, instead of by the slow putrefactive process which occurs in the old method of tanning. Further, I would observe, that to convert a hide into leather it is not sufficient that the whole of its animal matter be combined with tannin, for the leather thus obtained would present two great defects: 1st, the hide would not have increased in weight, and the tanner's profits therefore would suffer; 2ndly, the leather would be so porous as to be useless for many of the purposes for which leather is required. The reason of this is, that when, after a period of several months, the osseine has been converted into gelatine, and this has become thoroughly combined with tannin, a second series of reactions is necessary to render the leather more solid and less permeable to water, and to increase materially its weight. These reactions constitute what is called feeding the hide, and are brought about by leaving it to steep in more concentrated tanning liquor for a considerable period; and this necessary process, beneficial to the wearer as well as to the producer, appears to me to be that which offers the greatest impediment in the way of shortening the period of tanning. The hides as they leave the tanning vat require several operations before they are ready to be used for soles, or to be curried for various commercial purposes. They are first slightly washed and placed in a shed to partially dry, and are then rubbed with a brush and rough stone on the face of the leather, or hair side, to remove any loose tanning material that may remain on the surface ; but this rubbing is not applied to the back, as buyers attach great importance to the peculiar appearance called the bloom, which enables them to judge of the goodness of the tanning. The tanned hides are again slightly dried and oiled on the face, and then submitted to the pressure of a roller passed over the surface, which has the effect of rendering the leather more flexible and the surface perfectly uniform. These operations are repeated two or three times, when the leather is ready for soles. Before the tanned hides intended for shoe-soles are considered fit for that purpose, they must be slightly compressed and softened, so as to again diminish their permeability to water. This was formerly effected by beating with a hammer called the mace, but of late years this slow process has been superseded by compressing machines ; and I believe those most appreciated in the trade were invented by Messrs. Cox and Welsh, and Messrs. Iran and Schloss.

ON MUSEUM ARRANGEMENT AND ACCLIMATISATION.

BY DR. J. E. GRAY, F.R.S.

The following forms a portion of the opening address of Dr. Gray, as President of the Zoological and Botanical Section of the British Association, read at Bath :—In the first place I wish to say a few words on the subject of public museums. It may be well imagined that having, during the whole of my life, been intimately connected with the management of what I believe to be, at the present day, the most important zoological museum in the world, it is a subject that has long and deeply occupied my thoughts ; and it will also be readily believed that it is only after serious and prolonged consideration that I have come to the conclusion that the plan hitherto pursued in the arrangement of our museums has rendered them less useful to science, and less interesting to the public at large, than they might have been made under a different system. Let us consider the purposes for which such a museum is established. These are twofold—1st, for the diffusion of instruction and rational amusement among the mass of the people ; 2ndly, for giving to the scientific student every possible means of examining and studying the specimens of which they consist. Now, it appears to me that in the desire to combine these two objects, which are essentially distinct, the first object—namely, the general instruction of the people, has been to a great extent lost sight of, and sacrificed to the second, without any corresponding advantage to the latter, because the system itself has been thoroughly erroneous. The curators of large museums have naturally, and, perhaps, properly, been men more deeply devoted to scientific study than interested in elementary instruction, and they have consequently done what they thought best for the promotion of science by accommodating and exhibiting on the shelves or the open cases of the museum every specimen that they possessed, without considering that by so doing they were overwhelming the general visitor with a mass of unintelligible objects, and at the same time rendering their attentive study by the man of science more difficult and onerous than if they had been brought into a smaller space and in a more available condition. What the largest class of visitors—the general public—want, is a collection of the more interesting objects so arranged as to afford the greatest possible amount of information in a moderate space, and to be obtained, as it were, at a glance. The student, on the other hand (and though these are undoubtedly the most important, they form but an infinitesimal proportion of the mass), the scientific student requires to have under his eyes, and in his hands, the most complete collection of specimens that can be brought together, and in such a condition as to admit of the most minute examination of their differences, whether of age, or sex, or state, or of whatever kind that can throw light upon all the innumerable questions that are continually arising in the progress of thought and opinion. In the futile attempt to combine these two purposes in one consecutive arrangement, the modern museum entirely fails in both particulars. It is only to be compared to a large store, or a city warehouse, in which every specimen that can be collected is arranged in its proper shelf, so that it may be found when wanted, but the uninformed mind derives little instruction from the contemplation of its stores, while the student of Nature requires a far more careful examination of them than is possible under such a system. To consult such an arrangement with any advantage, the visitor should be as well informed with relation to the system on which it is based as the curator himself, and consequently the general visitor perceives little else than a chaos of specimens, of which the bulk of those placed in close proximity are so nearly alike that he can scarcely perceive any difference between them, even supposing them to be placed on a level with the eye, while the greater number of those which are above or below the level are utterly unintelligible. To such visitors the numerous specimens of rats or squirrels, or sparrows or larks, that crowd the shelves, from all parts of the world, are but a rat, a squirrel, a sparrow, or a lark ; and this is still more especially the case with animals of a less marked and less known types of character. Experience has long since convinced me that such a collection so arranged is a great mistake. The eye both of the general visitor and of the student becomes confused by the number of the specimens, however systematically they may be brought together. The very extent of the collection renders it difficult even for the student, and much more so for the less scientific visitor, to discover any particular specimen of which he is in quest; and the larger the collection the greater this difficulty becomes. Add to this the fact that all specimens, but more especially the more beautiful and the more delicate, are speedily deteriorated, and in some cases destroyed for all useful purposes by exposure to light, and that both the skins and bones of animals are found to be much more susceptible of measurement and comparison in an unstuffed or unmounted state, and it will be at once apparent why almost all scientific zoologists have adopted for their own collections the simpler and more advantageous plan of keeping their specimens in boxes or in drawers, devoted each to a family, a genus, or a section of a genus, as each individual case may require. Thus preserved, and thus arranged, the most perfect and the most useful collection that the student could desire would occupy comparatively a small space, and by no means require large and lofty halls for its reception. As it is desirable that each large group should be kept in a separate room; and as wall-space is what is chiefly required for the reception of the drawers or boxes, rooms like those of an ordinary dwelling-house would be best fitted for the accommodation of such a collection, and of the students by whom it would be consulted; one great advantage of this plan being that the students would be uninterrupted by the ignorant curiosity of the ruder class of general visitors, and not liable to interference from scientific rivals. There are other considerations, also, which should be taken into account in estimating the advantages of a collection thus preserved and thus arranged. A particular value is attached to such specimens as have been studied and described by zoologists, as affording the certain means of identifying the animals on which their observations were made. Such specimens ought to be preserved in such a way as to be least liable to injury from exposure to light, dust, or other extraneous causes of deterioration; and this is best done by keeping them in a state the least exposed to those destructive influences, instead of in the open cases of a public and necessarily strongly lighted gallery. Again, the amount of saving thus effected in the cost of stuffing and mounting is well worthy of serious consideration, especially when we take into account the fact that this stuffing and mounting, however agreeable to the eye, is made at the cost of rendering the specimens thus operated upon less available for scientific use. All these arguments go to prove that, for the purposes of scientific study, the most complete collection that could possibly be formed would be best kept in cabinets or boxes, from which light and dust would be excluded, in rooms specially devoted to the purpose, and not in galleries open to the general public; and that such an arrangement would combine the greatest advantage to the student, and the most complete preservation of the specimens, with great economy in point of expense. This having been done, it is easy to devise the plan of a museum which shall be the most interesting and instructive to general visitors, and one from which, however short their stay, or however casual their inspection, they can hardly fail to carry away some amount of valuable information. The larger animals being of course more generally interesting, and easily seen and recognised, should be exhibited in the preserved state, and in situations in which they can be completely isolated. This is necessary also on account of their size, which would not admit of their being grouped in the manner which I proposed with reference to the smaller specimens. The older museums were, for the most part, made up of a number of larger or smaller glass-fronted boxes, each containing one, or, sometimes, a pair of specimens. This method had some advantages, but many inconveniences; amongst others that of occupying too large an amount of room. But I cannot help thinking that when this was given up for the French plan of attaching each specimen to a separate stand, and marshalling them like soldiers on the shelves of a large open case, the improvement was not so great as many supposed; and this has become more and more evident since the researches of travellers and collectors have so largely increased the numbers of known species—of species frequently separated by characters so minute as not to be detected without careful and close examination. Having come to the conclusion that a museum for the use of the general public should consist chiefly of the best known, the most marked, and the most interesting animals, arranged in such a way as to convey the greatest amount of instruction in the shortest and most direct manner, and so exhibited as to be seen without confusion, I am very much disposed to recur to something like the old plan of arranging each species or series of species in a special case, to be placed either on shelves or tables, or in wall cases, as may be found most appropriate, or as the special purpose for which each case is prepared and exhibited may seem to require. But instead of each case, as of old, containing only a single specimen, it should embrace a series of specimens, selected and arranged so as to present a special object for study; and thus, any visitor looking at a single case only, and taking the trouble to understand it, would carry away a distinct portion of knowledge, such as in the present state of our arrangements could only be obtained by the examination and comparison of specimens distributed through distant parts of the collection. Every case should be distinctly labelled with an account of the purpose for which it is prepared and exhibited, and each specimen contained in it should also have a label indicating why it is there placed. I may be asked why should each series of specimens be contained in a separate case; but I think it most obvious that a series of objects exhibited for a definite purpose should be brought into close proximity, and contained in a well-defined space; and this will best be done by keeping them in a single case. There is also the additional advantage that whenever, in the progress of discovery, it becomes desirable that the facts for the illustration of which the case was prepared, should be exhibited in a different manner, this can easily be done by re-arranging the individual case, without interfering with the general arrangement of the collection. I believe the more clearly the object is defined, and the illustrations kept together, the greater will be the amount of information derived from it by the visitor, and the interest he will feel in examining it. Such cases may advantageously be prepared to show the classes of the animal kingdom by means of one or more typical examples of each class ; the orders of each class ; the families of each order ; the genera of each family ; the section of each genus ; a selection of a specimen of each of the more important or striking species of each genus or section ; the changes of state, sexes, habits, and manners of well-known or otherwise interesting species ; the economic uses to which they are applied, and such other particulars as the judgment and talent of the curator would select as the best adapted for popular instruction, and of which these are intended only as partial indications. No one, I think, who has ever had charge of a museum, or has noted the behaviour of the visitors while passing through it, can doubt for a moment that such cases would be infinitely more attractive to the public at large than the crowded shelves of our present museums, in which they speedily become bewildered by the multiplicity, the apparent sameness, and, at the same time, the infinite variety of the objects presented to their view, and in regard to which the labels on the top of the cases afford them little assistance, while those on the specimens themselves are almost unintelligible. When such visitors really take any interest in the exhibition, it will generally be found that they concentrate their attention on individual objects, whilst others affect to do the same in order to conceal their total want of interest, of which they somehow feel ashamed, although it originates in no fault of their own. I think the time is approaching when a great change will be made in museums of natural history ; and I have, therefore, thrown out these observations and suggestions, by which it appears to me that this usefulness may be greatly extended. In England, as we are well aware, all changes are well considered and slowly adopted. Some forty years ago, the plea of placing every specimen on a separate stand, and arranging them in rank and file in large glass cases, was considered a great step in advance, and it was doubtless an improvement on the pre-existing plan, especially at a time when our collections were limited to a small number of species, which were scarcely more than types of our modern families or genera. The idea had arisen that the English collections were smaller than those on the Continent, and the public called for every specimen to be exhibited. But the result has been that, in consequence of the enormous development of our collections, the attention of the great mass of visitors is distracted by the multitude of specimens, while the minute characters by which naturalists distinguish genera and species are unappreciable in their eyes. It was not, however, the unenlightened public only who insisted on this unlimited display, there were also some leading scientific men who called for it on the ground that the curator might be induced to keep specimens out of sight, in order to make use of them for the enlargement of his own scientific reputation, while the scientific public were debarred the sight of them, and that valuable specimens might thus be kept, as the phrase was, in the cellars. But any such imputation would be completely nullified by the plan I have proposed, of placing all the specimens in the scientific collection, in boxes or drawers appropriated to them, and rendering them thus at once and readily accessible to students at large. And I may observe, that the late Mr. Swainson, who was the first to raise the cry, lived to find that it was far more useful to keep his own extensive collection of bird skins in drawers, like his butterflies and his shells ; and that most scientific zoologists and osteologists are now convinced that the skins of animals unstuffed, and the bones of vertebrata, unmounted, and kept in boxes, are far more useful for scientific purposes than stuffed skins or set up skeletons. So also with reference to my proposal for the arrangement of the museum for the general public. I find that those who are desirous of exhibiting their specimens to the best advantage are gradually adopting similar plans. Thus, when Mr. Gould determined the exhibition of his magnificent collection of humming-birds, he at once renounced the rank and file system, and arranged them in small glazed cases, each case containing a genus, and each pane or side of the case showing a small series of allied species, in a family group of a single species. When lately at Liverpool, I observed that the clever curator, Mr. Moore, instead of keeping a single animal on each stand, has commenced grouping the various specimens of the same species of mammalia together on one and the same stand, and thus giving far greater interest to the group than the individual specimens afforded. In some of the continental museums also I have observed the same plan adopted to a limited extent. In the British Museum, as an experiment with the view of testing the feelings of the public and the scientific visitors, the species of the nester parrots and of the birds of paradise, a family of the gorilla, and of the impeyan pheasants, and sundry of the more interesting single specimens, have been placed in isolated cases, and it may be readily seen that they have proved to be the most attractive cases in the exhibition. I now exhibit a case of insects received from Germany, in which the plan I have suggested is fully carried out. You will perceive that in one small case are exhibited simultaneously, and visible at a glance, the egg, the larvæ, the plant on which it feeds, the pupa, and the perfect moth, together with its varieties, and the parasites by which the caterpillar is infested ; such cases, representing the entire life and habits of all the best known and most interesting of our native insects, would be, as I conceive, far more attractive to the public at large than the exhibition of any conceivable number of our allied or cognate species, having no interest whatever except for the advanced zoological student. I will only add, that I am perfectly satisfied by observation and experience, and that I believe the opinion is rapidly gaining ground, that the scientific student would find a collection solely devoted to study, and preserved in boxes and drawers, far more useful and available for scientific purposes than the stuffed specimens at present arranged in galleries of extent, and crowded with curious and bewildered spectators ; while, on the other hand, the general public would infinitely better understand, and conseqnently more justly appreciate, a well-chosen and well-exhibited selection of a limited number of specimens, carefully arranged, to exhibit special objects of general interest, and to afford a complete series of elementary instruction, than miles of glass cases containing thousands upon thousands of specimens, all exhibited in a uniform manner, and placed like soldiers at a review. I now turn to a very different subject, but one which has always occupied a considerable share of my attention, and on which a few observations may not be out of place on this occasion—viz., the acclimatisation of animals. This subject, which has been a favourite one with the more thoughtful student, appears all at once to have become popular, and several associations have been formed for the especial purpose of its promotion, not only in this country, but also on the Continent and in the Australian Colonies. I may observe that the acclimatisation of animals, and especially the introduction and cultivation of fish, was among the peculiar objects put forward by the Zoological Society at the time of its foundation, nearly forty years ago, although, as we all know, it has been able to do very little for its promotion. It would appear, from observations that are occasionally to be met with in the public papers, and in other journals, as though it were a prevalent opinion among the patrons of some of these Associations, that scientific zoologists are opposed to their views, or at least lukewarm on the subject. But I am convinced that they are totally mistaken in such a notion, and that it can only have originated in the expression of a belief, founded on experience, that some of the schemes of the would-be acclimatisers are incapable of being carried out, and would never have been suggested if their promoters had been better acquainted with the habits and manners of the animals on which the experiments are proposed to be made. The term "acclimatisation" has been employed in several widely different senses. Firstly, as indicating the domestication of animals now only known in the wild state; secondly, to express the introduction of the domesticated animals of one country into another ; and thirdly, the cultivation of fishes, &c., by the re-stocking of rivers, the colonization of ponds, or the renovation of worn-out oyster or pearl fisheries by fresh supplies. Commencing with the first of these objects, which is by many regarded as the most important, I would observe that some animals seem to have been created with more or less of an instinctive desire to associate with man, and to become useful to him ; but the number of these is very limited, and, as it undoubtedly takes a long period to become acquainted with the qualities and habits of these animals, and of the mode in which their services may be rendered available, it would almost appear as if all the animals which are possessed of this quality and are worth domesticating had already been brought into use. Indeed, all those which are now truly domesticated were in domestication in the earliest historic times. The turkey, it may be said, was not known until the discovery of America ; but I think that it has been satisfactorily proved that our domestic turkey is not descended from the wild turkey of America, but comes of a race which was domesticated by the Mexicans before the historic period. Again, the number of such animals is necessarily limited, for it is not worth while to go through a long process of domestication with the view of breeding an animal that is not superior in some important particular to those which already exist in domestication. For example, where would be the utility of introducing other ruminants, which do not breed as freely, feed as cheaply, afford as good meat, and bear the climate as well as our present races of domestic cattle ? It has been thought that some of the numerous species of African antelopes might be domesticated here ; but every one who has eaten of their flesh describes it as harsh and dry, and without fat ; and such being the case (even could the domestication be effected, which I very much doubt) such an animal must have some very valuable peculiarity in its mode of life, and be capable of being produced at a very cheap rate, to enable it to take rank in our markets beside the good beef and mutton with which they are at present supplied. And, even supposing it to be semi-domesticated only for the park, it could not for an instant be put in competition with the fine venison which it is thought that it might displace. I am aware that certain French philosophers have lately taken up a notion that it is desirable to pervert the true purposes of the horse, by cultivating him for food instead of work ; and that a Society of *Hippophagi* has been instituted with this view. Of course, under present circumstances, the flesh of old and worn-out horses is sold for much less than the meats of well-fed ruminants, and the *miserable* classes in countries are glad to obtain animal food of any kind at so low a rate ; but, whenever an attempt has been made to fatten horses for food, it has been found that the meat could not be produced at so low a rate as that for which far better beef and mutton could be bought. There are also some small semi-domesticated animals, such as the porcupine and other *glires*, which are said to afford good meat, but they have long been driven out of the market by the cheapness and abundance of the prolific rabbit. With regard to the larger ruminants, such as the giraffe, the eland, and some other foreign deer, the llama, and the alpaca, which have been bred in this country, but never brought into general use, I cannot consider them as at all acclimatised. They have almost always had the protection of warmed buildings, especially in the winter ; and though they may have lived through a certain number of years, they are liable to attacks of diseases dependent upon our climate, and generally die off before their natural term of existence is completed. I can only regard them as partially domesticated, and that only as objects of curiosity and luxury, and as incapable of being turned to any useful domestic purpose. With regard to those animals which may be considered as more or less completely under the control of man, there exists considerable difference in the nature of their domestication. The typical or truly domesticated among them, such as the ox, the sheep, the horse, the camel, the dromedary, the dog, and the cat, like the wheat and the maize among plants, are never found truly wild, and when they are permitted to run wild, as in the case of horses and oxen in South America, they are easily brought back to a state of domestication, especially if caught young. What may be called the semi-domesticated or domesticatable animals, such as the buffalo, the goat, the pig, the reindeer, the yak, and some other Asiatic cattle, are found both in the tame and wild state, and often in the same region, and in close proximity with each other. The Asiatic elephant, and a few other animals which can be made tractable under man's direction, never (or very rarely) breed in domestication, and all the individuals of these very useful races are caught wild and brought into subjection by training. The African elephant is evidently equally amenable to man's control, and was equally domesticated by the Romans ; but the negroes do not seem to appreciate the advantages which they might derive from its domestication, and only make use of its tractable disposition to keep it in captivity until such time as its ivory is best fitted for the market, when they also can feed upon its flesh. All our domestic or semi-domestic animals have their proper home in the temperate regions of Europe and Asia. They all, except the ass, bear great cold better than excessive heat, and even the ass suffers greatly on the coasts of the tropics. The sheep in the warmer regions require to be driven to the cool mountains during the hot season. In the tropics they lose their wool, and like the long-haired goats and dogs change the character of their fur. The inhabitants of the Arctic or sub-Arctic regions of Europe and Asia have partially domesticated the reindeer ; and either Asiatics have peculiar aptitude for domesticating animals, or the ruminants of that part of the world are peculiarly adapted for domestication. In the mountain regions of Thibet and Siberia the yak has been domesticated, and like the reindeer of the Arctic regions it is used as a beast of burthen, as well as for milk and food. The steppes of Asia is the home of the camel and dromedary. In the lower or warmer regions of Central and Southern Asia the zebu has been completely domesticated ; and the natives of India and of the Islands of the Malayan Archipelago have brought into a semi-domesticated state various species of wild cattle, such as the eyal, the gour, and the banting, and have even obtained some hybrid breeds between some of them and the zebus ; as well as the buffalo, which they have in common with Africa and the South of Europe. In the park of the Governor-General of India there are large herds of the sasin (*Antilope Cervicapra*) in a semi-domestic state; and our officers found in the park of the Emperor of China at Pekin more than one species of domesticated native deer. We have as yet received from Japan only one peculiar species of domestic animal, viz., a pig with a plaited face (*sus plicatus*); but it is not unlikely that the deer called *Cervus Luku* is a domesticated species, like the *Cervus Swinhoei*, of the Island of Formosa. In Celebes there is a small buffalo, called *Anoa;* and in the same island, as well as in Java and some of the other islands of the Indian Ocean, most of the aboriginal pigs, including the Babiroussa, have been more or less completely domesticated. These numerous instances will suffice to show how largely Asiatics have been enabled to draw upon the wild animals around them for additions to their domestic or semi-domestic races; but a glance at the habits and manners of most of them will suffice to show how little they would be suited to our more northern climate, and how small would be the advantage gained were it possible to introduce them here. Africa has only sent to Europe the Guinea-fowl, that vagrant from our farm-yards, but it, too, has some domesticated animals of its own. In the more fertile and well-watered parts of that continent there exist at least five different kinds of domestic cattle. The buffalo (*Bos Bubalus*) and humpless cattle, which appear to be of the same species, and to be derived from the same source as the buffalo and domestic oxen of Europe. The African zebu (*Bos Dante*) appears to be distinct from the zebu of India, and is probably an indigenous domestic race; and the long-eared bush-cattle or zamous (*Bos boachyceros*) is certainly an aboriginal species peculiar to Tropical Africa. Besides these, it has in the desert regions the camel, with Asia; this animal is also domesticated in the southern parts of Europe. America has only three, or (if we reckon the dog) at most four, domestic animals belonging to the country before it was discovered by Europeans, who have, however, since introduced into it most of those which they themselves previously possessed. The turkey was early domesticated by the native Mexicans; and it may be observed that in Europe these birds have been only imperfectly naturalized, requiring peculiar care and attention in their early stages, to protect them from the effects of an uncongenial climate. The llama and alpaca were also early domesticated by the native Peruvians, and it would appear as if these animals would not bear transportation to other quarters. All the attempts at least which have hitherto been made to introduce them into Europe and Australia have resulted in failure. The Esquimaux inhabiting the more northern regions have a peculiar race of dogs, which is in the highest degree useful to them, but it appears to be of the same original stock with the dogs of Europe, and has probably passed from one continent to the other. In some parts of this vast continent the ox and the horse, since their introduction from Europe, have so firmly established themselves in a half-wild state as to be often hunted and killed for their hides alone. Australia and the Islands of the Pacific have no native domestic animals, if we again except the dog; and Australia alone has many mammals sufficiently large to be hunted for their flesh. There formerly existed in New Zealand a large bird (the Moa) which was eaten by the natives, but it seems to have been exterminated, or nearly so, before the colonization of the islands. European animals have been largely and advantageously introduced throughout the Pacific Ocean, and in some cases have become wild and even dangerous. As in Europe, all the domestic animals of the various parts of the world appear to have been brought into their present condition for many ages, inasmuch as they were all found in a domestic state when the several countries were first visited by Europeans. And an attentive study of the list, and of the peculiarities of the animals composing it, induced me to believe that in attempting to introduce new domestic animals into some of our colonies, it would be desirable not to confine ourselves to European breeds, but to ascertain whether some of the domestic races of Asia and Africa might not be better adapted to the climate and other conditions of the colony, although, for reasons to which I have before adverted, it would neither be worth the trouble, nor consistent with good policy, to attempt their introduction here. There is evidently ample room for such experiments, which might be advantageously made in the colonies of the west coast of Africa; for instance, where our horse, ass, ox, sheep, and goats, and even the dogs, have greatly degenerated; where the horse and the ass live only for a very brief period; where the flesh of the ox and the sheep is described as bad and rare; and the flesh of the goat, which is more common, is said to be tasteless and stringy. The pig alone, of all our domestic animals, seems to bear the change with equanimity; and the produce of the "milch pig," so often sold to passengers by the mail-packets and the ships on the stations as the milk of the cow, or even of the goat, is rarely to be obtained. Unfortunately, both the white and the black inhabitants are merely sojourners in the land, and do not seem to possess sufficient energy or inclination to make the experiments themselves. Secondly, as regards the introduction of the domestic races of one country into another. There can be no doubt that this is a much more important object in relation to our Australian colonies, and other settlements planted in waste lands, than it is to old countries, such as all the European states, and that it has been pursued, as far as they are concerned, with great success. Dr. George Bennett, in the third annual 'Report of the Acclimatisation Society of New Holland,' has well observed:—"We have lately heard of acclimatisation dinners in London and other places, but a dinner in New South Wales of food naturalised in the colony occurs every day, and a finer display cannot be surpassed in any country." Few countries were so badly supplied by Nature with useful animals and plants as the Australian continent; and while we do not receive in Europe a single indigenous product for our tables, either animal or vegetable, from Australia, which in this respect has added nothing to the comforts of civilised man, no country has been more richly supplied with the useful products of other parts of the world; for, not only have the natural productions of the temperate regions of Europe been largely introduced, but even the flowers and fruits of tropical and sub-tropical regions. There is no doubt that the introduction into Australia of animals long domesticated in Europe is far more easy than that of semi-domesticated animals from countries in a ruder state of society. Perhaps this may explain why the leading animals and plants to which Dr. Bennett refers in his report (and which, be it observed, have all been introduced by individual enterprise) have succeeded so much better than the later attempts to introduce such animals as the llama and various ornamental mammalia and birds. Among other attempts referred to are the blackbirds, thrushes, starlings, and skylarks of Europe; these latter seem to be established in the Botanic Gardens, but it is doubtful whether such birds can find their appropriate food, except in cultivated gardens, or near the towns. On the other hand, it is to be observed that the introduction into a new country of domestic or semi-domesticated animals is not always an unmixed advantage. Thus, the domestic pig has been so completely naturalized in New Zealand, that its great multiplication has rendered it so mischievous a pest to the sheep-farmer, from its following the ewes and eating the new-dropped lambs, that the flock-masters have been compelled to employ persons to destroy the pigs, paying for their destruction at the rate of so much per tail. Many thousands are thus destroyed in a single season, without any diminution being discernible. Indeed, it has been proved by Dr. Hooker, in an interesting paper "On the Replacement of Species in the Colonies," that the introduction of a new animal or plant often results in its destroying and taking the place of some previous inhabitant, thus rendering its introduction a matter of doubtful advantage, or, at all events, a question to be approached with considerable caution. It is, however, manifest that, on the whole, more useful results are to be obtained from the introduction of races already domesticated into countries which they have not yet reached, than from the attempt to acclimatise animals for the most part either unsuited to the climate, or capable only of an inferior degree of domestication, or inferior in quality to those which are already in possession of the ground. Under the third head, the cultivation of fish, I have very little to observe, although the subject is unquestionably one of great importance. But as yet we have little practical information upon the question, and I consider that the advocates of the system are only for the present feeling their way, as the experiments have not been pursued for a sufficient length of time to have produced any positive or reliable results. To replenish rivers in which the fish which formerly inhabited them have been destroyed, it is necessary closely to study the habits of the fish, and to imitate as much as possible their natural proclivities. Thus, for example, it appears to me that, when attempting to introduce young artificially hatched fish into a river, we should place them in the smallest streamlets, where the fish would themselves deposit their ova, and not in the wider parts of the stream, where they are liable to injury from various causes. Again, the notion of fishing the breeding fish out of a river, collecting their eggs, and artificially impregnating them, seems to me an unnatural mode of proceeding, and such as is not practised in the cultivation of any other animal. I cannot see any practical advantage that can possibly be derived from it. For the replenishing of worn-out fisheries of oysters and pearl-shells, all that seems necessary or advantageous to be done is to place round the bed twigs and various similar substances, so arranged as to retain the eggs when deposited, and to protect them by all the means in our power, leaving the beds undisturbed for a sufficient time to allow the new brood to become firmly established in them. Besides the numerous attempts at home to replenish our rivers and oyster-beds, much has been written, and large sums have been expended, in trying to introduce salmon into the rivers of Australia ; but the many failures show how little those who undertook the task were acquainted with the most common physiological questions connected with the removal of fish, and how small was their knowledge of the habits and peculiarities of the fish which they proposed to remove. What, indeed, could be more absurd than the attempt to introduce salmon into rivers which for a considerable part of the year are reduced to a series of stagnant pools ? I think I may venture to predict that if salmon are ever introduced into Australia they are much more likely to succeed in the deep rapid rivers of Tasmania than in the streams of Australia proper. At the same time, when we consider the very limited geographical range of the salmon in Europe, confined as it is to those rivers which have their exit into the North Sea—that the attempt to remove it even from one river to another in Europe has always been a failure—and that it is not only necessary that the salmon should have a river similar to that which it inhabits here, but also the same food and other peculiarities, without which apparently it cannot subsist—I must confess that I have no great faith in the success of the introduction of the salmon into Australia. I think, therefore, that it is to be regretted that the Australian Acclimatisation Society do not rather make some experiments on the introduction of the gourami, or some of the other edible fish of countries nearer to, and more resembling their own.

PRODUCTS OF THE MONTANA OF PERU.

BY MR. CONSUL COCKS.

It has appeared to me that this great eastern Peruvian territory, the Montaña or region of the woods, has been much overlooked, and that it deserves a more attentive consideration from our merchants than it has hitherto received. Two portions of it—namely, the Department of the Amazonas and the littoral province of Loreto—are among the richest in Peru, possessing, as they do, unlimited resources for commerce and science, and of which it is no exaggeration to say that, in their peculiar character, they have no equal in any country.

The Amazonian basin possesses the most magnificent water communication in the world, and it offers facilities and means for commerce between the above-mentioned provinces, Peru generally, and Europe, which are unrivalled.

It is true the great Amazon river is at present, by the policy of the Brazilian Government, in a measure, shut to commerce, the duties imposed at their port at the mouth of the Amazon amounting to this; but there is little doubt but that this state of things will be changed, and that the Amazon river, at no distant period, will be made free and open to all nations, as it ought to be for the purposes of trade. So soon as this desirable event shall happen, it is more than probable that the greater part of the goods from Europe will be introduced by this admirable channel.

What the ulterior views of the present railroad company on the west coast may be, I am not prepared to say, but there appears to be little doubt but that they will extend their line of rail eventually to Cuzco. It is clear that Arequipa cannot be the terminus; the line must be continued further: and as Cuzco is an important town already, and the centre of Peru,* it may not seem premature to affirm that this town will again play an important part in the future progress of the Republic. Cuzco then will probably be the terminus, or rather the main trunk, whence will branch out in all directions other railroads, and probably the first direction taken will lead towards the provinces of Amazonas and Loreto above-mentioned.

With the railroad on the west coast, and the free navigation of the Amazon river on the east coast, the rich products of the interior of Peru may have a chance of egress to Europe, whilst, at the same time, the manufacturers of Europe will have an equal chance of ingress to this country.

The Montaña.—The territory of the Montaña is of the richest in the gifts of Nature. It possesses accumulated treasures, which, it may be said, are yet hidden in the greater part of it. The richness of its vege-

* Cuzco in the Quichnan language signifies "Navel."

tation, the abundance of its navigable rivers communicating with the Atlantic, the singularity and copiousness of the animal, vegetable, and mineral kingdoms, are all worthy of attention, particularly its ornithology, the most abundant and curious in the world. Its immense extent, its majestic aspect, the great volume of water of its rivers, the colossal size and peculiar character of its trees, its balsamic and medicinal products, its fruits and substances, exotic to all other countries, are sources of inexhaustible wealth.

It extends from the eastern slope of the Eastern Cordillera to the frontiers of Bolivia, Brazil, and Ecuador, comprehending the Pampas of Sacramento, between the rivers Pachitea and Huallaga. These pampas comprise the greater part of the territory which lies between the rivers Huallaga, Ucayali, Amazonas, and Pachitea, and are unrivalled in point of fertility.

From north to south it extends about 300 miles, and its breadth is from 40 to 100. Many rivers have their origin in the centre of the district, and uniting themselves with the Huallaga enter the Ucayali. The greater part of these rivers are navigable for small boats: the Aiguaitia, Cuxiabatai, and Santa Catalina are the most considerable, and fall into the Ucayali. In the northern part there are many canals between the Huallaga and Marañon. The soil is covered with trees of prodigious size, and herbs and plants of such a height that a man is lost in them. So fertile is the soil, that it is a wonder it has not been populated in proportion to the advantages it offers. The whole of it, or nearly so, is virgin land, and capable of maintaining millions of head of cattle, and domestic animals of all kinds.

Department of Amazonas.—The Department of Amazonas is bounded on the north by Ecuador, on the south by the department of Junin, on the east by the province of Loreto, and on the west by the departments of Cajamarca and Libertad, which are separated from it by the river Amazon. It contains two provinces, Chachapoyas and Luya. The capital of the department is Chachapoyas.

The three large rivers, Amazonas, Ucayali, and Huallaga, flow through this vast and fertile department, which receives, besides, a multitude of tributaries. Two Cordilleras run through it, one on the east of Chachapoyas, and the other on the west.

With respect to the plants and vegetables of this department which may be made available for commerce, they are many. I will mention a few that appear to be among the most important.

Nunu-huactana, or sour-cane, similar to maize, properly prepared, cures the intermittent fever; quinaquina, sarsaparilla, tamarind, linseed, ginger, cascarilla, ipecacuanha, &c.

The soil produces all kinds of vegetable aliments, among others—coffee, equal to that of Caraccas, which is perhaps the best in the world; cacao; yuccas; camotes, or sweet potatoes; common potato, various kinds; carrots; rice; French beans; lentils; chick pea, of various classes; onions; purslain; mint; maize; gourds; cocona, similar to the orange of Quito; mashantuesi, a tree which yields a fruit of the size of an orange; nuchuesi, a plant, yielding potatoes from its roots equal to the famous ones of Huamantanga of Lima, called yellow potatoes; sachapapa, a species of white potato.

The bombanaje, a palm of which hats are made like those of Guyaquil; agave; vanilla; cotton; long bejuco, yielding oil; tobacco, &c.

Barbasco, the root of which is poisonous, used by the savages for fishing, thrown into the water it operates as a narcotic; sami, whose leaves give a blue dye; llangua, useful for the same purpose; mispiganga, whose fruit is like a small black ball and is used for dyeing; casha, huasca, bejuco, of thirty yards in length, very elastic, and the women use it, when washing, instead of soap.

Ayac-mullaca, a kind of thorn, its leaves and fruit serve for soap; achupa, odorous fruit, and which gives a colour; huito or jagua, a high and thin shrub, of the trunk of which spoons are made, the fruit is eaten green; it dyes the hair a strong black; llanchama, the bark of which is so flexible, that, after cutting and pounding, it stretches like cloth; quimba, a tree forty-five feet high, its fruit not unlike cotton; sebo de macoa, its fruit the shape of little green balls, which yield grease or fat when cooked or pressed; sapaja, a tree like a palm, its leaves, from their hardness, serve for combs, colour yellow, and opaque like tortoiseshell; tamsi, very strong and elastic.

The fruits are those of the torrid zone, and very agreeable, a few may be mentioned, such as the marañon-castra, whose fruit is of the size of an egg, and yellow; chiope, a dark green tree, fruit of agreeable taste; gallo, similar to the tumbo; simbillo, like the French bean; runfinde, same as preceding; gigma, root similar to the sweet potato; chachuela, like a nut, yellow husk and white in the interior, has a sort of bitter-sweet taste.

In the mineral kingdoms there are many washings of gold; there are also quicksilver, copper, iron, lead, &c.

This department is also rich in animals, most of them peculiar to the country and unknown elsewhere.

The temperature or climate varies according to place, since, as already mentioned, two chains of mountains traverse it, one on the east and the other on the west of Chachapoyas, the capital. Rarely the thermometer passes 30° centigrade, or descends below 27°. Notwithstanding, it is said to be healthy, except on the margins of the Huallaga, Ucayali, and Marañon.

Industry is very backward in this department from the abundance and cheapness of articles necessary for subsistence, the want of roads, &c.

With respect to the province of Loreto, it is situated to the north of Peru, and occupies an extent of ground so large that it almost equals in surface all the rest of the departments of Peru put together. Its limits are not yet very precisely determined, however it may be said that it is bounded on the north by the Republic of Ecuador, to the east by the Empire of Brazil, to the south by the departments of Cuzco, Ayacucho, and Junin, and to the west by the departments of Junin, Libertad, and Amazonas.

Province of Loreto.—The productions of this province have a similar character to those of the department of Amazonas, some, however, have a distinct one ; for this reason, and for circumstances connected with them, such as the use that is made of them, and their disposal by way of commerce, it will be necessary to notice a few in detail, at the risk, it may be, of some repetition. For this purpose I shall avail myself of a little book written by Señor Raimondi upon this province, so far as it relates to productions and commerce.

Products of Loreto.—The plantano or plantain, of which there is a great variety, serves instead of bread, of which there is none in the province, on account of the difficulties of transport. Flour therefore would, at once, be in great demand there.

Yuca (*Manihot aipi*, Pohl), or Cassava, is another vegetable indispensable to the inhabitants, used also in place of bread, and for various other economic purposes.

Sugar-cane. This plant is not cultivated in Loreto for the purpose of extracting sugar, an article scarcely known in this part of Peru, but to obtain aguadiente, of which the natives are very fond.

The sugar-cane grows in the province with the greatest luxuriance, and it is sufficient to plant it once to have constant yields from the roots. It is very common to see roots of this vegetable with more than twenty vigorous cane-stalks. It promptly develops itself, and ripens at the end of six or seven months' planting. Rice and maize grow abundantly at the end of six months from their plantation.

Coca (*Erythroxilon Coca*, Lamark) is cultivated in all the villages along the banks of the Huallaga, and is of good quality ; it yields six crops a year, that is, one every two months.

This is not the place, perhaps, to comment upon this plant, but it deserves to be more generally known on account of its extraordinary qualities. A Peruvian will endure the severest labour whilst chewing the leaves of this plant, accompany a horse or mule for days together up hill and down, and through the deepest sand, without scarcely any other refreshment than chewing coca. Its effects are said to be truly surprising upon the human organisation. Tea, or a decoction of the leaves of this plant, is found to be a most wholesome and refreshing beverage, and very agreeable. Superficial travellers have decried coca, but more than one European has experienced its beneficial effects in the Sierra. For the poorer classes at home it would form, if needful, an excellent substitute for tea, or for tobacco-chewing.

Tobacco is cultivated the whole length of the Huallaga, and yields magnificent crops, part of which is consumed in the neighbouring departments, and part exported to Brazil.

Cotton grows almost spontaneously in the neighbourhood of the houses, and serves the inhabitants for domestic purposes, principally grey shirting, which is an article of exchange in this province.

Coffee grows with extraordinary luxuriance in this region; the activity of its vegetation is wonderful, the branches are borne down indeed with the weight of the numerous berries.

Cacao, besides being cultivated in all the gardens of Moyobamba, grows spontaneously, and is met with in abundance and of various kinds in all the woods of the province.

Bombanaje (*Carludovica palmata*, Ruiz et Pavon), of the leaves of which straw hats are made. Not only is this plant cultivated, but it is met with in a wild state in almost all the warm, moist, and shady places of this part of Peru.

Pischuayo (*Guilielma speciosa*, Mart.), an elegant palm of an elevated and thorny trunk; grows spontaneously, and is cultivated for its pulpy fruit, which is eaten cooked.

Aguaje (*Mauritia flexuosa*, Lin.) is a palm with leaves disposed in the form of a fan. This useful vegetable produces a scaly fruit of the size of a hen's egg which is eaten when cooked.

Tutumo (*Crescentia cujete*, Lin.). Of the fruit of this tree calabashes are prepared, vessels to preserve liquids, and for other domestic purposes.

A great number of fruit trees both indigenous and European grow in this province, such as orange, lemon, paltot (*Persea gratissima*, Gartn.), pacaes of various kinds (*Inga vera*, *insignis*, *fastuosa*, *&c.*), lucumos (*Lucuma obovata*, Kind.), papayo (*Carica papaya*, Lin.), prunes, plums, cherries, the bread fruit, pine apples—these abound in some parts and acquire enormous dimensions, often weighing 18 lbs., red pepper, &c.

The quantity of plants which grow spontaneously is incalculable. In the more elevated parts of the province are various kinds of sarsaparilla, and many other plants of great usefulness.

The Commerce of the Littoral Province of Loreto is yet in its infancy, having commenced, it may be said, only after the arrival at the Port of Nanta of the steam vessels of the Brazilian Company established for the navigation of the Amazon, by the treaty entered into towards the end of 1851 between Peru and Brazil. This commerce goes on sensibly increasing, and will reach to much importance if the means of communication can be facilitated, opening good roads conducting to the ports situated on the banks of the navigable rivers, making the transport of the produce in all the affluents of the Amazon less difficult by steamboats, and by all means avoiding monopoly.

Almost all the commerce of this territory is carried on with Brazil by the facility which exists of communication between these countries by means of the rivers. The commerce of importation is conducted both by the way of the Amazon and the ports of the Pacific.

The articles exported from the province are :—Straw hats, like those of Guyaquil, which are sold in Brazil at 3 dols. each. Sarsaparilla, growing chiefly in the environs of Sarayaco, where it is collected in abundance. An arroba (25 lbs.) is exchanged for 3 or 4 yards of tocuyo or grey shirting. In Nanta it is worth 3 dols. the arroba ; and in Para it is sold as high as 14 or 15 dols. the arroba. Salt fish, which is sold in Brazil under the name of piracucu at the price of 19 dols. to 20 dols. the arroba. Tocuyo or grey shirting of the country is sold at 1 real or about 6d. the yard. Bombanaje straw is sold at 1 real a pound. Bundles of tobacco, 4 reals each. Tobacco in leaf is worth 18 dols. the arroba. Coffee is sold in the province at 2 dols. the arroba, and in Para 3 dols. and 3 dols. reals. Cacao, 3 dols. the arroba. Flour, 5 dols. a quintal of 25 lbs.

In Moyobamba, the capital of Loreto, more than 3,000 women are occupied in spinning cotton, the clews or balls of which are current money, so are also coffee and tobacco ;—lona, a texture wove very strong ; condocillo, a species of woollen kerseymere ; coverlets, or counterpanes, plain and worked, and other cloths ; straw hats, network very rich for stuffs, and clothing for women, as fine and beautiful as the best lace. Cigar cases and hats of the finest workmanship. The inhabitants are also very skilful in the working of gold and silver and make exquisite works of art, especially in filagree.

CHEMISTRY.

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In all the advances of either Civilisation or the Arts, and whether pertaining to those which minister to the wants, the industry, or to the protection of man, Chemistry has been a prevailing good, and has left marks of its usefulness. It is, indeed, the *Alma Mater* of the sciences ; a great store-house filled with knowledge suited to the wants of all ; its boundaries being co-extensive with Nature itself.

Chemistry is the only true socialist ; for while it furnishes benefits to every community, it is upon fixed rules which neither policy, persuasion, nor legislation can change. She is immutable in her ways: acting as naturally as astronomy, with nicer precision than mathematics, greater certainty than human jurisprudence, and more industry than art or handicraft, for her operations never cease. It acts, too, with as much beneficence to mankind as all the theories of faith ; because in her work she manifests, by unvarying attributes, and by her fruitfulness of universal blessings, the unmistakable existence of a Great Great Cause —a *Providence.*

Chemistry, in its theoretical signification, is that science which teaches us the internal properties of bodies and the mutual action of their elements. Its grand practical division is into—1. Inorganic or mineral chemistry; 2. The chemistry of organised bodies, which we so term because, though now dead, they have had their origin in a vital principle; and 3. Organic chemistry, comprehending those substances which have a present vital existence.

Analytical chemistry devises methods for detecting the various elements of a compound, and estimating their proportions. Synthetic chemistry enables us to form homogeneous compounds of dissimilar substances, and is used to verify the results of analysis. Arraying or docimacy is the dry method of analysis.

Practical or applied chemistry comprises the application of chemical principles to the arts: for example, to the making and fixing of colours for paints and dyes; to the processes of tanning, distilling, and brewing; to the manufacture of glass, porcelain, and artificial stones; and to domestic and culinary purposes. It is more elegantly termed technological chemistry, and to this branch belongs also metallurgy, or the art of separating metals from their ores.

Pharmaceutical chemistry relates to the preparation of remedies employed in medicine.

Medical chemistry is allied to physiology, and treats of the application of chemical principles in the theory and practice of medicine.

Toxicological chemistry refers to poisons, their special action upon the system, and the means of detecting them.

The subdivisions of the science are still increasing, and the varied uses to which it is now applied are so great, that even subordinate branches are growing or taking place out of those that had previously existed.

It was said of Mercury, in the days of mythology, that he plundered Neptune of his trident, Venus of her girdle, Mars of his sword, Vulcan of his implements, and Jupiter of his sceptre. This is but an allegory referring to Chemistry, of which Mercury was the patron, and through the means of which he collected so much knowledge from unseen as well as visible sources; and now, Justice, acting upon her principle of retribution as to matters of this world, makes him return, with interest, to us, the prizes pillaged from the elements and the gods.

No one can tell to what extent the investigations in Chemistry may go;—no one can define its limit. It enabled Daguerre to seize the fleeting shadows of the air and fix them immutable upon metal; and hereafter its discoveries may transfix the very sounds of human voices, and hold them quivering in the hand as echoes to the wind. Even thought itself may be reached, and the very breath that gives it silent aspiration be made to stand out upon tablets like recorded words of utterance.

It is a searching agent, which exposes the errors of those who blunder in the studies of Nature—a confirmer of truths—a spirit that dives into the deep bosom of the earth and reveals her riches, that soars into the high region of the heavens and brings away its lightning—that, like light, penetrates everywhere, and, like light, clears away all obscurities.

It is true that Sir Francis Bacon was the first to teach us how to follow the genius of Nature through her many mansions. He began at the beginning in this particular ; and yet wonderful as was his learning then and as it still is, he had only reached the threshold of the great temple of science which succeeding generations have only partly built up. It is still an unfinished edifice ; not because it is labouring under the ban of a supernatural power, but because it is a structure to be made of mind, not matter—whose materials are to be drawn from the profoundest intellects, the tests of whose strength must be submitted to ages upon ages—whose increasing lights are beacons to guide its builders, and whose completion will be perfection.

PHORMIUM TENAX, OR NEW ZEALAND FLAX.

BY CHARLES CRAIK.

The valuable properties of the *Phormium tenax*, or New Zealand flax, as a fibre-producing plant, have long been known to botanists and others ; but, owing to various causes, its merits have not been, as yet, to any but a very inconsiderable extent practically tested in this country. The important purposes to which the *Phormium tenax* can undoubtedly be applied surely render it of importance that it be brought under the notice of our manufacturers, as there is good reason for believing that it is well adapted for the manufacture of paper, and in the event of a demand being created in the markets of Britain it could be exported from New Zealand to a practically unlimited extent.

The *Phormium tenax*, which belongs to the order *Liliaceæ* of the natural system of botany, is strictly indigenous to New Zealand, and grows abundantly in all parts of that colony. In different portions of the province of Otago, in the Middle Island of New Zealand, we have seen it thriving in profusion. It is one of the first objects that catches the eye of the emigrant as soon as he leaves the ocean and enters the magnificent natural harbour of Port Chalmers; and on the voyage thence up to the town of Dunedin, it is seen in hundreds of places growing down to the very margin of the shore, till it almost dips its leaves in the salt water. In the Botanical Gardens of Kew and Edinburgh specimens of it may be seen, but these afford but a very indifferent idea of its appearance as it grows in its native habitats, where it flourishes in such great luxuriance that we have often seen its sword-shaped leaves attaining a length of upwards of six feet; and the whole plant is in such profusion that in the gulleys and ravines the cattle, while wandering in the midst of it, are completely lost to view. The strength and tenacity of the fibre, which is got from the leaf of the plant, are such as to render it superior in these respects to that of any other vegetable production. The following table, by the illustrious botanist De Candolle (taken from Professor Balfour's 'Class-Book of Botany'), will show the strength of different vegetable fibres as contrasted with silk :—

Silk supported a weight of . . .	34
New Zealand Flax	$23\frac{4}{5}$
Common Hemp	$16\frac{1}{3}$
Common Flax	$11\frac{3}{4}$
Pita Fibre	7

The above comparison speaks for itself; indeed, it is unnecessary to insist at any length upon the value of the fibre in question, which has been admitted by all the scientific men and others, under whose consideration it has been brought, as far back as from the date of Captain Cook's voyages down to the present day. The real difficulties of the question are not connected with any doubts as to the nature and properties of the fibre, or as to the possibility of exporting it in sufficient quantities, but relate to a practical difficulty in its preparation; and we would now very briefly direct attention to this matter, and to what has been accomplished in regard to it.

As already alluded to, it is from the leaf that the fibrous material of the *Phormium tenax* is procured. Every leaf contains it in abundance, but at the same time it must be mentioned, that there is incorporated with it in the unprepared state a quantity of a substance of a gummy or resinous nature. To extract this resinous matter from the fibre, and at the same time leave the latter intact, has been found somewhat of a difficult problem. The solution of the problem has to some extent been obtained by the natives, who have long been in the habit of manufacturing clothing, baskets, &c., from this valuable production of their islands; but their process is somewhat defective, and being entirely manual, is unsuitable, both on economical and other grounds, for the preparation of the fibre to any large extent. It may be mentioned, *en passant*, that the settlers of New Zealand are a good deal in the habit of availing themselves in a rough and ready way of the tenacity and strength of this plant, which grows around and amongst their settlements, and are accustomed to employ strips of the green leaf in lieu of cord, &c., in various ways. The attention of the Government of New Zealand has been several times directed to this matter, the importance of which to the colony under its charge it has had sufficient reason to perceive; and in consequence it has offered various liberal rewards to any person or persons who should succeed in inventing a process by which the fibre of the *Phormium tenax* should be prepared in a proper condition for the purposes of the manufacturer. For some years past, several persons in the different provinces of New Zealand, induced by these offered premiums, have directed their attention to the subject, and, indeed, I believe that in the North Island a patent has actually been taken out and worked by one or more individuals, but it is understood that their operations have been as yet on but a limited scale. It is within the knowledge of the writer that practical experiments are at present being carried on in different quarters, and have already, in fact, been brought to a favourable conclusion. He has brought with him from Otago a sample of the fibre prepared by a gentleman lately of Glasgow, and now resident in Dunedin, but is in expectation of receiving soon specimens of a much superior character. The gentleman in question is of opinion that the flax could be prepared in a state superior to the sample referred to for about 12*l.* a ton in Dunedin, which, even with the addition of freight and other charges, would render it quite practicable to introduce the material into this country for the manufacture of paper, at a price which would allow it to compete with other substances.

It may be safely predicted, taking into consideration what has already been done and is at present doing in New Zealand in relation to the preparation of the *Phormium tenax* fibre, and keeping in view the great scientific and practical resources of our age, that the difficulties above adverted to will speedily be disposed of in a satisfactory manner. It only remains for the manufacturers of Britain to show that they have a desire for the introduction and employment here of the New Zealand flax, to add another important item to our multifarious imports, and a new and valuable addition to the exports sent home from our distant but thriving colony.

[There is no doubt of New Zealand flax being suitable for paper-making, for we have seen very excellent paper made with it ; but as in a raw state the cost of chemical treatment and loss of weight by bleaching is very great, it can scarcely be valued at more than 6*l.* or 7*l.* per ton delivered in this country. If it could be imported at a cheap rate, large quantities of it could be sold.—Ed. Tech.]

SILKWORM CULTURE.

The silk trade in France seems to be in almost as much difficulty with respect to raw material as its sister cotton manufacture. The culture of silk in France has long been in an unsatisfactory condition, the supply falling short of the demand or the price rising from time to time to a ruinous pitch. Great efforts have been made in various directions to increase the produce: silkworm eggs have been fetched from China and other places, with great care and cost, and many new kinds of eggs have been introduced from abroad with the hope of obtaining more hardy and more productive worms. The "Magnanerie," as a silkworm nursery is called, in the *Jardin d'Acclimatation* in the Bois de Boulogne of Paris, is just now an object of considerable attraction, and contains many thousand worms of various kinds, and amongst others the *Bombyx mori* of China, and the *B. blanche* of Japan, which feed on the leaves of the mulberry; the *Bombyx cynthia* and the *B. Arrindia*, which live on the castor-oil plant and the leaves of the Ailanthus, or Japan varnish-tree; and the *Bombyx Yamamai* and *B. Pernyi* of China and Japan, which devour oak leaves. These two latter are in the open air, and hopes are entertained that they may acclimatise in Western Europe. There is also another establishment adjoining the Imperial model farm of Vincennes, where M. Guérin-Méneville—whose exhibition of some of these worms and their produce in the French department of the London Exhibition of 1862 excited considerable attention—is pursuing their cultivation with a view to practical results. In the meantime, the want of the eggs, or seed as it is called, of the silkworms already cultivated in France is great, and apparently very difficult to supply. Not long since some adventurous persons announced their intention of seeking a supply of eggs in Independent Tartary, but they were warned by the Minister of Commerce that it would expose them to great danger in that country, and they therefore renounced their project. News has since been received from Teheran, by the Minister of Commerce, that there would be a better chance of success in Persia, and the attention of cultivators is now directed to that country. It appears, however, that several parties have set out on this errand from Constantinople, but have been deterred from proceeding by information which they obtained at Tiflis. The opinion seems to be that interested speculators in silk have managed, for their own interest, to prevent the French agents from obtaining a supply of the eggs. Be that as it may, it is certain that the trade in silkworm eggs is but little developed, although the demand is very great in Europe, and in spite of the success which has attended the importations which have been made from China. The cultivation of silk is carried on in five provinces of Persia, Meshed, Yezd, Cachan, Mazenderan, and Ghilan, but the quantity and quality differ greatly. The worms obtain little of the care which is bestowed upon them in France, where the duties of the sericulteur are constant and most troublesome. In Persia the worms are placed on rough wooden stages, and, being supplied with plenty of food, are left almost to themselves till the spinning time arrives; yet it is said that the disease which has attacked the worms so seriously in France is not known in Persia. The inference drawn is, that the Persian silkworm is more hardy than those reared in France. The statistics of the culture in the former country are not very complete, for the French authorities have been unable to procure even an approximate estimate of the amount of silk produced in more than three of the above-named provinces. Cachan is said to yield only 750 kilogrammes—an insignificant quantity; Yezal, 21,000 kilos.; and Ghilah, 206,000 kilos.; in all about 478,000 lbs. English.

M. Guérin de Méneville makes the following remarks:—

"For several years the Academy of Sciences has welcomed with interest the communications which I have had the honour to make to it on one of the most important applications of zoology, the introduction and acclimation of new species of silkworms, the products of which clothe the entire populations of India, China, and Japan.

"My attempts in this direction have been approved, for the immense good which would result from the introduction of these producers of textile fabrics is comprehended in view of the nearly irreparable cotton famine resulting from the deplorable American war.

"All now understand that the silkworms which live on the ailanthus and on the oak may become auxiliaries, susceptible of supplying to a greater or less extent this scarcity of cotton.

"Up to the present time I have attempted the introduction of three species of Asiatic silkworms living on the oak: the *Bombyx mylitta* of Fabricius, from Bengal; my *Bombyx Pernyi*, from the north of China; and my *Bombyx Yama-mai*, from Japan.

"To-day I have the honour of presenting to the Academy the first specimens received in Europe of a fourth silkworm of the oak, the *Bombyx* (*Antheræa*) *Roylei*, of Moore.

"Twenty living cocoons of this remarkable species were sent to me by Captain Hutton, obtained from the high plateaus of the Himalaya, on the frontiers of Cashmere. The caterpillar lives on the thick oak leaves, the *Quercus incana*, which bears a close analogy with our oaks—*liege* and the holm, and it is evident that they, like the three others, may be fed with the oaks of our forests.

"Its cocoon differs from those of the other three species—as may be seen in the comparative collection which I deposited on the bureau—in having a greater volume, and above all in being surrounded by an envelope also composed of silk of a clear, handsome grey.

"It is evident that this new worm of the oak will be easily acclimated in the centre and north of France, for the climate of the elevated parts of the Himalaya cannot differ notably from ours, since many of the vegetables of that central chain of Asia prosper very well among us.

"The twenty cocoons which I received on the 23rd of March gave me at first three males that came out on the 7th of April, and I began to fear that I should see them all hatch and perish before the appearance of the females. Finally, on the 19th of April, a male and female were hatched at the same time. These two butterflies united themselves together in the night of the 20th—21st, at one o'clock of the morning, and I obtained 108 eggs, a number sufficient to introduce the species, and to permit me soon to present specimens, first to the Society of Acclimation, and then to the agriculturists of all countries where the diverse species of oaks flourish.

"The instructions which I published in my *Revue de Séricicullure Comparée* (1863, p. 33), for the care to be given to my *Yama-mai* of Japan, are applicable in all respects to this new species, of which I have the honour to present the first reproductions to the Academy, as I had the honour to present to it in 1858 those that permitted me to introduce the ailanthus silkworm, which has begun to be acclimated in all the regions of Europe, Africa, America, and even Australia.

Cultivation of Silk in Java.—The introduction of a new branch of industry is not without its difficulties, more especially when, as is generally the case, public opinion characterises such as needless waste of money, time, and trouble. Never have worse results been foretold than in the case of the attempts now made to introduce the culture of silkworms. Remembering the scanty success which had attended former attempts, people were led to regard the hope of a future production of silk on the island as a fallacy. The difference between the former and present attempts was lost sight of. Was the Siam silkworm known in former years? Was the cultivation of the *Bombyx Cynthia* and *Bombyx Arrindia* thought of? These questions may, I believe, be all answered in the negative; for, if I mistake not, all trials were made with the Chinese and European *Bombyx mori* only.

The last attempts, on the contrary, were made with the silkworm of Siam, and with several varieties of what is known as wild silk-worms. The cultivation of the tame and wild species differs greatly; most of the trials were made with the first.

It is generally known that the Siam silkworm was brought over to Buitenzong by Mr. J. E. Teysman, Honorary Inspector of Cultures, in 1862. The first results were made public; not so those subsequently obtained. In the commencement of 1863, Mr. Teysman showed me the small establishment for the culture of silkworms which he had just erected. It consisted of two small buildings constructed of bamboos, the sides worked in the kepang pattern, with roofs of Atap (palm leaves). The surrounding grounds (some two and a half to three behoes) were planted with mulberry-trees (*Morus indica*), and in the immediate vicinity was the dwelling of the Cochin-Chinaman, André Locas, who, with his household, had the care of the worms. Everything was simple, and arranged in the Chinese fashion. One of the erections served for the development of the worms; the other for the winding and for the preparation of the cocoons. The whole establishment, inclusive of the plantation, I computed to have cost 400 florins; and at the end of one year Mr. Teysman had the satisfaction of being able to bring to market 80 lb. (Amsterdam weight) wound, and 89 lb. of floss silk, which were sold on the 24th December last (1863) at Batavia for the sum of 400 florins. This year's yield will be still greater, for now, after the lapse of six months, 50 lbs. of wound and much more of floss silk have been offered for sale.

But not only at Buitenzong were favourable results obtained, but at Samarang, too; and at Malang the trials were attended with success. The degeneration of the worms, which was so much feared, is nowhere visible; the cocoons have, on the contrary, increased in size since the worms have been carefully tended. The quality, too, of the silk is better.

The first musters (samples) sent to Europe were at 10 to 12 florins per kilogramme; the Buitenzong silk fetched, at the auction alluded to, the average of $14\frac{3}{4}$ florins; whilst a muster lately sent to Europe was valued in France at 22 florins per half kilo.! I believe that the facts here spoken of are so many reasons for asserting that a lucrative culture of the silkworm is not wholly imaginative. Mr. L. Weber says on the subject, in the introduction to his 'Handleiding voor eenige Kultures op Java' ('Handbook of Cultures in Java'), "that the culture of the silkworm will in time be a means of existence for the European as well as for the Malay, as will certainly be experienced by those who apply themselves to it. From the results which I myself have obtained, I do not hesitate to recommend its extension, and am convinced that the aid of our rulers may be reckoned upon."

Government, which lost such heavy sums with former attempts, is, we are informed upon good authority, endeavouring to introduce the culture of the Siamese silkworm on a large scale; the inducement to do so being the fortunate results which have attended the late trials. Already the planting of mulberry-trees in the residency krawang has been commenced. Private industry, too, should devote more of its attention to the subject. Not that it is necessary to erect extensive and costly establishments; it is sufficient if many small and inexpensive ones be founded; favourable results will then lead to extension. The trials with the so-called "wild silkworms" are not yet so far advanced. Although several trials on a small scale have been successful, the varieties of the worm are so numerous as to make it difficult to decide as to the best of the known varieties of the wild silkworm; not less than ten sorts might be used for spinning purposes in Java. In other tropical countries, as Surinam (Dutch Guiana), the Argentine Republic, and in Brazil, the *Bombyx Cynthia* and *Arrindia* have already been introduced; but Java herself has many silkworms which are found in a wild state, and perhaps one or other of these deserves the preference above the two just named.

ON THE POSITION AND MODE OF WORKING THE BATH FREESTONE.

BY J. RANDALL.

The paper which I have the honour to lay before this section of the British Association has reference to two subjects, both of equal local interest, the one in an economical and commercial point of view, and the other bearing upon the scientific conditions, both as regards the mode of working and geological positions of those beds in the great or Bath oolite, which may be called the "quarry stone," and which are so extensively worked in the Bath district. I purpose, therefore, to divide my paper into two sections, or arrange the materials into short, and yet I hope sufficiently detailed a manner under two heads: first, to determine the true horizon or geological position of the workable beds of this valuable freestone in the series termed the great oolite; secondly, to enter upon the mode of "working and getting" this extensively used and valuable building stone.

Geological Position.—Nowhere, I believe, in Great Britain (indeed, in Europe) are the lower members of the Jurassic group of rocks so extensively developed as in the Bath district, where each group seems to have attained its fullest recognised development; nowhere can the whole Jurassic series be so readily studied, nowhere so easily understood; and this applies to the lias itself in its three divisions—the fuller's earth (here extensively employed); the member of the lower oolite under consideration; and the Bath or great oolite, distinguished here for its economical value, and at Minchinhampton and other places for its fine and typical organic remains. Above this series, but intimately associated with it, the forest marble and cornbrash are highly and typically developed, succeeded by the Oxfordian and Kimmeridge groups, not omitting even the Portlandian at Swindon and the Purbecks of the Vale at Wardour. To each of these may be appended important notes bearing upon their high importance, economically considered, and which are extensively developed in the district; but I purpose drawing the attention of the members of this section to the Bath oolite only, determining the position of that zone from which the freestone is extracted, and on which the wealth and comfort of the population of this neighbourhood, engaged in quarrying operations, so much depend. I have also endeavoured to fix, by detailed and measured sections, the workable beds of the district, and to correlate them over a considerable area, useful, it is hoped, both to the man of business and the geologist. These sections, which I may here refer to, are all coloured the same in their respective zones, and show the importance of carefully determining the place or position of the workable beds, prior to any outlay of capital; and however difficult, indeed impossible, it may be to diagnose the quality of the freestone beds in depth, there can be no doubt as to their position and probable condition ; and when it is known that uniformity of condition over any large area is of extreme uncertainty, and knowing as we do that the thinning out of the marketable beds of freestone in this district, like the great oolite *en masse* on the line of deposition and dip, is a fact now well understood, it becomes a matter of high importance to the capitalist to be assured and confirmed as to the chances of success in opening out or developing a new district. The natural grouping of the beds constituting the great oolite series in this district fall under three well-marked divisions, all well exhibited in the sections exposed at Murhill, Westwood, and Farleydown, Combe and Hampton Downs, Box and Corsham workings, &c., &c. Indeed, generally where conditions have exposed them, and reading downwards from the surface, we meet with over the Bath area, immediately below the forest of marble (where present), the following groupings :—1. The Upper Ragstones. 2. The Fine Freestone, or Building Beds. 3. The Lower Ragstone. These constitute a series from 60 to 120 feet in thickness, depending upon local circumstances and conditions during deposition and perhaps subsequent denudation.

The Upper Ragstones.—This series consists of (in the upper part) coarse, shelly, and irregularly bedded limestones, with usually a few underlying beds of white fine-grained limestones, possessing a distinctly and well-defined oolitic structure and finely comminuted shells ; these are again succeeded by tough argillaceous beds of limestone, usually pale brown in colour and smooth in texture, the whole ranging in thickness from twenty-five feet to about fifty feet. No beds of workable value occur in this upper series.

The Fine Freestone, or Building Beds, in the Bath Stone Series.—Succeeding the upper ragstone are the Bath freestone, or fine-grained building beds, which vary in the number and thickness of the various beds comprising the series, and also economically distinguished from each other by their structural condition, the size and structure of the oolitic grains, the presence or absence of silicious particles or finely divided shelly matters, each of which may materially affect the limestone during the process of working, or influence them after being placed in position, and subject to weathering under atmospheric changes. In some localities the beds assume an earthy structure, indistinct in texture, smooth and close-grained, and hold more moistness.

The Lower Ragstone.—Below the fine building beds, or freestone series, are the lower ragstones, which appear to be persistent everywhere over the entire area, and resting upon the fuller's earth. They consist of numerous and generally well-defined beds of a coarse shelly texture, and hard crystalline limestone exhibiting much false bedding, especially near the base. Many species of mollusca occur in the bottom beds, such as Ostrea acuminata, Terebratula, Ornithocephala, Rhynchonella, Trikitis, Concinna, and Tancredia. These lower ragstones, as before mentioned, rest immediately upon the fuller's earth, but this member of the oolitic series concerns us only by position, and is in this district west of Corsham and Bradford a most persistent and important zone, between the inferior oolite beds below and the lower ragstones of the great oolite above, and, in some places, very fossiliferous, and varies in thickness from 150 feet to 200 feet. Taking, therefore, as our guide in this district the above three divisions of the great oolite, we are enabled to construct vertical sections to aid us in our determinations as to the position and condition of the few feet of stone profitable to work in the series, or the "freestone beds," at all times an anxious and important question when seeking for and developing new ground. In this paper I deal chiefly with facts, and therefore give detailed and measured sections of type localities, from which may be determined by comparison the probable conditions under which the beds may occur at intermediate and unexplored stations or localities on the table lands behind such outstanding mural precipices as Farley, Murhill, Box, on the eastern side of the Bradford and Slaughterford valleys, or on the elevated downs at Claverton, Combe, Hampton, Freshford, &c., to the south of Bath, and west of the Bradford Valley, and on the receding flats to the east of Monklow, Farleigh, and Bradford, &c., conspicuous for the numerous quarries opened in the cornbrash and forest marble, the latter of which occurs in detached patches or continuous lines, stretching from Malmesbury on the north, to Chippenham, Bradford, and other localities to the east of Bath, and especially conspicuous near Corsham, Chapel Korap, South Wraxall, and on to Melksham. The most complete section, and which may be regarded as a typical one of the great oolite and forest marble beds of the Bath district is that of the Box Hill and Corsham Quarry workings. No. 1, showing those beds not usually seen or exposed, but which were cut through by the construction of the Box Tunnel, and which we are now extensively working in that neighbourhood. Another exposition of the series is shown at Murhill, on the eastern side of the Bradford Valley, where the three divisions into which the series group themselves may be studied *in situ*. Also at Upper Westwood, on the opposite or west side of the valley, other sections occur, tending to show the same facts; and the variable condition and thinning out of the same beds upon the line of Diss, even at this short distance.

The Sections.—The shafts which are constructed along the line of the Box Tunnel, on the Great Western Railway, afford at the several points where they are carried through the beds of the great oolite accurate data for the construction of sections and clear evidence of the succession of the strata comprising the three divisions. I have endeavoured to maintain, as occurring through this district, and being situated considerably to the east of the Bath Valley escarpments, a large area, for the productiveness of that area is estimated by the lie, position, and condition of the building freestones, supposed to occupy the summit of the table land, stretching from the eastern escarpment of the Bradford, Box, and

Slaughterford valleys to Yatton Keynell, Biddestone, and Corsham. The Section No. 1 gives accurate measnrement and sufficient details to enable a practical observer to determine the series of beds at almost any point over the area above indicated, or even between the westerly extension of the Oxford clay line from Malmesbury to Corsham and Melksham, and the valley escarpments before mentioned. It is not necessary to notice the forest marble or cornbrash, which is foreign to my paper, and which, although usually present, may or may not occur on any special area above the great oolite proper, local conditions, during deposition or subseqnent denndations, having removed one or the other, or both ; but everywhere, so far as I know, over the whole table land do we find the coarse shelly limestones, and some finely grained oolite beds belonging to the upper ragstones or highest members of the great oolite. In the typical section No. 1, taken at No. 7 shaft, Box Tunnel, also at the shafts 4, 5, 6, these beds occur, and were cut through when sinking, and were found to be from twenty to thirty-five feet in thickness, before proving the "capping" to the building or "fine" beds below. At Murhill, near Winsley, these upper ragstone beds are about twenty feet in thickness, and are hard, coarse, and fine shelly limestones, highly comminuted in structure, and occasionally oolitic. In some localities many of the beds are of considerable thickness, and of regular and even texture, still they are too hard for those purposes for which the softer, fine-grained, whiter, and more easily worked architectural stone below (in the second series) are sought for, and to which they are applied ; and again, they are not good weather stones, but rapidly fall to decay on exposure to severe changes of weather. At Upper Westwood, on the south side of the Bradford Valley, opposite Winsley and Murhill, the beds comprising this upper series are thicker and of more even texture, but as weather stones are of little or no value. At Farley Down, overhanging Bathford, this upper series is nearly thirty feet in thickness, composed of coarse shelly limestones at the top, with hard and soft ragstones down to the capping of the fine "building beds" below. At Combe Down and Odd Down the beds closely resemble those of Farley and Box, and approximate in thickness. Thus we may examine detailed sections of the upper series at Murhill, Farley, Westwood, Coombe, and Odd Down, and the Box district generally, but the beds at neither locality are deemed of sufficient value to work for transit as a building stone.

The Second or Middle Series.—Succeeding the ragstones above mentioned, and commencing the second series, there appears to be everywhere a peculiar bed extending over a large area, termed the "cover," or capping, varying in thickness, but generally hard in texture ; this forms the roof, or ceiling, to the fine economical building freestones below, and over which it lies, and is a marked feature in extensive underground workings, both for its horizontal extent, application, and importance as protection to the workmen, and as commencing the second series, or middle beds, which occur between the "upper and lower ragstones." At Bradford, Westwood, and Murhill this bed is a coarse, shelly, hard limestone ; at Corsham and Box, a closer-grained and tough rock. I associate it with the building freestone, or fine beds below it, rather than with the ragstone above, from its persistency and the constancy of its conditions. Succeeding this is the true Bath stone, or fine freestone, and which I believe occupy, with minor differences, the same position or horizon over the whole of the Bath district. This second, middle, or freestone series are as a group from twenty to thirty feet in thickness, and are coloured chrome-yellow in all sections, and those beds worked for transit are usually evenly grained in texture, regularly bedded, yield well to the saw, are non-fossiliferous, and give evident proof of having been accumulated or deposited in a somewhat deep and tranquil sea, or away from any littoral or wave disturbance, and which the almost total absence of organic remains still further tends to confirm or demonstrate. It appears from observation, and the correlation of measured sections, and conditions observable underground, that the fine-grained regular beds thin away in a south-eastern direction, or upon the line of their general dip, a fact clearly determinable on examining the sections exposed in the valleys. Indeed, it cannot be doubted but that the great or Bath oolite as a group, in this neighbourhood, exists under extremely irregular conditions, and dies out and disappears in the form of a lenticular or wedge-shaped mass, to the east and south-east. This circumstance, causing the building freestones to thus vary in their relative thickness as we proceed from the western part of the area to the east and south-east, and the removing of much of the exposed belt comprising the oolitic series between Bath and Bradford, on the line of their strike, north-east and south-west, caused, it would appear, by the extreme denudation of the Bath and Bradford valleys, and the westerly extension of the cretaceous series from Melksham to Westbury, Frome, and Warminster, are due, perhaps, to physical conditions connected with the eastern extension of the Mendip axis, and the little understood, deeply-seated, but undoubted position of the Palæozoic series, between Frome on the south, and Bath and Wickwar on the north, or along the eastern edge of the Bristol coal-field ; but under any circumstances the extension or invasion of the cretaceous series in the east, the narrowing of the exposed oolitic series above-mentioned, and the mechanical arrangement of the rock structures themselves, evince and determine local deposition to have gone on under continued oscillation of the land at the time of the deposition of the great oolite series. It is to this second grouping, therefore, or the middle series, which exist between the upper and lower ragstones, that we must assign the workable beds of freestone now extensively quarried in the Bath district.

The Lower Ragstones.—These are an extensive series of rather fine and hard, as well as coarse and shelly, limestones. The lowest beds of this series being usually finer in texture than the upper, and when exposed, are generally from thirty to forty feet in thickness. Nowhere in this neighbourhood are finer sections to be seen than at Murhill, on the north side of the Bradford Valley, and Upper Westwood, on the south side. The beds comprising this division usually occur, or are exposed, in the escarpments of the denuded valleys or the projecting downs above. Masses of the thicker and fine-grained beds frequently occur on the inclined slopes of the valleys, owing to or rising from frequent slips or slides over the fuller's earth upon which these lower ragstones immediately rest. It is, therefore, in the narrowing of the valleys and abrupt cliffs that this series of the great oolite are best exposed. The chief economical value of these beds is confined to local purposes, being utterly unfit for architectural work or exposure to atmospheric influences. The stone used in the construction of the aqueduct conveying the canal over the river Avon, at Avon Cliff, came from the beds of this series at the Westwood Quarry; and although *in situ* the stone appears of fine texture and quality, yet it rapidly decomposes on exposure, and the stone work of the Avon Cliff aqueduct is a perishing evidence of its non-durability. At the Box and Corsham quarries these lower beds, though not observable at the surface, are, nevertheless, forty-three feet in thickness, and are chiefly composed of the fine-textured oolitic limestones, but are not worked, as they are of no value in a commercial point of view.

On the Mode of Working the Bath Freestones.—Having endeavoured to determine the horizon of the workable beds of oolite and the relations they *hold* to the ragstones, or shelly series—recognised *above* and *below* these freestones, I will endeavour to describe shortly the mode of opening, working, and extracting the rock; a matter of no little importance, when we consider that more than 100,000 tons of the Bath freestone is annually removed from its original position in this neighbourhood, and forwarded to various parts of the United Kingdom. In working for stone, the first question to determine is, whether the stone shall be reached by open or underground workings, and this must depend upon the presence and conditions of the upper ragstones (*and forest marble*, where they exist), as they must of necessity be passed through, unless the stone can be reached by tunnelling on the face of an escarpment, where the beds are vertically exposed, or by driving a level to cut the beds; but if the desired beds are not too much covered, open workings are resorted to. Few persons travelling from London to the West of England, *viâ* the Great Western Railway, through the Box tunnel, have any conception, on passing through it, that around and over them are large and extensively worked mines, from which the well-known Corsham and Box freestones are taken, or as they shoot from the tunnel-mouth into the Bath-hampton, Bath-eastern, and Bradford valleys, that it is the seat of so much quarry industry, having for its object the working of the Bath freestone. In describing the particular mode of getting the stone, I will take for my type the Corsham

Down and Box Hill workings. I do so, because these mines have had more thought and attention bestowed on them than any others in this neighbourhood, and because they are the most extensively developed. It is believed that the Box and Corsham locality has been worked for stone, with more or less activity, for three centuries, but it was not demonstrated that so large an amount of good workable freestone existed in the district until the fact was evidenced by the cutting of the Box tunnel, which at once exposed the beds, and showed that to the north and north-west of the tunnel, on the strike of the beds, there existed what we may practically call an inexhaustible supply of valuable freestone. The cutting of the Box tunnel having opened to view this fact, gave an impulse to the previously limited mining operations of the district. The chief operations are situated on the north side of the tunnel; the reason of this is, that the rock is found sounder in this direction, and the stone more even in colour, and more regular in quality and texture, than to the south or dip of the stone. The entrance to these workings is driven from the Corsham or eastern end, immediately contiguous to the mouth of the Box tunnel, and it is here that the railways of the underground workings join the Great Western Railway on the same level. The chief or main road through the workings is carried from this point due west, in a direct line towards the Box Hill escarpment, a distance of one mile and six-eighths; rising with the strata, for the purpose of keeping on the floor of the workable beds, thus making an incline to the west of about 1 in 40; and as the rise to the north is about 1 in 60, advantage has been taken of this, and the works so laid out, that much of the stone can be run on trollies without draught power—that is to say by gravitation—to the loading platform, where it is transferred from the quarry trollies into the railway trucks, which are taken into the mine to receive it. To economise and facilitate the operation of loading, the platform stands on a level a few inches higher than the sides of the railway truck, into which the stone has to be loaded, and by the upper level narrow-guage tramways this platform is placed in direct connection with the whole of the headings or workings; and by its lower level broad-guage railway it is connected with the Great Western Railway. By this loading arrangement, we are enabled to load off into railway trucks from thirty to forty tons in the hour. One uniform system of getting or working the stone prevails throughout the quarries, and this system is an inversion of the mode of working coal. The coal-miner undercuts his coal, that the mass may fall and break, but building-stone so worked would make a valueless rubbish heap. The freestone miner or quarryman has to commence his operations at the roof of the stone. This picking operation is effected by means of adze-shaped picks, on the heads of which longer handles are inserted as the work proceeds, and the men thus make their driving a distance of six or seven feet back into the rock. The width or span of these stalls must of course depend on the soundness of the rock. In the Corsham workings, they can, without danger, be driven a width of from twenty-five to thirty-five feet. In the Box quarries, where the rock is not so sound, and the capping bed, before referred to, not so regular, the drivings are limited to from twelve to twenty feet. This is, of course, regulated by the space that may be safely opened without danger to the working beneath. It must be evident that the removal of eight or nine inches of the rock immediately under the ceiling deprives the overlying strata of the support of this area of stone, as effectually as its removal throughout, from roof to floor, would do, and any tendency to settle or drop is at once determined and any risk of life thus guarded against. Another process, by a fresh agency, is now called into exercise, for the cutting of the rock into blocks of required dimensions; for this, a one-handled saw is used. These saws are worked in lengths of four, five, six, and seven feet, and are made broad, rather I should say, deep, at the head or extreme point, so as to insure the saw sinking to its work at that point. The saw is worked at first horizontally, dropping a little as the cut goes on; and after the rock is thus opened down to the next natural parting, and the block thus separated laterally from the parent rock, levers are introduced into the bed or parting at the bottom of the block, and these levers are weighted and shaken till the block is forcibly detached at the back. It is then drawn down by crane power, and the broken end and the bed dressed with the axe, so as to make the block shapely; it is then placed on a trolly, and allowed to run to the loading platform. After the first block is removed, it will be evident that the workmen have then access by that opening to the back of the bank of stone, and they avail themselves of this to work the saw transversely, which, separating the block from its back or hinder attachment, renders all further breaking off unnecessary, so the first block of each face is the only stone broken from the rock. To each face or heading of work, a ten-ton crane is erected in such position as to command the whole face. These cranes are now constructed telescopically, so as to accommodate them to slight variations in the headings, arising from differences in the depths of the valuable beds, and the expense otherwise attendant on frequent alteration of the crane is thus avoided, and the periodical shifts from old worked-out to new localities are effected with less trouble and loss of time. Sometimes after a block of freestone has been loosened *in situ*, a Lewis bolt is let into the face of the block, the chain of the crane attached to it, and the block is then drawn out horizontally. By the removal of the first stratum a sufficient space is obtained to allow the workmen an entrance under the roof; and vertical cuts are again carried down through the next bed to the parting below, and a transverse cut readily made; meanwhile, the cutting is continued in the picking bed, the upper layer removed as before, and everything below this point quarried away, with all the sides of the block sawn, except the bed on which it has rested, and those abutting on the natural joints; hence each block comes out ready to pass into the hands of the builder, sculptor, or dealer, and this with much less cost and loss in waste than formerly attended blasting and other powerful but rough modes of extraction. The continued repetition of these several operations produces a terrace or step-like profile in the workings, extending from the highest to the lowest of the beds worked, and thus they present themselves to the view.

Professor Phillips said such a paper as this was of the utmost practical importance in connection with science.

Professor Ansted pointed out that the Bath stone, when carried for building purposes to a distance, was exposed to rapid destruction by the action of the atmosphere. He attributed this to the manner in which the stone was quarried. It had been observed that this did not occur with the stone that was used in the immediate neighbourhood of Bath. This, no doubt, was attributable to the fact that the stone was not taken away from its own atmosphere, as is done. He would suggest, therefore, to the quarry-owners, that all the stone to be sent to a distance should be exposed to its own atmosphere for some considerable time, until it had became seasoned, as it were. He believed that if this were done, the stone would be as durable everywhere as it was in the immediate neighbourhood of Bath.

Reviews.

Practical Illustrations of Land and Marine Engines and Boilers. In Twenty Plates, Elephant Folio. By N. P. Burgh, Engineer.

A Pocket-Book of Practical Rules for the Proportions of Modern Engines and Boilers for Land and Marine Purposes. By N. P. Burgh. London: E. and F. N. Spon.

These are works calculated to be of great utility to professional men and machinists. The large plates give in detail all the modern improvements in high and low pressure engines, surface condensation, and superheating, together with land and marine boilers, and prove Mr. Burgh's great capabilities and excellence as a draughtsman, and judgment in making his plates complete working drawings.

Plates 1, 6, 7, 12, and 20, representing engines of various kinds, are designed by the author from the rules given in the Pocket-Book. These plates give the details of a high pressure steam-engine of 12 H.P.; and four plates illustrate the details of a marine-engine.

Plate 5 gives four views of a Cornish boiler of the usual kind, in which the mode of setting is clearly and practically shown.

Plates 13 and 14 give the details of a paddle-wheel and feathering-wheel, details which we have never before seen illustrated; and Plate 15, Griffith's patent screw propeller, contains five views on an unusually large scale. Messrs. Ravenhill, Salkeld, and Co. contribute a plate showing the arrangement of a pair of marine steam-engines, of 900 H.P., for the Imperial Ottoman iron-clad frigate Sultan Mahmoud.

Plate 17 is a drawing of a marine boiler with superheating tubes, which may be studied with great advantage for the information it affords in putting the boiler-plates together, fitting the stays, &c.

Plates 18 and 19 are examples of ordinary and surface condensers, with air-valves.

The Pocket-Book contains nearly 1,000 rules, chiefly for designing, constructing, and erecting land and marine engines and boilers. It commences with the high pressure engine, the latest and best known examples of which are described; the rules connected with this, 217 in number, are ranged under twenty-two sections. Then follows a description of the condensing beam engine, and mode of working the valves, with about 100 rules adapted to the subject. We then come to a description of the marine screw engines made by the most eminent firms in London; and there are nearly 300 rules, divided into forty-seven sections, adapted to the common and equilibrium slide valves, practical arrangement of the valves in the condenser, for the air-pump &c., &c., with many valuable improvements suggested by the author. Passing next to oscillating engines, we have upwards of 100 rules, with tables of cylinder proportions, starting gear for all kinds of engines, surface condensation, &c. We have then a large number of valuable rules for land and marine boilers, including safety valves and superheating. The work concludes with a collection of miscellaneous rules for general application, with tables of proportions of works, bolts, nuts, copper pipes, &c., and areas and circumferences; all of great practical utility for ready reference. We have thus given a sufficient outline of the research and mechanical knowledge condensed in a small compass calculated to be always available for consultation on dubious points, and must congratulate the author on the result of his arduous labours, which can only be fully appreciated by the practical man. His work will, there is little doubt, be looked up to as a standing authority among machinists and mechanical engineers.

Tables for comparing British with Metric Measures and Weights. By C. H. Dowling, C.E. Lockwood and Co.

We have in this work a long series of most valuable tables, in which the British standard measures and weights are compared with those of the metric system at present in use on the Continent. Through various foreign treaties our trade and commerce with continental countries are rapidly increasing, and, as the author justly observes, these tables will render important service to all engaged with those countries in manufacturing, mechanical, or commercial transactions. The bill passed for legalising the use of the metric system in England renders the issue of such a work at the present time the more important. In the compilation of the moneys, weights, and measures for his 'Dictionary of Trade Products, &c.,' the Editor of the Technologist much felt the want of such a manual of ready reference.

Scientific Notes.

Blistering Flies.—The following insects are employed in various countries instead of *Cantharis vesicatoria*:—1. A small variety of *Mylabris cichorii*, and 2. *M. trimaculatus* in Southern Europe, from Italy to the Caucasus; 3. *M. Cichorii* in Bengal and China; 4. *Lytta rufisses*, Illiq., in Java and Sumatra, and a variety in China; 5. *L. gigas*, and 6. *L. violacea*, Br. and Ratz., in India; 7. *L. vittata*, in North America; 8. *L. atomaria*, in Brazil; and 9. *Mylabris puncta et indica* in Pondicherry.

Manifold Uses for Leather.—The old saying, that there is "nothing like leather," is amply verified in the thousand and one little articles of feminine decoration which Madame Fashion has recently decreed for her daughters' wear. In a town stroll the other day, we paused before the tastefully arranged window of a shop, wherein were displayed the usual miscellaneous collection of ornaments, trimmings, &c., which go to make the sum total of such an establishment, and we thought, as we noted down how freely the material "leather" had been used in their construction—Oh that mother Eve, as she perambulated Eden in her primitive garment of fig-leaves, could have foreseen how skilfully her sons and daughters would convert the skins of such animals as those over which she held dominion into the multitude of articles, both useful and ornamental, which meet our eye on every side, and supply our needs at every step. Could she have seen the girdle, formed to encircle the waist of some fair damsel; the coquettish little bow which fastens the collar of the fashionable belle, the trimming of her dress, the rosettes upon her hat, the buttons scattered in delightful confusion over her garments, or arranged in mathematical precision, in rows containing twelve, eighteen, or twenty-four, as fashion and taste shall dictate; the gauntlet, to shade the delicate wrist; the bracelet, for its adornment; the anklet, to protect the ankle; the page, to elevate the trailing skirts from contact with muddy crossings; the reticule, the fan, for subduing summer's heat—these, and many other ornaments too numerous to mention, and all made of leather, so embossed, and stitched, and pinked, and otherwise decorated as almost to lose its identity, yet leather still, are additional evidence of the truth of the saying at the head of our paragraph.

The Nardoo Plant of Australia, noticed in our last number, is not, it seems, "one and indivisible," for at a recent meeting of naturalists at Stettin, Prof. Braun exhibited living specimens of four species of *Marsilea*, two of which had been raised from nardoo seed received from New Holland. These two were the *M. hirsuta* of R. Brown, and the *M. salvatriz* of Hanstrin, the latter of which was figured recently in the *Journal of Botany*, and identified by Mr. Currey with *M. macropus* of Hooker. In this view, however, Braun does not agree; but he considers *salvatrix* to be probably the same as a plant he had previously named *Muelleri*, and *macropus* as unquestionably one he had two years earlier named *Drummondi*. The learned Professor of Berlin has, moreover, reently published an interesting sketch of the genera *Marsilea* and *Pilularia*, thirty-seven species of the former and four of the latter genus being recorded, together with their geographical range and various other particulars respecting them.

Baking Powder.—We have received a pamphlet by a lady, who, however, withholds her name, "On the Practice of employing Certain Substitutes for the Genuine Ingredients in some Articles of Daily Food, as it affects the Health of the Community." She attacks, primarily, the ordinary "baking powder," of which about a ton a day is said to be sold, and which consists chiefly, we believe, of bicarbonate of soda and tartaric acid. In the following remarks of the authoress we heartily concur:—"It is a matter for serious consideration how far medical men are justified in allowing their names to be published, as analysts or otherwise, in connection with this or any other article of trade. It is questionable whether they promote their own interests by such a course; but it is certain that the practice is not consistent with the dignity of the profession to which they belong. Moreover, the name of 'Dr. This or That' tacked on to advertisements and circulars recommending some particular article of food affords no security to the public as to its genuineness; the fact of a sample having been examined is no proof that the whole stock is pure and unadulterated, excepting in the case of business houses of undoubted respectablity; therefore, in the interests of the public and of the medical profession, as well as of legitimate trade, the sooner the practice to which I have adverted is discountenanced and put down, the better for all parties concerned."

Oil from the Lawsonia Inermis.—The sample of essential oil of "Mehudee" alluded to by Mr. Paul Madinier, in page 79, No. 38, vol. iv., of the Technologist, was sent by me to the London Exhibition of 1862, having been Secretary to the Lucknow Committee on that occasion. The species of Lawsonia cultivated in Lucknow is the *inermis*. Roxburgh, in his 'Flora Indica,' under the head of "*L. inermis*, Willd.," writes as follows:—"Flowers small, greenish yellow, *very fragrant*." Further on, he says:—"The flowers are remarkably fragrant, whether fresh or dry, and are particularly grateful at a distance. The species called *spinosa* is nothing more, I imagine, than the same plant growing on a dry, sterile soil; at least, in such soils I have often found it very thorny, the branchlets being then short and rigid, with sharp, thorny points." Don, under the head of *Lawsonia alba*, gives as synonymes *L. inermis* and *L. spinosa*. He also says:—"Young trees unarmed, old trees having the branchlets hardened into spines." He says: — "It is a native of the East Indies, the Levant, and North Africa." I have just been examining a young plant in my garden. It consists of long, thin branches, with small branches all over them. On the latter are branchlets. On touching the points of the branchlets, the young leaves at the extremity fall off very easily, leaving a bare point, rather hard and sharp. Some of these branchlets are about half an inch long, and when they become old and the leaves fall off they are quite hard and rigid, and resemble spines more than anything else. This, I should say, is the origin of the different specific names this plant bears. I have some of the fresh flowers before me. The petals are of a dirty white, and emit a strong fragrauce, which is more grassy than flowery. The natives in Lucknow are very fond of it, but I should not think that it would be admired by Europeans. I am not aware that the otto from the petals is extracted in any other part of India than Lucknow. The leaves of the *Lawsonia inermis* ("Henna-mehudee") are here also used for colouring red the nails of fingers and toes, and the palms and soles. Mr. Paul Madinier asked for some information regarding this plant. This contribution may be acceptable to him.

E. Bonavia, M.D.

Lucknow, 28th June, 1864.

THE TECHNOLOGIST.

PHOTO-SCULPTURE.

BY A. CLAUDET, F.R.S.

If in our time opinions are divided as to whether photography is finally to exercise a beneficial influence upon the fine arts, or the contrary, there is no question that its innumerable useful applications are a boon to the community. After having been habituated to photography, we can scarcely suppose it possible to do without photography, as we might say of railways or of the electric telegraph. Photography may have been the enemy of all that was inferior in the arts of painting and engraving, but is that to be regretted? Instead of the dabblers in portraiture who were satisfying a morbid taste, we have a great army of photographers capable of representing the human form and features in the utmost perfection. The art of painting, instead of being injured, is served by photography, which enables artists to be more perfect in their design, and to study the beauty of forms yielded by the photographic mirror. Photography, in multiplying marvellous representations of the beauties of Nature, tends to inculcate the taste for artistic productions. There will be fewer bad painters, because there will be less and less demand for inferior paintings. Fine works only will be esteemed, and the taste for art will increase in proportion to the value of its productions. How can it be said that photography prevents the artist from imparting to his work the impress of genius? Photography is for him only a useful auxiliary. Nothing can arrest the strides of photography; it extends every day its applications and gradually invades every art. Who would have expected that photography was to be the means of sculpture? Yet, however extraordinary such a prognostication might appear, however difficult at first thought it may be to understand the possible connection between flat representation of objects and their solid form, it has been proved that, from flat photographs, a bust, a statue, or other object of three dimensions can be made by a mechanical process without the necessity of the sculptor's copying the original, or even seeing it at all.

Yet the result is a perfect fac-simile of the original. Moreover, the work is executed in one-tenth of the time required for modelling by hand. This beautiful application of photography is called Photo-Sculpture, and is the invention of M. Willème, an eminent French sculptor. Before explaining how M. Willème was led to this discovery, let me remind you that photography itself was invented by painters of talent—by artists, who, while using the camera obscura for studying the subject of their intended pictures, were struck with the beauty of those natural representations. In contemplating them they naturally desired that the pictures could be permanently fixed. Considering that these pictures were formed by the light reflected from the objects, they essayed to fix them by availing themselves of the known scientific fact that light had the property of blackening certain chemical compounds. The flash of that idea was enough; their genius and perseverance solved the problem, and they created that art which they desired so much—photography. A similar and no less instructive story may be told of photo-sculpture. M. Willème was in the habit, whenever he could procure photographs of his sitters, of endeavouring to communicate to the model the correctness of those unerring types. But how should he raise the outlines of flat pictures into a solid form? Yet these single photographs, such as they were, could serve him to measure exactly profile outlines. He could, indeed, by means of one of the points of a pantograph, follow the outline of the photograph, while, with the other point directed on the model, he ascertained and corrected any error which had been communicated to his work during the modelling. What he could do with one view, or one single photograph of the sitter, he might do also with several other views if he had them. This was sufficient to open the inquiry of an ingenious mind. He saw at once that if he had photographs of many other profiles of the sitter, taken at the same moment, by a number of camera obscuras placed around, he might alternately and consecutively correct his model by comparing the profile outline of each photograph with the corresponding outline of the model. Such was the origin of a marvellous and splendid discovery. But it soon naturally occurred to him, that instead of correcting his model when nearly completed, he had better work with the pantograph upon the rough block of clay, and cut it out gradually all round in following one after the other the outline of each of the photographs. Now, supposing that he had twenty-four photographs, representing the sitter in as many points of view (all taken at once), he had but to turn the block of clay after every operation 1-24th of the base upon which it is fixed, and to cut out the next profile, until the block had completed its entire revolution, and then the clay was transformed into a perfect solid figure of the twenty-four photographs—the statue of the bust was made. When this is once explained, every one must be struck with admiration at the excellence of the process. It is so sure, and so simple, that we are surprised it has not been thought of before. But so it is with the most valuable inventions. They wait until some genius grasps the idea and conceives how to make them practical. It will, perhaps, be argued as a defect of photo-sculpture, that, being the result of a mechanical process, it leaves no opportunity for the display of artistic taste or feeling, and that its productions must therefore be only vulgar and matter-of-fact. This would be a mistake, because the sculptor who has to direct the last operation will exercise his skill in communicating to the model all the refinement with which, as a sculptor merely, he could have endowed it; for, supposing the photographs to have been deficient in attitude or expression, in giving the last touches to the model, the sculptor can correct those imperfections. The pantograph of photo-sculpture will communicate to the clay the true character and the proportions of the object, with all the correctness of the photographs; it will produce a perfect likeness, and it will be necessary to give to this first draught the softness and finish of a work of art. These, of course, cannot be imparted except by a skilful hand and the intellectual feeling of a true artist. In short, as the model must be touched by a sculptor, it is clear that the sculptor so engaged should be such as will not spoil the work of the unerring machine, but, on the contrary, improve it in many particulars, and even add to it the sentiment of art. Therefore the process of photo-sculpture is to put in the hands of a skilful sculptor a model perfect in its proportions, correct in design, full of character, including draperies of the most elegant outlines such as only are represented by photographs; and this model, so prepared for him, would have required a tedious labour with the disadvantage of much uncertainty. As photography has been the means of improving the art of painting, so photo-sculpture is destined to improve sculpture, and to spread in all classes the taste for this noblest branch of the fine arts. It may be said that sculpture is understood only by a very limited number of educated minds. It is seen only in palaces, in the public galleries, and in the mansions of the rich. Good sculpture is very expensive, and for this reason it is not customary for the middle classes to employ sculptors to execute busts or statuettes of relatives or friends. Besides the question of price, there are very few artists capable of producing such a work as shall be an inducement to the possession of this kind of similitude. Photo-sculpture therefore opens a new era by the advantages of its procedure. The work is done with greater accuracy, in a very short time, and consequently at a moderate price. The original has only to sit once for the photograph, and then in a few days, without further trouble, or the necessity of appearing repeatedly before the sculptor, a bust or statuette is produced. Such facilities cannot fail to make the demand very general, and this must cause the employment of a great number of artists. The *ateliers* of photo-sculpture are indeed *to be the best school of sculpture*, from which will issue a succession of skilful artists, who, having practised the mechanical process, will be able, when photographs cannot be obtained, to model by hand. Therefore the art of sculpture must in every way benefit from the practice of photo-sculpture, which undoubtedly we shall see honoured in the dwellings of thousands, not only as regards portraiture in general, but also as to the resemblances of those who by their genius and virtues have deserved our admiration and esteem. Again, photo-sculpture will be the easy and inexpensive means of reproducing, in various sizes, and with unerring faithfulness, the beautiful remains of antique sculpture, whether statues, vases, or other objects which can only be seen in museums and galleries, and thus the public can possess, at a small cost, copies, or rather fac-similes, of the great creations of past ages. The only copies existing of those works cannot often be repeated, for they must be made at some risk of injuring the original, the only process hitherto known being that of taking casts ; hence they are expensive and rare. To obtain a certain number of photographs of these precious relics is all that will be needed for their production by the photo-sculpture process. Photography has already been the means of copying the paintings of celebrated masters existing in public and private galleries. By those photographs every one is enabled to possess copies of the noblest works in the art of painting. These copies contain composition, design, and everything capable of conveying the feeling of the artist; but they are deficient in one essential—colour. It is otherwise as regards the representation of statuary, which leaves to the mind to imagine colour. Photo-sculpture has, then, the advantage of reproducing works in sculpture without depriving us of any of the attributes which have made them famous. Photo-sculpture will further be applied to the representations of animals, showing them in true and natural attitudes ; by this means faithful modes will be introduced in the manufacture of porcelain, clocks, furniture, and much that contributes to the embellishment of our dwellings. In a word, photo-sculpture is calculated to spread the taste for the beautiful in form ; it opens a new era, which will be remarkable in the history of the fine arts. I have thought that I could not give to the meeting a better illustration of the process of photo-sculpture than by executing the bust of our illustrious President, Sir Charles Lyell. I invited Sir Charles for this purpose, and he was kind enough to sit for his photograph on the 16th August. The machine has done the work, the sculptor has given the finishing-touch to the model, and here is the bust complete, Sir Charles not having seen it before I brought it to the meeting. In so short a time as a fortnight I have also been able to obtain of the same bust a model in bronze, and I leave to the meeting to form some opinion of photo-sculpture by this and other examples now near me.*

* Proceedings of the British Association.

WOOLLEN MANUFACTURES IN AUSTRALIA.

As wool is the great staple of Australian produce, so woollen goods may be expected to become, at no distant day, her staple manufacture. At no time since the period of the gold discovery has so fair a prospect presented itself for the investment of capital and the success of enterprise in manufacturing pursuits as at this time. With the present and prospective rise in the price of cotton goods, consequent on the scarcity of the raw material, woollen fabrics must come into greater demand and consumption; and with a thorough knowledge of the latest methods and appliances on the part of colonial manufacturers, and the importation and adaptation of the most improved machinery, there can be no valid reason why—carrying on their operations in the country which produces the wool—they should not be able to drive from the field the goods imported from a heavily taxed country, sixteen thousand miles off. Colonial manufacturing enterprise is only now recovering from the severe depression which it underwent at, and shortly after, the period of the gold discovery. Almost every mechanical and manufacturing pursuit suffered more or less at that time, but more especially those branches of industry where large capital had been invested in expensive and complicated machinery, requiring special knowledge, and steady and painstaking workmen to keep it in profitable operation. Skilled labourers could not be found to replace those who had abandoned the hammer or the shuttle for the pick and the spade, even if the rate of wages demanded did not preclude its employment, except with the prospect of certain ruin to the capitalist. The consequence was that, in common with other industrial pursuits, the manufacture of woollen goods, previously in a most promising state, dwindled, in two or three years, almost to nothing. In 1852, when the gold mania set in, the number of yards of tweed made was 234,378. In 1855 it had fallen to 35,760 yards, and in the following year to 26,534 yards. This was the period of the greatest gold excitement, and, consequently, of the greatest manufacturing depression. From that time industry became more settled and steady. Many of those who had tried a digger's life began to tire of it, and most of them returned to their former less exciting but more reliable pursuits. From 1856 the quantity of tweed-cloth made gradually increased, and in 1861 the number of yards produced was 145,393, or about two-thirds the quantity made ten years before. This was an increase of 26,887 yards over the production of 1860, and nearly double the quantity made in 1859.

When it is considered that this comparatively rapid increase in woollen manufactures has taken place, without any legislative interference, or without the aid of the hot-bed but deceptive influence of protective duties, it must be admitted that the prospect for the future is encouraging. The number of tweed factories in operation in New South Wales, and the quantity produced in 1861, were as follows:—

	No. of Factories.	Yards made.
Hartley	1	7,893
Penrith	2	7,500
Sydney	1	95,000
Parramatta	1	35,000
Total.	5	145,393

This improvement is, no doubt, owing, in a great degree, to the introduction of the latest and most improved machinery and appliances from the mother-country. At the Messrs. Byrnes's establishment, at Parramatta, and at the Sydney factory of Messrs. Campbell and Co., may be seen in operation some of the most beautiful and complicated machinery in the Southern hemisphere. In 1852, notwithstanding the quantity of tweed-cloth manufactured, there was not a single power-loom in the colony, all being made by hand. At the present time, however, the Parramatta factory alone contains about twenty power-looms, as well as other machinery, which greatly enhances its productive capacity.

The manufacture of cloth is so complicated a process that it would be useless to attempt to describe all its details here, but without a short description of the different processes through which the wool passes, from the time it ceases to be a sheep's coat until it becomes the clothing of man, our notice of this branch of colonial manufactures would be incomplete. The wool when it comes into the hands of the manufacturer is scoured or washed in hot water, in large vats, until it becomes almost the colour of white paper, and all grass-seeds and other substances which had become mixed with it are carefully removed. It is then taken to the dye-house and placed in large boilers, filled with dye, for several hours, according to the colour intended to be produced. When sufficiently dyed it is taken to the drying ground, and from thence, when dry, it is brought to the mill and placed in a machine called a "devil." This devil consists of a large number of revolving cylinders, armed with numberless sharp spikes or teeth. The wool is placed in the machine at one end and comes out at the other, looking like tiny banks of fleecy clouds. It is next passed through a machine called a "scribbler," consisting of numbers of revolving cylinders covered with steel wire, set like the hairs of a brush. From this it comes forth more fleecy, cloud-like, and intangible in appearance than ever. It is then weighed (according to the thickness and quality of the cloth intended to be made) and passed through the carding machine. These carders are exceedingly complicated and beautiful engines, consisting of five large cylinders, and numerous smaller ones, having their surfaces covered with fine steel wires, so closely set as to present almost a solid surface to the eye. From the carder the wool falls out on a moving table in small rolls, about four feet in length and of the thickness of a child's little finger. It now, for the first time, presents the appearance of yarn ; its tenuity, however, is so small, that it requires to be handled with great care to prevent its dropping apart. These little rolls of wool are taken from the revolving table of the carding machine by children, and placed in an inclined frame belonging to what is called a "slubbing-billy." This machine moves on a sort of railway forwards and backwards, stretching out the little rolls of wool into threads by its forward motion, and winding them on to perpendicular reels or spindles on its return. The process is continued until the spindles are filled with the yarn. The children who attend these machines are called "piecers," and the dexterity with which they piece or join on the fresh rolls of wool to the retreating ends of those which are being drawn into yarn or thread is wonderful.

In the Parramatta factory new machines have been introduced, called "power-billies," in which the piecing is done by the machine, without manual assistance. The next machine through which the yarn or thread is passed is called a "mule;" this operation makes the thread finer, gives it a twist, and reels it on to spindles, ready to be placed in the shuttles, either for the power-loom or the hand-loom weaver. The mule finishes the spinning process, and it is up to this point in producing the yarn or thread that modern invention has worked such wonders. What follows—that is, the weaving process—is much the same now as it was in times of the most remote antiquity. It is still done by a frame and a shuttle, very similar to those in use two or three thousand years ago. Even that modern invention, the power-loom, is but the old-fashioned loom driven by machinery instead of by the feet and hands of a man. The machine is almost the same, although the method of driving it is different. As there is nothing novel in the weaving process, it is needless to describe it. Colonial tweed is woven in pieces of forty yards long, of double width, and the piece, after it comes from the loom, is divided lengthwise at a salvage left in the middle. There are, in the Parramatta factory, upwards of forty looms, about one-half being power-looms. In Messrs. Campbell and Co.'s factory the number of looms is probably larger, although we believe the power-loom has not yet been introduced there.

After leaving the loom, the cloth undergoes a variety of processes, passing through several machines, in which it is scoured and cleansed. One part of the operation is singular. The cloth is placed in what is called the stocks, and beaten by enormous hammers driven by steam. By this process it is felted or milled—that is, the fibres of the wool are so mingled together that all appearance of separate threads is lost. In this process the cloth shrinks in width and length, and becomes stouter. It is then passed through a cutting machine, where revolving knives, set like the threads of an endless screw, cut off all the loose fibres, and give the fabric a more even and finished appearance. It then goes through a brush machine, and lastly through a teazle mill. This produces a nap or down on the surface, after which it is placed between glazed paper, in a powerful hydraulic press, where it is left for many hours, and finally comes out in the state in which it is sold to the woollen draper.

Some of the tweeds now being made are very beautiful fabrics ; and we understand those sent home by the Messrs. Byrnes, and Messrs. Campbell and Co., to the International Exhibition of 1862, attracted the attention and excited the admiration of the English manufacturers. Colonial tweeds are made from a class of wool superior to that used in England in making a like description of goods, and are therefore much more durable. For this reason it is impossible that the imported article can stand its ground against the home-made one. Previous to the gold discovery a large majority of colonists wore colonial tweed, and this state of things is likely to be the case again at no very distant day. The cheapest and best article will inevitably force its way into consumption, and those who once make a trial of colonial tweed are not likely to abandon its use while it can be obtained at a price little, if at all, in advance of the sum charged for a much less durable and altogether inferior description of imported goods. We understand that the demand —especially in the sister colonies—is rapidly extending, and we may expect to hear, at no distant day, of new factories springing up, and of new fabrics being made of a lighter description to suit the requirements which are certain to arise for woollen goods, if the present scarcity of cotton should continue. To the Messrs. Byrnes, Messrs. Campbell and Co., Captain Russell, of Regentville, and others who have established or are engaged in the making of woollen fabrics in New South Wales, great credit is due for their efforts to develop this interesting branch of colonial manufacture. There is no pursuit which deserves greater encouragement, and it is pleasing to know that these enterprising gentlemen look for no class-legislation in their favour, or desire anything but fair play in the markets of the world. With such energy and opportunities as they possess, who can doubt of their ultimate success ?

ON CHEMISTRY APPLIED TO THE ARTS.

BY DR. F. CRACE CALVERT, F.R.S., F.C.S.

A COURSE OF LECTURES DELIVERED BEFORE THE MEMBERS OF THE SOCIETY OF ARTS.

LECTURE III.

LEATHER.—The Art of the Currier. Morocco, Russia, and Patent Leathers. The Art of Tawing Skins. Chamois and Glove Skins. Parchment. *Hair:* its Composition and Dyeing. *Wool:* its Washing, Scouring, Bleaching, and Dyeing. *Silk:* its Adulterations and Conditioning.

I SHALL have to crave the indulgence and patience of my audience during this lecture, as it will chiefly consist of descriptions of processes for the most part well known to manufacturers and others engaged in the leather trade. Thus, the art of currying, which is applied principally to such leathers as are intended for the upper parts of shoes, for harness, &c., is carried on at the present day nearly as it was fifty years ago, and still is but little known to the public.

Currying.—The objects in view in currying leather are several: to give it elasticity, to render it nearly impermeable, to impart to it a black or other colour, and, lastly, to reduce it to uniform thickness. These qualities are imparted by the following processes: After the leather obtained from hides or the thicker qualities of skins has been damped, it is placed on a stone surface and energetically rubbed, first with a stone, then with a special kind of knife, and lastly with a hard brush. The leather is then ready to be stuffed or dubbed, which consists in covering it on the fleshy side with tallow, and hanging it in a moderately warm room; and as the water contained in the leather evaporates, the fatty matter penetrates into the substance of the leather and replaces it. The dubbing process is then repeated on the other side of the leather, which is now ready to be softened and rendered flexible, and this is effected by rubbing it with a tool called a "pummel." The leather then undergoes the last mechanical operation, which reduces it to uniformity of thickness by shaving off the inequalities of its surface by means of a peculiarly-shaped knife called a "slicker." The greatest part of the curried leather is blackened on the grain side by rubbing it with grease and lamp black, and lastly brushing it over with a mixture of grease and glue. I believe that some kinds of curried leather are dyed by a purely chemical process, that of rubbing the tanned skin, first with iron liquor, and then with a solution of gall nuts or other tanning substance. The most tedious of the foregoing processes is that of dubbing, which has been greatly improved of late years by the Americans. The scoured skins are placed in a large revolving drum, of ten or twelve feet diameter, and lined inside with wooden pegs. A certain quantity of tallow is then introduced and the whole set in motion, and whilst the hides are thus tossed about, a current of warm air is passed through the drums, which carries off the moisture and allows the grease to penetrate the hide. By this means thick hide leather can be stuffed in four or five days.

Split Leather.—A large branch of trade has sprung up within a few years owing to the invention of machinery for splitting hides, skins, and kips, by which the quantity of leather has been considerably increased, though I am afraid this has been done at the expense of its quality.

Fancy Leathers.—Allow me now to give you a slight insight into the methods of preparing various fancy leathers, such as Morocco, Russia, enamelled, tawed, or kid leather, used for soldiers' belts, gloves, &c., and, lastly, oiled leathers, used for washleather, gloves, &c. Until the middle of the eighteenth century Morocco leather was wholly imported from that country, for it was in 1735 that the first Morocco works were established in Paris, and similar manufactories were soon set up in various parts of the Continent and in this country. The process by which Morocco leather is prepared is as follows :—The goat and sheep skins, which are especially used for this branch of manufacture, are softened, fleshed, unhaired, and raised or swelled by methods similar to those already described, but one essential element of success in this kind of leather lies in the perfect removal of all lime from the skins. This is effected by plunging the well-washed skins in a bath of bran or rye flour, which has been allowed to enter into a state of fermentation. The result is, that the lactic and acetic acids generated by fermentation of the amylaceous substances combine with the lime and remove it from the skins. The other essential point is the mode of tanning the skins. Each skin is sown so as to form a bag, and filled, through a small opening, with a strong decoction of sumach, and after the aperture has been closed the skins are thrown into a large vat containing also a decoction of the same material. After several hours they are taken out, emptied, and the operation is repeated. To render these skins ready for commerce it is necessary to wash, clean, and dye them. The last operation was formerly tedious, and required great skill, but since the introduction of tar colours, the affinity of which for animal matters is so great, it has become comparatively easy. The skins, after they have been dyed, are oiled, slightly coloured, and the peculiar grain, characteristic of Morocco leather, is imparted to them by means of grooved balls or rollers. There are two inferior kinds of Morocco leather manufactured, viz., those called *roan*, prepared in a similar way to Morocco, but not grained ; and *skivers*, also prepared in the same manner, but from split sheep skins.

Russia Leather.—The great esteem in which this leather is held is owing to its extreme softness and strength, its impermeability, and resistance to mildew, which latter property is imparted to it by the use of a peculiar oil in its currying—that is, birch-tree oil—the odour of which is well-known as a distinguishing feature of Russia leather. As to its preparation, I will merely state that it is very similar to that of Morocco, with these differences, that hot solutions of willow bark are used instead of sumach; that it is generally dyed with sanders wood and a decoction of alum; and, lastly, as already stated, the birch-tree oil is used in currying it.

Enamel Leather.—This class of leather is usually prepared with calf and sheep skins tanned in the ordinary manner. They are dyed black by rubbing them over with a decoction of logwood, and then with iron liquor or acetate of iron. The leather is softened with a little oil, and is ready to receive a varnish, which is applied by means of a brush. The varnish is composed of bitumen of Judea,* copal, turpentine, and boiled oil.

Tawed or Kid Leathers.—The manufacture of this class of leathers differs entirely from that of those already described, as their preservative qualities are imparted by quite different substances from those used with other leathers, the preservative action of the tannin being substituted by that of a mixture of alum and common salt. In the production of this class of leather, one of the most interesting characteristics is that of unhairing sheep, lamb, and kid skins, after they have been well washed and fleshed on the beam. The old process of unhairing by smearing the fleshy side with a milk of lime was improved by mixing with the lime a certain amount of orpiment, or sulphuret of arsenic; but Mr. Robert Warrington having ascertained that the rapid removal of hair in this case was not due to the arsenic, but to the formation of sulphuret of calcium, proposed, with great foresight, the following mixture as a substitute for the dangerous and poisonous substance called orpiment, viz.: Three parts of polysulphuret of sodium, 10 parts of slacked lime, and 10 parts of starch. The polysulphuret of sodium may be advantageously replaced by the polysulphuret of calcium. The skins, unhaired by any of these processes, are now ready to be placed in a bran or rye bath, as with Morocco leather, or in a weak solution of vitriol, to remove, as already stated, the lime. After the lime has been thoroughly removed from the skins, they are dipped in what is called the white bath, which is composed, for 100 skins, of 13 to 20lbs. of alum and 4 to 5lbs. of chloride of sodium or common salt, and the skins are either worked slowly in this bath or introduced into a revolving cylinder to facilitate the penetration of the preservative agent, which, according to Berzelius, is chloride of aluminium resulting from the action of the chloride of sodium on the alum. When the manufacturer judges that the skins have been sufficiently impregnated with the above mixture, he introduces them into a bath composed of alum and salt in the same proportions, but to which are added 20lbs. of rye flour and fifty eggs for 100 skins. After remaining a few hours they are removed and allowed to dry for about fifteen days, and

* Query Asphalte.—EDITOR TECH.

are then softened by working them with a peculiar iron tool, the white surface which characterises that class of leather being communicated to them by stretching them on a frame and rubbing them with pumice-stone. A large quantity of tawed leathers are also preserved retaining their hair, which is done by simply suppressing the unhairing and rubbing processes.

Chamois, Wash, or Oiled Leather.—These classes of leather are named from the fact that formerly they were exclusively produced from the skin of the chamois; but at the present day, sheep, calf, and deer skins, and even split thin hides, are manufactured into oiled leather. The employment of this kind of leather has greatly decreased of late years, owing to the general substitution of woollen fabrics in articles of clothing. The preparation of this class of leather differs entirely from those previously detailed; the conversion of skins into leather, or from a substance subject to putrefaction to one free from that liability, being no longer effected by tannin, as in the case of hides and Morocco and Russia leathers, or by the use of mineral salts, as in tawed leathers, but by that of fatty matters, especially animal oils, such as sperm. The skins are prepared in the same manner as for tawed leathers, and then submitted to what is called the prizing operation, which consists in rubbing the hair side of the skin with pumice-stone or a blunt tool or knife, until the whole of the rough appearance is removed, and the skin has acquired a uniform thickness. They are then worked on the peg until the great excess of moisture has been wrung out, and plunged into the trough of a fulling mill, to the action of the wooden hammers of which they are subjected until nearly dry. They are then placed on a table and oiled, and several of them, after being rolled together, are replaced in the trough of the fulling mill. When the oil has been thus worked into the substance of the skins, they are removed, exposed to the atmosphere, again oiled, and once more subjected to the fulling mill, after which they are placed in a moderately heated room for a day or two, the object of which is twofold—viz., to facilitate the evaporation of the water and the penetration of the oil, and to create a slight fermentation, by which the composition of certain of the organic substances have undergone such modification as to enable them to combine in a perfect manner with the fatty matters. These processes are repeated until the manufacturer deems the leather sufficiently prepared to be fit to undergo the following operations—viz., to be immersed for several hours in a caustic lye bath, to remove the excess of oily matter, washed, and pegged. It is only necessary to stretch the leather on a table, then on a horse, and lastly between rollers, after which it is ready for the market. The ordinary buff colour of these leathers is communicated by dipping them, previously to the finishing processes, into a weak solution of sumach. Before speaking of the further processes necessary to fit these leathers for the glove manufacturer, I may describe that of Mr. C. A. Preller, whose mode of preparing leather is very interesting, owing to the rapidity with which he converts hides into leather, and also to the remarkable toughness which his leather possesses. To attain these desirable ends, Mr. Preller proceeds as follows :—The hides are washed, slightly limed, unhaired, fleshed, and partially dried ; they are then smeared with a mixture made of fatty matters and rye flour, which having been prepared a few days previously has entered into fermentation, a process which has so modified the fatty matters as to render them more susceptible of immediate absorption by the hide. I think that this feature of Mr. Preller's plan deserves the serious notice of all engaged in the manufacture of oiled leathers, as it appears to prove that fatty acids (or modified fatty matters) are better suited for combination with skins than neutral fats. The hides, with additional fatty matters, are then introduced into the large American drums, previously noticed in speaking of currying. After four days they are removed, washed in an alkaline fluid, worked with a pummel and slicker, and when dried are ready for market.

Gloves.—The manufacture of this article is now a most important branch of trade, and is the means of giving employment to large numbers of people in several towns in this country as well as on the Continent. To render the above-mentioned oiled leather sufficiently soft and pliable for gloves it is necessary to submit it to the following further operations :—The chamois, kid, or other skins are rubbed over with a solution, composed of 1lb. of soap dissolved in half a gallon of water, to which is added 1½lb. of rape-seed oil and twenty yolks of eggs, or, what has been recently found to answer better than eggs, a quantity of the brains of animals reduced to pulp. The use of the two latter substances is extremely interesting in a scientific point of view, for they both contain a peculiar nitrogenated matter called "vitalline," and specially fatty matters called "oleophosphoric and phosphoglyceric acids," which, doubtless, by their peculiar composition, communicate to the skins those properties which characterise this class of leather. The skins are then washed and dyed in various colours, after which they are softened, and rubbed with an instrument adapted to slightly raise the surface, and give it that well-known velvety appearance belonging to glove skins.

Bleaching of Skins.—The only process known until recently for imperfectly bleaching chamois and glove skins was that of submitting them to the fumes of sulphur in combustion, or sulphurous acid, but latterly two modes of attaining that object have been proposed. The first consists in dipping skins, for two days, in a weak solution of neutral hypochlorite of soda, washing, drying, and rubbing them with soap and oil. The second mode is to dip glove skins into a solution of permanganate of potash, when they soon assume a brownish colour, due to the liberation of the oxygen of the permanganate of potash, and the fixation of the hydrate of sesquioxide of manganese by the skin. The skins so acted on are washed and then dipped in a solution of sulphurous acid, which becomes converted into sulphuric acid by the action of the oxygen of the sesquioxide of manganese, and the protoxide thus produced unites with the sulphuric acid, which is soluble in water. The skins thus bleached when dressed are ready for market.

Gilding of Leather.—The usual mode of ornamenting leather with gold is to apply, in such parts as are desired, a thick solution of albumen covering those parts with gold-leaf, and applying a hot iron, when the albumen is coagulated and fixes the gold. This plan is objectionable when the goods are intended for shipment, and the following method, lately proposed, is far preferable ; on the parts required to be gilt, a mixture, composed of five parts of copal and one of mastic, is spread ; a gentle heat is applied, and when the resins are melted the gold-leaf is spread upon them.

Parchment.—There are two distinct qualities of this valuable material, which has been used from time immemorial as a means of preserving records. The best quality is prepared from young lamb, kid, and goat skins, and the second quality from calf, wolf, ass, and sheep skins. To make parchment, the following is the process :—The skins are stretched on strong rectangular frames, limed, unhaired, fleshed very carefully, and rubbed with pumice-stone until they have acquired the proper thickness. They are then dried very carefully in the shade.

Dialysis.—Mr. Thomas Graham, Master of the Mint, has lately drawn the attention of the scientific world to a most remarkable property possessed by organic membranes, of separating when in solution crystallisable bodies from those which are not so. The former he names crystalloids, and the latter colloids. For instance, if a solution of sugar (crystalloid) is mixed with one of gum (colloid) and placed in the vessel, the bottom of which consists of a septum of animal or vegetable parchment, the crystalloid sugar will pass through the membrane into the surrounding water, whilst the colloid gum will remain in the vessel. Again, if solutions of iodide of potassium and albumen be mixed together, the iodide of potassium will diffuse itself through the membrane, which the albumen will not do. Also, if to an alkaline solution of silicate of soda weak hydrochloric acid be cautiously added, chloride of sodium will be produced, and silica will remain in solution ; and if such a solution be placed in the dialyser, the chloride of sodium (the crystalloid) will diffuse itself through the membrane while the silica (the colloid) will remain behind. It is impossible to calculate the immense service which the discovery of these facts by Mr. Graham will render to physiology, toxicology, and to manufactures, as, in fact, every day new applications of it are being made in these various departments of human research. Thus, to give an example which has special reference to the lectures, I have lately seen it proposed by Mr. A. Whitlaw to place salted meat in large dialysers, when it is stated that the salt only will be removed, leaving all the nutritive properties of the meat undiminished. Mr. Whitlaw also proposes to dialyse the brine in which meat has been salted, and thus to remove the salt, leaving the juice of the meat available for use, while the salt is again in condition to be employed as before.

It will now be my agreeable duty to examine with you a few facts relating to hair and wool. It is interesting to observe that hair, wool, feathers, nails, and claws, may be all considered as promulgations of the epidermis, and present nearly the same chemical composition, as will be seen by the following table :—

	Epidermis of Man.	Hide.	Man's Nails.	Hair.	Quill.	Horse's Hoofs.	Scale of Reptile.
Carbon . . .	50·34	50·89	51·09	50·14	52·43	50·40	53·60
Hydrogen . .	6·81	6·78	6·12	6·67	7·22	7·00	7·20
Nitrogen . .	17·22	17·25	16·91	17·94	17·93	16·70	16·30
Oxygen and Sulphur . .	25·63	25·08	25·88	25·25	22·42	25·90	22·90
	100·00	100·00	100·00	100·00	100·00	100·00	100·00

These substances have also this peculiarity, that, notwithstanding their great richness in organic matters, they are extremely slow to decompose.

Hair.—The only real point of interest connected with hair appears to me to be the question as to what its various colours are to be ascribed, and I regret that here I can only give conjectures and not positive facts. Vauquelin and Fourcroy, who analysed hair most carefully half a century ago, stated that hairs were hollow cylindrical tubes filled with oils of various colour ; but Gmelin and others state that the coloration of hairs is due to the different proportions of sulphur that they contain.

Quantity of Sulphur in Hair.

Brown	4·98
Black	4·85
Red	5·02
Grey	4·03

Recently Mr. Barreswil has published a paper, in which he states that the coloration of hairs is probably due to the proportion of iron in their composition ; and he argues that as iron is the essential element of the colouring matter of blood, it is highly probable that it fulfils the same office with respect to hair. I may state, *en passant*, that great improvements have lately been made in dyeing human hair. Formerly the patient had to undergo most unpleasant treatment, his head being covered with a paste consisting of three parts of lime, and one of litharge. An oil cap was then applied, and the patient left for twelve hours, when the disagreeable operation of removing the mass and clearing the hair was proceeded with. The black dye communicated to the hair in this process was due to the sulphur of the hair combining with the lead of litharge, and forming black sulphuret of lead. The present process consists in cleaning the hair thoroughly with a strong alkaline soap, or a little weak alkali, then carefully applying a solution of nitrate of silver, and lastly a solution of monosulphuret of sodium.

Wool differs from hair chiefly by its property of felting, which it owes to its numerous cross lines or serratures, as they are termed ; the finer the wool the greater the number of its serratures. Thus, whilst Mr. Goss has found in the finest Saxony wool 2,720 of these serratures in a single inch in length, he only found 2,080 in an inch of South Down wool, and 1,850 in Leicester. The wool of sheep can be classed under two heads, that is, into long wool and short wool. Certain classes of sheep will maintain the type or quality of their wool under every circumstance. Such are the original types of South Down, Norfolk, and Dorset, all of which are short wool, and all these sheep feed upon fine and short grass. It has been observed that if they are fed upon coarse grass, their wool will also become coarse. This is also true with Welsh, Scotch, and even Spanish merinos. A further proof that this view appears correct is, that the long-woolled sheep, such as those of Leicester, Lincoln, and Kent, feed in valleys where grass is long and coarse. In all cases the size of the animals appears also to correspond with their class of food. Another curious fact is the facility with which one type of sheep will merge into another if they change food and climate. Thus many attempts have been made to introduce into France our Leicester breed, the wool of which is so remarkable for its fineness, length, and silvery appearance. Still, after four or five years' residence there, the wool has lost its most valuable qualities. In fact, the sheep are no more the Leicester breed. The coarse wool of sheep, however, such as those of Devonshire, does not appear to be so rapidly influenced by any change of climate which the animal may undergo. The aptitude which various kinds of wool have for dyes is also interesting. Thus the wool of one kind of sheep will not dye with the same facility as that of another ; and wool dyes much more uniformly if the animal has been washed before shearing, than when the washing is performed upon the wool afterwards. Lastly, the wool removed by the liming process before described will be far inferior in dyeing properties to wool taken from the same kind of animal during life. It may be interesting to know the best method of removing these irregularities. I was engaged during my assistantship at the Gobelins in investigating this matter, and I found that the best plan was to steep the wool for twenty-four hours in lime-water, and then to pass it through weak hydrochloric acid. Wool, as it leaves the animal, is not fit for either dyeing or spinning. Thus when wool is washed with water it yields a large quantity and variety of substances, which in France bear the name of *suint.* The most interesting fact connected with this is, that the 15 per cent. yielded by wool does not contain, as shown by M. Chevreul, any salts of soda, but a large quantity of salts of potash, the greatest part of which is combined with an acid called sudoric ; and what increases the interest of this fact is, that Messrs. Maumené and Rogelet displayed at the Exhibition of 1862 salts of potash which they had obtained commercially from this new source. In fact, they have established in several of the large manufacturing centres of France, where considerable quantities of wool are used, factories for the extraction of salts of potash from the *suint*, and they supplied the jury with the following particulars :—That a fleece of wool weighing 8 lbs. yielded on the average about 1¼ lb. of dry suint, or sudorate of potash, and this would further yield about seven ounces of pure potash. If it is now considered that there is annually twenty million pounds of wool washed in Rheims, thirty millions at Elbeuf, and four millions at Fourmies, it would appear from this quantity that if it were all subjected to Messrs. Maumené and Rogelet's treatment, about two and a quarter million pounds of pure potash might be recoverable. (For further details on this point, see Dr. Hofmann's Report on Chemical Products and Processes in the last Exhibition.) Wool which has been simply washed, as above described, is not sufficiently free from extraneous matters to be fit for application in manufactures. It is necessary that it should be scoured, for which purpose, on the Continent, it is allowed to remain for some time in putrid urine, or weak ammoniacal liquor ; but in this country it is placed in strong alkaline of soap or soft soap, passed through rollers to press out the excess of soap, together with the impurities which it removes, well washed and dried. In these operations wool loses in weight above 50 per cent. when of good quality, and above 30 per cent. when inferior. But even then the wool still retains a certain amount of fatty matters, which it yields to hot alcohol.

The following table, published by M. Chevreul, will give an idea of the composition of wool (dried at 212°) :—

Earthy matters	27·40
Organic and inorganic salts, soluble in water (*suint*)	32·74
Fatty matters	8·37
Wool	31·49
	100·00

Elementary composition, C. 50·66, H. 7·03, N. 17·74, O. 22·32, S. 2·25.

Before proceeding further, I would call attention to the curious fact that the fatty matters of wool are completely different from the fatty matters of the animal itself ; thus, whilst the ordinary suet will be saponified by an alkali, the fat of the wool will not undergo that change, the stearine and oleine being only converted into an emulsion. From experiments I have made, I am able to state that the common opinion, that the differences in quality observed in various wools are owing to their fatty matters, is erroneous, for the pure wool, obtained as above, yielded to the dyer colours as brilliant as those presented by wools in which a part of the fatty matter still remained. Another important fact connected with the composition of wool is the quantity of sulphur it contains, which does not appear to be part of the fibre, as the matter containing it can be removed by a weak alkali, without destroying the fibrous appearance of the wool, although its tenacity is greatly impaired, and its power of taking dye considerably diminished. Another remarkable fact is, that when wool is bleached by sulphurous acid (the only agent known which will effect that purpose), it becomes incapable of taking many colours, especially the new and brilliant coal-tar dyes. The long-disputed question amongst chemists—How sulphurous acid operates so as to bleach wool? —has lately been solved by Messrs. Leuchs and Weber, who have proved that sulphurous acid unites with the colouring matter of the wool, forming a colourless compound; in proof of which it appears that if the wool is placed in boiling water this colourless compound is dissolved, and the wool regains its susceptibility to dyes, though it is slightly discoloured. A small amount of alkali added to the boiling water greatly facilitates the removal of this artificial sulphuretted compound. In a paper lately published by Mr. Grothe, he states that 100 parts of wool fix on an average 0·67 of sulphur, or 1·31 of sulphurous acid to bleach it, and practically 100 parts of wool require about five parts sulphur to be burnt to produce the result. I should also add that wool must always be wet before being submitted to the fumes of sulphur, and it is most advantageous to pass it previously through a soap lye or weak alkali. Wool so bleached should always be well washed in cold water, to remove the excess of sulphurous acid, which otherwise, if the wool were subsequently exposed to moisture, might be converted into sulphuric acid and destroy the fibre of the wool. It may be interesting to ladies to know the process used by a French scourer, named Jolly, to restore Cashmere shawls discoloured by time. It consists in dipping them into a solution of sulphurous acid, which bleaches the wool but does not affect the fast colours with which the fibres composing the patterns of the shawls are dyed. The shawls then only require to be washed and pressed to be restored to their original beauty. There is no doubt in my mind that a solution of sulphurous acid might be substituted for the gas in bleaching wool with advantage and economy, owing to the sulphurous acid being in a more condensed form, and in better condition for effecting the bleaching process. A few years ago, I took advantage of the fact that wool contains sulphur to produce upon it an artificial lustre. The woollen goods were passed through a weak boiling solution of acetate of lead, washed carefully in pure water, and submitted to the action of high-pressure steam, when the lead combined with the sulphur of the wool, producing galena, which gave the wool a lustre. The action was regulated by generating, under the influence of steam, nascent sulphuretted hydrogen from a polysulphuret of sodium, which facilitated the object in view. Wool is generally dyed either in the fleece, after undergoing the processes of washing or scouring, or it is first spun into yarn or worsted. To describe all the various methods of dyeing wool would far exceed the limits of this lecture. The operations of spinning wool into yarn or worsted are purely mechanical, and it is not therefore within my province to describe them. The same remark applies to the manufacture of felt and shoddy, now so extensively carried on in Yorkshire, and I shall therefore merely refer to one or two points having reference to chemistry—such, for instance, as the re-working up of the wool or the cotton of worn-out fabrics. To recover the wool from such fabrics the process is most simple, consisting simply in immersing them in diluted muriatic acid, and drying them at a temperature of about 220°, the wool remaining unaffected. The material is then submitted to the action of a "devil," which separates and blows away the cotton, leaving the wool ready for being worked up. To remove the vegetable fibre with the view of applying it to the purposes for which it is adapted—as the paper manufacture, for instance--the following process has been devised by Mr. F. O. Ward and Captain Wynants. The mixed fabric is submitted to high pressure steam (60 to 80 lbs. to the square inch), and under the influence of this high and moist temperature the vegetable fibre remains unchanged, whilst the animal one is so much disorganized, that when the rags are removed from the receptacle and dried, and submitted to the action of a beating machine, the cotton fibre remains intact, whilst the animal matter falls to the bottom of the machine in the form of a dark-coloured powder mixed with small lumps of the same substance; this residue has been advantageously applied as a manure, by these gentlemen, under the name of "ulmate of ammonia." I am happy to state that chemical science has discovered several means of distinguishing cotton from wool when employed in the same fabric, and even of determining their respective weights in it; but the aid of the magnifying powers of the microscope is often required in investigating the mixtures of wool with flax, cotton, jute, &c., which are now so extensively and so ingeniously spun together. The description of these processes, however, would involve so much technicality, and require so much time, that I must not trouble you with their details. The same remarks apply to the means used for distinguishing the materials used in mixed fabrics of silk and cotton, or silk, wool, and cotton.

Silk.—This material has always been highly esteemed, owing to its remarkable durability, and to the beauty of the fabrics produced from it. Thus the Chinese have used silk from time immemorial, and the Romans held it in such high estimation that, in the time of the Cæsars, silk was worth its weight in gold. The most interesting fact for us is the date of the introduction of the silkworm into Europe; it is related that in A.D. 555 two monks, returning from the East, concealed some silkworms' eggs in their staves, and having succeeded in rearing the worms, their culture soon spread through Greece and Turkey, and gradually found its way into Italy towards the twelfth century. The silk in use at the present day is chiefly derived from the *Bombyx mori*, but the extensive disease which has, during the last eight or ten years, destroyed very large numbers of the worms, has given rise to great efforts to introduce some new species, two of which, the *Bombyx mylitta*, feeding on the *Palma christi* or castor-oil tree, and the *Bombyx ailanthus*, feeding on the plant from which it is named, have been to some extent successful. The material forming the silk is secreted in two glands placed on the side of the animal's body, whence it passes into an organ called the spinaret, on each side of which are two other glands, which secrete a gummy substance, and this uniting with the former forms the silk fibre. Permit me to add here a fact which I think will interest you, viz., the extraordinary quantity of silk which a small weight of eggs will yield. Thus, four ounces of eggs will yield 87,900 to 117,000 cocoons, and as on an average a pound of silk requires 270 cocoons, the four ounces of eggs will give 422 lbs. of silk, or 100 lbs. of cocoons yield generally 8 lbs. or about 14 per cent. of silk. The production of silk fibre from cocoons is extremely simple. It is effected by placing the cocoons in boiling water; this softens or dissolves the gummy matter which binds the fibres together, and the end of the fibre being detached and placed on a reel, is easily wound. This is the state in which it is usually imported into this country under the name of raw silk. When two or more of these fibres are slightly twisted together they form what is called tram or weft, and when two of the threads are twisted in opposite directions and laid together they form organzine or warp. To render this substance susceptible of dyeing, it is necessary to remove the gum by an operation called boiling off, which consists simply in boiling the silk for some time in a soap lye, and washing and wringing it well afterwards, in which operation it loses about 21 per cent. The following figures will show the chemical composition of silk :—

Gelatine	19·08	Commercial yield, 79 per cent. of silk.
Albumen	25·47	
Wax and fatty substances .	1·45	
Silk fibre	54·00	
	100·00	

FIBROINE.

Carbon, 48·53; hydrogen, 6·50; nitrogen, 17·35; oxygen and sulphur, 27·62.

Conditioning Silk.—This expression implies the ascertaining of the real commercial value of silk, or, in other words, its condition; and the necessity of this has been so fully admitted that a conditioning house has existed for forty or fifty years in Lyons, and its advantages have been so fully appreciated that similar establishments have arisen and are well supported in every town on the Continent, where dealings in silk to any amount take place. I may mention, as an instance of the universal adoption of the practice, that even in Crefeld the finest building in the town is the conditioning house. The result is, that on the Continent the intervention of the conditioning house between buyer and seller has become quite a matter of course, with the happy result of abolishing a class of dishonourable dealing which is eating like a canker into the silk trade of Great Britain. I cannot understand why the attempts made to introduce this admirable system into our country have hitherto met with so little success, and can only infer that there is an unsoundness in the trade, which places many of the silk manufacturers to a great extent under the control of wealthy merchants, who, it appears, are the chief opponents of conditioning. Otherwise one would suppose that its advantages to all engaged in working up this valuable product are too obvious to require demonstration, for, taking the most moderate view of the matter, the average gain to the manufacturer by conditioning will be not less than five per cent., and this loss (if he does not condition) cannot be recovered in any subsequent stage, so that his foreign competitor has in this respect alone, an advantage over him of at least five per cent. I may state in a few words how conditioning is carried on. Silk being an exceedingly hygrometric substance—its moisture varying constantly with the amount of humidity and the temperature of the atmosphere—the first operation is to ascertain the total amount of water it contains, for which purpose samples, carefully selected from the bale when it reaches the conditioning house, are weighed in delicate scales, dried in hot-air stoves, and reweighed, the excess of moisture (beyond the 10 per cent. admitted to be the average normal quantity) being then easily calculated. The second operation carried out in the conditioning house is that of boiling off the samples dried as above, and again drying and reweighing, to ascertain the quantity of soap, oil, sugar, acetate of lead, &c., added to give weight, and the result of this operation is to show a loss of 30, 35, and even 40 per cent., instead of about 21 per cent., which is the average amount of natural gum.

THE PETROLEUM TRADE OF PENNSYLVANIA.

BY MR. CONSUL KORTRIGHT.

The petroleum of Pennsylvania has become a standard staple of consumption and of exchange with foreign countries. In 1862, the progress of the trade was very rapid, reaching an aggregate value of 8,198,000 dollars. Total value exported to foreign countries 3,183,917 dollars. In 1863, the quantity and value exported to foreign countries rose to the great magnitude of 27,934,944 gallons, valued at 10,664,379 dollars, or more than three times the value of the exports of the previous year. During the last year (1863), a greater portion was refined previous to exportation, and the prices advanced also, which increased the value of the exportations relatively to the year 1862. During the last part of 1863, petroleum was relied upon as the leading article for the creation of exchange in Europe by the chief cities. In 1862, flour and grain were the chief reliance.

The fact that this new staple has, at this crisis of national affairs, created exchange on Europe to the value of 2,000,000*l.* sterling in a single year, is one of national importance. The greater part of the value so represented is a direct product of the country, costing less than the cost of production of a crop, whether of grain or cotton.

The production at the wells has been steady, increasing with the increase of facilities for hauling and transporting the oil to the various points of departure from the district. The increase of production scarcely kept pace with the increase of exportation during the first half of the year, or before the high prices of the summer had brought out the best exertions of proprietors to deepen their wells and develop their full capacity. In 1863 there was sent abroad :—

	Gallons.	Value.
		Dollars.
From New York . .	11,448,080	4,127,639
„ Philadelphia . .	3,746,211	929,979
„ Boston . . .	1,168,678	470,000
„ Baltimore . .	693,000	200,000
Total . .	17,055,969	5,727,618

The production of the year was for the first six months at 5,800 barrels daily; the three months next following, 8,000 barrels daily; and that for the last quarter of the year at 5,800 barrels daily. The total product for the year 1863 at the wells is 2,286,000 barrels of crude oil. Perhaps 3 per cent. of this is loss and leakage in the immediate district before getting on any line of transportation out of it, leaving 2,220,000 barrels as the quantity actually marketed or refined.

Of this quantity, probably 1,600,000 barrels were sent out of the region, either as crude or as refined, to eastern or foreign markets. At Pittsburgh, 278,000 barrels of crude, and 230,500 barrels of refined, were sent east by railroad; 12,500 barrels of crude, and 20,000 barrels of refined, being sent to western markets. There is a local consumption and distribution other than by railroad of 10,000 to 15,000 barrels. There must have been sent from Pittsburgh and its vicinity about 875,000 barrels of crude oil. There was taken northwards for distribution in the Western States about 600,000 barrels. The quantity delivered at New York during the year is stated at from 720,000 to 750,000 barrels, nearly one half of which was refined.

The large production, giving an average of about 5,500 barrels net per day, surpassed the demand, and there is now a larger quantity of oil in the United States than at the beginning of last year.

The following table gives the figures for the distribution of the article and the stock on hand:—

	Barrels.	
Stock of crude and refined petroleum in the United States, January 1, 1863, estimated at equal to	350,000	refined.
Net production, say 2,000,000 barrels crude, at 65 per cent., equal to about . . .	1,300,000	"
Total supply	1,650,000	"
Of which were disposed of by consumption, estimated at 1,200 barrels per day, in average throughout the year about .	438,000	"
And by export, 668,275 barrels, crude and refined, equal to about	624,000	"
Loss by leakage, &c., on average stock of 400,000 barrels, say 3 per cent. per month	144,000	"
Total	1,206,000	"

Leaving stock of crude and refined oil in the United States, December 31, 1863, equal to about 444,000 barrels refined.

The greater part of this stock is in the interior of the country, chiefly at Pittsburgh. The stock at the wells is but light.

The increased shipments to Europe caused there likewise an accumulation of the article during the greater part of the year; but since the beginning of the winter months, when reasonable prices permitted the article to be more generally introduced, stocks greatly diminished.

Taking the result of the following table as the basis, the European consumption may now be estimated at about 1,450 to 1,500 barrels of refined per day throughout the year.

ESTIMATE OF THE EUROPEAN CONSUMPTION FROM OCTOBER TO DECEMBER, 1863.

	Barrels.
Stock in Europe, refined and crude, October 1, 1863, equal to about . . .	285,000
Ditto ditto January 1, 1864 . .	155,000
Decrease about . . .	130,000
Of which may have been occasioned by leakage, &c., on average stock of 220,000 barrels, 3 per cent. a month, about . .	20,000
Excess of consumption over receipts, about	110,000
Say equal to about, refined, 95,000 barrels.	
Shipped from the United States from middle of August to middle of November, about .	96,000
Deduct average leakage and loss, 10 per cent., about	9,600
Approximate receipts of crude and refined, about	86,400
Say equal to, refined, about 79,000 barrels.	
European consumption for three winter months about, refined	174,000
Per day, equal to about, refined	1,933

RANGE OF PRICES FOR REFINED AND CRUDE PETROLEUM.

Refined.

1863.	Price for Standard Quality.		Average Price for same.
	Lowest.	Highest.	
	Cents.	Cents.	Cents.
January . . .	36	45	40
February . .	35	40	38¼
March . . .	30	40	34¾
April . . .	29	37½	33¼
May . . .	35	45	39½
June . . .	39	50	44½
July . . .	46	55	49
August . . .	49	61	53½
September . .	56	61	58
October . . .	46	56	52½
November . .	40	45	41½
December . .	42	52½	46½

Crude.

1863.	Price for Standard Quality.		Average Price for same.
	Lowest.	Highest.	
	Cents.	Cents.	Cents.
January	21	26	28⅞
February	20	25	22¾
March	20	22½	21¾
April	20	24	21
May	23	33	26⅛
June	25	30	27¼
July	28	30	30⅞
August	32	32½	35⅛
September	34	40	36
October	20	37½	32⅞
November	24	35	27⅝
December	24	33½	30⅞

New uses for petroleum are being developed, which will greatly enlarge the demand for it ultimately. First among these is the application made of it as fuel for steam-ships. The United States' Navy Department have experimented on its use, and the result proves that a great saving would be effected by adapting steam-ship furnaces to its consumption. The United States' Government have ordered a war-vessel to be prepared for its use. In Rhode Island it has been substituted for coal in one of the largest manufacturing establishments, and many of the large mills are to be altered for its employment. This will reduce the consumption of coal greatly, and its price will be lower to the consumer than it ever was before in the United States. It was formerly used by the Indians as a remedy, under the name of "Seneca oil."

The destination of petroleum exported to foreign countries has been chiefly to England and the north of Europe. It is evident that the most extensive arrangements have been made to refine oil in various parts of Europe, and to provide permanently for the supply of the various products of refining to permanent markets. In Europe, all the products of refining have a value nearly equal; benzine and the residuum after the oil is distilled off are both peculiarly valuable—the last for the production of the finest modern dyes. The preference of foreign dealers is therefore generally for the crude oil, and the markets established on the Continent are of the most permanent character.*

The distribution of exports from Philadelphia in 1863 were as follows:—

* In vol. iii., p. 159, will be found an article on the "Purification of Petrolean Oils."—Editor.

	Gallons.	Value.
		Dollars.
To England . . .	2,473,921	748,936
Ireland . . .	436,837	150,188
Scotland . . .	570,913	120,050
France . . .	975,384	230,533
Bremen . . .	201,316	44,909
Antwerp (Belgium) .	125,174	31,594
British West Indies .	69,227	30,158
Cuba and Porto Rico	52,492	19,745
Venezuela . . .	1,811	7,626
British Guiana . .	5,627	2,359
Brazil . . .	7,355	3,863
Other foreign ports .	2,457	957
Total . .	4,939,708	1,382,080

The exports in the last three years were as follows :—

1861	86,383
1862	2,608,932
1863	4,939,708

The number of companies engaged in the petroleum wells of the State is 59, ranging from 10,000 to 200,000 shares each, and representing a capital of 25,000,000 dollars in the aggregate.

QUICKSILVER MINES OF NEW ALMADEN, CALIFORNIA.

BY B. SILLIMAN, JUN.

The New Almaden quicksilver mines are situated on a range of hills subordinate to the main coast-range, the highest point of which at the place is 1,200 to 1,500 feet above the valley of San José. South-west of the range which contains the quicksilver mines, the coast-range attains a considerable elevation, Mt. Bache, its highest point, being over 3,800 feet in height.

New Almaden is approached by the railroad running from San Francisco to San José, a distance of forty-five miles. In the course of it there is a rise of 100 feet, San José being of this elevation above the ocean. From St. José to New Almaden the distance is thirteen miles, with a gradual rise of 150 or perhaps 200 feet.

The rocks forming the subordinate range in which the quicksilver occurs are chiefly magnesian schists, sometimes calcareous and rarely argillaceous. As a group they may be distinguished as steatitic, often passing into well-characterised serpentine. Their geological age is not very definitely ascertained, but they are believed by the officers of the State Geological Survey to be not older than Cretaceous. But few fragments of fossils, and these very obscure, have yet been found in these metaphoic rocks. At a point just above the *dumps*, behind the reduction works at the hacienda (or village), there is an exposure, in which may be clearly seen in projecting lines the waving edges of contorted beds of steatite and serpentine, interspersed with ochery or ferruginous layers, more easily decomposed; and the partial removal of the latter has left the steatitic beds very prominent.

The mine is open at various points upon this subordinate range over a distance of four or five miles, in a north-east direction. The principal and the earliest workings of the mine were in a right line, but little more than a mile distant from the hacienda. The workings are approached, however, by a well-graded waggon-road, skirting the edges of the hills, which is 2⅝ miles in length.

It appears, partly from tradition and partly from the memory of persons now living, that the existence of cinnabar upon the hill was known for a long time prior to the discovery that it possessed any economic value. In fact, upon the very loftiest summit of this subordinate range, cinnabar came to the surface, and could be obtained by a slight excavation or even by breaking the rocks lying upon the surface. In looking about for physical evidences such as would aid the eyes of an experienced observer in detecting here the probable presence of valuable metallic deposits, one observes on the summit of the hill, at various points along the line of its axis for two or three miles, and also beyond, toward the place called Bull Run, occasional loose boulders of drusy quartz, with more or less well-characterised geodes and combs; accompanying which is an ochraceous or ferruginous deposit, such as frequently forms the outcrop of metallic veins. There is, however, no such thing as a well-characterised vein, the quartz and its associated metals occurring rather in isolated masses or bunches segregated out of the general mass of the metamorphic rocks, and connected with each other, if at all, somewhat obscurely by thread veins of the same mineral.

The main entrance to the mine at present is by a level about 800 ft. long, and large enough to accommodate a full-sized railroad and cars. This level enters the hill about 300 feet from its summit, and is driven into a large chamber, formed by the removal of a great mass of cinnabar, leaving ample space for the hoisting and ventilating apparatus employed in working the mine.

At this point a vertical shaft descends to an additional depth of nearly 300 feet, over which is placed a steam "whim" with friction gearing and wire rope, worked by a steam engine, and by means of which all the ore from the various workings of the mine is conveniently discharged from the cars, which convey it out of the level to the dressing floors.

The first thing which strikes the observer, on entering the mine, is the liberal scale of its exploration. Everything indicates a liberal and judicious use of capital in the development of a property which, upon any other principle of exploration, would probably have been unremunerative. We note also the absence of the usual galleries or levels, cut at regular distances of ten fathoms, common in the exploration, for example, of copper mines, and of other metallic deposits in which the ore is confined to well-characterised veins.

In order to reach the lower workings of the mine, the observer may employ the bucket as a means of descent, or he may, in a more satisfactory manner, descend by a series of ladders and steps, not in the shaft, but placed in various large and irregular openings, dipping, for the most part, in the direction of the magnetic north, and at an angle of 30 deg. to 35 deg. These cavities have been produced by the miner in extracting the metal, and are often of vast proportions ; one of them measures 150 feet in length, 70 feet in breadth, and 40 feet in height—others are of smaller dimensions ; and they communicate with each other sometimes by narrow passages, and at others by arched galleries cut through the unproductive serpentine.

Some portions of the mine are heavily timbered to sustain the roof from crushing, while in other places arches or columns are left in the rock for the same purpose.

The principal minerals associated with the cinnabar are quartz and calcareous spar, which usually occur together in sheets or strings, and, in a majority of cases, penetrate or subdivide the masses of cinnabar. Sometimes narrow threads of these minerals, accompanied by a minute coloration of cinnabar, serve as the only guide to the miner in rediscovering the metal when it has been lost in a former working.

Veins or plates of white massive magnesian rock and sheets of yellow ochre also accompany the metal. Iron pyrites are rarely found, and no mispickel was detected in any portion of the mine ; running mercury is also rarely, *almost never*, seen.

The cinnabar occurs chiefly in two forms, a massive and a subcrystalline. The first is fine granular, or pulverulent, soft, and easily reduced to the condition of vermilion ; the other is hard, more distinctly crystalline, compact, and difficult to break ; but in neither of these forms does it show any tendency to develop well-formed crystals. It is occasionally seen veining the substance of greenish white or brown compact steatite or serpentine.

The ores are extracted by contract, the miners receiving a price dependent upon the greater or less facility with which the ore can be broken. By far the larger portion of the workpeople in the mines are Mexicans, who are found to be more adventurous than Cornishmen, and willing oftentimes to undertake jobs which the latter have abandoned. The price paid for the harder ores in the poorer portions of the mine is from 3 dols. to 5 dols. per cargo of 300 lbs. This weight is obtained after the ore is brought to the surface and freed by hand-breaking from the superfluous or unproductive rock; by this arrangement, the company are secured from paying for anything but productive mineral. All the small stuff and dirt formed by the working of the "labours" are also sent to the surface to form the adobes used in charging the furnaces.

It has often happened, in the history of the mine, during the past fifteen years, that the mine for a time has appeared to be completely exhaused of ore. Such a condition of things has, however, always proved to be but temporary, and may always be avoided by well-directed and energetic exploration. Upon projecting, by a careful survey, irregular and apparently disconnected chambers of the mine in its former workings in a section, there is easily seen to be a general conformity in the line of direction and mode of occurrence of the productive ore masses. These are found to dip in a direction towards the north, in a plain parallel, for the most part, to the pitch of the hill, but at a somewhat higher angle. An intelligent comprehension of this general mode of structure has always served hitherto in guiding the mining superintendent in the discovery of new deposits of ore.

Since the settlement of the famous law-suit, which has so long held the company in a condition of doubt, the new parties, into whose hands the property has now passed, have commenced a series of energetic and well-directed explorations at various points upon the hill, with a view to the discovery of additional deposits of ore. At one of these new openings, distant, at least, 500 feet from the limit of the old workings, and not more than 200 feet from the summit of the hill, a deposit of the richest description of the softer kind of cinnabar has been discovered, which, so far as hitherto explored, has a linear extent of at least 70 or 80 feet, and, in point of richness, has never been surpassed by any similar discovery in the past history of the mine. A charge of 101,000 pounds, of which 70,000 were composed of this rich ore, 31,000 of "granza," or ordinary ore, 48,000 pounds or adobes, worth 4 per cent., making a total charge of 105,800 pounds, yielding, on the day of our visit, 460 flasks of mercury, at 76½ pounds to the flask. This yield is almost without parallel in the history of the mine. The only preparation which the ores undergo, preparatory to reduction, consists of hand-breaking, or "cobbing," for the removal of the unproductive rock.

The small ores and dirt hoisted from the mine are made into "adobes" or sun-dried bricks, sufficient clay for the purpose being associated with the ore. The object of these "adobes" is to build up the mouths of the furnaces to sustain the load of richer ores. No flux is employed, there being sufficient lime associated with the ores to aid the decomposition of the sulphurets.

The furnaces are built entirely of brick, in dimensions capable of holding from 60,000 to 110,000 pounds, according to the character of the ores employed. The chambers are fired from a lateral furnace, fed with wood, and separated from the ore by a wall pierced with numerous openings by the omission of bricks for that purpose.

Connected with the furnace is a series of lofty and capacious chambers, also of masonry, through which the whole product of combustion is compelled to pass alternately above and below, from chamber to chamber, until all the available mercury is condensed. The draught from these furnaces is carried by inclined stacks up to the top of a lofty hill several hundred feet distant; and here the sulphurous and other *effete* products of the furnace are discharged. Formerly no precautions were taken to prevent the escape of mercury through the foundations of the furnace to the earth beneath ; now the furnaces stand upon double arches of brickwork, and plates of iron are built into the foundations, so as to cut off entirely all descending particles of the metal and turn them inward. To be convinced of the importance of this precaution, it is sufficient to watch the operation of the furnace for a few moments, when an intermittent stream may be seen to flow into into a reservoir provided for it, and which by the former process was completely lost in the earth.

On taking up the foundations of some of the old furnaces within the last two years, the metal was found to have penetrated, or rather permeated, completely through the foundation and clay of the substructure down to the bed-rock beneath, a depth of not less than 25 or 30 feet. Over 2,000 flasks of mercury were thus recovered in a single year from the foundations of the two furnaces. This loss is entirely avoided by the improved construction which has been adopted.

The whole process of reduction is extremely simple, the time occupied from one charge to another being usually about seven days. The metal begins to run in from four to six hours after the fires are lighted, and in about sixty hours the process is completed. The metal is conducted through various condensing chambers by means of pipes of iron to a " crane-neck," which discharges into capacious kettles. It undergoes no further preparation for market, being quite clean from all dross.

Deducting two and a half years, during which the mines were in a state of inactivity, pending the decision of the law-suit, the average monthly product for twelve and a half years has been not far from 2,500 flasks, of 76½ pounds each, of mercury. The selling price in San Francisco is, at present, and has been for some time past, 75c. per pound, while in London and New York it has ranged from 40c. to 50c. per pound.

ON THE REVERSION AND RESTORATION OF THE SILKWORM.

BY CAPTAIN THOMAS HUTTON, F.G.S.,
OF MUSSOOREE, N.W. INDIA.

For many years past the utmost anxiety has prevailed on the European Continent, and more especially in France, in regard to the condition of the common silkworm, known to science as the *Bombyx mori*, the constitution of the worm appearing to be so thoroughly weakened and undermined, by diseases arising from a long and uniform course of domestication, bad nourishment, and other prejudicial influences, as to excite the most lively apprehensions lest the insect should suddenly become extinct.

That such apprehensions are far from groundless may be seen in the fact that one form of disease by which the worm is attacked, known in France as "*la muscardine*," is said by M. Guérin-Méneville annually to destroy more than *one-fourth* of the worms; and it has been clearly shown by this eminent entomologist, and by several experienced cultivators of silk, that the crop has, within the last ten years, dwindled down to about one-half of what it used to be.

Various remedies have, of course, from time to time been tried for the purpose of arresting the progress of disease, sometimes with partial and temporary effect, but more generally without any success at all.

In consequence of these maladies, and their inability to arrest them, the French, with prudent and praiseworthy foresight, are using every possible means to introduce and acclimatize other species, which may, in some measure, fill the commercial void which would be created by the loss of the common silkworm.

Under these circumstances it occurred to me, that while assisting our continental neighbours in the introduction of such wild species as occur within our Western Himalayan forests, I might as well at the same time endeavour, if possible, to reclaim and restore to health the most valuable species of the whole ; and, consequently, for several years past I have studied and experimented upon the *Bombyx mori* and its domesticated congeners with a degree of success which I now purpose to unfold.

In experimenting upon the worm, I have not confined my efforts within the narrow limits of an endeavour to cure particular phases of disease, but to effect a permanent benefit in the restoration of a healthy and vigorous constitution, which, if accomplished, as I think it may be, will of itself not only cast out this or that particular phase of disease, but all the diseases under which the worm is now labouring ; and I am fully convinced that until such radical change has been wrought, it will be but time and labour thrown away to seek to cure particular maladies as they appear.

Hitherto the results of my experiments have been such as to warrant my entertaining the most sanguine hopes of ultimate success, provided the same system be carried on for a few years longer, when it will of course depend upon the cultivator to maintain the advantages thus secured.

Of all the groups comprised within the family of the *Bombycidæ* that in which the genus *Bombyx* is contained is, perhaps, in a commercial point of view, the most interesting and the most valuable. This genus contains, besides a few wild indigenous species widely scattered over the continent of India, all those long domesticated species popularly known as "*silkworms*," which were centuries ago imported into Europe from the northern provinces of China, where for many centuries previously they had likewise been kept in a state of domestication.

Having, however, already, in a paper entitled "Notes on the Silkworms of India," entered somewhat fully into the history of the Chinese species, I need not here travel over the same ground, but shall call attention to facts not previously noticed, and endeavour, after exposing the folly of insisting, as some still obstinately do, upon the healthy and vigorous constitution of the insects, to show by how very simple a method the worms may be induced to *revert* from their present artificial and moribund condition to one of vigour and permanent health.

According to the commonly-received chronology, the discovery of the silkworm in China was made about the year B.C. 2640; and the means of reeling off, or unwinding the fibre from the cocoon, being also discovered, the regular domestication of the insect at once commenced.

Whether the species then discovered was in reality that to which naturalists have since assigned the name of *Bombyx mori*, or whether the discovery of more than one species then occurred, we have now no means of positively ascertaining; nor, indeed, does it much signify, as, for the present at least, it is with that known and cultivated in Europe as an annual that we have to deal; but from a paragraph quoted by Mr. F. Moore, from the "Account of the Ceremonies of the China Dynasty," it would appear as if more than one species were under cultivation at the time when the "Account" was written, inasmuch as it contains an allusion to a second crop of silk, when it says: "The officer who adjusted the price of horses forbade the people to raise a second breed of silkworms in one season." Now, whatever the *Bombyx mori* may be when cultivated in Cashmere, Persia, or Europe, it may undoubtedly be made, in a suitable temperature, to produce an autumnal brood; this, however, refers to the worm after having been submitted to my experiments for two or three years, and when, indeed, it is fast travelling back to a state of nature. The same thing occurs likewise with regard to another species, which is also an annual, as far as I can learn, in all countries, except Mussooree in the Western Himalaya; this is the *Boro Pooloo* of Bengal, and *Bombyx textor* (nobis), which, like the *Bombyx mori*, yields an autumnal crop when treated in a particular temperature. This fact, indeed, has led some people to declare that the two are but varieties of the same species, and that in a state of domestication all may, by the application of certain temperatures, be made to yield several crops of silk annually. This, however, may fairly be denounced as pure nonsense, the occurrence of the two crops arising solely out of the fact of our having in autumn a recurrence of the spring temperature, or what may be called a double season. Hence, since a particular degree of temperature causes the egg to hatch, whenever the season returns in which that temperature is produced, the young worm is of course excluded from the egg. It is quite possible, then, and even probable, that these species may originally have done the same in their native country, and the reason why they have ceased to be double-brooded in Europe and other localities is to be attributed solely to the uncongenial temperature, which is sometimes too high, at other times too low; and with respect to those species which are termed "monthly" worms, if it were really the case that the number of crops is due to cultivation in warm climates, it ought to follow that, when domesticated in a cold climate, the frequent succession of silk crops should become less frequent, and the worm give symptoms of reverting to its old habits. Such, however, I have not found to be the case; for although I have succeeded in obtaining two broods from *Bombyx mori* of Cashmere and *B. textor* of China, yet the small monthly China worm (*B. sinensis*, nob.) has continued yielding crop after crop even to the middle of December, when the eggs were again deposited in a temperature of 53° of Fahr. Hence I adhere with good reason to the opinion that all are naturally distinct species. Consequently, as all the other accounts, quoted by Mr. Moore and other authorities, lead to the conclusion that one spring crop only was produced by the worm originally cultivated in China, it will be well to allow the animal species domesticated in Europe as *B. mori* to retain that distinctive title, more especially when we consider that as the people were forbidden to rear—not merely *a second crop of silk*, but—"*a second breed of worms*," the stock, if double-brooded, would speedily have been destroyed and lost by such interdiction. This, then, would tend to prove that the worm under cultivation was an annual only, and that the prohibition extended to other species.

From the year before Christ 2640 until 550, or thereabouts, of the Christian era, the domestication of the worm appears to have been exclusively confined to China, severe punishments being inflicted upon anyone who ventured to attempt its exportation into other countries, when, at length, about the latter year, through the laudable zeal of missionary monks who had visited China and there learnt the mode of cultivation, the eggs were secretly conveyed into Europe and presented to the Emperor Justinian.

Thus, for a period of more than 3,000 years, the so-called cultivation of the worm had remained exclusively in Chinese hands. What wonder, then, if the constitution of the insect had during that time been gradually undermined by a course of imperfect feeding, close and tainted atmosphere, and various other enervating causes, until, at length, when imported into the West, it no longer retained its natural vigour, health, and original characteristics, but had become enfeebled, degenerated, and sluggish, by a long system of interbreeding with debilitated stock, and rendered liable, by the loss of constitution, to a multitude of diseases.

From the time of its introduction into Europe, the treatment it has experienced has been, with some modifications, nearly the same as that pursued in China ; so that for an uninterrupted period of no less than 4,500 years, the worm has had to contend against all those unnatural and purely artificial influences arising from a state of domestication, which we erroneously persist in terming *cultivation*, without one single renewal or infusion of the origiual healthy and natural stock from which the race has descended! Truly has it, as Darwin would say, undergone "the struggle for existence!"

One would almost be tempted to think, that the object of cultivators had actually been the destruction of the insect, for in what other department would breeders so long have neglected to infuse new blood into their domestic stock? Is it not a well-understood and long-established fact, that, whether among animals or plants, an occasional renewal of seed and re-infusion of the original stamina is found to be absolutely necessary for the preservation of health, and of that particular standard of perfection which it is thought desirable to maintain? And yet with the domesticated *Bombyx mori*, this necessary precaution has been uniformly neglected for 4,500 years! What wonder, then, that under the combined effects of bad and scanty food, want of sufficient light and ventilation, too high a temperature, and with the constant and unvarying interbreeding of a debilitated stock, the insect should have become subject to a multitude of maladies, and threaten, at no distant period, to become extinct.

By here condemning the system of interbreeding, I must, however, guard against the possibility of being misunderstood, for I am well aware that in France a very senseless outcry has been raised in some quarters against the interbreeding of brother and sister, and other near relatives, as if, in a state of natural freedom, such a proceeding was not the general and authorized rule. What I condemn, and in this I am happy to find myself supported by such weighty authority as that of M. Guérin-Méneville, is not the intercourse of near relations, but the incessant interbreeding of diseased and debilitated individuals, which, as "like produces like," cannot possibly do otherwise than perpetuate and aggravate both disease and debility. Where brothers, sisters, and cousins are all healthy and of sound constitution, no bad consequences will ensue from their interbreeding, for such is the established plan upon which Nature acts ; but where disease exists, the breeding from two deteriorated individuals, whether they be nearly or distantly related, will only add fuel to the fire and perpetuate, and even aggravate, disease.

I assert, then, that there is no such thing now in existence as a perfectly healthy domesticated stock of silkworms, the colour proving, beyond all doubt, that the constitution has been utterly destroyed, and the wonder rather is, that the worms have continued to live so long, and to yield such good returns under such a constant struggle against adverse circumstances; for it seems quite evident, since naturalists have never recorded the colours of the caterpillar to be otherwise than ashy or creamy white, that even so long ago as the time of the Emperor Justinian, the true colour of the worm had already been obliterated by the centuries of mismanagement to which the Chinese had subjected the insect. It is true that the occasional occurrence of dark-coloured worms among the general brood has been observed, yet these occurrences are always spoken of as exceptional cases indicating variety arising from domestication, rather than as denoting, what in reality is the fact, an attempted return, on the part of Nature, to the original colours and characteristics of the species.

Under no other supposition than this does it appear possible to account for the error committed by the older naturalists; and, consequently, I again assert, with the greatest confidence, and shall presently prove, that the whiteness of the worm is to be regarded solely as a positive indication of the loss of constitution, and that the species, in its natural colours, has yet to be described.

I shall probably be told that learned and experienced men have occasionally been sent from Italy and France, in order to collect fresh seed (as it is termed) for the purpose of renovating the sickly stock of Europe by the re-infusion of a healthier and more vigorous constitution from the worms of India and of China. Such an assertion, to a certain extent, would, no doubt, be true, since it cannot be denied, that a search for healthier stock has often been made, though never with success, from the simple fact, that whether in Europe, Persia, India, or China, the worms are all equally degenerated, or if indeed there be a difference yet perceptible, it is altogether in favour of the European race. We can all "call spirits from the vasty deep—but will they come when we do call?" Had a search been instituted in China for *the wild worm* in its original state of freedom, great benefit would no doubt have ensued from its discovery; but if we reflect that the worm, even in its native country, has, like that of Europe, been immemorially of a pale colour, a Chinese cultivator on being asked for the original wild stock would at once acknowledge that he knew the worm under no other aspect, and in no other condition, than that in which for so many centuries it had been cultivated by his forefathers, and the idea of its having possibly changed or lost its colour under domestication would in all probability never enter into the head either of the Chinaman or of his interrogator. Seeing then, as I shall presently show, that the Eastern is infinitely inferior to the European stock, the crossing with seed selected either in India or in China would only be adding to the disease which already threatens the West with such disastrous consequences.

I may, however, be asked, what proof I can adduce of disease and change of colour ? As regards the existence of disease, there is no occasion to reply, as the fact is only too well-known ; but as regards the loss of colour, I have abundant evidence now before me.

All those, indeed, who have had the least experience in the rearing of the silkworm must have perceived the occasional occurrence among the brood of one or more dark grey or blackish brindled worms, contrasting strongly and curiously with the pale sickly hue of the majority. These, by the French cultivators, are called "*vers tigres*" or "*zebres*," that is, "tiger or zebra-striped," and are regarded as a mere variety. Yet these are, in fact, the original and natural worms.

My attention having long since been arrested by this circumstance, it at length occurred to me to endeavour by a series of experiments to ascertain the cause, my conviction being, either that the species had at some time or other been crossed by another of different colours, and that Nature, as sooner or later she always will do, was making an effort to separate them ; or that the original colour of the worm had in reality been dark, and an effort was being made to *revert* from a sickly condition to the original healthy starting-point. Acting on this idea, I at once determined to assist Nature by giving her fair play, and, consequently, picked out all the dark-coloured worms and reared them separately, allowing the moths to couple only *inter se*, and the same course was pursued with the white worms.

In the following spring the one batch of eggs produced nearly all dark brindled worms, while the other produced white ones, sparingly interspersed as before with an occasional dark one ; these latter were removed into the dark batch, which was at the same time weeded of its pale worms.

In the third year the worms were still darker than before, and were always larger and more vigorous than the pale ones, giving likewise larger and better stuffed cocoons.

Unfortunately, just as the eggs of the third year had been deposited and collected, a violent and unexpected gale of wind suddenly upset the whole, and irretrievably scattered them abroad. I had, however, seen such good reason for hoping that I might eventually by this method succeed in restoring the constitution of the worm, that I commenced *de novo*, and went over the same ground again.

The eggs with which my experiment was recommenced were procured in the spring of 1862 from Mr. Cope, of Umritsir, in the Punjab, who assured me that they had just arrived direct from Cashmere, although, from their appearance, I strongly suspect they owed "their birth, parentage and education," to the Punjab, and had been sent by mistake. But however this may be, on their arrival at Mussooree, I submitted them to the microscope, which at once proclaimed them to be ill-formed, discoloured, and diseased.

This Mr. Cope denied ; nevertheless it was a fact, and as the worms proceeded towards maturity, various phases of disease became apparent; and I can only account for the denial of its existence by Mr. Cope and some cultivators in Bengal, by supposing that they do not know a disease even when they see it. The worst form attacked the worms just previous to their spinning the cocoons, and gave them the appearance of having been sprinkled with ink from a pen. This is, I believe, what the French term being "peppered," or "*vers poivres*"—a most expressive and appropriate term.

Nevertheless, the cocoons were formed, though, as might be expected, they were thin, papery, and greatly deficient in silk; as cocoons, indeed, they were perfect trash; but, as I had a point to ascertain in respect to the silk, I dispatched them to Mr. Turnbull, of Ganthal, an experienced and skilful superintendent of silk filatures, ever willing to oblige, and who had likewise reeled for Mr. Cope, of Umritsir, and Colonel Clark, of Oudh. The result was, that my worthless cocoons yielded a silk not one whit inferior *in quality* to that produced by the inordinately-belauded cocoons of the above-mentioned gentleman; and, indeed, although *in epistolâ* Mr. Cope pronounced Colonel Clark's cocoons to be "the finest he had seen in India," it was declared by Mr. Turnbull, who reeled them, that they had deteriorated fifty-six per cent. below the Cashmere standard furnished by Mr. Cope himself, and as that standard is itself about fifty per cent. below that of France and Italy, we may safely put down the best Indian cocoons of the true *Bombyx mori* as being seventy-five per cent. worse than they ought to be; and yet, in spite of common sense and twenty-five years' experience, I am modestly required to believe that the worm is not diseased. What then, in such case, is the meaning of the panic in France and Italy?

It is to be remembered, however, that all my sickly worms were of the white variety, and that the few dark worms picked out from them escaped disease altogether, although reared in the same manner, in the same room, in the same temperature, on the same quality of food, and in close contiguity to the others. These dark ones in due time spun cocoons and produced moths, which, coupling *inter se*, deposited a fair stock of eggs, with which the experiment was again carried on in the spring of 1863.

I may here observe that it is a well-known fact, that the more numerous are these dark-coloured worms in any brood, the healthier is it considered to be, and *vice versâ*.

Now, the eggs furnished by Mr. Cope in the spring of 1862 produced very few dark worms, while the eggs from dark worms descended from them produced in 1863 an undue number of white worms, which had to be weeded out, and proving at the same time the extreme weakness of constitution of the stock upon which I was experimenting.

Again, another proof of disease is found in the fact that, in the spring of 1862, the eggs received from Umritsir were all loose and detached: this is characteristic of the species whether in India or in

Europe, and proceeds from weakness in the glands attached to the ovipositor, and which do not, in consequence, secrete the gum necessary to attach the egg. A few will of course always be found to adhere at first, but so slightly, that the least touch causes them to fall.

In the spring of 1863 the eggs obtained in the previous year from the dark stock began to hatch on the 16th of March, and no sign of disease was apparent among them until the moths came forth from the cocoons, when many of these still showed defect in the malformation and dark spotting of the wings. As compared, however, with the previous year, there was decided improvement ; there were still too many white worms in the brood, but they did not show any symptoms of disease and none died ; they attained to a larger size by a quarter of an inch, increasing from three to three and a quarter inches in length ; they produced, in consequence, larger cocoons, though still deficient in silk, and the moths, although still showing the presence of disease, laid good-sized eggs, great numbers of which adhered firmly to the paper upon which they were deposited, and indeed one sheet of paper was thickly covered with them—a thing which, although I have paid attention to this subject for the last twenty-five years, I never witnessed before, nor even heard of it. The eggs of other species will adhere, but to find those of the *Bombyx mori* doing so is truly a novelty which betokens decided progress towards a healthier condition.

There was likewise another indication of returning strength to be seen in the fact that, while ordinarily the male moths are so sluggish as to make no attempt to fly, many of those produced from my black stock left the trays and flew off to seek the females in a distant part of the room. This is one of the marked characteristics of the wild moth *Bombyx Huttoni*, which flies off from tree to tree for long distances when " on amorous thoughts intent."

But still more extraordinary appears the fact that some of the eggs of *B. mori* of the spring crop of 1863 began to hatch *again for a second crop* on the 7th of August of the same year : these were all from the dark stock, and the circumstance, in itself perfectly novel, arises, I am inclined to think, from an accession of strength acquired by reversion to a state approaching more nearly to the original constitution.

The hatching continued throughout August, and occasionally even to the 23rd of September, when, fearing that my supply of leaves might fail, the eggs were removed to a temperature below 70° Fahrenheit in order to check the hatching.

The worms now hatched continued to grow and thrive, and spun good cocoons superior in size to those of the spring crop, the worms attaining to $3\frac{4}{10}$ inches in length. In due time the moths appeared and were fully twice as large as those of spring, depositing large well-formed eggs. In the beginning of December, to my dismay, more worms were hatched from the spring batch, and continued to come forth throughout the month at the rate of forty or fifty daily in a temperature of 53°

Fahrenheit, when, having no more leaves upon the trees, I was compelled to place the remaining eggs out in the open air at night in order that the sharp hoarfrosts might effectually put a stop to any further hatching. All these worms were of the dark kind, and no white ones now appeared among them as in the spring; indeed, from the white stock only three worms were produced, and these came to nothing. This circumstance, so thoroughly unusual with *Bombyx mori*, I attribute entirely to an accession of health and strength in the black worms, which are evidently now in a transition state, which may account in some measure for their hatching out of season, so irregularly and in such a low temperature. This, however, must close the experiment for 1863, and I must hope for some decided results in the spring of 1864 from the eggs deposited in October, 1863.

In the meantime, then, I will return to the consideration of what the worm ought in reality to be.

That the dark colour is the natural one is shown in some measure by the strong similarity, evinced in the disposition and arrangement of the markings, to the wild races of India; while the moth also, instead of remaining so purely white in wings and body, assumes a dark ashy or smoky hue on the body of the males, which is likewise diffused over a great portion of the wings, as in *Bombyx Huttoni.*

Here, then, I think I have already given in the above account strong proofs that the original colour of the worm was dark, and that the pale sickly hue which it has long since assumed is entirely owing to debilitated constitution.

Nor is there here much room for wonder when we reflect how often among our other domestic stock the original colour fades away, to give place to piebald, and finally to white. Need I do more than call attention to our domesticated rabbits, our pigeons, domestic fowls, turkeys, Guinea fowls, ducks, and geese, in proof that the more the white colour prevails the further do the species recede from their natural characteristics, and the weaker becomes the constitution. Even our cage-birds, as every bird-fancier well knows, exhibit this same tendency to lose their original colours, and become paler and paler, until many eventually turn altogether white.

On this subject, for the purpose of strengthening my argument, I feel that I cannot do better than quote a passage from General Daumas' very able work on 'The Horses of the Sahara,' that writer's views being so thoroughly in accordance with my own.

"It is abundantly apparent," says the General, "that legendary traditions and experience are in perfect harmony in according a decided superiority to coats of deep and decided hues. Coats of a light pale colour are held in no esteem whatever. The horse's coat, therefore, must be an index to his character. The long experience of Mahomed the prophet and of Moussa, the conqueror, must have placed them in a position to speak with full knowledge of the subject, and their opinion, confirmed by that of all the Arabs, the best horsemen in the world and the most interested in studying the animal, upon whom indeed depends their honour and their life, is certainly entitled to be regarded with some respect. It is beyond all question that the *Koummite*—red mingled with black, chestnut or bay—is preferred by the Arabs to all others. If I might be allowed to quote my own personal experience, I should have no hesitation in saying that, if there be any prejudice in the matter, I share it with them. Besides, must it necessarily be a prejudice because it may seem to be one? *No one will deny that all the individuals of the same species are, in their wild state, identical in colour and endowed with common instinctive qualities inherent in the race.* These colours and these qualities undergo no alteration or admixture *except in a state of servitude and under its influences, so that if any of these individuals by a return to their natural condition*, more easily proved than explained, *happen to recover the colour of their first ancestors, they will be equally distinguished by more broadly defined natural qualities.* The canine race may be taken as an illustration. Whence it follows that a certain number of domesticated individuals being given their coats alike and with dominant qualities, it may be fairly concluded that this coat and these qualities were those of the race in its wild state. In the case, then, of the Arab horse, if it be true that those whose coat is red shaded with black are endowed with superior speed, are we not justified in inferring that such was the uniform colour, such the natural qualities, of the sires of the race? I submit with all humility these observations to men of science.

"Abd-el-Kader assures us, moreover, that it is ascertained by the Arabs that *horses change colour according to the soil on which they are bred.* Is it not possible, in fact, that *under an atmosphere more or less light, of water more or less fresh, of a nurture more or less rich according as the soil on which it is raised is more or less impregnated with certain elements*, the skin of the horse may be sensibly affected? Every one knows that with any coat *the colour changes in tone and shade according to the locality where the animal lives, the state of its health, the quality of the water it drinks, and of the food it eats, and the care that is bestowed upon it.* There is, perhaps, in all this a lesson in natural history not to be despised, for if the circumstances in which a horse lives *act upon his skin, they must inevitably act also in the long run upon his form and qualities.*" *

Truly does the author here remark, that there is "in all this a lesson in natural history not to be despised," though, doubtless, he little thought how applicable were his observations to the actual condition of an insect of such value and importance to his own countrymen as the *Bombyx mori.* I have *italicised* those passages to which I wish more particularly to draw the reader's attention, and shall now proceed to show their applicability to my present subject.

* 'The Horses of Sahara,' by Gen. Daumas, p. 20. English Translation.

That the long-continued domestication of the silkworm has tended greatly to deteriorate its original constitution, the numerous diseases to which it is now subject, in every country where cultivated, furnish ample proof. That imperfect ventilation of the rearing houses produces a vitiated and impure atmosphere, highly injurious to health; that the nourishment derived from the mulberry leaves will be more or less good according to the condition of the tree from which they are gathered; and that the tree itself will be influenced by the nature of the soil and the temperature of the climate in which it grows, are facts of which every observant cultivator is well aware.

As with the horse, then, so with the silkworm; an unhealthy state of the atmosphere in which it is reared, together with an insufficiently nutritious diet, combined with other disadvantages which are incidental to a state of servility or domestication, must sooner or later exercise a very marked effect upon the general health of the animals, and the constitution, being once impaired, will necessarily, by affecting the animal functions generally, not only act upon the skin and colour, but engender debility and disease.

It is under such circumstances, and when the species threatens to become extinct, that Nature's great guide and ruler, acting for the creature's good, and with a view to the preservation of the species, invariably makes efforts to restore it to its original characteristics, and these symptoms of *reversion*, if seized and followed up by judicious efforts on the part of man, may enable him, perchance, eventually to cast out disease, and restore the species to its natural colour and original strength of constitution.

Herein consists the entire secret of my experiments with the *Bombyx mori*. Seeing that a very remarkable difference in colour sometimes occurred, and being fully aware of the truth of General Daumas' remark, that "the colours and the qualities undergo no alteration or admixture except in a state of servitude, and under its influences," I determined to ascertain whether the dark colour of some worms was or was not occasioned by an effort on the part of Nature to *revert* to the original point at which domestication had commenced, and that it actually is such is proved, not only by the colours remaining permanent in the black race, which *they do not in the white race*, but by the acquisition of qualities which originally belonged to the species, and which the pale-coloured worms do not exhibit. Thus, as the General truly observes, "the recovery of the colour of their first ancestors has caused them to be distinguished by more broadly-defined natural qualities.

Still further, we gather from the observations of M. Boitard, that, "the black worm, which is so often met with in the north of France, is absolutely unknown in Italy; and yet the eggs, which in France will produce them, are often purchased in Italy."

Here it is plain, if my views are correct, that climate tells upon the constitution of the insect even in Europe, and that in Italy, where the temperature is high, the black worm is unknown, simply because the heat of the climate, combined, perhaps, with too high a temperature in the houses, enervates the worm and causes it to depart further from its original type than it does in France, where the climate is colder and more favourable to the general health of the insect.

Again, the same writer informs us, that "in Lombardy the worm which produces the white silk will constantly furnish nine white cocoons to one yellow one, although in France, no matter how much care may have been bestowed upon the worm, the yellow cocoons will always far outnumber the white ones."

Now, I have long entertained the idea that the production of white cocoons is (except in cases where that colour is permanent in all climates) a strong sign of degeneracy, proceeding from weakness of constitution, the rather that such white cocoons are always more abundant where the temperature is high than in more temperate climates. Hence in Italy the worms, which in that high temperature will constantly produce an excess of white, will in a more favourable situation and circumstances, produce an excess of yellow cocoons. Thus, the *Boropooloo* of Bengal (*B. textor*, nob.), which there and in China, as a rule, produces white cocoons, when reared in the colder climate of Mussooree, yields almost all yellow cocoons; while to find a white cocoon among the worms of Cashmere (*B. mori*) is altogether the exception.

Hence I come to the conclusion, that the whiteness of the worm and the white cocoons are both indications of failing constitution, evidencing the existence of a higher temperature and of a more thoroughly artificial treatment than are conducive to the health of the insect. Were the white or the yellow colour to remain permanent in all climates and temperatures, the fact might reasonably be regarded as a specific character, but where, as in the above observations, we perceive these colours to be dependent upon temperature, we are compelled to regard the change as entirely dependent upon the state of health.

Thus heat, by causing debility, undermines the constitution, and gradually changes the natural colours, of both the insect and the silk secreted by it, into a sickly white, while a restoration to a cooler climate will, under proper management, restore the colours to their natural shade, by imparting vigour to the drooping insect.

Those who possess any real knowledge of the subject under discussion will, I am fully aware, require no further proof of the worm's deterioration than has already been furnished above; yet as there are not wanted some pretended *savans*, whose private interests prompt them to conceal as much as possible maladies under which all our worms are labouring, I shall proceed yet further to show, even from their own arguments, how very little they really know upon the subject.

Common sense will at once point out that a worm imported from the northern provinces of China will not long maintain its vigour in any part of the hot lowland provinces of India, and indeed this is fully shown by one cultivator proposing to preserve the eggs of *Bombyx mori*, by sending them from the Punjab to the mountain station of Durrumsala, as well as by the fact that Jaffer Ali of Mooltan invariably preserves his in a cool underground chamber or *tykhana.*

It is evident from this, that even the heat of the Punjab is far greater than the egg can bear, and if it be inimical and destructive to the egg, it will undoubtedly be equally so to the insect in every other stage. The loss annually sustained by the cultivator Jaffer Ali, even when the eggs are kept in the *tykhana*, is said to be " from a fourth to a third," the heat (even under ground !) drying up the eggs without hatching the worms ! * If this can be called successful cultivation, then no one need despair.

From this admission it is clear that what actual disease effects in France, where "*la muscardine*" is said annually to destroy more than one-fourth of the worms, is effected by heat, even in an underground cellar, in the Punjab ; how then, in such a climate, can really good results be expected, since the same writer, while trumpeting forth the wonders performed in the Punjab, very naively winds up his laudations with the assurance that "*out of tykhanahs the eggs cannot be preserved in the plains at all.*"

As to his assertion that those eggs " that survive the heat are not injured, but produce as healthy and fine worms as if the eggs had been kept in a cool climate," it actually amounts to nothing, unless at the same time we can feel assured that the writer is well acquainted with what the worms ought to be, and can prove that they are as large and produce the same quantity of silk as those of colder climates ; and that such is not the case is proved by the testimony of Mr. C. J. Turnbull, who states that Umritsur-reared cocoons are 56 per cent. below the Cashmere standard.

Indeed, this gentleman, who is undoubtedly a good authority, pronounces the cocoons of Oudh and Umritsur to be about equal, so that they had degenerated in those localities *in one season* 56 per cent. below the standard of Cashmere as furnished by Mr. Cope himself a couple of years before.

Again, cocoons raised at Lucknow in Oudh by Dr. Bonavia required 5,200 to the pound of silk ; at Candahar in 1849 the Afghans reckoned about 4,500 to the pound of silk ; while in France, previous to the late epidemic, 2,500 cocoons were, on the testimony of Mr. Bashford,† equal to a pound of silk.

Here, then, we have positive evidence that the climate of the Punjab and other parts of the plains of India is injurious to the health and general well-being of the insect.

Now it is also the opinion of Mr. Turnbull that the Candahar and Cashmere yield of silk is pretty nearly on a par; and as from the above

* Powlett's Report in Proceedings Agricult. Soc. of India, 9th July, 1862.

† 'Journal Hort. Soc. of India,' vol. ix., part 3, p. 261.

statistics the Oudh and Punjab cocoons are at least 50 to 56 per cent. below the Cashmere standard, which is itself considerably below that of France, we may safely say that the cocoons of the Indian-bred *Bombyx mori* are little short of 75 per cent. below what they ought to be.

What benefit, then, I would ask, is likely to ensue from the introduction into Italy of the eggs lately purchased in Cashmere by Dr. Carlo Orio? The worms reared from those eggs will no doubt be improved by the change of climate and more judicious treatment, but they will add nothing to the health and vigour of the European stock.

It has been justly remarked, "that there are few individuals who have not watched the interesting change which takes place in the larvæ of the *Bombyx mori*, or common silkworm, from the point of its exit from the egg until it has reached its full butterfly existence; and many there are who have been sadly disappointed at the mortality which comes over a brood of silkworms, in a single night, from some cause or causes unknown, and consequently irremediable. Such epidemics are continually occurring in China as well as Europe, and constitute one of the greatest obstacles to the introduction of the culture of the silkworm into England. What occasions this sudden decimation of these insects has never been determined, but has long led to a wish, on the part of those interested, that a more hardy breed of silk-producing worms could be introduced into Europe, even though the produce was coarser and of a worse colour than the ordinary mulberry silk."* Here, then, is a further and very recent testimony to the diseased state of the worm.

I shall doubtless be told that "the proof of the pudding is in the eating," and that as silk of the best quality and worth twenty-five shillings per pound has been produced in the Punjab, the worm cannot possibly be diseased or have lost it constitution.

To this I reply, that in order to test "the pudding" properly and fairly, we require a judge possessed of some knowledge of what a pudding ought to be.

In the introductory remarks to my 'Monograph on the Genus *Attacus*,' I have shown, after Kirby and Spence and other authorities, that the gum from the reservoirs being conveyed to the mouth by the constriction of certain muscles, passes through two small orifices in the lip, and the two fibres thus formed, being taken up and twisted together by the hook-like processes in the mouth appointed to that office, become one fibre of silk on coming into contact with the cold external air. Now these two orifices in the lip are expressly appointed to the purpose of regulating the thickness of the silken fibre with which the cocoons are formed; they are a provision of Nature which determines the thickness of the silken thread, and that thickness, in worms of equal size, will be constantly uniform, so that a large and healthy worm will yield a thicker fibre than a smaller and degenerated worm.

* 'Journal Soc. Arts,' Nov. 6th, 1863, p. 776.

As long as the reservoirs contain gum, the thickness of the silk will be the same whether the worm is diseased or not, provided always that the worms are of equal size ; and that simply owing to the regulating organ above mentioned. The quality of the silk comprises thickness of fibre, tenacity, and elasticity, and where the secreting glands are not affected by disease, this quality, from worms equally well fed, will be the same, even where the general health of the one is far inferior to the other ; indeed, it is the quantity, rather than the quality, of the silk that is affected by the maladies under which the worms are now labouring. The cocoons reared in Oudh by Colonel Clark, and pronounced by Mr. Cope *in epistolâ* to be "the finest he had seen in India," produced, on being reeled, a silk of precisely the same quality as that at Umritsir, and by my Mussooree cocoons reared from Mr. Cope's supply of diseased eggs in 1862, and which, as cocoons were absolutely worthless, there being little or no silk in them. Dr. Bonavia's cocoons, raised in Oudh in 1863, from seed furnished by Mr. Cope, yielded a silk in no respect inferior to the above, although the pound of silk requiring 5,200 cocoons to produce it proved how terribly deficient was the quantity of gum secreted. In cases where the glands are affected by disease, or where the leaf has not contained a proper proportion of silk-yielding matter, no silk at all will be secreted, and the worm will either die as such, or become a pupa without spinning. Many cases of this kind occur in all the broods, whether monthly or annual.

To talk, as some do, of coarse leaves producing a coarse silk, and therefore recommending the use of such as are thin and tender, is at once to prove non-aquaintance with the anatomy of the insect and ignorance of the whole art of nourishing the worm, since, as already pointed out, the thickness of the silk fibre is regulated by Nature, and a thin fibre produced by a worm, which, like *B. mori*, ought to yield one of a certain thickness, is a positive proof of the presence of disease, indicates the decreasing size of the orifices, consequent on the deterioration and degeneracy of the worm. The orifices in the lip being of a regulated size, no extra-natural coarseness of fibre can be produced, and no coarseness of leaf could ever make the fibre thicker than Nature intended it to be, or than those orifices were capable of admitting, simply because it is a well-ascertained fact that "a camel cannot pass through the eye of a needle."

(To be continued.)

Reviews.

THE UTILIZATION OF MINUTE LIFE, ETC. By Dr. T. L. Phipson. Groombridge and Sons.

The purpose of this little work is well intentioned, but scarcely does full justice to the subject treated of. The title, too, is somewhat deceptive; for many of the crustacea and mollusca treated of are far from minute. *Tridacna gigas, Turbinella pyrum, Pinna nobilis,* the Strombs, Cassids, and oysters attain a good size. The main object of the author is to notice the wonderful manner in which certain animals contribute directly to the welfare of mankind, and the methods by which they may be cultivated. Whilst Dr. Phipson enlarges ably on the anatomy, habits, and instincts of the animals treated of, he possesses but a slight knowledge of the actual value of the products of these animals, and the real extent of their commercial importance. Although it is not quite possible to arrive at any precise estimate of the commercial value of the animals and their products treated of for all countries, yet our official returns show us at least our indebtedness in the foreign imports. Dr. Phipson merely gives us, in a few instances, the value of the Liverpool imports; but these form a very small share of the gross trade of the kingdom. Here, for instance, is a summary of the official value of one of the latest years; and certainly, for the whole world, these figures may be safely quadrupled, when we consider the Eastern and European production and consumption of silk; the lac, shells, and pearls locally used in India; the bees'-wax and honey production of Europe and America; the consumption of crustacea; and the extended demand for sponges, coral, &c.

VALUE OF IMPORTS IN 1862.

	£
Insects:	
Raw and thrown silk	10,340,011
Silk manufactures	6,618,501
Cochineal	331,749
Lac-dye and shellac	342,217
Galls	31,830
Bees'-wax	60,817
Honey	13,139
Manna	2,086
Cantharides	4,540
Crustacea (London market only):	
Lobsters and crayfish	30,000
Crabs	8,000
Shrimps and prawns	6,000

Mollusca:	
Periwinkles, whelks, mussels, cockles	25,000
Oysters	125,000
Mother-of-pearl shell	38,677
Pearls	89,305
Worms:	
Leeches	9,455
Polypes:	
Coral	4,624
Sponges	100,204
	18,181,755

Dr. Phipson speaks of 50,000 or 60,000 lbs. of silk being received annually at Liverpool, but is he aware that the imports into the kingdom reach 10½ million pounds frequently? So with wax. The mere 25 tons imported at Liverpool are but a trifle compared with the 350 or 400 tons of foreign received in all, whilst nearly as much more is collected at home. Some 2,000 tons of honey are also said to be obtained from bees in the kingdom, whilst we import about 380 tons additional from abroad.

Passing seriatim over the sections, we think that Dr. Phipson might have told us something of the efforts making to introduce silk culture in different colonies; and had he watched the collection of cocoons in the last International Exhibition, he would have found subject for notice in the curious open net-like cocoons of several worms, and the green cocoon and silk of *Antherœa Yamamai* of Japan. The Japanese are very skilful in the management of silkworms and the preparation of silk. We have in our possession a very curious Japanese work in three volumes, full of illustrations of the culture and manufacture, and showing every stage of operation, prefaced by the mythology of the subject. In speaking of the colour-producing insects, Dr. Phipson forgets to allude to the attempts that have been made to introduce the cultivated cochineal insect into our East and West India colonies and Australia.

In speaking of bees, Dr. Phipson does not give us any account of the underground bees which furnish a blackish wax in Asia and South America. In the latter quarter, the number of honey-producing bees is said to exceed twenty-four; at least, as many species were shown in the Brazil Court of the London International Exhibition.

The trehala mentioned at p. 97 is probably a species of manna, formed by an insect, like the lerp of Australia, a similar insect saccharine product, which Dr. Phipson does not allude to, although common in several of the Australian colonies.

Dr. Phipson does not seem to be very well informed as to the commercial uses of shells, although he has gleaned some information from the pages of the TECHNOLOGIST.

Thus, with respect to the money cowry, they are more largely used for small cash payments in India than even in Africa, and are used for ornamenting elephant trappings.

The conch shell, yielding the pink cameo, is looked upon as an inferior material for cutting, because the colour is uniform and fades; and the helmet shells are not sometimes, but *always*, preferred, as they yield several layers of colour. Dr. Phipson is not aware that cameos are cut on the Cypreas, although bracelets and studs of them are very common in the jewellers' shops in Fleet street and the Strand. We should scarcely have thought that knife-handles and pen-holders were made of the clamp shell (*Tridacna*). Its texture is so hard, that even the feat of cutting a cameo on it is difficult. The diver's helmet and the diving bell have been tried in the pearl fisheries and failed.

The chapter on Infusoria and other animalculæ is more diffuse than requisite, as their industrial utility, with the exception of the edible "mountain meal," is almost *nil*. The section on Sponges might have been much amplified, considering the materials available in our own pages. Our criticisms are directed in a friendly spirit, and more with a desire to see future editions of this useful little work rendered more valuable. We hail with satisfaction every effort to diffuse scientific and practical information of a technical nature, and no one is more competent than Dr. Phipson to do this, if he but gives himself carefully and steadily to the task.

Our Grenada files by the last packet announce the death of Robert Kennedy, Esq., at the advanced age of eighty-three. He was the last survivor of the nine original founders of the Grenada Agricultural and Horticultural Society, of which he was ever an active, intelligent, and enterprising member and officer. Botany and horticulture formed his delight, and during his long and busy life he had gathered around his picturesque home the leafy treasures and vegetable wonders of all parts of the world. In the year 1837, the Agricultural Society presented Mr. Kennedy with a handsome silver cup, in testimony of his successful exertions in introducing the nutmeg—a product that is now so extensively and profitably cultivated in Grenada as to be one of its chief staples; and his nutmegs from Bellevue carried off the medal at the Great Exhibition of 1851, as the best in the world. Meteorology also is indebted to him for an uninterrupted record, throughout many years, of the fall of rain at Bellevue, which is situated at an elevation of about 800 feet above the sea, on the windward side of our island.

THE TECHNOLOGIST.

CORK AND ITS USES.

BY JOHN R. JACKSON.

Amongst the many materials or productions in use in everyday life, cork may certainly take a position in the foremost rank. We all know something of cork; from our earliest childhood we have been familiar with it. It is a substance that has retained all its ancient uses, as well as its importance and value, from its earliest history down to our own day. Unlike most other things, it has not, even in this age of application and invention, found a rival. True it is we have "corky" substances in abundance, produced in almost every country; but neither the productions of Nature nor the productions of mechanical skill have produced an efficient substitute for cork, one that could take the place of this valuable bark, or even go side by side with it.

Considering the great quantity of cork that is consumed even in this country alone, as well as the great amount that is wasted, the quantity of bark annually stripped in the cork-forests is an operation of no little importance. The slight value many individuals place upon cork, on the whole, does not lead us in the least degree to estimate its real importance, which, in a commercial point of view, is of no trifling nature.

There must needs be a large quantity imported; for amongst wine merchants, bottled-beer merchants, or soda-water makers, a cork is never used a second time: but then what an immense bulk would go to make up a ton of cork, and yet it is by weight that the imports are estimated. There is an immense consumption, and the demand of late years has almost exceeded the supply. The annual quantity imported into this country averages about 5,000 tons.

Of the early history of cork, it is very clear that it was well-known and in use amongst the Greeks and Romans. Theophrastus distinctly alludes to the fact, now so well-known, that the continual barking of the trees tends to improve the quality of the cork. With the Greeks it was called "Phenos," while the Romans knew it by its present specific name of "Suber." Though cork was probably used in very remote times for similar purposes to those of the present day — that of stoppers for bottles amongst the rest—this, however, does not seem to have been its common or general use, inasmuch as we find that vessels of that period were frequently closed by earth, clay, and other similar substances. Stoppers of cork, or "corks," as we now call them, appear not to have been generally introduced till some time in the latter part of the sixteenth century; from that period, however, its use has been getting more and more universal in all parts of the world.

Before the introduction of cork, or its general adoption for bottle-stoppers, various articles were resorted to for this purpose. We are told that apothecaries secured the contents of their phials with stoppers made of wax, which must have been a somewhat tedious process. But even in our own day, a similar custom prevails in many parts of Europe; for with many of the Italians and Neapolitans, for instance, the practice of securing their wines, by pouring oil into the mouth of the bottle before tying it down with skin, is still very prevalent.

Before entering into the uses of cork, however, let us pay a short visit to the forests from whence it is obtained, and trace its progress from its natural position to that of its ultimate application.

Cork, as we all know, is the bark of a tree, though commercially miscalled "cork-wood." It is produced by two species of oak, *Quercus suber*, L., and *Quercus occidentalis*, hence called the "cork-oaks." These trees grow abundantly in large forests in Spain, Italy, the South of France, and Northern Africa, the latter species being found alone on the Atlantic side. This species is also peculiar, from the fact that it ripens its acorns in the second year.

In general appearance, the cork-oaks differ little from the common oak, except, perhaps, that they do not attain to so large a size. There is also a slight difference in the form of their leaves—those of *Quercus suber*, L., being more lanceolate, and the margins not so deeply sinuate; the acorns are also somewhat longer and more tapering in form than those of the common oak.

The cork-oak does not require a rich soil; but, on the contrary, it seems to thrive best in poor and uncultivated ground. To collect the cork, incisions are made longitudinally and transversely in the bark of the living tree, the instrument used being a kind of axe, the handle of which terminates in a wedge-shaped form. After the bark is cut through, it is beaten to loosen it from the liber or inner bark, the wedge-shaped axe-handle being inserted to lift the bark from the trunk. The cork thus removed usually varies from three-quarters of an inch to three inches in thickness. The next operation is to divide it into pieces of an uniform or convenient size, and to flatten it, each piece having, of course, a similar curve, corresponding with the trunk of the tree from whence it was taken. For this purpose, the pieces are placed in pits and covered with water, and then pressed flat with heavy stones. The well-known charred surface upon these cork slabs is caused by the application of heat at an open fire, after the steeping, for the purpose of contracting the pores. The pieces are afterwards bound up in bales, in which form they appear in the market. In removing the cork from its paternal trunk, care has to be taken not to injure the inner bark next the wood, else it would affect the second crop of bark, and perhaps injure the tree. This operation of stripping the bark, if dexterously and carefully performed, has, as we have already said, no detrimental effect, either upon the growth of the tree or the rapid formation of the new bark ; but, on the contrary, the tree is said to grow more hardy and vigorously. The first crop of bark is usually taken when the tree is about twenty-five or thirty years old, but the crop is of less value than that of any succeeding gathering, as it is harder, very uneven, and more full of holes. The second gathering, however, which is in about eight or ten years after the first, is still of an inferior quality. The third crop, collected in about eight years after the second, is usually the first marketable cork—that is, the first crop that is fit for cutting into bottle-corks. When the trees have attained to this age, so that three crops have been taken off, they usually yield a supply of good cork about every seven or eight years ; and its quality improves, as well as the quantity enlarging, at each successive gathering. The season chosen for the cork harvest is usually the months of July or August.

It will be seen by the foregoing that the quality, and consequently the commercial value, of cork is materially affected by soil, length of time allowed in growing, and also of care in collecting. There is as much difference existing in the quality of cork as in most other articles of daily use. The finest kind should be compact and firm, but at the same time not hard, of an even texture or grain, and of a slightly pinkish tint. This kind of cork is generally selected by wine-merchants for bottle-corks ; while the coarser kind, which is always more porous, full of small holes, and perhaps punctured by insects, serves for bungs for casks and for the various other applications to which cork is put in a cheap form. When cork is required to be thick, it is usually found coarse, as it must be allowed a longer period of growth to promote its thickness. The charring or singeing process to which this kind of bark is frequently subjected, for the purpose of filling up the pores and making it impervious to fluids, has also a detrimental effect, as it secretes an empyreumatic oil, which is given off and frequently taken up by the liquids it confines ; but there is no doubt that care is taken in the selection of these corks, and methods adopted for the prevention of this chemical contamination, as much as possible. This operation of charring, to which all cork was formerly subjected for the purposes we have just mentioned, has been partially succeeded of late by that of boiling the cork and afterwards scraping the surface. This is said to improve rather than to deteriorate the cork, in being more effectual in filling up the pores.

The uses of cork are so numerous, and its applications so continually increasing, that the supply of late, as we have said before, has not been sufficient to meet the demand. It is not our intention to enumerate all the uses to which this most useful article is put—indeed, it would be unnecessary to do so, so well known as they are to all; but there are a few modern uses or applications to which cork has been found suited in recent inventions, and which are perhaps among the "things not generally known;" but these uses chiefly consume waste or refuse cork, such cuttings as were formerly considered of no value.

The new elastic floor-cloth, now so well known as "Kamptulicon," is a combination of caoutchouc and cork; and this is but one instance showing that cork, treated with other substances, can be made into a really useful article. Cork-dust has been used successfully with india-rubber in the process of vulcanising, and to so fine a powder is it reduced for this purpose, that india-rubber so treated is capable of being moulded into the most delicate forms. Another recent application of cork is for stuffing beds, and we believe this is now done to a large extent.

A large Cork Company, lately established in London, and owning large forests in Portugal, have recently imported the virgin cork into this country, with the impression of its becoming useful for rustic garden work. It is brought in very large pieces, and, from its rugged, uneven surface, which is frequently covered with lichens, together with its portability and its porous nature, which makes it capable of retaining moisture, will no doubt cause it to be used for such purposes.

Though the bark of the cork-tree contains a considerable amount of tannin, it is not in general favour among tanners, on account of its not imparting the required "bloom;" and for this reason it is seldom used alone, but is mixed with English oak bark. The inner bark is that which is used for tanning purposes, the outer bark being quite devoid of any of the required properties. The removal of the inner bark causes the death of the tree; and it is chiefly from Sardinia and some parts of Spain, where the trees are very abundant, that it is imported for this purpose. The quantity of tannin, as well as the colour of the bark, varies much, according to the district from whence it is obtained. The Sardinian bark is thicker and of a deeper red colour than any other.

To return to cork itself and its more common applications, we find that there are two sorts or qualities known in commerce, called respectively white and black cork. The white, which is chiefly produced in the South of France, is the best, as it is smoother, of a more even and finer grain, and freer from holes and knots.

The operation of cork-cutting is one requiring great dexterity and neatness, and is carried on to a great extent both in France and England, though, as might be supposed, the French surpass the English in this art. Machinery has been tried for the purpose of cork-cutting, but all is now cut by hand. Considering the difficulty, with which we are all acquainted, of cutting a clean surface to cork, it is surprising to see the rapidity with which the workman turns out a perfect cork stopper from the little square pieces furnished to him. The knife used for this purpose has necessarily to be very sharp, as well as being very thin; the blade is broad, and when the edge has become dull, it is quickly sharpened on a very fine-grained stone. The bench or tabe at which the workman sits has a ledge round it, to prevent the corks falling off. On the Continent, a notch is made in the edge of the bench to place the back of the knife in, to prevent it from slipping. Thus the edge is uppermost, and the knife has to be guided slightly while the cork is pressed against the edge, and so dexterously turned and rounded to the required form. All the corks thus cut are thrown into a basket to be sorted, which is usually done by women and boys.

The great importance of cork as a commercial article has been the cause of experiments being tried for its introduction into the Southern States of North America. It is, however, some years since the American Government tried this plan of naturalization, for which purpose large quantities of the acorns were imported from the South of Europe. More recently, we learn, from Sir W. J. Hooker's last Report on the Royal Gardens, Kew, that steps are now being taken by the Colonial Government of South Australia to introduce the cork-tree, and a number of young plants have been raised at Kew expressly for transmission to that colony.

We sincerely hope that these efforts to establish a tree furnishing so useful a product as cork, in a colony where it would become a valuable addition to its commerce—as well as adding to the supply, which, at the present increasing rate of consumption, is much to be desired—may be crowned with success.

ON CHEMISTRY APPLIED TO THE ARTS.

BY DR. F. CRACE CALVERT, F.R.S., F.C.S.

A Course of Lectures delivered before the Members of the Society of Arts.

Lecture IV.

Animal Fatty Matters: the Various Processes for liberating them from the Tissues in which they are contained. Their Composition and Conversion into Soap. Composite Candles. The Refining of Lard. *Cod-liver*, *Sperm*, and other Oils. *Spermaceti* and *Wax*.

It will be quite out of the question for me to enter upon a general description of the properties and composition of fatty matters, as to do so would be to undertake far too wide a field of research. All that I can attempt in this lecture is to give an idea of their composition, and to describe some of their most recent applications to arts and manufactures.

The question of the source of the fatty matters in herbivorous animals has been the subject of a great number of scientific researches, but those of Baron Liebig, Dumas, Boussingault, Payen, and Milne Edwards, have left no doubt that when the food of an animal contains a sufficient amount of fatty matter, this is simply extracted from the food, and stored or consumed according to the animal's habits—that is to say, its consumption is in ratio to the activity of the animal; thus, an animal in a state of great activity is comparatively thin, but when confined in a pen or stall it quickly fattens. These gentlemen also proved that when the food is deficient in fatty matters a portion of the amylaceous or saccharine matter becomes converted into fatty matter. The most decisive experiments on this head were made by Mr. Milne Edwards, who found that when bees were confined under a glass shade with no food but honey, they converted the greater portion of it into wax. Notwithstanding these proofs, however, chemists found it difficult to understand how substances so rich in oxygen as amylaceous ones became converted into a class of matters containing so little of that element, but Baron Liebig has recently published a paper which has partially solved this problem, showing that animals give off, during respiration, a larger amount of oxygen than is contained in the air inspired, which excess must be derived from certain organic substances circulating in the blood. Fatty matters may be classed under two heads, viz., vegetable and animal. The first are generally composed of a solid, called margarine, and a liquid, called oleine. The latter generally contains three substances, viz., two solids, stearine and margarine, and one liquid, oleine. I say generally, because there are exceptions; thus in palm-oil palmetine is found, in linseed oil linoleine, in sperm oil spermaceti, and in waxes several peculiar acids. Let us now examine the composition of some of the most abundant fatty matters found in animals. The knowledge of the composition of these substances—of suet, for example—was most unsatisfactory until 1811, when my learned and eminent master, M. Chevreul, published his elaborate researches, by which he demonstrated the real composition of fatty matters in general, and that they might be considered as real organic salts. Thus suet is composed of stearic, margaric, and oleic acids combined with the oxide of glyceryle. The three above-named acids he showed to be composed as follows:—

	Stearic acid.	Margaric acid.	Oleic acid.
Carbon	... 68	... 34	... 36
Hydrogen	... 66	... 33	... 33
Oxygen	... 5	... 3	... 3
Water	... 2	... 1	... 1

also that oxide of glyceryle, as it is liberated from the fatty acids, combines with water and forms glycerine. He further showed that when fatty matters were saponified, the change consisted in the substitution, for the oxide of glyceryle, of the oxide of sodium or soda in ordinary hard soaps, of the oxide of potassium and potash in soft soaps, of oxide of lime, baryta, or lead in insoluble soaps. You will easily conceive the pride of M. Chevreul when, forty years later, M. Berthelot effected the synthesis of the fatty matters, the analysis of which M. Chevreul had published in 1811. This he accomplished by heating in sealed tubes, at a temperature of 520 deg. for several hours, one, two or three equivalents of each of the above acids with one equivalent of glycerine, leaving the mixture to cool, and then boiling it in a vessel with water and lime, when the excess of fatty acids not combined during the experiment were removed by the lime, leaving the neutral fatty matter, which was dissolved by ether, and thus obtained in a state of purity. By this interesting series of researches, M. Berthelot has not only reconstituted neutral fatty matters, but showed that the oxide of glyceryle was triatomic—that is, that one equivalent of the oxide would neutralise three equivalents of the acid, whilst it required three equivalents of soda to produce a neutral stearate with three equivalents of stearic acid—

Stearic acid, $3\,(C_{66}\ H_{66}\ O_5)$; Glycerine, $C_6\ H_6\ O_6 - 4\,HO$
Stearic acid, $3\,(C_{68}\ H_{66}\ O_5) + 3$ Soda $NaO - 3\,HO$.

In fact, the researches of this eminent chemist on the synthesis of organic substances have effected a complete revolution in the last few years in that branch of organic chemistry.

I shall now proceed to give a rapid outline of the properties of these substances.

Stearic acid is a white crystalline substance, fusible at 158 deg. F., soluble in alcohol and ether, insoluble in water, and saponified by alkalies.

Margaric acid is a solid crystalline substance, presenting the same properties as stearic, excepting that its fusing point is 140 deg.

Oleic acid is a fluid remaining in that state even at several degrees below the freezing point of water, and is also soluble in alcohol and ether, but not in water.

Glycerine, or the sweet principle of oils, was discovered in 1779, by Scheele, who extracted it in boiling oil of sweet almonds with oxide of lead, which, combining with the fatty acids, liberated the oxide of glyceryle, and this, in combining with water, formed glycerine. In consequence of the numerous applications of glycerine in medicine, the French have manufactured this substance on a large scale from the liquors in which they have saponified their fatty matters into soap ; but the purest and most extensive supply is furnished by Price's Patent Candle Company. In the course of this lecture I will give you a description of its preparation, as carried out at their works. Glycerine is a colourless, syrupy fluid, of sweet taste, and sp. gr. 1·28, highly soluble in water and alcohol, combining easily with hydrochloric, hydrobromic, benzoic, tartaric, &c., acids, forming neutral compounds. Diluted nitric acid converts it into glyceric acid; concentrated nitric acid into nitro-glycerine, or a substance exploding with violence by percussion, which has caused it to be proposed as a substitute for fulminating mercury, by its discoverer, Professor Sobrero. The application in medicine of glycerine has been greatly extended by its highly hygrometric properties. Thus, bandages moistened with glycerine remain constantly moist, because the glycerine attracts moisture from the air as fast as it is lost by evaporation. It has also been found eminently useful in diseases of the eye and ear. Glycerine boils at 527 deg., but when distilled is partly decomposed into a peculiar oily fluid, of a noxious odour, called acroleine. M. Bertholet has succeeded, by fermentation, in converting glycerine into alcohol. Again, Mr. George Wilson, F.R.S., the talented director of Price's Patent Candle Company, has applied glycerine with great success to the preservation of vegetable and animal substances. Another useful employment of glycerine is its substitution for water in gasometers, where the evaporation of the latter is a source of serious loss. Its addition to a soap solution increases the facility of forming soap bubbles to an extraordinary degree. In fact, by its aid, bubbles of seven or eight inches diameter can be produced, exhibiting most beautiful purple and green colours, the beauty of which is greatly enhanced when illuminated by the electric light. To prepare this peculiar soap solution the following proportions are stated to be employed :—Distilled water, 5 ounces; soap, ⅛ of a dram; glycerine, 2 drams.

The extraction of the fatty matters of animals from the tissues enveloping them is a simple operation. The old process of doing this, technically called "rendering," consisted in introducing the suet into large iron pans and applying heat, which caused the fatty matters, by their expansion, to burst the cells confining them, and to rise to the top of the contents of the boiler, which were left to stand for a few hours, and the liquid fat was then run off. The organic tissues remaining with a certain amount of fat at the bottom of the boilers were removed, and subjected to pressure so as to separate the rest of the fat, the organic tissues remaining behind being sold under the name of "greaves," for feeding dogs, &c. As this operation gives rise to noxious vapours, causing thereby great annoyance, other methods have been generally adopted. For instance, Mr. D'Arcet's, the leading feature of which is, to place in a boiler say 350 lbs. of suet with 150 lbs. of water and 15 lbs. of sulphuric acid, carrying the whole to the boil for some hours, when the sulphuric acid dissolves the organic matters and liberates the fatty ones, which are then easily separated from the aqueous fluid. Mr. Evrard's process appears preferable. He boils the fatty matters with a weak solution of alkali; or, in other words, he uses 300 lbs. of suet with half a pound of caustic soda dissolved in twenty gallons of water, carrying the whole to the boil by means of a jet of steam. Under the influence of the alkali the tissues are swollen and dissolved and the fat liberated. By these operations a better quality of fat is obtained and no nuisance is created. It is found advantageous to purify or bleach the above fatty matters by the following means. Mr. Dawson's process consists in passing air through the melted tallow, and Mr. Watson's in heating melted fatty matter with permanganate of potash. Both these processes are based on the oxydation of the colouring organic matter. Some tallow-melters further clarify their tallow by adding 5 lbs. of alum in powder to 100 lbs. of melted tallow, which separates and precipitates any colouring matter. The white snowy appearance of American lard, which is rather deceptive to the eye than profitable, is obtained by thoroughly mixing, by means of machinery, starch in a state of jelly with a little alum and lime, with the fatty matter, by which means two ends are attained—viz., the introduction of 25 per cent. of useless matter, and a perfect whiteness from the high state of division of the same. The fatty matters from fish are generally obtained by boiling those parts of the fish containing them with water, when the fatty matters rise to the surface of the fluid, and one whale has been known to yield as much as 100 tons of oil. According to M. Chevreul, the composition of whale oil is as follows :—

Solid fats......... { Margarine, Cetine,

Liquid fats ...... { Oleine, Phocénine,

together with a small amount of colouring matter, and of phocenic acid, which gives to whale oil its disagreeable colour and odour. Many attempts have been made to sweeten whale oil by the use of weak caustic lye, milk of lime, sulphuric acid, and steam ; but although a great improvement has been effected, the oil is still recognisable by its unpleasant odour. I have no doubt in my mind, from experiments made by my friend Mr. Clift, that fish oils might be obtained as sweet as vegetable oils, if proper means for its extraction were adopted. Allow me here to revert to animal fats to show you that their comparative hardness or solidity, as shown by the following table, depends upon their relative proportions of stearine or margarine and oleine :—

	Stearine or Margarine.	Oleine.	Melting. point.
Ox tallow	75	25	111·0°
Mutton suet	74	26	109·0
Hog's lard	38	62	80·5
Butter (summer)	40	60	86·2
Do. (winter)	63	57	79·7
Goose fat	32	68	79·0
Duck fat	28	72	77·0

M. Pelouze proved some years ago that the rancidity of ordinary animal as well as vegetable oils is due to a fermentation; that is to say, that under the influence of the azotised principle associated with all fats, the fatty matters split into their respective fatty acids and glycerine, which in their turn undergo a further change resulting in the production of volatile fatty acids, such, for example, in the case of butter, as butyric, caproic, capric, and caprolic acids; in the case of goat's milk, hirsic acid; of fish oil, phocenic acid. Further, M. Pelouze demonstrated, that in the case of olive oil this change occurred a few hours after the crushing of the fruit, the oil thereby coming in contact with the albuminous principles or ferment.

I shall now have the pleasure of calling your attention to some of the special applications which fatty matters receive. The first of these arises out of the action of alkalies upon those substances, the result of which is the conversion of an insoluble matter (oil) into a soluble one (soap). I shall not enter into minute details of this well-known manufacture, but content myself with touching upon some of the most recent improvements. The usual mode of making soap is to add animal fats or vegetable oils to a weak lye, or caustic solution, carrying the mixture to the boil by means of steam-pipes passing through the vessel above a false bottom, and keeping the whole in constant agitation by means of machinery. During this operation the oxide of sodium replaces in the fatty matter the oxide of glyceryle, and when the lye is killed, that is to say when all its alkali is removed by the oil, a fresh or stronger lye is added, and these operations are repeated until the manufacturer considers that the matter is nearly saponified, which is easily judged of in practice. He then proceeds with a second series of operations, called salting, which have for their object to separate the glycerine and impurities from the soapy mass, and also to render the latter more firm and compact—in fact, to contract it. This is effected by treating it with stronger lye mixed with a certain quantity of common salt, and allowing it to stand for a few hours, so that the mass of soap may separate from the fluid containing glycerine and other impurities. When the second series of operations are finished the clarifying or finishing process follows: this requires the use of still stronger lye and salt, which not only completes the saponification, but separates any remaining impurities; the semifluid mass of soap is then allowed to stand for twelve hours, when the soap is either run or ladled into large wooden moulds, and allowed to remain until quite cold. After standing for a day or so, the wooden frame is removed from the solid mass of soap, when it is divided into bars by means of a brass wire. The difference between *white curd* and *mottled* soap is caused by the addition to the fluid mass of soap of about four ounces of alum and green copperas to every 100 lbs. of soap, which gives rise to an alumina and ferruginous soap, which on being diffused through the mass by means of agitation, mottles or marbles the mass when cool. When well prepared this is the most economical soap, as no large quantity of water can be introduced to weight it, because this would cause the separation of the mottling material from the soap. *Fancy soaps* are prepared in the above manner, by the employment of a better quality of materials and the addition of various perfumes. *Rosin or yellow soap*, as its name implies, is one in which a portion of the fatty matters is replaced by rosin, which is added to the soap paste when there is but little aqueous solution of alkali left to dissolve it, so that the rosin can at once enter into the composition of the soap, instead of being dissolved in the alkaline lye and lost. Rosin soaps, nearly white, are now manufactured, owing to the discovery of Messrs. Hunt and Pochin, who have succeeded in obtaining nearly white rosins by distilling common rosin with the aid of superheated steam. *Silicated soaps* are much used in America, owing to their cheapness, which is due to the introduction of a certain amount of silicate of soda. *Transparent soap*, the method of making which was so long kept secret, is now known to be obtained by dissolving soap in alcohol and allowing a concentrated solution of it to cool slowly, when it is poured into moulds and allowed to solidify. One of the most useful and recent improvements in soap-making is that which enables the manufacturer to produce what is called *glycerine soap*, which is characterised by the retention of the glycerine of the fatty matter. Its manufacture only occupies a few hours, instead of several days, as is the case with ordinary soap. It is prepared by employing 63 parts of fatty matter, 33 of water, and 5 of alkali, which are heated to a temperature of between 350° and 400°, for two or three hours, when the mass is entirely saponified, and then has only to run into moulds to be ready for the market. But the most important discovery connected with the saponification of fatty matters by means of alkali is that recently made by M. Mèges Mouries, for this gentleman has arrived at the remarkable result of saponifying fatty matter in the space of twelve hours, and, what is more extraordinary still, at natural temperatures. If we connect this fact with the one that caustic soda is now manufactured by tons, it appears highly probable that in a few years the fatty matters of Buenos Ayres and Monte Video, instead of being sent to this country as such, will be converted into soap there, and imported thence by us in that form. M. Mouries has discovered that fatty matters are susceptible, under peculiar circumstances, of being brought into a globular state, and that when in that state they present new and peculiar properties. Thus, for example, fatty matters, when kept in a damp condition, usually become rapidly rancid, whilst when in the globular state they may be kept for a very long period without undergoing that change. This peculiar state can be imparted to fatty matters by melting at 113° and adding a small quantity of yolk of egg, bile, albuminous substances, or, what is best, a solution of alkali, composed of five to ten parts of alkali for every 100 parts of oil, at the same temperature, agitating the whole for some time to bring the fatty matter into a globular condition. If at this stage the action of the alkali is continued and the temperature is raised to 140°, it is found that instead of the fatty matters requiring a long time to saponify (as is usual even at a temperature of 212°) the saponification is most rapid, because each globule of fatty matter offers an immense surface to the action of the alkali, and it is found that in two or three hours the whole of the fatty matters are converted into soap. In fact, saponification is so perfect that the mass of soap dissolves completely in water; and if the purpose is to liberate the fatty acids, this can be done at once by the addition of a little vitriol. The fatty acids produced by this comparatively cold saponification are so pure that when subjected to pressure the solid fatty acids have not the slightest odour, and fuse at the point of 138 deg. As to the oleic acid prepared by this process, instead of being brown (as is usual with the commercial acid) it is colourless, and can be employed in manufacturing soap of good quality. When M. Mouries desires to make soap with the entire fatty matter, he acts at once upon the globular fatty mass, by adding salt, which separates the soap from the aqueous fluid; it is then melted and run into moulds. Whilst speaking of the mode in which alkalies can be made to act upon fatty matters, I ought to state that M. Pelouze observed the curious fact that large quantities of fatty matters could be split into their respective elements—viz., fatty acids and glycerine—by heating them for some hours with a small quantity of soap. This discovery of his, as we shall presently see, has been taken advantage of in the manufacture of stearic candles.

Permit me to state that *soft soaps* differ from hard soaps mainly in the substitution of potash for soda, and in the omission of the salting and clarifying processes, so that the soapy mass is not separated from the excess of water, and therefore after the fatty matter has been saponified by the alkali, the whole is evaporated to the required consistency. I cannot conclude better this hasty and imperfect sketch of the soap manufacture than by the following table of compositions, showing the percentages of the various elements in the following soaps :—

Names of Soaps.	Fatty acids.	Alkali.	Water.
Curd	62	6·0	32·0
Marseilles	60	6·0	34·0
White	60	6·4	33·6
White cocoa	22	4·5	73·5
Yellow rosin	70	6·5	23.5
Calico printers'	60	5·2	34·8
Silk boiling	57	7·0	36·0
Wool scouring	55	9·0	36·0
Soft	43	10·0	47·0
Theoretical	63	6·4	30·6

As it is easy to introduce into soaps a much larger quantity of water than they should contain to render their employment economical, it behoves those who use large quantities in their manufacture to ascertain the extent of the moisture contained in soaps. This may be pretty accurately approximated to by placing a quarter of an ounce, divided into thin shreds, upon a hob or other warm situation, and leaving it for several days, when it will lose nearly the whole of the water it originally contained, or about a third of its weight if it does not contain an undue proportion. In many instances the proportions of alkali in soap may seriously affect its applicability. Thus, I ascertained a few years since that the quality of soap best adapted to clean madder purples should not contain more than 5 per cent. of alkali, whilst for pinks, where it is necessary to remove any loose colour which the mordants may have mechanically retained, a more active soap is required, viz., one containing from 6 to 7 per cent. of alkali.

I have now to draw attention to a totally different kind of manufacture, viz., that of composite, stearic, and Belmont candles. Many years elapsed between the scientific discovery by M. Chevreul of margaric and stearic acids, and their application to illuminating purposes, for it was early in 1825 that MM. Chevreul and Gay-Lussac took out a patent with a view of realising this advantage. But it was reserved for a manufacturer, M. de Milly, to perfect the manufacturing details of the processes, and to render these candles a marketable commodity. This he effected by also improving the manufacture of the wicks, and he was the first to introduce this article to the trade in 1832, under the name of *bougies de l'étoile.* The following was his *modus operandi.* 100 lbs. of tallow, 17 lbs. of lime previously slacked, and 1,000 lbs. of water were placed in a large iron boiler, and kept at the boil for several hours by means of a jet of steam. The result was that the glycerine dissolved in the water, whilst the fatty acids united with the lime. The insoluble stearate, oleate, and margarate of lime were then decomposed by weak vitriol, under the influence of heat. Insoluble sulphate of lime was produced, and the fatty acids liberated. These, in their turn, were submitted to hot and cold pressure which liberated the oleic acid, leaving the solid stearic and margaric acids behind; it was then only necessary to cast them into moulds containing wicks, and the *bougies de l'étoile* were produced. MM. de Milly and Motard have introduced, of late years, several important improvements into this branch of manufacture, the most important of which is that of operating under pressure, by which means they succeed in decomposing the fatty matters with 3 or 4 per cent. of lime instead of 17, this of course involves the saving of a large quantity of vitriol. M. Bouis has made a further improvement, by adding to stearic candles 3 or 4 per cent. of sebacic acid, which is extracted from castor oil, and has the high fusing point of 261°. M. Chevreul also suggested a simple method of increasing the whiteness of these candles, by the addition of a small quantity of ultramarine blue to neutralise the slightly yellow tint of the manufactured acid. One of the greatest improvements in the manufacture of these candles is that carried out by Price's Candle Company; but before describing to you this beautiful process, as adopted by Mr. G. F. Wilson, at this company's works, allow me to state a few facts. Up to 1840 the best kind of candles were those made of spermaceti, or of animal fatty matters, which were cold and hot pressed. In that year Mr. Wilson, whilst experimenting with the view of making candles which would not require snuffing for the illumination on the occasion of Her Majesty's marriage, discovered that a combination of cocoa-nut stearine with stearic acid would make candles giving a beautiful light, and free from the necessity of snuffing. These he called "composite," and they were soon largely sold. In 1838 Mr. Fremy published his interesting discoveries, showing that when oils or fatty matters were mixed with 20 or 30 per cent. of concentrated sulphuric acid, the fatty matters were split, or, as he calls it, saponified, and that sulpho-margaric, sulpho-stearic, sulpho-oleic, and sulpho-glyceric acids were formed. He further observed that boiling water decomposed the sulpho-stearic and margaric acids, and only partially the sulpho-oleic, into stearic, margaric, oleic, and sulphuric acids, which last acid remains in the water together with the sulpho-glyceric acid and that portion of the sulpho-oleic acid not decomposed, the other acids remaining insoluble and floating on the surface. In 1842 Messrs. G. Price and Jones secured a patent to carry out on a practical scale the scientific discoveries of Mr. Fremy. In that patent two or three important facts are brought out; first, that if instead of operating at a low temperature, as recommended by Fremy, heat was employed, the action of the sulphuric acid on the organic compounds would give rise to sulphurous acid, which they discovered had the remarkable property of converting the liquid oleic acid into a solid acid called "elaidic," thus largely increasing the yield of solid fatty acids. Their mode of operating was this—10 or 12 per cent. of concentrated sulphuric acid was added to the fatty matters which had been previously liquified by heat, and the whole was kept at a temperature of 200° for 24 hours. During that time the fatty matters were split into their primitive elements, and the oleic acid was converted into elaidic acid. The whole was then repeatedly treated with boiling water, to dissolve the sulpho-glyceric acid and other impurities, leaving the solid fats ready for distillation. Mr. G. F. Wilson has since then greatly improved this part of his manufacture, as the beautiful candles, everywhere to be seen, will amply prove. The most important improvement in a chemical point of view is the following:—He has found, for example, that fatty matters are split up into their component parts, by decreasing quantities of vitriol, as the temperature used is increased. Thus, at a temperature of 200°, 15 parts of vitriol are required; at 350°, 6 parts; at 500°, 1 part. Further, by employing this small proportion of sulphuric acid, not only is the expense of washing the fatty matters after their saponification by the acid avoided, but the distillation may be proceeded with in the same vessel. The distillation of fatty matters, first performed by Mr. Wilson, and since carried by him to a state of perfection, is based on the fact that, whilst fatty matters, if distilled by direct heat, are completely decomposed, giving rise to the noxious vapours of acroleine, from the destruction of the glycerine, &c., this evil is completely avoided in distilling them by passing a current of superheated steam at a temperature of between 550° and 600° through the mass of melted fatty matters previously brought to the same temperature. By this means the glycerine passes first without decomposition, and is then followed by the fatty acids. In fact, the distillation proceeds with such rapidity and regularity that a stranger might witness the distillation of 1,000 gallons in 24 or 36 hours, and all the time would probably suppose that water only was distilling. The results are so perfect, that the Jury at the Paris Exhibition of 1855 could hardly credit their genuineness, and actually deputed Mr. Warren de la Rue to come from Paris to verify the fact that the beautiful products exhibited were obtained in many instances from very inferior kinds of fat. The glycerine only requires redistillation to be fit for all purposes to which it is applied. As to the acids, they are submitted to an intense cold pressure, which separates the oleic acid from the stearic, margaric, or palmitic acids. These are melted, and when near the point of solidification, the vessel containing them is run on rails over the moulds, which are so arranged that each frame contains 200 separate moulds, in which already the wicks, prepared with borax or a salt of ammonia, are fixed. The only remaining operation is to fill the moulds and allow the candles to cool.

Oleic acid has recently been made available for several valuable purposes: it has been largely employed in the manufacture of soap; but its most important application as yet is its use on the Continent, and recently in England, as a substitute for olive oil in the greasing of wool for spinning, the advantages of which are marked, as its removal by alkalies in the scouring process is much easier, and its price lower. Messrs. Laing and Wilson have recently taken out a patent for the employment of oleate of ammonia as a mordant, and it increases in a marked manner the beauty and brilliancy of the coal-tar colours on cotton.

It now only remains for me to refer to another interesting process for splitting fatty matters into their elements, I mean that of Mr. Tilghman, which consists in mixing fatty matters with one-third to one-half of their bulk of water, and placing them in a vessel capable of resisting a very high pressure. There they are submitted to a temperature of 550 deg. and 600 deg. Fahr., and under the influence of that heat and pressure, the fatty matters are decomposed into glycerine and fatty acids. M. Tilghman has also adapted an apparatus which enables him, by means of coils of tubes, to keep up a constant stream of fatty matters and water through the tubes surrounded by fire, by which means the decomposition is rapidly and continuously carried on.

Spermaceti.—This valuable substance is found in large quantities in the bony receptacles of the head of the white whale of the South Seas, and as it is there mixed with a fluid substance called sperm oil, these are separated by means of filtration. The solid mass which is thereby left in the linen bags is first pressed cold, and then between heated plates (hot-pressed). It is then physicked or heated in a boiler with a solution of caustic potash of sp. gr. 1·45, which dissolves a small amount of oily matter, still adhering to the spermaceti, and this, after being well washed, is run into moulds to cool. The manufacture of spermaceti candles requires great care and practical experience. The only fact I shall mention is, that about 3 per cent. of wax is added to spermaceti to prevent the mass being too crystalline or brittle. M. Chevreul, who chemically examined pure spermaceti, or cetine, at the beginning of this century, succeeded in unfolding it into an acid, which he called ethalic acid, very similar to palmitic, and into a neutral substance called ethal, the composition of which he prognosticated would be found to contain pure alcohol. This, I am pleased to say, has proved to be the case, for its composition can be considered as represented by—

$$C_{32}\ H_{33}\ O_3\ +\ HO.$$

Mr. Heintz has recently published a very elaborate paper on the composition of this substance, and states that spermaceti contains the following components :—

			Ethal or oxide of cetyle.
Stearopharate	$C_{36}\ H_{35}\ O_3$	...	$C_{32}\ H_{33}\ O_3$
Margarate	$C_{34}\ H_{33}\ O_3$	...	„
Palmitate	$C_{32}\ H_{31}\ O_3$	...	„
Cetate................	$C_{30}\ H_{29}\ O_3$	...	„
Myristate	$C_{28}\ H_{27}\ O_3$	...	„
Create	$C^{26}\ H_{25}\ O_3$	...	„

It appears to me that several of these products do not exist ready formed in spermaceti, but are the results of chemical reactions.

Bees' Wax.—Bees either gather wax from the flowers on which they alight, or are capable of producing it direct from saccharine matters. The wax as it is obtained from the honeycomb being coloured, it is necessary to bleach it for most of the applications which wax receives. The old process (still followed in many parts of Europe) consists in melting wax in water and allowing it to run into a second vessel so as to separate it as completely as possible from its impurities. When cooled to nearly its melting point, it is allowed to fall on rollers which revolve in cold water, by which means thin ribbons of wax are obtained, these are then placed on meadows to bleach under the influence of the atmosphere. The above operations are repeated until the wax is perfectly bleached. This plan is so tedious and expensive that several chemical processes have been proposed. Mr. Casseraud's is to pass steam through the melted mass, which is at the same time subjected to the influence of sun light. Mr. Solly's is to treat the melted wax by a mixture of nitrate of soda and sulphuric acid, when the nitric acid liberated oxidises and destroys the colouring matters of the wax. Pure wax melts at 149°, and, when treated with alcohol, is found to be composed of—

Cerine or Cerotic acid...	C_{54}	H_{53}	O_3	H O...	65
Myricine	C_{92}	H_{92}	O_4	...	30
Ceroleine				...	5
					100

Sir Benjamin Brodie, who examined most minutely the chemical composition of a great variety of waxes, considers that the substance called by chemists cerine is really cerotic acid, and that myricine is a compound of palmitic acid and melissine. The lecturer here illustrated and explained the various adulterations of wax, giving the means of detecting them. The adulterations were common, owing to its value.

Chinese Wax is a compact substance, imported from China and said to be secreted by an insect called *Coccus sinensis.* This wax, which is harder and more brittle than bee's wax, melts at 181°, and has yielded, in the hand of the above eminent chemist, cerotic acid and cerotine, or oxide of cerotyle.

FRENCH MACARONI.

BY J. BERNIS.

ALGERIAN products obtained an immense success at the International Exhibition of Bayonne. From the day of the opening, crowds flocked to the brilliant group where the riches of the African soil appeared in all their splendour.

The impression was profound and decisive, and the delegate of the Minister of War, M. Teston, who had arranged with so much acknowledged taste all these magnificent specimens, had good reason to be satisfied with his labours.

It was, in effect, for the Algerian colonists and for the French manufacturers who use their products, an indisputable triumph ; and M. Teston hastened, as every chief of an army would do in such a case, to address to his Excellency Marshal Randon a report dated from the field of battle, even on the first day.

One of our coadjutors ought to send you shortly a complete account of the International Exhibition of Bayonne. While I regret not being able to forward you such a detailed account, I believe I ought not to defer submitting, for the appreciation of your readers, the following particulars from the last number of the 'Monde Thermal.' They treat of the important manufacture founded by Messrs. Bertrand and Co. for the fabrication of alimentary pastes called Algerian. One of the Algerian products attracted above all the constant attention of visitors, because it is so large an article of consumption—we mean the hard wheat of Algeria, which the house of Bertrand, of Lyon, has transformed into nutritive pastes of every kind; we have never seen anything so beautiful in appearance and so perfect to the taste.

Messrs. Bertrand and Co., who since 1855 have applied themselves to make known on a large scale the hard wheat of Africa, have published documents on this important manufacture of the highest interest for the future Algerian production. Let us examine the details. For several years the wheat used in France for the manufacture of Italian pastes had been brought principally from Odessa, Taganrog, and Sicily. When Algeria had become a colony of France it was found that it produced in great abundance hard wheat, suitable for the manufacture of these pastes. This variety of grain was, too, that which succeeded the best in Africa, and the trials made of it led to the establishment of the fact that the products were equal to those of any other country of the world.

At the Universal Exhibition at Paris, in 1855, Messrs. Bertrand and Co. were enabled to bring to light in the most brilliant manner the fact that French industry could make from the hard wheat of Algeria the fine alimentary pastes known until then only under the name of Italian.

Different analyses made public by M. Riche, principal of the Chemical works at Sorbonne, establish the fact that the hard wheat of Africa equals that of the Black Sea, the most esteemed in Europe, whether in nutritive properties or quantity, and contains more gluten than the wheat of Auvergne. The manufacturers of France, who till then had supplied in profusion to the French markets seminolas and pastes manufactured from indigenous wheat—were moved with the result of these analyses. A very lively opposition was hence directed against the Algerian products and the manufacture of Lyons.

In a vigorous reply made to their adversaries, Messrs. Bertrand observed with justice, Do not have any fears for the fertility of Africa, its power of production is unlimited, as it has been the granary of ancient Rome so it will become that of France. It will aid powerfully to compensate for the failure of the cereals in bad harvests; its corn is found everywhere now in the markets of our Mediterranean ports; before 1830 its grain was one of the principal articles of exchange with Europe. The colonists, under the favour of the Government, have for several years collected all the wealth that agriculture was able to give to them, and they have cleared, worked, and sown large tracts of land. The fertile Limagne is nothing in comparison with the districts of Tell, and Africa will furnish to the manufacturers of Lyons, Clermont, Marseilles, Avignon, and Toulon, all the hard wheat they can require.

Events have since then justified completely this assertion. Carrying out on a large scale, by means of a numerous staff and two steam machines, the manufacture of Algerian paste, Messrs. Bertrand and Co., after obtaining the first-class silver medal at the Paris Exposition of 1855, had the boldness to present themselves in 1858 at the national gathering in Turin—that is to say, in the very centre of Italian industry. There remained nothing now but to brave the competition of an established home trade of several centuries, having an European renown. The most decisive success, however, crowned this bold attempt. The jury of Turin declared that the Algerian pastes equalled the best products of the kind known, and awarded to the house of Bertrand the unique silver medal.

From that day the foreign market has been open to the purest alimentary pastes of France. Called on in 1861 to furnish valuable information on this branch of industry to the Commission of the Legislative body, who were discussing the project for the law on cereals, these manufacturers prepared themselves to support worthily at the London Exhibition the celebrity the Algerian pastes had acquired at Turin, a fame which had been further established by the gold medal at the great Agricultural meeting held in 1860 at Paris.

In order to bring into general use the employment of Algerian hard wheat for the manufacture of alimentary paste, Messrs. Bertrand disseminated in France and in England a detailed notice on the culture of this grain and its different qualities; and they added to these interesting documents information upon the mode of manufacture employed by their house.

The prize medal awarded them at the close of the Exhibition of 1862 gave assurance that the Algerian pastes were superior to all the other pastes known or sold.

The International Exhibition of Bayonne has again brought to light the superiority of these products. The specimens shown were made of wheat from Constantine. In the number of the articles exhibited remarkable above all for its cheapness, was a special product, cream paste, made from the refuse paste, principally macaroni, without having recourse to fresh kneading.

In the manufacture of macaroni there are usually considerable quantities of refuse and broken pieces. These are generally remixed in the trough by all the manufacturers, and occasion the double inconvenience of changing the products with which they are mixed, and of causing a fermentation, which makes the paste sour.

In reducing this refuse of macaroni into large and small grains, by a particular system of manufacture, Messrs. Bertrand preserve the same nutritive elements as those of the first-class pastes, selling them under the name of cream paste at a price 25 per cent. below the former.

From its cheapness, the cream paste can be advantageously used as food by the lower classes, and for hospitals and schools.

We appreciate with more interest the essential qualities of these beautiful and excellent Algerian pastes, as this question concerns in the highest degree the public health, which is every day menaced by adulterations of many kinds introduced into products which are most necessary for use.

MANUFACTURE OF GLOVES IN THE UNITED STATES.

Kid Gloves.—In dressing kid or goat skins for gloves the process varies considerably from that practised upon buck and sheep skins. The skins are first soaked in water and "freshed," and are then thrown into the vats of lime-liquor. From these they are removed after a period that varies from three to six weeks, according to the season of the year, a much longer time being required for most of the processes in winter than in summer. Here they are lifted, and turned, and moved, and replaced until the hair is sufficiently loosened. They are then taken from the vats and stretched upon the "beam," and the hair is then removed with the blunt drawing-knife, but not the grain, as in the coarser skins; and great care is taken not to deface or injure the surface. They are next put into a "drench" of bran and water, or more properly moistened bran, where they remain for a considerable time. This softens and renders the skin very pliable. On being removed from this the tanning process takes place. The skins are covered by a mixture of salt and alum, which soon makes leather of them. After being thoroughly cleansed and dried they are ready for the finishing processes. They are suspended and "staked," that is, evened by a blunt knife drawn over the surface. Afterwards they are spread out upon a flat surface and rubbed with a sponge dipped in the beaten yolk of eggs. This preparation is absorbed by the leather and serves to make it elastic.

The next and last process is colouring. Liquid dyes are used for this purpose, and they are applied to the surface or grain of the leather with a brush. It is said that we have now no native workmen who understand this process thoroughly, and the skilled foreign workmen employed in the factories are by no means willing to impart their knowledge. Thus far they have succeeded in maintaining the secret of the rare dyes, and the methods that give both brilliancy and permanency of colour to the better styles of glove leather. Even the employers are not permitted to gain this knowledge.

Having the matter so entirely in their own hands, these men have been able hitherto to sustain this attempt at secrecy. But the constant introduction of working men from Europe, and the preparations which the manufacturers are now making, some of which are already completed, will soon unveil the mystery, and Yankee skill will, doubtless, achieve results equal to that of European.

It is a noticeable fact that of the foreign workmen now in this country the French still maintain the supremacy. Englishmen make good leather and good gloves, but in elasticity, durability, and finish, as well as in the beauty and brilliancy of the colouring, the French far surpass them. In the cutting and making up of gloves it is still the same. A better fit is obtained by a French workmen, and the sewing is superior.

Besides, a Frenchman will cut one or two more pairs of gloves out of a skin than an Englishman, and still have no inferior ones. "Yankees are in too great a hurry to perform such work well," remarked a manufacturer; "they pride themselves rather upon the amount of labour performed in a given time, than upon the skill displayed;" which is doubtless true. So that until our countrymen learn the lesson of patience, they will not be likely to rival their foreign competitors in glove-making.

After all the process of trimming, finishing, and dying are completed, the skin is stretched upon a marble table and rubbed with a blunt knife. It is then cut through the middle, and a strip for the palm and back of a glove cut, just wide enough for the purpose, from one end of each piece. Being cut in this way the pairs are alike, of similar finish, thickness, and tint. In France 375,000 dozens of skins are thus cut annually. In time, with protection and native industry, there is no reason why as large a number should not be manufactured here.

A French glove-cutter cuts nearly all his "sized-gloves" by eye. By sized gloves is meant those whose size is indicated by numbers, which includes all the ladies' kid gloves and all the finer men's gloves. In securing an accurate and easy fit, great care is necessary in placing the thumb-hole. M. Jouvin has invented a mode of cutting the thumb with the hand.

In some factories these gloves are cut in part by punches, steel instruments similar to the "gouges" used in cutting buck gloves. These punches have a toothed apparatus that pricks the holes for the stitches. The seams are then sewed with perfect regularity, by laying the edges evenly together, and placing them in a vice provided with teeth one-twelfth of an inch apart, between which teeth the needle passes in sewing. After the seams are sewed, the embroidery is put upon the back, the wrist bound or otherwise finished, and the fastenings sewn on. The glove is then stretched, placed in a linen cloth, slightly dampened and beaten to make it more flexible. After being pressed, it is ready for the market.

The skins used in making fine gloves are usually those of the kid and goat, but many are made of Cape sheep and other fine and flexible leather. It has been repeatedly and confidently asserted that many of the most celebrated styles of French gloves were made from the skins of rats, and we have even seen the statistics of the rat-catching trade, fostered, as it was asserted, by the demand created by gloves, set forth in a startling army of figures, which went to show that this most prolific of the rodents was destined to speedy annihilation. The catacombs of Paris were said to be the great hunting ground of the rat-catchers, and the business of trapping the animals, and dressing the skins, to be one of growing importance. But these statements do not appear to be borne out by facts. Very few, if any, rat skins have been used for gloves. The skins are not large enough to cut any but a small-sized glove, which alone disproves the assertion that they are largely used.

Many dressed kid-skins are imported into this country at present. Most of them come from France and Germany. It is probable that the demand for gloves for importation has considerably decreased, and the surplus skins are sent to this country instead. A fine lot, of the best finish and choicest colours, was recently sold in this city as low as eight dollars in gold, and this though the duty on dressed skins is one hundred per cent. From these skins, and they are such as have never before been offered in this market, we may expect to see our American manufacturers produce gloves that rival the best French ones.

A very good article of genuine kid, as well as of Cape sheep gloves, both for ladies and gentlemen, is now made in Gloversville, N.Y., in Philadelphia, in Water-town, Massachusetts, and possibly elsewhere in the country, but those are the principal seats of the manufacture. A large number of skilled workmen in this branch of business have already been brought to this country, and several enterprising manufacturers are now in Europe purchasing machinery and securing operatives. The present tariff protects efforts of this kind, and the result will be to increase largely all, or nearly all, manufacturing interests.

Most of the skins used in American manufacture are imported. Deer skins are mainly furnished by the Western States, though many come from South and Central America. The sheep skins used come mostly from England, salted and packed in casks. The English sheep have skins of a fibre finer than ours, but those from the Cape of Good Hope are superior to them ; they resemble kid. Calcutta kid is the Indian buffalo, an animal somewhat resembling the ox. It is used as a beast of burden in India. Goat skins come mostly from South America, the West Indies, Mexico, the Sandwich Islands and India. They are seldom used for anything but gloves. The white hog of South America has a skin of thick close fibre, used for making heavy, durable gloves.

The imported skins are brought into New York or Boston, and from thence are distributed throughout the country. They are then dressed, put through the process of tanning, which requires several weeks ; then treated with oil, and thus prepared for manufacturing. Various minor details of the preparation we omit.

In making up gloves the division of labour is similar to that in making shoes—one set of workmen cut the work out and another sew them. The cutting-out with economy requires great skill; from two to six dozen pairs constitute a day's work. The remnants from cutting the body of the gloves are used for the thumbs and smaller pieces.

The sewers are generally females in the country adjacent to the factories; the prices paid per day for sewing varies with the quality, the finest work being the best paid. The price of gloves is very much higher than formerly, as all the raw materials that enter into the manufacture are much enhanced in price. Many gloves are made of cloths of various kinds, or woven or knit.

The manufacturers are numerous, and carry on the business on a large scale, in some instances to the amount of 500,000 dols., or even more annually. Investments are large in material, but they calculate to "turn" them and realize within almost eighteen months, sometimes twice in the year. The works are run constantly, with the exception of about two weeks at the New Year, when all the scattered stock and material are called in, inventories taken, and the business adjusted for another year.

Fur Gloves.—A variety of fur gloves is made in this country. Nearly all manufacturing furriers make them. Gloves are sometimes made with the inner portion or palm of kid or dog skin, and the back of fur. They are lined with flannel or an inferior quality of fur, usually the white squirrel or coney, and are well adapted to use in winter travelling for driving, &c. As they are easily made from the small pieces of fur left in cutting larger articles, they are very profitable to the manufacturer. The sewing of these, as of most kinds of gloves, is done by women, and gives employment to a large number.

India-rubber Gloves.—A large number of india-rubber gloves are made in this country under Goodyear's patent. They are manufactured principally at Naugatuck, Connecticut. The heavy rubber gloves and mittens are intended for the use of manufacturing chemists, druggists, and photographers, or all who work among acids, alkalies, and other caustic materials. The rubber is not affected by these articles, and effectually protects the hands. They are also adapted to the use of firemen, hatters, tanners, lumbermen, and a variety of mechanics. They are useful to dyers, and to those whose avocations expose them to storms. These heavy gloves are made of solid rubber, as the india-rubber overshoes were formerly.

The first process in the manufacture is to heat slightly a mass of the gum, called a "batch," which in this state is passed between revolving cylinders and becomes a flat sheet of the required size. From this sheet the gloves and mittens are cut by gouges similar to those employed in the cutting of leather gloves. They are then joined by placing the edges in contact, and covering them with strips of heated rubber.

The lighter styles of rubber-gloves are made thus: a piece of stockinet, or cotton cloth, usually the former, is passed through the cylinders at the same time with the "batch" of gum, which by this process completely coats it. From this the gloves are cut and joined by covering the edges with strips of heated rubber. These gloves are made of a variety of colours, are very soft and pliable, and have a very neat finish. They are very useful in domestic pursuits and gardening, and to be worn in all kinds of employment likely to discolour the hands. By protecting the hands from the atmosphere, and retaining the insensible perspiration, they soften them and increase their whiteness; and often prove a cure for chapped hands and salt-rheum. The joining of these gloves is done by women, and is considered a healthful and profitable employment. We do not learn that there are as yet any silk or cloth gloves made in this country.

ON THE REVERSION AND RESTORATION OF THE SILKWORM.

BY CAPTAIN THOMAS HUTTON, F.G.S.,

(Concluded from page 189.)

Having been frequently applied to from different quarters for information as to the best kind of mulberry leaf on which to rear the silkworm, it may be as well perhaps to give the result of my own experience, and leave each inquirer to please himself as to the species he may find it most convenient and most suitable to adopt.

The question then is, "what species of mulberry tree is best adapted for the nourishment of the silkworm, and for the production of good silk?"

Were all climates alike the question might be easily answered, but in its present form it is too vague and general; besides which, thus put, it assuredly implies a belief that we have only one species of silkworm under cultivation, and that whether monthly or annual, all come under the head of *Bombyx mori*. This, however, is not the case, the name of *B. mori* belonging of right to the worm known in India as the Cashmere worm, which is an annual, and is cultivated in Afghanistan, Bokhara, Persia, Syria, Italy, France, and other European countries. It was originally brought from the northern provinces of China, where the country is mountainous, and the climate, especially in winter, very severe and cold. There is also another worm cultivated as an annual in Bengal under the native name of *Boro-pooloo*, which means "large cocoon," it being the largest species of *Bombyx* under cultivation in Bengal. As compared with the cocoon of the Cashmere worm, however, it is very much smaller, of a different form and texture, and yielding generally a pure white silk, although, as already observed, in the colder temperature of Mussooree the yellow cocoons are at least quite as numerous as the white. This likewise is from China, and from its being an annual is supposed, with good reason, to be a native of the northern parts of that country. This species I have named *Bombyx textor*, as it is totally distinct from the Cashmere worm.

Three other species domesticated in Bengal are respectively termed the Madrassee or Nistry,—the Dasee,—and the small Chinese monthly worm; these three are termed monthly worms because they yield from six to eight crops during the year. These I have respectively named *Bombyx Crœsi*, *B. fortunatus*, and *B. sinensis*, while from the fact of their yielding several crops a year I am inclined to regard them as belonging to the warmer and more southern parts of China, the number of broods indicating a climate in which food is abundant throughout the year, while the annuals on the contrary, as every naturalist is aware, indicate a far more temperate climate.

Besides these, there is said to be another species cultivated in Arracan which yields a silk superior to that of the Bengal worms, but as I have been hitherto unable to procure it for examination, I can do no more than indicate its existence and name it provisionally as *Bombyx Arracanensis.*

Seeing, then, that this diversity exists among the worms, it is but reasonable to infer that in their native countries and in a state of nature, they did not all feed upon the same species of mulberry leaf, but that the annuals, like the wild *Bombyx Huttoni* of the Western Himalaya, were originally restricted to the trees indigenous to the cold mountainous regions of the north of China, while the monthly worms were in like manner confined to species adapted to the greater heats of the southern lowland provinces.

The inquiry, then, as to which is the tree best adapted, in India or elsewhere, for the production of good silk, although apparently a very simple one, is in reality not easily answered, since much must depend upon the species of worm under cultivation, as well as upon the climate itself, and the difficulty is enhanced by the fact that every one who, possessed of much zeal but little knowledge of the subject, essays to rear silkworms, appears to think it necessary to extol some particular species of mulberry, and to pronounce it, for the time, the very *ne plus ultra* of silkworm diet.

One while it is the white-fruited mulberry only that can enable the insect to elaborate good silk, and anon, for some inexplicable whim, the white is discarded and another tree adopted in its stead. The purple-fruited species are unhesitatingly denounced, and to be "condemned without benefit of clergy." * And yet the white mulberry is found to be nothing more than an Albino variety of the purple-fruited tree.

* Proc. Hort. Soc. of India, 10th August, 1859, vol. xi. part 1, p. 64.

Count Dandolo long since pointed this out; and I have myself sown the seed of the dark purple mulberry, known to the natives as the "*Siah Toot*," and found that several of the young plants produced therefrom eventually bore white fruit only, the shape and flavour being entirely changed, and in some respects the leaf also. To my surprise, moreover, three young trees, said to be from Cashmere, and which for the past three years had borne white fruit alone, were this season (1863) covered with purple fruit.

The difference in the quality of silk reared respectively upon these two kinds—which are thus in reality not two, but one and the same—must be to a very great extent purely imaginary, and I will venture to assert that if two skeins of silk thus grown, that is to say, the one from the purple and the other from the white-fruited tree, were placed before any cultivator in India, he would not be able to distinguish between them.

Of the *Morus alba*, Count Dandolo remarks,—"This species comprises the common wild mulberry, which has four varieties in the fruit —two have white berries, one red and the other black."

Here, then, the merest tyro may perceive that the red berry merely forms the connecting link between the black and the white fruit, and consequently that there can be but little, if any, difference in the quality of the leaf; indeed, all that the Count ventures to observe on the subject is, that "the leaf of the black mulberry, hard, harsh, and tough, which is given to the silkworms in some of the warmer climates of Europe, in Spain, in Sicily, in Calabria, and in some parts of Greece, &c., produces abundant silk, the thread of which is very strong, but coarse. The white mulberry-leaf of the tree planted in high lands exposed to cold dry winds and in light soil produces generally a large quantity of strong silk of the purest and finest quality."

Now, if by the term "coarse," as here applied to the silk raised from the black mulberry, is meant *thick as to fibre*, the difference is seemingly of little importance, and would be overcome, I should imagine, in the reeling by assigning fewer fibres to the thread; while that the produce of the white mulberry is not uniformly the same or to be depended upon is shown in its being only "generally," and not always, of the finest quality; and moreover "the finest quality" does not necessarily imply *thinness of fibre*, but may refer to other qualities, such as evenness, tenacity, and elasticity; while, with regard to the degree of coarseness above alluded to, it must be borne in mind that it could not possibly be coarser than Nature intended it to be, because the regulating orifices in the lip would prevent it. Besides which it is extremely questionable whether "high lands exposed to cold dry winds" and with a "light soil" are suitable to the mulberry-tree, especially in such high latitudes; and if not, then the worms fed upon the leaves of such trees would be naturally less healthy and of smaller size than those reared under more favourable circumstances, and, consequently, the worm and the labial orifices being smaller, the silk would of necessity be finer. This, however, is not an argument in favour of the white mulberry, but against the locality in which it is grown. Seeing, then, that the silk cannot be coarser than Nature intended it to be, while it may be much finer, the argument tends altogether to prove that great fineness of fibre is a consequence of decreasing size in the worm, produced by increasing debility of constitution.

M. Boitard, a French writer on the cultivation of silk and of the mulberry-tree, informs us that the white mulberry is often tinged with red, a statement which upholds and confirms my remark that the red holds an intermediate place between the black and the white fruit.

In 1858 the white mulberry appears in some quarters to have fallen in estimation, and the *Morus multicaulis* was likewise condemned, as it was said, "because it produces so few leaves, though they are larger, and partly because those few are too soft and milky for the worm, yielding a weak fibre." *

This statement, however, unfortunately proved to be an egregious blunder, the tree thus denounced being in reality not the *Morus multicaulis,* which, as the specific name points out, instead of having few leaves of large size, has a multitude of branches thickly covered with a moderate-sized leaf. The large-leaved tree is now named *Morus cucullata,* from the leaf taking the form of a *skull cap,* and strange to say, although pronounced to be worthless when supposed to be *M. multicaulis,* was subsequently, by the same authority, and under the equally erroneous name of *Morus sinensis,* extensively cultivated as a first-rate silkworm diet.

Whatever may be the value of *M. multicaulis* and *M. cucullata* in their own native climates, they do not appear to have given much satisfaction elsewhere, and certainly in a cold northern climate they can scarcely be expected to do so ; at Mussooree, I regard them both as trash, and although in Oudh, Dr. Bonavia found that *B. mori* and *B. sinensis* both ate them readily enough, yet in the later stages of the worm a leaf of greater substance was required. In such case I would recommend the coarser leaf from the very beginning, for if the young worm lacks sufficient nourishment in the first two stages of its growth, it will be next to impossible, by any amount of subsequent good feeding, to recover the ground thus lost.

It is, I am convined, precisely because in the early stages the worms have been fed upon chopped and thin watery leaves, that the constitution has been at length brought to the very extreme of weakness. Starvation in childhood is surely not the best method of eventually producing either a strong, healthy man, or any other animal.

The climate, the tree, and the species of silkworm to be reared should all, as much as possible, be adapted to each other ; whereas under the

* Journ. Hort. Soc. of India, vol. x. part 2, p. 182.

present system the cultivator appears to think that climate, food, and the constitution of the insect are all mere secondary considerations to be set at naught, and disregarded with impunity, and then wonders, because he has steadily pursued certain stereotyped rules, at the failure of hi speculation.

Lest, then, this blind laudation of certain species should lea mischievous results and disappointment among those who are desi entering into the speculation, I shall here beg leave to call the attention of the sericulturist to the well-known fact, that "what is one man's meat is another man's poison," and remind him that the diet which is admirably adapted to keep up animal heat and to nourish an individual in the vicinity of the North Pole, will be found both unsuitable and highly injurious to health in lower and warmer latitudes. We have but to cast a glance around us in order to perceive that each nation, according to its climate, differs somewhat from another in the matter of food; those of the warmer parts of the world being more frugal and less gross in their diet than those of the colder regions. Is it not proverbial, that where a Frenchman, content with thin wines and a few field herbs wherewith to make a salad, would thrive, an Englishman, addicted, as he is, to strong ale, with an unlimited allowance of beef and bacon, would starve outright? The raw seal blubber, so palatable to the Esquimaux, would be wholly unsuited to the more temperate countries of Europe, and, as a rule, we find that the diet is the simplest in the hottest regions, and becomes gradually more gross as we approach the North, where the cold requires the use of more solid and stimulating food to promote and keep up the animal heat of the body.

Something of the same kind is assuredly perceptible also among the feral tribes; the bears, for instance, being far more carnivorous in high latitudes than near the tropics, where fruits, vegetables, and insects constitute the animal's food; but confining my remarks for the present to the larvæ of the *Bombycidæ* or silk-spinners, we find that Nature has ordained that the species in different latitudes shall feed upon different trees.

It may be said that this arises from the fact that the same trees are not found in these different localities, and consequently that the insects are compelled to seek another food, or to starve; this, however, does not appear to disclose the true philosophy of the question, and it certainly does not prove that such food in southern regions is equally stimulating with that of northern climes, but rather that instinct teaches the insect to accommodate itself to the provisions provided for it, precisely as a traveller to the northern regions makes use of pemmican, which he discards on returning home. There are, indeed, not wanting proofs that even where the food of one latitude exists in another, the insect will refuse to eat it, as if aware that it is no longer suitable to its wants! The truth seems to be this, that where a tree and an insect have existed together in, perhaps, a southern latitude, and the tree ceases to grow in some more northern locality where the insect is still found, it is because the tree in the colder locality would no longer be able to furnish a sufficiently stimulating diet, and is, therefore, replaced by one more suitable to the wants of the insect. And this after all is simply one of those wise provisions of Nature whereby her productions and the conditions under which they exist are mutually adapted to each other.

As a proof of this, we find that although the larvæ of the beautiful *Attacus atlas* are known in Kumaon to feed freely and principally upon the leaves of the yellow-flowering barberry (*Berberis asiatica?*), called at Mussooree *Russot*, yet with us, where the plant is equally common, I have never yet succeeded in inducing the worm to touch it, nor have I ever found either the larvæ or the cocoons upon this shrub. And yet out of forty-six cocoons now before me from Kumaon no fewer than forty-three have been spun among the leaves of *B. asiatica!* Surely this looks like a case in point; besides which it is an unquestionable fact that among the mulberry-trees which are known to be true species, and not mere varieties, the leaves of those from the north possess far greater thicknesss, consistency, and nourishment than those from the tropics or warm lowland provinces. Take for example the leaves of *Morus multicaulis* and of *M. cucullata*, as compared with those of *M. sinensis*, *M. nigra* (?), and the wild indigenous trees of the North-Western Himalaya.

At Pondicherry, according to information derived from my obliging correspondent M. Perrottet, the *Actias selene* is entirely restricted to the *Odina wodier* of Roxburgh, while at Mussooree it is polyphagous, feeding on *Coriaria nipalensis*, *Carpinus bimana*, *Andromeda ovalifolia*, *Cedrela paniculata*, the common walnut, *Cerasus puddum*, or wild cherry, *Pyrus variolosa*, and several others. Again, *Attacus cynthia*, which in China is nourished on the leaves of *Ailanthus glandulosa*, feeds in Cachar upon a tree called "*Lood*," and at Mussooree on *Coriaria nipalensis*, *Xanthoxylon hostile*, and some others; and so on, indeed, throughout the family.

The wild indigenous mulberry of Mussooree, with thick coarse leaves full of milky juice, is often so thickly covered with the larvæ of *Bombyx Huttoni*, that by the beginning of May there is not a single leaf upon the tree wherein the worm can spin its cocoon; yet although the thinner-leaved cultivated mulberry may abound in the immediate neighbourhood, it never by any chance experiences the same treatment; so that taking the hint from Nature, I am inclined to recommend for the *Bombyx mori*, when cultivated in the upper provinces, and more especially in the hills, such leaves as those furnished by *M. nigra*, *M. sinensis*, *Bédana* or seedless long white mulberry, and others of the thick rough-leaved kinds.

At the same time it is highly probable that certain species, which are wholly unadapted to a cold hill climate and the action of severe frost, may thrive well in the lowland provinces of India, where they will likewise be suitable to the worms of warm localities, such as I consider the Bengal monthly worms to be. But to extol in general terms one species above another, and endeavour, on wholly insufficient and often purely theoretical data, to persuade people that it is the best adapted for the nourishment of the silkworm,—the species of worm, moreover, not being specified,—is, in my opinion, the surest way of propagating pure sophistry and of insuring the failure of speculations in other districts, which, from the nature of their climates, require both a different diet and a different mode of treatment.

There is, moreover, yet another point to be considered, for although certain trees, such as *M. multicaulis* and *M. cucullata*, may thrive well enough in the Punjab and the Gangetic provinces, yet it is more than doubtful whether the Cashmere worm will thrive upon them ; for while the trees delight in and are adapted to a warm lowland temperature, the insect, whose cultivation is becoming fashionable in the upper provinces, is from the northern mountainous tracts of China, situated between 32° and 34° of north latitude, whereas in our Himalayan regions frost and snow are the accompaniments of winter. The cultivator should remember that a northern insect requires a northern tree, and the northern tree requires a northern climate, and that he himself requires a certain amount of knowledge and the exercise of common sense.

Trees producing leaves of extreme thinness, like those of *M. multicaulis* and *M. cucullata*, are far from desirable on account of their containing but little nourishment, and necessitating a larger and more frequent supply. A good and healthy leaf should contain the four ingredients of fibre, water, saccharine, and resinous matter ; the first two go directly to the nourishment and growth of the worm, while from the latter two is secreted the supply of gum which eventually furnishes the silk. Where the two former only are found, or where they are greatly in excess, as is sometimes the case, the worm will grow and attain to a goodly size, but will produce little, or perhaps no, silk. In breaking off a good healthy leaf, a drop or two of thick milky viscous juice should exude from the stalk, and in this resides the silk-producing matter ; the *Morus sinensis* and all the thick-leaved trees possess this is in far greater quantity than either *M. cucullata* or *M. multicaulis*, and indeed from the latter species, when grown in a cold climate, it is almost absent, being thin and watery.

Yet after all, it has long since been laid down as an ascertained fact, that however much *the quantity* of silk may be dependent upon the presence of this juice, *the quality* is far less dependent upon the good properties of the leaf than upon the temperature in which the worms have been reared ; so that where this is higher than the constitution of the insect is fitted to endure, no matter how well it may have been fed, the yield will always be inferior to that produced in a more genial temperature ; and that the *Bombyx mori* of Cashmere is greatly influenced by the heat of the Punjab, is proved beyond all contradiction by M. Perrottet's observation, *in epistolâ*, that eggs deposited there and sent to him by Mr. Cope, of Umritsir, were inferior in size, and far more irregular in form, than those sent by me from Mussooree, where the climate is better adapted to the species. The fact is moreover fully established by the annual loss sustained by Jaffer Ali as above narrated, as well as by Mr. Cope's expressed intention of sending his Punjab-bred eggs to the hills during summer, and of importing annually fresh seed from Cashmere. The same remark is equally applicable to Oudh.

That the thinness of the leaf, both in *M. multicaulis* and *M. cucullata*, is a very serious defect may be gathered from Count Dandolo's remark, that "the less nutritive substance the leaf contains, the more leaves must the silkworm consume to complete its development. The result must, therefore, be that the silkworm which consumes a large quantity of leaves that are not nutritive, must be more fatigued and *more liable to disease* than the silkworm that eats a smaller proportion of nutritive leaves. The same may be said of those leaves which, containing a sufficiency of nutritive matter, contain little resinous substance; in that case the insects would thrive and grow, but probably would not produce either a thick or strong cocoon proportionate to the weight of the silkworm, as sometimes occurs in unfavourable seasons. My experiments," continues the Count, "prove in the ultimate analysis that, all things balanced, the qualities of the soil produce but a very slight difference on the quality of the leaf; that which will appear most evident is, that the principal influential cause of the fineness of the silk is the degree of temperature in which the silkworm is reared. It is neither the water nor the fibre of the leaf which nourishes the silkworm and renders the cocoon heavy, but *the resinous and saccharine substances*."

The concluding sentence, however, is scarcely to be relied on, since the worm in its growth is undoubtedly nourished by the water and the fibre of the leaf, although it is equally true that the weight and thickness of the cocoon depend upon the presence of the other substances, while it is necessary to guard against the error of endeavouring to produce too much fineness in the silk, since I have already shown that to be an indication of too high a temperature and of the consequent degeneracy of the worm. Besides which, that the soil must in some measure act upon the quality of the leaf can scarcely be doubted when we consider that it is from the soil that the tree derives its nourishment, and the changes which occur both in the shape and substance of the leaf and in the colour of the fruit can be attributed, I imagine, to nothing else.

In regard to the treatment of the trees, it has been justly remarked that they may be very seriously injured by too close plucking; it has been forgotten, however, by those who in India have laid some stress upon the fact, that the remark applies rather to the mulberry-trees of Europe and other temperate climes, than to those of tropical regions; for in the former there is too short a summer to enable the tree to produce fresh leaves without an injurious effort on the part of Nature;* whereas in tropical and neighbouring climates, where the summers are warm and long, and otherwise conducive to the growth of vegetation, the dread of injury need scarcely be entertained. Nature, indeed, herself points out that such is the truth, for in the Himalaya the indigenous mulberry-trees may often be seen in the early part of May without a single leaf upon them, all having been devoured by the first or spring-brood of the larvæ of *Bombyx Huttoni;* and yet in about three weeks afterwards, or even less, the same tree will be found to have put on an abundant and healthy foliage, ready for the second or autumnal brood of the same worm. This sometimes goes on year after year without the least apparent injury to the tree, and even the cultivated kinds are often stripped of every leaf and berry by the monkeys (*Semnopithecus schistaceus*), and yet put forth a second crop of both. What, therefore, Nature does, man may surely, in similar situations, and under similar circumstances, imitate with like success.

Many things, indeed, in regard to the rearing of the silkworm, have passed into laws without the persons who adopt them having the slightest notion why they have done so, or even caring to reason on the subject; thus, we have one law forbidding more than a certain degree of denudation of the foliage, which is strictly applicable to northern climates only, and necessitates the planting of an additional number of trees. Then, again, another law enjoins that no moisture must remain upon the leaf for fear of injury to the worm; and yet, in a state of nature, we must feel assured that the leaves are often wet with rain and dew without doing injury to the worms which feed upon them: why, then, are they injured when in a state of domestication? Simply because Nature always feeds her worms with the best and freshest leaves, and in that state no injury ensues—as I, indeed, have often proved, even with domesticated worms; but if the leaves, as is too generally the case, from being closely packed, brought from a distance in the heat, and kept for hours before they are given to the worms, have begun to fade and lose their natural freshness, the moisture on them, by imbibing the exhaling gases, will act as an active poison on the worm, and kill it.

Again, where the temperature of the rooms can be kept down to 80° of Fahrenheit, it is obstinately asserted that the constitution of the worm cannot suffer; yet such reasoners forget that in a warm climate they can only keep down the temperature by shutting up the house and excluding heat, and that in so doing they cause malaria to arise among the worms and ordure, by the exclusion of every breath of that pure fresh air which is so essential to the insect's healthy existence.

Lastly, chopped leaves must likewise be compassionately given to the new-born worms, for fear the hardness of the leaf should *hurt their*

* Mr. F. Moore informs me that eggs of *B. Huttoni* hatched in April, when there were yet no leaves!

gums, and give the tender brats *the tooth-ache.** Not a breath of wind, not a change of temperature, must pass over these tender beings, for fear the destroying angel should stretch forth his hand and ruthlessly exterminate the whole. But common sense would fain inquire,—"Is the worm naturally of so tender a constitution that no change must be suffered to come nigh its dwelling? If so, how did the insect contrive to brave the storms, and outlive the daily changes of temperature, even from day to night, when exposed upon the trees in its own native and northern mountain climate? Nay, why was such change from day to night ordained, if it were to prove injurious to organic structures?"

I have proved, however, at Mussooree that the worms of different species, even in their present debilitated state, are not so delicate as it has hitherto been the fashion to suppose, and have successfully reared great numbers of worms that were night and day exposed to every change of temperature, to every gale that blew, and above all to the constant moisture of the mists which were permitted to pass through the room, saturating leaves and trays, and causing the worms themselves to sparkle through the moisture deposited upon them. Yet notwithstanding this rough treatment no deaths occurred, no particular diseases showed themselves, and the cocoons produced were pronounced by competent judges to be good and the silk of the best quality.

They have likewise been successfully reared in France in the open air, and the cocoons are pronounced to be superior to those reared within the house.

And yet after all, seeing that the constitution of the issue has been completely destroyed, what wonder if it be found unable to bear up successfully against the sudden changes of temperature of a foreign climate? Too great a degree of heat,—an improper system of feeding,—the exclusion of fresh air from the rooms, and, above all, the long-continued system of breeding in and in with debilitated stock, have at length reduced the worm to the condition of a *leper*, and have banished from its skin every trace of those with which Nature had originally ornamented it. Even in Europe it has been found that heat is inimical to its health, for not only in Italy is the best silk produced in the mountainous parts of Piedmont, but M. Guérin-Méneville, in a tour made in 1858 through France and Italy, likewise declares that it is in "those elevated localities where the vine and the mulberry escaped disease, that the worm was found to enjoy the best health."

This indefatigable naturalist also notices a custom which has long struck me as being most objectionable, and one which has certainly contributed in no slight measure to destroy the strength and healthiness of the worm. "Nature," observes M. Guérin-Méneville, "distinctly shows that it is her wish that the sexes should remain coupled for a certain

* 'Journ. Hort. Soc. of India,' vol. x. part 2, p. 182.

time, and that time is generally from ten to twelve hours, and often more."

Yet, notwithstanding the truth of this remark, it has become the custom, after Count Dandolo, whose opinions are not always to be depended on, to separate the sexes at the end of five or six hours, and the unavoidable consequence is, that while half the eggs remain altogether unimpregnated and wasted, the other half will produce weakly and sickly worms. It naturally follows then, from this unnecessary interference with Nature's mysteries, that the worms produced are pre-disposed to disease, and as this goes on year after year, and has done so for centuries past, of course the worm becomes more and more degenerated and debilitated.

Surely even here a useful lesson may be learned from the proceedings of the wild species, since every one who has tied out the females of any of the larger *Bombycidæ*, such as *Antheræá* or *Attacus*, must have observed that the wild male found coupled with the female in the morning, will, if unmolested, remain so until sunset, when a voluntary separation takes place.

That matters, as regards the silkworm, are in a very critical and unsatisfactory condition, is fully acknowledged by the French cultivators, but I very much doubt if they have adopted the best means of checking the various maladies with which the insect is beset. Quacks, doubtless, will be found in numbers ever ready to extol some secret nostrum, but the remedies hitherto applied to cure particular phases of disease are calculated to exercise but a temporary effect, and do not by any means strike boldly home and remove the causes from which the maladies arise ; hence in 1861, it was feared that the yield of silk throughout all France would scarcely rise to one-half the return given in previous years. Perfectly useless is it to seek in foreign lands for a healthier and more vigorous seed, since the loss of constitution is universal, and I confidently aver that nothing short of the re-discovery of the insect in its original state of nature, or of the complete restoration of the constitution of the domesticated stock by causing the worm *to revert* to its pristine colour and characteristics, will ever be able to avert the doom which now appears to be impending over the whole domestic stock of *Bombyces*.

The mode of doing this is as simple as could be wished. Nature, ever watchful over the welfare of her productions, herself points out the course to be pursued, and invites us to profit by her wise suggestions, when she gives us so broad a hint of the true state of affairs as to place before us in almost every brood of domesticated worms a few dark individuals, as if for the express purpose of attracting and fixing the naturalist's attention and compelling him to adopt a method of perpetuating that dark race. Let the sericulturist separate these from his general stock, and set them apart for breeding from ; let him annually weed them of all pale-coloured worms, and in the course of three or four years he will be enabled to cast aside his present sickly colourless stock, and rejoice in the acquisition of a worm far healthier that ever it has been since the day when it was first imported from the east by the enterprising to whom we are indebted for its introduction into Europe.

Mussooree, N.W. India.

THE RESINS, GUMS, AND GUM-RESINS OF VICTORIA.

Of the resins proper two representatives only, the products of indigenous trees, are at present known to exist in Victoria, namely, that from the *Callitris verrucosa* and *cupressiformis*, and from the *Xanthorrhœa Australis.* The first mentioned resin from the two trees commonly known as the Desert and Mountain Cypress Pine, may be collected in the northern and north-western parts of the colony in considerable abundance. It exudes naturally from the bark in tears, or small pendulous masses, and also flows from incisions made to encourage exudation. This substance may be described as a resin of excellent quality, almost identical with the best samples of Sandaric from the *Callitris quadrivalvis* of the Mediterranean, so largely used in the manufacture of varnishes. It is a transparent, colourless. or pale yellow body, fragrant and friable, fusing at a moderate heat, and burning with a large smoky flame, very soluble in alcohol, and the essential oils, and almost totally so in ether ; turpentine at ordinary temperatures does not act upon it, nor do the drying oils, but it may be made to combine with those solvents by previous fusion.

The balsamic resin from the *Xanthorrhœa Australis* is a subject of much interest. It is found in masses of irregular globular shape within the body of the tree, and exuding in large tears and drops near its roots. It is a dark red friable substance, the purer homogenous specimens exhibiting a most brilliant ruby colour when crushed into fragments ; it fuses readily with the same deep colour, and exhales the characteristic odour of gum benzoin and dragon's blood under such circumstances. In many respects it resembles the last-named substance, but its solutions are less intensely red, inclining to yellow, while as a varnish it has much more body and gloss. When grass-tree gum is ignited it burns with considerable energy, and its destructive distillation gives rise to liquid as well as solid products, which have not as yet been investigated. It is very soluble in alcohol, and in the essential oils from the Eucalypti, that from the Dandenong Peppermint (*E. amygola lina*) proving an exception. Ether takes up a portion only, leaving behind a resinous substance coloured more intensely red than that which it dissolves ; turpentine exercises no solvent action upon it, and the drying oils but very little. According to Mr. John Kruse, of Melbourne, who examined this substance, and published the results he obtained in the "Journal of the Pharmaceutical Society of Victoria, July 1858, grass-tree gum contains cinnamic in addition to benzoic acid ; and he also mentions the interesting fact, that the action of nitric acid upon it gives rise to picric acid, which he states to be of practical use for dying yellows upon silk or wool.

The *Xanthorrhœa Australis* is very common in many parts of Victoria, in some heathy localities, as in Gipps Land, covering tracts of many square miles in extent ; and the resin, were its uses properly investigated and determined, and thereby drawn into technical use, might be collected in very large quantities.

A very interesting discovery of fossil resin has been made by Mr. Richard Daintree, of the Victorian Geological Survey, in the tertiary lignites of the Bass River, in the Western Port district. This remarkable substance was obtained at a depth of about fifty feet below the surface ; the formation in which it occurs is of great extent, but not sufficiently explored at present to enable an estimate to be made of the probable quantity of resin available. Like many fossil substances of this class, the resin from the Bass River is not easily dissolved in the ordinary menstrua, alcohol and ether take up a portion of it, the former giving rise to a brown-coloured solution, leaving the insoluble remainder in a swelled and bleached state ; the latter forms a clear colourless solution, which by evaporation leaves a pure white residual resin. Turpentine does not exert any solvent power, while the essential oils from Victorian Myrtaceous trees appear to be its best solvents, as only a small insoluble portion remains after their action, consisting to a great extent of mineral impurities. This resinous body appears in small rounded masses, somewhat translucent internally, but possessed of a rough opaque covering ; its colour is a pale brownish grey, with a glassy fracture, it is very friable and inflammable. On being heated it fuses with the disengagement of much volatile matter, causing a frothiness that does not subside for some time. It is less fragrant under these circumstances than the fossil resin of New Zealand, the odour resembling that of Sandarac, a circumstance leading to the opinion that this substance was originally the produce of a tree allied to the genus Callitris. It burns readily, leaving unconsumed a quantity of bright and bulky charcoal.

The genus Acacia furnishes several true gums, of which those from the species *A. mollisima*, *A. dealbata*, *A. pycnantha*, and *A. homalophylla* are the most important. These substances exude from the trees, as do the Acacia-gums of commerce, and occur in rounded or irregularly-formed masses, at times almost colourless or pale yellow, but not unfrequently tinged with red or brown. Some samples are occasionally so intersected with an infinite number of cracks as to present an amorphous white appearance. Generally speaking, the Victorian Acacia-gums are less soluble than the gum arabic of commerce; but, on the other hand, they appear to yield a more adhesive mucilage, which is less liable to splinter and crack when dry. Most of these bodies possess a slight amount of astringency, which varies in one and the same sample from a single tree ; and it would seem that while this peculiarity is absent, or but very faintly perceptible, in the pale-coloured pieces, it increases in proportion as the colour of the gum deepens—a circumstance which would much facilitate their classification.

Under the term Gum-Resins, a numerous series of indigenous vegetable productions may be classed which could be procured in great abundance in Victoria, but which have not hitherto received the attention they deserve. They are produced in greater or lesser quantities by all the species of the genus Eucalyptus, and might be largely accumulated with little trouble by wood-splitters and sawyers throughout the forests of the country.

These substances occur within the trunks of trees of all sizes, in flattened cavities in the otherwise solid wood, which often lie parallel to the rings of growth. In such places the deposition of gum, which is at first a viscid liquid, becomes gradually inspissated, and subsequently hard and brittle. The liquid gum may also be obtained by suitable incisions in the stems of growing trees ; but whether such a method affords greater facilities for its collection than those naturally offered, appears to be still an undecided question.

In their general characteristics the gum-resins from the Eucalypti resemble each other very closely. When in the solid form they present the appearance of small angular masses, intermixed with occasional striated pieces and particles of wood. The prevailing colour is dark red-brown, in some cases dull with olive and yellowish tints, in others bright ruby-coloured and transparent ; black and opaque pieces are also very commonly found interspersed through each of the several descriptions of gum-resin.

The fracture, when these substances are thoroughly dried in the water-bath, is vitreous, and they are, moreover, then exceedingly friable, and easily pulverized. Dessication in this way causes them to lose from fifteen to twenty per cent. of their weight.

In the mouth they are tough and adhere to the teeth, colouring the saliva red ; their taste is intensely astringent, without much bitterness ; although it should be remarked that in this particular they are not all equally potent.

The liquid gum-resins are very viscid treacle-like fluids, which do not differ in chemical constitution from those which have undergone induration, save that they contain about sixty-five per cent. of water, capable of being expelled by the temperature of a water-bath.

The solvent action of water on these bodies is not the same in the case of gums from different species of trees. If, for instance, cold water be poured on the produce of the *E. corymbosa*, whether it be in the solid or liquid state, a portion only is taken up, while the gum from the stringy bark is completely dissolved. When, as in the case just cited, a flocculent residue remains after the action of water, a few drops of ammonia render the solution perfect.

The aqueous solutions of the eucalyptine gum-resins all give an acid reaction with test-paper; but the differences in the behaviour of each, when dissolved by water, subjected to the several re-agents, become very manifest. The precipitate caused by a solution of gelatine—indicative of tannic acid—does not appear in any case to correspond in quantity with their intense astringent taste; and occasionally the addition of that substance causes no precipitate at all. This fact has an important bearing upon the value of this whole class of bodies under consideration for tanning purposes, and as substitutes for catechu and similar bodies.

With acetate of lead these astringent bodies give copious gelatinous precipitates; and with the salts of iron various shades of green and black. The mineral acids also determine in them bulky flocculent deposits.

One or more of the substances which have been made the subject of the foregoing very imperfect sketch appear to have been forwarded from these colonies from time to time, in small quantities, to Great Britain, and to bear there the name of Botany Bay kino; but little seems to be known respecting their properties or uses, the general belief being that Australian kino is only furnished by the Ironbark tree (*E. resinifera*). It becomes, therefore, the more necessary to follow up this subject to a conclusive termination, to establish by a searching chemical investigation the proper uses of substances so abundantly available, and thereby increase the industry and prosperity of the land.

THE CIRCULATION OF SAP IN TREES, AND THE FORMATION OF MAPLE SUGAR.

Trees are made up of fine tubes which extend from the root to the leaf, and it is through these tubes that the circulation of the sap is carried on. If a growing tree is pulled up by the roots, and the roots are placed in a vessel of water containing some coloured solution which they will absorb, we can trace the course of this coloured solution through the tree by cutting notches into it at successive periods. The colouring matter is always found first in the body of the wood near the root, then in the wood higher up, and so on until it reaches the leaf; then it begins to appear in the inner bark near the leaf, and it passes down through the bark again to the root. This observation shows that the circulation of the sap is up through the wood, and down through the bark.

There has been much speculation in relation to the force that causes the sap of plants to circulate, but it has never been settled by observation and experiment. It is pretty well established that sap circulates in the winter, though less rapidly than in the summer, and less rapidly at that time in deciduous than in evergreen trees.

The solid portions of thoroughly dried wood, and other parts of plants, are composed mainly of water and charcoal. When charcoal is burned, a small portion of ash is left. This ash is the mineral or inorganic portion of the substance of the tree, and consists principally of potash, lime, and flint or silex. That portion which burns is carbon. In burning, the carbon unites with oxygen to form carbonic acid, an invisible gas that floats away in the atmosphere.

The water and the inorganic matters enter the tree through the roots ; the carbon enters mostly through the leaves. Carbon forms about one-half of the solid substance of the tree, and water the other half.

Water is composed of two elements, oxygen and hydrogen, in the proportion of eight pounds of oxygen to one of hydrogen. These in entering into a chemical combination with carbon, lose the liquid state of water, and form the various solid substances which make up the body of the tree.

In its course the sap undergoes important transformations. The trunks and leaves of trees are scenes of constant chemical operations, many of them more mysterious than any of the operations of the laboratory. One of these is the decomposition of carbonic acid in the leaf. The affinity of carbon and oxygen is very strong indeed, and there are few forces in Nature that can rend these two elements asunder ; but the combined action of light and vegetable life is separating them throughout every day in the leaves of all growing plants. Carbonic acid is absorbed from the atmosphere by the leaf, its two elements are torn apart, the oxygen is returned to the air, and the carbon combining chemically with other elements in the sap is carried to the places where new wood is being formed, and is there deposited in its proper place to help build up the structure of the tree. The symmetrical order in which the carbon is deposited in a tree may be seen by looking at a piece of charcoal.

If wood is examined under a powerful microscope, it is found that the tubes through which the sap circulates are formed of minute sacs or cells. The substance of which the walls of these cells are formed is called cellulose. It has been the subject of a great deal of chemical research, and is found to consist of carbon and water, or more strictly, of carbon and the elements of water, oxygen and hydrogen. Cotton and linen are almost pure cellulose. Each atom of cellulose contains twelve atoms of carbon, ten atoms of hydrogen, and ten of oxygen, $C_{12}\ H_{10}\ O_{10}$. Starch, gum, and sugar all have the same composition, $C_{12}\ H_{10}\ O_{10}$.

This is one of the wonders of chemistry, that substances composed of the same elements, combined in the same proportion, should have properties so different as gum, starch, sugar, and cotton or linen fibre. Their different properties must of course result from the varied modes in which the atoms are arranged.

Besides these four substances there is one other constituting a considerable portion of the body of trees, which is also formed of the same elements as the others but in slightly different proportions. This is lignin. It is an incrustation on the inner surfaces of the cell walls, and its office appears to be to strengthen and stiffen these walls. Its constitution is $C_{12}\ H_8\ O_8$. In this case, as in the others, there are just as many atoms of hydrogen as of oxygen ; these two elements enter into the compound in the same proportion to each other as that in which they unite to form water. If a tree or other plant is thoroughly dried so as to expel all of its uncombined water, nine-tenths of the remaining substance consists of the five compounds, cellulose, lignin, starch, gum, and sugar, and all of these are composed of hydrogen and oxygen in the same relative proportion as that in which they exist in water, chemically combined with carbon.

Why it is that the atoms of these substances are so arranged in one part of the plant to form cellulose, and in another to form starch ; why it is that they are so arranged in one tree as to form gum, and in another to form sugar, are mysteries which lie beyond the present boundaries of human knowledge.

There is one other organic element, and several inorganic, besides those mentioned, which enter, though in small quantities, into the constitution of plants, but a full discussion of the part which they perform in vegetable economy would demand an exhaustive treatise on agricultural chemistry and vegetable physiology.

ON THE NEW CHINESE SILKWORM LATELY INTRODUCED INTO EUROPE.

BY LADY MARY THOMPSON.

It has long been supposed, and it is still the belief of many, that silk is obtained exclusively from the *Bombyx mori*. To this day, in France, in Italy, and even in China, the silkworm is artificially reared, being kept under cover and fed on the leaves of the mulberry gathered for its use. The *Bombyx Cynthia* is also a silkworm, and has been reared at Sheriff Hutton Park, in the open air, on plants of the *Ailanthus glandulosa*. It is a native of the coldest parts of China, and some of the living cocoons were sent thence in 1856 by a Piedmontese missionary (the Abbé Fantoni) to his friends at Turin, with the information that the worm fed on a tree resembling the Acacia. They tried the leaves of the Ailanthus with success. From Piedmont it was introduced into France, where the cultivation is now being pursued with profit by independent persons, and also by others with assistance from the Government. Though the silk of this insect is already used extensively in France, it is only as spun silk—that is to say, carded like wool, instead of being wound direct from the cocoon in a continuous thread, as in the case of the mulberry silkworm. It was thought that, owing to the structure of the cocoon, there was an insuperable difficulty in doing so; but there is reason to believe that some ingenious person has lately discovered a method. Having watched the caterpillar in the act of spinning, it does not appear to me that there is an impossibility in obtaining a continuous thread. The difficulty arises from the threads being laid more compactly than those of the mulberry silkworm, and being cemented with a gum which we have not yet the secret of dissolving. To unwind the cocoon of the ordinary silkworm hot water is sufficient. The cocoon of the *Bombyx Cynthia* is formed with an elastic opening for the egress of the mature insect, and the supposition was that such an opening could not be made unless the threads were cut; but that, however, has already been proved to be a mistake. From France the insect has been brought into England. The experiment of its acclimatization was first tried by Lady Dorothy Nevill, at Dangstein, near Petersfield, Hampshire. Her success was great, and Lady Dorothy has recorded her experience in an interesting little pamphlet, 'The Ailanthus Silkworm and the Ailanthus Tree.'

In the autumn of 1863 (with a view to a similar experiment), some Ailanthus were planted in the garden at Sheriff Hutton Park; and in the spring, two were set in pots in the greenhouse, as it seemed not unlikely that the worms might do better on the living tree than on sprays gathered and placed in water, which was the method usually adopted. My wish of making the experiment (of how far the climate of this part of England might suit these silkworms) becoming known to Lady Dorothy Nevill, she very kindly made me a present of two dozen newly-hatched worms, which reached Sheriff Hutton Park at half-past seven o'clock on the morning of June 30th. They were first supplied with fresh-gathered leaves, and, within two hours, twenty-three were placed on one of the plants in the greenhouse; the other worm, though alive when the letter was opened, died shortly afterwards. In this situation they throve satisfactorily, making changes, the description of which, by Mons. F. Blain (in a little publication entitled 'Le ver à soie de l'Ailante et son éducation en Anjou'), is so accurate, that I prefer using it to attempting any one of my own. One little omission, however, I must supply in its place.

"The first age is the interval which passes from birth to the first change; in this age the young caterpillar is blackish, and its length is about four millimètres (about one-sixth of an inch). The second age is that which separates the first change from the second. The body of the caterpillar at that time is yellow, with the head, the points of the segments, and the tubercles, black. It measures from eight to ten millimètres long; and in the third age the body is from fifteen to seventeen millimetres long: it is soon covered with a waxy substance, quite white, intended to shield it from the rain."

Mons. Blain has omitted to notice that at this age the tubercles grow into (as it were) pyramids, or rather obelisks, each one capped with a black spot, the insect presenting a more singular appearance than it does at any other time. While in the greenhouse, three worms unaccountably disappeared, twenty only remaining for the open-air experiment. On Friday, 15th July, the plant was taken, with the worms upon it, from the greenhouse, and placed under the Ailanthus in the garden (which, as a safeguard against birds, had been netted over), and the silkworms soon dispersed themselves over the tree. The change from a heat of upwards of 70 deg. to a low summer temperature seemed in no way to injure, but on the contrary, to invigorate them, and they grew rapidly. Shortly afterwards, however, one died, apparently in the attempt to move from one to another of the trees. The changes proceeded regularly, the worms increasing wonderfully in size in the course of a very few days. One, however, remained in the waxy state, and seemed utterly unable to divest itself of that skin.

Mons. Blain's description of these changes is as follows:—"In the fourth age the waxy substance still exists, but the body and tubercles, from white, pass little by little to green; the head and the feet become of a beautiful golden yellow, as well as the last segment. At that time it attains from twenty to twenty-five millimetres. In the fifth age, the green colouring becomes more decided; the extremity of the tubercles is blue; it has on the last segment a blue border, as well as a little speck of the same colour at the rise of its membranous feet. It quickly acquires a length of from eighty to ninety millimètres; in this condition it eats less, its colouring becomes yellowish, after which it loses no time in finding one or two leaflets, which it fastens firmly to the principal stalk, in order to fix its cocoon." On Friday, the 29th of July, between seven and eight o'clock in the evening, the gardener noticed that one was spinning, and before morning it had covered itself up entirely. On Sunday, the 31st, another began, and by two o'clock had made considerable progress, but rain coming on prevented me observing it. After this there never was a day when cocoons were not begun, and by the afternoon of the 3rd of August (the last opportunity I had of seeing the worms), twelve had already covered themselves up. On my return home, the gardener reported to me that, in the week beginning Sunday, the 14th, three died, owing, it may be supposed, to a violent hailstorm, for they never seemed to thrive after it. This loss left only one remaining to spin, the one the changes of which had been so protracted. On Saturday, the 20th of August, I saw it; it had grown to be larger than any, and appeared extremely vigorous. Up to the evening of Monday, the 22nd, it was eating voraciously ; but, on Tuesday morning, it was found at the foot of its tree, and it died soon afterwards : the great cold of the night was probably the cause. Wednesday, 24th, gathered all the cocoons, fifteen in number, fearing that, as the thermometer had been down in the night to the freezing point, the cold might injure the worms, or rather the chrysalids. Friday, 26th, divested the cocoons of all leaf, and hung them up in a temperature seldom lower than sixty, and occasionally warmer. On Friday, the 23rd of September, about 7·30, a bat, supposed to be in the room in which were the cocoons, was caught, and proved to be a *Bombyx Cynthia.* The specimen was unfortunately greatly injured by being caught with the *tongs!* It was caged in a basket, where it lived between ten days and a fortnight. During the day it remained very tranquil, towards evening increasing in liveliness, and being invariably in a state of excitement in the night. On Wednesday, the 19th of October, about twenty minutes past five o'clock P.M., another *Bombyx* emerged from its cocoon. The expansion of its wings proceeded visibly but unequally, the upper one on the left side keeping much in advance of the others. It should be mentioned that the worms generally, previous to spinning, attained the full size given by Mons. Bain (80 to 90 millimetres), and some even exceeded it.

It may be observed that the worms, on arriving, were apparently of the same age, nevertheless there was an interval of three weeks between the spinning of the first on the 29th July, and the death of the last without spinning on the 22nd August. The Ailanthus has been long known in England as an ornamental tree, bearing all the changes of our variable climate; the silkworm, to judge by the limited experiment at Sheriff Hutton Park, can be raised in the open air even in Yorkshire. It is scarcely, therefore, being too sanguine to hope that at no distant time a new cultivation will be practised, which may contribute somewhat to the prosperity of the country. In order to pursue the experiment as rapidly as possible, the propagation of the plant has been tried at Sheriff Hutton Park by several different methods—namely, by pieces of the root which struck readily, by seeds sown in a cool frame, and by seeds sown in an open border, which last succeeded the best, a crop of vigorous young plants appearing in about four weeks. Believing that the climate of this part of Yorkshire is not unsuitable, and that the Ailanthus would grow well in not fertile land, I had some few planted in a sandy situation, but the extraordinary frost of the 1st June destroyed the young foliage, though it did not kill the trees. It was mentioned in a French publication that, owing to the very unpleasant odour of the *Ailanthus glandulosa,* it was safe from the attacks of ground game—a statement which, I am sorry to say, my experience does not confirm, rabbits having injured the trees planted in a spot to which they had obtained access.

Scientific Notes.

Silk Culture in Canada.—Efforts are being made by the Botanical Society of Kingston to introduce into Canada from China a species of silkworm Bombyx (*Bombyx Cynthia*) said to be hardy, and which feeds on the leaves of *Ailanthus glandulosa*, a well-known ornamental plant, rather tender for the climate, but still capable of cultivation here. Dr. Lawson has furnished for publication a valuable paper on the subject by Mr. Patterson, of Leith. It appears to me, however, that the silk of some of our native moths might be rendered more available than that of any foreign species. The ubiquitous moths of the genus *Clisio campa*, which devastate our forests and orchards, produce delicate silken cocoons, tons of which go to waste anuually, and the amount could, no doubt, be greatly increased by the artificial culture of the animal. A still more abundant source of silk would be the cocoons of the great emperor moths of the genus *Attacus*, some of which, and especially the *A. cecropia*, yield cocoons superior to those of many of the species cultivated in China and India. Harris, in his 'Insects of Massachusetts,' states that the silk of this moth is very strong and quite available for manufacture. The writer of an excellent article on this subject in the 'Journal of the Board of Arts and Manufactures for Upper Canada,' adduces additional facts as to the easy breeding and culture of the moth. An esteemed correspondent and good entomologist, Dr. Morris, of Baltimore, has naturalized there the *Ailanthus* moth, and is now engaged in experiments on the culture of the American species. There seems no reason why these creatures, instead of reducing our forests and orchards to nakedness, might not be employed in clothing the daughters of Canada with fabrics equal to those of China and India, and in adding silk to our articles of export. In effecting this result, the naturalists must, in the first instance, at least, take the lead.—Professor Dawson in 'Canadian Naturalist.'

The South Kensington Museum.—Eventually, main features of the ground plan will be two large open quadrangles, whereof one in the centre of the whole ground will have elevations with rich detail in terra-cotta, while next the Cromwell road there will be two wing or pavilion buildings, and a recessed centre with quadrant junctions to the wings. The iron structure, at present containing the Educational Museum, the Museum of Patents, the collection of building materials, casts, and furniture, besides, on the upper floor, the animal products and food museum, and the naval models, the latter in the gallery formerly appropriated to the Architectural Museum, will be removed, along with the present refreshment rooms. The present lecture theatre and offices will also disappear, and the corridor leading to them, and continued westward. A new theatre will be the principal feature of a group of buildings in the centre of the whole plan, engaged with the middle one of the three cross or connecting ranges of building. The upper portion of the theatre will be seen, over and beyond the screen, from the Cromwell road. This group and range are now in course of erection, and, while the design repeats the character of the residences, Captain Fowke is using terra-cotta for the cornices and strings where he had in the previous case employed Portland stone. The terra-cotta is unusually free from the defects of burning ; and while in the first-built front the stone is much discoloured, the other material maintains its original character. Few architects have seen this front. It deserves attention, not only from the use of terra-cotta, but from the general decorative result of the design. Other work in progress is that of a range of buildings skirting the eastern side of the ground where the separate entrance to the National Gallery is.

What "Brocade" is.—Originally this term was applied only to those silks into which gold or silver threads, or a mixture of these, were interwoven. They were highly esteemed by our ancestors, but now their use has been discontinued. The richest brocades appear to have been made in Italy, where an extensive manufactory was carried on in the thirteenth century. In the manufacture of gold brocade a silver wire is gilt, drawn out to a great fineness, and flattened. This is twisted around a silk thread, dyed of a colour as near as possible to the metal, and interwoven in the fabric. Latterly the term brocade has been applied to rich stuffs adorned with raised flowers, foliage, or other ornaments. The plan of introducing metals into the composition of fabrics was a taste originally Oriental, where a love of rich and splendid stuffs prevails so extremely. In China and India it has long been the fashion to ornament silk and muslin with threads of gold and silver.

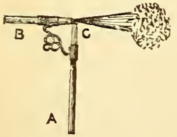
White Ants.—In the Lucknow central gaol, the walls, built of sun-dried bricks, are plastered with clay mixed up with cow-dung, a system very frequently used by natives of India. On the site where the central gaol is erected, the white ants exist in unlimited numbers, and they eat through the plaster in order to get at the cow-dung, so that the walls require to be constantly replastered. Some time ago, the gaoler was getting some floor mats made from the fibre of the American aloe (*Agave Americana*). The way the fibre is extracted by the prisoners in the gaol is by beating the green leaves by means of wooden mallets, and so separating the pulp from the fibre. The gaoler mentioned to me on one occasion, while I had temporary medical charge of the gaol, that he found white ants did not touch mats made from the aloe fibre. On the contrary, they always destroyed mats made from other materials. I suggested it would be a good plan to place a piece of the aloe fibre-mat in a spot where he knew white ants swarmed. He did so, and still found that they did not touch that kind of mat. I then asked him what use he made of the pulp which is separated from the fibre of the aloe-leaves. He said it was thrown away. It struck me that it might be very profitably used for mixing up with the cow-dung used for plastering the gaol walls, as then probably the white ants would not touch the plaster. I suggested the idea to the gaoler. He tried the experiment and found that it quite answered the purpose. Plaster which was impregnated with the juice and pulp, or washings of the fibre of the aloe-leaves, has stood for months, and is not yet touched by white ants ; while the plaster of walls free from aloe-juice becomes covered with white ants shortly after it is put ou.

E. Bonavia, M.D.

Lucknow, 9th July, 1864.

Electric Fire and Burglary Alarms.—A novel, and at the same time very complete, apparatus has been for some time patented, for the purpose of affording to the public the means of protecting property and person from the horrors of fire and the attack of the burglar. Although unable to preveut the origiu of fire, it is nevertheless so complete in its construction, that, immediately upon the air of any room becoming heated above its natural temperature, it is announced by the ceaseless ringing of a bell, thus allowing time for the preservation of life. The same continuous ringing also occurs upon the openiug of any protected door or window more thau the space of an iuch, so preventing the ingress or egress of any person without an instautaneous alarm being given. The apparatus by means of which these important effects are produced is so simple, that it is manageable even by a child ; and its operations may be suspended during the day, or when desired, by the turning of a small handle similar to that of an ordinary bell. The whole is neatly enclosed within the small space of about twelve inches.

Mr. Eugene Rimmel, who is always inventing some agreeable surprise in the perfume line for the delectation of the ladies, has just brought out what he terms a "*rafraichisseur*," or perfumed shower dispenser. This simple and ingenious little instrument consists of two tubes in juxtaposition, as represented in the annexed engraving. By plunging the end of the lower tube A into a bottle of eau de Cologne or other perfume, and blowing smartly through the tube marked B, the current of air causes a minute shower of the liquid scent to issue from the other end, C. This ambrosial dew, blown upon the forehead, causes a refreshing and most agreeable sensation, and affords prompt relief in cases of nervous headaches. If used on the beard or clothes by gentlemen after smoking, it removes the unpleasant odour of tobacco.



THE TECHNOLOGIST.

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ON THE COTTON PLANT.

BY MAJOR TREVOR CLARKE, F.R.H.S.*

IN the spring of the present year I was one of a party of officers—of this Society, by whom the idea was started, that a series of short lectures, each illustrative of some one plant, should be undertaken by ourselves and other Fellows who might have made such plant or family of plants his particular study.

As it was known to some present that I had for several years turned my attention to the improvement of the cotton plant, by cross breeding, with a view to its better cultivation in India, and as I happened to have one of the beautiful golden blossoms of the illustrious Sea Island plant in my button-hole, I was at once "told off" "to do" Cotton. I accepted the challenge, but I knew not what I had undertaken. The cotton plant is a vast and difficult subject; its cultivation at home or abroad is yet a problem; its history and commercial statistics voluminous; its botany impossible. I use this word advisedly, and will explain presently why I do so. In the mean time, in deprecation of the many shortcomings which will inevitably appear in my lecture, I must, in justice to myself, now glance at the difficulties I had to encounter.

Seed was scarcely to be had in England, and the habits of the different kinds under glass were almost unknown. Now, to carry out the scheme properly, I had to show the plant—its species and varieties—to the botanist in flower and fruit, to the horticulturist in the pride of its strength and beauty; and to the commercial mind of our country it was due that I should display, not only the plant decked in its fleecy ornament, but should be able to turn out my own little harvest in as great variety and quantity as possible, accompanied by such specimens in the pod or seed, from the countries where it is cultivated, as I could

* A Lecture delivered before the Fellows of the Royal Horticultural Society, Nov. 8.

get together in the time. Now the different sorts come into bloom from about four months to eight from the sowing, and the fruit takes two months after that to ripen. In some places the plant is scarcely adult the first year at all, and certain sorts, at any rate when cultivated in England, do not appear to show for flower, even in the second year, till October or November, when the weak and scanty sunlight of our English autumn and winter fails to keep the cotton—essentially a sun plant—in a growing state, with its reproductive powers unimpaired. Again, after the crop, a most valuable consideration to the cross-breeder, has been secured, the plants have become shabby and exhausted, and blossom is then out of the question ; when one does appear it is "like a dying lady wan and pale," not like the last rose of summer, bright in its decadence and fair as ever.

In the summer time, however, but little ripe produce could be shown, and plants, under experiment, were too precious for removal. I could not now have produced this case of hybridised pods had I sent away my plants and lost my time at that working period of the year. And so November was decided upon as being upon the whole the best fixture for most purposes. I look forward, as I write, with great apprehension as to the appearance my collection will present, especially after their transit by railway ; but, thanks to the unsurpassed horticultural skill of the Garden Superintendent, I am able to show you some splendidly grown specimens, in a younger state, from the Kensington department of our Society.

My present difficulty is simply this ; how to say a very great deal in a very short space of time. To describe the various sorts, that is, seminal or climatic varieties, with their ever-varying forms and their apparently great but really invalid points of difference, would be taking up your time to no present purpose ; suffice it to say, they are as numerous as the kinds of wheat in our corn fields or peas in our kitchen gardens. In India especially, every great geographic division, seaboard, central, or peninsular, every district, nay, almost every mountain or valley, cultivates its own form or variety. Could all this be told in half an hour ? For the same reason I am obliged to omit the history, rise, and progress of the trade and manufacture of the raw material.

Unwillingly I pass by the lives and labours of those gifted men who, starting from the simple distaff and wheel, and the rude handloom of the cottage weaver, invented and improved, modelled and re-modelled, the long series of mechanical contrivances, of which the crowning result was that wondrous and beautiful marvel, the self-acting mule-jenny. It is a romance in itself, that story of the machines. It has been told, and told again, never too often, and the names of Hargreaves, Arkwright, Cartwright, and Crompton, are among the "household words" of the country of their birth. But our business is with the plant and its produce. Let us take its early history. The history of the cotton plant is old, old ; so old that no man may tell when or where it was—in the dim

Cyclopean times, ages, incomprehensible ages ago—that the thoughtful observer first saw and plucked that fair and fleecy treasure from the tree—the "wool-tree," from which he might clothe himself without bloodshed, and which stood before him, as if planted by the hand of the Creator for the comfort of His creatures. Did he dream that those silver threads—and who shall view them through the optician's achromatic glass and say that they belie the designation ?—did he dream that the silvery fibres of the pretty cotton pod would be changed into gold by the magic of time, to the golden fleece half worshipped by a busy world? Perhaps it was a woman. It must have been. I see her now—the lithe Asiatic form, glowing in deep sun tints and instinct with life and beauty. She seems lost in admiration of some object before her. It is a little shrub of rare beauty ; she plucks the fair blossom, cinque spotted purple in its golden chalice, and weaves it in her crisped hair ; then the ripe fruit pod, with its white and downy flocks of spotless purity. Now she plays with it—she pulls it from hand to hand, and while lost in thought unconsciously twists it into a thread—the first thread ever twined by human fingers.

Certain it is that the Hindoo women two thousand years ago produced threads and wove muslins only very lately surpassed by the power-loom and mule-jenny. Spinning Jenny ! still female.

The thread of my story has led me to the East. Let us follow the clue. To the well-preserved literature of ancient India we owe the fact that cotton was well known and manufactured eight hundred years before the Christian era. In the book of the Institutes of Menu, perhaps the oldest law books in existence, occurs the following passage : "Let a weaver who has received ten palás of cotton wool give them back increased to eleven by the rice water and the like used in weaving ; he who does otherwise shall pay a fine of twelve panás." So that sizing, and the abuse of it, is nothing new. Arrian mentions cotton as an article of import into Rome, from India, and describes the means of transit, the principal marts, and the commerce in general. But it appears to have been costly, and only used sparingly by the higher classes, who stuck to the toga, and it is on record that Horace's father had no pocket handchief, cotton or otherwise.* The Greeks were as perfectly acquainted with the Dacca muslins as we are.

Nearchus describes the Indians as having garments of "tree-wool" which reached to the middle of the leg, a sheet folded about the shoulders, and a turban round the head. One would think it was but yesterday, the description is so perfectly that of the modern Mussulman in his outer man. Long before this, Herodotus, a young Greek nobleman, travelling in India for pleasure and information, speaks thus, in his own grand language, "τα δε δενδρα τα αγρια αυτοθι φερει καρπον ειρια καλλονη τε προφεροντα και αρετη των οιων· και εσθητι οι Ινδοι απο τουτων των δενδρεων χρεωνται."

* *Quoties vidi patrem tuum digito se emungentem.*

And in language "understanded of the people" as follows. "The trees of the field there bear wool as fruit, in beauty and quality surpassing that of sheep, and Indians use clothing from these trees." He came home, and, as was the custom in that classic and sporting land, recited his observations, which were accurate, and his priest-imparted stories which were "crammers," at the Olympic Games. Fancy Lord Dufferin or Sir Gardner Wilkinson reading their experiences of Greece and Egypt at Tattenham Corner! The word "cotton" occurs in many etymological forms, as Gotn, Kotun, and so on. Pliny first mentions it as Gossypium or Gossympium, while other old authors, and, following them, the earlier botanists, use the word Xylon. But the oldest designation of the manufactured article is the Sanscrit kurpasum. Hence the Greek καρπασον, the Latin Carbasum, and our canvass and cambric. Cotton, as a cultivated crop, did not get into China till the 13th century, though they had long possessed the handsome red-flowered *G. arboreum* as a garden plant. It is curious that the Celestials, who never do anything like anybody else, seem to have taken a fancy to the brownish yellow stapled sort produced principally by the Indian form called *religiosum*, but also by the American plant. This was imported, rather largely, at one time to make Nankin trousers for the English fashionables, having first attracted notice from its strength and durability. Seeing this, the crafty Chinaman began to dye his common white cotton yellow, and the depreciated article lost him his trade. This sort is said to be one of those held sacred by the Asiatics, and, as such, used only for the head and upper parts of the body, while the British dandy's practice was just the contrary. Undoubtedly ancient as the use of cotton was in Egypt, I fear the mummy cloths were not made of it. This, however, was long supposed to be the case, but the matter was settled a few years ago by my friend Sir Gardner Wilkinson, who pronounced it to be linen, and the microscope, in the able hands of Thompson and Bauer, confirmed his decision.

Old as our subject is in India, it can boast as high, and probably a higher, antiquity in the western world, and the botanical genealogy of the Occidental plant is far more inscrutable than that of the Oriental. Columbus found it in the West Indies, Magellan in Brazil. Ferdinand Cortez found the Mexican Court clad in cotton, and presents of it were brought home by the gorgeous and cruel buccaneer to his imperial master—better had they not been stained by the blood of Montezuma! Cotton, both in its raw state and beautifully woven, has been found in the ancient Peruvian tombs.

The Indian plant, however, appears to have been first cultivated by the British colonists in America prior to the French Revolution, before the high qualities of the indigenous Mexican form, so close at hand, were known. Cotton was grown on a limited scale in Maryland, in 1736, by Miss Lucas, the daughter of the then Governor of Antigua. Again a lady! No conjured vision now, but an enterprising English girl. Listen to her journal "July 1, 1739.—Wrote to my father to-day on the pains I had taken to bring the indigo, ginger, and cotton to perfection, and that I had greater hopes," &c.

In 1775, just before the revolutionary war, the Southern States of America had begun to turn their attention to cotton growing, and the cultivation of thirty-three acres by one person of "green seed cotton," probably the *Xylon americanum præstantissimum semine virescente* of the old botanist Schwartz, was considered a great feat in those days. After the peace in 1783, the independent spirit of the Americans was directed more to their own manufactures at home, than to their exports or imports, and Mr. Madison expressed his conviction that the United States, in the extensive regions south of Maryland, would certainly become a great cotton country. Shortly after, an American gentleman came to England to purchase machinery. British law then forbade its exportation ; so a Mr. Slater, who had been Arkwright's pupil, carried off the fruit of his master's brains to America, and working from recollection, his plans and models having been seized, made the first cotton machinery ever used or seen in the United States. In 1784, eight bales had been shipped to Liverpool, and seized at the Custom House as an illicit importation of British colonial produce, but were restored to the consignees so soon as it was discovered that so "large" a quantity of cotton could be grown on the American continent. Exportations have continued from that day to this. The blockade can only be considered as a temporary inconvenience, with a great resulting advantage. It has taught the world to grow cotton. But enough of dry history ; let us get to the botany.

I must now refer you back to a remark I made, perhaps a flippant one, but I am sure excusable in the case of any one who has painfully floundered through the subject as I have, "that the botany of cotton was impossible." It is not alone I who have said this thing. Better men have given it up in despair, quieting their consciences by lumping the whole family, with its numerous and undefinable clanships, into two or three specific heads, leaving even these to fight it out, like the cats of Kilkenny, till nothing be left to tell the tale, and one *Gossypium*, genus and species, be left alone in its glory.

All are agreed that the genus is good in law, but the specific differences are so slight, and the seminal variations so great, that botanists have always been in a perpetual puzzle on the subject ; and what is worse, they seem to have shaken up their specimens and descriptions in one bag, and their names in another, put them together at random, and returned them to their herbariums to puzzle posterity. Linnæus admits five species ; Lamarck follows with eight ; Poiret describes four more ; Roxburgh adds two more, and with reason, as they would appear to be stirpes, or really wild forms ; De Candolle enumerates, not insists upon, thirteen, and rests upon his oars, quietly remarking that all were uncertain, and that no genus more required the labours of a monographer, who could describe them from living specimens; and I believe our own Lindley is of much the same opinion. The distinguished botanist and traveller, Dr. Welwitsch, adds another undoubted wild species, *G. microcarpum*, Welw., from the district of Mossamede, near Loanda, in Western Africa. I shall have the gratification of being able to show you a specimen by-and-by, of this very curious plant, which I shall always be proud of as a present from the discoverer of *Welwitschia mirabilis.*

I need not say that the popular accounts of the plant present an amount of error and confusion past all understanding. But there is reason and excuse for all this. Cotton is a domesticated plant, and has been so through unknown ages, in every part of the world where the climate would bring it to perfection. What the caninæ are to the zoologist, fowls and pigeons to the ornithologist, cereal grain, potatoes, pinks, and polyanthuses to the farmer, gardener, and florist, this has cotton been to the botanist. Naturalists know that no two reproductions of animal or vegetable life are exactly alike. However slight it may be, each has an individuality, more or less visibly stamped upon it. This disposition to sport, as it is termed, is enormously increased by cultivation, by which I mean, rich food and immunity from disturbing influences.

Upon any plant weeded, watered and manured, fenced in and fostered by the hand of man, Nature rings her weird changes with unbridled energy, and in no case more curiously than in the genus Gossypium. What are or were the countless Gossypium legionaries, uplands and lowlands, Sea islands, and Bourbons, long staples and short staples, with the botanical *hirsutums*, *glabrums*, *vitifoliums*, and *latifoliums* of the West? What the *albums*, *nigrums*, *rubrums*, and *purpureums*, *palmatums* and *tricuspidatums* of the Eastern world? They are mastiffs, greyhounds, pointers, setters, pugs, poodles, and turnspits, Taylor's bright Venuses and Buck's George the Fourth's, white Talavera and brown Lammas, beautiful man-made monsters, fair to the eye and good for food and raiment and other wants of the world, but inscrutable as to their origin and a stumbling-block to systematism?

But it is time to get to work.—*Loquitur* Royle.

The genus Gossypium is distinguished, that is from other mallowworts, by having a double calyx, or in other words a simple calyx supported externally by three leaf-like bracts, forming an involucre, and a three to five-celled capsule, with seeds immersed in the wool-like substance, so well known by the name of cotton. Time compels me to refer you to Royle or other reliable botanists for the general description.

Slight as are the real specific distinctions, in the strict scientific sense of the word there is an outward physiognomic difference between at least two great and important races of the plant, to wit, those of the American and those of the Asiatic continent, which no person, however slightly acquainted with plants, can fail to observe. And this outward appearance is accompanied by an equally great and important difference in the commercial product. We will first take the American forms.

These, according to the best and latest authorities, are but two in species ; far the greater part of them being derivations of one—*Gossypium barbadense.*

They are handsome, more or less short-lived trees, biennial or perennial in warm climates ; annual wherever a true winter ends the year. The Bourbon plant is generally received as a type, or *varietas princeps*, of the species. It is supposed to be indigenous to the hottest regions, the *terras calientes* of Mexico, whence it was taken to the Isle de Bourbon, Anguilla in the Antilles, the Mauritius, and finally to Barbados ; and these islands were undoubtedly the nurseries from whence came the stock which supplied plants to the cotton-producing States of America. The varieties into which this species runs take their peculiar forms and qualities of staple from the various aspects, soils, sites, and altitudes in which they have been cultivated. Some of these variations are extremely curious, as in the case of seed, which in the same sort varies from a smooth black naked grain, parting from the wool with a very slight pull, to a distinct-looking form, covered with a short green or brownish nap, to which the tufts of available fibre cling with more or less tenacity. The celebrated Sea-island plant is the form taken by the Barbadian type when transferred to the warm, moist climate, and rich low-lying lands, on the Georgian coast and in the adjacent islands. The fibre is long, strong, and of the highest excellence. Cultivated in Egypt it retains its properties to a certain degree, is a good, useful, long cotton, and is much used for the same purposes. The appearance of the plant is slightly modified by the climate.

Uplands, or short-stapled American (not Surat), now includes, according to Royle, the produce of the interior and upland country of Georgia and Carolina, as well as of Alabama, Mississippi, Louisiana, and Tennessee —bowed Georgian as it was once called, from having been first cleaned by the Indian contrivance of a bow and string, flicking the fibre from the seed. Just now the fashionable sort is called the Mexican Gulf Hill seed. I am indebted to the Cotton Supply Association for a sample of this. Three seeds of it produced me three very different-looking plants. One nearly approaching the type, with glabrous foliage much angled and divided. Another with hirsute strong branches and more spreading habit ; and a third with the most remarkable foliage of any I have hitherto seen of its race ; the lobes, especially the central one, are so long as to give the leaf almost the palmate appearance of the Indian plant, and the individual lobes are also curiously divided. The seed was peculiar and different from the rest in being very small and nearly clean or naked. There is a sort called little Mexican or Petit Gulf ; I think this may be it. Venezuelan seed, also from the Association, resembled this. The plants, however, were like the Gulf seed, but a little more hairy. These were all sown very early this spring, but have, at present, shown no signs of flowering.

But the favourite staple of the Manchester men is produced by the

New Orleans plant; it has more of an herbaceous or annual habit than the Upland race, comes to maturity in a few months from the seed, rests for a few weeks after the effort of producing its beautiful wool, and either dies if touched by frost, or shoots forth again, bearing a second, and often the best crop. The flower is large and saucer-shaped, of a pale yellow tint, or nearly white, wanting the purple basal spots, with cream-coloured anthers, and elliptical pod. Closely allied to this sort, and indeed undistinguishable before the pod bursts, is the American Nankin plant.

The Sea Island is by no means so conspicuous an object, as far as the pod of fibre is concerned, though the fibre itself is more costly and showy. Its habit is different from that of the last. The whole plant is more or less glabrous, the branches slenderer, and set on at a more acute angle; the blossom is golden yellow, almost tubular from the convolution of the petals, each of which has a rich brown-purple spot at the base; the pod long-oval, often much acuminated, and rough, with pitted depressions. Like the New Orleans, this comes quickly to maturity, and, like it, is often treated as an annual, though they will both live several years in a winterless climate. The seed is black, clean, and free from nap, except at the extremity or extremities, where there is a little tuft to which the lock of cotton adheres loosely. It varies with an entire covering of greenish nap, which it is said to put on, as a gentleman puts on his great coat, when taken up to the hills or into a cooler climate. I have raised plants from both kinds of seed, and find the habit reproduced in the seedlings respectively. It has been said, upon the authority of cotton farmers, that these two races interchange habit, appearance, and quality with each other after cultivation for a generation or two, under opposite conditions respectively.

I should feel very much obliged to any observer of the plant in its own climate, if he could tell me of any authentic instance where the change of appearance of seed was accompanied by a corresponding alteration in the flower—whether, in short, the Sea Island plant has ever put on the widely expanded, pale, self-coloured hollyhock-like blossom and large smooth elliptical pod, of the New Orleans or *vice versâ*. Every monographer, or even pseudo-monographer, like myself, has a conceded right to a crotchet, and mine is that there exists, or has existed somewhere among the Aztecs or elsewhere, a typical *Gossypium hirsutum* distinct from the smooth *barbadense*.

Here is Mr. Wanklyn's superb "Vine Cotton," the seeds of which were kindly presented by him to our Society. The Vice-Secretary sent me three, one of which grew into the plant before you. There must have been some misconception in the description given to Mr. Wanklyn as to its habit of rambling like a vine. The plant is simply a gigantic form of New Orleans, differing only from the normal sort in a general exaltation of development in all its parts. The staple, although injured by the syringe, in the small propagating house here at Kensington, was pronounced by Dr. Forbes Watson to be of very high quality.

Away now westwards across the sultry continent: we have had enough of the Bourbons, like our neighbours.

Brazil and Peru boast of the most curious and distinct cotton tree known. A noble great fellow he is; too much so for me. My hothouse is fourteen feet high, and in another week he would have broken his neck against the luffer boards! The seeds in the species are agglomerated together into one kidney-shaped mass, to which the cotton adheres so slightly that it is easily separable by the hand or machine. Some of you may remember to have seen a curious-looking specimen, enshrined in a glass case here at Kensington, and labelled "native African." Of this my friend Mr. Murray surrendered me a seed or two, and here is the result. It produces, I believe, the Pernambuco staple, or Pernams of the trade. The flower has not yet appeared, nor do I know what it will be like, but I think I can anticipate the bright yellow tube and purple spots of the Sea Island. And here, again, crops out my crotchet. In two separate pods of the Sea Island I found seeds adhering to each other by twos; they are very like those of *acuminatum*, our present subject, and so is the whole plant except in stature.

I have another plant here very nearly resembling this in habit, size, and other particulars. It is the Peruvian cotton of Mr. Clements Markham, so well known on account of his services in the establishment of the quinine plant in India. He has succeeded in introducing this fine cotton also,* and the Indian-grown produce has been pronounced most satisfactory. The seeds, however, are free, and not massed as in the Kidney cotton.

Away again, Eastward Ho! and we are in India with the anything but gentle Hindoo and his despised Surat cotton.

What a different plant it is, with its deeply-cut five-fingered leaf and dull-tinted foliage, sometimes a short and shrubby bush, sometimes tall and slender as a fairy fishing-rod. The flower is very handsome—purple and gold—like that of the Sea Island aristocrat, but the cotton—the cotton—is nowhere. It is usually short, harsh, and only useful in Manchester, when mixed with the medium-stapled sorts from America. Some varieties, however, have the silky quality. The fibre of these is also so extremely fine, that the native women, by their wonderful hereditary fine sense of touch, have been, and are still able, to spin those gossamer threads and weave those "webs of woven air" which have been the admiration of all times, and have been even sung in soft Sanscrit by the dusky poets of the land.

I have been able, by the kind assistance that has been given to me, to get together several of the numerous varieties of the Indian plant. Here is the celebrated Dacca sort—at least, it pretty well answers the descriptions. Here is the *Sacrosancte religiosum*, if indeed *religiosum*

* The Piura and Imbabura cottons of Spruce.

it be ; for, in hunting among the books, religiosum is generally found to be something else, and something else to be religiosum. It has broader lobed leaves than the common sorts, tinged and veined with brownish pink, and bears very decidedly green seeds. I have raised it from a sample sent me, under that name, by the Cotton Supply Association ; and also mixed with the sort called "oopum," from the same source. The "oopum" plant I have retained at home, in hopes of ripening the one single late-set pod which it produced. Very like it, with the same green seeds, but with more acute and numerously-divided lobes, is the very interesting species *arboreum*. I assume it to be such, upon the authority of the Botanic Garden of Saharunpore, associated as the name is with Royle and cotton. My plants were raised from seed received from thence through my friend Mr. Arthur Grote, of the Asiatic Society at Calcutta. Now this *arboreum* was, on many accounts, a desideratum—desideratissimum. For years it eluded my search with the cunning of a fox. I was once fond of fox-hunting, and could hold my own across a country as well as my neighbours ; but of all the foxes to hunt, for intense excitement, there is nothing like a scientific fox. I first "put up" the *arboreum* fox in the covers of my old friend Tenore, at Naples, kept it for years, and never could do anything with it, as it always showed for bloom in November, and went leafless to rest in December. Again I got the same plant from Chiswick, but now under the name of South Sea Island. I have it now just trying to ripen a pod. It is the acclimatised Bourbon of India. So for ten years I was "running hare." I then took to books, botanic gardens, and friends in the tropics. Tropical friends sent big Bombaxes, and the eternal Bourbon again, with a sprinkling of *acuminatum*. Botanic gardens were out of the question, as they always stuck religiously to the label the captain in the navy, collector of customs, or consul's wife sent with the seed. Books were worse than botanic gardens, as almost every writer has a pet *arboreum* of his own. Now, for popular and general information, every Brahmin, you must know, wears a hank of cotton of three threads round his neck for religious motives, and this *arboreum*, a plant nearly resembling the ordinary Indian cotton in all respects, except in bearing a red flower, and being a decided perennial, is known to be cultivated in the gardens of priests and fakirs, and in the precincts of temples, for the purpose of furnishing the mystic threads. But travellers say that the large kidney cotton plant is used for the same purpose ; and we read that Linnæus named another sort *religiosum*, as being a cotton tree under the shade of which religious ceremonies were performed, and which furnished the sacred threads. It was afterwards said that this tree was simply a Bombax. Here I was running four foxes at once. Finally, I ran into my fox in Royle's "Illustrations." Here it is ; it answers pretty well to Royle's figure which I now exhibit. It has not yet flowered. It closely resembles *religiosum* in the tinted foliage and green seeds. From a sample of Kupas, or seed with the wool on it, labelled "Good native

Cotton, Dholerah," I raised plants with very distinct habit and foliage, with short broad elliptical, sometimes mucronate leaves and many hirsute zig-zag branches. The segments of the outer calyx are much expanded, so as to give them a sort of butterfly appearance. The cotton is long and soft, and approaching in quality to the American staple. Here is a very fine form of the Indian plant from one of Dr. Forbes Watson's samples, marked "From Nymansing, Assam," with thick dark green leaves lanceolate, and wanting the small supplementary lobes; the nearly entire bracts enclose large long pods, rivalling in size those of the American plant. This sort was detected by the keen eye of the Doctor among the Indian specimens sent over to the last Great Exhibition. The staple appears bulky, strong, and, I believe, is very good. Seeds from the same packet produced a beautiful little miniature form, with small round pods. Another packet, from Assam, gave me a plant somewhat like the last, but with a yellowish tint in the leaf and smaller pods.

These comprise my Indian menagerie of cultivated kinds. And now I must show you perhaps the most curious and interesting thing in my whole collection, Dr. Welwitsch's wild African species. If we look with Darwin back into the dim pre-historical ages and watch as it were our beautifully developed forms fading back into one first created wild type, I am afraid the dark lady of my dream would have had stiff work to spin a thread from this. Here is the seed with the cotton on it. The colour of it is Nankin.

I must now, at the risk of wearying my audience, touch upon the all-important subject of the cultivation of American staple in India; and as it will be absolutely to explain the commercial relations which the Indian and American staples bear to each other, I will read part of a capital speech made by Mr. Smith, once member for Stockport, which gives a short and masterly explanation of the subject. It is from a capital book—'The Cotton Trade,' by George McHenry, published by Saunders and Otley. It has a strong Yankee leaning, but is exhaustive of the subject as a commercial history.

"The long staple, or long-fibre cotton, is used for making the warp, as it is technically called, *i. e.*, the longitudinal threads of the woven tissue. These threads, when of the finer sorts—for all numbers, say above 50's—must be made of long-staple cotton; for numbers below 50's they may be made of it, and would be so made were it as cheap as the lower qualities of the raw material. No other quality of cotton is strong enough or long enough either to spin into the higher and finer numbers or to sustain the tension and friction to which the threads are exposed in the loom.

"The medium-staple cotton, on the contrary, is used partly for the lower numbers of the warp (and as such enters largely into the production of the vast quantities of 'cotton yarn' and sewing thread exported) but mainly for the weft, or transverse threads of the woven tissue. It is softer and more silkier than the quality spoken of above, makes a fuller and rounder thread, and fills up the fabric better. The long-staple article is never used for this purpose, and could not, however cheap, be so used with advantage ; it is ordinarily too harsh. For the warp, strength and length of fibre are required ; for the weft, softness and fullness. Now, as the lower numbers of 'yarn' require a far larger amount of raw cotton for their production than the higher, and constitute the chief portion (in weight) both of our export and consumption ; and as, moreover, every yard of calico or cotton-woven fabric, technically called cloth, is composed of from two to five times as much weft as warp, it is obvious that we need a far larger supply of this peculiar character of cotton, the medium-staple, than of any other.

"The short-staple cotton is used almost exclusively for weft (except a little taken for candle-wicks), or for the very lowest numbers of warp, say 10's and under. But it is different in character from the second description, as well as shorter in fibre ; it is drier, fuzzier—more like rough wool, and it cannot be substituted for it without impoverishing the nature of the cloth, and making it, especially after washing or bleaching, look thinner and more meagre ; and for the same reason it can only be blended with it with much caution, and in very moderate proportions. But its colour is usually good, and its comparative cheapness its great recommendation.

"It will be seen, therefore, that while we require for the purposes of our manufacture a limited quantity of the first and third qualities of raw cotton, we need, and can consume, an almost unlimited supply of the second quality. In this fact lies our real difficulty ; for while several quarters of the world supply the first sort, and India could supply enormous quantities of the third sort, the United States of America alone have hitherto produced the second and most necessary kind."

I have read most attentively the history of the Indian experiments. They tell of the well-directed skill, the stout and willing heart, the rough hard toil and untiring energy of the Royles, Wights, and other earlier and later labourers in the field of Indian experiment. They prove that good useful cotton, such as goes by the name of good middling New Orleans in Manchester, can be, and has been, produced on Indian soil. The accounts, the authentic accounts, and the samples received from time to time, only strengthen the conviction. The long series of experiments carried on under the auspices of the Indian Government for now nearly a century, go to prove that the principal impediments to the production of good Surats are the filthy habits of the gentle Hindoo, and the religious prejudices of his priesthood.

In the case of the cultivation of the exotic species by Europeans or natives, the casualties would appear not to differ greatly from those to which every agricultural crop is subject in India, or England either. Even the elements can be coaxed, if not controlled. Irrigation is now no problem, and the periods of sowing can be so arranged that the wild monsoon may foster rather than injure. Each and all of these difficulties seem to have vanished whenever the strong will of these gallant pioneers had determined they should do so. Royle alludes to experiments in hybridisation once or twice, but no authenticated results have been recorded. A year or two ago, however, certain of the American sorts were intercrossed, both by myself and Dr. Bonavia, of Lucknow. We are now waiting the final report of the Doctor's experiments. Mine produced what is apparently a very beautiful and prolific cotton, second only, according to Watson—the Cocker of cotton fibre—to the best Sea-Island.

I must here offer my tribute of thanks to all good friends who started me and helped me on my way. First and foremost to my kind friend Dr. Lindley, who, always ready alike to encourage an aspirant or smash an impostor, supplied me with advice and introductions. To Dr. Wight the same. To the Manchester Cotton Supply Association, Dr. Forbes Watson, Mr. Clements Markham, Mr. Arthur Grote, Mr. P. L. Simmonds, and Dr. Welwitsch, for plentiful supplies of seed of commercial or botanical interest; and last, but not least, to my friend Mr. A. Henderson, of Pine Apple Place, for the seeds of the Nankin and Sea Island, from which I produced my first cross-bred plant. In Cotton literature I have profited by and used largely the contents of Royle's great work, the prize Essays by Dr. Shortt and others, and the Journal of the Agri-Horticultural Society of India. There was one want, however, which neither men nor books seemed able to supply. Search where I would I could not find "the poetry of cotton." One could wander through ferny glades with Mr. Moore, and feel inspired; there was poetry in the fairy bells of the modern and in the mournful *αι αι* of the mythic hyacinth; the rose was bathed in it; but there was no poetry in cotton. At last I found it—in a negro melody: "picking cotton in the field, there first I saw a yellow girl, her name was Lucy Neal." Nay, scoff not; nigger melody though it be, it is one of the most exquisitely pathetic ballads of modern times. Listen to the last verse, the outpourings of the poor negro's profound love melancholy—

> "They bore her from my bosom, but the wound they cannot heal,
> For my heart is breaking, breaking, for the love of Lucy Neal;
> Ah! yes, and when I'm dying, and dark visions o'er me steal,
> The last low murmur of this life shall be poor Lucy Neal."

Farewell now, my friends, and thank you for your kind attention. If I have mixed science and Lucy Neal, it was that you should not be sent home to your firesides with ears quite stuffed with cotton.

The lecture was amply illustrated by samples of cotton pods of the Major's own growth under glass in this country and seeds of various kinds and drawings; also by numerous living plants from his conservatory, in most cases well furnished with pods, and by others in blossom grown at Kensington.

ON THE GOLD MINES OF CANADA, AND THE MANNER OF WORKING THEM.

BY T. STERRY HUNT, F.R.S.

THE existence of gold in the sands of the Chaudière valley, to the south of Quebec, was, so far as we were aware, first announced to the world by General Baddeley (then Lieutenant), of the Royal Engineers, in the year 1835, and by him communicated to Professor Silliman. (See 'American Journal of Science for that year, vol. xxviii., p. 112.) In 1847, and the three or four years following, careful examinations were made in that region by the Geological Survey, and it was found that the precious metal is not confined to the valley of the Chaudière, but exists in the superficial deposits of a wide area.

The source of the gold throughout this extent appears to have been the breaking up of the crystalline schists of the region, in which the metal has occasionally been met with. One example of this is in a vein of quartz in clay state, in the parish of St. Francis, on the Chaudière, where it occurs with argentiferous galena, arsenical pyrites, cubic iron pyrites, and sulphuret of zinc,—the latter two ores containing a notable proportion of gold. The results of assays of all these materials will be found in the reports of the Geological Survey for 1853, p. 370. During the past year, another vein of quartz, about one hundred yards from this last, has yielded very rich and beautiful specimens of native gold, also accompanied by arsenical pyrites. The precious metal occurs again not far from the Harvey Hill copper mine, in Leeds, at a locality known as Nutbrown's shaft, which is sunk on a vein of bitter-spar, holding specular iron, vitreous copper ore, and native gold, generally in small grains or scales. Some specimens from this locality, however, have weighed as much as a pennyweight. The only attempts as yet made at gold-mining in Canada have been in the diluvial deposits. We extract from the General Report of the Geological Survey of Canada the following details with regard to these deposits, together with the results of some of the trials hitherto made to work them, and suggestions as to the best mode of obtaining the gold :—

"These rocks of Eastern Canada may be traced south-westwardly through New England, along the Appalachian chain, to the State of Georgia, and furnish gold in greater or less quantity in nearly every part of their extension. They constitute the great gold-bearing formation of eastern North America, which in its mineralogical and lithological characters is similar to that of the western coast, and to those of Russia and Australia. These auriferous rocks in Canada belong for the greater part to the Quebec group, of Lower Silurian age ; but the quartz veins containing gold, mentioned above, are found cutting strata which are supposed to belong to the upper Silurian period. The auriferous drift covers a wide area on the south side of the St. Lawrence, including the hill country belonging to the Notre Dame range, and extending thence south and east to the boundary of the province. These wide limits are assigned, inasmuch as although gold has not been everywhere found in this region, the same mineralogical characters are met with throughout. In its continuation southward in Plymouth, and elsewhere in Vermont, considerable quantities of gold have been obtained from the diluvial deposits. In Canada, gold has been found on the St. Francis River, from the vicinity of Melbourne to Sherbrooke; in the townships of Westbury, Weedon, and Dudswell, and on Lake St. Francis. It has also been found on the Etchemin and the Chaudière, and nearly all its tributaries, from the seigniory of St. Mary to the frontier of the State of Maine, including the Bras, the Guillaume, the Rivière des Plantes, the Famine, the Du Loup, and the Metgermet. Several attempts have been made to work these alluvial deposits for gold in the seigniories of Vaudreuil, Aubert-Gallion, and Aubert de l'Isle, but they have been successively abandoned, and it is difficult to obtain authentic accounts of the result of the various workings, although it is known that very considerable quantities of gold were extracted. The country people still, from time to time, attempt the washing of the gravel, generally with the aid of a pan, and are occasionally rewarded by the discovery of a nugget of considerable value. In the years 1851 and 1852, an experiment of this kind on a considerable scale was tried by the Canada Gold Mining Company in the last-named seigniory, on the Rivière du Loup, near its conjunction with the Chaudière. The system adopted for the separation of gold from the gravel was similar to that used in Cornwall in washing for alluvial tin, and the water for the purpose was obtained from a small stream adjoining. Great difficulties were, however, met with, from a deficient supply of water during the summer months. The gravel from about three-eighths of an acre, with an average thickness of two feet, was washed during the summer of 1851, and yielded 2,107 pennyweights of gold; of which 160 were in the form of fine dust, mingled with about a ton of black iron sand, the heavy residue of the washings. There were several pieces of gold weighing over an ounce. The value of this gold was 1,826 dols., and the whole expenditure connected with the working 1,643 dols., leaving a profit of 182 dols. In this account is, however, included 500 dols. lost by a flood, which swept away an unfinished dam; so that the real difference between the amount of the wages and the value of the gold obtained should be stated at 682 dols. The average price of the labour employed was sixty cents a day.

"In 1852, about five-eighths of an acre of gravel were washed at this place, and the total amount of gold obtained was 2,880 pennyweights, valued at 2,496 dols. Of this, 307 pennyweights were in the form of fine dust mixed with the iron sand. A portion was also found in nuggets or rounded masses of considerable size. Nine of these weighed together 468 pennyweights, the largest being about 127, and the smallest about 11 pennyweights. Small portions of native platinum, and of iridosmine, were obtained in these washings, but their quantity was too small to be of any importance. The washing season lasted from the 24th of May to the 30th of October, and the sum expended for labour was 1,888 dols., leaving a profit of 608 dols. A part of this expenditure was, however, for the construction of wooden conductors for bringing the water a distance of about 900 feet from the small stream. As this work would be available for several years to come, a proper allowance made for it would leave a profit in the year's labour of about 680 dols. It thus appears that from an acre of the gravel, with an average thickness of two feet, there were taken 4,323 dols. of gold; while the expenses of labour, after deducting, as above, all which was not directly employed in extracting gold, were 2,957 dols., leaving a profit of 1,366 dols. The fineness of the gold dust of this region was 871 thousandths; another sample in thin scales gave 892, and masses 864. A small nugget of gold from St. Francis gave 867 thousandths, the remainder in all cases being silver."

"Although the greater part of this gold was extracted from the gravel on the flats by the river side, a portion was obtained by washing the material taken from the banks above. As has been before remarked, the distribution of the gold-bearing gravel over the surface of the country took place before the formation of the present water-courses, and the reason why the gravel from the beds of these are richer in gold than that which forms their banks, is, that these rapid streams have subjected the earth to a partial washing, carrying away the lighter materials, and leaving the gold behind with the heavier matters. According to Mr. Blake, it is found in California, that the gold in the diluvial deposits, which have not been subsequently disturbed by the streams, is not uniformly distributed, but is accumulated here and there in quantities greater than in other places. It would seem that during the first deposition of the earth and gravel, the precious metal became in some parts accumulated in depressions of the surface rock, constituting what are called pockets by the miners. It would appear from the facts here given that the quantity of gold in the valley of the Chaudière is such as would be remunerative to skilled labour, and should encourage the outlay of capital. There is no reason for supposing that the proportion of the precious metal to be found along the St. Francis, the Etchemin, and their various tributaries, is less considerable than that of the Chaudière."

"What is called the hydraulic method of washing deposits of auriferous gravel is adopted on a great scale in California, and to some extent in the states of Georgia and North Carolina. In this method, the force of a jet of water, with great pressure, is made available, both for excavating and washing the auriferous earth. The water, issuing in a continuous stream, with great force, from a large hose-pipe, like that of a fire-engine, is directed against the base of a bank of earth and gravel, and tears it away. The bank is rapidly undermined, the gravel is loosened, violently rolled together, and cleansed from any adhering particles of gold ; while the fine sand and clay are carried off by the water. In this manner hundreds of tons of earth and gravel may be removed, and all the gold which they contain liberated and secured, with greater ease and expedition than ten tons could be excavated and washed in the old way. All the earth and gravel of a deposit is moved, washed, and carried off through long sluices, by the water, leaving the gold behind. Square acres of earth on the hill sides may thus be swept away into the hollows, without the aid of a pick or a shovel in excavation. Water performs all the labour, moving and washing the earth, in one operation ; while in excavating by hand, the two processes are of necessity entirely distinct. The value of this method, and the yield of gold by it, as compared with the older one, can hardly be estimated. The water acts constantly, with uniform effect, and can be brought to bear upon almost any point, where it would be difficult for men to work. It is especially effective in a region covered by trees, where the tangled roots would greatly retard the labour of workmen. In such places, the stream of water washes out the earth from below, and tree after tree falls before the current, any gold which may have adhered to the roots being washed away. With a pressure of sixty feet, and a pipe of from one and a half to two inches aperture, over a thousand bushels of earth can be washed out from a bank in a day. Earth which contains only one twenty-fifth part of a grain of gold, equal to one-fifth of a cent in value to the bushel, which will pay the expense of washing in the old way, gives enormous profits by the new process. To wash successfully in this way requires a plentiful supply of water, at an elevation of from fifty to ninety feet above the bed-rock, and a rapid slope or descent from the base of the bank of earth to be washed, so that the waste water will run off through the sluices, bearing with it gravel, sand, and the suspended clay."

The above description and the added details are copied from a report on the gold mines of Georgia, by Mr. William P. Blake, who has carefully studied this method of mining in California, and by whose recommendation it has been introduced into the Southern States. He states that in the case of a deposit in North Carolina, where ten men were required, for thirty-five days, to dig the earth with pick and shovel and wash it in sluices, two men, with a single jet of water, would accomplish the same work in a week. The great economy of this method is manifest from the fact that many old deposits in the river beds, the gravel of which had been already washed by hand, have been again washed with profit by the hydraulic process. He tells us that in California the whole art of working the diluvial gold deposits was revolutionised by this new method. The auriferous earth, lying on hills, and at some distance above the level of the water-courses, would, in the ordinary methods, be excavated by hand and brought to the water ; but by the present system, the water is brought by aqueducts to the gold deposits, and whole square miles, which were before inaccessible, have yielded up their precious metal. It sometimes happens, from the irregular distribution of the gold in the diluvium in California, that the upper portions of a deposit do not contain gold enough to be washed by the ordinary methods; and would thus have to be removed, at a considerable expense, in order to reach the higher portions below. By the hydraulic method, however, the cost of cutting away and excavating is so trifling, that there is scarcely any bank of earth which will not pay the expense of washing down in order to reach the richer deposits of gold beneath.

The aqueducts or canals for the mining districts of California are seldom constructed by the gold workers themselves, but by capitalists, who rent the water to the miners. The cost of one of these canals, carrying the waters of a branch of the Yuba River to Nevada County, was estimated at a million of dollars; and another one, thirty miles in length, running to the same district, cost 500,000 dols. The assessed value of these various canals in 1857 was stated to be over four millions of dollars, of which value one-half was in the single county of Eldorado. The Bear River and Auburn Canal is sixty miles in length, three feet deep and four feet wide at the top, and cost in all 1,600,000 dols.; notwithstanding which, the water-rents were so great that it is stated to have paid a yearly dividend of twenty per cent., while other similar canals paid from three, to five and six per cent., and even more, monthly. The price of the water was fixed at so much the inch, for each day of eight or ten hours. The price was at first about three dollars, but by competition has now been greatly reduced.

From these statements, it will be seen that the great riches which have of late years been drawn from the gold mines of California, have not been obtained without the expenditure of large amounts of money and engineering skill. This last is especially exhibited in the construction of these great canals, and the application of the hydraulic method to the washing of auriferous deposits, which were unavailable by the ordinary modes of working, on account of their distance from the water-courses, or by reason of the small quantity of gold which they contain.

In order to judge of the applicability of this method of washing to our own auriferous deposits, a simple calculation based upon the experiments at the Rivière du Loup will be of use. It has been shown that the washing of the ground over an area of one acre, and with an average depth of two feet, equal to 87,120 cubic feet, gave, in round numbers, about 5,000 pennyweights of gold, or one and thirty-eight hundredths grains to the cubic foot; which is equal to one and three-quarters grains of gold to the bushel. Now, according to Mr. Blake, earth containing one forty-fourth part of this amount, or one twenty-fifth of a grain of gold, can be profitably washed by the hydraulic method, while the labour of two men, with a proper jet of water, suffices to wash one thousand bushels in a day, which in a deposit like that of Rivière du Loup would contain about seventy-three pennyweights of gold. It is probable, however, that a certain portion of the finer gold dust, which is collected in the ordinary process, would be lost in working on the larger scale. It has already been shown that the gold is not confined to the gravel of the river channels, and the alluvial flats. The beds of interstratified clay, sand, and gravel, which occur on the banks of the Metgermet, were found to contain gold throughout their whole thickness of fifty feet, and even though its proportion were to be many times less than in the gravel of the Rivière du Loup, these thick deposits, which extend over great areas, might be profitably worked by the hydraulic method. The fall in most of the tributaries of the Chaudière and of the St. Francis, throughout the auriferous region, is such that it will not be difficult to secure a supply of water with a sufficient head, without a very great expenditure in the construction of canals ; and it may reasonably be expected that before long the deposits of gold-bearing earth, which are so widely spread over South-Eastern Canada, will be made economically available.

PROPERTIES AND USES OF GUN-COTTON.

BY W. PROCTER, M.D.

Gun-cotton, since the time of its discovery, has been regarded as a substance of great interest, both on account of the singular properties it presents to the chemist, and for its numerous useful applications under the form of collodion. But lately it has assumed new and greater importance in another direction, consisting in the probability that its substitution for gunpowder, which was attempted unsuccessfully, shortly after its discovery, and failed, will now be carried into operation, arising from improved processes of manufacture, and the results of experiments which have shown that the slow or rapid combustion of gun-cotton depends on its mechanical arrangement and condition.

Gun-cotton is a modification of lignin, the basis of vegetable fibre, by which a new element, nitrogen, is introduced into its composition. In 1815 Braconnot gave an account of an explosive compound obtained by the action of nitric acid on starch, and to which he gave the name of "xyloidin." In 1838 Pelouze observed that nitric acid produced a similar change in paper, and in 1846 Schonbein announced that he had discovered a new explosive compound which he believed would prove a substitute for gunpowder, and was the result of the action of a mixture of nitric and sulphuric acids upon cotton. This announcement and a demonstration of the properties of gun-cotton attracted very general attention, and, in England, experiments were made upon it by Teschemacher, Taylor, Gladstone, and others, with a view to its utilization as a substitute for gunpowder. Messrs. Hall, of Faversham, commenced its manufacture upon a considerable scale; but their works had not been long in operation before an explosion, attended with loss of life, took place, which put a stop to further proceedings, until Hadow, in 1854, elaborately investigated the subject; and to him is due the credit of having first given us correct notions of the mode of formation and composition of gun-cotton.

In France, likewise, the matter occupied much attention; and during the winter of 1846 gun-cotton was made the subject of numerous experiments, and its manufacture established at the Government powder works at Bouchet, near Paris. The results of the trials, made under the direction of Piobert, Morier, &c., showed that to produce equal effects from gunpowder to those which were the result of a given weight of gun-cotton, it was necessary to employ a double quantity of sporting powder, three times the weight of musket powder, and four times the weight of cannon powder. These promising experiments were, however, put an end to, at that time, by disastrous explosions, one taking place in 1847 and two in 1848.

In Austria the experiments were unfavourably reported upon by the German Commission, but, fortunately for the future of gun-cotton, one of its members, Baron von Lenk, devoted himself to the study of it, so that in 1852 the Austrian Government were induced to reconsider their previous decision. A manufactory was established near Vienna, and extensive trials were made of it in gunnery. The results attained at that time for such purpose were not so satisfactory as the employment of the material for mining and similar operations, although forty batteries of a peculiarly constructed gun were used. But in 1862 the further progress of the investigations were arrested by an explosion at Lichening. Another Austrian committee, however, gave so favourable a report upon gun-cotton, that the disfavour into which it had fallen was removed. Early in 1862, the Austrian Government communicated full details respecting the manufacture and mode of applying gun-cotton to the British Government. At the meeting of the British Association in the autumn of that year, General Sabine directed the attention of that body to this subject, and the result was, the appointment of a committee to report upon the mechanics and chemistry of gun-cotton. This committee, composed of the most eminent chemists and engineers, presented their report to the Association at Newcastle in 1863, which contains the information communicated by Baron von Lenk as well as the results of the researches of Mr. Abel. Subsequently a committee of investigation was appointed by the Secretary at War, composed of scientific, military, and naval men, fully to investigate the properties of Lenk's gun-cotton in relation to its application in military, engineering, and industrial purposes.

Such, then, is the history of gun-cotton up to the present time; and it is proposed to devote the remainder of this paper to a brief consideration of Lenk's method of preparation, and the results which have thus far been arrived at, chiefly in Austria, regarding its application for military and mining purposes.

Hadow showed that by the action of nitro-sulphuric acid on cotton, several distinct compounds could be obtained. In proper gun-cotton three equivalents of hyponitric acid should be substituted for three equivalents of hydrogen of the cotton, but it often happened that from one to six or more atoms were replaced and substituted, giving rise to substances of varying composition, and less stable and, therefore, more liable to undergo change or even spontaneous decomposition. This, it was shown, depended upon inattention to certain parts of the process, such as relative proportions of the acids, their strength and their temperature at the time that the cotton was immersed, the time it remained in contact with the acids, as well as imperfect subsequent washing. The process of Baron von Lenk is founded upon the strictest attention to these minutiæ ; and although, in principle, his process is identical with that of Schonbein, in detail it is essentially different, and produces an uniform gun-cotton, whilst the result of the latter was frequently variable in composition and properties. Without entering into minute detail, the Austrian plan of preparation is of this kind :—The first object is to purify the cotton as far as can be, and for this purpose, in whatever form used, it is boiled with potash, carefully washed, and dried. A mixture of one part (by weight) of nitric acid, pure and strong, and three of sulphuric acid is then made ; when this mixture is cold, the jars containing it are put into cold water, and the cotton immersed in the acids for *forty-eight hours* ; it is then taken out, and, after draining away the acid, is dried in a centrifugal machine. It is then moved about in water and washed until all acidity is removed, put into frames and placed in a stream of water for *two or three weeks*, again treated with an alkali, and again immersed in the stream for several days ; on removal it is dried at a temperature below 212°. Von Lenk finishes the preparation by steeping the gun-cotton in a solution of silicate of potash ; this, by the majority of English chemists, is considered needless.

The properties of this gun-cotton are, that it does not differ in appearance from ordinary cotton; in moist situations it absorbs six or seven per cent. of water, but in a dry situation it parts with all, except two per cent., which is normal ; and it may be preserved for any length of time in a moist state, but dried possesses, without deterioration, the usual properties. Gun-cotton ignites at about 300° F., burning with a bright flash and large body of flame, with no smoke, and leaving no residue, differing in these respects widely from gunpowder, which demands a temperature between 500° and 600° for ignition.

Many attempts have been made at various times to diminish the rapidity of the burning of gun-cotton ; and the credit of overcoming this difficulty is due to Baron von Lenk, who, by a simple mechanical arrangement, can make it either a powerful explosive agent or a simple, harmless flame. In the form of loose cotton the mode of ignition has been mentioned. In the form of spun thread, like that of candle-wick, gun-cotton burns slowly, at the rate of six inches per second. If the cotton is in the form of a hollow cone, as the wick of a moderator lamp, it shows a greater amount of explosive power, and burns at the rate of six feet per second ; and inclosed in an india-rubber casing, twenty to thirty feet are consumed in a second. So that the modifications in the degree of explosive force of gun-cotton essential to its application as a substitute for gunpowder, are effected simply by altering the mechanical conditions of the material. Thus, for cannon cartridges, where it is desirable to obtain a gradual action, coarse gun-cotton yarn is wound firmly round a cylinder of wood of such a size that it fills a space allotted to the charge of the gun ; whilst small-arm cartridges are made of cylindrical plaits of fine yarn fitted compactly, one over the other, on a small spindle of wood, or else it is enclosed in a stout paper tube, to prevent it being rammed down.

On the other hand, in charges for shells, where the greatest disruptive effects are needed, the cotton is used in a condensed form, as plaits ; for quick-matches, a similar mechanical arrangement is adopted : so that, to effect its object, gun-cotton requires room, and, in relation to gunpowder, it needs as much space as one-third or one-fourth the quantity of that explosive material. In mining, gun-cotton is required to produce the most destructive effects, and for this purpose finely-twisted cotton ropes with hollow cores are used, which, for military purposes, are enclosed in cases of sheet metal. Mr. Scott Russell remarks that, to make gun-cotton formidable and destructive, squeeze it and close it up ; to make it gentle, slow, and manageable, you must give it room.

In considering the properties which gun-cotton possesses in relation to those of gunpowder, they will be best considered under several heads.

First, then, as to power or a force to propel a projectile. A charge of gun-cotton weighing 16 ozs. projected a 12 lb. solid shot with a velocity of 1,426 feet per second ; whilst 49 ozs. of gunpowder gave a similar shot a speed of 1,400 feet per second. The Austrian experiments furnish some curious results in this direction ; they show that, as the gun is shortened, an increased charge of gun-cotton is required, yet the effect of the normal powder gun (previously mentioned) may be attained by a tube shortened from 13½ to 9 calibres, therefore lighter guns may be used with this agent. If the disruptive effects of the two are compared in this respect, gun-cotton is six times more powerful than gunpowder—1 lb. of the latter can detach 10 tons, the same quantity of the former can detach 60 tons, of rock—and by putting in the charge loose or compact its action admits of a nice regulation and control. Another great advantage of gun-cotton is, that the explosion is unattended by smoke, which not only renders the atmosphere impure, but, by producing obscurity, delays work both in gunnery as well as in driving tunnels, &c. In boring the great tunnel in Mount Cenis, Mr. Russell says that the delay caused by the smoke of the powder, &c., will alone delay the opening of the line for many months. The advantage of this freedom from smoke in the casemates of fortresses and under the decks of men-of-war during firing is obvious. Trials were made in the fortress of Comara in casemates, the ventilation being intentionally obviated. After fifteen rounds with gunpowder cartridge, the further sighting of the gun was impossible, and on account of the injurious effect on the men, it was necessary to stop firing after fifty rounds in eighty minutes. But when gun-cotton was used under similar conditions, after fifty rounds the men serving the gun felt no inconvenience, and the aim was visible. This property of gun-cotton, coupled with the fact of less recoil as well as less heating of the gun, enables a more continuous and rapid fire to be carried on. One hundred rounds were fired from a six-pounder in thirty-four minutes, and was raised by gun-cotton cartridges to a temperature of 90° ; whilst 100 rounds of gunpowder in 100 minutes raised the temperature considerably above 212°, and the firing with gun-cotton was continued to 180 rounds without inconvenience. There is likewise another important advantage attending the use of gun-cotton in artillery, especially in the case of breech-loaders. The results of its decomposition are gaseous, with no solid residue, so that the gun in which it is fired is left clean, without any "fouling ;" and it is also now known that, exploded under pressure, as in cannon, no nitrous acid is produced. From these circumstances Mr. Scott Russell seems disposed to consider the action of the gun-cotton cartridge is, as a propulsive agent, analogous to the steam-gun ; that it is entirely resolved into highly-heated steam and gases, whilst a considerable portion of the force produced by the decomposition of gunpowder into gases is expended in the removal of the solid residue, amounting to 68 per cent. The most important question with respect to gun-cotton is, whether it is stable, or, in other words, will it keep or does it undergo change or spontaneous decomposition at ordinary or elevated temperatures ? Mr. Abel brought this subject forward at the last meeting of the British Association at Bath ; and after considerable experience deduced, from a numerous series of experiments, that Lenk's gun-cotton was at ordinary temperatures stable, and thus differed from the opposite opinion which had been arrived at by the French chemists.* Gun-cotton is decomposed at a temperature from 120° to 212° F., and even at 90° occasionally acid fumes are evolved ; but the change in its constitution which takes place from 90° to 130° is so very slight, that it does not practically affect its value, and is considered to be due to the action of the acids on various foreign bodies existing in the cotton operated

* These experiments will be found detailed in the current volume of the 'Chemical News.'

on, and which, in spite of every care, cannot be removed. Light has some decomposing effect upon it, but it has been kept unaltered for fifteen years. The unchangeability of gun-cotton is a very grave matter, and will be fully settled before it is generally employed; for there is no doubt that if, by decomposition, acidity can be generated, it will be fatal to its employment.

If the danger of the manufacture is compared with that of gunpowder, gun-cotton has the greatest advantage. All the operations adopted in the manufacture of the latter substance are perfectly harmless, and contrary to what happens with gunpowder. In every stage, except the last one, the cotton is wet or damp, and therefore not explosive, and the drying is effected in a chamber kept at the required temperature by means of hot air, and is from thence conveyed either to storage houses or prepared for use. At Hirtenberg, where large quantities are annually made and stored up, no explosion has occurred after an experience of twelve years—a strong proof of the indisposition of gun-cotton to explode spontaneously. There have been, it is true, two or three explosions on the Continent, but they were traceable to obvious causes, such as neglect of proper precautions in the drying or spinning apparatus; and it is a pregnant fact that, in a very large proportion of the other cases of explosions, both gunpowder and gun-cotton were stored in the same building.

We have thus endeavoured to give a summary in a brief manner of the present state of the question, and it will be readily admitted that the researches of Baron von Lenk, resulting in the production of a uniform and stable gun-cotton, places the matter in a very different position to that in which it stood previous to his investigations. Judging from the reports of English and foreign chemists, mechanists, and military and naval officers, there is every reason to believe that gun-cotton will prove a powerful rival to gunpowder for every purpose for which that compound is used. In this country we believe that, as yet, it has not been tested practically to any very great extent, although General Hay speaks well of the exploits of gun-cotton as a rifle-cartridge. It has become an article of commerce, being largely manufactured by Messrs. Prentis, of Stowmarket, for sale, and has met with a most favourable reception for mining and engineering purposes, being more safe, manageable, and powerful than gunpowder.

York.

FURS AND THEIR PREPARATIONS.

BY DR. PARMELEE.*

IN the prepared state the skins are called fur; but without preparation they go by the common name of peltry.

In Russia, Poland, East Prussia, Hungary, Bohemia, and Saxony, lamb-skins constitute an essential part of the dress of thousands among the lower classes, and the skins of various other animals may be considered as articles of absolute necessity.

So early as the sixth century the skins of sable formed an article of fashionable attire at Rome, and were brought from the confines of the Arctic Ocean, at great cost, to supply the demand of that wealthy capital.

The traders of Italy brought a considerable supply of fur to England in the time of George III.; so much so, that this monarch prohibited their use except among the wealthy classes.

The Canadian fur trade was commenced by the French, soon after their settlement on the St. Lawrence. The company formed in London, and called the Hudson's Bay Company, was chartered by Charles II., in 1670. This prosperous company founded many establishments, and carried on its trade for more than a century, when it met with a powerful competitor in the form of a new company composed of wealthy and influential British settlers in Canada. This second company was called the North-West Company, and its chief establishment was at Montreal, though trading upward of 4,000 miles further to the north-west. After long duration the two companies united into one, under the name of the Hudson's Bay Fur Company.

The Indian trade of the great lakes, Upper Mississippi, &c., was enjoyed by the North American Fur Company, having its chief establishment at New York. Important as is the trade of these companies, yet the most costly and highly-esteemed furs are furnished by the trade carried on by Russia. The ermine is one of these, a fur which is produced in many countries, but only in perfection in Russia, Sweden, and Norway.

The colder the climate the finer and warmer is the fur of animals. The finest furs are therefore brought from the colder regions.

The effect of cold on the Hudson's Bay lemming was made the subject of an experiment during Ross's voyage. The little creature was kept in a warm cabin during several months. It retained its summer fur. It was then exposed on deck, at night, to a temperature of 30° below zero. After one night's exposure the fur on the cheeks, and a patch on each shoulder, had become perfectly white. On the second day those patches had extended, and the posterior part of the

* A paper read at the Polytechnic Association of the American Institute.

body and flanks had turned to a dirty white. During the next four days the changes continued, and at the end of a week the animal was entirely white. On examining the skin it was found that all the white parts of the fur were longer than the unchanged portion, and that ends of the fur only were white so long as they exceeded in length the dark-coloured fur. By removing these white tips with a pair of scissors the original dark summer dress appeared.

The fur of the ermine ranks first in value; and the older animals furnish the best. These little animals are caught in snares and traps, or by shooting with blunt arrows. The skins are sold in lots of 40, called "the timber."

Next in value are Russian sables. The length of the animal is from 18 to 20 inches. The darkest in colour are considered the most valuable. The produce of Russia in these skins is about 25,000 annually.

A great quantity of mink skins are sold to the inexperienced as real Russian sables.

There is also an inferior sable, called the Kolinski or Tartar sable, procured from Russia. This fur when dyed is sold among inferior sable.

Next to the sable in rarity and cost comes the fur of the silver fox, which is a native of the country below the falls of the Columbian River, in Washington and Oregon Territories.

The softest and most delicate fur is that of a little animal called the chinchilla, about the size of a small squirrel, which inhabits Peru and the northern parts of Chili.

The sea otter has a very fine, close, soft fur; jet black in winter, with a silken gloss. That of the young animal is a beautiful brown.

The Persian lamb-skins have a soft, compact, and elastic wool, which is formed naturally into elegant curls or waves. When killed immediately after birth, or taken from the mother, they are still more beautiful and expensive. These skins have been considerably used in Europe, but not yet in this country. A few have been very recently imported. The most prized of these skins are the fine black.

The sloth has a beautiful fur of a high lustre.

Mr. Lusac, of New York, an elderly and intelligent merchant in furs, informs us that the Germans excel all others in dressing and manufacturing furs, in a general degree. But furs, he adds, are put up in New York which are not excelled by any in Europe.

The Chinese possess arts connected with the dyeing of furs, as well as in the preparation of skins, which would command a large price if they could be transferred to European or American artisans.

The dyeing of furs may be considered the most difficult part of their preparation. It requires the most careful and skilful manipulation. Mr. Aphold, of London, has gained much repute for his skill in dyeing brown, which is a difficult shade to attain.

Otter fur has been dyed in New York better than in Europe. Musk-rat is dyed to imitate mink ; also to imitate the German fitch. Opossum is likewise thus dyed. Sable fur is frequently dyed to improve its shade.

The furs of the gray fox and of the wolf are difficult to dye.

An objection to the fur of the Norwegian and Lapland dog is a peculiar odour that always attends it.

The skins of hares and rabbits are used, in common with beaver and many other skins, for felting purposes. And this branch of the manufacture of furs is a very interesting one.

The introduction of silk plush for hats, as a substitute for beaver, has brought about some curious changes in the fur market; for example, in 1827, 1828, and 1829 mink skins were worth in New York from 37 cents to 40 cents each. Now these skins are worth from 8 dols. to 9 dols. Musk-rat skins were then worth 50 cents each and are now worth about the same.

The first process in dressing furs for use belongs to the hunter, who, on capturing the animal, strips off the skin and hangs it up to dry in the open air without fire. If it is well dried, and carefully packed, it reaches its destination, however distant, in good condition ; but, if any moisture be left, or, if it be packed with others imperfectly dried, so that the slightest putrefaction takes place, then it is unfit for use, so far as the furrier is concerned. A minute examination of the skin is, therefore, his first business. The next step is to cleanse them from greasiness. This is accomplished by the use of water, bran, alum, and salt.

This process is not, however, employed by any practical workman ; farmers and Indians use it when they do not understand any other. A man cannot put what is called a "leather" on a skin by the use of salt and alum ; for when it is damp weather the fur will be soft, and in dry weather it will be hard and stiff.

A kind of oil which is found in the fur itself is not wholly removed by the first treatment, so that it is necessary to afterwards wash it with a solution of soda and soap. Finally, the skin is well washed in clean water and dried; the previous treatment having converted the skin into a kind of leather.

The process that has been used these last thirty years, both in Germany and England, is as follows.:—

When the furs come from the hunter, in the raw state, to the furriers, they are sorted over and then prepared for tanning; the term used is "leathering." They are greased with common grease, on the fleshy side, and then put into a tub large enough for a man to get into and work easily at them. A cloth is then bound around the man's waist, so as to keep the steam in the tub, and the skins are worked by the feet until warm, which takes an hour or more ; they are afterward taken out and greased again ; when the skin and grease are worked again a few handfuls of mahogany sawdust are thrown in and worked to leather.

When the skins are leathered they are taken out and pulled through a rope; they are then pickled over-night in water and sawdust, and in the morning are ready for the flesher. When fleshed they are hung up to dry, then greased again, and leathered once more; they are then taken out and the fur combed, well beaten and drawn over the knife, or "pared" as we call it. The skins are again put into the tub, with plenty of fresh, clean sawdust, and worked into the sawdust until the fur is perfectly freed from grease. It may be necessary to change it two or three times. The fur is then taken out and well beaten and corned, and it is then ready for the cutter. This is the way all fine furs are dressed, from the musk-rat to the Russian sable. Buffalo and bear skins are dressed in a somewhat different style, but still under the same general processes.

The cutting up of the skins requires much judgment to avoid waste. The refuse cuttings if not cut to waste are available for making articles of the less costly description. And it has been remarked that many a lady on having her furs fresh lined under her own superintendence, has viewed with surprise approaching to dismay the elaborate patchwork which the skins present on their inner side.

Skins to be used in felting undergo a longer treatment. And by means of ingenious machines the fur and hair is not only separated from the skin, but the hairs are separated from the fur; and even the fur itself is assorted into quantities of like specific gravity.

The use of fur in an economical and sanitary point of view is a subject on which there would probably be a great diversity of opinion. It is remarkable that in some countries the custom regarding clothing differs materially from ours. We dress warmer when we go out than when we sit in the house; the Turks, who seldom have fires in their apartments, use warmer clothing than when they go out, considering the exercise of moving about as a source of warmth. The Chinese are said to practise the same custom.

A very large business is carried on in several parts of this country with sheep-skins in manufacturing leather called "linings." The skins are not subjected to solutions such as oak and hemlock bark, sumach, or catechu, which contain tannin, but are converted into leather with solutions of alum and salt. Most of these skins are dyed red, bronze, marone, purple, and other colours. A very difficult process in their treatment is the separating of the wool from the membranous tissues. It has to be pulled off, and this cannot be effected without treating the skin in such a manner as to cause the hairs to become loose at the roots. To effect this without injuring the wool and the skin has been a desideratum. After sprinkling some dry slaked lime in the inside of a skin, then folding it up and allowing it thus to remain for several hours, the wool can be pulled somewhat freely. This is a mode very generally pursued; but the skins have to be carefully watched, especially in warm weather, or they may be injured by the action of the lime. A great improvement over this mode has been practised for several years by many morocco-dressers. It consists in smearing the fleshy side of the skin with milk of lime, containing some orpiment or sulphuret of arsenic. As the orpiment is a poisonous substance, a suitable and innocuous substitute for it has been a desirable object. This has been obtained by a mixture of three parts of polysulphuret of sodium, ten parts of slaked lime, and ten parts of starch. The easy removal of the wool (the same effect is produced on kid and calf-skins) has been found to be due to sulphuret of calcium. The mixture is made up into a paste, and applied to the fleshy side of the skins, and after being subjected to its action over-night, in a morocco factory, they are fit for pulling. After this they are placed in a weak solution of vitriol, to remove the lime. Our morocco manufacturers will find this mode to be a great improvement over the old methods of treating sheep-skins for the removal of the wool.

PAST AND PRESENT STATE OF THE SILK INDUSTRY OF BALE.

BY MR. BURNLEY,

HER MAJESTY'S SECRETARY OF LEGATION.

In the course of a visit during the past summer to Bâle and Zurich, for the purpose of getting some information from the manufacturers themselves relative to the prospects of the trade, I made the acquaintance of Professor Kinkelin, of the University of Bâle, who was good enough to confide to me some manuscript notes relative to the silk industry of his canton, which contain a good deal of matter, both present and historical, of considerable interest. From these notes I have extracted what seemed to me useful to record, adding thereto some short remarks relative to the educational establishments bearing more particularly upon the manufacturing classes, and the unions and societies which have any connection with the subject. It can hardly be denied that great efforts are made in all the cantons to raise the young Swiss to a certain standard, fitting them to follow the peculiar path they may have chosen, and no canton possesses so many various incitements for a young man to improve himself, no matter what his social position may be, as Bâle. Swiss political life presents but few attractions to the wealthier classes; the consequence is that by far the greater number devote themselves to manufacturing industry, which renders a more grateful and remunerative return.

Professor Kinkelin observes that silk ribbons were in former times woven by the gold and silver lace-makers on small one-shuttle weaving looms, and the shuttles were thrown by hand. Silk ribbons were then not very extensively used, wool and linen being worn for the most part, and these stuffs, like all the stuffs of that period, were of a substantial texture. The lace-makers, like the other artisans, then formed a particular guild, having their own laws, regulations, and customs. No one could become a master before he had gone through an apprenticeship of several years, and had been abroad as a working journeyman for at least the legal term of three years. In the second half of the seventeenth century, a considerable change took place in this manufacture. It was about the time when in France the power-looms, then called ribbon-mills ("bändelmühlen"), were invented and worked with great success. In these new looms, where the shuttle was set in motion by mechanical means, several ribbons could be woven simultaneously. With the increasing use of these machines, which economised the cost very considerably to the manufacturer, the dearer products of the hand-looms had, of course, to give way. Ribbon-mills, therefore, met with strong opposition on the part of the lace-makers everywhere; in several places—in Cologne, for instance—they were burnt by the hangman as the work of the devil. They nevertheless kept their ground, and several ribbon-weavers of Bâle began to buy ribbons woven upon such mills, and to trade with them. They were, therefore, as far back as 1659, ranked among the merchants' guild. Observing the success of the French manufactories, several merchants attempted to procure such machines, and to carry on themselves the manufacture of the ribbons without restraint on the part of the guilds. These were the Bassier, Weiss, De Lachenals, Fatios, Iselins, Hofmanns.

The lace-makers, who in 1670 worked 359 shuttles, saw in all this the ruin of their trade, opposed it, and induced the Government of the day to prohibit such machines, leaving them the monopoly of the ribbon manufacture. This took place by a decree of the City Council of 26th February, 1681, which ran as follows:—"The High and Honourable Council decrees the prohibition of the new ribbon-mills in this city." In the next meeting of the Council, however, it was decided not to put this order into execution, but to await the report of the thirteen aldermen. These thirteen aldermen, the most prominent members of the community, were a committee formed for deliberating beforehand on the most important affairs of the state before they were handed over to the executive. As the matter was a delicate one, there being already no inconsiderable number of ribbon-mills in Bâle, and as it could not be foreseen that, although by their abolition the lace-makers would be protected (not, however, without inflicting great injury on the general weal—the machines abroad, particularly in France, being tolerated), the thirteen aldermen delivered their opinion in this sense only ten years later. The ribbon-mills were accordingly officially allowed in 1691, under certain conditions—namely, on the payment of a tax of $\frac{1}{4}$ per cent.

of the pecuniary value of the material worked up by a mill in the course of the year.

Notwithstanding that the ribbon-mills were at last allowed, the quarrel still continued between the lace-makers and the ribbon-makers, particularly with regard to the sort of ribbon which both parties were entitled to manufacture, the fairs they were allowed to frequent, &c. A difference arose among the manufacturers themselves, which lasted very long; the same with the lace-makers. Such disputes were mostly settled by the Government, by amicable interposition. They were not able to prejudice the rapid progress of the ribbon manufacture, in spite of the prohibition by the Germanic Empire of the import of Bâle ribbons, which induced the Government in 1725 to send an envoy to the Diet at Augsburg, who succeeded in procuring the removal of the prohibition. This branch of trade suffered more severely in a moral point of view in the middle of the late century by the numerous thefts committed by the operatives on the silk entrusted to them, and which obliged the Government to take more stringent measures. In February, 1738, they appointed a committee of six, and issued a severe decree against this abuse. In July of the same year a second decree was issued, directed rather indirectly against it. Therein it was ordered—first, that all the manufacturers should inscribe themselves on the books of the committee, and that the non-inscribed should be forbidden to manufacture; secondly, that the manufacturers should pay the wages of their operatives as fixed by the Government, in full, and that they should make no deductions whatever under any pretence; thirdly, no operatives were to be allowed to work cheaper, either for a native or a foreign manufacturer; fourthly, no operative could work at another manufacturer's, unless he produced a regular permit or discharge from his former employer. In the same year it was fixed how many ells each sort of ribbon should contain per piece. An occurrence which took place at this time is worth mentioning, as it throws a strong light on the state of affairs at that period. A Bâle ribbon manufacturer, Hans Henrich Hummel, asked the Government to give him the Hospital-mead near the Steinenthor, together with the waterworks, in fee simple, against an annual ground rent of twenty-four batzen (a trifle more than three francs), for the water privilege, and an annual rent of 1½ per cent. of the purchase-money to be fixed by the Government; he offered to build a manufactory on the spot at a cost of 600 florins, to work his looms by water-power, and manufacture lace-ribbons, and to employ orphan children for throwing the silk, as well as board, lodge, and clothe them. His request was refused and declared impracticable by the Government. In consequence, Hummel tried to remove his industry to another place; he determined to emigrate to Paris, to take his looms with him, and to induce lace-makers to emigrate. He himself and several of his people travelled about in the canton, promising to give high wages and to pay travelling expenses. The Government and the other manufacturers endeavoured to prevent this, pursued him by the police, declared his right of citizenship to be forfeited, and ordered his property to be attached. Nevertheless, Hummel succeeded in establishing himself in Paris, with several looms and operatives. What became of him afterwards seems unknown.

From 1750 the manufacture of ribbon increased considerably, and the Government bestowed upon it its greatest care and attention ; new enactments were framed, regulating the length of the pieces and the rate of wages. In February, 1764, it was decreed :—

1. The cabinet and loom-makers shall manufacture no looms, except for citizens of this place. The sale of looms to country people and to foreigners is strictly prohibited.

2. Looms can only be transported from one place to another on the production of a certificate given by a manufacturer, and that only on Bâle territory.

3. It is forbidden to keep foreign workmen.

4. The operatives are enjoined to abide by their regulations.

5. Persons emigrating clandestinely forfeit their civil rights and property.

6. Any attempt to inveigle operatives involves a fine of fifty thalers.

In 1756, the importation of foreign looms into Bâle territory was totally forbidden, under penalty of their destruction. In contravention of this prohibition, eight ribbon-looms were sent from Mülhausen to Bâle in 1762 by Dollfuss, Father, and Co., for sale, which caused great annoyance. As the Mülhausen firm, however, only possessed this number of looms, and intended definitively to give up the manufacture of ribbons, the sale of them to manufacturers in Bâle was at last allowed.

A number of similar decrees, partly in favour of the munufacturers, and partly in favour of the operatives, were issued during that century. In times of distress, also, when the market was dull, the Government took energetic measures, as, for instance, in 1712, 1732, and 1770. On the 31st of December, 1788, an ordinance was issued relative to the establishment of a poor relief fund in favour of the lace-makers in the country, towards the maintenance of which one rappen (one centime) for every livre of wages for simple ferret ribbons had to be contributed, and two rappen for every other kind of ribbon. At a later period this fund was the cause of great annoyance. In 1798, the year of the French Revolution, it had increased to 90,000 livres, and was handed over to the representatives of the country. They found, however, the sum too small and demanded that the books of all the manufacturers should be examined. They stood the test in a most honourable manner, one account agreeing entirely with the other.

In consequence of the Revolution of 1798, the ancient customs and factory regulations were only partly or not all observed. The silk dyers, for instance, who until then were not allowed to keep more than ten hands, were, at the request of the manufacturers, released from this restriction. At the request of the latter, however, in 1811, the prescribed length of the pieces had again to be sworn to. In 1820 a table of the length of pieces was decreed, under a penalty of 4,000 Swiss francs old currency (5,710 francs new currency) in case of contravention. The little importance attributed to these renewed decrees may be seen from the fact that already, in 1823, the President of the Ribbon Manufacturers' Union in their name again petitioned the Government to prohibit the export of ribbon-looms and the employment of foreign workmen. This step, however, produced no result, and there was no question any more of a renewal of the old decrees, or even of the establishment of new ones. At the Peace of 1815 the ribbon manufacture assumed quite a new shape. The number of manufacturers increased, ribbon manufactories were established also in other cantons, and the number of looms increased in a still larger proportion.

The following are the data relative to the extension of the Bâle ribbon manufacture at different periods :—

According to official census, there were in the whole canton of Bâle 1,225 ribbon-looms, 219 of which belonged to operatives.

Thirty-two years later, in 1786, there were 2,246 ribbon-looms, 250 of which belonged to operatives.

According to a reckoning of Councillor Sarassin, in 1846, there were 3,550 ribbon-looms, 2,950 of which were in Bâle town, and 600 in Bâle country.

In 1863 there were about 7,250 in the cantons Bâle town and country, Argovy, and Soleure.

The number of ribbon manufacturers, who are at the same time inscribed as mercantile firms in the "Book of Firms" ("Razionenbuch"), was—

In 1760	20
1786	21
1811	19
1823	21
1863	38

while the number of manufacturers in general is stated—

In 1837	46
1860	78

Actual State of the Ribbon Manufacture.—From the preceding statement of Professor Kinkelin, it appears that the conditions of the ribbon manufacture in this city have entirely changed in the course of the present century. Whilst formerly a prudent government superintended the adjustment of the relations between employer and operative, the rate of wages, the length of the pieces, and the relations between the manufacturer and the dyer, there is now no question of such interference with the private rights of each citizen. It can no longer forbid the citizen to transact business and to manufacture at his own pleasure; it can no longer prescribe to him the number of operatives nor the amount of wages, but it leaves all this to himself, for every one is the best judge of what conduces most to his profit and to honourable dealing. At the same time, former governments ought not to be unjustly censured for measures which may be attributed to the interest of a few influential persons. The great object of the government of that day, when principles of free trade were not so well understood as at present, was to keep up the reputation of its merchandise and the good name of its manufacturer. We thus see that they took great care to preserve to Bâle the secrets of the ribbon industry ; to prohibit the export of ribbon-looms, because the Bâle looms were considered the best ; to prohibit the manufacture of new looms in the country and the removal of old looms from one place to another without especial formalities, and to prevent the emigration of the operatives. With the exception of four firms, foreign manufacturers were not permitted to have their work done in the canton. These were the firms of Hans Adam Senn at Zofingen (Argovy), Sachser at Schönenwerth (Soleure), Rothpletz in Aarau, and Jenny in Trubschachen (Berne), who owned, throughout the whole of the last century, neither more nor less than sixty-four ribbon-looms in this place. The operative worked upon his loom, which either was his own, or, for the most part, the manufacturer's property ; he was not permitted to change employer without the consent of the latter. If, however, the employer unjustly withheld his consent, he applied to the "Fabrik Commission." Larger localities where many operatives could find room for working in common were not to be found ; and, as in the case of Hummel, the Government had once refused such a request. The operative could, beside his ribbon-weaving, till his little piece of land, or get it tilled by his family, which was a support to him in hard times, and not to be under-estimated, irrespectively that it enables him to enjoy the ties of the family circle. The advantages of this system are very generally acknowledged abroad by philanthropists and political economists. It is true the quality and excellence of the work is perhaps not so high as it is where the "Hausbetrich" (the working at home, not in the factory) does not exist, but at the same time this disadvantage is counterbalanced by the greater cheapness of the merchandise, and by the healthy and independent spirit it engenders among the people. Of the 7,250 ribbon-looms, 5,000 are in the private dwellings of the operatives in the country or in town, and 2,000 only in manufactories, independently of the 250 looms upon which the ribbon patterns are woven under the eyes of the manufacturer. In the manufacture of silk the favourable circumstance exists that the localities destined for it must be light, airy, and dry, and must not contain any vapours injurious to the lungs, which deprive cotton operatives of life, strength, and health. A great progress has been made in the employment of mechanical power for the working of the looms, remunerative to the manufacturer from the greater cheapness of the work, and beneficial to the operative, as it protects him against too great and injurious fatigue. It was to preserve to his family life and health which induced the ingenious but poor Jacquard, of Lyons, to invent his celebrated machine which was burnt by his ungrateful fellow-citizens. At this place 6,000 looms are still worked by hand, about 500 by water-power, and 750 by steams. Another peculiarity of the Bâle industry which enables it to maintain its superiority as regards its principal rival at St. Etienne is, that the greater part of the looms belong to the manufacturer and not to the operative ; for the manufacturer has the means and more inclination for improving his loom, because it is for his own peculiar benefit. He is thereby enabled to keep the wages at a more uniform level, and, on the other hand, is less dependent upon the abilities of the operative. While at St. Etienne the rate of wages varies as it were with the rate of exchange, and the manufacturer has no stable foundation on which to fix the price of his article; the reverse is the case at Bâle. The wages remain very nearly constantly the same. During the last hundred years the number of looms has increased more than sixfold, the number of manufacturers hardly fourfold, so that at present a far greater number of looms fall to one mandfacturer than formerly, and hence they are better enabled to manage the scale of prices. The operative pays 2 per cent. of his wages for the use of the loom. Other security than "honesty and faith" are not required of him. The wages are as follows :—

	Fr. c.		Fr. c.	
Silk reeler	1 50	to	2 0	per day.
Warper	2 50	to	3 0	"
Lace-maker (weaver) . .	4 0	to	5 0	"

The majority of the operatives contribute monthly towards the sick relief fund, out of which they are supported daily in case of sickness, or else the hospital charges are paid. Few manufacturers have a private fund for this purpose ; several, however, give annual donations to the existing public funds, and frequently they are assisted by testamentary endowments.

One principal advantage of the Bâle ribbon manufacture consists in the perfection of the ribbon-looms. In fact, they have improved from year to year, particularly of late, so that already a considerable demand for them exists from abroad. There are several workshops of high reputation. Bâle possesses seven loom-mechanicians, occupying about 250 operatives ; eight loom-mechanicians (in the country), with about fifty operatives.

The annual number of new looms manufactured is about 500, 350 of which are destined for Switzerland, and 150 for abroad. The waste of old looms is made up annually by about 100 new ones. They represent a total value of about 700,000 francs ; the raw material of which may be estimated at 200,000 francs, leaving a profit of about 500,000 francs.

Dyeing has also made considerable progress, both as regards quantity and quality. Certain colours are nowhere to be found so fine as here. This particular branch seems destined to have a brilliant future ; for while formerly Bâle manufacturers had to send their silk to France to be dyed, the reputation of the Bâle dyers frequently induced the contrary to take place. The dyers are responsible to the manufacturers for the proper dyes, as well as for any spoiled or damaged goods, and that at the current price. The dyers' wages are from two francs to fifteen francs and upwards. With superfine colours a deduction up to 10 per cent. on the length of the ribbons is made for the higher dyeing price.

There are in Bâle eight dyeing establishments, the largest of which employs 300 hands.

In 1846 the total value of ribbon manufactured at Bâle amounted to at least 20,000,000 francs annually, somewhat less than half the product of the silk manufacturers of the whole of Switzerland, the export of which was estimated at about 46,000,000 francs. In the above 20,000,000 francs are included—for actual wages, 2,070,000 francs, 1,500,000 of which were paid in the canton of Bâle country, and 500,000 in Bâle town; for dyers' wages, exclusively to dyers of this place, 620,000 francs; for finishers ("appretur"), dressers and packers, salaries of employés, cost of management in general, 1,530,000 francs, or about 4,500,000 *in toto*, which are annually paid away on the spot. At present the total production may be about 35,000,000 francs.

With regard to the goods themselves, they may be classed into about one-third figured and two-thirds plain articles. In the same way as, 100 years ago, there was a transition from linen and woollen ribbons to silk ribbons, so within the last thirty-five years the figured (fancy) articles, which, at the beginning of this century, were almost unknown, were adopted. It was in the nature of things that, owing to the increased competition of the native and French manufactories, the plain articles would have to suffer the most, and that those articles would pay the best which left more play-room to the spirit of invention, taste, and activity. It was not, however, the prospects alone of a greater gain which occasioned the increase in the manufacture of figured silks, but with the decrease in the former the market of the latter increased enormously when Switzerland had learned to manufacture cheaply, as well as tastefully and beautifully. At the same time the great improvements in the ribbon, and in the adoption of the Jacquard machines, as well as in the introduction (for the first time at Bâle) of bars for several shuttles, promoted the manufacture of figured articles. As a proof of the progress of this industry it may be worth mentioning that several houses have succeeded, under equal conditions, in the manufacture of rich figured ribbons in such a way as not only to successfully cope with their French competitors, but even to secure a market at the focus of fashion and taste at Paris, at a disadvantage of from 5 to 7 per cent. which Bâle manufacturers have to pay as import duty into France. The principal articles of the Bâle ribbon industry are the beautiful courant ribbons; the quite rich ones are still left to the French manufacturers. With regard to patterns, the French manufacturers complain of being purloined by the

Bâlois, and demand of their Government a rigid protection for such patterns. But no official protection would be of any avail; the only result would be that the French Government would inevitably aim a blow at their own industry. The patterns which the Bâle people are accused of borrowing from the French are just as much their own property as that of the French. The Bâlois procure a great many of them direct from Paris, where they have their own designers, as well as the French manufacturers, and frequently the same persons work for both parties. Besides, the native designers are continually improving, and endeavouring to furnish even more beautiful and elegant patterns, notwithstanding their dependence upon the leading fashions at Paris.

Latterly great importance has been attached to the preparation of the raw material. The finest qualities of silk were procured and used by the French; this is one reason why they have maintained their superiority in the richest ribbon patterns. The Bâle industry has therefore to direct its particular attention to the manufacture of a fine article from the ordinary and fine sorts. This is effected by careful spinning and throwing. Whilst formerly they had no throwing establishments at all, several manufacturers now throw their own silk themselves. The advantage is thereby gained that this operation is done more skilfully and accurately than by the silk cultivators. They endeavour to purchase the cocoons themselves, and to spin them off by improved methods, which gives greater uniformity to the thread. The working up of the raw silk, the throwing and winding, is beginning to be executed on the most extensive scale, and by the most perfect machinery. A new branch of industry is thereby obtained, and an adequate return secured by the improvement of the raw material.

With regard to the sale of the staple, it is impossible to give any exact statements, as the general relations have considerably varied during the last three years. The first and most natural, because the nearest, market was in neighbouring Germany. Then, those countries whose demands are entirely or in part supplied by German houses, such as Holland, Denmark, Sweden, Russia, Poland, Galicia, Turkey, and Greece. The next important markets are those of North America and England; less so France, Central and South America. Almost unsupplied are the markets of Italy, Spain, and Portugal, which may be accounted for by the smaller consumption in these countries. The average may be as follows:—

	Per cent.
Germany	38
North American and Great Britain . .	44
France	10
Other countries	8

In conclusion, the four following reasons may be given as the basis on which lies the greater producing power, and the superiority of Bâle to other places:—

1. The amount of the ready working capital, about 500,000 francs, for the working of 100 looms, without including the buildings and mechanical constructions. This allows of the work being done at a smaller profit. The merchandise becomes cheaper, a large margin is left for the speculation in the raw material, and more can be employed on perfecting the machines and what pertains to them. Only through the possession of a very large capital has it been possible to establish here the largest ribbon manufactory in the world, one with more than 900 looms, whereas formerly the largest number of looms under one hand was, at the most, 200.

2. The general fair dealing of the manufacturers and operatives towards the buyers; the knowledge that it is the genuineness of the article with regard to the quality and length of the piece which can alone sustain their credit.

3. The accommodating themselves easily to the demands of their customers.

4. The higher education of the operatives, as well as of the manufacturers, as compared with their French rivals, ought to be prominently brought forward. No operative enjoys, like the Swiss, such excellent schooling, and every chance is left him to perfect himself further. While the French workman is lighter and nimbler, conceivesand executes new things quicker, the Swiss is slower and heavier, but the more solid, steady, and reliable. The Swiss manufacturer has the advantage of a larger capital, and greater skill and practice in mercantile business. While the French manufacturer is, in nine cases out of ten, nothing but manufacturer, an l does not engage in the traffic abroad, the Bâlois is both merchant and manufacturer; he makes his purchases and sales himself, is, thereby, more independent, and can turn all the advantages of the markets of the world and the secret springs of commerce to his profit.

ON CHEMISTRY APPLIED TO THE ARTS.

BY DR. F. CRACE CALVERT, F.R.S., F.C.S.

A COURSE OF LECTURES DELIVERED BEFORE THE MEMBERS OF THE SOCIETY OF ARTS.

LECTURE V.

MILK: its Composition, Properties, Falsification, and Preservation. *Urine:* its Uses. A Few Words on Putrefaction.

Milk.—The composition of this important fluid varies not only in different classes of animals, but also in different individuals of the same class. Further, the composition of milk is modified by the influence of food, climate, degree of activity, and health. Notwithstanding these variations, an average can be arrived at by numerous analyses, and the following table will give a general idea of milk :—

	Women's.	Cows'.	Asses'.	Goats'.	Ewes'.
Dried caseine .	15·0	44·8	18·2	40·2	45·8
Butter . . .	33·5	31·3	1·1	33·2	12·0
Sugar of milk .	65·0	47·7	60·8	52·8	50·0
Salts . . .	4·5	6·0	3·4	5·8	6·8
Water . . .	881·8	870·2	916·5	868·0	885.4
	1000·0	1000·0	1000·0	1000·0	1000·0

The various substances comprised in milk may be classified under three heads—cream, curd or caseine, and whey.

Cream, according to Dr. Voelcker's* analysis, is composed of:—

Water . . .	61·67	...	64·80
Butter . . .	33·43	...	25·40
Caseine . .	2·62	...	7·61 (Caseine and Sugar of milk together)
Sugar of milk . .	1·56		
Mineral matters .	0·72	...	2·19
	100·00		100·00

And may be considered as consisting of small, round, egg-shaped globules, composed of fatty matters, enclosed in a thin cell of caseine, which, being lighter than the fluid containing them, rise to the surface and constitute cream, and in proportion to the quantity of this removed from the milk, the latter becomes less opaque, and assumes a blue tinge. When exposed to the air for a short time in a dry place it loses water, becomes more compact, and constitutes what is called cream cheese. When churned, cream undergoes a complete change ; the caseine cells are broken, and the fatty globules gradually adhere one to the other and form a solid fatty mass, called butter, and it is found, on an average, that 28 lbs. of milk will yield 1 lb. of butter. Fresh butter is composed of:—

Fatty matters	Margarine, Oleine, Caproine, Caprine, Butyrene, Caproleine	...	77·5
Caseine	... ...	...	1·6
Whey	... ...	...	20·9
			100·00

* For further particulars on this subject, the reader is referred to Dr. Voelcker's paper, published in the 'Journal of the Royal Agricultural Society of England,' vol. xxiv.

But as butter rapidly becomes rancid, it is necessary to adopt means to prevent this as much as possible, and the following are the usual methods—viz., working the butter well with water, and then adding 3 or 4 per cent. of common salt, or melting the butter at a temperature below 212° ; but the following method, employed by M. Bréon, appears to give general satisfaction. It consists in adding to the butter water containing 0·003 of acetic or tartaric acid, and carefully closing the vessels containing it. The rancidity of butter is due to a fermentation generated by the caseine existing in it, which unfolds the fatty matters into their respective acids and glycerine, and as the volatile acids, butyric, caproic, &c., have a most disagreeable taste and odour, it is these which impart to butter the rank taste. Allow me to add, *en passant*, that whilst butyric acid possesses a repulsive smell, its ether has a most fragrant odour—viz., that of pineapple, for which it is sold in commerce.

Curd of Milk or Caseine has, according to Dr. Voelcker, the following composition :—

Carbon	53·57
Hydrogen	7·14
Nitrogen	15·41
Oxygen	22·03
Sulphur	1·11
Phosphorus	0·74
	100·0

And is easily recognisable by its white flocculent appearance. It is insipid and inodorous, like albumen, from which it differs in its insolubility in water, though it is dissolved by a weak solution of alkali or acid. But what chiefly distinguishes caseine is that it is not coagulated on boiling, and that rennet precipitates it from its solutions. Dr. Voelcker has proved, however, in his researches on cheese, that the commonly-received opinion that rennet coagulates milk by decomposing the lactine into lactic acid is incorrect, for he has coagulated milk while in an alkaline condition, and it is owing to the difference in the action of rennet on albumen and caseine that chemists have been able to detect the presence of ½ to ¾ per cent. of albumen in milk. This important organic substance not only exists in milk, but is also found in small quantities in the blood of some animals, such as the ox, and in a large class of plants, but more especially in the leguminous tribe, such as peas, beans, &c. Caseine is the basis of all cheeses, and when these are made with milk from which the cream has been previously taken the cheese is dry, but when part of the cream has been left the cheese is rich in fatty matters as well as in caseine ; and I may add that the peculiar flavours characterising different cheeses are caused by modifying the conditions of the fermentations which the organic matters undergo. The following researches made by M. Blondeau illustrate this point, as well as the modifications which cryptogamic life under peculiar circumstances may effect in the composition of organic substances, and his interesting results were obtained in studying the conversion of curd into the well-known cheese of Roquefort. He placed in a cellar some curd of the following composition :—

Caseine	85·43
Fatty matters	1·85
Lactic acid	0·88
Water	11·84
	100·00

To which he added a small quantity of salt. After a month, and again after two months, he analysed portions of the same, with the following results :—

	After one month.	After two months.
Caseine	61·33	43·28
Fatty matters	16·12	32·31
Chloride of sodium	4·40	4·45
Water	18·15	19·16
Butyric acid	—	0·67
	100·00	99·87

The above figures show a most extraordinary change in the caseine or curd, for we observe that the proportion of caseine gradually decreases, and is replaced by fatty matters. Considering the circumstances under which this phenomenon has occurred, there can be no doubt that this curious conversion of an animal matter into a fatty one is due to a cryptogamic vegetation or ferment ; and if the Roquefort cheese be exposed to the air under a bell jar for twelve months, the decomposition becomes still more complete ; for it is no longer the caseine which undergoes a transformation, but the oleine of the fatty matters. The following analyses clearly illustrate this curious action. Composition of the cheese after two and twelve months :—

	After two months.	After twelve months.
Caseine	43·28	40·23
Margarine	18·30	16·85
Oleine	14·00	1·48
Butyric acid	0·67	—
Common salt	4·45	4·45
Water	19·30	15·16
Butyrate of ammonia	—	5·62
Caproate of ammonia	—	7·31
Carprylate of ammonia	—	4·18
Caprate of ammonia	—	4·21
	100·00	99·49

The substances to which cheeses owe their peculiar flavour are ammoniacal salts, chiefly composed of various organic acids, such as acetic, butyric, capric, caproic, and caproleic. I cannot better conclude my remarks on cheese than by extracting from Dr. Voelcker's interesting papers a few of his numerous analyses of different kinds of cheese :—

	Cheshire.	Stilton.	Old Cheddar.	Double Glo'ster.	Single Glo'ster.	American.
Water . .	32·59	20·27	30·32	32·44	28·10	27·29
Butter . .	32·51	43·98	35·53	30·17	33·68	35·41
Caseine . .	26·06	33·55	28·18	31·75	30·31	25·87
Sugar of milk / Lactic acid	4·53		1·66	1·22	3·72	6·21
Mineral matter	4·31	2·20	4·31	4·42	4·19	5·22
	100·00	100·00	100·00	100·00	100·00	100·00
Nitrogen .	4·17	3·89	4·51	5·12	4·85	4·14
Common salt	1·59	0·29	1·55	1·41	1·12	1·97

The principal application of caseine in arts and manufactures is that first introduced by Mr. R. T. Pattison, who used it under the name of lactarine for fixing pigments in calico-printing. His process consists in drying the washed curds of milk, which he sells to the calico-printer, who mixes it with a solution of ammonia or weak alkali, which swells it out and renders it soluble in water. To a solution of this substance, of proper consistency, he adds one of the tar colours, prints it, submits the goods to the action of steam, which drives off the ammonia, leaving fixed on the fabric the caseine and colour. In consequence of the insoluble compound which caseine forms with lime, it has often been used as a substitute for glue or linseed oil in house painting, and it may be useful to some of my audience to know that when caseine is dissolved in a concentrated solution of borax, an adhesive fluid is formed, which is capable in many cases of serving the purposes of glue or starch. Mr. Wagner has made another useful application of caseine, mixing it with six parts of calcined magnesia and one part of oxide of zinc, and a sufficient quantity of water to make a pasty mass, which he leaves to solidify, and when dry it is extremely hard, susceptible of receiving a high polish, and is sold as a substitute for meerschaum.

Whey.—According to Dr. Voelcker, the composition of whey is as follows :—

Water	89·65
Butter	0·79
Caseine	3·01
Sugar of milk	5·72
Mineral matters	0·83
	100·00

When whey is concentrated to the state of syrup and kept in a cold place, it gradually deposits fine, well-defined crystals, which, on further purification and re-crystallisation, yield white quadrangular prisms of a substance called lactine, or sugar of milk, which is highly interesting. It is remarkable that while sugar of milk has only been known in Europe for a comparatively short period, where homœopathists are its principal employers, in India lactine has been known for a great number of years. Let us now study some of the chemical facts connected with sugar of milk. Thus cane sugar, when acted upon by nitric acid, gives oxalic acid, whilst lactine gives mucic acid ; cane sugar, when unfolded under the influence of a ferment, gives alcohol and carbonic acid ; lactine yields lactic acid. As the latter transformation is most important, in a physiological and chemical point of view, allow me to dwell upon it for a few minutes. The substance which possesses the property of most readily converting lactine into lactic acid is caseine after it has undergone some peculiar modification, which renders it a ferment. Thus when milk leaves the cow it is alkaline, but when exposed to the air it rapidly becomes acid, and this is due to the conversion of lactine into lactic acid, a change most interesting as a chemical fact, since both lactine and lactic acid have the same composition, the only difference being that two equivalents of oxygen and two of hydrogen cease to exist as such in the acid, but may be considered as combined in the form of water with the remaining elements—

$$\text{Lactine } C_{12}\ H_{12}\ O_{12} = 2 \text{ Lactic acid } (C_6\ H_5\ O_5\ HO).$$

M. Pasteur has shown that this lactic fermentation is not merely confined to milk, but that it is a peculiar fermentation, differing from the previous one, which frequently occurs during the decomposition of organic matters, and is due to a distinct ferment of its own ; and his researches on lactic fermentation have explained the fact, observed by M. Pelouze, some years since, that when a vegetable substance, such as sugar or starch, was put in contact with chalk or other alkali and an animal substance, lactic fermentation ensued, but until the researches of M. Pasteur, we did not know why sugar and starch in these circumstances should give lactic acid instead of alcohol and carbonic acid, which would be the result of a fermentation produced by yeast. Lactic acid is a most interesting substance to the physiologist, for it is found in large quantities, free or combined with lime, in gastric juice, in the muscular part of animals, or with soda, in blood, and its production is easily accounted for when we remember that it can be produced from the starch and sugar existing in our food. When lactic acid is purified by various chemical means and separated from the fluid in which it is combined, it presents itself as a syrupy fluid, of an intensely acid reaction, which, when submitted to the action of heat, first loses its one equivalent of water, and becomes anhydrous lactic acid, and on a further application of heat loses still one equivalent of water, and is transformed into a neutral substance called lactide. This acid, in a free state, has not yet received any important application in art and manufactures, but I have little doubt that it will some day be largely employed, for we have noticed in a former lecture its advantageous use when produced from rye and other amylaceous substances in removing the lime from various skins intended to be tanned or prepared as there described ; and Mr. E. Hunt has used it in the form of sour milk for the conversion of starch into dextrine (see 'Journal of the Society of Arts,' December 23, 1859). I wish now to say a few words on the mineral substances existing in whey, and which play a most important part in milk as a nutritious substance. We are all of us too apt to overlook the importance of the mineral elements in food, and to consider as essential the organic matters only. In milk, however, its alkaline salts, and especially the phosphate of lime, are as essential (as food) as caseine or fatty matters, for if an infant requires the lactine to maintain respiration and the heat of the body, the caseine to contribute to the formation of blood, the phosphate of lime is equally essential to the production of bone ; permit me here to state that the practice adopted by some mothers of feeding infants upon amylaceous substances, such as arrowroot, sago, tapioca, &c., in place of milk, is most pernicious, for these contain neither flesh nor bone-forming element, and milk is the only proper food for infants.

Having now examined the general properties of some of the most important constituents of milk, let us say a few words on that fluid in its integrity. We all know how rapidly milk becomes sour, especially at a temperature of 70° to 90°, and as this is owing, as already explained, to the formation of lactic acid, the best way to preserve milk sweet for domestic purposes is to add to it every day a few grains of carbonate of soda per pint, to keep the milk alkaline. The possibility of preserving milk for a lengthened period has repeatedly occupied the attention of scientific men, as a most important problem to solve for the benefit of persons undergoing long sea-voyages, but up to a recent date with very imperfect success. One of the best plans proposed is to add to milk 7 or 8 per cent. of sugar, and evaporate the whole, agitating all the time, to prevent the formation of the skin, and when reduced to one-fifth of its bulk to introduce it into tin cans, which, after being subjected for half an hour to a temperature of 220°, are hermetically sealed. In 1855, l'Abbé Moigno drew the attention of the members of the British Association at Glasgow to milk which he stated contained nothing injurious, and which would keep for a long period. This statement has proved correct, for I have here some milk which has been in the hands of the Secretary of this Society since that period, and which, on being opened to-day, was found perfectly sweet. But if l'Abbé Moigno's process has remained a secret, M. Pasteur has succeeded in effecting the same end, and probably by the same method. Thus he has found that if milk be heated to 212° it will only remain sweet for a few days, if heated to 220° it will remain sweet for several weeks, but if to 250°

(under pressure, of course) the milk will keep for any length of time. This, according to M. Pasteur, is owing to the spores or eggs which generate lactic fermentation being destroyed by the high temperature, and thus the possibility of fermentation is put an end to. The adulteration of milk by various substances stated to have been discovered therein has, I think, been greatly over-estimated, as I have never found any of them in the samples of milk which I have analysed; in fact, the most easy and cheapest of all is the addition of water. It is comparatively easy to ascertain if milk has been tampered with; but, without entering into details of the methods necessary to estimate the exact extent of adulteration, I may mention the following plan:—If a glass tube, divided into 100 equal parts, is filled with milk and left standing for twenty-four hours, the cream will rise to the upper part of the tube, and, if the milk is genuine, will occupy from eleven to thirteen divisions. Another practical method is to add to the milk a little caustic soda, and agitate the whole with a little ether and alcohol, which dissolves the fatty matters; this etherial solution is removed from the milk and evaporated, when the fatty matters remain, and experience has shown that 1,000 parts of good milk will yield thirty-seven parts of fatty matters. Any milk leaving no more than twenty-seven must have been tampered with. Dr. Voelcker suggests the employment of a hydrometer as a means of ascertaining the quality of milk, as the specific gravity of that fluid is an excellent test. From a great number of experiments he has ascertained that good new milk has a specific gravity of 1·030, whilst if good milk is adulterated with 20 per cent. of water its specific gravity will fall to 1·025.

Urine is a fluid secreted by the kidneys, which organs separate from the blood as it circulates through them any excess of water it may contain, as well as many organic substances which have fulfilled their vital function in the animal economy, and which require to be removed from the system. The composition of urine varies greatly in different individuals, and in the same individual at different times, and is influenced by diet, exercise, state of health, &c., as shown by Dr. Bence Jones and Dr. Edward Smith; but without detailing these variations, which would occupy far more time than the limits of a lecture would permit, allow me to call your attention to the following table, showing the composition of human and herbivorous animals' urine:—

HUMAN.

Water	933·000
Urea	30·100
Lactic acid Lactate of ammonia Extractive matter Kreatin Kreatinine Hippuric acid Indican Colloid acid (W. Marcet)	17·140

Uric acid	1·000
Mucus	0·320
Mineral salts	18·440
	1000·000

HORSES.

Water	910·76
Urea	31·00
Hippurate of potash . . .	4·74
Lactate of do . . .	11·28
Do. of soda . . .	8·81
Bicarbonate of potash . . .	15·50
Carbonate of lime . . .	10·82
Carbonate of magnesia . . .	4·16
Other salts	2·93
	1000·00

The substances in human urine which call for special notice are urea and uric acid; in herbivorous animals, hippuric acid; and in birds, uric acid.

Urea is a substance crystallising in various derivative forms belonging to the prismatic system—it is very soluble in water and alcohol, and gives beautiful and well-defined salts with nitric and oxalic acids. Urea, under the influence of a mucous substance secreted at the same time, and which is easily modified into a ferment, is rapidly converted, by the fixation of two atoms of water, into carbonate of ammonia, as seen by this formula :—

Urea . . .	C_2	O_2	N_2	H_4
Water . . .		O_2		H_2
Carbonate of ammonia .	C_2	O_4	N_2	H_6

This will explain the strong ammoniacal odour arising from urine after being kept for a short time; and, as it may be most important for medical men to be able to preserve urine in its normal condition for several days, I observed a few years since a most effectual method of preserving it, which is merely the addition of a few drops of carbolic acid immediately after the production of the urine. Urea is peculiarly interesting to chemists, as it was the first organic substance which they succeeded in producing artificially from mineral compounds. This interesting discovery was made by Wöhler in 1820, in acting upon cyanate of silver by hydrochlorate of ammonia. Since then Baron Liebig has devised a more simple process, which consists in decomposing cyanate of potash by sulphate of ammonia, which gives rise to sulphate of potash and cyanate of ammonia or urea. The average quantity of urea rejected daily by an adult man is about an ounce, or $2\frac{1}{2}$ per cent. of the fluid itself. Although human urine does not contain more than 1 per cent. of uric acid, and this generally combined with soda, still I deem it my duty to say a few words respecting it, for it is often the principal source of gravel and calculns, owing to various influences which make the urine strongly acid before its rejection, whereby the soda is neutralised, the uric acid liberated, and this being nearly insoluble separates, and has a tendency to form gravel or calculus. In fact, the deposit which occurs in this fluid is generally represented by uric acid, phosphate of lime, and magnesia, mucus, and colouring matter. It may be here stated that calculi were formerly held in great estimation, especially those formed in the intestine and called bezoars, and this was the case in Eastern countries until very recently. Thus it is related that a Shah of Persia sent to Napoleon the First, among other valuable presents, three bezoars, which were considered to be of great antiquity, and capable of curing all diseases. The urine of birds and reptiles being almost entirely composed of urate of lime explains why their refuse is of such value as a manure, which arises from its transformation into carbonate of ammonia. When large masses of this refuse undergo a slow and gradual decomposition, as in the dry climate of the Pacific Islands, on the coasts of Peru and Chili, it constitutes guano. It may be interesting to know that in 1835, 6, and 7, a most beautiful colour was prepared from the uric acid contained in guano, and used largely by calico-printers and silk-dyers under the name of Roman purple, or murexide.

Before leaving the study of this important animal secretion, let me say a few words on the urine of herbivorous animals. It is generally alkaline, and contains, besides an aromatic principle, an acid discovered by Liebig, and called hippuric acid, together with urea and uric acid, also found in human urine. Hippuric acid is easily obtained in the form of well-defined crystals, by rapidly evaporating the fluid containing it. This acid does not exist in the food of the animal; but benzoic acid, or its homologues, are found there, and during the phenomena of digestion the nitrogenated principles produced by the wear and tear of life fix themselves on the benzoic acid, and convert it into hippuric acid, as seen by this formula:—

$$\underset{\text{Benzoic Acid.}}{C_{14}H_5O_3 + HO} \quad \ldots \quad \underset{\text{Hippuric Acid.}}{C_{18}H_8O_5N_2 + HO.}$$

A further proof of the correctness of this view is that when hippuric acid is treated with strong acids or alkali, it transforms itself into benzoic acid, which can be easily extracted.

ELECTRO-PLATING.

In France, electro-plating is regulated by law, every manufacturer being required to weigh each article when ready for plating in the presence of a comptroller appointed by the Government, and to report the same article for weighing again when the plating has been done. In this way the comptroller knows to the fraction of a grain the amount of the precious metal that has been added, and puts his mark upon the wares accordingly, so that every purchaser may know at a glance just what he is buying. As to the amount of silver consumed in ordinary plating: An ounce and a half of silver will give to a surface a foot square a coating as thick as common writing-paper. And since silver is worth 5*s.* per ounce, the value of the silver covering a foot square would be about 7*s.* 6*d.* At this rate, a well-plated tea-pot or coffee-pot is plated at a cost in silver of not more than 7*s.* to 8*s.* The other expenses, including labour, would hardly be more than half that amount. Electro-gilding is done in like manner. The gold is dissolved in nitric-hydrochloric acid, washed with boiling nitric acid, and then digested with calcined magnesia. The gold is deposited in the form of an oxide, which, after being washed in boiling nitric acid, is dissolved in cyanide of potassium, in which solution the articles to be plated with gold, after due preparation, are placed. Iron, steel, lead, and some other metals that do not readily receive the gold deposit require to be slightly plated with copper. The positive plate of the battery must be of gold, the other plate of iron or copper. The process is the same as that above described. The popular notion is, that genuine-electro gilding must necessarily add a good deal to the cost of the article plated. This is erroneous. A silver thimble may be handsomely plated, so as to have the appearance of being all gold, for 3*d.*, a pencil-case for 10*d.*, and a watch-case for 4*s.* An estimate of the relative value of electro-gilding, as compared with silver-plating, considering the cost of material alone, is about 15 to 1. The quantity of silver used in plating the ware sent in such large quantities to the colonies is about an ounce to the square mile; one hard cleaning exposes the base metal, and your bargain of plate from auction or that cheap store may be thrown on the dust-heap.

THE TECHNOLOGIST.

A VISIT TO THE COSSIPORE SUGAR WORKS, BENGAL.

The Cossipore Sugar Works occupy much the same position in a map of Calcutta that Chelsea Hospital does in a map of London, except that, in the Oriental city, the river runs north and south instead of east and west, while the fashionable quarter of the town lies, not "up-river," but, as we should term it, "below bridge."

A considerable interval, both of time and labour, separates the sweet juice of the cane or the date-palm from the beautiful crystals with which a European lady mitigates the acrid flavour of her coffee. Let us describe, as briefly as possible, a few of the intermediate processes.

The Cossipore Company do not begin at the very beginning; they purchase their raw material already partially refined. It does not pay in India to use elaborate appliances for the earlier stages of sugar-making. The plan has been repeatedly tried, and always with ill-success—a fact which may be proved by the heaps of neglected machinery which lie rusting and rotting in the steamy atmosphere all over Lower Bengal. Machinery cannot, at this stage, compete with the rude yet serviceable method of the native labourer.

In the early part of the cold season (say about the month of November) every date-palm tree has a man clinging to it, monkey-fashion. He hangs one or more earthen jars round the trunk, makes an incision above the jar, and inserts a little bamboo tube into the wound. Next morning the jars are full of juice, and an evening or two later, while wandering about the outskirts of a village, you may come suddenly on a blazing fire of logs in a jungle-clearing, round which fire half a dozen swarthy, half-naked figures are seen squatting, or engaged in stirring the contents of a number of large earthen pots. The scene is weird and picturesque, and you think of the witches in "Macbeth," but, in reality, a very prosaic process is going on—the native growers are boiling their sugar. When the syrup has attained a certain thickness, it is poured into wicker baskets lined with a peculiar species of clay, set in large saucers. In course of time, the molasses filters through the clay into the saucers beneath, and the sugar which remains (called "Dulloah") is ready for market. Should this sugar be submitted to a second boiling, which gets rid of more molasses, the product is styled "Gurpatta." We mention these names, as untravelled people are apt to think that Dulloah and Gurpatta imply the names of place where sugar is grown, instead of the particular stages of refinement at which the sugar has arrived.

The raw material is now ready for the Anglo-Indian manufacturer. Let us visit the Cossipore Company's works. The factory is a lofty building, five stories high, surrounded, as is common in the fertile and luxuriant climate of Bengal, with umbrageous flowering shrubs, while the noble Hooghly, broader than the Thames at Gravesend, flows at the foot of the garden.

Here let us answer a supposed question. Why should a sugar factory be so lofty? The reply is, to avoid unnecessary pumping and lifting, by beginning work at the top, and letting the sugar, as it passes through the different processes, find its way to the bottom.

1. We will commence our saccharine tour on the roof, where we find a large tank or cistern of water thoroughly impregnated with lime, for the purpose of supplying—

2. The "blow-ups" on the fourth floor. These are large circular open pans, into which, after they have been nearly filled with lime-water, numerous bags of raw sugar are emptied. Steam, at a high temperature, is then forced into the liquor through pipes, passing through the sides of the vessel, causing the fluid to boil. The object of the lime is to neutralize acidity, which hinders crystallization. At this stage the liquid is not thick and viscid, as when a nurse makes a dish of "toffey" for the little ones, but is largely diluted with water, quite thin, and of the colour of rum.

3. The next object is to get rid of mechanical impurities. For this purpose a number of bags, as large as wheat-sacks, but made of very thin cotton, are severally stuffed into a series of stoutly-made cases resembling extra long Bologna sausages. These are arranged perpendicularly in chambers highly heated by steam, and the saccharine fluid is forced by this means through innumerable folds of cotton cloth.

4. We have arrived at the second floor. Our liquor is purified, but still dark in tint. We must get rid of the rum colour. With this object the liquor is passed through a series of immense vats filled with animal charcoal more or less pulverised. This charcoal is made from bones burnt in close retorts. After a time it becomes saturated with colouring matter, and has to be burnt over again, which, for a time, renews its bleaching quality. When totally exhausted it is shipped to England for manure.

5. We now reach the first floor, where the sugar is "boiled." This is the technical word, the process already described in the top-story being termed "blowing-up." The boiling is carried on in a large dome-

shaped copper vessel, half of which is sunk below the floor, and protrudes through the ceiling of the next story. This vessel is called a "vacuum pan." Formerly great difficulty was experienced in sugar-boiling for the following reason :—In an open pan the liquor would not boil, and consequently would not crystallize, except at a temperature of 212°. But, unluckily, this high heat restored all the colour which the charcoal had so laboriously removed. For a long time the dilemma appeared insuperable, until it was ingeniously suggested that if the air were pumped out of an air-tight pan, the liquor would boil at a much lower temperature. (There is a well-known chemical experiment whereby water, in a Florence flask, is made to boil by the mere heat of the hand.) Practical sugar-boilers find that complete exhaustion is not advisable, but with the air-pump attached to the vacuum pan they reduce the boiling point to about 140°. This allows the syrup to crystallize without discolouration. Should the foreman wish to test how the process is going on, he withdraws an ingeniously-contrived little brass cylinder, called a "proof-stick" from the side of the pan (like a spigot from a barrel). This "proof-stick" is so constructed that, without admiting a particle of air, it extracts a sample of crystallizing syrup, just as a cheese-taster extracts a sample of cheese.

6. When the syrup has boiled long enough, a plug is drawn out of the bottom of the vacuum pan, and the whole contents, now thick, viscid, and apparently somewhat discoloured, resembling honey in consistence, are allowed to fall into a large open vessel beneath. We have now reached the ground floor. The syrup is then ladled into small circular pans, called "drums," perforated at the sides, like a cullender, with numerous holes. A metal cap is placed over these drums, and they are then attached to the machinery, and spun round at a prodigious rate. In a few seconds a marvellous change has been effected. All the water and molasses have escaped through the holes, being prevented by the metal cap from spirting over the apartment ; and the residue has become manufactured sugar, perfectly dry, brilliant and beautiful, well deserving to aid in ornamenting a grocer's Christmas window.

We have not space to enter upon many other interesting details, but we will touch on two or three points:—

1. The so-called molasses, just spoken of, contains a considerable percentage of sugar, and is boiled several times over until it has yielded up all its crystallizable particles. It is then shipped under the name of "treacle."

2. Only the yellow sugar made at Cossipore finds its way to this country. The differential duty shuts out the higher kinds, which are purchased for the Arabian and Australian markets. The Hindoos refuse to eat our sugar, because it has been defiled by passing through animal matter. The crystals vary greatly in form and appearance. The finest and strongest resemble a miniature sheet of plate glass, being perfectly square, with an invariable line down the centre.

Lastly. We may remark that the wages of every *employê* in the Cossipore factory, from the head boiler down to the coolie, who carries the bags of sugar (weighing nearly two cwt.) to the export warehouse—that all these wages are calculated according to the production of manufactured sugar during the month. The result is that everyone works with a sense of self-interested alacrity, which would astonish some of those complacent Englishmen who regard the Hindoos as a set of lazy, lethargic barbarians.

NOTES ON THE USE OF THE DENTALIUM SHELL BY THE NATIVES OF VANCOUVER'S ISLAND AND BRITISH COLUMBIA.

Amongst the objects of natural history and ethnology brought from British Columbia and Vancouver's Island by Mr. J. K. Lord was a belt composed of numerous specimens of a species of *Dentalium* strung together. The species bears an exceedingly close resemblance to that described by Linnæus as *Dentalium entalis* (*Entalis vulgaris* of Risso and of Dr. Gray's 'Guide to Mollusca'), and appears, notwithstanding the difference of habitat, to be undistinguishable from that European species. It has, however, been described by the late Mr. Nuttall as *Dentalium pretiosum*, and a figure has been given of it by Mr. Sowerby in one of his late numbers of the 'Thesaurus Conchyliorum.'

From a careful comparison of the typical specimens of *D. pretiosum* in Mr. Cuming's collection, there can be no doubt of the identity of that species with the specimens brought by Mr. Lord from Vancouver's Island : those in Mr. Cuming's collection are said to be from California. In examining the old graves on the banks of the Columbia River, along with numerous other articles, such as human bones, flint instruments, &c., Mr. Lord found a number of specimens of a species of *Dentalium*, considerably eroded and worn, which, when compared with some in Mr. Cuming's collection, appear to be identical with the *Dentalium striolatum* of Stimpson, from Newfoundland. Although the habitats of all these are very different from each other, in the absence of distinct specific characters they may be taken to be only slight varieties of the old Linnæan species.

"It is somewhat curious," observes Mr. Lord, "that these shells (*Entalis pretiosus*, Nuttall sp. *Entalis vulgaris?*) should have been employed as money by the Indians of North-West America—that is, by the native tribes inhabiting Vancouver's Island, Queen Charlotte's Island, and the mainland coast from the Straits of Fuca to Sitka. Since the introduction of blankets by the Hudson's Bay Company, the use of these shells, as a medium of purchase, has, to a great extent, died out, the blankets having become the money, as it were, or the means by which everything is now reckoned and paid for by the savage. A slave, a canoe, or a squaw, is worth in these days so many blankets; but it used to be so many strings of *Dentalia*. In the interior, east of the Cascade Mountains, the beaver skin is the article by which everything is reckoned—in fact, the money of the inland Indians.

"The value of the *Dentalium* depends upon its length; those representing the greater value are called when strung together, end to end, a 'Hi-qua;' but the standard by which the *Dentalium* is calculated to be fit for a 'Hi-qua' is, that twenty-five shells placed end to end must make a fathom, or six feet in length. At one time a 'Hi-qua' would purchase a male slave, equal in value to fifty blankets, or about 50*l.* sterling. The shorter and defective shells are strung together in various lengths and are called 'kop-kops.' About forty 'kop-kops' equal a 'Hi-qua' in value. These strings of *Dentalia* are usually the stakes gambled for. The shells are generally procured from the west side of Vancouver's Island, and towards its northern end; they live in the soft sand in the snug bays and harbours that abound along the west coast of the island, in water from three to five fathoms in depth. The habit of the *Dentalium* is to bury itself in the sand, the small end of the shell being invariably downwards and the large end close to the surface, thus allowing the fish to protrude its feeding and breathing organs. This position the wily savage has turned to good account, and has adopted a most ingenious mode of capturing the much-prized shell. He arms himself with a long spear, the haft made of light deal, to the end of which is fastened a strip of wood placed transversely, but driven full of teeth made of bone, resembling exactly a long comb with the teeth very wide apart.

"A squaw sits in the long stem of the canoe and paddles it slowly along, whilst the Indian with the spear stands in the bow. He now stabs the comb-like affair into the sand at the bottom of the water, and after giving two or three stabs draws it up to look at it; if he has been successful, perhaps four or five *Dentalia* have been impaled on the teeth of this spear. It is a very ingenious mode of procuring them, for it would be quite impracticable either to dredge or net them out, and they are never, as far as I know, found between tide-marks.

"At one period, perhaps a remote one, in the history of the inland Indians, these *Dentalia* were worn as ornaments. I have often found them mixed with stone beads and small bits of the nacre of the *Haliotis*, of an irregular shape, but with a small hole drilled through each piece, in the old graves about Walla-walla and Colville. In all probability, these ornaments were traded from the coast Indians; but as these graves were quite a thousand miles from the sea, it is pretty clear the inland and coast Indians must have had some means of communication."

ON THE CINCHONA BARK OF BRITISH INDIA.

BY DR. J. E. DE VRY.

AFTER almost six years spent in Java, in the near vicinity of the cinchona plantations in that island, I have obtained leave of absence for two years in order to recruit my health by a visit to Europe. During my stay in Java I had heard much about the cultivation of the cinchona in the Neilgherries and other parts of the English dominions in India, which information rendered me desirous of inspecting some of these plantations on my way home; and although want of time prevented my reaching the plantations in the Khasee hills, I had the pleasure of examining those of Hakgalle, in Ceylon, as well as those upon the slopes of the Neilgherries in the Madras Presidency.

Before I proceed further, I cannot do other than acknowledge my deep gratitude to their Excellencies Sir Charles MacCarthy and Sir William Denison, the Governors respectively of Ceylon and Madras, for their liberality and kind assistance in my inquiries; nor must I omit to mention my esteemed friends Mr. Thwaites and Mr. M'Ivor, who not only promoted my investigations by supplying me with the necessary materials and valuable information, but also by their kind hospitality made my visits to Peradenia and Ootacamund sources of the most agreeable reminiscence.

The system of cultivation *without shade* which Mr. M'Ivor, after careful study of the cinchona plant in the propagating-house, has put in practice, is very different to that adopted in Java by Mr. Junghuhn, who grows the plants in the dense shade of the virgin forests. Some facts which I observed during frequent visits to the cinchona plantations in Java induced me to judge less unfavourably of Mr. M'Ivor's system than had Mr. Junghuhn, and I went therefore to the English plantations in order—

1stly. To convince myself, by personal inspection, of the healthy appearance and growth of the trees in the open sunshine.

2ndly. To collect bark and leaves of different species of cinchona, and to investigate them chemically after my return to Europe.

I began my inquiries by visiting Ceylon, where I saw in the botanical garden of Peradenia a few specimens of *Cinchona succirubra*, which, as this locality is comparatively but little elevated, being only 1,600 feet above the level of the sea, had been planted in the shade. Although the plants looked very healthy, the oldest being from eight to nine feet high, Mr. Thwaites informed me that they grow much better in more lofty situations, such as Hakgalle. Among the leaves of *C. succirubra* which I collected at Peradenia was one which measured eighteen inches in length and twelve inches in breadth. The leaves collected at this low elevation above the sea have interested me much, because they contain almost twice as much quinovic acid as the leaves of the same species grown in the much loftier situation of Ootacamund.

Upon the beautiful coffee-estate of Messrs. Worms, 3,200 feet above the level of the sea, I saw a few specimens of *C. succirubra* and *C. micrantha* growing amongst the coffee-trees, in the most luxuriant state *in the open sunshine.* I was sorry that the paucity of plants prevented my asking for a small quantity of the leaves.

My most interesting visit, however, as regards cinchona culture in Ceylon, was that to Hakgalle, situated at about 5,200 feet above the level of the sea, where I saw a number of 22,050 plants of different species of cinchona, under the direct care of Mr. M'Nicoll. The system of planting in this locality is as yet a mixed one, part of the plants being grown in the shade of the forest and part in the open sunshine. The shade of the forest, however, is not so dense as in Java, so that even trees planted in the shade obtain a certain amount of sunshine. Of the most valuable species, I saw 13,820 specimens of *C. succirubra,* the largest plant, only thirty-one months old, being ten feet high, with the stem seven inches in circumference at the base ; and 57 of *C. Calisaya,* the produce of twelve healthy plants obtained from the Dutch Indian Government in Java. During my inspection of the plants I obtained from Mr. Thwaites a dead tree of *C. succirubra* five feet high, with the stem two and three-quarter inches in circumference at the base. I was informed by Mr. M'Nicoll that the loss of his cuttings by death do not exceed one half per cent.—a fact which I thought particularly remarkable, knowing from Mr. Junghuhn's report of the month of December, 1856, that the loss of cuttings in Java had amounted to *ten per cent.*

Having left Ceylon on the 7th of November (1863), I arrived on the 14th of that month at Ootacamund, situated 7,416 feet above the level of the sea. During a stay of sixteen days under the hospitable roof of Mr. M'Ivor, I had the fullest opportunity to convince myself of the excellent state of the cinchona plants under his care, and of his careful system of propagation, which has enabled him to increase the number of plants from 1,128 on the 30th of April, 1861, to 248,166 on the 31st of October, 1863. One of the most striking proofs of the success of his system of propagation is the fact, that the single plant of *Cinchona Uritusinga* presented to the Government by Mr. J. E. Howard, which was received by Mr. M'Ivor on the 18th of April, 1862, had been increased by buds, cuttings, and layers during the following eighteen months to 4,733 plants. As my former colleague, Mr. Junghuhn, however, in his pamphlet published at Batavia in February, 1863, and translated from the Dutch by Mr. Clements R. Markham, takes an unfavourable view of the future prospects of Mr. M'Ivor's plants raised by cuttings, buds, and layers, I examined with particular attention the roots of these plants, and found them, as it appeared to me, to be in the most satisfactory condition, so I was compelled to conclude that the objections of Mr. Junghuhn are without foundation. Having requested Mr. M'Ivor to present me with some rooted cuttings and buds, so that I should be able to show them, partly in a dried state, partly preserved in spirit, to the Minister for the Colonies in Holland, he kindly acceded to my wishes, and I can now give him the satisfaction of knowing that his rooted cuttings and buds have been admired by every one who has seen them. I must, however, candidly admit that there is some truth in the statement of Mr. Junghuhn respecting the unsatisfactory rooting of the plants obtained from cuttings: but it applies only in the case of cuttings which are *too large*, such as I have seen in Java. If the cuttings are made *as small as possible*, in accordance with Mr. M'Ivor's practice the plants obtained have not in the least degree the defect which has been pointed out by Mr. Junghuhn, and can bear comparison with the best seedlings.

In reference to the system of planting the cinchona in an open situation without the least shade, I inspected very carefully the Neddiwattum plantation, where this system has been most fully carried out. Although the large leaves of *C. succirubra* had suffered a little from a recent storm, all the plants in the plantation looked very healthy and vigorous, many of them having already attained a height of seven to eight feet. As a hint to the cultivators of cinchona in Java, I may point out the fact that the experience of Mr. M'Ivor has taught him that if he were compelled to choose an *excess* of dryness or moisture for a cinchona plantation he would prefer the former. . . .

The results of experiments on No. 7, *Red Bark*, thickened by moss, deserve the greatest attention; for although Mr. Howard had already ascertained that Mr. M'Ivor's experiment of thickening the bark by covering it with moss had been really successful, I was quite struck by the enormous amount of 8·4 per cent. of alkaloid in so young a bark. The other peculiarity of this bark was that I never obtained cinchona alkaloids so easily pure as from it; hence I hope that the experiment will be repeated by Mr. M'Ivor on a large scale, not only with the *C. succirubra*, but also with other species, and particularly with *C. Calisaya*.

Before I conclude, I must still point out the fact that the roots of *all* species of cinchona which I have investigated contain a greater amount of alkaloids in their bark than is contained in the bark of the stem. My attention was first fixed on this fact by repeated investigations of *C. pahudiana*. I enter upon no speculation whatever, but must persist in maintaining the fact, which seems not only to be true in British India and in Java, but likewise in South America, for the bark of the root of *C. lancifolia* which my friend Mr. A. Delondre forwarded to me during my stay in Java, proved to contain not less than 8·66 per cent. of cinchona alkaloids.

THE TINNEVELLY PEARL-BANKS.

BY CLEMENTS R. MARKHAM, F.S.A., F.R.G.S.*

From time immemorial the pearl fishery in the narrow sea which separates India from the Island of Ceylon has been famous in all the marts of the Old World, and has rivalled the still more renowned fishery of Bahrein, in the Persian Gulf. Opinions have always varied respecting the value of the pearls from these fisheries. Tavernier, the old travelling jeweller, said, in 1651, that the pearls from the sea that washes the walls of Manaar, in Ceylon, are, for their roundness and water, the fairest that are found, but rarely weigh three or four carats. Master Ralph Finch, a London merchant, who made a voyage to the Indies in 1583, says, on the other hand, that though the pearls of Cape Comorin are very plentiful, they have not the right orient lustre that those of Bahrein have. Whatever the truth may be respecting the water and orient lustre of the pearls of these rival fisheries, there can be no doubt that a vast concourse of merchants and others has been annually attracted to the fisheries in the Gulf of Manaar from the most ancient times, which is sufficient evidence of their value.

The Ceylon fisheries have retained their old reputation down to modern times. But it is to the smaller and hitherto less productive pearl-banks, on the opposite side of the Manaar Gulf, off the shores of the Indian Collectorate of Tinnevelly, that the reader's attention is requested. An experiment, with a view to the improvement of the fishery, has now been commenced there, which posssesses considerable scientific and general interest.

In the golden age of the Tamil people of Southern India, the Tinnevelly pearl fishery, then established, as Ptolemy states, at Keru, the more modern Coil, paid tribute to the Pandyon kings of Madura ; and at this period, we are told by the author of Periplus, of the Erythræan Sea, none but condemned criminals were employed in the fishery. Marco Polo, in the end of the thirteenth century, mentions the land of Maabar,† where many beautiful and great pearls are found off the coast. The merchants and divers, he says, congregated at Belaler in April and May, and he relates how the divers, called *Abrai amain*, performed incantations to preserve themselves from the attacks of great fish in the depths of the sea. In those days the sovereign received a tenth, and the divers a twentieth of the proceeds of the fishery. The great number of pearls from these Tinnevelly banks excited the wonder of all the bold wanderers who complete the perilous voyage to India in early times. Friar Jordanus,

* From the 'Intellectual Observer.'

† *Maabar* of Ibn Batuta and Marco Polo is the southern region of the Coromandel coast, comprised in the modern districts of Madura and Tinnevelly. Colonel Yule has suggested that the word may be Arabic (*Ma'abar*, a ferry), in reference to the passage or ferry to Ceylon.

a quaint old missionary bishop, who was in India about 1330, says that 8,000 boats were then engaged in this fishery and that of Ceylon, and that the quantity of pearls was astounding, and almost incredible. The head-quarters of the fishery was then, and indeed from the days of Ptolemy to the seventeenth century continued to be, at Chayl or Coil, literally "the temple" on the sandy promontory of Ramnad, which sends off a reef of rocks towards Ceylon, known as Adam's Bridge. Old Ludovico di Varthema mentions having seen the pearls fished for in the sea near the city of Chayal, in about 1500 A.D., and Barbosa, who travelled about the same time, says that the people of Chayal are expert jewellers who trade in pearls. This place is, as Dr. Vincent has clearly shown, the Keru of Ptolemy, the Kolkhi of the author of the Periplus, the Koil or Chayl of the travellers of the Middle Ages, the Rama-na-Koil (temple of Rama) of the natives, the same as the sacred promontory of Ramnad and isle of Rameswaram, the head-quarters of the Indian pearl fishery from time immemorial.

But Tuticorin, the present head-quarters of the fishery, has supplanted the ancient Coil for the last two centuries; and since the middle of the seventeenth century, the powers which have successively presided over the fishery, whether native, Portuguese, Dutch, or English, have uniformly taken their station at this little port, which is about ninety miles north-east of Cape Comorin, on the Tinnevelly coast. When the Portuguese were all-powerful on the coast, the Jesuits were allowed the proceeds of one day's fishing, and the owners of the boats had one draught every fishing day. The Naik of Madura, the sovereign whose family succeeded the ancient Pandyon dynasty, also had the proceeds of one day as lord of the coast. These Naiks were the builders of all the magnificent edifices which now beautify the city of Madura, and their dues from the fishery were probably used as offerings to Minakshi, the fish-eyed goddess of the vast Madura pagoda, who now possesses, amongst her jewellery, a numerous collection of exquisitely beautiful pearl ornaments. In the days of the Naiks and Portuguese there were 400 or 500 vessels at the annual fishery, carrying sixty to ninety men each, a third of whom were divers; and at the subsequent fair held at Tuticorin there was an assembly of from 50,000 to 60,000 persons. The divers at that time were chiefly Christians from Malabar. Captain Hamilton, who was travelling in the East from 1688 to 1723, described Tuticorin when the Dutch were all-powerful at that port, as well as in Ceylon. He says that a Dutch colony at Tuticorin superintended a pearl fishery a little to the northward of the port, which brought the Dutch company 20,000*l.* yearly tribute.

The Dutch appear to have fished too recklessly and too often; and, when the English succeeded them at Tuticorin, the banks were very far from yielding 20,000*l.* a year. Our predecessors had well-nigh killed the goose with the golden egg; and for many years we followed in the same track. It is the old story: a valuable product is discovered to be a source of considerable wealth, and forthwith a system of reckless destruction for the sake of immediate gain is inaugurated. Then the supply begins to fail—a panic ensues ; and, when science and forethought are called in, it is discovered that ordinary prudence and a judicious system of conservancy would have insured an annual unfailing yield from the first. Such has been the history of cinchona bark in South America, of the teak and other timber of the Indian forests, and such also is the story of the Tinnevelly pearl-banks since the Dutch times.

In 1822, the Tuticorin pearl fishery contributed about 13,000*l.* to the Indian revenue, and in 1830 about 10,000*l.* ; but after the latter date there was no yield at all for many years. Between 1830 and 1856 there were thirteen examinations of the banks, and on each occasion it was found that there was not a sufficient number of grown oysters to yield a profitable fishery, and none was therefore attempted. The unsatisfactory condition of the banks was attributed to several causes. Captain Robertson, the Master Attendant at Tuticorin, thought that the widening of the Paumben channel, which caused a stronger flow of current over the banks of the coast, prevented the molluscs from adhering, and that the fishers for large conch shells called *chanks* (which are used as horns in the worship of idols, and cut into segments of circles as ornaments for women's wrists), anchoring their boats on the banks, killed the oysters. The dead oysters would, of course, have a fatal effect on their neighbours. The native divers attributed the state of the banks to the pernicious influence of two other shell-fish, called "soorum" (a kind of *Modiola*) and "kullikoz" (an *Avicula*), which are mingled with the pearl oysters on the banks, and, as the natives believe, destroy them.

In 1856, however, an examination was made by Captain Robertson, and it was found that at least four of the banks off Tuticorin, called "Cooroochan Paur" "Navary Paur, "Oodooroovie Paur," and "Clothie Paur," were well covered with young pearl oysters, which would be old enough to be fished in 1860-61. The Madras Government therefore determined that every precaution should be taken in order that the banks might receive no injury during the interval. The chank fishery off Tuticorin was ordered to be entirely put a stop to at the termination of the contract, and vessels were provided to protect the pearl-banks from poachers, on board one of which Captain Robertson was unfortunately lost in March, 1859.

Captain Robertson was succeeded as Master Attendant of Tuticorin and Superintendent of the Tinnevelly Pearl-Banks by Captain Phipps, to whose zeal and intelligence the fishery owes its present hopeful condition, and under whose auspices the fiishery of March, 1860, the first that had been attempted since 1830, was opened.

A Government pearl fishery is a most legitimate source of revenue, and forms an exception to all other monopolies, which, as a rule, have in modern times been justly condemned. But pearls are simply articles of luxury in the strictest meaning of the word; the seas in which they grow cannot well become private property; and, if a profit can be derived from their sale, it is certainly a branch of revenue which can give just cause of complaint to no man, while it benefits the community at large. In India, too, the Government are possessed of advantages which enables them to get the work of superintendence and management done with far greater economy and efficiency than could be secured by any private individual or company. So high an authority as Mr. McCulloch has taken an opposite view, for he asserted that the Government monopoly ought to be abolished, because the expense of guarding and managing the banks exceeds the sum for which the fishery is let, and that anyone who likes should be allowed to fish on paying a moderate licence duty. The last edition of the 'Commercial Dictionary' was published in 1860, and during the two following years the Tinnevelly pearl fishery yielded a large net revenue to the Government, which is a sufficient answer to Mr. McCulloch's argument. It is true that there has since been disappointment; but the way to secure regular annual returns is by adopting a carefully-considered scientific system of conservancy, and not by throwing the banks open to the depredations of all comers.

The fishery of 1861 commenced on March 7th, and the sale of the Government share of oysters was conducted by public auction, which began at Rs. 15, and gradually rose to Rs. 40 per 1,000. As many as 15,874,500 shells were sold, realizing upwards of 20,000*l.*, as the net result to Government, exclusive of all expenses and of the shares allowed to the divers. The annual expense of the guard boats for protecting the banks is only 500*l.*

In 1862 the results of the fishery were also satisfactory; but in 1863 the banks were found to be in a most unpromising state, and no fishery was attempted. Out of seventy-two banks that were examined, only four contained oysters free from soorum, eleven had young oysters mixed with soorum, and fifty-seven were blank. It is this unexpected failure of properly-grown shells which has given rise to Captain Phipps' experimental culture now in course of trial, and to a very careful consideration of the conditions most likely to secure a good annual fishery which shall not be liable to this periodical sterility.

The pearl-banks are about nine miles from the shore, and eight to ten fathoms from the surface, being scattered over an area seventy miles in length. They are exposed to ocean currents, which, by washing sand into the interstices of the rocks, often destroy the young oysters over a considerable area; the dead fish, when not removed, soon contaminate their neighbours; and, in addition to these sources of evil, the soorum shells, a species of *Modiola*, like a mussel with a swollen face, which often grow amongst the pearl oysters, exercise a pernicious influence, either by dying and spreading death around them, or by accumulating sand. It is obviously quite impossible to watch these banks efficiently and to eradicate the evils caused by sand accumulations and dead molluscs, owing to their great depth and exposed situation in the open sea at a distance from land. Unless some plan is adopted for rearing the young fish on banks which shall be constantly accessible and free from the above drawbacks, the fishery will always be liable to failures, sometimes of long duration. The perfection to which science and intelligent care have brought the fisheries of edible oysters on the English, and especially on the French coasts, leaves no doubt that equally satisfactory results might be obtained from similar measures on the Tinnevelly pearl-banks.

A few remarks on the habits of the pearl oyster will make this part of the subject more clear.

It is, perhaps, unnecessary to observe that the pearl oyster (*Meleagrina margaritifera*, Lam.) is not in reality an oyster at all, but seems more allied to a mussel, having, like the latter animal, a byssus or cable, by which it secures itself to the rocks—one of the most important points in its organization. The animal's foot is composed of muscular fibres, and is $2\frac{1}{2}$ inches long when distended. On the lower side there is a groove lined by a secreting membrane, which is an exact mould for the formation of the byssus. When the animal desires to attach itself to the rock its foot is protruded, and, after seeking out a suitable spot with the tip for some minutes, is again retracted into the shell. A strong fibre, of the form of the groove in the foot, is thus left attached to the base of the foot at one end, and to the rock at the other. The process is again and again repeated until a strong cable is formed; and it was one of the most important results of the careful investigations of Dr. Kelaart in Ceylon, that the power to cast off its byssus at pleasure was ascertained. It leaves it behind to make another in a more convenient place, like a ship slipping her cable and going to sea. From this ability to shift its berth it follows that the pearl oyster might safely be taken from its native beds and made to colonize other parts of the sea; and also that it would move of its own accord if the surrounding water should become impure or sandy, or when there is an influx of fresh water. The animal can reform the byssus at pleasure, if in good health and condition.

The formation of pearls is another point which has received much attention, but which has not as yet been definitively settled. Pliny and Dioscorides believed that pearls were productions of dew, but that observant old Elizabethan navigator, Sir Rich. Hawkins, shrewdly remarked that "this must be some old philosopher's conceit, for it cannot be made probable how the dew should come into the oyster." Modern investigation has suggested various causes for the intrusion of the nucleus round which the pearl is formed. The free border of mantle lining each valve of the shell dips downwards to meet a similar edge on the opposite side, thus forming a double-fringed veil. The tentacles of this fringe consist of long and short flat filaments, which are exceedingly sensitive; so that even the approach of a foreign substance makes them draw forwards and shut out the intruder. They doubtless prevent the pearls from dropping out of the shell, and preserve the fish from the host of carnivorous creatures which infest its place of abode; and if it be true that particles of sand form the nuclei of pearls, they must run the gauntlet of these ever-watchful sentinels before they can intrude themselves amongst the interstices of the mantle. The food of pearl oysters consists of foraminifera, minute algæ, and diatoms; and Dr. Kelaart has suggested that the siliceous internal skeletons of these microscopic diatoms may possibly permeate the coats of the mantle, and become nuclei of pearls.

Lastly, the ova which escape through the distended coat of an overgrown ovarium may, perhaps, become embedded in the interstices of the mantle and become the nuclei of pearls, especially as pearls are usually found embedded in the mantle near the hinge, where the ovarium is most liable to rupture. Large pearls often work their way out of the mantle, and lie loose between it and the shell, or become attached to the surface of the latter. They have even been found outside the shell altogether, entangled among the strands of the byssus. When the pearl-banks are under constant supervision, the causes leading to the formation of pearls, as yet imperfectly understood, will, doubtless, receive close attention.

It now only remains to describe the plan by which it is hoped that, in future, the Tinnevelly pearl-banks will be kept supplied with a sufficient number of well-grown shells to supply a remunerative annual fishery. The idea was suggested by the method adopted with regard to edible oysters on the English and French coasts. The chief external difference between the pearl and edible oyster is, that the former secures itself to rocks and stones by means of byssus, while the latter merely lies flat on the ground on its convex side; but there is no reason why the pearl oyster should not thrive on artificial banks as well as the edible oyster.

In the Colne oyster fishery, the brood (oysters two years old) are dredged up out at sea, and placed on "layings" within the river Colne. These layings are about 100 or 150 yards by 80, according to the breadth of the channel, most of them dry at low water, and they are paved with stones, old shells, and any other hard substances, to a depth of a few inches, so as to form a bed for the oysters, which would be choked in soft mud. This material is called "cultch." In France, M. Coste has adopted a system of placing fascines on the layings, instead of cultch, as a resting-place for the oysters; but the natural advantages of the ground render any artificial method of this kind unnecessary in the Colne. It is very important that the cultch should be kept perfectly clear of mud; above all, that every mussel-shell should be weeded out. These mussels have a remarkable tendency to collect mud round them in heaps, probably owing to their elongated shape, and if they are allowed to remain on the layings there is danger of the oysters being choked with mud. The oysters remain on the layings for two years, when they are fit for eating, and during this time there are constant examinations in order that all dead fish may be removed, and the cultch kept clear of mud. In places where the layings are never laid bare by the tide, this is done by means of a dredge, all live fish and cultch being carefully thrown back, while dead fish, soft mud, and mussels are removed.

There can be little doubt that some such system might be adopted in rearing pearl oysters; and Dr. Kelaart says that "he sees no reason why pearl oysters should not live and breed in artificial beds, like the edible oysters, and yield a large revenue." He has ascertained, by his experiments in Ceylon, that the pearl oysters are more tenacious of life than any other bivalve with which he is acquainted, and that they can live in brackish water, and in places so shallow that they must be exposed for two or three hours daily to the sun and other atmospheric influences. Captain Phipps, the superintendent of the Tinnevelly pearl-banks, has come to the same conclusions; and, convinced that artificial nurseries for the young oysters are the only means by which remunerative fisheries can be insured, he has proposed the following plan, which has been adopted:—

The harbour of Tuticorin is formed by two long islands, and between them and the mainland there is a bank about three miles long by a quarter of a mile broad, with a depth of from three to seven feet, entirely free both from surf, currents, and influxes of fresh water. Captain Phipps proposes that this bank should be walled round with loose coral until it is formed into a basin, the edges rising three feet above high-water mark. Over the bed of the shallow basin thus enclosed, live coral will be regularly spread, so as in a few years to form a solid mass, serving the purpose of cultch, and the basin will be divided into three parts, one for the old oysters, and the other two for the young ones that may be in process of rearing. After the division of the basin set apart for breeding has been stocked, it will be carefully watched, and when the spawning has taken place and the young oysters are well formed, they will be removed from the old oysters and rocks to which they are attached, and placed in one of the separated parts of the basin, and the same plan will be followed each succeeding year. On reaching a sufficient age, they will again be removed to one of the pearl-banks in the open sea. The last operation is necessary, because it would be impossible to enclose an artificial space which would hold as many grown oysters as are required for a remunerative fishery, and because it is believed that the quality of the pearl depends on the depth and clearness of the sea in which it has been formed.

A single oyster, five or six years old, often contains no less than 12,000,000 eggs, and in the fishery of 1861 the total number taken only amounted to 15,874,500, so that the number of young ones annually obtained from the nursery will be abundantly sufficient to stock banks for each year's fishery. Care will of course be taken that only such banks are selected for stocking as have the rocks which compose them raised well clear of the surrounding sand.

By this system, adapted as it is from those of the English and French edible oyster fisheries, several advantages will be secured, and all the dangers to which the pearl oysters are now exposed will be avoided. The young growing molluscs, safe on their carefully-watched laying at Tuticorin, will be secured from the choking sands of their natural banks, as well as from their alleged enemy, the soorum, the effects of which are probably the same as those caused by the mussels on the edible oyster laying in the Colne. It is during the period of their growth that the pearl oyster is so exposed to these dangers, and very frequently banks have been found well stocked with young oysters, and giving promise of a lucrative fishery, at a preliminary examination, which, when the time of the fishery arrives, are bare, all their inhabitants having died and been washed away. But if preserved during the period of growth in the artificial nursery, and only placed out when they have reached maturity, the oysters can then form their pearls in security until the season for fishery arrives, and well-stocked pearl-banks may be reckoned upon for each year.

Thus it is hoped that, adopting these carefully-considered plans, and improving upon them as experience and watchful investigation dictate from year to year, a regular and unfailing source of revenue will be secured to the State, and the Tinnevelly pearl-banks will, after laying dormant for thirty years, regain the immemorial renown which was conceded to them, alike in the days of Ptolemy, of Marco Polo, and of Hamilton. They form the most ancient fishery in the world, and, now that science and careful supervision has been supplied, they will no longer be the least remunerative.

ON THE COCOA-NUT OF THE SEYCHELLES ISLANDS, OR COCOS-DE-MER (*LODOICEA SEYCHELLARUM*).

BY GEORGE CLARK.*

THE cocos-de-mer is undoubtedly the most remarkable plant in this colony and its dependencies, one of which is the only spot in the world where it is indigenous. The fruit was known long before the plant which produces it, or the locality in which it was found; and various fables were invented as to its origin, and marvellous virtues were attributed to its qualities. The few known specimens of it which existed were valued at an enormous price, till, in 1742, the discovery of the Seychelles Archipelago made known the habitat and nature of this sin-

* From the 'Annals and Magazine of Natural History.

gular production. The name "coco-de-mer," or sea cocoa-nut, was given in consequence of the first specimens of it which were known having been found floating in the sea, into which they had been carried by the streams; and some of these having been met with in the neighbourhood of the Maldive Islands, their name was added to that of coco-de-mer. When the Seychelles Archipelago was discovered, three of the islands composing it, Praslin, Curieuse, and l'Ile Ronde, were covered with magnificent forests of this unique palm, and their soil strewed with its huge and singularly-shaped nuts. The value of their shells as domestic utensils for various purposes was at once perceived, and from that time to the present they have supplied to the inhabitants the place of buckets, bowls, jars, dishes, measures for grain and liquids, drinking vessels, paint-pots, &c.; and they were extensively used among the labouring population of Mauritius, until the diminution of the plant and the great demand for the fruit which has arisen within the last few years in India and Persia, greatly enhanced their value. The palm which produces this singular nut is the only member of its genus. Its systematic name is *Lodoicea Seychellarum*. It may be termed an equatorial plant, the islands on which it is found lying between 4° 15′ and 4° 21′ S. lat., and 55° 49′ E. lon. Its stem attains a height of 80 or 90 feet, is quite straight, cylindrical, and smooth, but slightly marked throughout its length by the scars left by its fallen leaves. These scars are naturally more or less distinct from each other according to the rapidity of the growth of the plant. On the barren hill-sides they are scarcely two inches apart, while in the moist and fertile gorges they are as much as three. The diameter of the stem varies, from the same causes, from 12 to 15 inches. A stalk so long and slender, crowned by leaves of vast size and strength, is necessarily much influenced by the wind, and in strong breezes the plants bend considerably, while their elasticity causes them to wave in the most graceful manner. The clashing of the leaves in a stiff gale produces a louder noise than I have heard from any other trees, and quite of a different nature; and the occasional fall of the ponderous fruit renders a passage among the sea cocoa-nuts a somewhat dangerous affair, except in calm weather. I have heard of an instance of a woman being struck by one while washing at a brook. A companion who was washing beside her was only made aware of the circumstance by the fall of the nut. The victim died without a cry or a groan. The stem of this, like other palms, consists of a mass of hard fibres, enclosing a medullary substance; but the fibrous portion of the stalk of the coco-de-mer is harder than that of any other palm I know, and can only be cut by a sharp and well-tempered tool. The form of the stem likewise resembles that of most members of its family, its largest portion being that which rests on the surface of the ground. The root is in some cases bell-shaped, in others, nearly hemispherical, and a vast number of rootlets radiate from it in all directions except upwards. These extend to a great distance around it, and form admirable stays to resist the strain to which the play of so long a lever subjects them; and so well do they perform their office, that I have never known an instance of a coco-de-mer having been blown down.

The leaves of the *Lodoicea* are winged and palmated, and bear a great resemblance to those of the fan-palm. They are largest when the stem is just appearing above the ground, and in favourable situations they may be fonnd as much as 15 feet long (exclusive of the petiole, which is of an equal length) by 12 wide. As the trunk increases in height, the length of the petiole and the size of the leaf diminish. Did they not do so, the strength of the stem and its supports, great as it is, could not resist the effects of the wind with so great a leverage as the lofty stem would give. The petiole is so strong, and so firmly attached to the stem, that a man may firmly sit on its extremities, and even swing upon it. I only know one man who would venture on this perilous feat. He was a native of the Maldive Islands, settled at Seychelles; and among all the perilous gymnastics I ever beheld, none made me shudder more than to see him seated on the leaf-stalk of a coco-de-mer at nearly 100 feet from rocky ground, rising and falling to the utmost flexibility of the stalk allowed. He never met with any accident.

The leaf, previous to unfolding, is covered with a thick, fawn-coloured down, of a cottony feel. When the trees were numerous, this down was collected in sufficient abundance to form the stuffing of mattrasses and pillows for the Praslinois; the male and female flowers are produced on separate trees. About three years after fecundation the fruit has attained nearly its full size, and is then called *Coco tendre*. It may in this state be easily cut through with a knife, and exhibits in a most interesting manner the different substances of which it is composed:—First, externally, is the drupe itself, green on the outside and whitish within, of a harsh taste and astringent quality, like that of the ordinary cocoa-nut. Next comes what will form the hard shell of the nut. This is lined with a layer of a white, feculent substance, almost tasteless. This covers a yellow matter, very bitter, and said to be poisonous, which envelopes the perisperm—a jelly-like mass, presenting much the appearance of cold starch slightly tinged with blue. This has a sweetish taste, is considered cooling, and is much esteemed by the Seychellois. In the centre of this, at the point of the junction of the two lobes, lies the embryo. In the mature state, which is not till seven or eight years after the fecundation, the drupe has become fibrous, and from a rich dark green has turned to a reddish yellow, and falls from the stem. Germination takes place sometimes before and sometimes after the fall of the fruit, the shell of which is hard and black, and marked all over by the traces of the fibres which were inserted in it. The trunk does not show itself till twenty or twenty-five years after the germination of the nut; and fourteen or fifteen years from this period the plant is in its greatest beauty and begins to blossom.

The coco-de-mer grows in every kind of soil, but attains its greatest size and beauty in the deep moist gorges of the mountains, where a rich bed of humus favours the growth of that as well as of other palms, some of which greatly surpass it in height. By the seaside and in situations much exposed to the wind, the coco-de-mer presents a somewhat barren aspect; its leaves, being renewed so slowly, are withered and rent, and the trees might be supposed to be dying. It has been observed that, at the discovery of the islands which produce it, vast forests of the coco-de-mer existed. The height and smoothness of the trunk rendered it a less difficult matter to cut down a high tree than to climb it, to obtain its fruit, and thousands have thus wantonly been destroyed; so that, a few years ago, hundreds of male trees might be found without a single female among them. Many fires have also occurred in these woods, and a vast number have been destroyed in the conflagrations which have taken place. Five or six years ago, a fire broke out at Praslin, which continued for several weeks, blazing up again and again after it was thought to be extinguished; and by this a very considerable number of these trees perished. On l'Ile Ronde not a plant remains. Curieuse, occupied as an establishment for the treatment of lepers, has a considerable number of fine young trees; and as the island is Government property, it is to be hoped that strict injunctions will be given to preserve every remaining tree, and also to plant others. If this is not done, it is not improbable that, a few generations hence, this unique and interesting palm will no longer be found. Its extremely slow growth has prevented most persons from planting it. There are not, perhaps, a score of trees in all the islands except in Praslin and Curieuse.

The growth of many young plants is stopped by cutting out the unopened leaves as fast as they appear for the making of hats and other objects. These are called "cœurs-de-cocos," and are very pretty objects. The leaflets are so compactly packed together, that they seem to form a solid mass, as smooth as ivory. Their edges are of a most beautiful delicate green, and the lamina of a clear, pale straw-colour. They form a material of unequalled quality for the making of hats and bonnets, and could they be supplied in sufficient quantity, a large trade in them might be carried on. A large bonnet maker in England, who cleaned some for a lady from Seychelles, was particularly struck with the excellency of the material of which they were made, and said he could insure a ready sale for any quantity of it. The splitting of the leaflets into strips of the desired breadth is a much more difficult affair than straw splitting, on account of the transverse fibres which cross it. This operation is performed with considerable skill by those accustomed to it. They employ a simple little machine, made of a piece of hard wood, with a sharp blade fixed in it. This blade is set at the required distance from a raised edge, which determines the width of the strip and keeps it straight. The strips, however fine, can only be cut singly.

Very useful and pretty little baskets, called "tentes," are also made of these leaves. They last for many years, and by washing and bleaching may be always restored to their original colour. It is cut out into various tasteful patterns, and made into fans, which are much admired for their lightness and durability. Artificial flowers are also made of it, which want nothing but colour to be a good imitation of nature. Work-baskets (corbeilles) of great beauty and in great variety are made by some of the Seychelles ladies, and some of these productions obtained much admiration and a prize at the Great Exhibition of 1851. The nerve which strengthens each leaflet is employed to stiffen hats made of the leaf, each seam of the rows of plait being sewed over it. This may also be split into fibres as fine as hair, and possesses considerable tenacity. I have seen a little basket, of very complicated and delicate structure, made of this material. It was manufactured by a lady of the Vendries family, which is unrivalled for the taste and skill displayed in the articles made from the coco-de-mer by its members. Mats of great beauty and unequalled durability are also made of these leaves. The extreme hardness and smoothness of their surface and the length and strength of their fibres are unrivalled by any substance within my knowledge. The expanded leaf forms an excellent thatch, nearly equal to shingles in durability. Its strength is so great that when pinned together with little skewers of bamboo, it forms a basket capable of bearing nearly a bushel of fruit.

The petiole forms a strong and durable paling and is also sometimes used for small rafters. The trunk, when cut into lengths and split into palisades, is used instead of boards for the sides of houses, and will last, I believe, as long as any wood. When split in two and hollowed, it is used for gutters for conveying water, and is almost imperishable. The size of the nuts varies greatly. I have seen some which would not hold a bottle and others which were sixteen times as large. These extremes are rare, but a nut of ordinary size will hold from six to eight bottles. When intended to be preserved whole, they are kept in a damp place till the perisperm has rotted away—a process which requires many months to complete. During this process it not unfrequently happens that flat-shelled snails introduce themselves into the nut and grow too large to get out by the hole by which they entered, and die there, like the weasel in the fable. They are then called *Cocos legers.* They are pierced with an augur at one end, or the extremity is sawn off; the orifice through which the germ sprouts is stopped up with a little pitch, and a withe round the cleft converts it into a convenient bucket, strong and tight. When sawn longitudinally, it forms an elliptical vessel, called "*Coco scie,*" superior to everything else for baling out boats.

Three-lobed nuts are sometimes met with. I have possessed one with five lobes, and have heard of one having as many as seven. The kernel of the *Lodoicea* contains a portion of oil, but its excessive hardness and the difficulty of detaching it from the shell (itself so valuable) render it practically useless for oil manufacture. The shell is about equal in hardness to that of the ordinary cocoa-nut, and equally susceptible of a fine polish. It is from one-tenth to three-sixteenths of an inch in thickness.

The foregoing simple account of the *Lodoicea Seychellarum* proves it to be a most interesting plant in a scientific point of view, and a very valuable one in an economical one. It is therefore well worthy of the attention of the Government, as well as of private individuals, to use means not only to prevent its extinction, but to favour its propagation.

COLONIAL TWEED AND CLOTH MANUFACTORY AT SYDNEY.

By the invitation of the proprietor, O. B. Ebsworth, we lately had an opportunity of inspecting an Australian cloth establishment. The premises, consisting of the mill, fulling house, press house, weaving shops, dye house, overseer's house, &c., form a portion of the well-known Barker's Steam-mills, situated in Sussex street, Sydney, running from thence to the waters of Darling harbour, forming almost a little colony in itself. Although adjoining the flour mill of Messrs. Barker and Co., the works in no way interfere with them, their driving power being supplied by a separate engine. In describing the manufacture of a piece of tweed, it will be better to follow the raw material from the time the bale of wool is received within the walls, for which purpose we are first conducted to the dye-house, a large building containing four large dye-pans and an indigo vat. Water is laid on throughout, and the furnaces under each are fired from the outside of the building. Here the wool is scoured thoroughly, and is ready for the pots, where it is dyed as required. Indigo-dyeing has lately been introduced, and the *vat* is the first of the kind erected and made use of. The colour is perfectly fast, but this process is much more expensive than the common dyeing. There is likewise the process of yarn-dyeing carried on ; and this is made use of principally for fancy and delicate colours.

The wool thus prepared is ready for the operation of the mill, but all wool required for white of checks or fancy goods is scoured at the proprietor's wool-washing establishment at Newtown, and is returned from thence almost as white as cotton. The first machine through which it passes, called the *devil*, opens the wool and deprives it of burrs or other extraneous substances. It is then spread out about six inches thick and oiled, another layer of wool, then oil, and so on until the *blend* is complete.

The operation of *teazing* commences by passing it through the *teazer* another kind of devil, consisting of a cylinder fitted with large steel teeth, having four strippers and workers, similarly fitted, revolving on the top of it. At the end of the machine is a fan armed with a different shaped tooth, which, revolving at great speed, strips the wool from the cylinder and blows it several feet from the machine in the form of flakes, resembling snow. In this state it is conveyed to the first floor, where it is spread lightly on the felt cloth of the *scribbler*, a large machine having two cylinders of 5ft. 6in. in diameter, with sixteen strippers and workers, besides doffers and flies. These are all covered with card cloth or filleting—minute pieces of wire inserted through leather, which have an angular form imparted to them, and they take up the fibres of the wool, separate them, and lay them all one way, so that it comes from the machine in one continuous uniform thickness, like a thin veil, almost resembling crape. It is not yet sufficiently open and laid to be made into yarn, so a given quantity is weighed and spread on the feed of the *carder*, a machine similar to the last described, only having the cards of finer wires, and instead of coming out continuous, by an alteration in the doffer, the comb-plate takes off only a given quantity, which, falling into a *shell* with a roller nicely adjusted, delivers the carding in the form of a roll, about 3ft. long—these rolls have no twist in them, and are taken by children to the *slubbing billy*, a machine which gives it the first rough twist prior to its being spun into yarn. There are two *billies* of seventy spindles, employing each one man and four boys, besides the feeders for the scribbling and carding engines, who are mostly girls. On this same floor, there is to the novice a most complicated machine, called a *condenser;* it is attached to one of the carding engines, and its object is to impart the first twist which is done on the billy, and this machine it does away with, besides effecting a saving in the employment of about seven hands, doing the work more evenly, taking up considerably less space, and making no waste. To watch each thread leave the machine in the form of a thin gossamer, twist itself evenly, and then wind itself on a large reel, is surprising, and the motion of the different parts, horizontal and circular, is considered to be one of the most ingenious problems in machine-making.

Ascending to the next floor, we come to the *mules* or spinning machines. There are two of them, each with 300 spindles, where the slubbings are spun into yarn ; these are used for making weft, and from them the weavers receive their supply of *bobbins*. On this floor there is an ingenious machine for twisting two threads into one ; the yarn so made is employed for the making of fancy goods, stripes, &c. Proceeding to the top floor, we come to another pair of *mules*, each 300 spindles. These are fitted to receive the bobbins or reels from the condenser ; they are of a similar construction to the ones below, but impart a greater twist to the yarn, which is exclusively used for the *warp*, the threads forming the length of the piece. The warping form is on this floor, and it was amusing to watch how a piece of cloth (when finished turning out

160 yards) could be made from thirty to fifty threads only, as the case might be. There is likewise a reel for skeining; when the yarn is to be dyed it requires a separate process, otherwise the colour would not be even. When the warper has filled the *form* he takes it off, and winds it or folds it in a peculiar manner, resembling a large ball, called a *chain.* In this state the weaver receives it from the factory, and he first immerses it in a quantity of size and lays it on the *stretch* to dry, when, if any thread be broken, it will be seen. Next comes the operation of *beaming*; and here again, should any thread be wanting or out of place, it is taken up. To describe the *weaving* in a casual visit would be impossible, when volumes are written on the art. And what with the numerous terms, such as headles and treadles, and motion of this and that name, we must be content to say that there were twenty-four looms, some weaving the plain twill, whilst others were working patterns of various designs, and which we were informed had not been attempted before in the colony; but they were not in a forward state to leave the looms. They are all worked by manual labour. As the cloth leaves the loom it certainly looks far from prepossessing, having the appearance of very coarse canvas, not over-clean, and certainly not smelling particularly sweet, consisting of stale size, oil, and mouldiness combined. However, the wool has arrived at about half the stage; that is to say, it is woven.

Leaving the weaving shops, which are detached from the main building, we enter the wash and fulling house—here the before-described dirty-looking cloth is subjected to the operation of scouring, and may be considered the first step of the finishing process, which is of as much importance as the making of cloth, and almost a distinct business from that before described, the beauty of the cloth entirely depending on the care bestowed on the finishing. The scouring is performed in the following manner:—One end of the cloth is passed between two rollers in a frame above a large trough, into which is poured some preparation; it is sewn to the other end, and when the machine is in motion it travels as an endless band, the passing between the rollers washing it far better than by hand. When cleansed the liquor is run off and cold water allowed until the piece is thoroughly purified. It is next partially dried, and subjected to the action of the *gig mill* in an adjoining building. This is a most powerful machine, its object being to raise a nap on the cloth, take out any *fribs* or knots, and deprive the surface of any unevenness there may be on it. It consists of a number of rods previously filled with teazles secured to a cylinder revolving at great speed, and the cloth is brought in contact with the teazles, but in an opposite direction. It begins now to assume the appearance of cloth, only feels thin, open, and rough. When dry it passes under the hands of the *curlers,* women, whose duty it is to examine it well and take out any double thread, seeds, or mend any flaw. The curling irons used are like large tweezers, with one end very sharply pointed. The cloth is now returned to the fulling house for the purpose of being *milled;* in other words, felting it by reducing it from about thirty-six inches in width to twenty-eight. The machines used are the French mills, not stocks. Steam has been recently introduced, and we were informed the cloth so milled is considerably improved. In this building steam is conveyed from the boiler and used for all purposes, such as boiling water, melting soap, preparing other ingredients used. After being milled to the required width, it is scoured for the last time, and again subjected for the second time to the action of the gig mill. When raised with a nap resembling a very fine blanket, it is dried on the *tenters,* consisting of a strong frame of wood, having hooks top and bottom, the lower bar being movable so as to make the width whatever may be the number of inches required. The next process it goes through is being brushed, laying the nap perfectly smooth; the machine used is a very powerful one, and has steam attached to it; thence to the *cutter,* a very ingenious machine, whereby the cloth is shorn. It consists of spiral blades fitted to a cylinder revolving at great speed; and as the cloth passes under and over two plates called *ledger blades,* every fibre is regularly shorn. This operation requires great attention and exactness in the adjustment of the machines, and it was surprising to see the quantity of *flock* so cut off. To all appearance it was so much waste, but it is used, when new cards are put on the machines, to strengthen the wires. Saddlers use it largely for stuffing saddles and harness, and it makes most excellent beds and pillows. Leaving the cutter, the cloth is steamed and brushed, and then passes to the press-house, where it is folded between mill boards and hot pressed, taken out the next day, turned, and undergoes a similar operation, when it is measured and rolled, and ready for delivery.

The above is a brief general outline of the various processes through which wool passes from the raw material to a bale of cloth, and in so doing the time occupied is about four to six weeks.

ON THE BOTANICAL ORIGIN OF GAMBOGE.

BY DANIEL HANBURY, F.L.S.

The botanical origin of Gamboge has been long involved in some obscurity, for although the drug was evidently produced by a plant of the genus *Garcinia* it has not until recently been possible, for want of good specimens, to determine the species.

Hermann, a Dutch naturalist of the seventeenth century, who resided in Ceylon, referred the origin of gamboge to two plants, one of which is known to modern botanists as *Garcinia Morella,* the other as *G.*

Cambogia; and we have it, on the authority of Mr. Thwaites, Director of the Royal Botanic Garden of Peradenia, that the former is capable of affording a very good form of the drug, but that such is not the ease with the latter. It is, however, well-known that gamboge is not an export of Ceylon, but that it is a production of Siam, a country which is still nearly unexplored by the botanist. Whether gamboge in Siam was yielded by the same tree as that which affords it in Ceylon, was a question which could only be settled by a careful examination of good botanical specimens.

Some years ago Dr. Christison, of Edinburgh, received from Singapore specimens of a *Garcinia* cultivated there on the estate of Messrs. D'Almeida and Sons, which *Garcinia* had been brought from Siam as the true gamboge-tree. Dr. Christison, whose account appeared in the 'Pharmaceutical Journal' for November, 1850, found this plant to be nearly allied to the *G. elliptica* of Wallich, but to differ from that species in having male flowers *pedicellate*, instead of *sessile*. Desirous of carrying the inquiry a little further, and of attempting to set at rest the question of the origin of gamboge, I recently addressed myself to Messrs. D'Almeida, who promptly replied to my letter, and forwarded a jar containing numerous specimens of the gamboge-tree cultivated on their plantation at Singapore. These specimens I carefully examined, comparing them with published descriptions and figures, as well as with specimens contained in the herbaria of the British Museum, of the Royal Gardens at Kew, and of the Linnean Society, in which investigation I had the valuable assistance of my friend Professor Oliver. The correctness of Dr. Christison's observation respecting the pedicellate flowers was immediately obvious, and it was also evident that the plant, but for this character, bore a strong resemblance to *Garcinia elliptica;* we noticed further that it came equally near to the *G. Morella* of Desrousseaux. Under these circumstances we thought it desirable to obtain the opinion of Mr. Thwaites, who, besides being an excellent botanist, was familiar with various species of *Garcinia* in a living state, and especially with *G. Morella.* Mr. Thwaites, after examining specimens of the Singapore gamboge-tree, which we had sent to him in Ceylon, replied that the plant was, in his opinion, a form of *G. Morella,* scarcely differing from the Ceylon type, except in having pedicellate instead of sessile flowers. This opinion was completely in accordance with that of Professor Oliver and other botanists whose opinion I had asked, and I therefore felt warranted in bringing the plant before the Linnean Society, in whose 'Transactions' a figure of it has been published, under the following name and synonyms :—

Garcinia Morella, Desrouss., var. *pedicellata.*

G. Morella, Desrousseaux, in Lamarck's Encyclop. Méthod. Botan. iii. 701, pl. 405, fig. 2; Thwaites, Enum. Plant. Zeylan. i. 49.
G. elliptica, Wallich, Catal. no. 4869.

G. Gutta, Wight, Illustr. of Indian Botany, i. 126, tab. 44 (exclus. synon. Linnæi).

Hebradendron cambogioides, Graham, in Hooker's Companion to Bot. Mag. ii. (1836, 193, tab. 27).

Var. β. *pedicellata;* floribus masculis pedicellatis (pedicelli ad 3 lin. longi).

Messrs. D'Almeida informed me that the number of gamboge-trees cultivated on their plantation is twenty-eight, but that it might have been increased to thousands had any pains been taken to do so. The trees are from thirty-five to fifty feet in height, the largest having a circumference of three feet. They grow very luxuriantly, without any attention, on the slope of a low hillock. Gamboge has at various times been extracted from them, but rather, it would seem, as an object of curiosity than for the purposes of commerce.

Professor Bentley said that, in his opinion, Mr. Hanbury had now put the last link in the chain of evidence necessary to prove the botanical source of our commercial gamboge. Commercial gamboge, as was well known, was derived from Siam; it did not differ in any marked particulars from the gamboge of Ceylon, and the botanical source of the two kinds had now been satisfactorily traced to varieties of the same species of *Garcinia*.

ON THE CULTIVATION OF MEDICINAL PLANTS AT MITCHAM.

BY THOMAS T. P. BRUCE WARREN.

The medicinal plants principally cultivated at Mitcham are—lavender, peppermint, chamomiles, roses, liquorice, and henbane. Large quantities of poppies, rosemary, squirting cucumber, belladonna, and pennyroyal are also cultivated, and smaller quantities of spearmint, marshmallow, horehound, foxglove, stramonium, &c.

The amount of ground laid out for the cultivation of medicinal plants varies every year; the total acreage under cultivation at present is 736 acres, and consists of—

Chamomiles (*Anthemis nobilis duplex*)	55 acres.
Roses (*Rosa Gallica et Rosa Damascena*) . .	119 ,,
Peppermint (*Mentha piperita nigra*)	219 ,,
Lavender (*Lavandula vera*)	172 ,,
Henbane (*Hyoscyamus niger*)	30 ,,
Liquorice (*Glycyrrhiza glabra*)	32 ,,
Sundries	109 ,,
Total	736 acres.

The sundries consist of—

Stramonium (*Datura Stramonium*); horehound (*Marrubium vulgare*); savine (*Juniperus Sabina*); pennyroyal (*Mentha Pulegium*); mallow (*Althæa officinalis*); spearmint (*Mentha viridis*); rosemary (*Rosmarinus officinalis*); squirting cucumber (*Elaterium Momordica*); belladonna (*Atropa Belladonna*); foxglove (*Digitalis purpurea*); poppies (*Papaver somniferum*); rue (*Ruta graveolens*); celandine (*Chelidonium majus*); elecampane (*Inula Helenium*); balm (*Melissa officinalis*); wormwood (*Artemisia Absinthium*); hyssop (*Hyssopus officinalis*); tansy (*Tanacetem vulgare*); and many others of less importance.

The greater portion of the lavender and peppermint is distilled for the oils. Formerly, a considerable quantity of chamomiles, rosemary, pennyroyal, rue, and spearmint was cultivated for distillation, but they are now merely dried.

The yield of oil per acre varies with the season and the soil on which the plants are raised; scarcely ever does it happen that two acres turn out alike; hence different growers obtain different amounts of oil.

The average yield of oil from lavender is from 10 lb. to 11 lb. or 12 lb. per acre; one grower informed me that it averaged from 12 lb. to 24 lb. per acre.

I have been assured by a distiller that even more than 24 lb. of oil were obtained from lavender some years ago, and that the plants remained good for four or five years; but the maximum yield of even the best summers of late years is about 12 lb. per acre.

The lavender plants are now renewed after three years; and it is a singular fact, due, no doubt, in part to a want of skill in planting and slipping the plants, that the yield of oil, even from the third year's growth, is scarcely sufficient to repay for the labour and expense of distilling,—the yield of oil from plants of the second year's growth being greater in every case than either that of the first or third year's.

The yield of oil per acre, from peppermint, likewise varies with the season; the yield obtained by different growers is from 8 lb. to 12 lb., 10 lb., 8 lb., to 12 lb., 10 lb., 8 lb.

The effects produced by the qualities of the soil are more striking in the case of peppermint than in any other plant. Two crops of peppermint standing side by side indicate, when distilled, considerable difference in the yield of oil, and the smaller quantity is not unfrequently obtained from that crop which had the most promising appearance; and it has been remarked by many growers, both at Carshalton and Mitcham, that peppermint plants raised at Mitcham and laid out at Carshalton* yield a very different product when distilled, both in the aroma of the oil and the quantity obtained. I may observe that equal care is taken both in tillage and cultivation, and that the superiority of the Mitcham produce is due to some peculiarity of the soil alone.

I examined a sample of chamomile flowers, which the grower

* Carshalton is the parish adjoining Mitcham.

informed me he cultivated entirely for distillation, and which as dried flowers he had a difficulty to dispose of. I could see no difference, further than the flowers were fuller and more expanded. It is not improbable that the oil receptacles might have an abnormal development by manuring and particular care. I do not believe that it is a distinct variety. The yield of oil per acre from this kind is 8 lb.

The yield of chamomile flowers per acre is about 4 cwt.

Pennyroyal yields about 12 lb. of oil per acre; and so extremely variable is this plant in its yield of oil, that one grower informs me that he obtained only five ounces from a quarter of an acre: of course, he ceased to cultivate pennyroyal for distillation.

The Provence rose is extensively cultivated for the production of rose-water; large quantities are also dried for the London markets. The damask rose is cultivated by a few growers for drying, and is never distilled. During a favourable season, 300 bushels of roses are produced per acre.

If all the lavender and peppermint cultivated were distilled, the amount of oil supplied by Mitcham will be about 2,190 lb. ol. menthæ pip., and about 2,060 lb. ol. lavand.; but as a considerable quantity of lavender is "bunched" and dried, the amount of oil supplied must be much less. Between 30,000 and 40,000 bushels of roses are annually produced in Mitcham, and about eleven tons of chamomile flowers. Great care is taken in gathering and drying these flowers. The roses are collected before sunrise. They are dried in ovens heated by air, and are maintained at a constant temperature of 100° F. by a regulating arrangement. After the chamomiles are dried they are "picked." This operation consists in separating the darker flowers. The "bunched" plants are dried in open sheds, secluded from the action of direct sunlight.

The stills are of very large capacity, holding from 1,000 to 2,000 gallons. A charge occupies from six to eight hours. The distillation is conducted at the lowest possible temperature; and, as soon as the contents of the retort have reached the boiling-point, the fire is withdrawn.

The finest portion of the oil comes over during the first period of distillation, and the receiver is exchanged. Only two qualities of oil are generally collected and the receivers are exchanged after three hours' run. There is a peculiar fragrance and delicacy in the oil first obtained, which is decidedly wanting in the product which comes over towards the end.

I find that a much less proportion of camphor exists in the Mitcham oils than in oils generally. This might be due to their freshness, and to the peculiar alchemistical notions of the distiller of conducting everything in the dark. No doubt, exclusion from the actinic rays is as desirable for the preservation of essential oils as other products of the vegetable kingdom. The oils generally are of very light specific gravity, and their refractive power is very great.

In operating with such large quantities of water, involving as it must some considerable loss of oil, a plan was tried, some time ago, to economize this unnecessary consumption of the oil, by using the impregnated water for successive charges of the retort, but the expense of pumping and storing away this water was greater than the loss arising from the solution of the oil.

The extracts obtained from belladonna, foxglove, stramonium, henbane, poppies, and elaterium, cultivated at Mitcham, are in their action and appearance very good.

In the laboratory of Mr. William Hooper these cultivated plants have been very extensively consumed ; and there can be no doubt but that the uniformity of these extracts, as regards their medicinal activity, is due in part to cultivation ; but it must not be overlooked that the process by which these extracts are obtained is calculated to preserve the activity of the plant,—for extractive matter, if oxidized, ceases to be soluble.

The soil of Mitcham is generally a good holding one, that is, retains moisture well, and is naturally rich. It varies in depth even on the same estate, being in some places only a few inches, whilst in others it is several feet.

Most growers supply large quantities of manure to their land, but evidently do not supply the elements abstracted by the growing crops, as the yield is continually diminishing. They do not lay out for two successive seasons the same plants on the same ground. This is axiomally admitted by them to be as desirable as the rotation of agricultural crops. Some growers plant potatoes, &c., after peppermint ; and after renewing the soil with manure, again plant peppermint. This plan is considered highly beneficial to the production of crops.

The uncertainty of the seasons in England, and the introduction of foreign produce, have considerably reduced the annual production of Mitcham. A large farm, consisting of more than 1,000 acres, which was a few years ago laid out with lavender, peppermint, roses, chamomiles, carraways, and henbane, is now employed entirely for the production of cereal crops ; and most growers, rather than meet with the disappointment of a failure, lay out a large proportion of their land with culinary vegetables.

The flowers obtained during a very dry season such as the past yield a larger proportion of oil than the flowers obtained during an ordinary summer ; but, from the combined effects of the frosts during the latter part of May, less oil will be obtained this year than for years past. The yield of oil of lavender will be from 4 lb. to 5 lb. per acre.

I have intentionally omitted to include in this paper the analyses of the soils, as I consider them more intimately connected with the phenomena of cultivation when considered in reference to physiological effects.

IRON MINIUM.

Iron Minium, a colouring matter founded on the iron principle, is destined to supplant red lead and other pigments that have been used until now for coating wood, iron, and other metals. The advantages of iron minium are, its solidity, durability, cheapness, and, above all, its property of preserving the iron completely from oxidation, and of hardening the wood. These qualities, now acknowledged by first-rate manufacturers, have assured the fullest success to the iron minium, which is advantageously employed all over Europe in the largest manufactories and sugar works, as well as by the railway and steam navigation companies.

The great solidity of this new paint is principally due to its extreme purity. It contains no acid, no adulteration, and is therefore superior to lead minium, which contains almost always large quantities of powdered brick ; to the ochres, which are nothing but washed clay ; and to colcothar, which by its very mode of production contains always some sulphuric acid—a small quantity, it is true, but quite enough to attack the iron and to eat into it, after a very short space of time.

Iron minium forms a very smooth and stripeless coat upon the iron, varnishing, as it were, the metal, and preventing the atmospheric influences from having any action upon the paint.

It results, from statements made by eminent English and French chemists and engineers, that the use of red lead, and generally of all preparations in which lead is employed, is injurious to the iron coated with it. They examined vessels in which the iron, after one single voyage to the East Indies, was visibly corroded, and blisters discovered on the coating itself, containing a clear liquid, and exposing thus the iron, which presented a certain number of metallic crystals. Each blister was found to be a sort of galvanic battery, and corrosion in such a case is unavoidable, because there is always a chemical action going on, whenever electricity is produced. This phenomenon must needs continue, as long as there remains any red lead, in consequence of the immediate contact of the lead paint with the metallic surface. Red lead, therefore, as well as any other lead pigment, ought to be completely excluded from the paint of iron vessels.

The best result, therefore, has been obtained by coating with iron minium the exterior and the interior of iron vessels.

Iron minium has been tried by first-rate manufacturers, and always to their greatest satisfaction ; it is employed in the most important building yards ; for sugar works; for railways and steam navigation ; for the prisons of Belgium and other countries ; it has been adopted by the great public services, civil and military, in almost all the countries of Europe.

Iron minium is also preferred for the under coat of all the running railway material, the painting inside and outside of the waggons, as well as for the under and upper part of carriages.

Locomotives, tenders, and iron and wooden bridges are all, with great advantage, coated by this minium.

It also covers usefully all kinds of tarpaulins.

The iron minium is employed the same as all other paints, with boiled or unboiled linseed oil; if the oil is not boiled, some dryers must be added, for instance litharge, or any good siccative, but not turpentine. For iron vessels or any works exposed to the contact of salt water, it is necessary to take boiled flax oil, and not to employ litharge, but a good siccative, and not to expose the object to the action of the water before the painting is perfectly dry.

Iron minium mixes easily with other colours; such as black, yellow, green, &c.; and by so doing a variety of colours is obtained to the convenience of persons who would not like the dark brown of the iron minium paint.

It has been proved by experiments that the iron minium paint lasts twice and even three times as long as red lead paint.

Iron minium has also been employed for the painting of sugar vats, standers of iron plate or cast-iron boilers, and all kinds of steam-engines; it resists generally the strongest heat. Mixed with mineral tar it forms an excellent coat for wooden vessels, since it hardens the wood to a remarkable degree. It is most advantageous for gas tubes.

It is another important advantage of this paint, that mixed with oil there is no apparent alteration, whilst red lead, when it remains a few days not used, shows some clots not to be reduced, and brought forward by the influence of the oil on the oxide of lead.

The iron minium paint is to be applied in several layers: the first ought to be thin, the second a little thicker. The proportions of the mixture are as follows:—

One pound of iron minium to be ground with $1\frac{1}{4}$ per cent. of boiled or unboiled flax oil: to be added, 1-20 per cent. of dryers.—*Practical Mechanics' Journal.*

THE SPONGE FISHERY OF THE OTTOMAN ARCHIPELAGO.

BY M. BILIOTTI,

BRITISH VICE-CONSUL AT RHODES.

As sponges form the principal article of exportation from this district, and as a great portion of them is sent to Great Britain, I think it may be interesting to enter into some details on the subject.

There are nearly as many different qualities of fine, common, and coarse sponges as there are spots of fishery. The sponges in this quarter are known in commerce by the names of the respective coasts where they dive for them.

I show in the following statement the spots where the inhabitants of the islands in the Ottoman Archipelago dive for sponges, the five categories into which the sponges can be divided, and the difference which exists between these.

The following is a statement of the spots where the inhabitants of the islands in the Ottoman Archipelago dive for sponges. These sponges may be divided into five categories, besides the ordinary classification of fine, common, and coarse:—

1. Bengazi (comprising the sponges fished in the Gulf of Sidra, Tripoli). Few fine sponges are fished in this Gulf. They are dark-coloured, and much hollowed in the centre. The common and coarse sponges, although of a rather darkish colour, are considered, in consequence of their nice forms, to be the best after the Mandruha.

2. Mandruha (comprising the sponges fished between Egypt and Cape Ras Sem). All the sponges from these coasts are of a beautiful colour, and mostly of nice forms.

3. Syria (comprising the sponges fished from Egypt as far as Alexandretta). The sponges fished between Tripoli and Alexandretta are inferior to those found between Tripoli and Egypt. The third category of fine sponges comprises also good sponges, but small.

4. Caramania (comprising the sponges fished from Alexandretta as far as Castel Rosso). All the sponges from these coasts are considered to be of a very inferior quality, in consequence of their being reddish towards the root. This colour is probably owing to the nature of the rock on which they grow.

5. Cyprus. The sponges fished on the north side of this island, both fine and common, are comprised in the second categories, being superior in quality to those fished on the south coasts. The common sponges found in this last spot are considered as the worst of all sponges known, being almost rotten. There are no coarse sponges on the coasts of this nor on those of any other island.

6. Crete. The sponges fished on the south coasts of this island are, on the contrary, good, and those on the north bad. Those from the first spot are comprised in the second categories.

7. Rhodes, Stampalia (Turkish Island), Fareglia, Levitha (Greek Islands), Amorgo, on the coast of Anatolia, near the Seven Capes. Although finer, perhaps, than those of Mandruha, they are, however, placed in the same category, as they contain less sponges of good forms. Few of the common sponges have fine spaces; they are placed in the second category, and the remainder in the fourth.

8. Other Turkish islands in the Archipelago. The fine sponges obtained here, owing to more irregularity in their forms, are considered as inferior in quality to those fished in the preceding islands. Amongst the common there are more of nice forms than in the former.

9. Greece. Of all sponges fished by the inhabitants of these islands, those from Greece in general are considered the most inferior, in consequence of their very irregular forms. Those fished on the north coasts are the best. The fifth category is the worst of all sponges known in these parts for shape and colour.

It is by no means necessary to suppose that there are spots where nothing but good sponges are found. Even in the Mandruha sponges, which are considered to be the best, there are only about 30 per cent. of this description, while in those from the worst spots, such as Greece, there are sponges as good as at Mandruha, but no more than about 7 or 8 per cent.

The foregoing classification, therefore, is based on the proportion of good sponges, which are usually found amongst those coming from the above-mentioned places.

Merchants, when they purchase sponges, take into consideration the form, the size, the colour, the quantity of extraneous matters contained in them, such as stones, sand, or a kind of viscous white substance embodied in the sponges, and which come out of it in proportion of their being more or less washed shortly after they have been fished. All these circumstances increase or decrease the mercantile value of nearly every fishing boat, and render this trade very difficult; more especially as, with the exception of the Mandruha and Bengazi, which are paid so much a piece, the other sponges are usually sold in a lump, for which a price is fixed upon between the sponge diver and the merchant.

Lately, however, as the divers experienced that it was not worth their while to introduce sand in the sponges, with a view to make more profits, they begin to offer them for sale without sanding them, a circumstance which has induced merchants to purchase again sponges by weight.

The Bengazi and Mandruha sponges, however, are, and will always be, sold at so much a piece.

As a general rule, the sponges, as classed above, are sent to the following countries :—

Large-size sponges of first, second, and third categories to Great Britain.

Small-size sponges of the same categories to France and Italy.

Sponges of fourth, fifth, and some of the three other categories to Austria.

The average prices do not always agree with the classification made below, to which different circumstances concur, such as greater demand on one quality, unsuccessful fishery in a particular spot, and many other causes which it would be useless to enumerate. In 1863, for instance, the common sponges from Bengazi, although inferior in quality to those from Mandruha, were sold 20 piastres more per oke. This circumstance is owing to the Bengazi sponges having been purchased immediately after some common sponges having been sold at Trieste and Marseilles at high prices, which had induced merchants to believe that there was in Europe a great rise on the article, which, however, was not the case. Good common sponges fetched in general, in 1863, 20 per cent. more than in the preceding year, but inferior qualities have been paid 10 per cent. less. Of fine sponges there has been no difference of note between the prices of the last two years, while a rise of 25 per cent. has taken place on coarse sponges.

I show in the following table the respective cost per oke of the three different kinds of sponges, also of those sold per piece, which I have proportionately reduced in order to afford a criterion of the prices.

Names.	Fine.			Common.			Coarse.	
	£	s.	d.	£	s.	d.	s.	d.
Bengazi . . .	1	8	4	1	5	0	6	8
Mandruha . . .	2	3	4	1	1	8	11	8
Syria	2	3	4	0	12	8	4	2
Caramania . . .	1	16	8	0	10	0	3	0
Cyprus . . .	1	16	8	0	10	0	...	
Crete	2	10	0	0	12	6	...	
Rhodes . . .	2	18	4	0	10	0	...	
Other Turkish Islands	1	16	8	0	10	0	...	
Greece	1	10	0	0	10	0	...	

It is to be regretted that British sponge merchants continue to procure their sponges through second or third hands, instead of sending, as several French mercantile houses have done for some years, agents here who purchase the sponges direct from the divers at much more convenient prices than they used to get them formerly through Smyrna merchants.

The following particulars show the number of boats from each island employed in 1863 in the sponge fishery, the respective places where their crews dived, and the sums in round numbers derived therefrom by each island and from each fishing spot:—

From Syria 210 boats divided 4,080,000 piastres. The spots where they fished were, 40 at Bengazi, 60 at Mandruha, 10 at Syria, 50 at Caramania, and 50 at the Turkish Islands.

From Calymnos and Leros 295 boats divided 4,300,000 piastres: 22 fished at Bengazi, 43 at Mandruha, 10 at Syria, 30 at Caramania, 20 at Cyprus, 70 at the Turkish Islands, and 100 on the coasts of Greece.

From Halki there were 57 boats, which shared 1,000,000 piastres: 3 fished at Bengazi, 4 at Mandruha, 45 at Crete, and 5 about the Turkish Islands.

Thirty Castel Rosso boats fished at Caramania, and divided 550,000 piastres, 15 boats from Stampalia and Telos about the Turkish Islands, obtaining sponges for which they obtained 200,000 piastres.

The aggregate sum divided between the 607 boats was 10,130,000 piastres, which was obtained in the following localities :—

Fishing Spots.	Boats.	Piastres.
Bengazi	65	1,440,000
Mandruha	107	2,110,000
Syria	20	430,000
Caramania	110	1,500,000
Cyprus	20	500,000
Crete	45	800,000
Turkish Islands	140	1,950,000
Greece	100	1,400,000

The number of boats employed in the sponge trade that called at Rhodes or fished in the neighbourhood of the island during the five years ending 1863 was as follows :—

	Vessels.	Tonnage.
1859	89	222
1860	67	400
1861	100	620
1862	69	380
1863	103	795

The crews employed in these have ranged from 439 men in 1860, to 750 in 1863 ; on the average there are about seven hands to a boat.

[In the first volume of the Technologist, p. 17, we gave a detailed account of the extent and character of the sponge fishery in the Turkish seas, with statistics brought down to the year 1858 ; the present article brings the information to a more recent date. In vol. iii., p. 168, some particulars were given of the returns of the fishery for 1861. The following figures supplement the information given in vol. i., p. 20, on the imports of all kinds of sponge into the United Kingdom :—

	Quantity.	Value.
1859	204,772 lbs.	£26,240
1860	272,588	48,095
1861	697,829	137,489
1862	544,882	100,204
1863	474,748	77,907

A French savant, M. Artus, has been experimenting on the bleaching of sponges. Some good sponges were well washed by M. Artus, in river water, and whilst still wet were placed in a bath of six parts water and one part commercial hydrochloric acid, and were allowed to remain until all the carbonic acid gas was discharged. They were then washed again, and afterwards strung together and immersed in hydrochloric acid diluted with 6 per cent. of hyposulphite of soda dissolved in water. The vessel was then closed, and left for forty-eight hours, when the sponges were taken out, washed, and dried. M. Artus tried another experiment, in which the quantity of hyposulphite of soda was doubled. In a third experiment the sponges were, on removal from the bath, treated with hydrochloric acid, subsequently well washed, and then exposed to sulphurous acid gas. The sponges, however, by each of these processes were not thoroughly bleached, and a fourth method was tried. The sponges were well washed in hot diluted soda lye, then placed in a bath of weak hydrochloric acid and hyposulphite of soda, using only half the quantity of hyposulphite that was used in the first experiment, and a very satisfactory result was thus obtained.—EDITOR.]

ESSENTIAL OILS FROM INDIGENOUS PLANTS OF VICTORIA, ADAPTED FOR USE IN MEDICINE, PERFUMERY, ETC.

UNDER this heading all the oils obtained from the genera Eucalyptus and Melaleuca might be enumerated, inasmuch as they are all possessed of medical properties. In this respect it is probable that they differ from each other only in degree, and that essentially they will all be found to act as diffusible stimulants, anti-spasmodics, and sudorifics, greatly resembling the oil of cajuput to which they are so closely related botanically, and which they approach so nearly in their physical and chemical properties.

Atherosperma moschatum (Native Sassafras).—This beautiful tree requires a humid soil and climate, and is met with in the Fern Tree gullies of Victoria, and Tasmania, sometimes in considerable abundance; it attains in such localities the dimensions of a middle-sized tree. The bark of the *A. moschatum* is now recognised in this colony as a useful addition to the Materia Medica, and is rising in the estimation of medical men. It contains an essential oil obtainable by distillation, which acts with great energy upon the vital functions; the manufacture of which in quantities is now regularly prosecuted. It is sold for about 15s. per ounce.

This oil has a thin unctuous consistence, and a pale yellow colour when first distilled, deepening to a yellowish brown by age. Its smell is oppressive and disagreeable, resembling that of the sassafras oil of commerce—whence the popular name of the Victorian tree—with an admixture of oil of carraways. Its taste is aromatic, and rather agreeably bitter, producing a local prickling sensation upon the tongue, which lasts for some time, but does not extend to the fauces. This oil is heavier than water, its specific gravity being 1·04, and its boiling point is very high, namely, 446° F., the mercury continuing to rise until it reaches 473°. It burns under all circumstances with a very smoky flame.

The physiological effects of this oil, in small doses, are described as diaphoretic, diuretic, and sedative, and it appears to exert a specific lowering influence upon the heart's action. As a medicine, it has been introduced into the hospitals, and employed in cases of heart disease; the dose being one drop administered at intervals of six or eight hours. In large quantities it must be regarded as a dangerous poison. Rubbed externally upon the skin, it does not, like the myrtaceous oils, act as a rubefacient or irritant.

In the preparation of this liquid the bark is reduced—if possible while it is yet green—to small shavings or chips; 100 lbs. of these when dry yield 18 ounces 6 drachms.

The leaves of the Victorian sassafras also yield an essential oil, of which as yet no examination has been made.

Although partaking of the nature of a digression, it has been thought advisable to attach to the description of the oil of the Victorian native sassafras the following remarks, bearing upon some of the other proximate constituents of this interesting bark.

For some years past it has been known that a decoction of the bark of the *Atherosperma moschatum* was possessed of valuable therapeutic properties, as a diuretic and diaphoretic, some of the first physicians in Victoria having employed it also in bronchial affections with beneficial results. The decoction of this drug is a dark-coloured fluid, of a peculiar bitter flavour, from which by far the greater part, if not the whole, of the volatile oil is expelled by boiling. To the latter substance therefore its physiological effects cannot be ascribed, and require to be sought for in some other active agent. Judging from these facts, Dr. Mueller acquired the conviction that the bark contained an alkaloid, or other equally important substance, the investigation of which would lead to valuable practical results; and he accordingly forwarded a quantity of the new drug to Professor Dr. Wittstein, of Munich, who entrusted its analysis to M. N. J. Zeyer, and the result has proved that Dr. Mueller's anticipations were well founded.

M. Zeyer has published a detailed and very interesting account of the results arrived at, and the methods he employed to obtain them. He found the bark to contain, in addition to woody fibre, an essential oil, a fat oil, colouring matter, wax, albumen, gum, sugar, an alkaloid, starch, resin, tannic acid, butyric acid, and oxalic acid, together with inorganic substances consisting chiefly of lime, salica, and the alkalies, and amounting in weight to 4·05 per cent. of the bark, dried at 212° F.

Of the above substances, the alkaloid is undoubtedly the most important; its existence has not hitherto been known, and to it the name of Atherospermine has been given. The properties of this substance are peculiar, and without entering too much into detail, the more important of them may be summed up in a few words.

Atherospermine presents the appearance of a greyish white powder, exceedingly light, and electric; its particles showing a great tendency to adhere together in little masses. It has no smell, and tastes persistently bitter. Under the microscope it gives indications of a commuted crystalline character. Heated carefully *per se*, it melts, and emits the odour of putrifying meat, which is followed by empyreumatic vapours. It melts at 262·4° F. In water it is but little soluble, 1 part requiring 600 parts to dissolve it; but even this quantity imparts a bitter taste to the water. Ether and boiling alcohol both take it up; the solution in the latter giving an alkaline reaction. It is very soluble in chloroform, sulphide of carbon, and oil of turpentine, also in dilute and concentrated acids. M. Zeyer has obtained for this substance the formula $C_{30} H_{20} NO_5$.

Its physiological effects have not as yet been subjected to investigation.

The extract prepared from the decoction of this bark, produced while operating upon it in the still, contains, judging from M. Zeyer's analysis, the new alkaloid and tannic acid, or rather a peculiar variety of that acid, together with most of the other organic substances enumerated above, with the exception of the resin, which boiling water alone is not capable of separating from the woody portion of the bark left in the still.

In concluding this account of the *Atherosperma moschatum*, it is of interest to draw attention to the fact, that this tree belongs to the Monimiaceæ, a family of plants largely represented in South America, and also found in Asia and Australia; but from which, until the present time, no drug has been procured.

Prostanthera lasianthos.—This species of Prostanthera is widely distributed, and is one of the most common of the smaller trees met with in the forest valleys of Victoria and Tasmania, as also in a portion of New South Wales. The oil is procured from the leaves, which, should its medical properties bring it into request, could without difficulty be obtained in large quantities for distillation. The oil is a limpid, greenish-yellow fluid, of a mint-like odour, and rather mild mint-like taste; the after-taste is not disagreeable. The specific gravity of this fluid is 0·912, and the yield from 100 lbs. of fresh leaves is 2 ounces 4½ drachms. It is worthy of remark, that this plant is one of the few species of the comprehensive order of *Labiatæ*, which attains to large arborescent growth.

Prostanthera rotundifolia.—This plant is of a shrubby character, and is not so common as that which has just been noticed. It yields an oil which resembles that from the *P. lasianthos* both in smell and taste. In colour it is darker, and its specific gravity is also considerably higher, being 0·941. The yield from 100 lbs. is 12 ounces.

Mentha Australis.—This plant and the two following are true mints; they do not exceed the size of herbs, or half shrubs. They are all available in very considerable quantity in Victoria, and are also found in New South Wales, South Australia, and Tasmania. Of the *Mentha Australis* three samples of oil were forwarded to the Exhibition of 1862. It is procured by the distillation of the herb; and as the leaves do not constitute more than one-fourth by weight of the whole, its productiveness must be regarded as tolerably considerable. The yield is variously stated, as will be found recorded in the table concluding this class of oils. Owing to the smallness of the quantities produced, the specific gravity of this oil could not be determined. In taste and smell this oil hardly differs from ordinary oil of peppermint, but it may be described as somewhat coarser than the best samples of that substance.

This oil would undoubtedly be a saleable commodity in Australia, for the use of the druggist and confectioner, in place of the imported peppermints, some of which suffer adulteration to a large extent.

Mentha grandiflora.—This mint has a fiery, bitter, and very unpleasant nauseous taste, together with the characteristic after-taste ; it could not be used as a substitute for common peppermint, except for medical purposes. Its specific gravity is 0·924, and its yield 5 ounces from 100 lbs. of the fresh herb.

Mentha gravilis.—The herb from which this oil is produced contains a portion of its volatile oil in the stems ; the total yield from 100 lbs. of the green plant being 3 ounces. In its properties this oil resembles the *M. Australis* more closely than the *M. grandiflora*. Its smell is like oil of peppermint, with a slight admixture of pennyroyal. Its taste is very diffusible, but less pungent than the officinal oil.

There can be no question that for medical purposes the three oils of the genus Mentha, which have been described, would prove to be carminative stimulants like the European species.

Zieria lanceolata.—This shrub or small-sized tree is an inhabitant of moist valleys and river banks, in Victoria, New South Wales, and Tasmania. Its botanical classification requires it to be placed with the plants of the Rue tribe, and in the same category with the next following genus.

It is thought that both these plants might be used medicinally as substitutes for the South African buchu.

The supply of oil from the leaves of the *Zieria lanceolata* is tolerably copious, 100 lbs. of the fresh green shrub inclusive of branchlets furnishing 6½ ounces of a pale yellow limpid oil, the odour of which is hardly distinguishable from that of the oil of rue, though perhaps a little less intense and penetrating. Its taste is very disagreeable and acrid, strongly resembling that of rue. The medicinal action of this oil is that of a diuretic and diaphoretic.

Eriostemon squameus.—The oil from this shrub resembles that of the preceding, but is less disagreeable, and more aromatic both in taste and smell, and is in these respects also preferable to oil of rue. 100 lbs. of the freshly gathered leaves and branchlets yield 4 ounces of a pale yellow oil.

Pittosporum undulatum.—The essential oil from the blossoms of this plant is a limpid colourless fluid, lighter than water, of an exceedingly agreeable odour, resembling the perfume of jasmin flowers. Its fragrance is best developed by solution of a small quantity of the oil in dilute alcohol, in which it is but sparingly soluble. In taste this substance is disagreeably hot and bitter, with a slight trace of the flavour of the oils of turpentine and rue. Iodine when brought in contact with it gives rise to an explosion.

Irrespective of the odour which the blossoms of this plant exhale, it is a highly ornamented bush, which would flourish well in the South of France, and the distillers of essences and perfumes in that country might cultivate it with great advantage, as it is easily raised from seed, and blooms with great profusion, and would afford a new and agreeable perfume.

Its habitat in Victoria is Gipps Land; it is also found in New South Wales. The seed vessels contain an essential and a fat oil.

This species of Pittosporum is the first likely to be of practical importance; its leaves yield a very bitter extractive principle, as in a still higher degree do also those of the *Pittosporum phillyroides.*

TIN AND ITS USES.

FOR many years the chief resources for the supply of tin, which enters so largely into the uses of common life, were some parts of Cornwall and some of the eastern islands on the equator; but this is now no longer the case, for it has been added to the catalogue of discoveries of the great deposits of copper and gold in Australia; and it is more than likely, as civilisation extends, other localities will be discovered possessing sufficient of this useful article to satisfy the exigencies of the day. It is therefore not unimportant, at a time like the present, when the enterprising minds of Englishmen are concentrated upon exploring the resources of our colonies, especially Australia and New Zealand, to indicate, as an incentive and a guide to research, some of the characteristics of this branch of metallurgy as practised in Cornwall.

Tin is a crystalline metal, and its quality variable in accordance with the quantity and description of alloy with which it is permeated; thus, mechanically judging, a piece of tin cast in a mould of sandstone, if maintaining a spotless surface, will be very ductile, because no abrasion occurs to its crystals in separation; but if the surface is clouded, it is the presence of some extraneous matter hardening the metal, causing in deflection a fracture of the crystals. It is thus, by comparison, that a quality or condition is determined, which places the varied products of a wide range of lodes and deposits into a classification, under the following denominations of common, refined, tin-plate, and best grain tin.

Tin, as Robert Hunt informs us, was obtained at a very early period from these islands. The Cassiterides, or Tin Islands, were celebrated in ancient histories and in classic song. The Scilly Islands have frequently been considered as the Tin Islands of the ancients, although there is not the slightest evidence that tin was ever found in any quantity on them. Certainly, no tin is found at the present time in any of this interesting group of English islands. There can be but little doubt that the term "Cassiterides" was applied to the western promontory of this island; and if we look at Western Cornwall from the British Ocean, it assumes the appearance of a collected group of islands. Indeed, an alteration of a few feet in the levels of the land and ocean would at once give an insular character to that portion of Cornwall which lies westward of the line extending from Marazion on the south, to Hayle on the northern sides of the county.

Regarding, after the most careful examination of all the evidences which have been brought into the discussion, St. Michael's Mount as the Ictis of Diodorus, I am disposed to believe that the tin districts westward of Helstone, and those around St. Austle, supplied the ancient world with the largest quantities of tin, which they knew so well how to use, although I cannot but think it probable that some may have been derived from the Islands of the Indian Archipelago. Tin *mining*, in the strict sense of the term, was unknown before the time of the Romans. The Britons, or rather that tribe of them grouped under the general epithet of the Damnonii, who maintained themselves so long as a separate family to the west of Exeter, obtained the tin they used or sold by washing the drift deposits of the valleys; and from the evidences which have from time to time been discovered, the process of washing adopted by our ancestors was similar to that which may now be observed with the modern tin streamer of Cornwall, or the gold washer of Australia.

There are many evidences that the Romans made great excavations in search of tin: but subsequently the tin trade of Cornwall passed into the hands of the Jews, and the remains of Jews' workings—Jews houses, &c., as they are called, sufficiently prove the extent of their search. They appear to have confined themselves to washing processes, or merely to have followed the veins appearing on the exposed faces of the rocks. We have no means of ascertaining the quantities of tin raised by the Jews, but it was less than half the quantity which has been produced in Cornwall during the last century. In the search for stream tin, it is curious to observe the circumscribed limits by which the streamer has been bound, the districts of St. Just, of Helstone, and St. Austle being the most marked. Tin mining has been for some time carried on to a great extent, and it is extending.

The total quantity of tin ore raised in Cornwall and Devonshire in 1853 was 8,866 tons, the average value of which was about 68*l.* per ton. In 1861 it was 11,640 tons, valued at 725,560*l.* Metallic or white tin produced from the above 7,016 tons. The black tin, or tin ore, produces on the average 65 per cent. of metallic, or white tin, as it is called. The quantity of this metal of British produce brought into the market is about 6,000 tons annually. Our annual imports of tin from Singapore, our Indian territories, from China, Peru, and Brazil, amounts to 2,700 tons. Of this foreign tin there is re-exported about 1,100 tons, and of British tin about 4,400 tons annually.

Much tin ore is contaminated with wolfram, which, as it cannot be removed by the ordinary process of dressing or cleansing, or by the opetions of smelting, remains with the metal and renders it of low value. At the Drake Walls Mine they employ a process invented and patented by Mr. Robert Asland. This process is essentially one for effecting the combination of the tungstic acid of the wolfram with soda by roasting and dissolving out the tungstate of soda formed, leaving the pure tin behind. Although at present there is no demand for the tungstate of soda, or for the tungstic acid, and it is allowed to run to waste, the increased value of the tin ore thus treated renders the process profitable. Mr. T. A. Phillips has also introduced a process for the purification of tin, which promises many advantages.

Attention should be directed to this curious metal—tungsten and its salts—since it appears highly probable that it may be rendered available for some important manufacturing purposes. One of the purposes to which tin is applied is to enable the dyer and calico-printer to give permanence to his reds and scarlets. For this muriate of tin is largely employed—it was expected that tungsten would have answered this end, and that thus a market might have been created for a new material. Hitherto, however, the experiments have not been successful. Mr. Young has patented a process by which stannate of soda is formed directly from the ore, and this preparation is extensively employed.

It was formerly considered that tin was one of the superficial formations, and that it was useless to seek it at any great depth below the surface. A remarkable example of the incorrectness of this view exists in Dolcoath Mine, near Camborne. This mine was, more than a century since, worked as a tin mine, and was exceedingly productive. As it increased in depth, the mine became poor for tin and exceedingly productive for copper, and as a copper mine was profitable for a long period. Eventually this mine became so poor that the water was allowed to accumulate in all the lower levels, and those near the surface alone were worked. At length a mining captain advised the removal of all the water from the mine. The recommendation was adopted, and now, at the depth of nearly 300 fathoms—far below the copper—an immense formation of tin is being worked. In 1853 there was produced from this formation 120 tons of tin ore, which was sold for 7,658*l.* 5s. 2d. Huel Basset, Huel Buller, South Huel Francis, are, strictly speaking, copper mines, producing, however, large quantities of tin at considerable depths.

The early history of the Cornish mines, their discovery, and the primitive modes of working them, have occupied the attention and given rise to great research on the part of many writers and antiquarian students ; and Mr. Hawkins, in a volume of 'Transactions of the Cornwall Geological Society,' has given the world an interesting and instructive essay thereupon. That the Romans worked tin mines in Cornwall there is no room to doubt, and Roman coins have frequently been discovered in mines and stream works. Touching the tin trade of Cornwall in the middle ages, Mr. Hawkins remarks, that there appears at all times to have been a steady demand for it in the markets of the East, from the invariable usage in those countries of tinning the inside of their kitchen utensils, which are composed of copper, and that a great increase of demand arose in the eighth century, when bells of great size were frequently cast for cathedrals and churches, and when their use became general. In the thirteenth century the mines were very productive, for Richard, Earl of Cornwall, then possessed immense wealth derived from that source. The introduction of brass guns for field artillery in the fifteenth century created also a new demand for the main ingredient in the composition of that metal.

It may be stated, that there is a court for the administration of justice, exclusively devoted to the tinners of Cornwall, and this is called the *Stannaries* (from *stannum*, Latin for tin). The rights and privileges of the tinners are confirmed by a charter of very ancient date—of the reign, indeed, of Edward I. There is a volume called the 'Laws of the Stanneries,' and these go into the minutiæ of the working of mines, buying and selling their produce, &c.

By far the larger portion of tin ore raised in Cornwall is found in lodes, and, consequently, mineralised with the contents of those lodes, whatever they may be, but which are generally sulphur, lead, iron, blende, &c., and always combined with oxygen for a base. The miner's occupation does not cease until he has prepared it for the smelting-house, by stamping, washing off the matrix, and evaporating the sulphur by calcination ; and in this condition it is brought to the smelter, who purchases an oxide of tin, according to the quantity of metal contained, and its quality, by assay ; this, when smelted, is called block, or technically, common tin. It is used for making pewter, piping, plumbers' solder, &c., and it is also cast into small strips, and called bar tin ; and so exported, chiefly to Turkey, from whence it finds its way into the interior of Asia Minor, where it is used in the fabrication of culinary and other articles.

The refined and purest tin is that which is used in the manufacture of tin plate, the tin being used for this purpose in a molten state, and thin plates of iron dipped into it, just like dipping thin boards of wood into liquid varnish. The metal plates for tinning are made of the best charcoal iron. All the oxide is first removed from them, then they are scoured bright, and kept in soft water ready to be dipped in the molten tin. The tin is melted in an iron pot over a fire, and its surface is covered with about four inches of molten tallow. The prepared plates are dipped in this, and left to steep for an hour or more, when they are lifted out with tongs, and placed on a block. The plates generally have a surplus quantity of tin adhering to them when taken out of the first pot ; this is removed by dipping them into a pot of molten tallow and brushing. Great care and experience are required in all these manipulations in order to cover the plates smoothly, and not have too thick or too thin a coating of tin. More than 55,000 tons of tin plates were exported from Great Britain in 1863.

The covering of such an oxidizable metal as iron with tin, like a varnish, is one of the most useful qualities which this metal possesses, and renders it better adapted for making various vessels, such as our common tinware, than any other metal. Nails, bridle bits, and many small articles of iron may be covered with tin by first scouring them to remove the oxide, then dipping them into the molten tin.

The metal is so ductile, that it can be rolled out into sheets of tin-foil as thin as writing-paper. It is now much used for covering tobacco, for coarse gilding, for what is called " silvering looking-glasses," and for bronzing powders.

Peroxide of tin is used by jewellers as a polishing material ; and fused with glass it forms a white opaque enamel. It is much used mixed with copper, to form useful alloys of metal, such as gun-metal, the specula for telescopes, the bearings for shafting, the bronze of statues, and was used by the ancients for swords, spears, and armour ; and, it is said, these were tempered by a process now lost to the arts.

Block tin is struck by dies into various vessels for drinking, such as cups, tea and coffee pots, and mixed with a little copper to give it hardness, it forms the beautiful "Britannia ware." In the chemical arts, tin is dissolved in acids, such as nitric and muriatic, and forms a common mordant for some of the most brilliant colours printed on calicoes, and those dyed on wool and silk. The uses of tin are more various than those of any other metal, and it possesses very valuable properties. England is the greatest tin-producing country on the globe. She possesses the most abundant natural sources of this metal, and has long been *the* tin-plate manufacturer of the world. The produce of the metal in Cornwall and Devon is about 11,000 tons per annum, but it is used for so many purposes that it is the source of a vast amount of wealth to Great Britain. The whole of the tin trade is in the hands of the Dutch and English, but the latter control the former.

There is a large quantity of ore which is alloyed in less degree than that to which reference has already been made, but treated in precisely the same manner—this, when smelted, presenting a purer surface, greater fluidity and ductility, is called refined, and is employed exclusively by the makers of tin plate for their manufacture.

Grain tin ore is always characterised as stream tin, as contra-distinguished from lode or mine tin ; it is found in deposits or beds in alluvial soil, only a few feet beneath the surface, and it is but fair to conjecture that it was these deposits in ancient times, and not the lodes, which gave such interest to this country, enduring yet in the word of Britain, or Etain, the Tin-land. Thus far the ore received in this country from Australia partakes of these characteristics, leaving in all probability large lodes to be worked and explored when, as in Cornwall, the deposits become insufficient to satisfy the demand. As time advances, however, we shall doubtless notice this distinction—viz., instead of the system of smelting by the use of a blast furnace, a reverberatory will be used, and, probably, discoveries in chemistry will be made which will render the mode of reduction yet more satisfactory and philosophical.

The description of ore now under notice being found in a granulated state, or in the form of small grains, the operation of stamping is unnecessary, and from its being free from sulphur, and altogether purer than the kinds previously spoken of, it is adapted for different purposes from those already named.

There is a difference between tin plate and best grain. The former not being quite pure, containing a little iron, is used in some of its many modifications, for coating the superior kind of tin plates ; and the latter, requiring great care and circumspection in selection, is used, when smelted, by the dyers as mordants. When a piece of cloth is to be dyed, it is absolutely necessary to preserve its texture, and fix the dye, whatever it may be, in neutralising its destructive elements by a solution of tin in acid, and hence the term mordant, a killing of the injurious constituents of the dye. For this purpose it is necessary the tin should be pure, because, if impure, the solution would render the dye and the cloth dull and dirty. When smelted, an interesting operation is performed in preparing it for use, called "granulating," which is done by the immersion of a hot block, weighing about four hundredweight, in a vessel of liquid tin, and after a short space of about twenty minutes, just at the moment of melting, it is lifted out and struck gently, and in this condition the crystals will separate, the block being fractured into a thousand pieces, which adapts it for solution by presenting so many surfaces for the action of the acid.

Having considered the mineral, its preparation, and adaptability, the process of assaying comes next, so as to discover the product of metal in any given quantity ; and this is accomplished at the smelting-house, or place of purchase. The system generally adopted is that of weighing a portion or sample of the ore, about two-and-a-half ounces, representing 20 parts—or 100 parts, at the option of the assayer,—then adding to this 4-5ths of culm, or anthracite coal, as a flux, with 1-20th of fluor spar ; the whole having been mixed together, is put into an assay furnace, in a crucible, and in about fifteen or twenty minutes the operation of smelting is performed by the oxygen of the mineral entering into combination with the carbon from the culm, eliminated by heat during combustion ; a rapid boiling action takes place, but after awhile ceases, the cessation of this action demonstrating that the whole of the oxygen has been liberated, and the mineral consequently transmitted into a metal. After casting the assay into a little iron mould, and scraping the crucible, the scoria or slag, composed of a decarbonised culm, is pounded and washed off on a concave shovel, leaving there the fine particles of tin on account of their greater specific gravity as a residue, which were not included in the assay on emptying the crucible. By weighing the whole the produce is ascertained, and by re-melting gently the assay, and refining it by separating the dross the quality is determined.

The produce of mines vary very much, the better quality of ores yielding the best results; but from stream tin a produce of 13 to 15 per 20 or 65 to 75 per cent., and from mine tin of 12 to 14 per 20, or 55 to 65 per cent., may give a general idea of the yield. The purchase takes place in the following manner:—It is understood that a reduction from the produce takes place of $1\frac{1}{4}$ in 20, or $6\frac{1}{2}$ per cent., as the cost for smelting defrayed by the miner; but as such a charge is exorbitant, although custom still allows the deduction, it is compensated for by a corresponding increase or decrease in the standard, as the circumstances of the trade admit. Assuming a produce of 15 per 20, and a deduction of $1\frac{1}{4}$ for returning charges, with a standard of 110s. per cwt., the following calculation will show the price payable to the miner:—15 product, less $1\frac{1}{4}$ deduction, leaves $13\frac{3}{4}$; and this, at 110s. per cent. standard, gives 1,512s. 6d., equal to 75*l.* 12s. 6d. per ton, or from the price per ton equal to 75*l.* 12s. 6d.; and a produce of 15, less $1\frac{1}{4}$ deduction, the standard may be found thus:—Produce 15, less $1\frac{1}{4}$, equals $13\frac{3}{4}$; and 75*l.* 12s. 6d. equals 1512·5 shillings, which being divided by $13\frac{3}{4}$ gives 110s. standard.

There is always 5 per cent. allowed on the weight, which may be considered as an equivalent for waste; and allowing 2*l.* per ton for smelting charges, the following will show the actual difference in an assumed case between the cost at the smelting-house and the market of sale:—

Supposed price in London, 130*l.* per ton, from which deduct interest and discount equal to 5*l.*; this leaves net cash for the smelter, 125*l.* The gross produce being 15, free from deduction, and 75*l.*, the price per ton payable to the miner, will give 100s. standard per cwt., or 100*l.* per ton, to which add 2*l.*, the cost for smelting, making 102*l.*: this will give a difference of 23*l.*

When a sufficient quantity of ore has been collected, the smelting is commenced, and the system is alike in all cases:—A reverberatory furnace is used, the general size being about 8 × 3 feet. This furnace will smelt about $1\frac{1}{4}$ tons in six hours, consuming as flux about one-fifth of culm; and for fuel about $1\frac{1}{2}$ tons of Welsh coals. The ore and culm, as flux, are mixed together, well wetted to prevent the escape of the fine particles of tin until conglomerated by the heat, and as already alluded to in the case of the assay, during the smelting there is great ebullition, but on its ceasing, and while the white wave of flame is sighing over the heated and quiescent mass, the smelter discharges the contents into a receiver built of fire-bricks and clay. When the highly heated mass has cooled, a scoria which coats it is removed, and it is formed into small blocks of one cwt. each. When a number of these blocks are obtained, the second process of refining or purifying is commenced,—1st. The furnace is brought to a gentle heat that will just melt the tin, a few degrees only above boiling water, in this condition it receives these small blocks, which are skilfully placed in it, and the more fluid portion runs off. This is received into an iron vessel, having a fire beneath it, and when full the furnace is again heated up, and the dross and heavier and impure portions that are left behind are roasted, and then formed into small blocks to be merged in the next operation. 2nd. The tin contained in the iron vessel is subjected to a further process. A piece of thoroughly-saturated balk timber is forcibly kept at the bottom of the vessel which produces great disturbance of the metal, and causes dross to rise to the surface, thus relieving it of a further portion of impurity, which is discoverable by the assay showing a cleaner surface and greater ductility. This operation is called "boiling" the tin. 3rd. The last process, called "tossing" the tin, now takes place. This is accomplished by means of large ladles having handles, about twelve feet in length, which rest upon a fulcrum ; and the tin is tossed high into the air, and allowed to fall again into the liquid mass, which causes a further discharge of its impurities. During all these operations the tin has gradually assumed a condition which may be understood by the word "fineness :" it has become more fluid, more crystalline, the dross much finer, resembling charred wood. It is now manifest that it has been cleared of the extraneous substances which deteriorated its condition, and that a sub-oxide of tin is forming. It is now refined to the required standard, and put into moulds of various sizes to meet the conveniences of the consumer.

It has been observed that culm has been used in the operation of smelting, for the obvious reason that it contains carbonic gas, which unites with the oxygen from the mineral : this necessary article after use is called "slag," and is pounded by stamps, and subjected to various processes of washing, by which means the small particles of tin are collected, with which it is permeated, and are merged into the mass of new smeltings.

Such is an outline of the mode of smelting tin, which has been maintained, with little variation, for many years past ; to trace its individual history, and its history in conjunction with other metals, would alone be a subject of considerable interest. While discoveries are constantly adding to the wealth of the repertoire of metallurgy, but little has been done as regards tin. In comparison to the importance of other metallurgical operations, it may be insignificant ; but yet a metal with an annual yield of 7,000 tons cannot be unworthy of the philosopher's attention ; and it may not be too much to suspect that, sooner or later, some Bessemer may touch a secret spring in Nature, that may reveal a simple law, which shall cause the present circuitous method to be entirely abandoned.

One practical observation, in conclusion, may be permitted. The consumers of tin have often to contend with an inconvenience, if not a loss, in the accumulation of dross—it is an oxide of tin. Let him obtain some of the waste which is saturated with oil, after having been used for wiping engines, &c., and put it into his kettle with the dross, over a brisk fire, stirring it well ; he will find the carbon and oxygen will unite, and the tin will be sweated out from the dross.

The Nitre Beds of Ecuador.—M. Boussingault has communicated to the Academy of Sciences a paper on the nitre beds of Tacunga, in the state of Ecuador. Nitre, or saltpetre, is a substance formed by nature in astonishing abundance ; it is to be met with in rain, snow, hail, and fogs ; in the water of rivers, and consequently also in the ocean. It is produced in the air and in various soils ; but though found everywhere, it is seldom found in large quantities ; the only spot on the globe where it is met with in this shape is Zarapaca, in Peru. Elsewhere this salt makes its appearance spontaneously, producing efflorescences on the surface not unlike vegetation. One day the soil is black and damp ; the next is white and crumbles into dust. The saltpetre is collected by sweeping the surface, and if the weather continues fine, a new crop soon appears. It is thus they get it on the banks of the Ganges after an inundation ; in Spain they obtain it by lixiviating vegetable mould, which may, therefore, serve the double purpose of a profitable nitre-bed or a rich corn-field. Tacunga is a town situated 59 minutes S. lat. and 80 deg. 10 min. W. long. from Paris ; it was built in 1524 on the site of an Indian city ; its altitude is 2,860 metres, its mean temperature 15 deg. Centigrade. It lies between two rivers, the Alaque and the Cutushee, and at the base of the Cotopaxi. Its soil rests on a bed of trachyte and volcanic tufa, and consists of fine sand containing particles of trachyte and pumice-stone. The saltpetre effloresces on its surface, and is collected as above described. A kilogramme of dry earth here produces 18 per cent. of nitre, independently of nearly 2½ per cent. of nitrogen combined with organic substances. Efflorescence of saltpetre denotes an extremely fertile soil ; indeed, M. Boussingault considers fertility and nitrification to be intimately connected ; the latter, however, depends in a great measure upon certain atmospherical conditions ; thus, dry weather favours it ; but damp, and especially rain, will dissolve and wash away the nitre already formed.

THE TECHNOLOGIST.

THE GOLD-FIELDS OF IRELAND.

A paper by Dr. W. Lauder Lindsay, "On the Geology of the New Zealand Gold-Fields," was read at a meeting of the Royal Geological Society of Ireland on the 11th January, after which the following interesting statements were made relative to the Irish "diggins."

Mr. Gilbert Sanders said he thought it not out of place on that occasion to offer a few words in reference to the gold-valleys of the county of Wicklow. They had much more interest in them than in those of New Zealand, although he was sorry to say that the former fields were as yet not quite so productive as those which had just been described. He had not prepared a formal paper, but would simply describe the proceedings of the Carysfort Mining Company, who had at present the working of the Wicklow gold-fields. The geology and the mineralogy of that entire district, and more especially of the gold-valleys, had been so fully described by many geologists, that it was unnecessary to speak of them; but the fact was, that he might adopt the geological descriptions contained in the papers just read as applicable to the gold-fields of the county of Wicklow. The parallel between the two districts was so complete, that he could almost fancy that the gentleman who described the New Zealand districts had never stirred beyond the valley of Croghankinsella. It was a singular thing that at the antipodes of the world there should exist two gold-fields agreeing so closely in their geological relations. The object of the Mining Company in their explorations was to discover if there were in existence at or near the surface a vein of quartz or other mineral from which the gold that was now distributed over the surface of the land originally emanated. They had examined the rock wherever it was laid bare by Nature, and had inspected numerous veins of quartz; they had blasted portions of rocks, and had crushed the quartz. Some of the more promising lodes of quartz had been pierced by shafts of a couple of fathoms deep. As yet, however, no stone containing gold had been found in the Croghankinsella district—that is, nothing which could be properly called a vein of gold-bearing stone. The searches which had been made into the deposits in the valley showed a wide distribution of the particles of gold. Of those particles which could be called nuggets the larger were found at the upper parts of the streams towards their sources ; and as they descended the streams the particles became much more minute. That was not, perhaps, an absolute rule, but was generally the case. From the facts which had been brought to light—from the examinations which he had himself made, and from the reports which he had heard from others—he had no doubt whatever that the original source of the gold was high up towards the sources of these streams. It was reasonable to suppose that the smaller particles should be more easily swept down, while the larger masses should hold their position amongst the rocks during a series of ages. Therefore they should look for the original source of the gold, not in the valleys below, but in the upper part of the Croghankinsella mountain. The papers which had been read described the gold of the districts referred to in them as found for the most part in metamorphic slates, such as the silurian slates of the county Wicklow. Amongst such slates in that county they found gold deposited. The Auckland gold was said to be met with in the chinks of rock where the edges of that rock protruded through slate. They found in Wicklow no quartz bearing gold ; but they did find there gold carrying portions of quartz with it. It was to be supposed that that gold came from a quartz vein. He had seen many specimens of gold containing quartz, but he had never found there any masses of quartz with gold embedded in them, such as were found in other parts of the world. They had examined a great many of the quartz reefs, of which there were an immense number running through the slate across the valley, and in no instance had they discovered gold in those reefs. Yet it was impossible to imagine that the gold could be anywhere except in those quartz reefs. At the time the Government worked the district the engineers were of the same opinion, and examined a great many of those reefs. They ran an adit of 120 fathoms, which he had been in, and which cut through not less than from fifty to sixty quartz veins, some of them of from a foot to two feet in breadth, but not one of these had yielded the smallest particle of gold that he was aware of. The question was, how was the presence of gold in the Croghankinsella valley to be accounted for. Dr. Lindsay stated that at the Auckland gold-fields they had spent 2,000*l.* in collecting 1,100*l.* worth of gold. The Mining Company had spent something more in proportion, in collecting gold in the county of Wicklow, notwithstanding that they believed that the indications afforded there fully warranted the directors in pursuing their investigations. Hitherto the gold discovered in Wicklow had been found in the streams or taken from the washings of gravel, or dirt as the miners called it. The company had "costined" the surface of the mountain to a considerable extent, but up to the present they had not succeeded in discovering the lode from which the gold originally proceeded. In working at the lower portions of the rivers they had sunk shafts under the soil to the rock below, and had from thence collected gravel, from which gold had been washed out. Lately, a discovery had been made on their property of a very large "gossan" lode. This was a lode which he believed must have at one time contained gold, but the gold had been washed out, or otherwise eliminated during a long course of ages, leaving nothing behind except an ochrous matter. The paper treating of the Auckland fields stated that magnetic iron was also found there. It was a remarkable fact, that iron sand of a similar description, and perfectly magnetic, also existed in the county of Wicklow. Mr. Sanders showed some of this sand, which had been taken from the washings there. It was stated in the 'Field' of the 7th of January, that no gold had been found in Ireland, and that the gold used in the manufacture of the antique Irish ornaments, which were preserved in museums, was brought here by foreign merchants, who took in return for it the inhabitants of the country, who were sold to them as slaves by the lords of the soil. In reply to, and in contradiction of, this statement, he had only to exhibit the result of a smelting he had himself made. [Mr. Sanders here produced a crucible from which he extracted, by breaking it, a large mass of gold.] This, he stated, had been obtained from Carysfort materials. It will be remembered that a mass of gold was shown by Mr. Sanders at the last meeting of the Carysfort Mining Company. The mass now exhibited was the additional result obtained from operations which Mr. Sanders then stated that he had not had time to finish. It was valued at 120*l.* Mr. Sanders, in conclusion, mentioned that tin, lead, and copper, were also found in the Wicklow valleys.

Mr. Scott exhibited a nugget and the model of a nugget, the former of which and the original of the latter having been taken from the Wicklow district in the year 1796, shortly before the breaking out of the rebellion. The "model" is a gilt leaden image of what was the largest nugget of rolled gold ever found in Europe, and which weighed twenty-two ounces. Several other models of the same nugget, which is a genuine sample of the Wicklow product, now belong to the mineralogical collection of the Royal Dublin Society. It consists of a mass of gold through which a vein of quartz runs ; and was found by Mr. Scott to weigh 1,500 grains.

The Chairman said he regretted that Dr. Lloyd had been obliged to leave, as it was his intention to have stated some views entertained by his father respecting the Wicklow gold-mines, which were quite novel. Those views would, however, be communicated by Dr. Lloyd in writing to the Secretary. Dr. Lindsay, of Perthshire, whose paper on the New Zealand gold-fields the meeting had heard, was also well acquainted with those of the county of Wicklow, and he had desired that his paper should be brought before the Irish Geological Society, because he considered that the gold-fields of New Zealand bore a more striking resemblance to those of the county of Wicklow than any others that he was acquainted with.

Mr. J. Knight Boswell said that the failure of the Government effort to find gold in the county of Wicklow, in 1796, was no reason why the present mining operations which were conducted there for that purpose should not be persevered in. It was many years since he first visited those mines, and purchased gold from the people there. He had in his possession a beautiful specimen of that gold—a piece of quartz, with gold all round it which was evidently the effect of water. He then formed the opinion that the gold came from the quartz reefs of the district, and that whoever should discover those quartz-bearing reefs would make a princely fortune ; and he had not changed that opinion since. He believed that at a very remote period, when the surface of the soil there was utterly destitute of vegetation, masses of gold were carried from the upper parts of the mountain downwards by the action of water. In the course of subsequent ages a deposit of vegetable matter or peat had accumulated to the depth of from fifteen to twenty feet, so as to hide the site of the original quartz reefs. He would mention a circumstance which he heard from a family named Byrne, who were farmers at Croghankinsella some thirty years ago. They said that in the upper part of one of the rivers they found a mass of metal about a pound and a-half in weight, which they supposed to be copper. It remained for several years in their possession, and was used by them as a weight ; but at length it was disposed of to a travelling tinker, who carried it to Dublin, where he sold it for a large price to a jeweller in Capel street. That was what led to the Government investigations there in 1796; and it was stated, on the authority of Government, that at that time, during a space of two months, 10,000*l.* worth of gold was purchased from the people of the district by jewellers in Dublin.

Mr. Scott said he understood from official records that the amount of gold raised in Wicklow which passed through the hands of the Government in 1796 was about 9,000*l.* worth.

The Chairman (Dr. Haughton) said this was a most interesting subject, and that society was the proper place for the discussion of it. The first point that occurred to him was the extraordinary manner in which the gold occurred in the localities referred to. The large " model " which had been just inspected by those present, represented a very celebrated Wicklow nugget which some people said had been presented to George the Fourth, but which others said that that monarch took the liberty of stealing out of this country. Without prejudging the question, there was no doubt that it was a very remarkable specimen, and the museums of Trinity College, the Dublin Society, the British Museum—in fact, all the museums—had copies of it. The peculiarity of it was, that the gold appeared to consist of masses conglomerated or lumped together. The other which had been exhibited was real ; and as it had gone round the room through the hands of the audience, he had been much amused by noticing that the eye of his friend Mr. Scott, to whose care it had been entrusted, never left it for an instant (laughter), and that as it approached the door his glance redoubled in vigilance (laughter). That nugget was of the same character as the mock one, being also a specimen of rolled gold. With respect to gold of that description, the problem was, to determine how it came to assume that form, it being known that gold was most difficult to be reduced by fire. These nuggets would appear to have either been fused by heat or to have been welded together mechanically. The next question which arose—namely, as to where they came from—was of still greater interest. He was perfectly well acquainted with the chemical composition of every part of the Croghankinsella mountain, which was most remarkable. No other granite mountain had such an extraordinary diversity of composition as it possessed. On its slopes were the gold-bearing streams which had made Wicklow famous, and the sands of which contained magnetic iron and other minerals, the connection of which with gold was at present very obscure and ill-understood. Why those streams should carry down masses of gold was, in the present state of science, incomprehensible. How the gold came to be originally in the higher parts of the mountain, and also how it was blended together in masses, as was evident in the nuggets produced, were problems yet unsolved. He agreed with Mr. Sanders, and the other gentlemen who were associated with him, that those questions were of the greatest importance, and should be solved. The quartz reefs containing the gold must be found. He was not an antiquarian, but he thought it was a mistake to suppose that the gold which the ancient Irish used in the manufacture of their ornaments came from abroad. He believed that every particle of it came from Wicklow, and that the trade which some antiquarians alleged to have existed in gold between Ireland and Spain, and other countries, was a delusion. There was no satisfactory evidence that gold was then found in any other part of Ireland except Wicklow, unless, perhaps, a small quantity in Mayo and some other parts of the west of Ireland ; and he believed that the cross of Cong, the torcs, and the other ornaments were made by Irish workmen, of gold found at Croghankinsella. It was right to say that he believed the farther we went back in time the larger were the nuggets that had been found in the Wicklow districts, so that in all probability those from which Malachy's collar was made were six or seven times larger than any now to be met with ; and until we reached the quartz gold-producing reef, he did not believe that we should get any more large nuggets. It appeared to be a law that, in old times, through causes unknown, the quartz reefs were altered, and large masses, like the model, were produced, amalgamated by forces that we now do not understand. That the first diggers carried off the largest nuggets appeared to be true of the searchers in all the gold countries ; but he believed a very rich harvest was open to those who should explore the gold-fields of Wicklow.

Mr. Sanders, in reply, expressed his confident belief that there was nothing in the facts as now known with respect to the Wicklow district, to discourage the mining company from continuing their operations. He believed that the gold-bearing vein did exist somewhere at Croghankinsella. A theory had been broached by some that the gold of Ireland had been transported here from other countries by icebergs at a remote period. He did not believe in that theory. The largest Wicklow nugget that ever came under his observation was one of 320 grains. The fact was remarkable that all over the world deposits of gold, when found, were associated with quartz rocks.

WOOD FOR RAILWAY SLEEPERS.

As lines of first-class and feeder railways gradually extend over India, the question of the future supply of sleepers forces itself more and more on our attention, and the durability and prime cost of wood, and the possible timber supply from the forests of India, claim our most serious consideration.

For high speed railways, wood has so many advantages over iron, whether cast or wrought, that it is scarcely likely that recourse will be had to the latter material, when the former can be obtained in sufficient quantity to meet the requirements, being at the same time of durable kind and of not excessive cost. The wear and tear of the rolling stock on a road laid on cast iron is a serious objection to any form of iron sleeper, such, *e.g.*, as Greaves' pots. These sleepers are, we believe, still employed to some extent on the East India line as well as on that of Madras, but much difficulty is found in so laying them as to preserve them from unequal strains, and the consequent breakages render their use by no means economical.

On the Bombay and Baroda lines, Adams' No. 1 sleeper, consisting of angle bars bolted longitudinally to the rails, were laid in the first instance, but were found to bend under the great weight of the engines employed on that line, and were, after a short trial, replaced by Adams' No. 2 sleeper, which consists of two balks of timber similarly bolted to each side of the rail by bolts beneath it. Here also, therefore, iron has been rejected, on experience, in favour of wood.

Assuming, then, that only in the case of failure of supply of wood sleepers will those of iron be introduced to any great extent on the Indian lines, we have to direct attention to the sources of the former, and these we find are as follows :—

Creosoted pine from England.
Jarrah and other woods from Australia.
Teak, ironwood, &c., from Burmah.

Native Indian woods (Sal (*Shorea robusta*), &c.), chiefly from the forests of the Himalaya and West Coast.

The first of these appear to be durable in all the variations of Indian climate—in Scinde and in Bengal. A part of the East Indian Railway near Bally was laid with fir sleepers in 1852, and they are now perfectly sound, and promise to last for several years to come. Dr. Brandis, in a report written at the beginning of last year, considers that the average life of a good creosoted fir sleeper is probably not less than fifteen years. In Scinde, they are liable to split and twist, owing to the great dryness of the climate, but show no signs of decay. The cost is now Rupees 5 a sleeper in Calcutta. In Kurrachee four years ago it was Rupees 4-7.

Australian woods have been more extensively used in Madras and Bombay than on Bengal lines. Of those hitherto tried, the Jarrah or Australian mahogany is preferred. This is a heavy wood, weighing 52¼ lbs. to the cubic foot. It is very hard, and in Madras is found more liable to split from exposure to the sun than teak or the Indian native woods ; so that, in an average period of eighteen months from the time of laying, 10 per cent. of the sleepers were found to have deteriorated from this cause. The Madras climate is, however, much drier than that of Bengal, and it is probable that it would prove more durable here. A wood called "Jarool," which may possibly be the same as the above,* sleepers of which were laid at Howrah in 1858, is found to be still sound. Blue and white gum have been tried on the Scinde Railway, but were found to split by the driving of the spikes. But many woods, which would prove unsuited to the dry climate of Scinde, might give more favourable results elsewhere, and we must therefore consider their applicability as sleepers on our Indian railways as still an open question. The cost of blue gum at Kurrachee was Rupees 4 a sleeper But, like Jarrah, this is a heavy wood, and carriage to the interior would therefore add much to its ultimate cost. The possible supply of Australian woods appears to be unlimited.

We are indebted to Dr. Brandis for some very valuable information on the capability of the Burmah forests of yielding a supply of sleepers. Of the durability of teak, there appears to be little or no question ; while its weight (between 40 lbs. and 50 lbs. per cubic foot as stated by Dr. Brandis ; by Mr. Brunton, as the result of actual experiment on seasoned timber, at 33¾ lbs.) is considerably less than that of sal or the Australian woods above mentioned. Its cost, however, is greater, viz., Rupees 6 per sleeper, in Calcutta ; but Dr. Brandis considers that it would prove so much more durable than sal or other woods yet tried, that this would fully compensate for the greater cost. There is a large quantity of small and second-class timber in the Burmah forests

* "Jarool" is the Bengalee and Hindostanee name for the wood of *Lagerstrœmia reginæ*.—Editor Technologist.

now useless, and generally left to rot on the ground or to be consumed by the annual jungle fires. It is this that Dr. Brandis would propose to utilise for sleepers, and he calculates the probable yield from this source to be 300,000 pieces per annum.

Another wood supplied by the forests of Burmah in great abundance, and which is scarcely less durable than teak, is ironwood. This is now being tried for the first time on the East India Railway, the sleepers being cut to half the usual thickness, viz., 2½ inches (instead of 5 inches), a plan which, if found to answer, will remove much of the objection attaching to this wood on account of its great weight, 65 lbs. per cubic foot. The ironwood of the forests of the West Coast has been tried on the Bombay and Baroda line to a considerable extent, but, like many other hard woods, was found to be split by the spikes. The strength of the ironwood to resist breakage has been tried by Mr. Power, who finds that the creosoted pine sleepers, 10′ × 10′ × 5″, were broken by a weight which the ironwood of half the thickness resisted without fracture. Experience will show whether sleepers so thin as 2½″ will deaden vibration to the same extent as the 5″ sleepers of the softer wood. Judging *à priori*, we should doubt whether they would do so, and whether this would not prove an objection to their employment.

Dr. Brandis suggests the trial of some other native woods of the Burmese forests, which are found in sufficient quantity in forests comparatively easy of access to justify the assumption that they may some day form an article of trade on a large scale.* These are—

	Weight of one cubic foot of half-seasoned wood.
Seet (*Albizzia elata*) . . .	42 to 55 lbs.
Nabhay (*Odina Wodier*) . . .	65 „
Bambouay (*Careya arborea*) . .	55 „
Pyimma (*Lagerstrœmia reginæ*) .	44 „
Htouksha (*Vitex leucoxylon*) . .	42 „

They are less durable than teak, but might be procured at a cheaper rate. The Pyimma might be imported from Chittagong at three rupees a piece. It is liable to be attacked by white ants, but experience seems to show that railway sleepers are less exposed to destruction from this cause than wood in other localities. It is well known that white ants will only work in undisturbed ground, and it seems probable, from the extreme rarity of railway sleepers being attacked by them, that the frequent vibration to which the latter are exposed drives away or destroys the insect.—*The Engineer's Journal, Calcutta.*

* Dr. Brandis' accounts of the woods of British Burmah will be found in the second volume of the Technologist, page 321.

ON CHEMISTRY APPLIED TO THE ARTS.

BY DR. F. CRACE CALVERT F.R.S., F.C.S.

A COURSE OF LECTURES DELIVERED BEFORE THE MEMBERS OF THE SOCIETY OF ARTS.

LECTURE VI.

FLESH: its Chief Constituents, Boiling and Roasting. *Animal Black:* its Manufacture and Applications. Various Methods of Preserving Animal Matters. Employment of Animal Refuse in the Manufacture of *Prussiate of Potash.* A Few Words on the Decay of Organic Matters, and their Fermentation and Putrefaction.

Flesh.—M. Chevreul, in 1835, and Baron Liebig, in 1845, examined the changes which flesh undergoes when placed in contact with hot and cold water; and the following table, taken from Liebig's interesting work on the chemistry of food, will furnish an idea of the composition of flesh:—

Cold Water.		Action of Boiling.	
Soluble	66	Coagulated albumen	29·5
		Gelatine	6·0
		In solution	30·5
Insoluble	164	Fibres and membranes	164·0
Fat	20		
Water	750		
	1,000		

Liebig and Chevreul further succeeded in isolating, from the 30 parts soluble in water, some of the following substances:—

Kreatine	$C_8 H_9 N_3 O_4 + 2 HO$
Kreatinine	$C_8 H_7 N_7 O_2$
Sarcosine	$C_6 H_7 N_3 O_4$
Inosinic acid	$C_{10} H_6 N_2 O_{10}$
Lactic acid	$C_6 H_5 O_5 + HO$
Guanine (Scherer)	$C_{10} H_5 N_5 O_2$
Xanthine (Strecker)	$C_{10} H_4 N_4 O_4$
Glycocale	$C_4 H_5 N_1 O_4$
Leucine (Cloetta)	$C_{12} H_{13} N_1 O_4$
Ozmazone	

The most important mineral salts in flesh are the acid phosphate and lactate of lime, and, according to Fremy, the acid phosphate of potash and chloride of potassium. The above statement shows that flesh is a most complicated substance, and it is easy to conceive that this must be so, when it is remembered that it is derived from blood, of which it contains a large amount; but a most interesting and curious fact is, that whilst blood is rich in salts of soda and poor in salts of potash, in flesh the relative proportion of these salts is directly reversed. Another interesting fact is the small amount of solid matter contained in flesh, and also the small amount of nutritive matter it yields to water under the most favourable circumstances. I repeat "the most favourable circumstances," for when meat is placed in boiling water the 3 per cent. of albumen it contains is coagulated, closing the vessels of the flesh, and preventing all further exit of the fleshy fluids, and such should be the case when meat is intended to be eaten as boiled meat and is properly cooked; but when the object in view is to extract the whole of the matter soluble in water, as in the preparation of beef-tea, then the meat should be cut in small pieces and brayed in a mortar with water, the whole then thrown into clean linen and pressed. The juice of the flesh so obtained should then be carried just to the boil, again passed through the strainer, and after the addition of a little common salt will be ready for the patient. Beef-tea even prepared by this process, which is certainly the best to my knowledge, contains, as the table given shows, but a small quantity of nutritive matter, there being only a little gelatine and a small proportion of the other substances named above. Chevreul attributes the odour of beef-tea and meat soups to osmazone, and Liebig to kreatine; in fact, Liebig considers kreatine to be one of the essential substances characterising the aroma of various kinds of flesh. Liebig during his researches on this substance succeeded in obtaining from—

Fowl's flesh	3·21	of kreatine.
Ox heart	1·37	,,
Pigeon	0·82	,,
Beef	0·69	,,

Further he observed, that the flesh of wild animals contained a much larger proportion of kreatine than that of those which were confined: for instance, that there was six times as much in the flesh of a wild fox as in that of a tame one. Allow me to say a few words on the properties of this curious substance, which presents itself in the form of moderately large white rectangular prisms, having a pearly lustre, soluble in water, insoluble in alcohol. Although this substance is neutral, it is converted when heated with hydrochloric acid into another solid crystallized substance called "kreatinine," which possesses strong alkaline properties. When kreatine, instead of being treated by an acid is acted upon by baryta, it is converted into an acid compound called "inosinic acid." Liebig ultimately succeeded in finding these substances, as well as another called "sarcosine," in various animal secretions. I shall not take up more of your time by discussing the chemical properties of these substances, but merely state that they enable us to distinguish real soup tablets from spurious ones. For this purpose a solution of the tablet in cold water should be made, when, if genuine, it will give a precipitate with chloride of zinc, whilst the spurious one, which contains gelatine but no kreatine, will not do so. Another reaction is, that the pure article will yield 85 per cent. of its weight to alcohol, whilst the imitation will only yield about five.

Preservation of Meat and Animal Substances.—A low temperature is most favourable to the preservation of flesh and other animal substances, and under that condition it will not enter into putrefaction, the best proof of which is that elephants in a perfect state of preservation have been found in Siberia buried in ice, where they have doubtless existed for many thousands of years. It is also well known that the inhabitants of polar regions preserve their meat fresh by burying it in snow, and I mentioned an instance in one of my previous lectures, viz., the preservation and bleaching of sturgeon's bladders on the banks of the Volga. A high state of desiccation or dryness also contributes powerfully to the prevention of decay. Thus, in Buenos Ayres and Monte Video meat is cut into thin slices, covered with maize flour, dried in the sun, and it is consumed largely, under the name of "tasago" or "charqui," by the inhabitants of the interior, and also by the black population in Brazil and the West Indies. Further, dried meat reduced to powder is used by travellers in Tartary and adjacent countries, and I may add that of late years meat biscuits have been extensively consumed by the emigrants having to travel from the United States to California and the West Coast generally. It is stated that six ounces per diem of this meat biscuit will maintain a man in good health throughout the journey. A remarkable instance of the preservation of animal matter by extreme desiccation is related by Dr. Wefer, who states that in 1787, during a journey in Peru, he found on the borders of the sea many hundreds of corpses slightly buried in the sand which, though they had evidently remained there for two or three centuries, were perfectly dry and free from putrefaction. Although it is not within the scope of these lectures to describe the preservation of vegetable matters, still I cannot refrain from mentioning the interesting method adopted by MM. Masson and Gannal, by which, as you are doubtless aware, vegetables are preserved in the most perfect manner. Their process is most simple, as it consists in submitting the vegetables for a few minutes to the action of high-pressure steam (70 lbs. to the square inch), then drying them by air heated to 100°, when, after compression by hydraulic pressure, they are made into tablets for sale, and when required for use it is only necessary to place the tablets for five hours in cold water, when the vegetable substances swell out to their former size and appearance, and are ready for cooking. As the presence of oxygen or air is an essential condition of putrefaction, the consequence is, that many methods have been invented to exclude that agent, or rather, as I shall show at the end of this lecture, the sporules or germs of cryptogamic plants or animals, which are the true ferments or microscopic source of fermentation aud putrefaction. Permit me to describe concisely some of the methods proposed; and I believe that one of the best processes for excluding air was that invented by Appert, in 1804. It consists in introducing the meat or other animal substance with some water into vessels which are nearly closed, these are then placed in a large boiler with salt (which raises the boiling point of the liquor), and the contents of the vessels are kept boiling for about an hour so as to exclude all air, and destroy, by the high temperature, all the sporules or germs of putrefaction they may contain, when they are hermetically closed. M. Chevalier Appert has improved this process by placing the prepared vessels in a closed boiler, by which means he raises the temperature (by pressure) to 234°, effecting thus the same purpose more rapidly and economically. To give you an idea of the extent of this trade, I may state that M. Chevalier Appert prepared above 50,000 lbs. of meat for the French army in the Crimea. I am aware that many modifications have been applied to this process, but I shall only mention that of Mr. J. McCall, who adds to the previous principle of preservation a small quantity of sulphate of soda, well known to be a powerful antiseptic. The beautiful specimens now on the table, which have been kindly lent to me by Messrs. Fortnum and Mason and by Mr. McCall, will satisfy you of the applicability of the above-named methods for the preservation of meat and other animal substances. But before concluding this part of my lecture, I must add that the preservation of animal and vegetable substances by the exclusion of air and cryptogamic sporules is also effected by other methods than those above described; for instance, they are imbedded in oil, or in glycerine, as suggested by Mr. G. Wilson, or in saccharine syrups. I should not forget to mention that several plans have been proposed for protecting animal matter by covering their external surfaces with coatings impermeable to air. Two of the most recent are the following:—M. Pelletier has proposed to cover the animal matter with a layer of gum, then immerse it in acetate of alumina, and lastly in a solution of gelatine, allowing the whole to dry on the surface of the animal matter. The characteristic of this method is the use of acetate of alumina which is not only a powerful antiseptic, but also forms an insoluble compound with gelatine, thus protecting the animal matter from external injury. Mr. Pagliari has lately introduced a method which is stated to give very good results. It consists in boiling benzoin resin in a solution of alum, immersing the animal matter in the solution, and driving off the excess of moisture by a current of hot air, which leaves the above antiseptics on the animal matter. It is scarcely necessary to mention the old method of using smoke arising from the combustion of various kinds of wood, except to state that in this case it is the creosote and pyroligneous acids which are the preservative agents. The preservation of animal matter by a very similar action is effected by the use of carbolic acid, a product obtained from coal tar. It is much to be regretted that this substance, which is the most powerful antiseptic known, cannot be made available for the preservation of food, but there can be no doubt that for the preservation of organic substances intended for use in arts and manufactures, no cheaper or more effective material can be found. For example, I have ascertained that one part of carbolic acid, added to five thousand parts of a strong solution of glue, will keep it perfectly sweet for at least two years, and probably for an indefinite period. Also, if hides or skins are immersed for twenty-four hours in a solution of one part of carbolic acid to fifty of water, and then dried in the air, they will remain quite sweet. In fact, hides and bones so prepared have been safely imported from Monte Video. From these facts and many others with which I am acquainted, I firmly believe that this substance is destined, within a few years, to be largely used as an antiseptic and disinfectant. I need hardly speak of the power of chloride of sodium, or common salt, in preserving animal matters, and it is highly probable that the interesting process described by Mr. J. Morgan, for the employment of salt, is likely to render great service in preserving animal food from putrefaction. But with regard to the feasibility of its use in Monte Video and Buenos Ayres, I cannot offer an opinion, as it depends upon so many local circumstances which it is impossible to appreciate here. Messrs. Jones and Trevethick displayed at the last Exhibition some meat, fowls, and game preserved by the following process, which received the approbation of the jurors. Meat is placed in a tin canister, which is then hermetically closed, with the exception of two small apertures in the lid. It is then plunged into a vessel containing water, and after the air has been exhausted through one aperture by means of an air pump, sulphurous acid gas is admitted through the second aperture, and the alternate action of exhausting the air and replenishing the sulphurous acid gas is kept up until the whole of the air has been removed. The sulphurous acid gas in its turn is exhausted, and nitrogen admitted. The two apertures are then soldered up, and the operation is completed. As I consider the action of carbon on animal matters rather as a case of oxidation than of preservation, I shall refer to that subject further on, and shall, therefore, proceed to consider the employment of certain animal matters not yet alluded to during this course of lectures, such as the flesh of dead animals not used as food, and those other parts of their carcases which have not been applied in any of the processes already described. The greatest part of these refuse matters are used for producing animal black, which differs from bone black, referred to in my first lecture, being used in the state of impalpable powder, whilst bone black or char is composed of small hard grains. The manufacture of animal black is generally carried out by introducing into horizontal retorts connected with a coil or condenser, and with an exit pipe for the gases, some of the animal matters mentioned ; on the application of heat decomposition occurs, the oily matters distil and condense in the worm, and constitute what is called oil of dippel, formerly much used in the art of currying certain classes of leather ; water also distils, charged with a variety of ammoniacal salts, which are generally converted into sulphate of ammonia for agricultural purposes. As to the gases, they are usually ignited and burnt to waste. The carbonaceous mass which remains in the retort is removed, and ground to powder with water in a mill, allowed to settle, and, lastly, dried and sold under the name of animal black. Its chief uses are in the manufacture of blacking and printing ink. Another manufacture which consumes a large quantity of animal refuse, especially the horns, hoofs, &c., of too inferior a quality to be used for the purposes described in my first lecture, is that of the yellow prussiate of potash, a most important salt, for it is extensively used in calico printing, silk and wool dyeing, and in the manufacture of the pigment called prussian blue—for gilding silver, copper, and other inferior metals ; and lastly, it is the source from which cyanide of potassium is procured, a substance much employed in the art of photography. Let me now call your attention to the manufacture of prussiate of potash, the greatest portion of which is still prepared at the present day by the old process devised by Dr. Woodward, F.R.S., in 1724. It consists in introducing into large cast-iron pots American pearlash, melting it, closing the vessel, and then setting the mass in motion by means of a revolving shaft. At this period of the operation, hoofs, horns, and other animal refuse are introduced in small quantities at a time. Under the influence of heat and of the alkali, the nitrogen of the organic matters splits into two parts, one part combining with the hydrogen to form ammonia, which escapes, whilst the other portion unites with the carbon, producing cyanogen, which remains combined with the potassium of the potash. After several hours the operation is considered to be completed and the melted mass is run out into small cast-iron receptacles ; when cool, these are placed in large vats with water, and a jet of steam is introduced, and the whole is kept on the boil for several hours, when the cyanide of potassium is partly decomposed, giving rise to carbonate of potash and to cyanide of iron, for not only has a portion of the iron of the melting pots been attacked and combined with the mass, but a certain quantity of iron filings has been used during the operation. However, two parts of the cyanide of potassium combine with one part of cyanide of iron, and the result is that a double cyanide, called ferrocyanide of potassium, or yellow prussiate of potash, is formed. The liquors are then allowed to clear by standing, and the aqueous solution is evaporated until a pellicle appears on its surface, when it is permitted to cool, and the salt is deposited on strings which have been passed through the crystallizing vat, and which facilitate the crystallization of the prussiate salt. In consequence of the large amount of animal matter used as compared with the quantity of prussiate obtained, this salt has always commanded a good price in the market, and has induced many eminent chemists to try to devise cheaper processes for obtaining it. To attempt here to give merely an outline of these various proposed plans would involve so much technical description as would occupy far too much time for this lecture, but I would recommend those interested in this branch of manufacture to read the learned account given by Dr. A. W. Hoffman, in his report on "The Chemical Products in the last Exhibition," page 57, where they will find the process of M. Gauthier-

Bouchard for obtaining salts of cyanogen from the ammoniacal waters of gas-works; those of Mr. R. T. Hughes and Messrs. Bramwell, of Newcastle, for the conversion of nitrogen of the atmosphere into cyanide of potassium; that of M. Kamrodt, for decomposing ammonia by carbon carried to a high temperature; and lastly, that of MM. Marguerite and De Sourdeval, for producing cyanogen from the nitrogen of the atmosphere and fixing it by means of barium. This latter process seems to be highly commended by the learned reporter to whom I have referred. I must not, however, omit to mention the scientific and interesting process devised by Mr. Gelis, and based on the chemical reaction which ensues when bisulphide of carbon is mixed with sulphide of ammonium. Yellow prussiate crystallizes in large crystals belonging to the octohedral system, composed, as before stated, of two parts of cyanide of potassium, 2 Cy K, and one of iron, Cy Fe + 3 of water or H O. This salt is freely soluble in water, but is insoluble in alcohol, and when mixed with weak vitriol and heated gives rise to prussic acid, which distils, and may be used either as a violent poison or, in qualified hands, as a most valuable therapeutic agent. When ferrocyanide of potassium is heated with several times its bulk of concentrated sulphuric acid, instead of yielding prussic acid, as above, it gives rise to a poisonous gas, called oxide of carbon, which burns with a beautiful blue flame, and which we have all seen burning in our fireplaces when the combustible matter has lost all its volatile constituents and nothing remains but a red incandescent mass. When chlorine is passed through a solution of this salt chloride of potassium is formed, and the yellow prussiate is converted into red prussiate or ferrocyanide of potassium, composed of $3\ Cy\ K + 3\ Fe_2\ Cy_3$. When heated with peroxide of mercury, potash, peroxide of iron, and cyanide of mercury are produced, the latter being a most violent poison. To produce Prussian blue on silk with this salt, all that is required is to dip the silk in a slightly acidulated liquor containing a persalt of iron, and when the silk is washed and mordanted, it is dipped in a weak acidulated solution of yellow prussiate of potash, when it assumes a beautiful blue colour, due to the formation of Prussian blue. To dye wood it is necessary to pass it through a boiling bath composed of yellow prussiate, muriate of tin, and a small quantity of sulphuric acid. Prussian blue is gradually formed, and fixes itself on the fibre. To produce blue on calicoes, a solution of yellow prussiate of potash is made, to which is added some tartaric acid and muriate of tin. This mixture, after having been properly thickened, is printed on the calico, and then submitted to the action of steam, the Prussian blue so produced being fixed on the cotton fibre by means of the oxide of tin, resulting from the decomposition of the salt employed.

Nothing is more simple than to gild or silver metals by means of ferrocyanide of potassium, or to cover iron and other metals with copper. To obtain a gilding liquor, it is only necessary to take 1,000 parts of water, adding to it 100 parts of yellow prussiate of potash, 10 parts of chloride of gold, and 1 part of caustic potash. Each of these should be added successively, and the whole of the liquor carried to the boil and filtered. It is then ready for gilding silver or brass objects, when properly attached to the pole of a galvanic battery. The silvering liquor is made by substituting for the chloride of gold, in the above process, ferrocyanide of silver, prepared by adding nitrate of silver to a solution of ferrocyanide of potassium, the white precipitate resulting being washed and added to the liquor intended for silvering. For covering zinc or iron with copper it is simply necessary to substitute the ferrocyanide of copper for that of silver. Ferrocyanide of potassium, as above stated, is also employed for the manufacture of Prussian blue, which was accidentally discovered by Diesback, in 1718, by adding alum, containing iron, to the ammoniacal liquors sold to him by Dippel, which were produced, as already stated, during the distillation of animal refuse. These liquors, being rich in cyanide compounds, yielded, with the salt of iron of the alum, Prussian blue. At the present day Prussian blue is manufactured by different processes, but they are all based on the principle of mixing various salts of iron with red or yellow prussiate, when double cyanides of iron (or Prussian blues) are produced.

I shall now examine with you some of the various causes which contribute to the destruction of animal matters, when it arises from slow decay or putrefaction. The first of these to which I shall have the pleasure of calling your attention is that observed by Dr. Stenhouse, who, in 1854, made the curious discovery, that if the body of an animal be buried in a carbonaceous mass, such as charcoal, after a few months the whole of the animal, excepting the skeleton, would entirely disappear: and what was still more remarkable was, that, though the experiments were conducted within his laboratory, no unpleasant effluvium was apparent to those who were constantly there. This eminent chemist attributed the rapid and complete destruction of animal tissue in these experiments to the oxidation of the animal matters by the oxygen of the atmosphere ; but to enable you fully to understand how this occurs, I must call your attention to the following facts. Lowitz, many years since, observed that charcoal possesses the property of absorbing and condensing in its pores large quantities of various gases, and Theodore de Saussure made an extensive series of experiments, from which I extract the following data :—

One cubic inch of boxwood charcoal absorbed of—

Ammonia	90 cubic inches.
Hydrochloric acid	85 " "
Sulphurous acid	65 " "
Sulphuretted hydrogen . . .	55 " "
Carbonic acid	35 " "
Oxygen	10 " "
Nitrogen	7 " "

Consequently the absorption or condensation of a gas in charcoal appears to be in proportion to the solubility of the gas in water, and although the condensation by a solid and by a liquid may at first appear necessarily due to different causes, and therefore to bear no relation to each other, yet in my opinion these two actions are identical. Seeing that the gas is condensed by the molecular attraction of the solid, I do not see why the same attraction should not be exercised by the molecules of the liquid. The different degrees of solubility of various gases are no doubt owing to their respective physical properties, such as specific gravity, repulsive or expansive forces of their molecules, &c. I may here mention that I am now engaged in a series of experiments in the hope of throwing some light on this interesting question.

Gay-Lussac, in his researches on the condensation of gases by charcoal, found that one gas may expel and take the place of another gas already condensed in the charcoal; and Dr. Stenhouse, following up this observation, states that the gases, vapours, and sporules generated by the putrefaction of animal substances, are absorbed by charcoal and brought into immediate contact with the oxygen of the atmosphere also contained in the pores of the charcoal, which oxidising or destroying the products of putrefaction converts them into water, carbonic acid, nitric acid, &c. These important scientific observations of Dr. Stenhouse have already received practical application; thus Mr. Haywood has established charcoal filters at the mouths of public drains, thereby arresting the escape and diffusion in the atmosphere of the noxious effluvia given off by the putrefying matters in the sewers. Further, charcoal respirators have become extensively used since Dr. Stenhouse called public attention to the valuable properties of this substance; and lastly, atmospheric filters, containing charcoal, have been successfully applied in the Houses of Parliament to purify the entering air from any noxious gases it may contain before passing into the building. The natural decay or destruction of organic matters is due to two perfectly distinct causes, one of them chemical and the other physiological. The former has been investigated by many of the most eminent chemists of the day, and no doubt can remain that the action of the oxygen of the atmosphere converts the carbon of organic substances into carbonic acid, the hydrogen into water, the sulphur into sulphuric acid, the nitrogen into nitric acid, the phosphorus into phosphoric acid, &c. Much light has recently been thrown upon these phenomena by Mr. Kuhlmann, who clearly shows that the oxides of iron play a most important part therein; thus, that the sesquioxide of iron yields its oxygen to the elements of the organic matters; that the protoxide of iron thereby formed absorbs oxygen from the air, which reconverts it into sesquioxide, and this again yields its oxygen to a fresh portion of organic matter, so that sesquioxide of iron is a most powerful oxidising agent, it being, in fact, the condenser of oxygen and the medium of its conveyance to and destruction of organic substances. MM. Chevreul and

Kuhlmann have also shown that sulphate of lime acts in a similar manner, namely, that it yields its oxygen to the elements of organic substances, and is thus converted into sulphuret of calcium, which having a great affinity for oxygen is again rapidly converted into sulphate of lime, and thus the oxygenation and destruction of the organic matter is effected. Mr. Millon has published an interesting paper on the formation of nitre, or nitrate of potash, through the ammonia generated during the destruction of organic substances being oxidised into nitric acid, which combines with potash, if present, and if not with lime or magnesia, which are present in all soils. Mr. Millon has remarked that this important chemical reaction is effected by an organic substance called humic acid, which acid, or its homologues, exists in large quantities in all earthy loams containing much organic, and more especially vegetable, matters in a state of decomposition. Humic acid absorbs the oxygen of the atmosphere, which oxidises the ammonia into nitric acid and water. The chemical theory of the destruction of organic matters through oxidation and their absorption of plants and reconversion into the same substances, from which they were derived, such as sugar, starch, gum, oil, essences, &c., or albumen, fibrine, gluten, caseine, &c., was greatly in favour a few years since, as it appeared to fulfil all the requirements of nature. It has, however, been greatly shaken by the beautiful researches of M. Pasteur on fermentation, putrefaction, and spontaneous generation, which prove clearly that these physiological actions play a most active part in the destruction of organic substances. This most skilful chemist has demonstrated that there is no such thing as spontaneous generation, and that the notion entertained by some physiologists, that if matter is placed in favourable circumstances as to heat, light, &c., and in a proper medium, it will become spontaneously animated, is undoubtedly erroneous, and that life in all instances proceeds from a germ or egg in which the vital principle is implanted by the Creator. He proves that life, even in the most insignificant of microscopic creatures, always originates thus, and that there is no single instance of matter being animated by purely physical causes. Let me draw your attention to a few among many facts observed by M. Pasteur, proving that life is not a property of matter, like weight, elasticity, compressibility, &c., but is always the result of a germ even in its lowest development.

When arterial blood is carefully introduced from the artery into a clean vessel, and there brought into contact with oxygen, no fermentation or putrefaction of the blood ensues ; and if the experiment is repeated, substituting for the chemically prepared oxygen, atmospheric air which has been passed through a tube containing pumice stone and carried to intense heat, in this case also, there is no putrefaction or fermentation ; but if ordinary atmospheric air be used in the place of pure oxygen, or heated air, and left in contact with some of the same blood, this vital fluid will rapidly putrefy, which is doubtless owing to the presence in the atmospheric air of the sporules or eggs of mycoderma and vibrios, or organized ferments, which give rise to the various chemical phenomena and changes of organic matters into products which characterise fermentation and putrefaction. The same results are obtained when fresh urine is substituted for blood, an important fact, proving that the germs of fermentation do not exist in the fluids themselves, and that fermentation does not proceed fom any molecular or chemical change in the composition or nature of the organic substances contained in blood and urine, but that the ferment from which these phenomena proceed is to be sought for in the atmosphere. I shall substantiate this view by several other interesting observations made by M. Pasteur.

If some asbestos is heated to a red heat and plunged into a liquor susceptible of putrefaction, such as a saccharine liquor, no fermentation ensues, but if atmospheric air is passed through asbestos at natural temperature, and the latter then immersed in a similar solution of sugar, active fermentation soon takes place, proving that the atmospheric air has left on the surface of the asbestos sporules of the Mycoderma vini, which, being introduced with the asbestos into the saccharine fluid, orginated the well-known alcoholic fermentation. Another beautiful series of experiments by M. Pasteur is the following: —He introduced into sixty small balloons a small quantity of a highly putrescible fluid, and after boiling the fluid in order to drive out the air remaining in the balloons by the formation of steam, he closed the small apertures so that on cooling the steam condensed and a vacuum was produced. He then proceeded to open twenty of these balloons at the foot of one of the hills of the Coté d'Or, twenty others at the summit of the same (about 2,000 feet high), and the remaining twenty at a point near Chamounix, and the following results were observed: Of the first twenty balloons the contents of fifteen entered into putrefaction within a few days; of the second twenty only six, and of the third twenty only two gave signs of fermentation. These results, as well as some others published by M. Pasteur, prove that the sporules or germs of putrefaction and fermentation exist in all parts of the atmosphere, but more abundantly in the lower strata, which are necessarily in contact with great quantities of organic matter in a state of decay, and that these sporules become scarce in the upper regions of the atmosphere, which are further removed from the source of pollution. Further, he has proved, as I stated in my last lecture, when speaking of the preservation of milk, that fluids extremely liable to fermentation or putrefaction may be prevented from entering into those conditions by heating them to 250° or 260°, a temperature at which the sporules cannot resist decomposition in the presence of water. M. Pasteur has advanced a step further in this interesting inquiry, for he has demonstrated that there are two distinct phases in putrefaction. In the first there are the vibrios produced in the bulk of the fluid containing animal matters in solution, and that these microscopic animals resolve the organic substances into more simple compounds; in the second phase, there are produced on the surface of the fluid cryptogams, which he calls mycoderms, and which absorb oxygen from the air, and oxidise the products developed by the vibrios. In the case of the fermentation of vegetable substances, such as saccharine matters, there are mycoderms (*Mycoderma vini*), which resolve them into, say alchol and carbonic acid, while other mycoderms (*Mycoderma aceti*) are produced, and grow on the surface of the fluid, oxidising alcohol into water and acetic acid. He therefore concludes that the animal vibrios and vegetable mycoderms exist abundantly in nature, and that they must be and are the most active causes of the destruction of vegetable and animal substances which have fulfilled their vital function on the earth, reducing them into water, carbonic acid, ammonia, sulphuretted hydrogen, &c., which, in their turn, become the food of a succeeding generation of plants and animals, We may therefore truly say that death is life in the constantly reviving world.

M. Pasteur has observed another most curious fact connected with these microscopic beings—(I say microscopic, because it requires a most powerful instrument and high powers to distinguish them, and to ascertain that vibrios possess a vibratory motion while mycoderms are stationary); this is, that vibrios are the only animals which can live in pure carbonic acid, and which are killed by oxygen even diluted with another gas. Oxygen is essential to the life of mycoderms, and some of them can also exist in carbonic acid. Lastly, M. Pasteur has noticed that if a very small amount of yeast is added to a saccharine fluid, the yeast will not materially increase in quantity, because the new generation which is produced lives on the remains of its parent; but if phosphate of ammonia or of lime and some sal ammoniac is added with the yeast, the latter will rapidly increase and occupy several times its original bulk. It is curious to observe that these microscopic cryptogams require the same kind of food as man. Thus, they require nitrogenated food—so do we. They require mineral food, as phosphates—so do we. They require respiratory food—so do we. They produce carbonic acid as part of their vital functions—so do we. I cannot do better than conclude this part of my subject by giving the following table descriptive of the various ferments observed by M. Pasteur:—

Fermentation.

Mycoderma vini.	Resolves sugar.	Alcohol. Carbonic acid. Succinic acid. Glycerine.
Mycoderma aceti.	Oxidises alcohol.	Acetic. Water.

Putrefaction.

Infusorial Ferments.

Vibrios resolve animal substances.

Bacterea oxidises organic matters of an animal origin.

I should mislead you, however, if I did not call your attention to another class of fermentations, which are chemical in their nature and in their action. This, for example, is the case when bitter almonds are crushed and mixed with water. The amygdaline they contain is decomposed into prussic acid, hydruret of benzoil, &c., by the ferment they contain, which is called "emulcine." Again, when black mustard is reduced to meal, and placed in contact with water, the myronic acid it contains is decomposed into the essential oil of mustard, a most corrosive fluid, and this is also effected by a special ferment called "myrosine." Again, when malt is mashed with water of a temperature of 170°, its starch is converted into sugar by a ferment called "diastase." We also know that the starch which we take into our stomachs as food is converted into sugar by animal diastase, which exists in the saliva as well as in the pancreatic juice, and that this conversion is identical with that which takes place in the mashtub. In fact, the whole of the changes which our food undergoes to render it fit for assimilation in the digestive organs of the body may be considered as a series of different fermentations. What gives a further interest to these chemical ferments is, that not only are they all nitrogenated, and possess a similar composition, but they present many identical properties, and each has its own peculiar action, that is, it will only cause fermentation in those matters which have been placed by Nature in contact with it. Thus, diastase will not convert amygdaline into prussic acid, hydruret of benzoil, &c., nor will myrosine convert starch into sugar.

In conclusion, it is certain that our knowledge of these interesting phenomena of putrefaction, fermentation, &c., is yet in its infancy, and there is no doubt that many important discoveries in this intricate branch of knowledge will from time to time be brought before the world, and reward science for its persevering efforts.

ON THE DENTALIUM SHELL AND SHELL-MONEY.

BY EDWARD T. STEVENS.

IN the very interesting paper upon "The Use of the Dentalium Shell by the Natives of Vancouver's Island and British Columbia," which appeared in the last number of the TECHNOLOGIST, it is stated that twenty-five dentalium shells placed end to end should measure six feet (a fathom) to make a "Hi-qua" or the highest value capable of being represented by a single fathom of these shells, and that the shorter and defective shells are strung together in various lengths, and are known as "kop-kops," forty of which equal a "hi-qua" in value.

Mr. Paul Kane (quoted by Dr. Daniel Wilson) gives some particulars as to the value of these shorter shells. He states that forty dentalia go to the fathom as the standard number, which, he adds, is equal in value to *one* beaver's skin; that if thirty-nine shells measure the fathom, it is then worth *two* beavers' skins, and so on increasing in value one beaver's skin for every shell *less* than the standard number.

Among the Chinooks and other Indians of the Northern Pacific coast, dentalia, called by them "ioqua," serve for ornamental purposes, as well as for money; they are formed into necklaces, and the robes of the natives are fringed with them. Curiously enough, dentalia were used for a necklace by some long-forgotten Celtic chieftain, who found his last resting place on this side of the Atlantic, upon that large tract of bleak down-land known as Salisbury Plain. The smooth grass-clad knoll which marked the spot at Winterborne Stoke, near Salisbury, when opened by the late Sir Richard C. Hoare, disclosed the mouldering remains of the warrior, with his highly-prized *bronze* dagger-blade and his rude ornaments, which consisted of some imperfectly-burnt clay beads, two joints of a fossil encrinite, and a necklace of dentalium shells. From this and similar examples it appears that necklaces and such ornaments were worn by the *male* sex in the British Isles during the period that stone and bronze weapons were in use; thus, to give but one corroborative example, two *male* skeletons were found in a tumulus in Phœnix Park, Dublin, in 1838, and each had been buried with a necklace of shells (*Nerita littoralis*) around the neck. In this instance no trace of metal was found in the interment; the brooch (*fibula*) was of bone, the arrow point merely chipped from a flint. How exactly does this practice agree with what is known to exist among the aborigines of North America; it is not so much the squaw as the warrior who is loaded with ornaments and decorations.

Whilst the dentalium constitutes the circulating medium of North-Western America, shells in another form represented money among the tribes which inhabited the south-eastern districts of that continent. This shell-money is known as *wampum*, an Iroquois word meaning a *mussel*. Wampum was made from shells cut into pieces from half an inch to one inch in length; these pieces were perforated and strung on deer's sinews. An old writer (John Josselyn) asserted that the Indians made wampum so cunningly, that neither Jew nor devil could counterfeit it. As events have turned out, this was an idle boast, for a spurious imitation, very closely resembling real wampum, was introduced by the fur traders at so low a price, that the whole Indian country was soon flooded with it, destroying at once the value and meaning of real wampum.

Wampum is of two colours, dark purple and white; the former is made from the *Venus mercatorius*, the latter from the columella of various shells. Not only did wampum at one time form the regular circulating medium in the eastern districts of North America, but the wampum belt was passed as a pledge of friendship at treaties, or was sent to hostile tribes as the messenger of peace. Did fortune prove adverse, then so many fathoms of wampum were paid as tribute to the conquering tribe. Ninigret paid the English in two years about 1,100 fathoms of wampum (cir. 1650). Pometacom (a New England Indian, cir. 1671) possessed a coat, band, and buskins "thick set with these beads, in pleasant wild works," which were valued at 20*l.*

About 1650 a fathom of white wampum was worth rather more than 5*s.* 7*d.*, the purple representing double that sum. By number, six white and three purple beads were equivalent to one penny English.

Wampum is found in ancient graves in Western New York, in tumuli of the West. It has been obtained from the plains of Sandusky, from graves near Buffalo, and north of the Niagara river in Canada. Not less than 1,700 of these shell beads were taken from one tumulus in Western Virginia.

Catlin observed that, after he had passed the Mississippi River, scarcely any wampum was used; he did not notice it at all among the Upper Missouri Indians, very little among the Missouri Sioux, and none among tribes north and west of them. Below the Sioux, and along the whole of the western frontier of the United States, the use of wampum was profuse. In tumuli in Tennessee, and in the Ohio Valley, wampum occurs together with the raw material (the columella of the *Strombus gigas* as found on the sea-coast) and all stages in the manufacture up to the finished beads.

Doubtless the tropical marine shells which have been found in American tumuli, at considerable distances from their native habitat, had been treasured by their owners during life for their rarity, and were buried with the cherished belongings of the deceased. It is probable that they represented money, just as appears still to be the case with certain marine shells in Central Africa. Strinte hung a string of beads with the end of a *cone-shell* around Dr. Livingston's neck as a last and convincing proof of his friendship. Two such shells would have bought a slave, and five would have been a handsome price for an elephant's tusk worth 10*l.*

The value of the money cowry (*Cypræa moneta*) appears to have varied considerably—a variation which depended upon the supply of shells, the distance they had to be transported, and the difficulties of transit. Thus, in Bengal, eighty cowries made a *poni*, and from sixty to sixty-five *ponis* (according to the scarcity or the abundance of cowries in the country) were of the value of a rupee; whilst in the interior of Africa the value of the cowry was increased tenfold.

If shells have served for money, they have also ministered to man's wants, to his luxury, and to his pride in a thousand ways. I can but enumerate a few instances:—The Caribs made knives, lances, and harpoons from shells. The application of shells to the manufacture of fish-hooks is well known; the natives of Tahiti caught cuttle-fish with a bait made from highly-coloured shells. Whilst many natives have decked themselves with ornaments made of shells, the natives of Darnley Island, off the coast of New Guinea, are stated (cir. 1843) to use shells as *substitutes* for dress. The Malays need calcined shell, (chunam) to impart a relish to their favourite masticatory, the sliced betel nut. The American mound-builders reduced shells to a coarse powder, and mixed it with the clay employed in making their pottery. According to tradition, a dog broke a shell on the sea-shore, and thus led to the discovery of the renowned dye—the Tyrian purple—so highly prized by the ancients. The byssus of the Pinna shell was spun and woven into a silky cloth by the ancients; indeed, gloves and other articles are still made from it as curiosities.

I say nothing of the value which has always attached to pearls, or of the importance of shell-fish as food, although the Danish shell-mounds (Kjökkenmödding) and those of Massachusetts and Georgia, U.S., carry us back to a period when certain tribes almost subsisted upon molluscs.

The modern British trade in shells, however, is not unimportant, as your readers may learn by looking to the TECHNOLOGIST, vol. i., p. 271. Details are there given of the value of the imports of foreign-collected shells for the year 1859, amounting to the very respectable sum of 274,268*l.*

Salisbury Museum.

IRISH BOG-OAK ORNAMENTS.

ONE branch of art manufacture exclusively Irish is the manufacture of ornaments from Irish bog-oak. In compensation as it were for the coal-fields of England, Ireland possesses vast tracts of peat moss or bogs. In these have been found, deeply buried, the relics of primeval forests which flourished, it may be, before man had trodden the earth. Oak, fir, deal, and yew have been dug up and used for firing and other purposes; but in the present century the hand of Art has converted portions of this product from comparative uselessness to articles of artistic value.

The history of bog-oak manufacture is somewhat interesting. When George IV. visited Ireland in 1821, a person of the name of M'Gurk presented him with an elaborately-carved walking-stick of Irish bog-oak the work of his own hands, and received, we believe, a very ample remuneration. The work was much admired and M'Gurk obtained several orders from time to time. Subsequently a man of the name of Connell, who lived in the lovely lake district of Killarney, commenced to do somewhat more regular business in carving the oak to be found plentifully in the district, and selling his work to the visitors as souvenirs of the locality. The trade prospered sufficiently to induce him to establish himself in Dublin some twenty years ago, and at his retirement the business, now a profitable one, passed to his son-in-law, Mr. Cornelius Goggin, of Nassau-street. The beauty of the carving and the elegance of the designs, chiefly taken from objects of antique Irish art, made these ornaments in fashion not only in Ireland, but in England. The Queen, the Prince Consort, and other members of the royal family and the nobility were purchasers of the most beautiful specimens ; and so carving in Irish bog-oak attained the position of a native art, giving employment to many hands and supporting many establishments.

The oak is black and hard as ebony ; that best suited for carving is brought from the counties of Meath, Tipperary, Kerry, and Donegal. Of a load which will be purchased for about thirty shillings, a considerable portion is unfit for use, by reason of flaws or splits. The wood is cut into pieces suitable for carving and is worked on the end of the grain or section, and not on the length of the grain, or plankwise. The process of carving is similar to that of ivory. The more experienced workmen carve designs without any pattern before them, and can earn from forty to fifty shillings a week. The wages of the less expert vary from ten shillings upwards, and women earn nearly as much as men. The total number of persons employed in this artistic handicraft is something over two hundred. Many of them work on the premises of their employers, while others take the material to their own houses.

A method of producing very fine effects at a great saving of cost and labour has been patented by Mr. Joseph Johnson, of Suffolk-street. This is effected by stamping: the piece of wood, cut to the required size, is placed on the top of the die, which latter is heated by means of a hot plate of metal upon which it stands ; over the wood a similar hot plate is laid ; upon this a powerful screw-press descends, and the wood receives the impress of the die as freely as wax, the bitumen in it preventing the fibre from cracking or crumbling. In this way objects of exquisite delicacy and very high relief, almost to the height of an inch, are produced in a moment. The designs thus obtained by the die are readily distinguishable from those wrought by the carver's tool; they want the extreme sharpness of the carving, but they are capable of showing, in compensation, more minute figuring and more elaborate details. The dies, some of which are very beautiful in design and all sharply cut, are made on the premises.

This branch of trade has done some service to Art in Ireland, by producing many excellent native carvers, several of them in the humblest walks of life. Amongst those one pre-eminently deserves to be mentioned. Many years ago, three ladies of the name of Grierson, persons of education and refinement, turned their attention to educating some of the young people in their neighbourhood, in the Dublin mountains, in the art of wood-carving, as they had seen it practised in

Sweden. The project was successful, and amongst the pupils one of the name of Thomas Rogers attained to such excellence that his work will safely bear comparison with the best artists of any country. He is, of course, in full business. From time to time he comes down from his retired home, a glen in the Dublin mountains, known by the poetic name of Glen-na-Smohl, or the "Valley of the Thrush," receives his orders, takes home his wood, and returns in due time with his work executed in the most exquisite manner. This year he executed for Mr. Johnson, of Suffolk-street, one of the most elaborate and beautiful pieces of work that has ever been produced in Ireland—the large bog-oak box made for the purpose of holding the Irish lace presented to the Princess of Wales by the ladies of Ireland, the box being a gift to her from the Irish gentry.

It is not easy to estimate the amount of the sales of bog-oak work. Mr. Johnson sells between 4,000*l.* and 5,000*l.* a year, and Mr. Samuel M'Connell and others do a proportionately large business. It is to be regretted that a very inferior imitation is produced in England made of common deal, stamped and coloured, which is sold as genuine Irish carved bog-oak. It can, however, deceive only the very ignorant or the very unwary.

The stranger who visits Dublin may dispose of an idle hour very agreeably in the inspection of the shops where these bog-oak ornaments are sold. The principal establishments are those of Mr. Johnson and Mr. Goggin already alluded to, and of the brother of the latter in Grafton-street, and those of Mr. Samuel in Nassau-street and Mr. Johnson in Fleet-street. Articles of very much the same character may be seen in them all: antique sculptured crosses in high relief, round towers, abbeys, antique brooches and fibulæ, harps, shamrocks, and other national emblems, besides a multitude of articles used in the boudoir and the drawing-room.

Unhappily, there are not many Irish manufactures; it is a duty to encourage those that do exist. They will in time become better as well as more numerous. We have strong faith, not only in the capabilities of the country—so fertile in raw materials of every available and useful kind—but in the power of its people to turn them to valuable account. —'The Art Journal.'

FOREIGN AND HOME FISHING VESSELS AND BOATS.*

Amidst the variety, or rather the profusion, of objects which the Exhibition displayed, ships and vessels of all kinds were few in number, and occupied but little space, notwithstanding the large share they had in bringing these very objects to our doors from every part of the habitable globe, the intercommunication they keep up between remote nations, and the deep influence they have exercised on mankind by being the pioneers of discovery and the means of spreading civilization to the uttermost parts of the earth. And especially does this remark of scarcity of specimens apply to the various forms of native vessels, boats, and canoes which the navigator meets with in the eastern seas and among the numerous islands in the Pacific Ocean, where each group has its peculiar form, some of which, when we were first introduced to them by our earlier circumnavigators, as Tasman, Vasco da Gama, Cook, La Pérouse, Dumont-Durville, Lütke, and Krusenstern, were found to be of unusual shape, to have many good qualities, to be very picturesque under sail, and occasionally ornamented by most elaborate carving. As from some cause or another these types are fast passing away, it may not be without interest to mention some of the more characteristic of them, and to compare them with the more familiar European forms. At the same time we cannot but express our regret that so few specimens of them were to be found in the Exhibition of 1862; nor, indeed, as far as we are aware, is there anything approaching a complete collection of models of native boats and vessels in any museum in Europe. The best, we believe, is in the Louvre at Paris.

On the western coast of Africa, in the deep rivers of Senegal, and the delta of the Niger, the canoes are hollowed out of the trunks of large trees, and some of them, especially those used for war, are fine powerful boats, propelled by thirty paddles. On the shores of Arabia, the dhow and bagala of Mokha, and Maskat, with a high poop and very low raking stem, appear to have been the type of vessels of the middle ages. One peculiar feature is having the maximum of displacement abaft. The *garûkuh* boat, with its long raking stem, the *beden safar*, or great fishing boat of Maskat, with an upright stem and one large lateen sail, and the *dungiyah* of the Gulf of K'ach, has each its peculiarity. On the Malabar coast is the *putamar*, with its arched keel, and farther south the snake boat, a long pirogue, which is light for use on the back waters or lagoons that extend south of Cochin. In Ceylon the outrigger becomes a prominent feature, and with its aid the boat carries a larger sail in proportion than any that swims the seas. It is of light cotton cloth, and its surface is more than 200 times that of the immersed section of the canoe and its outriggers.

* From the Jurors' Report on Class XII., International Exhibition, 1862.

On the Coromandel coast we meet with the catamaran, or raft, with its brown triangular sail, which at a distance resembles a buoy placed to mark a shoal; off Madras with the masulah or surf boat, apparently clumsy and frail, yet admirably adapted for landing on the beach, on which the rollers of the Indian Ocean unceasingly break. On the Ganges and Hooghly are numerous flat boats, a sort of floating houses, with very high pointed sterns, low bows, and kiosk-like buildings amidships to give shelter from the sun. The war galley of the Birmans with its thirty rowers, and the *shupán doghe,* or state yacht, are magnificent vessels in their way.

On the coast of China there is an entire change; and however fantastical the form, there is no want of intelligence in adapting the junks for the work they have to do; they have their greatest breadth abaft the beam, the stern is round, and the bow sharp, with no hollow lines; the sail is of palm canvas with bamboo laths across it, sometimes upwards of thirty in number, like a persienne or Venetian blind. A Tonkin coasting junk with its radiating ribbed sail and the curved head drawn forward, looking like a gigantic nautilus. In the Philippine Isles, as in all the country of the Malays, double outriggers, or one on each side, are used, the weather one serving to give stability by its weight, the lee one by its buoyancy; the *tarayas* or fishing rafts with their two masts in the form of shears, their very long bamboo lateen yards curving right and left, and the fishing nets suspended from them are very picturesque. The Malay coasters have triple masts in the form of a triangle, while the build of the boats is not unlike that of the fishing boats of Provence. In these seas, which are always smooth, the notorious Malay pirates have reproduced the biremes and triremes of the ancient ages. They are very long boats, and the banks of oars or paddles are placed one above and outside the other on the outriggers, and the boats attain a great speed.

To the eastward of New Guinea we meet with only the single outrigger, the happy invention of some savage Archimedes, which by its leverage enables the small and narrow canoes to carry large sails. In the Caroline Islands we first see the flying praos, the sail being an equilateral triangle, having its side equal to the length of the canoe. This enormous sail is balanced by a single outrigger in the form of a small solid boat, and the lateral resistance is further increased by the lee side of the canoe being straight and nearly upright, as they can always present the same side to the wind, changing the rudder from stem to stem when necessary. The natives of this group, the sailors *par excellence* of the South Seas, go distances of 700 miles out of sight of land, and their speed is such that the name of flying praos given by the earlier circumnavigators hardly seems an exaggeration.

At Vanikorro, where La Pérouse perished in the year 1788, the ends of the canoes are decked, and in the centre is a raised caboose, from the top of which long slight spars curve down to the outriggers on each side, giving the appearance at a short distance of a gigantic spider walking on the sea. Amongst the Viti or Fiji group, as well as in the Tonga Islands, the canoes are much longer, reaching to sixty and occasionally eighty feet; some elaborately carved, evincing the skill and patience of the natives, when we consider that their tools were only sharp stones or pieces of shell. Their war canoes are preserved from the sun and weather under beautiful roofs supported on elegant pointed arches. In New Zealand the raised stem and stern of the canoes is often adorned with large tufts of feathers. At Taiti, in the Society Islands, and Hawaii, in the Sandwich Islands, large double canoes were used; in the latter group, Captain Cook, in the year 1778, saw a canoe 110 feet long in the fleet of King Otu, but all these have disappeared, and coarse fishing canoes are the only native boats to be now seen.

On the north-western coast of America the baidar, or umiak, made of skins, is entirely covered up, except a hole in the centre, where the native sits and dexterously plies his double paddle, and this form prevails as far as the coast of Labrador and Greenland. A specimen of a Greenland fishing-canoe, fitted complete, was exhibited by the Danish Government. In Guayaquil and along the coast of Peru, the balsa or large raft, made of a peculiarly light wood, is in use; and where the surf is very heavy, as at Arica and elsewhere, two large inflated skins, placed side by side, and united by a light platform between them, carry the passenger with safety to the beach. Prince Edward Island, in the Gulf of St. Lawrence, exhibited a specimen of the North American Indian bark canoe.

The models of fishing boats were not near so numerous in the last Exhibition as those sent to the Exhibition of 1851; still, there were some from the ports in the United Kingdom, from Norway, and other countries which deserve notice, and which we shall have occasion to refer to a little later. The value and importance of the fisheries to every maritime country, not only in a commercial point of view, but as supplying the poor with cheap and nutritious food, and as a means of raising up a body of intelligent seamen conversant with the set of the tides, and inured to every hardship, ready to man life-boats and carry succour to a stranded vessel in case of need, is of such interest to all seafaring nations, that a brief notice of the more important European and trans-Atlantic coast fisheries, with a description of the best forms of fishing vessels and boats in use, might well form a suitable preface to our Report. But the means are not available, and we are reluctantly compelled to limit our notice to the fisheries of the coasts of the United Kingdom and the surrounding seas, as the trawling grounds frequented by the Penzance, Plymouth, and Torbay fishermen, in the western part of the Channel, the Dogger Bank and North Sea fisheries, the herring fishery on the coast of Scotland, the Nymph Bank, off Waterford, and the recently-discovered Rockall Bank, off the north-west coast of Ireland.

The fishing vessels and boats of Penzance, Plymouth, Torbay, and the south coast generally, are remarkably fine vessels, whether considered as sea boats or pilot boats. The Torbay or Plymouth vessels vary from thirty to sixty-five tons old measurement; they are cutter rigged, and keep the sea in the heaviest weather, trawling with a hawser of 100 fathoms in the midst of Channel gales. The following are the dimensions of the pilot and fishing cutter "Queen of the Craft," of Plymouth:—Length on deck, 17 ft.; breadth, 16 ft.; draught of water, 10 ft.; 62 tons, old measurement; value 400*l.* On a wind these vessels spread 500 yards of canvas, but in trawling with a free wind they set a square sail and a studding sail over, making, with the other sails, a spread of from 700 to 800 yards.

Such vessels sweep the bed of the sea with a very large net, of from eighty to ninety feet in length; it is of a purse form with wings forty-eight feet at the mouth, with the same length of trawl beam. The management in trawling displays good seamanship, and skill and knowledge of the position of the shoals and rocks at the bottom of the sea, which is determined by landmarks and experience. The fishermen, with a large hawser and net astern, wear and stay their vessels even in severe weather with great ease. The quantity of fish caught is occasionally very great, amounting sometimes to between three and four tons on a day's fishing. The fish consist of hake in large quantity, turbot, soles, whiting, dory, brill, plaice, and other kinds of fish.

In addition to these pilot fishing cutters, there is a fine class of boats, generally yawl rigged, termed the Cawsand Bay boat. They are usually clipper built, vary from twenty-five to forty tons, and are rigged with a gaff mainsail. Value from 80*l.* to 150*l.*, or more. Of late years light luggers have been employed, or about thirty feet keel, and drawing about five feet. There is another class of boat on the south coast termed a hooker, also worthy of notice. These are generaly clench built, yawl rigged, and are used for hook and line fishing, in about thirty fathoms. They ride easily, and come to an anchor often in severe weather ten to fifteen miles or more from the land; they are thirty-two feet in length, and cost about 70*l.*

Besides these vessels, more immediately employed at Plymouth and Torbay, there is a very fine class of lugger-rigged boats found between Portland, to the east, and the Land's-end to the west. The eastern luggers are from forty to fifty feet long, fifteen feet wide, and draw about seven feet abaft. They are usually sailed with a fore and mizen lug and jib. They are generally employed in mackerel fishing with drift nets. These nets are each about fourteen fathoms on the rope and four fathoms deep. One hundred-and-twenty such nets are commonly laid out in a line, to which the boats ride during the night. They not unfrequently land in the morning from 30,000 to 40,000 mackerel, which are immediately sent off by rail to London and other parts. The Cornish or Penzance luggers are vessels of a similar kind, but with a narrow bow and stern. They are sailed in much the same way as the eastern luggers, and are very fast and weatherly. They likewise enclose large catches of mackerel and pilchards.

Well-smacks suitable for fishing in the North Sea were first constructed at Harwich in the year 1712. Fifty years later the first attempt was made to fish for cod with long lines on the Dogger Bank, an extensive bank about sixty miles east of Flamborough Head, and in the year 1798 the number of vessels had increased to ninety-six smacks. About this period Gravesend, Greenwich, and Barking sent out smacks of similar description. At present the number and tonnage of the well-smacks, and of their crews, and the names of the ports they hail from, are as follows:

Name of Port.	Smacks.	Tons.	Men.
Harwich	5	300	50
Aldborough	10	500	90
Gravesend	10	600	60
Grimsby	14	900	130
Greenwich	41	2,066	370
Barking	180	10,800	1,620
Total . . .	260	15,166	2,320

These vessels are employed—forty on the cod fishery, six on the haddock fishery, and the remaining 214 in trawling.

There are also many of what are termed dry-bottomed vessels—viz., smacks built without wells, all fishing with trawls in the North Sea. The number of these vessels, their tonnage, and crews, now nearly equal those of the well-smacks. Hull sends out 100, Ramsgate, 96, and Brixham in Torbay, 113, averaging about thirty-five tons and five men each, or a total of 309 vessels, of 11,185 tons, and 1,488 men and boys.

With respect to the shore fisheries, the following statistical account of the number of fishing boats and their crews on the coast of England was prepared by Mr. John Miller, the intelligent General Inspector of Fisheries in Scotland, and is for the year 1850, since which time, it is believed, no record has been kept. It will be seen that in the nine districts into which the coast of England is divided, there were 4,698 boats, manned by 20,459 men and boys.

Name of District.	Extent in miles.	No. of Stations.	Boats.	Men and Boys.
North Sunderland district . .	80	29	576	1,238
Scarborough district . . .	130	10	283	950
Yarmouth district . . .	180	34	859	5,216
London district	300	24	626	2,826
St. Ives district	200	37	940	3,233
Bristol district	200	16	193	500
Liverpool district . . .	—	—	371	1,838
Isle of Man district . . .	70	4	605	3,865
Whitehaven district . . .	120	14	245	793

The above tables did not include the Channel Islands oyster fishery, which employs forty-two boats and 200 men. On the adjacent coast of France, at the four ports of Granville, Cancale, St. Malo, and Dinan, 426 vessels and 2,938 men are employed. The French have lately set a good example in establishing oyster parks on different parts of their coasts with great success. In the year 1859, M. Coste, of the Institute, who had been so successful in his endeavours to stock the rivers of France with salmon, was authorised by the Emperor to establish oyster beds in the Bay of St. Briduc, about thirty miles to the westward of St. Malo; these have proved so successful that it is understood they are being extended to Brest, Ré, Oléron, and elsewhere on the west coast of France.* This has been done in England at Alnmouth, where the Duke of Northumberland has recently formed oyster beds, which are thriving well; he has also established beds of mussels to enable the fishermen to supply themselves with bait close at hand, without having to go to a distance to procure it.†

In Scotland on the east coast, the herring fishery is carried on from the shore, and, with the exception of some half-decked boats at Fraserburgh, entirely in open boats, which, partly on account of the shallow harbours, are found by experience to be most convenient for the purpose; the boats vary much in form, the Buckie or Moray Firth boats appear to be the best; but the very raking stem and sternpost are objectionable, as rendering the boat unsteady when sailing before the wind. The boats are from thirty-six to forty feet in length by thirteen feet breadth of beam, and they cost from 40*l.* to 70*l.* On the west coast four-fifths of the Loch Fyne herring boats are half-decked, greatly to the safety and comfort of their crews. The number of boats employed in the thirteen districts into which the east coast is divided is about 13,000, and on the west coast about 2,500 boats, making a total of 15,500 boats, manned by 60,000 men and boys.

In Ireland much of the fishing is carried on in open boats; but on the south coast the Kinsale hooker is used to go off to the Nymph Bank, which lies about forty miles off shore, extending from Waterford westward nearly to Cape Clear, and also for trawling along shore. The hooker has the reputation of being a good sea-boat; but this would seem to be its only good quality; the bow is very full, and the quarter so lean that the mast is not only obliged to be placed far forward, but to be stayed over the bows, in order that the boats, when under sail, may not be always flying up in the wind. On the iron-bound coast of the west, from the Shannon to Galway, the fishermen use a canoe, a framework of ash covered with canvas, which each time they land they are obliged to haul up on to the cliffs. Altogether the fishery employs

* See 'Voyage d'Exploration sur le Littoral de la France et de l'Italie,' par M. Coste, 2ème édition, Paris, 1861.

† Since the date of this report the subject has occupied much attention, and the establishment of oyster beds on our coasts is becoming more general.

about 12,000 boats, making a total for the United Kingdom of 33,000 boats, manned by 130,000 men and boys, a branch of industry well deserving proper encouragement, as affording an inexhaustible source of abundant and nutritious food.

It is to be regretted that few models of European fishing boats were exhibited, nor can we obtain any description of the build of the boats, nor any statistics of the fishing ; yet France, Holland, and Sweden must have large fisheries. Norway alone sent models of fishing boats, several well-executed specimens being furnished by the Naval Department.

The principal herring fishing stations on the west coast of Norway are at or near Stavanger and Bergen, and, for the cod fishery, at the Lofoden Isles. In a country with so extensive a seaboard, and with its numerous deep fiords, having a large part of the population constantly employed on the water, it might be expected that many lives would be annually lost by drowning, but we were not prepared for anything like the amount of loss that really does occur. It appears from a small periodical named ‘Volkevennen,’ or ‘Friend of the People,’ published at Christiania, by Mr. Eilert Sundt, one of the Royal Commissioners for Norway at the International Exhibition, that the average annual loss from drowning for the last ten years, in a population of only a million and a half, exceeded 700, and this chiefly by the upsetting of boats. In the single diocese of Tromsö, which is the most northern of the five dioceses into which the country is divided, and has a large extent of sea-coast, the accidents from drowning, on an average of ten years, were 206 out of a population of 132,242.

The cause of this startling fact, which could hardly have been credited but for the authority it rests upon, deserves to be the object of the most careful inquiry and philanthropic interference. Is it that the boats are faulty in form? or the fishermen and others are reckless in the use of them? or that the men, as a general rule, cannot swim? or that there is a want of a humane society, and of the most efficient means for saving life in such accidents, and for restoring animation? Perhaps all these causes combined, and we would fain hope that not the least of the benefits of the Exhibition of 1862 may be that, having witnessed the various establishments and means specially provided for the saving life from drowning in this country, including the swimming schools set on foot by the Duke of Northumberland in the north of England, those appliances may be extended to the coasts and fiords of Norway.

In the Australian colonies generally, and especially in Tasmania and at Sydney, there are many well-built boats of good form, and well adapted to the fisheries in those seas ; but the only specimens exhibited were two whale-boats by the Commissioners of Tasmania, the production of the best builders of Hobart Town (Chandler and Miller). These boats are of colonial wood, the harpoons and all the exquisite fishing gear being fitted by colonial workmen.

In connection with Tasmania, whale fishing is a branch of colonial industry deserving mention. The fishing ground extends from the shores of this noble island to the Antarctic regions, and attracts many foreign whale ships, who rendezvous at Hobart Town. The value of the produce from the South Whale Fishery, exported in 1861, was 60,350*l.* At the present time there are twenty-five vessels, with an aggregate tonnage of 5,746 tons, engaged in whaling from the port of Hobart Town, and 131 whale boats (including fifty-one spare ones), identical in all respects to those exhibited, are attached to these twenty-five vessels, each boat costing, when fitted complete, about 70*l.* The boats of the Tasmanian fleet find employment for about 700 men. A colonial writer, in treating of this branch of industry, observes :—"Whale fishing is sometimes attended with great hardship, but being looked on as a colossal aquatic sport, and combining the excitement of bold and perilous adventure with the contingency of a good prize, and promotion according to merit, it has always been a favourite pursuit with the young Tasmanians, from whom might be selected some of the smartest boatmen in the world."

ON THE OAK-FEEDING SILKWORM OF CHINA.

BY T. T. MEADOWS.

THE British Consul at Newchang has written an interesting letter to the Shanghai Chamber of Commerce, regarding the silk produced in the neighbourhood of that port and the probability of foreigners deriving profit from its exportation. The worms there feed on oak-leaves instead of the stereotyped mulberry, and naturally produce a much coarser thread ; but the Chinese utilize it to a considerable extent. It is intermixed with cotton, and used for fabricating silk cloth of a rough texture. Dealers come up from the South in junks about the end of March, go into the interior, and advance money to the farmers. Two crops are produced, the latter of which is taken to the coast in the early part of November, shortly before the navigation is closed by ice.

As to the quantity annually exported, I have not been able, observes Mr. Meadows, to get any information. My principal informant tells me that from one valley, which is, however, one of the most productive, about eighty cart-loads are taken away annually. Each cart carries ten baskets, which, from his description, must each contain fifteen cubic feet. That would give about 12,000 cubic feet of loosely-piled cocoons from that one valley. What I myself know is, that the production in the whole region could be quadrupled in a few years, if the entering of foreigners into the trade should give sufficient inducement to the cultivators.

I have sent down samples and submitted them to Mr. Major, the inspector of Messrs. Jardine and Matheson's silk establishment at Shanghai, and he is of opinion that, notwithstanding its coarseness, it could be used with advantage in manufacturing the coarser kinds of silk fabrics in Europe. The yield is infinitely less, inasmuch as 20 lb. of cocoons only give 1 lb. of silk against 5 lb. or 6 lb. which are reeled from a similar quantity of ordinary Chinese cocoons.

"Of the value of these cocoons" Mr. Major remarks, "I can say nothing before I get a sufficient number of them to make 2 lb. or 3 lb. of silk, say at least four times 1,500 cocoons, and know exactly what they cost in dollars or taels at Shanghai; but I think it will be worth while making such a trial and sending the produce to Lyons or London (there is more skill in Lyons) to be dyed and manufactured into goods.

"Besides this, it is requisite to ascertain—

"1st. How often does this worm sleep while feeding?

"2nd. Is the worm fed on the mulberry leaf, of which Mr. Meadows speaks, of this same species (that feeds on oak leaves), or bred of the usual China silkworm eggs? I should much like to see a few cocoons of worms fed on mulberry leaf there.

"3rd. An experiment ought to be made of this breed (eating oak leaves) to ascertain what they come to when fed in a more congenial climate on mulberry leaves. If I could get an ounce of eggs of the first (July) crop, I would willingly attend to their feeding myself. The eggs ought to be sent here during the winter, protected from frost, but not kept near a fire or in a too warm cabin; 66° Fahrenheit would be too hot, or the utmost they would bear.

"It strikes me that this species of silkworm may turn out of the greatest consequence in restoring the silkworm breed in Europe, now quite lost, and even in restoring the silkworm of China, which I find also greatly deteriorated, to a more healthful state (this, however, is almost hopeless, considering the Chinese character). In all nature, too much and long-continued culture degenerates a breed; then new strength and vigour is acquired by cross-breeding with a healthy kind of the same species.

"Now, this worm gives me the impression of being very strong and healthy. It would be a great boon to the silk trade and industry to introduce any such means.

"New seed has for years been tried from all parts of the world in Europe, but to no effect; the whole family of one and the same race seems to have outlived itself by constant generating in the same family, at an enormous rate, to supply our augmented and constantly growing luxury.

"In Naples I tried, during three years, cross-breeding the old European breed with the usual China worm, and that with very good success. When I left for China I gave all the seed I had thus collected to an English gentleman, who, I fear, has not persevered, or I should have heard something of it ; people look too much to immediate benefits.

"If this new family is to be introduced for cross breeding, I should recommend feeding them in their first and second stages on oak leaves, and after that only on mulberry leaves.

"I beg leave to conclude with my opinion, that great thanks are due to Mr. Meadows for making so great an exception among the consuls in China, by turning his eye and mind towards what may be advantageons to the commerce and industry of the country he represents, and thereby also, to the country he occupies."

Mr. Major has had much experience in silkworms both in Europe and China, he having been engaged in silk farming in the south of Italy many years before he went to the East; and his opinion, that a cross between the Newchang worm and that of China and Europe might be effected with advantage, is, therefore, worth consideration. Kang-ni, the second Emperor of the reigning dynasty, appears to have made the first experiment of feeding silkworms on oak leaves about 200 years ago; and specimens of the cocoon obtained are to be seen in the Museum of the Chamber of Commerce at Lyons at the present day, having been sent home by the Jesuit missionaries who, under that Emperor, gained so prominent a position in China. It is evident, from Mr. Meadows' report, that since then the worm has thriven and multiplied.

THE SUPPLY OF TURPENTINE AND RESIN.

BY THE EDITOR.

In a former volume (vol. ii., p. 209) we gave some information as to the *modus operandi* pursued for obtaining turpentine in the Southern States of America. The supply from that quarter has been cut off, owing to the protracted civil war; and the Secretary of State for the Colonies, at the instigation of the Board of Trade, has drawn the attention of the colonial governors to the subject, in order that persons who are in a favourable position for furnishing a supply of these articles may have the facts before them. Canada, Vancouver, and New Zealand might do something in this matter. At present, France, Greece, and Turkey are deriving benefits from the demand for these products, the market price for which has doubled in the last three years.

The decreasing supplies are shown in the following figures :—

	Turpentine. Cwts.	Resin. Cwts.
1861	112,312	598,080
1862	12,722	339,011
1863	27,343	385,388

In 1859 our imports of turpentine were 256,663 cwt.; and of resin 886,789 cwt. The price then was about 10*s.* for the former, and 8*s.* for the latter; now it is 23*s.* and 28*s.* respectively.

The 'Journal of the Board of Arts and Manufactures of Upper Canada' of a recent date states:—We have received from Mr. Peter Irish, of Brighton, county of Northumberland, several samples of resin, and one of spirits of turpentine, of his manufacture. Mr. Irish took the first prize for both these articles at the late Provincial Exhibition, in the city of Hamilton. The samples of resin comprise black and white, with many intermediate shades of both transparent and opaque. We regret not having an analysis of Mr. Irish's turpentine; we have, however, Professor Croft's analysis of the specimens exhibited by Messrs. Connell and Cotter, of Hastings, which was awarded the second prize, and of Mr. Luke's specimen, of Angus, highly commended by the judges. The notes of analysis on Messrs. Connell and Cotter's turpentine are,—"Smell much like pure turpentine; boiling point, 154°C.; specific gravity, 0·865." For Mr. Luke's—"Smell of oil from pine-wood, by distillation; boiling point, 153° C.; specific gravity, 0 868." The boiling point of pure spirits of turpentine is 155° C.; specific gravity, 0·865.

In a communication from Mr. Irish, accompanying his samples, he gives a description of his process of procuring the raw article. He says he obtains it from the white (not the Norway) pine, by cutting notches or boxes, about two feet from the ground, with long-bitted axes, and a good axeman can cut about three hundred boxes per day. These boxes are made *dishing*, so as to hold from a gill to half a pint each, and should be cut between the 20th of May and the end of June. During the hot weather it will be necessary to gather the sap from these boxes at least once a week. In a tree one foot in diameter he cuts one box, of two feet in diameter two boxes, and so on. This, he says, will injure the tree but little, as the boxes he cut in some forty years ago are now completely grown over.

Mr. Irish paid 10 dollars per barrel for the raw article. The price obtained by him for resin during the year averaged 8 cents (4*d.*) per lb., and spirits of turpentine 1¾ dollars per gallon.

There is no danger of the supply exceeding the demand, even for local consumption in the colony; for, according to the trade returns in 1863, the imports of spirits of turpentine into the province were 13,913 gallons, valued at 26,312 dollars, and of resin, 3,650 barrels, valued at 63,484 dollars.

The sap in the wood of pines consists in variable proportions of turpentine and resin, according to the species. When the turpentine abounds, the sap of the tree operated on exudes a very fluid and volatile kind of turpentine, and when dry the wood is strong, slightly resinous, and generally light. On the other hand, when the turpentine is viscous, it leaves, on drying, an abundant resin in the tissues, and the wood is heavier. The hooked pine, the Cembra pine, and the

Weymouth pine are of the first-class ; the Scotch fir, the larch, and the maritime pine are of the second.

Colophony, or common rosin, is the residue of the distillation of turpentine. The oil or essence of turpentine passes over, and the residue is a soft yellow substance, which hardens by exposure to air, and is known as white or yellow resin. When melted it loses water, and concretes on cooling into black or common resin.

M. Auguste Mathieu, Inspector of Forests, in his description of the trees that grow spontaneously in France, points out the following as more or less utilized for obtaining resin and turpentine :—

Pinus abies, Linn. ; *Picea excelsa*, Link.—To obtain the resinous sap of this tree, long incisions are made through the entire depth of the bark. This operation, although very productive, is very weakening to the tree, necessarily dwarfing the dimensions to which it would attain. From this product is made spirits of turpentine, rosin, Burgundy pitch, and lampblack.

Pinus larix, Linn. ; *Larix Europœa*, D. C.—This tree furnishes the Venice turpentine, from which is obtained spirits of turpentine and other products. The tree is tapped with an auger of about three centimetres in diameter ; several incisions are made, inclining downwards, in the direction of the heart of the tree, but not penetrating beyond the sapwood. In these orifices, gutters or channels of wood or bark are placed, conducting the sap to a bucket.

Pinus picea, Linn ; *Abies pectinata*, D. C.—This tree is occasionally tapped for its resinous sap. The operation consists simply in piercing with a metal tool the resinous blisters that form on the bark, in order to collect the drops of turpentine which exude. This practice, which is attended with but small results, is, however, being more and more abandoned.

Pinus Cembra, Linn., yields a considerable quantity of turpentine of an agreeable odour.

Pinus sylvestris, Linn.—This tree is not generally tapped for turpentine. The resin sometimes accumulates in very great abundance in certain parts of the trunk and impregnates completely the wood, which is hard and almost translucid like horn. The wood is cut up and made into small bundles and sold in the markets under the name of fat wood, for lighting fires. The cones, after extracting the seed are also sought after for the same purpose. Resinous products are obtained from the stumps, where the resin is more abundant than in the stem. This is obtained by burning in close vessels in ovens of masonry of a special construction. The resin is liquified and mixed with the empyreumatic products of distillation, and flows over the surface of the furnace, being carried by a special channel to vessels placed on the exterior to receive it. The dark and viscous deposit is known as tar.

This operation is performed in fine weather, and the boring the trunk is by preference done near mid-day. A tree of fifty or sixty years old will yield annually from 3 to 5 kilogrammes of turpentine; and this for five or six successive years, if the channels or incisions made are carefully plugged or closed in winter.

The pursuit is followed in Valais by the Lombardians, who traverse the forests yearly to exercise their industry. It is not much practised in France, at least with less regularity.

The leaves of this tree exude a particular resinous substance, in the shape of small white grains, which are used medicinally as a purgative, under the name of Manna of Briancon.

Pinus Laricio, Poir.—This pine has only of late years been much employed for turpentine; but attention is now being generally directed to it, and this industry is established on a definite scale in Corsica. Resin was first extracted from the Corsican tress in 1856. In 1863, 175,000 trees (laricio and maritime pines) were subjected to tapping. Two kilogrammes (about 4½ lbs.) of resin were considered as the probable average yield of each tree; but this estimate, it is thought, will be considerably exceeded, as the Corsican pine proves to be much richer in resin than was anticipated. Still, this extraction of resin according to M. Tassy, the Conservateur of Forests, must always remain of secondary importance, and should only be carried on in forests which are difficult of access. Even if the quality of the trees is not injured by the tapping, there is reason to believe that their growth is impeded.

The composition of the forests of Corsica is stated to be as follows:—Of 45,810 hectares belonging to the State, 34,350 are covered with resin-yielding trees, of which the *P. Laricio* predominates. Of 57,428 hectares belonging to the communes the laricio and maritime pines are predominant in one-half.

The Austrian pine may be operated on with advantage; the turpentine contains in the proportion of 1 spirit to 3⅓ of resin. The trees which have been tapped for six or eight years yield better products than those which have been recently operated on. From trees of about thirty centimetres in diameter a mean annual yield of four kilogrammes of crude turpentine is obtained.

Pinus halepensis, Mill.—In Provence this pine is tapped in the same manner as the maritime pine is in the west, and the same products are obtained, but of less value. In general the tree is tapped when it has attained the dimensions of twenty or thirty centimetres in diameter. If properly attended to, it will yield for fifteen or twenty years six or seven kilogrammes of turpentine annually per tree. The notches which are made in the bark to induce the flow of the sap are about ten centimetres wide, and are called "Surlés." Every fifteen days the flow is invigorated by a small fresh cut at the upper part, until, in the course of the year, the incision or notch reaches the length of thirty centimetres. The turpentine is received in holes opened in the earth at the foot of the tree. It is known under the name of "Périnne vierge." After preparing and cooling in cakes, the resin so obtained is called "Raze." After exhausting the tree for turpentine, the trunk and root are distilled for tar, &c.

Turpentine is abundant in all the parts of the Weymouth pine (*Pinus Strobus*), but containing very little resin; it volatilises rapidly, and yields little at each extraction.

The extraction of resin from the pine trees in the extensive forest of Lairvaux (Morbihan) is about to be carried on on a large scale. For that purpose several cargoes of earthenware cups have been imported at Vannes. These are extremely simple, each cup resembling a small flower-pot, with the difference that one of the sides is concave, so that it can be fixed against the tree to be tapped, so as to facilitate the flow of the sap when the tree is pierced. The wood of the pine which has been tapped or resinated is considered in the Landes as far superior in resistance and durability to that which has not been tapped, and with good reasons. If the tapping exhausts the trees and reduces their dimensions, it produces, on the other hand, wood of feebler growth, and more charged with autumnal shoots; it causes, besides, an active flow of turpentine from the interior to the surface, of which the most liquid effuses, losing in the woody tissues which it traverses a considerable portion of resin. Therefore, the proportion of the resin the trees contain determines their weight, solidity, durability, and inflammability.

The wood is not always the principal product of the pignadas, or pine forests, for very often the timber is sacrificed for the turpentine. It is principally in the Landes that the tapping is carried on on a large scale; it is generally performed in the following manner:—A tree is ready for tapping as soon as it measures about four feet in circumference at the base. The tapper, to prepare it for his work, thins with his hatchet the bark where he intends to pierce it, and smooths it; then, with a special instrument, he makes a rectangular incision or channel called "quarre," which lays the sap open; it is generally a foot long by one inch wide. At the lower part of the "quarre" he digs a little trough in some protruding part of the stem to receive the produce.

If that is not possible he attaches a portable trough. Every week the incision is renewed by cutting off a thin slice from the upper part, so that it always increases in height, preserving the same width, or, better still, decreasing in width, and in five years probably reaches a height of about ten feet. Then it is abandoned, and a second one commenced, conducted like the first, from which it is separated by a belt of bark of two inches at most, and which is called "Ourle" or "Bourrelet." This is done all round the tree, taking care to put each "quarre" a little higher than the preceding one; then the belts ("ourles") are attacked, which, in the meantime, have spread and covered, more or less, the old wounds, and they are incised in the same way.

A well-regulated tapping may last 150 years and more, especially if the precaution be taken in the first years, whilst the tree is still weak, to give a year's rest after each period of extraction of seven or eight years.

Sometimes, when the tree is vigorous enough to bear it, two incisions are made at a time—a high "quarre" and a low "quarre," or "basson." Lastly, instead of opening the channels side by side, they are put as opposite to each other as possible, the new ones in the centre of the intervals which separate the old ones.

The tapping, when managed so as to preserve the vitality of the trees, is called "life-tapping." If, however, the pine is to be exhausted in a short time, none of these precautions are observed; they are cut on all sides, the channels being carried in one year to treble the height, and this is called "lost pine" or "tapped to death." To reach up to the height which the channels attain, a pole with notches on opposite sides is used by the operator. The tapping is begun in May and continued to the end of September; the turpentine flowing out collects in the troughs, whence it is removed from time to time. A good workman can notch 200 to 300 trees a day.

A strong and hardy pine, standing isolated, will produce from fifty to 100 lbs. of the raw material in the year, but trees growing in clumps will not yield more than twelve or fourteen pounds. The pines of the downs of Gascoigne are much more productive than others; those of the "Provence," which were submitted to a similar treatment, did not give any such satisfactory results.

The gross proceeds or raw products from tapping are of three kinds:—First, the soft resin, or liquid part, which has collected in the troughs; secondly, the "Galipot" resin, solidified in the grooves or channels, and which may be detached in pieces without being mixed with particles of the bark; thirdly, the "Barras," which must be scraped off, and is only an impure galipot, mixed with slices and fragments of bark, &c.

All these products are formed of essence of turpentine, and of resin or colophony; they only differ in the proportion of the two elements. Industry purifies, manipulates, and mixes them in the most varied processes, and manufactures them into a multitude of substances, of which the principal are—

1st. Pastes of turpentine, viscous liquids extracted from the raw materials by means of a low artificial heat filtering through straw hurdles (common turpentine paste), or by exposure to solar heat upon inclined planes, formed of boards badly joined together (fine sun turpentine paste).

2nd. The essence or oil of turpentine, a colourless liquid of slight oleaginous substance, produced by distillation of the soft resin or turpentine pastes.

3rd. The dry resin, or colophony, the residue of the distillation of the turpentine pastes ; melted and mixed with hot water and "barras," it forms the oil of resin. The yellow resin is a kindred substance obtained by a mixture of soft resin "barras," and "galipot," melted, filtered, and formed into cakes in moulds.

4th. The greasy "pitch," a viscous substance, of a reddish brown, produced by burning in a brick stove the filtering hurdles and all the *débris* and residues of the manufacture.

After exhaustion, the stems of the pines are cut in pieces, and burnt in ovens of earth or brickwork, when another product is obtained, the "goudron," or a pitch coal of medium quality. All these materials are of great importance :—The Navy could not do without tar and pitch ; the spirits of turpentine serves for numerous uses, especially as a solvent for varnishes ; the colophony is applied directly to the purpose of illumination ; the resin oil and the yellow resin for making gas for burning, soap-making, paper-making, and other uses.

OSTRICH BREEDING.

The problem of the domestication of the ostrich in the temperate regions of Northern and Southern Africa appears already to be attended with satisfactory results; and instead of chasing the bird for its destruction, in order to obtain the valuable spoils of its plumage, it can be bred and led to yield its feathers periodically for the wants of fashion. Some few years ago, it was stated that great success had attended experiments at the Jardin d'Acclimatation, at Hamma, in Algeria, the director of that establishment having received the premium of 80*l.* offered by M. Chagot, sen., feather florist, of Paris, a member of the Commission of Valuers to the French Ministry of Commerce, who was the first to get the ostrich to breed in a domestic state ; and the reproduction promises to obtain for commerce the ostrich plumes, which are daily becoming more rare and dear.

At a recent meeting of the Cape Agricultural Society, M. L. von Maltiz, well known as one of the most enterprising and successful farmers in the Colesberg district, gave a statement of his short experience in ostrich farming ; and any theory formed as to the profits which might be realized by such a pursuit falls immeasurably short of the result obtained. M. von Maltiz said : "My desire is that a prize be given to the proprietor of the largest number of ostriches in the district. I believe I am at present the only owner of those birds, and, therefore, I may, in making the proposal, be suspected of interested motives. To set that at rest, if a prize be offered and awarded to me, I will return it to the Society, to be again competed for at the following show. My sole object in moving the resolution is to encourage ostrich farming in the district, by which I am convinced, from my own short experience, enormous profits may be realized. Towards the close of last year, I purchased seventeen young ostriches of three or four months old. I placed them in an enclosure of 300 acres in extent, in which they had a free run. They have been kept there ever since, and have subsisted entirely upon the herbage of the enclosure, except an occasional feed of grain when driven up to the house for the inspection of visitors. I had at the same time other stock within the enclosure, and the opinion I have formed with reference to the extent of ground requisite for their grazing is that thirty-five birds can be carried year in and year out upon 300 acres of good grazing land—I mean land rather superior to the common run. At the end of last April I had the wings of the birds plucked, where the feathers of commerce grow. In consequence of the youth of the birds, the feathers then obtained were valueless. I now find, by recent examination, that the birds will be fit to pluck again at the end of the present month, verifying the statement made at the last Swellendam Show by one of its members, who was, like myself, experimenting in this novel description of farming, that he obtained feathers fully grown from his ostriches every six months. My ostriches are so tame that they allow themselves to be handled and their plumage minutely examined. Being desirous of ascertaining the opinion of those versed in the trade, as to the commercial value of the feathers, I have had the birds examined by several, and the general opinion is that the largest feathers, of which there are twenty-four on the wing of each male bird, are worth 25*l.* per lb., and that the yield of the whole plucking, the majority of the birds being males, will not fall short of 10*l.* each upon the average. I think the statement made at the Swellendam Agricultural Show sets the value of each half-yearly plucking at 12*l.* 10*s.* per bird, and this, I have no doubt, will be the average of mine when they arrive at maturity, according to the present market value of feathers. The original cost of the young birds was about 5*l.* each."

This hitherto neglected district (Colesberg), which, with the adjoining Free State, is pre-eminently the ostrich country, is likely to eclipse the gold-mines of Australia, California, and British Columbia, and landed proprietors may congratulate themselves in possessing the veritable El Dorado of the colony. In the last Cape papers it is stated that only a few small parcels of ostrich feathers had come to hand during the month, and for those offered at public auction competition had been very keen. All descriptions realized extreme prices, the best being sold as high as 27*l.* 10*s.* to 30*l.* 10*s.* per lb. In 1863 there was imported into the United Kingdom, chiefly from South Africa, Morocco, and France, 28,500 lbs. of ostrich feathers, valued at 153,059*l.*

Scientific Notes.

WE learn from the 'Chemical News' that a M. Richter, of Stuttgard, has devised a novel means of extracting the juice from grapes. Instead of pressing them in the ordinary way, he puts them in a drum provided with a suitable strainer, and rotating at the rate of 1,000 or 1,500 times a minute. The process is said to have the following advantages over the ordinary method :—The time required for the operation is greatly lessened, the whole of the must from one cwt. of grapes being obtained in five minutes ; the quantity of juice is increased by five or six per cent. ; "stalking" is rendered unnecessary ; and the agitated must is so mixed with air that fermentation begins comparatively soon.

THE *Société Impériale d'Agriculture* has offered a prize of 2,000 francs, to be given in 1867, for the best analyses of the following woods : —Oak (heart-wood) of the age of at least forty years (*Quercus robur* or *pedunculata*) ; ash (*Fraxinus excelsior*), of the age of at least twenty-five years—the whole of the wood except the liber and bark ; pine (*Pinus maritima* or *sylvestris*) of the same age, and poplar (*Populus tremula* or *alba*) of the age of twenty years. Analyses of the same trees five years old are also to be made, with the view of comparing the composition of wood of different ages. Specimens of the woods and of the principles obtained from them must be sent with each paper.

THE COAL-TAR COLOURS.—The trade in coal-tar dyes, which began in 1860, continues to expand, amounting probably to from a quarter to half a million annually. The colours are magenta, various shades of blue and violet, purple, yellow, orange, and green. The dyes are sent from London to Lancashire and Yorkshire and other places, to be used in the preparation of silk and cotton velvets, printed calicoes, delaines, merinoes, finished cottons, silks, ribbons, flannels, and fancy and flannel shirtings. An export trade is beginning to China and the United States, the dyes being sent in their solid form to save freight. It is said that several thousand pounds are annually spent in defending the patent.

BEET SUGAR IN GERMANY.—How the manufacture of beet sugar continues to prosper in the States of the Zollverein may be judged by the following figures, condensed from a recent official report :—" In 1863 there were about 250 factories in operation, which used up more than 36,000,000 cwts. of beet root. Twenty years ago only 5,000,000 cwts. of beet root were worked up into sugar. Then 18 cwts. of beet root were required to produce one cwt. of sugar ; now only 12 cwts. are needed. The duty levied produced 9,000,000 dols. The enormous profit derived from the cultivation is well known. In Austria alone 18,500,000 cwts. of beet root are grown, and 14,500,000 cwts. are worked up by 125 factories; and 32 of these each use above 140,000 cwts. of roots annually, one using as much as 408,000 cwts.''

The Nephrite of New Zealand.—This mineral, which is held in high esteem among the natives as a material for weapons, tools, and various ornamental objects, occurs exclusively on the west coast of the south island which is called "Te Wari Pooramoo," which means the Place of the Green Stone. It appears generally in the form of pebbles in river-beds and on the sea-shore; it is, however, said to occur also in masses in the vicinity of considerable veins of serpentine. The natives distinguish by name a great number of varieties, differing in hardness, colour, and translucence. These varieties may be divided between the two following groups:—1. Those of an intense green (generally leek-green) more or less translucent, with a hardness between that of felspar and quartz, compact, not schistose. 2. This group is of less value than the first, and its members are analogous in physical properties and chemical constitution to M. Damour's "jade blanc," and probably belong to the family Amphiboles.

Asiatic Manna.—A letter from Mr. Hardinge, to Sir Roderick Murchison, describing the appearance of a large quantity of manna in July, 1864, observed near Diarberker, Asia Minor, was published some time since, and created a good deal of controversy regarding the nature of manna. We believe, however, that there can be very little doubt that it is a species of lichen, which, like a fungus, springs up in the course of a single night, and thus gives rise to the notion that it has fallen from the skies. This manna is ground into flour and baked into bread, the Turkish name of it being "Kudert-bogh-dasi," which means wonder-corn, or grain. Though used as bread, its composition is remarkable; for it contains more than 65 per cent. of oxalate of lime, and has about 25 per cent. of amylaceous matter. This substance is evidently the manna of the Hebrews, who gave it the name of "Man-hu," which signifies "What is it?" from the circumstance of its sudden appearance and their previous unfamiliarity with it.

Bunslochur.—This is a silicious concretion, or crystallization, formed in the hollow bamboo, which is said to be found in old wood only, and about one bamboo in three producing it. It is used by the natives of India as a stimulant, tonic, and astringent, in doses of about five grains. The native practitioners have great faith in it as a medicine, and use it largely; its properties are said by them to be of a very heating nature. The substance, however, in a medicinal point of view, must be quite useless, as it seems to be merely impure silicate of potash. There are three varieties—pink, white, and blue. It is a very common article in the Bengal market, and comes from Sylhet, as also from other parts of India.

Paper for Pattern Cards.—Many attempts have been made to substitute punched paper, in the form of a web, for the heavy, cumbrous, and costly cards employed in Jacquard looms, but without practical success, until M. Acklin, a French engineer, at length solved the problem, and fitted up several looms, which are now at work in or near Paris. They save 30 per cent. in the cost of pasteboard, the tedious operation of lacing is avoided, and the expenses of preservation and transport of bulky and heavy pasteboard cards are saved, and the work is more regular, the "backing off" more certain and accurate, and the weavers' time and labour economised, and the rapid working of power-looms is facilitated. The improvement may be applied to existing Jacquard looms with little expense, and may be erected or removed in a short time.

Reviews.

The Book of Perfumes. By Eugene Rimmel. Chapman and Hall.

This is a work which will be popular, in the most widely-extended sense of the term, for it will interest large numbers, not only by the elegance of its getting up, but by the variety of the information it affords. Mr. Rimmel must have read long and deeply to have accumulated the vast stores of information of which he has given us the cream. From his valuable jury report at the last International Exhibition, and his paper read before the Society of Arts, we were prepared to find a large stock of knowledge opened up to us in any work emanating from his pen. But this elegant volume, with its various beauties of illustration, exterior and interior, and its sweet scent of perfume wafted on the air as we turn the leaves, more than fulfils the promise. After a preliminary chapter on the physiology of perfumes, we are led through the manners and customs in this respect of the Egyptians, Jews, ancient Asiatic nations, Greeks, Romans, Orientals, and natives of the countries of the far East, whilst uncivilized nations are not overlooked. Then the use of perfumes and the varying partialities of Gauls and Britons in ancient and modern times are dwelt on. Lastly, we have chapters devoted to the commercial uses of flowers and plants, and the several materials chiefly used in perfumery.

To say that all these subjects are treated with a master-hand is no more than the truth ; and, despite the modest preface of the author, his erudition and widely-extended practical knowledge are evidenced in every page. The general mode of treatment of the subject, as well as the taste and skill shown in the selection of appropriate woodcut illustrations, are alike creditable to the author. Indeed, it is just such a work as may be read with profit and pleasure by all, whether old or young, and as a drawing-room book, or agreeable souvenir, it forms one of the most entertaining and seasonable presents that could be made. Although the book can scarcely add to the already world-wide fame and European reputation of this well-known purveyor of sweet odours, it will certainly largely extend his circle of admirers, and become familiar as a household word wherever pleasant reading and useful information is appreciated. Such a book as this will necessarily run through many large editions, the more especially when its cheapness is borne in mind, coupled with the fact that it contains more than 250 illustrations.

Rust, Smut, Mildew, and Mould: An Introduction to the Study of Microscopic Fungi. By M. C. Cooke. With nearly 300 figures by J. E. Sowerby. Robert Hardwicke.

Mr. Cooke has established for himself a deservedly high reputation as a close investigator of Nature and a careful describer of Fungi. The beautiful little work before us opens a new field of research, not only for the microscopists, but also for all interested (and who is not more or less so ?) in those minute pests of the field and garden.

In the twenty years since the fifth volume of the British Flora appeared, the progress of Mycological science has been much extended.

Corn rust, smut, and the mould, or parasitic fungi, are diseases well known to the farmers ; but the true nature of these he has seldom stopped to inquire into. The popular work now before us, with its many beautiful coloured illustrations, will enlighten him on many points, and may be studied with advantage by others besides the mere microscopist seeking novelties for his object-glass.

Mr. Cooke thus sums up his remarks :—

" This fragment of a history of microscopic fungi goes forth to plead for students and prepare the path for something more complete. Is it not a shame that two thousand species of plants (never mind how minute, how insignificant) should be known to exist, and constitute a flora, in a nation amongst the foremost in civilization, and yet be without a complete record ? It is, nevertheless, true that hundreds of minute organisms, exquisite in form, marvellous in structure, mysterious in development, injurious to some, linked with the existence of all, are known to flourish in Britain without a history or description in the language of, or produced in, the country they inhabit. It is also true that the descriptions, by which they should be known, of hundreds of the rest lie buried in a floating literature whence the youthful and ardent student needs, not only youth and ardour, but leisure and perseverance unlimited, to unearth them."

We hail the appearance of all such works as this with satisfaction, from being calculated to fill an existing void, and also likely to interest the botanical student, the agriculturist, and the horticulturist.

Plantes Medicinales de Maurice. Par Louis Bouton.

This is the second edition of a valuable treatise on the medicinal plants of Mauritius, by the Curator of the Colonial Museum at Port Louis. The descriptions are brief, but the English, French, and native names are given, as well as the scientific ones.

Ensayo Sobre el Cultivo de la Cana de Azucar. Por D. Alvaro Reynoso. Second Edition. Printed at the expense of the Government. Madrid: M. Rivadeneyra.

This Spanish treatise is highly interesting, from being the result of the practical labours of a scientific planter, who has carried on the culture of the sugar-cane in Cuba on an extensive scale, and availing himself of all the modern improvements which machinery, new manures, and chemical research can give.

Engraving and other Reproductive Art-Processes. By S. T. Davenport. W. Trounce.

This is a valuable and exhaustive paper, reprinted from the "Society of Arts Journal," which summarises all that has been done in the various art-processes of engraving.

Naval Armour. By James Chalmers. W. Mitchell.

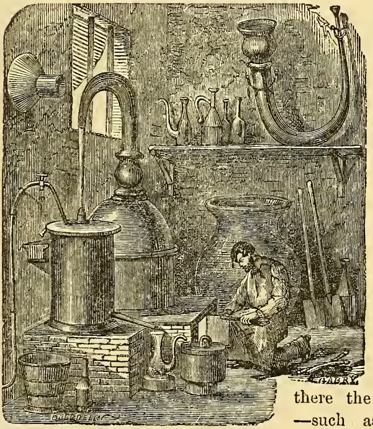
This treatise deals with an important and interesting subject, but one with which we do not profess to deal in our pages. It is chiefly devoted to the armour-plating of ships and targets, and especially treats, as a matter of course, of the author's own system of compound backing.

THE TECHNOLOGIST.

—o—

THE COMMERCIAL USES OF FLOWERS AND PLANTS.

BY EUGENE RIMMEL.*



NDER this heading, I shall describe the art of perfumery as it is now practised in the South of France, Italy, Spain, Turkey, Algeria, India — in fact, wherever the climate gives to flowers and plants the intensity of odour required for a profitable extraction. The South of France furnishes the most abundant supply of perfumery materials; there the most fragrant flowers —such as the rose, jasmine, orange, &c.—are cultivated on a large scale, and form the basis of the finest perfumes. Italy produces chiefly essences of bergamot, orange, lemon, and others of the citrine family, the consumption of which is very great. To Turkey we are indebted for the far-famed otto of roses, which enters into the composition of many scents. Spain and Algeria have yielded but little hitherto, but will, no doubt, in after times, turn to better account the fragrant treasures with which Nature has endowed them. Travelling in the plains of Spanish Estremadura, I have passed through miles and miles of land

* From Rimmel's 'Book of Perfumes.'

covered with lavender, rosemary, iris, and what they call "rosmarino" (*Lavandula stœchas*), all growing wild in the greatest luxuriance, and yet they are left to "waste their sweets on desert air," for want of proper labour and attention. I also found many aromatic plants in Portugal, and among others one named "Alcrim do norte" (*Diosma ericioides*), which has a delightful fragrance.

From British India we import cassia, cloves, sandal-wood, patchouly, and several essential oils of the Andropogon genus; and the Celestial Empire sends us the much-abused but yet indispensable *musk*, which, carefully blended with other perfumes, gives them strength and piquancy without being in any way offensive.

It has been proposed to cultivate flowers in England for perfumery purposes, but the climate renders this scheme totally impracticable. English flowers, however beautiful in form and colour they may be, do not possess the intensity of odour required for extraction, and the greater part of those used in France for perfumery would only grow here in hothouses. The only flower which might be had in abundance would be the rose, but the smell of it is very faint compared with that of the Southern rose, and the rose-water made in this country can never equal the French in strength. If we add to this the shortness of the flowering season, and the high price of land and labour, we may arrive at the conclusion that such a speculation would be as bad as that of attempting to make wine from English grapes. As a proof of this, I may mention that I had a specimen submitted to me, not long since, of a perfumed pomade which a lady had attempted to make on a *flower-farm* which she had been induced to establish in the North of England, and I regret to say it was a complete failure.

The only two perfumery ingredients in which the English really excel are lavender and peppermint, but that is owing to the very cause which would militate against the success of other flowers in this country; for our moist and moderate climate gives those two plants the mildness of fragrance for which they are prized, whilst in France and other warm countries they grow strong and rank.

There are four processes in use for extracting the aroma from fragrant substances—distillation, expression, maceration, and absorption.

Distillation is employed for plants, barks, woods, and a few flowers. (The mode of distillation was described in vol. iii., p. 173.) A great improvement has lately been introduced in the mode of distillation: it consists in suspending the flowers or plants in the still on a sort of sieve, and allowing a jet of steam to pass through and carry off the fragrant molecules. This produces a finer essential oil than allowing those substances to be steeped in water at the bottom of the still.

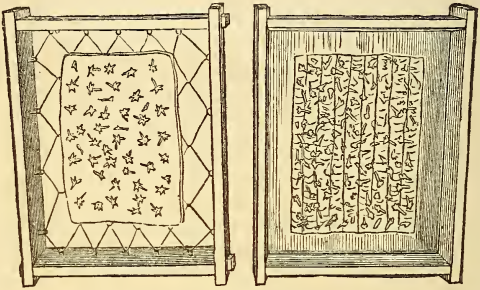
Expression is confined to the essences obtained from the rinds of the fruits of the citron series, comprising lemon, orange, bergamot, cedrat, and limette. It is performed in various ways: on the coast of Genoa they rub the fruit against a grated funnel; in Sicily they press the rind in cloth bags; and in Calabria, where the larger quantity is manufactured, they roll the fruit between two bowls, one placed inside the other, the concave part of the lower and the convex part of the upper being armed with sharp spikes. These bowls revolve in a contrary direction, causing the small vesicles on the surface of the fruit to burst and give up the essence contained in them, which is afterwards collected with a sponge. The rinds are also sometimes distilled; but the former process, which is called in French *au zest*, gives a much purer essence.

Maceration and *absorption* are both founded on the affinity which fragrant molecules have for fatty bodies, becoming more readily fixed into them than into any others. Thus the aroma of flowers is first transferred into greases (called pomades) and oils, which are made afterwards to yield it to alcohol; whilst the latter, if placed in direct contact with the flowers, would not extract it from them. The first attempt that was made in this way, some two hundred years ago, was to place some almonds in alternate layers with fresh-gathered flowers, renewing the latter several days, and afterwards pounding the almonds in a mortar, and pressing the oil which had absorbed the aroma. This is the same process now used in India by the natives for obtaining perfumed oils, substituting gingelly or sesamum seeds for almonds. The next improvement was to use a plain earthen pan, coated inside with a thin layer of grease, strewing the flowers on the grease, and covering it over with another jar similarly prepared. After renewing the flowers for a few days, the grease was found to have borrowed their scent. This process was abandoned in France some fifty years ago, but is still resorted to by the Arabs (who were probably the inventors of it), the only difference being that they use white wax mixed with grease, on account of the heat of the climate.

Maceration is used for the less delicate flowers, such as the rose, orange, jonquil, violet, and cassie (*Acacia Farnesiana*). A certain quantity of grease is placed in a pan fitted with a water-bath, and is brought to an oily consistency. Flowers are then thrown in and left to digest for some hours, stirring them frequently, after which the grease is taken out and pressed in horsehair bags. This operation is repeated until the fatty body is sufficiently impregnated with the fragrance of the flowers. Oil is treated in the same way, but requires less heat.

The process of *absorption*, called by the French *enfleurage*, is chiefly confined to the jasmine and tuberose, the delicate aroma of which would be injured by heat. (For a description of the process, I may refer back to vol. iii., p. 174.)

A new mode of *enfleurage* has been lately devised by Mr. D. Séméria, of Nice, and found to offer advantages over that previously in use. Instead of laying the flowers on the grease, he spreads them on a fine net mounted on a separate frame. This net is introduced between two glass frames covered on both sides with grease. The whole series of frames is inclosed in an air-tight recess, and all that is required is to draw out the nets every morning and fill them with fresh flowers, which give their aroma to the two surfaces with which they are in contact. This system saves the waste and labour resulting from having to pick the old flowers from the surface of the grease, and produces also a finer fragrance.



Oil and Pomade Frames.

A very curious pneumatic apparatus for the same purpose has been invented by M. Piner, the eminent Parisian perfumer, who submitted to the jury a plan of it at the last International Exhibition in London. It consists of a series of perforated plates, supporting flowers placed alternately with sheets of glass overlaid with grease, in a chamber through which a current of air is made to pass several times, until all the scent of the flowers becomes fixed into the grease.

A no less remarkable invention is that of M. Millon, a French chemist, who found means to extract the aroma of flowers by placing them in a percolating apparatus and pouring over them some ether or sulphuret of carbon, which is drawn off a few minutes after, and carries with it all the fragrant molecules. It is afterwards distilled to dryness and the result obtained is a solid waxy mass, possessing the scent of the flower in its purest and most concentrated form. This process, although very ingenious, has not received any practical application as yet, owing to the expense attending it, some of these concrete essences costing as much as 50*l.* an ounce.

Grasse, Cannes, and Nice are the principal towns where the maceration and absorption processes are carried on. Since Nice has become French, its manufactures have much increased, for it is admirably situated for producing all flowers for perfumery purposes, and its violets in particular are superior to any other.

The following are approximate quantities and values of the flowers now consumed in that locality for preparing perfumery materials:—

Orange flowers . .	2,000,000 lbs.,	worth about	£40,000
Roses . . .	600,000 ,,	,,	12,000
Jasmines . . .	150,000 ,,	,,	8,000
Violets . . .	60,000 ,,	,,	4,000
Cassie . . .	80,000 ,,	,,	6,000
Tuberose . . .	40,000 ,,	,,	3,000

Grasse.

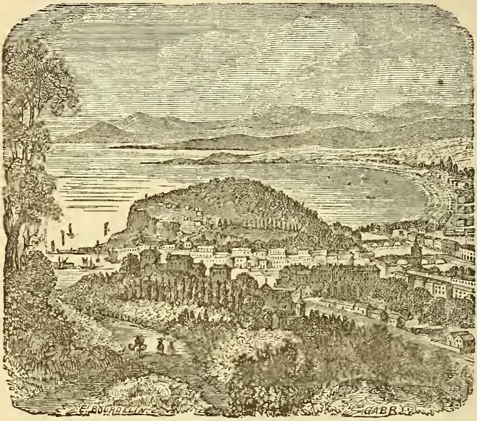
These flowers are procured from growers by private contract, or sold in the market. The average quantities of the following articles are manufactured with them yearly:—700,000 lbs. of scented oils and pomades, 200,000 lbs. of rose-water, 1,200,000 lbs. of orange-flower water, 1st quality,* 2,400,000 lbs. of orange-flower water, 2nd quality; 1,000 lbs. of neroly, an essential oil obtained from orange-flowers. The other flowers do not yield essential oils, but the latter are extensively distilled in the same places from aromatic plants, such as lavender, rosemary, thyme, geranium, &c. Many readers may have considered flowers hitherto as simply ornamental; the above figures will give them an idea of their importance as an article of commerce.

The second branch of the art of perfumery is the manufacture of scents, cosmetics, soaps, and other toilet necessaries.

The principal manufacturers of perfumery and toilet soaps reside in

* That is distilled twice over the flowers.

London, where they number about sixty, employing a large number of men and women ; for female labour has been introduced nearly twenty years in almost all the London manufactories and found to answer very well for all kinds of work requiring more dexterity than strength.*



Nice.

According to the official returns published, the exports of British-made perfumery for the year 1863 amounted to 106,789*l.* ; we must, however, say that very little reliance is to be placed on these figures, which do not represent, perhaps, one-fourth of the actual amount exported.

Next to Hungary-water the most ancient perfume now in use is eau-de-Cologne, or Cologne-water, which was invented in the last century by an apothecary residing in that city. It can, however, be made just as well anywhere else, as all the ingredients entering into its composition come from the South of France and Italy. Its perfume is extracted principally from the flowers, leaves, and rind of the fruit of the bitter orange and other trees of the *Citrus* family, which blend well together, and form an harmonious compound.

The toilet vinegar is a sort of improvement on eau-de-Cologne, containing balsams and vinegar in addition to the above. Lavender-water was formerly distilled with alcohol from fresh flowers, but is now prepared by simply digesting the essential oil in spirits, which produces

* I believe I was the first to employ female labour in *England,* and I am happy to say my example was soon followed.

the same result at a much less cost. The finest is made with English oil, and the common with French, which is considerably cheaper, but is easily distinguished by its coarse flavour.

Perfumes for the handkerchief are composed in various ways: the best are made by infusing in alcohol the pomades or oils obtained by the processes I have just described. This alcoholate possesses the true scent of the flowers entirely free from the empyreumatic smell inherent in all essential oils; as, however, there are but six or seven flowers which yield pomades and oils, the perfumer has to combine these together to imitate all other flowers. This may be called the truly artistic part of perfumery; for it is done by studying resemblances and affinities, and blending the shades of scent as a painter does the colours on his palette. Thus, for instance, no perfume is extracted from the heliotrope, but as it has a strong vanilla flavour, by using vanilla as a base with other ingredients to give it freshness, a perfect imitation is produced, and so on with many others.

The most important branch of the perfumer's art is the manufacture of toilet soaps. They are generally made from the best tallow soaps, which are remelted, purified, and scented. They can also be made by what is called the cold process, which consists in combining grease with a fixed dose of lees. It offers a certain advantage to perfumers for producing a delicately-scented soap, by enabling them to use as a base a pomade instead of fat, which could not be done with the other process, as the heat would destroy the fragrance. This soap, however, requires being kept for some time before it is used, in order that the saponification may become complete. Soft soap, known as shaving cream, is obtained by substituting potash for soda lees, and transparent soap by combining soda-soap with alcohol. Another sort of transparent soap has been produced lately by incorporating glycerine into it, in the proportion of about one-third to two-thirds of soap.

The English toilet soaps are the very best that are made; the French come next, but as they are not remelted they never acquire the softness of ours. The German soaps are the very worst that are manufactured; the cocoa-nut oil which invariably forms their basis leaves a strong fœtid smell on the hands, and their very cheapness is a deception, for as cocoa-nut oil takes up twice as much alkali as any other fatty substance, the soap produced with it wastes away in a very short time.

Cosmetics, pomatums, washes, dentifrices, and other toilet requisites are also largely manufactured, but they are too numerous to be described here at length, nor shall I attempt to descant on their respective merits, which depend, in a great measure, upon the skill of the operator, and the fitness and purity of the materials used. The greatest improvement effected in these preparations lately has been the introduction of glycerine. Although this substance was discovered in the last century, it is only a few years since medical men fully recognised and appreciated its merits, and applied it to the cure of skin diseases, for which it answers admirably. Perfumers are now beginning to avail themselves of its wonderful properties, and to combine it with their soaps and cosmetics.

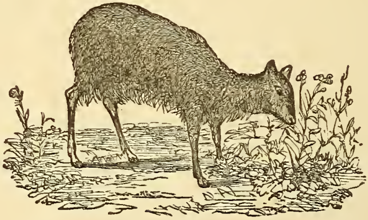
The volatilization of perfumes by means of steam is also a modern improvement. A current of steam is made to pass through a concentrated essence, from which it disengages the fragrant molecules, and spreads them through the atmosphere with extraordinary rapidity and force. A whole theatre may be perfumed by that means in ten minutes, and a drawing-room, naturally, in much less time. This system has the advantage of purifying the air, and has been adopted, on that account, by some of the hospitals and other public institutions.

It remains now for me to give a brief description of the various materials used for perfumery, which are supplied by all parts of the world, from the parched regions of the torrid zone to the icy realms of the Arctic pole.

They may be divided, according to their nature, into twelve series—viz., the animal, floral, herbal, andropogon, citrine, spicy, ligneous, radical, seminal, balmy or resinous, fruity, and artificial.

The animal series comprises only three substances—musk, civet, and ambergris. It is very useful in perfumery, on account of its powerful and durable aroma, which resists evaporation longer than any other.

Musk is a secretion formed in a pocket or pod under the belly of the musk-deer, a ruminant which inhabits the higher mountain ranges of China, Thibet, and Tonquin. "It is a pretty grey animal," says Dr. Hooker, "the size of a roebuck, and somewhat resembling it, with coarse fur, short horns, and two projecting teeth from the upper jaw,



Musk-Deer.

said to be used in rooting up the aromatic herbs from which the Bhoteas believe that it derives its odour." * The male alone yields the celebrated perfume, the best being that which comes from Tonquin. The next in quality is collected in Assam, whilst the Kaberdeen musk, obtained from a variety of the species called Kubaya (*Moschus*

* 'Himalayan Journals,' by Dr. Hooker, vol. i., p. 256.

Sibericus), which inhabits the Siberian side of those mountains, is the most inferior of all.

The Chinese have known musk for many ages; they call it *shay heang*, *shay* being the name of the animal, and *heang* meaning perfume. Tavernier is the first European traveller who mentions the precious drug, and says he bought 7,673 pods in one of his journeys, which shows how plentiful it must have been even at that early period. He gives the following description of musk-deer hunting, which takes place in February and March, when hunger drives these animals from their wild snowy haunts towards cultivated regions:—"At that time," says Tavernier, "the hunters lie in wait for them with snares, and kill them with arrows and sticks. They are so lean and exhausted through the hunger they have endured, that they are easily pursued and overtaken."* The accompanying illustration, faithfully copied from a

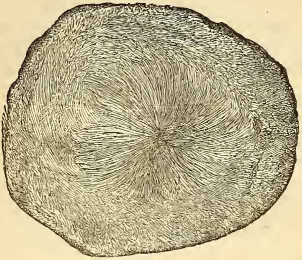
Musk-Deer Hunting. (From a Chinese Drawing.)

Chinese drawing, in which were wrapt up some musk-pods I purchased lately, would tend to prove that the same weapons are still used in the musk-deer chase.

Musk is an unctuous substance of a reddish-brown colour, which soon becomes black by exposure to air. It is so powerful that, according to Chardin's authority, the hunter is obliged to have his mouth and nose stopped with folds of linen when he cuts off the bag from the animal, as otherwise the pungent smell would cause hæmorrhage, sometimes ending in death. As, however, the natives take good care to

* 'Voyage de Jean Baptiste Tavernier,' vol. iv., p. 75.

adulterate the musk before they send it to Europe, we are not exposed to such accidents. The substances used for this adulteration are generally the blood or chopped liver of the animal, which they cleverly insert into the pod, or sometimes pieces of lead are introduced to increase the weight. Some even manufacture artificial pods from the belly-skin, and fill them with a mixture of musk and other materials. Musk in pods is generally imported in caddies of twenty ounces in weight, and the price of it varies from 25s. to 50s. per ounce, according to quality. *Grain musk*, which is the musk extracted from the pods, is much dearer. Musk is, without any exception, the *strongest* and *most durable* of all known perfumes, and is in consequence largely used in compounds, its presence, when not too perceptible, producing a very agreeable effect.



Musk-Pod (Natural Size).

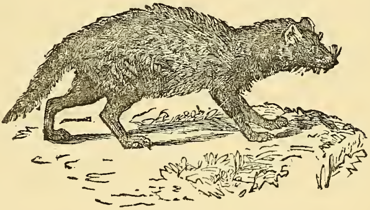
The odour of musk is not confined to this species of animal ; it is also to be found, though in a less degree, in others—such as the musk-ox, the musk-rat, the musk-duck, &c. Mr. Chief-Justice Temple, of British Honduras, who presided at the Society of Arts when I read my paper "On Perfumery," assured the meeting that the glands of alligators had a strong musky odour ; and, wishing to ascertain the fact, I procured, through the kindness of my friend, Mr. Edward Grey, of the Royal Mail Steam Navigation Company, the head of one of these monsters ; but I must say that, when the case was opened, the stench it diffused was so great that it required some little amount of courage to extract the glands, and the *perfume* they seemed to possess was strongly suggestive of Billingsgate market on a hot day. Some polypi, and, among others, the *Tipula moschifera*, which is found in the Mediterranean, and principally at Nice, give out a musky smell, but of a very evanescent nature.

The musky fragrance likewise occurs in some vegetables, such as the well known yellow-flowered musk-plant, but its intensity is not sufficient for extraction. The definition *moschatus* (musky) is often applied to plants and flowers, but it must not always be taken in its literal sense, for botanists are apt to distinguish by this name strong scents, such as the nutmeg, which is termed *Myristica moschata*, although it bears no resemblance to musk. The so-called *musk-seed* itself (*Hibiscus abelmoschus*) is much more like civet than musk. Dr. Cloquet pretends that some preparations of gold and other mineral substances have also a musky fragrance,* but I have never met with any which bore out this assertion.

Civet is the glandular secretion of the *Viverra civetta*, an animal of the feline tribe, about three feet in length and one foot in height, which is found in Africa and India. It is now chiefly imported from the Indian Archipelago, but formerly Dutch merchants kept some of those cats at Amsterdam in long wooden cages, and had the perfume scraped from them two or three times a week with a wooden spatula. Civet in the natural state has a most disgusting appearance, and its smell appears equally repulsive to the uninitiated, who would be tempted to cry out with Cowper—

> "I cannot talk with civet in the room,
> A fine puss gentleman that's all perfume;
> The sight's enough, no need to smell a beau
> Who thrusts his nose into a raree show."

Yet when properly diluted and combined with other scents it produces a very pleasing effect, and possesses a much more *floral* fragrance than



Civet Cat (*Viverra civetta*).

musk; indeed, it would be impossible to imitate some flowers without it. Its price varies from 20s. to 30s. per ounce, according to quality.

Ambergris puzzled the *savans*, who were at a loss to account for its origin, and thought it at first to be of the same nature as yellow amber, whence it derived its name of grey amber (*ambre gris*). It is now ascertained beyond a doubt to be generated by the large-headed or spermaceti whale (*Physeter macrocephalus*), and is the result of a diseased state of the animal, which either throws up the morbific substance, or dies through it and is eaten up by other fishes. In either case, the ambergris becomes loose, and is picked up floating on the sea, or is washed ashore. It is found principally on the coasts of Greenland, Brazil, India, China, Japan, &c., and sometimes on the west coast of Ireland. The largest piece on record was one weighing 182 lbs., which the Dutch East India

* 'Osphrésiologie,' p. 76.

Company bought from the King of Tydore. I have in my possession a very curious specimen, extracted by a North American whaler from a whale which he killed. Part of it is quite grey, and the remainder still black, which shows that the disease had not yet attained its maturity. Ambergris is not agreeable by itself, having a somewhat earthy or mouldy flavour, but blended with other perfumes it imparts to them an ethereal fragrance unattainable by any other means. Its price varies very much, according to the quantity to be found in the market. I have seen it as low as 10s. and as high as 50s. per ounce.

The floral series includes all flowers available for perfumery purposes, which hitherto have been limited to eight—viz., jasmine, rose, orange, tuberose, cassie, violet, jonquil, and narcissus.

Jasmine is one of the most agreeable and useful odours employed by perfumers, and highly valuable are the fragrant treasures which they obtain

> "From timid jasmine buds, that keep
> Their odours to themselves all day,
> But, when the sunlight dies away,
> Let their delicious secret out." *

It was introduced by the Arabs, who called it Yasmyn, hence its present name. The most fragrant sort is the *Jasminum odoratissimum*, which is largely cultivated in the South of France. It is obtained by grafting on wild jasmine, and begins to bear flowers the second year. It grows in the shape of a bush from three to four feet high, and requires to be in a fresh open soil, well sheltered from north winds. The flowering season is from July to October. The flowers open every morning at six o'clock with great regularity, and are culled after sunrise, as the morning dew would injure their flavour. Each tree yields about twenty-four ounces of flowers.

We next come to the queen of the flowers, the rose—the eternal theme of poets of all ages and all nations, and which for the prosaical perfumer derives its principal charms from the delicious fragrance with which Nature has endowed it:—

> "The rose looks fair, but fairer we it deem
> For that sweet odour which doth in it live."†

And well does the perfumer turn that sweetness to account, for he compels the lovely flower to yield its aroma to him in every shape, and he obtains from it an essential oil, a distilled water, and a perfumed oil and pomade. Even its withered leaves are rendered available to form the ground of sachet-powder, for they retain their scent for a considerable time.

The species used for perfumery is the hundred-leaved rose (*Rosa centifolia*). It is extensively cultivated in Turkey, near Adrianople, whence comes the far-famed otto of roses, and the South of France,

* 'Light of the Harem.' † Shakspeare's Sonnets, liv.

where pomades and oils are made. Rose-trees are planted in a cool ground, and may be exposed to the north wind without any injury. They bear about eight ounce of flowers in the second year, and twelve ounces in the following ones. The flowering season is in May, and the flowers, which generally open during the night, must be gathered before sunrise, as after that they lose half their fragrance.

The orange-blossoms used for perfumery are those of the bigarrade or bitter orange-tree (*Citrus Bigaradia*). They yield by distillation an essential oil known under the name of *néroly*, which forms one of the chief ingredients in eau-de-Cologne; a pomade and an oil are also obtained from them by maceration. From the leaves of the tree is produced an essential oil called *petit-grain*, and from the rind of the fruit another essence is expressed which is styled *oil of orange*, or *Portugal.* The edible orange-tree (*Citrus aurantium*) also produces essences, but they are of a very inferior quality.

The largest bigarrade-tree plantations are to be found in the South of France, in Calabria, and in Sicily. This tree requires a dry soil with a southern aspect. It bears flowers three years after grafting, increasing every year until it reaches its maximum, when it is about twenty years old. The quantity depends on the age and situation, a full-grown tree yielding on an average from 50 lbs. to 60 lbs. of blossoms. The flowering season is in May, and the flowers are gathered two or three times a week after sunrise.

The tuberose (*Polianthes tuberosa*) is a native of the East Indies, where it grows wild, in Java and Ceylon, and was first brought to Europe by Simon de Tovar, a Spanish physician, in 1594. The Dutch monopolised this flower for some time, cultivating it in hothouses; but it has now found its way to France, Italy, and Spain, and thrives well in those climates.

"Eternal spring, with smiling verdure here
Warms the mild air, and crowns the youthful year.
The tuberose ever breathes, and violets blow."


Tuberose (*Polianthes tuberosa*).

It springs from a bulb which is planted in the autumn and bears flowers the following year. Each plant rises about three feet, and produces every day two full-blown flowers, which open from 11 A.M. to 3 P.M., according to localities, but always with the most precise regularity; they must be gathered immediately, as their fragrance does not last long.

Cassie (*Acacia Farnesiana*) is a shrub of the acacia tribe, which grows in southern latitudes. Its height ranges from five to six feet, and it becomes covered in the months of October and November with globular flowers of a bright golden hue, which, peering through its delicate emerald foliage, have the prettiest effect. All those who have travelled in that season on the coast of Genoa will no doubt remember what charming bouquets and garlands are made of the cassie intermixed with other flowers. To perfumers it is a most valuable assistant, possessing in the highest degree a fresh floral fragrance which renders it highly useful in compounds. It bears some resemblance to violet, and, being much stronger, is often used to fortify that scent, which is naturally weak.

Cassie (*Acacia Farnesiana*).

The cassie requires a very dry soil, well exposed to the sun's rays. The tree does not bear flowers until it is five or six years old; the yield varies from 1 lb. to 20 lbs. for every tree, according to age and position; the blossoms are gathered three times a week after sunrise. A very strong oil and pomade is obtained from them by maceration. In Africa, and principally in Tunis, an essential oil of cassie is made, which is sold at about 4*l.* per ounce, but French and Italian flowers are not sufficiently powerful to yield an essence.

The violet is one of the most charming odours in nature, and well might Shakspeare exclaim—

> "Sweet thief, whence didst thou steal thy sweet that smells,
> If not from my love's breath?"

It is a scent which pleases all, even the most delicate and nervous, and it is no wonder that it should be in such universal request. The largest and almost only violet plantations have hitherto been at Nice, its exceptional position rendering it the most available spot for them. The violet used is the double Parma violet (*Viola odorata*). It requires a very cool and shady ground, and is generally placed in the orange and citron groves, at the foot of the trees, which screen it with their thick foliage from the heat of the sun. It flowers from the beginning of February to the middle of April, and each plant yields but a few ounces of blossoms, which are culled twice a week after sunrise.

Jonquil (*Narcissus Jonquilla*) and narcissus (*Narcissus odoratus*) are two bulbous plants, which are also cultivated for perfumery purposes, but in much smaller quantities than any of those already mentioned, their peculiar aroma rendering their use limited. The former is to be found chiefly in the South of France, and the latter in Algeria. Mignonette, lilac, and hawthorn are also sometimes worked into pomades, but on such a small scale that they are not worth mentioning.

The extracts named after those flowers are generally produced by combination.

The herbal series comprises all aromatic plants, such as lavender, spike, peppermint, rosemary, thyme, marjoram, geranium, patchouly, and wintergreen, which yield essential oils by distillation.

Lavender was extensively used by the Romans in their baths, whence it derived its name.* It is a nice *clean* scent, and an old and deserving favourite. The best lavender (*Lavandula vera*) is grown at Mitcham, in Surrey, and Hitchin, in Hertfordshire. It is produced by slips, which are planted in the autumn, and yield flowers the next year and the two following ones, when they are renewed. Mr. James Bridges, the largest distiller of lavender and peppermint, cultivates those two plants on an extensive scale near Mitcham. During the flower season he has three gigantic stills in operation, each able to contain about one thousand gallons. A great deal of essence of lavender is also manufactured in France, but, as I said before, it is very inferior to the English. It is obtained from the same plant, which grows wild in great abundance in most Alpine districts. Portable stills are carried into the mountains, and the herb distilled on the spot. The same process is used for rosemary and thyme.

Spike (*Lavandula spica*) is a coarser species of lavender, which is principally used for mixing with the other, or for scenting common soaps. A third sort of lavender (*Lavandula Stœchas*) has a beautiful odour, and would yield a very fragrant essence, but it is very scarce in France; the only places where I met with it in quantities were Spain and Portugal, and there it is only used to strew the floors of churches and houses on festive occasions.

Peppermint (*Mentha piperita*) is more used by confectioners than by perfumers, yet the latter find it useful in tooth-powders and washes. It is, like lavender, best grown in England, the foreign being very inferior. The American comes next to the English in quality.

Rosemary (*Rosmarinus officinalis*) is another plant of the labiate order, which yields a powerful essence, used chiefly for scenting soap. Its resemblance to camphor is very remarkable.

There are two sorts of thyme distilled—ordinary thyme (*Thymus vulgaris*) and wild thyme, or serpolet (*Thymus Serpyllum*). Marjoram (*Origanum Majorana*) belongs to the same class.

The rose-geranium (*Pelargonium odoratum*) yields an essence which is greatly prized by perfumers on account of its powerful aroma, by means of which they impart a *rosy fragrance* to common articles at a much less cost than by using otto of roses, which is worth six times as much. It is principally cultivated in the South of France, Algeria, and Spain. The latter produces the finest essence.

Patchouli (*Pogostemon patchouli*) comes from India, where it is known

* From the Latin *lavare*, to wash.

under the name of *puchapat.* It has a most peculiar flavour, which is as offensive to some as it is agreeable to others.

Wintergreen (*Gaultheria procumbens*) we receive from North America. This essence is exceedingly powerful, and requires to be used with great caution to produce a pleasing effect. Well blended with others in soap. it imparts to it a rich *floral* fragrance.

The andropogon * series embraces three sorts of aromatic grasses, which grow abundantly in India, and principally in Ceylon, whence we obtain their essential oils. They are the *Andropogon Schœnanthus*, or lemon-grass, which is used to imitate verbena, having a somewhat similar fragrance; the *Andropogon citratus*, or citronella, which forms the basis of the perfume of honey soap; and the *Andropogon Nardus*, or ginger-grass oil, improperly called Indian geranium. The chief use of the latter for some persons, I am sorry to say, is to adulterate otto of roses, which costs from 30s. to 40s. per ounce, whilst the latter is scarcely worth one shilling per ounce.

The citrine series comprises bergamot (*Citrus bergamia*), orange (*Citrus Bigaradia*), lemon (*Citrus medica*), cedrat (*Citrus cedra*), and limette (*Citrus Limetta*). Essential oils are expressed or distilled from the rind of those fruits.

The spice series includes cassia, cinnamon, cloves, mace, nutmeg, and pimento.

Cassia, which was, like cinnamon, well known and highly-prized by the ancients, is distilled from the *Laurus Cassia*, a tree of the laurel tribe, which is abundant in the East Indies and China.

Cinnamon belongs to the same class, and is extracted from the bark of the *Laurus Cinnamomum.* A coarser essence is also obtained from the leaves of the same tree.

Cloves are the flower-buds of the *Caryophyllus aromaticus*, a tree found in the Indian Archipelago. The finest come from Zanzibar. The essence is chiefly used for scenting soap, but when in infinitesimal quantities it also blends well with some handkerchief scents, and principally with the carnation and clove-pink, the fragrance of which it closely resembles.

Mace and nutmeg are both produced by the *Myristica moschata*, the latter being the fruit of that tree, and the former one of its envelopes.

Pimento, or allspice, is the berry of the *Pimenta vulgaris*, from which an essential oil is distilled, which, like the two last-named, is used for perfuming soap.

The ligneous series consists of sandal-wood, rose-wood, rhodium, cedar-wood, and sassafras.

Sandal-wood comes from the East, where it is highly esteemed as *the* perfume *par excellence*, forming the ground of all their toilet preparations. There are several species, the best being the. *Santalum citrinum*, from which the essential oil used by perfumers is chiefly distilled. I

* From *ανδρος πώγον*, so called because this grass resembles a man's beard.

observed also, some very fine specimens in the last Exhibition from Western Australia and New Caledonia.

Rosewood (*Lignum aspalathum*), rhodium (*Convolvulus scoparius*), and cedar-wood (*Juniperus virginiana*) likewise yield essential oils, but which are little used by perfumers.

Sassafras, distilled from the *Laurus Sassafras*, a tree which grows abundantly in North America, is a very useful essence for soap, on account of its fresh and powerful aroma.

The radical series is confined to orris-root and vetivert.

Orris or iris is the rhizome of the *Iris Florentina*, which is extensively cultivated in Italy, and principally in Tuscany. It exhales, when dry, a delightful violet fragrance, which renders it very useful for scenting toilet, sachet, and tooth powders. When infused in spirits it loses this violet odour, owing to the resinous matters contained in it, which become dissolved and overpower it; but it is still sufficiently pleasant to form the basis of many cheap perfumes.

Vetivert, or khus-khus, is the rhizome of the *Anatherum muricatum*, which grows wild in India. It forms the basis of the perfume called *mousseline*, which derived its name from the peculiar odour of *Indian muslin* which had formerly great repute in Europe, and which was scented with this root by the natives.

The seminal series includes aniseed (*Pimpinella anisum*), dill (*Anethum graveolens*), fennel (*Anethum fœniculum*), and carraway (*Carum carui*), all umbelliferous plants, with aromatic seeds which yield essential oils. The last-named is the most largely used. Musk-seed, obtained from *Abelmoschus moschatus*, belongs also to the same series.

The balsamy and gummy series comprises balsam of Peru, balsam of Tolu, benzoin, styrax, myrrh, and camphor. With the exception of the last, they are all exudations from various trees: balsam of Peru being obtained from the *Myroxylon peruiferum*; balsam of Tolu from the *M. toluifera*; benzoin (or gum-benjamin) from the *Styrax Benzoin*; and myrrh from the *Balsamodendron myrrha*. The four first-named possess a fragrance somewhat similar to vanilla, but less delicate. Myrrh was the most esteemed perfume in ancient times, but tastes must have changed since, for it is now but little in request. Camphor, which is more used in medicine than perfumery, is obtained by boiling the wood of the *Laurus Camphora*, a tree found principally in China and Japan, and in which the gum exists ready formed.

The fruity series includes bitter almonds, Tonquin beans, and vanilla. The essential oil of bitter almonds is obtained by distilling the dry cake of the fruit after the fat oil has been pressed out. It contains from 8 to 10 per cent. of prussic acid, which can be removed by re-distilling it over potash.

Tonquin beans are the seed of the *Dipterix odorata*, a tree which grows in the West Indies and South America.

Vanilla is the bean of a beautiful creeper (*Vanilla planifolia*) which is a native of Mexico, but has lately been introduced in the French island of Réunion, where it thrives admirably. This colony now yields annually more than 12,000 lbs. of the costly perfume, and among the many beautiful specimens shown at the last Exhibition, nine were deemed worthy of medals or honourable mention. A sort of bastard vanilla, called vanilloes, is obtained from the *Vanilla Pompona*, which is found in the West Indies and Guiana.

This closes the list of materials used hitherto by perfumers; but there are many other fragrant treasures dispersed all over the globe, which, from want of communication or difficulty of extraction, have not yet found their way to their laboratories, but may do so at some future time.

In Australia there are many trees with fragrant leaves, and principally the Tasmanian peppermint (*Eucalyptus amygdalina*), the peppermint tree (*Eucalyptus odorata*), the blue gum tree (*Eucalyptus globulus*), &c. Essential oils distilled from these leaves were shown at the last Exhibition; and, although described in the catalogue as only fit for painting purposes, I expressed an opinion that they might be rendered available for perfumery. An experiment which I made with the oil of *Eucalyptus amygdalina* (possessing a strange flavour of nutmegs combined with peppermint) confirmed me in that idea, and I am pleased to find that colonists have turned their attention to the subject, and are now sending these oils to our market. The wattle flower is also very abundant in those parts; and, as it closely resembles the cassie in fragrance, it might be turned to good account. I received not long since from Tasmania a specimen of pomade made from the flowers of the silver-wattle (*Acacia dealbata*), but it was very inferior, owing to the want of experience of the operator. New South Wales and Queensland produce myall-wood (*Acacia homophylla*), which has an intense and delightful smell of violets, a very scarce odour in nature.

Among other novel odorous products shown at the Exhibition I may mention *Alyxia aromatica*, a fragrant bark from Cochin China; another bark from New Caledonia called *Ocotea aromatica*; and a highly-scented wood (*Licaria odorata*) from French Guiana which has a strong flavour of bergamot.

INFLUENCE OF TERMINAL AND AXILLARY BUDS ON THE QUALITY OF TIMBER.

BY ALFRED GRUGEON.*

The object of this paper is to show that, whatever influence the different tissues may have on the hardness and strength of various kinds of woods, the more important differences are caused by their arrangement, and that these arrangements are governed by the position and power of the buds on the primary and secondary axis. Let us premise that the most important quality in timber is lateral cohesion, both in hard and soft woods. This point admitted, our task will be to show that terminal and lateral buds determine the amount of lateral cohesion in different classes of wood, and that the length of the internodes between the buds will, in a great measure, account for the differences in woods of the same kind. Many timber-trees present very little uniformity in the nature of their wood, as may be imagined from the difference in their commercial value, for the same kind of wood may vary from fourpence to four shillings the superficial foot at the same sale. Such being the variation in wood of one species, we may naturally look for greater differences in wood produced throughout an entire natural order of timber-bearing trees.

The Coniferæ, or Pine tribe, may be divided into two sections—the first containing the Pines, Spruces, and Araucarias, and bearing always terminal and no axillary buds; the second, containing the Yews, Arbor vitæ, and Cypress, bearing axillary and terminal buds.

These two sections have very opposite qualities of timber, and also present great differences as to the facility with which they can be propagated.

The Coniferæ, especially the Araucarias, have little or no lateral cohesion, in a structural sense, as most of them, when exhausted of sap and their resinous secretions, soon split up into fragments if cut into short lengths; these can only be raised from seeds, as cuttings will never take root, owing, no doubt, to the absence of lateral buds. Now, if we examine the other section, we shall find a marked difference in the character of the wood. In the yew we have great lateral cohesion, hardness, and closeness of grain, and great durability; it was at one period, from possessing these qualities, the wood most used for domestic furniture in England.

In the cypress, again, we have an example of one of the most durable woods in the world, having an amount of cohesion that astonished the French when they bombarded Rome, for some gates and posts made of cypress, whose age numbered certainly a thousand years, after having been well pounded with shot and shell, appeared to be none the worse for

* Being the abstract of a paper read before the Society of Amateur Botanists, March 1, 1865.

the treatment. We may mention a few other woods in this section not so generally known, all of which are hard and durable and take a brilliant polish—viz., *Thuja*, *Dacrydium*, *Phyllocladus*, and perhaps *Salisburia;* these can all be propagated either by cuttings, layers, or the leaves.

Leaving the Coniferæ, we will turn to another class of trees, the Willows or *Salices.* Here we have a totally distinct feature from those already examined : non-continuance of the primary axis, and the buds being all axillary. The wood of all the willows is light, but tough, and possesses lateral cohesion in the greatest degree, so that it is exceedingly difficult to cleave. The tenacity with which it holds together is exemplified by the shavings being woven up into a fabric, which, for enduring many vicissitudes without material injury, stands pre-eminent among woods ; and the manner in which our cricketers wield their bats of willow without damage exemplifies fully its value as a tough, light wood. For facility of propagation it ranks second to none : a fish-basket made of willow twigs, in which you have brought home a cod from Billingsgate, may be thrown on the dust-heap, and nearly every twig become a willow-tree.

In a more special reference to a few other kinds of timber, what is so fit to take the first place as the oak. In this tree we have both terminal and lateral buds, but till the tree arrives at its full growth, the terminal bud always shows more vigour and retains a preponderating influence over the lateral ; and such influence is more marked when they are grown together in forests or plantations. The young timber from our own plantations, and also the white oak imported from Quebec, show lateral cohesion in a very low degree, as can be easily ascertained by examining a lot of Quebec staves at any timber yard, or by a visit to a wheelwright's shop, where you will find the materials for the spokes to be young oak, riven to the thickness necessary ; or an inspection of our park palings, made of oak shingles, riven from young trees. We know that the ease with which these trees are riven is mainly owing to the very thick medullary rays peculiar to the oak ; but they only exercise that favourable influence while the terminal bud has the preponderating power, and have little or no influence on a matured tree, which has grown singly, and which for a length of years has made as much latitude as longitude, or rather, where the balance of power in the buds has been equalized. If any one doubts the truth of this, let him demonstrate the contrary by taking the section of a trunk about three feet long, from a tree of a hundred years old or upwards, and cleaving it into wheel-spokes, if he can. The same argument applies to beech ; and we must also keep in mind the fact, that there will always be a great amount of difference between trees that have grown naturally and those that have been brought up in a plantation with nurses. There will also be differences, though less perceptible, among those grown naturally, from the vicissitudes they may have undergone individually. Thus, a number of acorns may have been blown from the parent tree and germinated ;

all may appear to have been under the same influences, but yet no two of them grow up alike, either in size, aspect, or habit : one may get a start and grow rapidly, the internodes will be longer, the buds in the axils will be developed with regularity, the whole contour of the tree will be symmetrical and noble, and the timber will be sound and clean. Its commercial value can also be reckoned pretty accurately by the merest novice.

A second acorn having germinated begins very early to show a marked difference in habit ; the internodes are unusually shortened and thickened, the tree takes a dwarfed and spreading appearance, with the foliage most dense ; at an early period the lateral buds would compete with the terminal. From this tree we should expect a very different quality of timber from the preceding, nor should we be disappointed. The wood will be found more dense, the specific gravity greater, and the grain more wavy and intricate, owing, perhaps, to the compression of the spiral.

Yet another acorn germinates, and makes a few leaves the first season, but somehow is deficient in vigour ; some of the buds are arrested in the second season, so that we get less wood deposited than we should have had if all the buds had been developed; subsequently, these early misfortunes influence and eventually give a character to the tree. A tree growing slowly is more subject to accidents than one which grows rapidly or even at the normal rate : thus, larvæ may denude the branches of leaves and eat out the buds, or all the growing parts may be predisposed to disease. These early influences produce great results in the wood, increasing the variety of the grain and beauty of the colouring in woods that are of value for show.

Again : the power of the terminal bud is shown by the less amount of lateral cohesion in wood near the centre of the tree to that of the circumference, where the wood has been formed later, when the power of the buds has become equalized.

Connected with propagation, another point may he urged in favour of bud influences. The *Ericas*, which are hard-wooded shrubs, with very few lateral or axillary buds, are, of woody plants, the most difficult to propagate from cuttings, and require years of practice before anything like success can be attained. These few facts respecting the influence of leaf-buds on lateral cohesion, we will not, in the present state of our knowledge, insist upon being of a sufficient value whereon to found a theory, as they may possibly be only accidental coincidences. Still, we think it proven that they are important enough to direct attention to the subject.

NOTES ON THE INDIGENOUS VEGETATION OF NORTHERN PERU.

BY RICHARD SPRUCE, PH.D.

Any person, even one accustomed to the study of and search for plants, might travel through the whole extent of the deserts of Piura and Sechura, and (excepting the strip of verdure along the banks of the rivers) would confidently assert them to be entirely destitute of herbaceous vegetation; and yet three kinds of herbs exist there, which, burying themselves deep in the earth, survive through the long periods of drought to which they are subjected. Some of the smaller *medanos*, especially those under the lea of a low ridge of land, may be seen to be capped with snowy white, contrasting with the yellowish or greyish white which is the ordinary colour of the sand, and yet at a short distance liable to be taken for sand a little whiter than common. The whiteness, however, is that of the innumerable short cylindrical spikes of an Amarantacea, whose stems, originating from beneath the medano, ramify through it, and go on growing so as to maintain their heads always above the mass of sand, whose unceasing accumulation at once supports and threatens to overwhelm them.

The other two herbs of the desert are known to the natives, the one as Yuca del monte, or wild Yuca, the other as Yuca de caballo, or Horse Yuca, from their having roots like those of the cultivated yuca (*Manihot Aipi*), or not unlike parsnips, but three times as large. Both roots are edible, and the former is sometimes brought to market at Piura when the common yuca is scarce. The Yuca de caballo is too watery to be cooked, but is sometimes chewed to allay thirst by the muleteers and cowherds, who detect its presence by the slightest remnant of the dried stump of a stem; for both kinds maintain a purely subterranean existence during many successive years, and only produce leafy stems in those rare seasons when sufficient rain falls to penetrate to the roots. A few animals that roam over the desert, such as goats, asses, and horses, obtain a scanty supply of food and drink from these yuca roots, which they scrape out with their hoofs. The fruit of the Yuca de caballo may frequently be seen blowing about the desert, looking more like a pair of very long-hooked bird's claws than anything vegetable. It is an elongated capsule with a fleshy pericarp (incorrectly described as a drupe) terminating in a beak several inches long, and when ripe splitting into two valves, which remain united at the base and curl up so as to resemble claws or ram's horns. At Piura it is known by the not very apposite name of *espuelas*, or spurs. In Mexico the fruit of an allied species is called Una del diablo, or Devil's claws. The Yuca de caballo is a *Martinia*, of the family of Gesnereæ (or, according to some, of Cystandraceæ). I was fortunate enough to see a single plant of it with leaves and flowers in 1863, near the river Piura, on ground which the inundation had barely reached, but had sufficed to cause the root to shoot forth its stems, which spread on the ground, branching dichotomously, to the distance of a yard on all sides. The roundish leaves, clad with viscid down, are lobed much in the same way as those of some gourds, but the large sweet-smelling flowers are like those of a foxglove.

I have never seen either leaves or flowers of the Yuca del monte; but, from the description given me of it, I should suppose it a Convolvulacea, allied to the sweet potatoes (*Batatas*), and the lanceolate leaves point to the genus *Aniseia.*

The arborescent vegetation of the desert, although perhaps really more scanty than the herbaceous, is from its nature more conspicuous wherever it exists. There are points from which not a single tree is visible all around the horizon, but they are rare; generally the view takes in a few widely-scattered trees growing in basin-shaped hollows or towards the base of slopes, where at a certain depth there is permanent moisture throughout the wide interval between the *anos de aguas*, at which epochs the supply is renewed. Wells dug in such sites reach water (too brackish for drinking) at various depths, the first deposit often at only a few feet from the surface. The moisture derived from the garuas, scanty as it is, no doubt aids in keeping the desert plants alive; and the air is never so excessively dry as might be supposed, but, on the contrary, sometimes approaches complete saturation. The trees of the desert are the Algarrobo (*Prosopis horrida*), the Vichaya (*Capparis crotonoides*), the Zapote de perro (*Colicodendron scabridum* ?), and an Apocynea with numerous slender branches, bright green lanceolate acuminate leaves, axillary clusters of small white flowers, and fruits, consisting of small twin drupaceous follicles, which are slender, curved, and coated with a thin white flesh. The *Capparis* and the *Apocynea*, although they grow to be trees in favourable situations, as in valleys near the sea, are mere shrubs on the desert; and the *Prosopis* and *Colicodendron* are low trees of very scraggy growth, their branches all bent one way by the prevailing wind, and the trunk itself often semi-prostrate.

Far away over the desert a tall-branched Cactus begins to be met with; the same species abounds on the desert-coast of Ecuador. Farther still, near the roots of the Cordillera, the vegetation becomes gradually more dense and varied, comprising several other kinds of trees, and amongst them most of those about to be mentioned as denizens of the valleys.

When the traveller across the despoblado comes suddenly on one of the valleys, he passes at once from a desert to a garden, whose charms are enhanced by their unexpectedness. Standing on the cliff that overlooks the Chira, about Amotape, he sees at his feet a broad valley filled with perpetual verdure, the great mass of which is composed of the pale green foliage of the algarrobo; but the course of the river that winds through it is marked (even where the river itself is not seen) by lines or groups of tall coco-palms, here and there diversified by the more rigid date-palm, both growing and fruiting in the greatest luxuriance, their ample fronds never mutilated by caterpillars as they are wont to be in other regions. On the river bank grow also fine old willows (*Salix Humboldtiana*), noticeable for their slender branches and long narrow yellow-green leaves, contrasting strongly with the dark green of the spreading *guavas* (*Inga* sp.), and with the bright green foliage (passing to rose at the tips of the branches) of the mango (*Mangifera indica*). Mingled with these, or in square openings in the algarrobo woods, are cultivated patches of sweet potatoes, yucas, maize, and cotton plants, the latter distinguishable by their pale but fresh green colour. It was a magnificent sight to look from this cliff towards the mouth of the Chira when the sun was just setting over it, steeping the hills of Mancora in purple and violet, and gilding the fronds of the palms and the salient edges of the adjacent cliffs, while the deep recesses of the latter and the algarrobo woods were already shrouded in gloom.

On descending into the valley, the natural forest of algarrobo is found to occupy a strip of from a few hundred yards to three or four miles in width, extending from the river on each side as far out as there is permanent moisture at a moderate depth. It is divided by fences into plots of various sizes, all private property, except a small breadth of common lands adjacent to each village. I was surprised to hear these plots called not "woods," but "pastures" (potreros), for the trees grow in them as thickly as trees do anywhere, and there is not underneath them an herb of any kind. They are so called because the fruit of the algarrobo is the main article of food for most of the domesticated animals, and therefore corresponds to the pasturage of other countries. The algarrobo is a prickly tree, rarely exceeding 40 feet in height, with rugged bark not unlike that of the elm, but more tortuous, and with bipinnate foliage like that of the Acacias, to which it is closely allied. The roots penetrate the soil to only a slight depth, but extend a very long way horizontally. On the desert I have seen an algarrobo root, no thicker than the finger, stretch away to a length of 40 yards, evidently in quest of moisture. As the trunks never grow straight, and soon become tolerably corpulent, and their roots take too little hold of the friable earth to sustain them against the squally winds, they very generally fall over in age either into a reclining posture or quite prostrate, but immediately begin to turn their heads upwards, send off new roots from every part of the trunk in contact with the soil, and thus get up anew in the world ; so that an old potrero or algarrobo wood has a most irregular and fantastic appearance. Twice in the year the algarrobo puts forth numerous pendulous racemes of minute yellow-green flowers, which nourish multitudes of small flies and beetles, that in their turn afford food to flocks of birds—negritos (blackbirds), soñas, chirocas, putias, &c.—most of them songsters, and all of them more pleasantly garrulous than any similar assemblage of little birds I have met with elsewhere in the world. The flowers are followed by pendulous flattish yellow pods, 6 to 8 inches long, about a finger's breadth and half as thick, containing several thin flat rhombic seeds, immersed in a sweetish mucilaginous compactly spongy but brittle substance, which is the nutritive part. These pods are greedily devoured by horses, cows, and goats, but especially by asses, which are more numerous than any other domestic animals. It is a very concentrated and heating kind of food, and I have seen horses after eating it chew the leaves of the castor-oil plant, or any kind of rubbish, to counteract its stimulating properties. It is also a very strong aphrodisiac, and in the month of April, when the first crop is ripe, and the pods which the wind shakes off in great quantities are picked up by animals as they fall, one cannot walk in the potreros without risk of being run over by the amorous donkeys that career madly about. I am assured that a similar effect is produced on the Indians by eating a sort of porridge which they call llupishin, made of mashed algarrobo pods and maize flour. The seeds pass through the intestines of animals uninjured, and are to be seen in vast quantities blown about the country by the winds. From their shape and size they look exactly like the articulations of a Mimosa pod.

The algarrobo secretes an inflammable gum-resin, which exudes from cracks in the bark and coagulates into a blackish mass. Advantage is taken of it to prostrate the trees by fire, when it is required to clear the ground for cultivation. Cutting them down is scarcely ever resorted to, the timber being so hard as soon to render useless the best-tempered axe. The method employed is this :—A truncheon of wood, alight at one end, is laid on the ground with that end touching the tree to windward. The trunk soon takes fire, and (especially if the wind be strong) is in a few hours burnt right through nearly horizontally, the part destroyed rarely exceeding from half a foot to a foot in breadth ; and being thus prostrated its still burning end is covered with earth to extinguish the fire. There is no better material for fuel than algarrobo wood, and its very great hardness and durability would make it a most desirable timber for any kind of construction, were it not that it grows so crooked and is so intractable to work.

Potreros from which animals have been long excluded sometimes grow so thick, from two kinds of lianas which fill up the intervals of the trees, as to be impassable. A species of *Rhamnus*, called "Lipe," armed with formidable decussate spines, and producing minute 4–5-merous flowers, followed by small edible black berries, supports itself against the algarrobos and climbs high among their branches. When it grows alone and has room to spread, it forms large round bushes, each many yards in diameter, and 12 to 15 feet high. Bushes of lipe, scattered over the bare ground, look at a distance not unlike the small groves of hollies or other evergreens that stud the sanded or gravelled surface of an English shrubbery. In these bushes hide by day numerous foxes, which come out by night in quest of food. They are as fond of melons as

Æsop's fox was of grapes, and do not despise them even when green, so they can get at them. Lizards and a few snakes also seek the shelter of the lipe. Flocks of small birds roost there by night, and by day pick the berries.*

The companion of the lipe is a rampant Nyctaginea (*Cryptocarpus* sp.), whose local name I forget. It climbs to the tops of the algarrobos, and often hangs therefrom in dense masses. It has heart-shaped stellato-pubescent leaves (fleshy when growing near the sea), and panicles of minute green flowers, which persist on the enclosed black utricle. A stout parasitical *Loranthus*, with small yellowish flowers, often forms large bushes on the algarrobo, and generally ends by destroying the tree whereupon it has established itself.

A far handsomer tree than the algarrobo sometimes grows along with it, especially where there is rather more moisture than usual ; this is the Charán (*Cæsalpinia* sp.). It is a widely-spreading tree, often branched from the very base, and the shining reddish bark is being constantly renewed. It has exceedingly graceful bipinnate foliage—roseate at the tips of the branches—panicles of yellow flowers, spotted with red, and thick deep-purple pods, which (like those of the allied dividivi of the Spanish main) are extensively used in tanning.†

The *Azota-Cristo* or Whip Christ (*Parkinsonia aculeata*), so called from its excessively long pendulous leaves, from whose thong-like rachis the small leaflets often fall away, is less handsome but still more uncommon-looking than the Charan, and it is also much rarer in this region. It reappears in the Antilles.

A few other trees are occasionally met with, such as a *Calliandra*, conspicuous for its numerous flowers—green tinged with rose—out of which hang the long silky straw-coloured stamens, and for its curled scarlet pods ; two Acacias, one of them the widely-dispersed *A. Farnesiana ;* a *Maytenus*, which is especially abundant at the mouth of the Chira, and is common enough along the coast of Ecuador as far north as the Equator ; and the Oberál (*Varronia rotundifolia*), a solaneous tree or shrub, with numerous bright yellow trumpet-shaped flowers and white berries, abounding in a viscid juice, which is used by the dusky beauties of Guayaquil to straighten out their hair and hide its natural crispness. The Oberal grows in much greater abundance and luxuriance in Ecuador, where it is called Muyúyu, and also at Lima, where it is known as Membrillejo.

The trees mentioned above as belonging to the desert grow also in the valley, and far more luxuriantly there, but generally scattered along

* The lipe sometimes straggles out on the desert, and is then either wholly or in part leafless. In this form it is the *Rhamnus senticosus*, H.B.K.

† The Charan is so like the Cascol of the coast of Guayaquil (*Cæsalpinia corymbosa*, Benth.) that it is hard to say whether it deserves a distinct specific name ; the leaflets, however, are larger, and the panicles are not corymbose. The pods of the Cascol have the same use as those of the Charan.

the outer margin of the algarrobo belt, especially wherever the soil is much impregnated with salt. The Zapote de perro bears a large berry, not unlike a smallish melon in size, shape, and the alternating green and white streaks. Its taste is disagreeable, and I have not seen it touched by any animal, although it is said to be eaten by dogs (as its name implies) and also by foxes and goats. The Vichaya, a dense-growing bush, with oval hoary leaves, has yellow berries the size of a damson, containing a few stony seeds involved in a mawkish sweet pulp. Another *Capparis*, which scrambles up into the trees, also grows here, but rarely; it is much more frequent near Guayaquil, as is also the Vichaya, which is there called Cuchuchu. In fact, all the trees and shrubs hitherto mentioned (with one or two exceptions) grow also on the desert coast of Ecuador, along with a few others not found in Northern Peru.

In the ravines which run from the tablaze to the valley, besides a few stunted algarrobos, there is another small prickly tree, a species of *Cantua*, with black stems and branches, which becomes clad with fugacious roundish Loranthus-like leaves and pretty white flowers only in the rainy years. There also grows a cactus called Rabo de zorra (fox's brush), from its usually simple stems being densely beset on the numerous angles or striæ with reddish-like prickles.

On the margin of the river, except where the banks are unusually high, there is another strip of land, called the vega, which is overflowed every year about February or March by the flush of water from the Andes, although no rain may have fallen in the plain. The vega is in many parts of the valley the only ground kept under cultivation, and the indigenous vegetation there is of a quite distinct character. Instead of the algarrobo, we have the willow and a small composite tree, *Tessaria legitima*, with leaves very like those of *Salix cinerea*, and soft brittle wood, which is the common fuel at Lima and elsewhere on the coast, where it is called Pajaro bobo. Less abundant than those two trees are *Buddleia americana*, a pretty *Cassia*, two species of *Baccharis*, two rampant *Mimosæ* (one of them *M. asperata*), *Muntingia Calaburu* and *Cestrum hediondinum* (called Yerba Santa), of which only the two last grow to be trees of moderate size, the rest being weak bushes or shrubs. Over trees and bushes climb a half-shrubby Asclepiad (*Sarcostemma* sp.), with very milky stems and umbels of pretty white flowers, a *Cissus*, a *Passiflora* allied to *P. fœtida*, a pretty delicate gourd plant, and a *Mikania*.

It is usually only on the vega that we find any herbaceous vegetation, except in the rainy years. There the *Cana brava*, a *Gynerium*, with a stem fifteen feet high and leafy all the way up, and with smaller and less silky panicles than the other species, grows in large patches. The huts of the Indians and Mestizos in the suburbs of Piura have often nothing more than a single row of Caña brava stems stuck into the ground for walls, and others laid horizontally over them for roof, affording of course little protection from sun and wind, and none at all from the rain, which happily falls so very rarely. Along with it grow a few other perennial grasses, chiefly species of *Panicum* and *Paspalum*, besides the Grama dulce (*Cynodon dactylon*), originally brought from Europe, but here so completely naturalised that if allowed to spread it would exclude almost every other plant. It is valuable as an article of fodder. A few annual grasses, chiefly species of *Eragrostis*, grow about the outer margin of the vega. Of sedges also (*Cyperus* and *Scirpus*) there are four or five species.

Other herbaceous or suffruticose plants are, a tall *Polygonum*, the handsome *Typha Truxillensis* (which is called Totorra or bulrush), the Yerba blanca (*Teleianthera peruviana*), several species of *Chenopodium*, including the strong smelling Paico (*Ch. ambrosioides* and *multifidum*); a *Cleome*, a *Portulaca*, *Scoparia dulcis*, a *Stemodium*, and three or four other Scrophulariaceæ; a *Melilotus*, a *Crotalaria*, a pretty *Indigofera*, with numerous prostrate stems spreading every way from the root, and pink flowers; a *Desmodium*, a sensitive-leaved *Desmanthus*, a *Sonchus*, *Ambrosia peruviana* (called Altamisa), and a few other Compositæ; a *Datura*, allied to but very distinct from *D. Stramonium*, two species of *Physalis*, *Dictyocalyx Miersii*, Hook. f. (exceedingly variable in the size and shape of its leaves), and the ubiquitous *Solanum nigrum*; *Verbena littoralis*, two species of *Lippia*, *Tiaridium indicum*, a *Heliophytum*, three *Euphorbiæ*, a small Lythracea allied to *Cuphea*, and a few others. In the river itself occasionally grows a *Naias*, in dense masses, like those of *Anacharis alsinastrum* in English streams and ponds.

Two lichens, *Roccella tinctoria* and a *Ramalina*, both known by the name of *Orchilla*, grow in a sparing and rudimentary manner on the trees. On the coast of St. Elena, in the isle of Puna, and in the Galapagos, these lichens are so abundant and luxuriant as to form an important article of commerce.

Two mosses, both species of *Bryum*, are occasionally found on the banks of the river Chira, and on the filtering stones kept in houses, but only in a barren state.

I did not remain long enough in the country to witness the full effect of the rains of 1864 on the desert. The first plant to spring up, in the ravines leading down from the tablazo to the valley, and then on the tablazo itself, were two delicate *Euphorbiæ*, distinct from those of the vega. A little later on they were followed by a fragile dichotomously-branched *Scrophulariacea* (which is common on the coast to northward of Guayaquil); two viscid *Nyctagineæ* (species of *Oxybaphus*) with pretty purple flowers; and two or three grasses (one of them an *Aristida*), but very sparingly. The Yuca de caballo (*Martynia* sp.) also began to put forth its leaves, but the Yuca del monte had not, up to the 20th of April, shown itself above ground. I had seen far more wonderful effects of the rains of 1862 at Chanduy, where a desert nearly as bare as that of Piura became clad in a month's time with a beautiful carpet of grasses, of many different species, over which were scattered abundance of gay flowering plants. Something similar must have occurred this year to northward of the hills of Mancora, for people who have travelled between Amotape and Tumbez in the middle of April reported the whole country clad with verdure, and the grass in the hollows up to horses' girths.

Agriculture, especially as applied to Cotton-growing.—Several kinds of fruit-bearing trees are cultivated on the Chira, and none of them appear to have been indigenous there. The principal are cocos, dates, mangos, oranges, limes, lemons, pomegranates, two sorts of guayaba (*Psidii* sp.), guavas (*Inga* sp.), "paltas" or alligator pears, ciruelos (*Spondias purpurea*), papayas, and tamarinds. These all bring forth fruit abundantly, yet not in sufficient quantity to supply the consumption of the towns of Payta and Piura, which obtain most of their oranges, mangos, and pine-apples from Guayaquil and from the foot of the Cordillera. From the warm or temperate valleys towards Loja and Ayabaca, at from 3,000 to 5,000 feet elevation, are brought great store of delicious cherimoyas ; unfortunately, when they are ripe (in June and July) the weather is at its coldest in Piura, so that their cooling properties are not so appreciable there as at Guayaquil, whither also they are exported in vast quantities.

Plantains, maize, yucas of two kinds, sweet potatoes, achira (a sort of *Canna*, the fecula of whose tubers is what is called tapioca in Peru and Ecuador), and many other edible plants of the tropics, are cultivated on the Chira; but the wonder is to see many plants, usually considered peculiar to cool climates, thrive and mature their peculiar products in that warm valley. Potatoes grow and yield well, especially a kidney potato of which I have seen tubers ten or eleven inches long. Carrots form large roots, perfectly good tasted, and re-sow themselves all along the vega. Radishes, salsafy, onions, cucumbers, &c., thrive as well as in Europe. Cauliflowers are magnificent, and even cabbages can sometimes be induced to form a head. Now all these plants in a moist rainy region, where the heat was as great as on the Chira, would probably either not grow at all or would run all to leaf ; but growing on the vega or elsewhere in the valley where by means of irrigation just so much moisture as they need and no more can be supplied to them, and where they run no risk of being drenched or beaten down to the earth by the rains usual to other parts of the tropics, the great heat of the summer months seems merely to act on them as a beneficial stimulant, and to accelerate their ripening. The cultivation of these plants, however, is in the hands of Europeans and North Americans, for simple as it is, it requires a little more *ménagement* than it would get from the natives, whose agriculture may be said to be limited to two operations, sowing and gathering in the crops.

For growing maize in the valleys of Chira and Piura, so soon as the inundations subside, they open with rude spades, called lampas, square or round holes, a yard or so apart, about a foot across and as much deep.

Then the sower with his pico (a sharpened stake of the hard wood of the algarrobo) makes a smaller hole at the bottom of the larger one and drops into it six or eight seeds. Three crops are obtained in the year, but at each successive sowing deeper holes have to be made to reach the moisture, and even so the second and third crops are much inferior to the first.

Cotton, water-melons, &c., are sown in the same way, but the holes are made larger and at a greater distance—say two feet in breadth and depth, and eight to fifteen feet apart.

Where the ground is nearly flat, cultivation is often extended to a long way beyond the limit of the vega, and sometimes nearly as far out as there is any algarrobo; but then the plants require to be watered daily, until their roots have penetrated to permanent humidity, and sometimes for the term of their natural lives. Orange and other fruit trees when planted far away from the river have to be watered for years before they become firmly established; and all this watering must be done by hand, and the water carried by men, women, and children in huge calabashes to where it is required.

A good deal of water is diverted from the upper part of the Chira and its tributaries for irrigating the adjacent lands, principally with the object of growing sugar-cane, maize, and lucerne; but in the lower part of the valley, which is best adapted to the growth of cotton, there has been no systematic irrigation in modern times until very lately, when it was undertaken by foreigners, the lands there being generally at a much higher level than the water in the river, so that to irrigate them the water requires to be raised a certain height by steam or other power.

To come now to the cultivation of cotton, which has always been an important staple of this department, and with the actual high prices is at present absorbing nearly all the disposable capital and labour, I propose to trace briefly the history of this branch of industry. The *conquistadores* found the cotton plant and fabrics of cotton almost everywhere among the native tribes, both on the mainland of the new continent and in the adjacent islands. How many kinds of cotton were then in existence we have no records to show; but at the present day all the cottons I have seen cultivated by the Indian tribes of South America, from the Atlantic to the Pacific, in the hot plains and in the temperate valleys of the Andes, are referable to one species, the *Gossypium barbadense* of Linnæus. In Peru itself, both on the arid sea-coast and in the humid valleys on the eastern side of the Andes, we still meet with only forms of *G. barbadense* among the Indians, and never of *G. peruvianum.*

Corpses disinterred from ancient Peruvian tombs, or *huacas*, are nearly always found wrapped in cotton cloth, which is sometimes in wonderful preservation. Underneath this cloth wrapping the body is occasionally found enveloped in the brown cotton which was considered sacred by the Peruvians, and about which a word of explanation is needed. All through tropical South America there is a variety (or rather accidental form) of *G. barbadense* which yields cotton of a reddish brown colour. If a number of seeds taken from pods of perfectly white cotton be sown together, a few of the plants are sure to produce only brown cotton, and the browner it is the shorter and more brittle the staple ; so that the brown cotton plant is a mere degeneration from the white. And yet the tint is rather pretty—to the Indian's eye, so much so, that he formerly considered it sacred, and limited its use to his priests and Incas, and to his dead ; and at the present day he weaves it alternately with the ordinary white cotton, in stripes and checks, in his mantas and listados. At Tarapoto, in Maynas, the people weave a strong listado for trousers, and a still stouter manta for shoes and slippers, both with alternate stripes of white and brown cotton. These fabrics are largely used there, and are exported to other parts of Peru, and also to Brazil. I have had garments of them and found them very pleasant and durable wear. The brown stripes preserve their colour after any number of washings ; it is true they begin to wear rather earlier than the white, but even so it was impossible to get in Maynas any English or North American cottons as durable as the native fabrics.*

Some time after the dominion had passed from the Incas to the Spaniards, a decree went forth from Madrid that the inhabitants of Peru proper and Chili should dedicate themselves to mining and agriculture, and to the making of wine from the recently introduced grape, but might not set up *obrajes*, or factories for the weaving and dyeing of cloth. This latter branch of industry was to be carried on in Quito (now Ecuador), where it was forbidden to mine or to grow grapes for making wine. Thus it happened that, until the early part of the present century, the wool and cotton raised at Piura used to be sold chiefly to manufacturers of Loja, Cuenca, and Quito, having been first spun into coarse thread, called "pabilo," and made into balls of the value of a real (one-eighth of a dollar) and of a pound weight each, which gives $12\frac{1}{2}$ dollars for the value of a quintal; but sometimes clean cotton was worth as much as 14 or 15 dollars the quintal. From Quito the wool was returned to Peru in bayetas or serges, ponchos, &c., and the cotton chiefly in *tocuyo*, a coarse fabric which sold at a real the vara, and was used for bags, sails, &c., as well as for the commoner kinds of garments. The Indians, however, appear to have been allowed to reserve enough of the raw material to make their own simple garments, or at least those of the women, which often consisted solely of the *anaco*, a sort of tunic not unlike a friar's gown, confined at the waist by a cord or belt.

* For exportation to Europe it is necessary to reject the brown cotton, or at least to keep it apart from the white. I was told by a cotton-dealer in Peru, that he had lately found a good market in France for his brown cotton, at a rather lower price than the white, but still a remunerative one.

Nankin is a similar variety of Chinese cotton, of a rather paler brown than the Peruvian, but equally permanent in colour.

At Piura, on the margin of the river, the kitchen middings form an embankment the whole length of the city, whose lowest layers may be supposed contemporaneous with the establishment of Piura on its actual site (1728). In that climate (as before-mentioned) it is rare that anything rots, so that the *rejectamenta*, however ancient, are perfectly recognisable. In 1863, the river having undermined the embankment at one place, part of it fell down when the water subsided, leaving a perpendicular section of about thirty feet high, where the domestic habits of the Piuranos for the last 135 years might be studied in the remains of their clothing, food, utensils, &c. Fragments of the stem of the *cana brava*, the ordinary material for the walls and roofs of the Indians' huts, occurred all through the mass. Cotton rags were everywhere common, but of coarser quality towards the base of the deposit. Silk rags were scattered throughout, but more abundantly in the upper strata. Towards the base sandals were common, but shoes were very rare. The comparative abundance of the latter, and of the bones of oxen in the upper strata, showed that the modern inhabitants of Piura are both better shod and better fed than their ancestors were.

When Peru became free of Spanish rule, the coloured races at once acquired the name of citizens, and by little and little the rights of citizenship; so that at the present day (in the coast-region at least), many Indians and Mestizos are landed proprietors, and a nearly pure Indian (General Castella) has lately been seen occupying the presidential chair. The cultivation of cotton has continued to be carried on, probably on nearly the same lands and at least to an equal extent, as before the independence. But the cotton of Piura has no longer had to be sent to be manufactured in the province of Quito, a large proportion of it being worked up on the spot into tocuyos, mantas, excellent saddle-bags and belts woven in gay devices of various colours, &c.; while the surplus has been exported to England, from which country the Peruvians were at length free to import the calicos, muslins, &c., which they could previously only obtain at exorbitant prices from the merchants of Spain.

Cotton has always been sold at Piura and the port of Payta by the cargo or mule-load of 14 arrobas 14 lbs., or 364 lbs. of raw cotton, from which the seeds have not yet been separated; when it has undergone that process there remains only about one-third the weight, or say 120 lbs. of clean cotton. Fifteen dollars the gross cargo (which is just one real the pound of clean cotton) used to be considered a very remunerative price, and it has been sold for exportation at as low as eight dollars; but of late it has rarely been below C0, and sometimes over 70 dollars the cargo, which at 37*d.* the Peruvian dollar—the actual rate of exchange on London—gives 22*d.* to 26*d.* for the price of a pound of cotton at Payta, scarcely a remunerative price for exportation to England, where it has been sold at from 27*d.* to 30*d.* per lb. It ought, however, to be a very paying business to the cotton-growers, whatever it may be to the brokers, and the wonder is, that for many years the quantity of cotton grown in the department has been diminishing. I am informed by Alexander Blacker, Esq , H.B.M.'s Vice-Consul at Payta, that when he first established himself there, now some twelve years ago, 22,000 quintals of cotton were exported yearly, and some years previously, the quantity had been still greater ; but that for the last four or five years, the annual exportation had not exceeded from 6,000 to 8,000 quintals, notwithstanding the enormous increase in the value of the article.* This has arisen, not from a less breadth of land being planted with cotton, but from a falling off in the crops, the causes of which the planters themselves are not very well agreed on, while the principal one (as it seems to me) is altogether ignored by them. It is that the same sort of cotton has been grown for centuries on very nearly the same land; the seed grown on the land constantly resown, without any attempt at selection from the most vigorous plants or the largest pods, and no seed ever brought from other parts to renew the growth,—no rotation of crops—no manuring—in a word, no change of site, climate, or food ever resorted to, without which both animals and plants, in a domesticated or cultivated state, are apt to languish. The consequence is that the plants have got into a quasi-cachectic condition, and have contracted a hereditary liability to certain disorders which threaten to reduce them to complete unproductiveness. The planters, however, have but one answer when asked to account for the failure of their crops, viz., "*las heladas*" (frosts),—*frosts* in a climate where the thermometer never descends so low as 60° ! Of course this opinion has no foundation whatever in fact, and it has arisen from an apparent analogy with the effects of real frost in the adjacent cordillera at a height of from 7,000 feet upwards. *There* frost is truly said to be "el azote de la sierra" (the scourge of the highlands): it occurs at any time of the year, and the serenest and sunniest day is most liable to be followed by a frosty night. When frost falls on the maize in flower, or with the seed still green and tender, it utterly destroys it ; but if the seed be well set it resists a moderate frost. Other plants suffer from frost, but none so much as maize, which of all the products of the earth is the most important to the Indian, as the material for his indispensable chicha. What the ailments of the cotton plant, attributed to *heladas*, really are, we shall see anon, when I come to detail what I have seen of the recent attempts to cultivate cotton by irrigation.

I cannot make out that any one proprietor has ever had a cotton plantation on a large scale in Piura. A few of the *hacendados*, owners of large cattle farms at the foot of the cordillera, have been accustomed to grow cotton on the low lands bordering the river, irrigating them after

* Mr. Duvall says that the exportation of cotton from Payta, from 1852 to 1858, was from 7,000 to 10,000 bales annually (each bale of about 156 lbs.), or from 11,000 to near 16,000 quintals, and that the price for exportation in 1857 and 1858 was 16 Peruvian dollars the quintal.

a fashion by turning the water on them whenever the river rose sufficiently high, which in some years was for two or three months, and in others perhaps for only a few days; but it was rare that any one cotton-grower could bring more than a hundred cargoes to market in a season. By far the greater part of the cotton has in fact been produced by the Indians, especially by those of Catacaos, on the Piura, and of Colan, on the Chira, who have each their small plot of land by the river-side. There the cotton is planted either on the vega, where it gets an annual watering from the rise of the river, or on the adjacent low land, where the plants have to be watered by hand until their roots penetrate to a good depth. Sowing is generally done just after the floods have subsided and left the vega dry, say in April, and nine months afterwards the first crop is ripe. The plants receive no further care, except perhaps to facilitate the access of the water to their roots at the time of the annual floods, and they are never pruned; yet after the first crop they yield again every six months, and go on bearing cotton for six or seven years, when the cotton beginning to deteriorate, the bushes are stubbed up and the ground resown. The Indian's wife and children pick the cotton when ripe, and to clear it from the seed take it out on the despoblado, select a space of a few feet in extent where there is only clean white sand (not mixed with dust), which they smooth down and beat the cotton thereon with slender sticks, one in each hand, until it is quite separated from the seeds. Then with a slight shake every grain of sand falls out, and the cotton remains in a white felty sheet, called a *madeja*, and is thus sold to the merchants for exportation, at so much the pound weight, or the arroba of 25 lbs.; but if it be intended for the country weavers, it is first spun into *pabilo*, as in ancient times. The loose seed of the Piura cotton makes this rude process practicable, which it would not be in varieties that have the cotton adherent to the seed. Latterly, gins have been got out from North America and set up at Payta and on the Chira, whereby much of the cleaning by hand has been superseded.

When the supply of cotton to England from the United States was suspended by the breaking out of the civil war, many Englishmen and North Americans, resident in Peru, turned their attention to the practicability of growing cotton there on a large scale; and one of them, Mr. Alfred Duvall, presented a memorial to the Manchester Cotton Supply Association, dated Baltimore, February, 1861, recommending the north of Peru as a favourable locality for the employment of English capital and labour in cotton cultivation. The author is led away by enthusiasm for his subject into a little exaggeration of the advantages, and lessening of the difficulties incident to such an undertaking; but, apart from that, his memorial contains many valuable hints and details, showing far more practical acquaintance with the subject than I can pretend to. He insists that the climate, although tropical, is temperate and salubrious, such as a white man can bear to work in all the year round, and that, therefore, there is no necessity for African labour, slave or free.

He says, "It is seldom the thermometer rises higher in the shade than 86° to 88° Fahr. in the warmest season, and then only for a few hours in the day, and but for a few months in the year, viz., from about the 15th of January to the 15th of April ; moreover, owing to the dryness of the climate, and the constant invigorating sea-breeze or trade-wind, with the thermometer at 90°, the heat is not so oppressive or enervating to the system as in a humid climate with the thermometer 10° to 15° lower. . . . I have found my own health better, and my powers of endurance greater than in the warm season in the most healthy parts of the United States."

He then enters fully into an exposition of his project for irrigating the land by steam-power, and calculates approximately the requisite outlay of capital, the current yearly expenses, and the profits resulting, even although the cotton should not fetch at Payta more than $6\frac{1}{2}$*d.* the pound. Experiment has shown that these calculations would require to be much modified, the preliminary expenses being greater than he estimated them at, and the crop of cotton so precarious as to vary within very wide limits from one year to another ; yet even so, it seems proved, that so long as the price does not fall below 15*d.* per lb. in England, cotton may be profitably cultivated on the Chira.

At the very time when Mr. Duvall was putting forth his speculations in North America and England, Mr. Stirling had purchased a tract of land on the Chira below Amotape, and begun to set up the requisite machinery, and make the canals for irrigation ; and shortly afterward Mr. Gerald Garland, of Lima, in partnership with Don Pedro Arese, the owner of Tangarará, projected devoting the most fertile portion of that estate (viz., the site above-mentioned of Monte Abierto) to the cultivation of cotton. Mr. Duvall was employed as engineer of the works for irrigation, &c., and immediately after returned to Peru, taking with him from the United States all the needful machinery. As I have seen much more of Mr. Garland's than of Mr. Stirling's cotton farm, I proceed to give some account of what has been effected on the former up to the end of January of the present year (1864), or in two years' time after it was first entered upon.

Monte Abierto, according to the observations of Mr. Duvall, is in lat. 4° 53′ S., long. 80° 56′ W., and the variation of the compass was 8° 15′ E. in 1862. The river Chira forms thereabouts several abrupt bends, with long intervening reaches, running N.W. and S.E. ; in former times it has often changed its course, and portions of its deserted beds have a great depth of rich alluvium ; they are called *vegas*, like the actual inundated margin of the river. The hills of Mancora are about two leagues away, and stretch from W.S.W. to E.N.E. Deep ravines run from them out into the plain, and along their base are many remains of ancient aqueducts. About half a league down the valley (or to westward) from Mr. Garland's house, are remains of Indian houses and forts, square enclosures sometimes with internal divisions, scattered through a like distance to W.S.W. On an adjacent hill, now called the Cerro de las Tres Cruces, there are the ruins of an ancient fort or burying place. Across the river, and half a league distant from Monte Abierto, there is still a small Indian village called Bibiante, and a league lower down the much larger village of La Huaca, where many of the merchants of Payta have their country houses, but which sufficiently indicates by its name that it was formerly a place of sepulture of the ancient Peruvians.

There were already at Monte Abierto some half-dozen scattered huts of Indians and others, who held chacras on the vega, rented from the proprietor, Señor Arese ; but for working the cotton farm it has been found expedient to induce other families to settle there by offering to each a chacra and a house.

The cotton plantation of Monte Abierto appears now as a plain of some 400 acres in extent, mostly reclaimed from the algarrobo forest, which encircles it on every side except that of the river, and of that space from two or three hundred acres are covered with luxuriant cotton plants, and with the necessary farm buildings, and the houses and chacras of the "colonos," as the resident mechanics and farm labourers are called. The engine-house, gin-house, warehouses, and workshops stand about a hundred yards away from the river and parallel to it, the water being conveyed to the engine in a canal lined with boards dug sufficiently deep to be always supplied with water even when the river is at its lowest. All these buildings, as well as the dwelling-house, have the floors, walls, and roofs plastered with hydraulic cement, made from an argillaceous limestone obtained at the base of the hills of Mancora. It is hard and looks very neat, but is not quite so waterproof as might be desired. The drying-ground, whereon the recently picked cotton is spread out in the sun, is also floored with the same cement.

From these buildings a lane, fifty feet broad, fenced in on each side and skirted with an avenue of willows, runs out northward to the present boundary of the farm, and at some 200 yards up it there is a cross lane of the same width, running east and west. At the crossing there is an oval space called the "plaza," and a little below it is the commodious dwelling-house, with attached flower and kitchen gardens.

Along the lanes on each side are square enclosures, of a little more than an acre, each with its cottage in front. These are the chacras of the colonists, who plant as much of them as they choose with vegetables for their own use, and the rest with cotton, which is sold to the proprietor at the market price. This plan has been found to answer so well that Mr. Garland has never any lack of workmen, and has indeed had applications for more chacras than he cares to let.

Over the engine-house a small observatory has been constructed, whence there is a magnificent view up and down the valley. Here, indeed, the proprietor might sit and "farm with a telescope and speaking-trumpet," as Sydney Smith proposed to do.

The engine for working the pumps and the cotton-gins is of twenty-five-horse power. The fuel used is chiefly algarrobo wood, which the estate affords in inexhaustible abundance, but cotton seeds are also burnt. The pumps in use are four strap (or Chinese) pumps, and one centrifugal pump, which throws up more water than all the rest ; but it exacts so nearly all the force of the engine that it cannot be used at the same time as the gins. By keeping the centrifugal pump or the four strap pumps in moderate action for twelve hours each day, the whole of the cotton plants can be watered at least once a week, and oftener where it is found necessary. The canals are raised by embankments to various levels, so as to provide for the prompt and equable distribution of the water over the land to be irrigated. These levels are respectively 16 feet, 20 feet, 23½ feet, and 26½ feet above low water in the river. The highest level has not yet been made use of; it would convey the water over an extent of 2,000 acres. Even the next in height would suffice to irrigate a much greater breadth of land than has yet been brought under cultivation.

Monte Abierto was begun to be worked in January, 1862, the first process being to clear away the algarrobo which covered nearly all the ground. By the end of September the preparations were so far advanced that an experiment could be made in the growth of cotton by irrigation; and seven different varieties—150 seedlings of each—being planted out on the 26th of that month, grew up and began to yield their first crop of cotton as under :—

	When sown.	When ripe.		Interval.
Egyptian . .	Sept. 26	Feb.	10	137 days.
Boyd's Prolific .	„	„	18	145 „
Sea-Island . .	„	March	11	166 „
Georgia . .	„	„	11	166 „
New Orleans .	„	„	15	170 „
Imbabura . .	„	„	19	174 „
Piura or Criollo .	„	May	20	236 „

Of all these kinds, the (so-called) Egyptian and the native Piura gave the largest crop of cotton, although the entire yield of the 150 plants of each kind was, unfortunately, not recorded ; and the percentage of pure cotton ginned from the mass of cotton and seeds was as under :—

Piura, 37 to 38 per cent.
Imbabura, 36 to 37 per cent.
New Orleans, Egyptian . } 32 to 33 per cent.

The percentage of clean cotton to gross weight of cotton and seeds is important only to the growers and exporters, and not at all to the English merchants and manufacturers ; for if the proportion of cotton to gross weight be small, then the overland carriage to the port of Payta becomes more costly to the producer ; and the broker who buys it there will find his profits proportionally diminish if, after ginning, the seed turn out to weigh more than he had reckoned on.

To render intelligible these results, and others which I shall have to adduce, it will be necessary to describe fully all the varieties of the cotton plant whose produce I have to compare; and it may not be amiss, in the first place, to recall the more important characters belonging to all the American species or varieties of *Gossypium.*

The cotton-tree grows in the equatorial regions to 15 feet or more in height, with a trunk sometimes exceeding 6 inches in diameter, ascending alternate branches, and soft brittle wood. In the village of Daule, near Guayaquil, there was, in 1861, a brown cotton-tree, supposed to be fifteen years old, of which I could only just reach the lowest branches with my upraised arm. Its trunk had been much gashed by wanton blows from knives and cutlasses, yet the wounds seemed to heal speedily, and the plant to go on growing with unabated vigour. On the river Piura, just below the town, I saw, in 1863, a tree of the common white cotton, whose trunk forked from a little above the ground, each fork being as thick as a man's thigh. It height was not more than 12 feet, but the expanse of its branches was enormous, covering an oval space whose greatest diameter was 27 feet, and least diameter 18 feet. I suppose it may still be growing there, for it was luxuriantly leafy, and produced a good many pods, of small size, and containing cotton of a very short staple, as is usual to old plants. Judging from these examples, and from others I have seen, I conclude that a cotton-tree, if allowed to reach the natural term of existence, in favourable circumstances, would probably live twenty years. Usually, however, it is cultivated as a shrub, its upward growth, beyond easy reach of the cotton-pickers, being checked by breaking off the leading shoots; and in the temperate zones it is grown as an annual, either because that has been found more profitable, or because it is the only possible way, where the winter cold is so great as to kill the plant. It sends down a very long tap root, the Indians say, exactly equal to the height of the tree; and the lateral roots are usually few and short.*

* People who have seen cotton growing only as a small annual bush, or even herb, are apt to be incredulous of its becoming a tree under more favourable circumstances. They require to be reminded that many plants, unavoidably treated as annuals in the north temperate zone, are grown as perennials near the equator. To take an instance in the potato, which, in the Andes of the department of Piura, towards the towns of Ayabaca, and Huancabamba, is cultivated in this way. The land having been ploughed and manured, is again ploughed over, and in this state is left for a whole year; at the end of which time they plough it once more, and in the furrows drop potatoes, a vara apart, covering them up with their feet. When the tubers are ripe they are scraped out as required, without uprooting the plant, which thus lasts many years without being renewed.

At Ambato, in lat. $1\frac{1}{4}°$ S., ripe strawberries of large size are exposed for sale in the market *every day in the year.* They are grown on adjacent sandy slopes, The whole plant is beset with blackish glands, which are rather protuberant on the petioles and pedicels, but are imbedded in the substance of the leaves and flowers, one in each areole of the network of the veins, so that they can only be seen when the leaf or flower is held up to the light.

Leaves 3 to 5 (rarely more) on each ramulus, alternate, spreading horizontally on longish petioles, rather broader than long, deeply heart-shaped at the base, palmately 3—5 cleft (the upper ones very rarely entire), more or less beset with slender stellate hairs. On the under side there is usually a concave gland or scrobicule a little above the base of the mid-rib, and a similar one on each side of the two lateral ribs; but these vary much even on the same plant, and are sometimes obsolete. (The form of the leaves and their stellate pubescence sufficiently recal some of our common mallows and hollyhocks, which are close allies of the cotton-plant; but the black-currant bush would exactly represent its external aspect if it had only a little larger leaves.)

Stipules smallish, herbaceous, linear, tapering to a slender point, subfalcate.

Pedicels short (scarcely an inch long), solitary, one-flowered, not exactly axillary, but springing from the upper side of the ramulus adjacent to the base of the petiole.

Involucral leaves 3, large, completely hiding the calyx, and sometimes equalling the corolla, valvate, heart-shaped, deeply laciniate, very rarely entire or nearly so; laciniæ subulate, tapering to a long slender point, the numerous ribs (one to each lacinia) forming, with the intermediate veins, a prominent network. Usually there is a large circular concave gland at the base of each involucral leaf; in some forms it is obsolete, and in others its presence is inconstant.

Calyx closely embracing the base of the corolla, cup-shaped, pale green, pellucid, dotted with prominent black glands, margin usually merely truncato-pentagonous, but in some varieties with the angles elevated into nearly equilateral triangles.

Petals 5, usually sulphur-yellow, rarely nearly white, with a large blood-red spot near the base, and turning reddish or purplish at the apex after the pollen is shed, broadly cuneate, sub-oblique, united at the base to the staminal tube and to each other into a monopetalous corolla, convolutivo-imbricate, twisting more and more as they fade, and often not falling off until the capsule is half ripe.

Stamens numerous, in 5 parcels, combined so as to form a tube half the length of the corolla, and funnel-shaped below; *filaments* of unequal length, with a very short free apex standing off to the upper part of the tube at a wide angle; *anthers* reniform, 2-valved.

Ovary ovata-tri-pentagonous, 3—5-celled, with numerous obovate

at an elevation of 9,000 feet above the sea, by means of irrigation. I could adduce many other instances of the perennial production of fruits and roots in those favoured regions.

ovules, nearly sessile on axile placentæ in two rows; style included, club-shaped, 3—5-sulcate at the apex, and bearing 3 to 5 stigmas.

Capsule (pod or boll) more or less ovate, 3-5-celled, broader and more nearly approaching to globose when the cells are 4 or 5 than when they are only 3, with a coriaceous or subligneous pericarp, when ripe bursting from the apex with from 3 to 5 valves, which bear the dissepiment on their axis. *Seeds* fig-shaped or pear-shaped, with a black, rather spongy skin, beset with long slender filaments (the cotton), which either separate entirely from the seed when a gentle force is applied, and leave it naked, or break it off near the base, leaving the seed covered with a greyish or greenish tomentum (called *fuzz* by the North American planters). There is also sometimes, both on the naked seeds and on the fuzzy seeds, a short white pencil of fibres at the base, but its presence is inconsistent even on seeds of the same plant. The fuzz itself is very variable, for in a single capsule I have found seeds quite naked, and others half-covered with fuzz, so that its presence or absence can never serve as a specific distinction.*

CAMBRIDGE COPROLITES.†

BY GEORGE SANDYS.

The coprolite‡ is a fossil remain, and until within the last few years was considered of no commercial value; but modern science has clearly demonstrated that it is one of the finest manures that a farmer can possibly use.

These coprolites are found in several counties, but in none so plentiful as in that of Cambridge. They run in veins, about from eight to ten

* The above description of the cotton-plant was drawn up from a comparative view of as many sorts of American cotton as I could get together in a fresh state. It professes to contain nothing new, beyond noticing that the stamens are really in five separate parcels united into one tube, and that both ovary and capsule are far oftener 3- or 4-celled than 5-celled (as usually described), of which I have satisfied myself by examining thousands of examples.

† See an article "On Phosphate Nodules," vol. iv., page 111.

‡ "The word coprolite is taken from two Greek words, κόπρος, dung, and λίθος, a stone (kopros-lithos), or fossilled dung or excrement. The microscope oftentimes detects membranous matter in these fossils. The coprolite is composed of phosphate of lime; that is to say, it contains lime, together with a salt, which neutralises its power. The admixture with sulphuric acid causes it to heat, and the affinity of the acid to salt being stronger, it is carried away with the fumes, the lime remaining, which being mixed with ammonia, becomes superphosphate of lime. This is the sole food of plants. The coprolite belongs to a silurian age, supposed to have been buried long before the creation of man."

feet below the surface of the ground (similar to geological strata), and, when washed and pulverised, are largely used in all kinds of nitrate, super-phosphate, and other chemical manures. The advantages gained by using such are too well appreciated by the agricultural community to need any further favourable notice from me. The largest works or diggings for obtaining these valuable fossils are at the little village of Abington (of which Mr. Charles Cooper is manager), about thirteen miles from Cambridge, and four miles from the little town of Royston.

Here was a tract of country nearly two hundred and fifty acres in extent, some parts of it submerged in large lakes of limpid mud, the refuse of the numerous washing-mills by which the works are studded; around could be heard the labouring groan of the steam-engines, the unceasing flow of water, and the merry hum of the voices of nearly four hundred men at work, whilst the musical din of the engineers' and blacksmiths' hammers at the repairing sheds adjacent, made a pleasant addition to the busy and interesting scene. Here may be seen thirty or forty men stripped and hard at work in deep trenches, digging the precious coprolites, whilst others are in constant attendance, ready to convey them to the washing-mills.

The method of preparing the coprolite for market may be divided under four heads—viz., digging, washing, grinding, and mixing. On these works the coprolites are only *dug* and *washed*, ready for the grinding-mills, the latter process being carried on at Ipswich. It may be necessary for the reader to understand the process of digging and washing, as carried on at Abington, before he can enter thoroughly into the subject.

The men are divided into gangs, one portion digging, the others filling, washing, and loading. The strata are found about nine inches in thickness; a party of men carefully remove the top soil, which is afterwards replaced, and then dig a trench about six feet wide and eighty or ninety feet long, until the strata of coprolites are reached; these are then removed in small and peculiar trucks especially constructed for the purpose, several of which are attached to each pit, or gang of men, and drawn by a horse on a line of tramways to the washing-mills. A brief description of these trucks may not be uninteresting. They are mounted on four (flanged) wheels, with a body independent of the frame or carriage, and connected only by a rod running completely through and uniting the two parts; the top or body when loaded is kept in its upright position by means of a small catch, or bolt; the truck is then run abreast of the washing-mills; a boy draws the bolt or catch, and the body of the truck turns over and discharges its contents into the ring of the mill. Simple as this may be, it tends to show how nicely time is calculated on these extensive works. When the men have removed the fossils from their bed, the land is undermined, and large iron crowbars or levers are inserted on the surface, by which means the whole mass is thrown over the ground already dug; by these simple means a fresh seam of coprolites is exposed to view, and so whole fields are dug without the necessity of barrowing such vast quantities of earth. The mills for washing are erected at convenient distances from each gang of men, and are constructed as follows: first, there is a ring, composed of strong sheet-iron, well riveted together, about eighteen feet in diameter and two deep; into this ring the coprolites are thrown, and are kept continually in motion by means of wrought-iron harrows, similar to those used for agricultural purposes, until the clay and fossils are separated. At certain times or stages of washing fresh streams of water are allowed to flow into the ring, and at intervals a small trap or sluice is drawn up, and the refuse water, or, as it is locally termed, "slud," runs from the mill and falls into an immense reservoir, whence it is removed by means of a dredger, or "Jacob's-ladder," above the mills, and then finds its level in the immense beds prepared for its reception. After a certain time this "slud" becomes hardened, the top soil is replaced, and the land is again fit for tillage. By an ingenious mechanical arrangement the engines not only drive the washing-mills, but also work the dredgers, or "Jacob's-ladders," and pump all the water necessary for the entire use of the mill.—From 'Once a Week.'

ON THE FOOD-VALUE OF THE KOLA-NUT—A NEW SOURCE OF THEINE.

BY JOHN ATTFIELD, PH.D., F.C.S.

A SHORT time since, Dr. Daniell placed in my hands a few ounces of hard dry fragments of Kola-nuts,* stating that in the fresh state they were largely used as an article of food and medicine by the natives of Western Central Africa; that he had himself once partaken of the fresh nut, the effect being that he was kept awake for many hours; that he therefore inferred that they must contain a principle similar to that which exists in tea, coffee, &c., namely, Theine; and that he had, in fact, by a rough chemical process, succeeded in obtaining crystals resembling theine in appearance. As a medicine, the *fresh* nut, Dr. Daniell said, was esteemed of great value in diarrhœa and affections of the liver; and that indeed, for all purposes, it was in the fresh state that the nut was generally employed, portions being chewed, the juice swallowed, and the solid part ejected from the mouth. If the nuts were allowed to become dry, they were considered to have depreciated in value, and were then only chewed by the lower classes of the natives. Altogether, Dr. Daniell considered that the nut possessed an amount of interest sufficient to demand analysis. I quite agreed with him, and the following is the result of the examination.

* *Sterculia acuminata.*

Search was first made for theine. Colouring matter, mucilage, &c., having been precipitated from a decoction of the nut by solution of basic acetate of lead, and excess of lead removed from the filtered liquid by sulphide of hydrogen, the clear supernatant fluid was evaporated to dryness over a bath, the residue digested in hot alcohol, and the latter evaporated to a small bulk. This on cooling solidified to a pasty mass of crystals, which were examined and found to have all the characters of theine. They were identical in crystalline form with some theine prepared from tea, both when seen under the microscope with and without polarized light, and in their general silky character when viewed by the naked eye; they yielded the beautiful colouring-matter known as red caffeo-murexid when treated with nascent oxygen, and gave gaseous methylamine when treated with caustic potash. These reactions and the effect of the nuts on Dr. Daniell, together with the well-known peculiar curved or fan-like character of the crystalline masses as usually formed, and their long, acicular form when deposited from a highly dilute and perfectly pure alcoholic solution, as in preparing a specimen for the microscope, will probably be considered sufficient to establish the identity of the crystals with theine. I shall, however, subject the substance to ultimate analysis so soon as the possession of more nuts enables me to prepare a sufficient amount. A quantitative determination showed that the proportion of theine present in dried Kola-nut is 2 per cent. Coffee contains from ·5 to 2·0, and tea from ·5 to 3·5 parts in 100.

The dried nuts were next examined for any basic, neutral, or acid principle to which the properties other than those of causing sleeplessness might be due, but no such principle was found. This result might have been expected, from the statement that the fresh nuts lose so much of their properties in drying as to greatly diminish in value. Moreover, the fresh nuts, Dr. Daniell tells me, have a bitter taste, while the dried fragments I examined had no trace of bitterness. Apparently, therefore, it is to the bitter principle that a portion of the activity of the nut must be ascribed. I shall endeavour to throw more light on this point when I succeed in obtaining specimens that have been preserved in a moist condition.

The presence of theine, then, at once points to the analogy of Kola-nut, or at least of dried Kola-nut, with coffee, tea, and two other similar but less common substances—Paraguay tea and Guarana. Infusions of one or other of these vegetables products are used as beverages probably by three-fourths of the human race, and each contains the same active principle—theine. To these must now be added the Kola-nut. Thus does Chemistry reveal the true reason why the unerring instinct of man, even in his savage state, has led him to select from the many thousands of plants presented to him in nature, just four or five with which to concoct a beverage that would seem to be a necessary rather than a luxury of life. And what makes the matter more remarkable is that these plants are not botanically allied. What theine really does do for the system is not yet very well made out. Liebig thinks that it may aid in the formation of that substance, a normal quantity of which is so necessary, and an abnormal so unpleasant—namely, bile. Most chemists agree that it arrests that rapid consumption of tissue and consequent feeling of fatigue which we all experience when we work hard with mind or body. Whatever may be its exact office, its discovery in Kola must greatly enhance its physiological interest, showing, as it does, that the instinctive desire for it in one form or other by Europeans, Americans, and Asiatics, is shared by the natives of Africa.

The other constituents of dried Kola-nut also indicate that it has the character of coffee, though differing from that article of diet in some important respects. Thus, on examining some finely powdered-coffee under the microscope, but few or no granules of starch are to be seen; while the powder of Kola is, apparently, one half starch, the granules forming the prominent object enclosed by the brownish yellow-coloured cell-walls of the tissue. A rough quantitative determination, accomplished by kneading the thoroughly-powdered nut in a fine calico bag under a stream of water, a process by which the starch is washed out into a receiving vessel, and the cell-wall remains in the bag, showed that starch dried at 212° F., is present to the extent of 42·5 per cent., and cell-wall and colouring matter to the amount of 20 per cent. Kola-starch granules are of about the same size as those of wheat, namely, from one thousandth to one ten-thousandth of an inch in diameter, are readily distinguished by their action on polarized rays of light, which they so affect as to be apparently traversed by a black or white cross, whose four arms meet at the hilum in the centre of the granule, the beauty of the effect being of course enhanced when a plate of selenite is placed beneath the object in the path of the ray. The colouring matter of the cell-wall of the nut is soluble in alkaline solutions, yielding reddish yellow solutions. Then, again, Kola resembles coffee in containing a small quantity of a fragrant aromatic volatile oil, having a burning, persisting, penetrating taste. In the case of Kola the odour closely resembles that of myrrh. Probably, as in coffee and tea, some of the activity of Kola is due to this volatile oil. Kola also contains a fixed fatty matter, the fat and oil being dissolved out of the powdered nut by ether to the extent of 1½ per cent. In coffee there is 10 to 12 per cent. of fat, while tea has none. There is 1·56 per cent. of nitrogen in dried Kola-nut. Subtracting from this number ·56, which is the amount that belongs to the theine, there is left 1 per cent., which appears to exist in the form of 6·33 per cent. of an albumenoid substance resembling legumin, one of the so-called flesh-forming materials. Kola can, however, be but of little value as a flesh-forming article of food, because apparently the juice only of the nut is swallowed; the more solid part, which would of course contain nearly the whole of this nitrogenous matter, being rejected. Moreover, unless the natives consume very much more of Kola than we do of coffee, the total amount of flesh-forming material they would eat at a meal, even if they swallowed the whole of the nut, would be too small to be worth taking into consideration as a constituent of food. Coffee contains 13 per cent. of this nitrogenous matter, and tea about 22, but in our methods of making beverages from these two substances, scarcely any of it is swallowed, it remaining as valueless along with the spent leaves and fragments. The ash obtained on burning Kola is 3·2 per cent., about half the amount that coffee or tea yields. It resembles the ash of coffee and tea in being composed of chlorides, sulphates, and phosphates of potash, lime, and magnesia. The greater part of the phosphoric acid is, in the soluble condition, probably combined with potash or ammonia, and would of course be swallowed with the juice on chewing the nut. Gum, sugar, and other organic matters, the nature of which could not be determined, are present to the extent of 10·67 per cent., a proportion similar to that in coffee and tea. Finally, the common astringent principle, tannin, which occurs in coffee to the amount of 5 per cent. and in tea to 15 per cent., and which gives to tea and coffee beverages their pleasant rough taste, is entirely wanting in Kola.

The following is a tabular form of the composition of dry Kola-nuts :—

	In 100 parts.
Water	13 65
Cell-wall and colouring matter	20·00
Starch	42·50
Volatile oil, Fixed fat	1·52
Albumenoid substance	6·33
Gum, Sugar, Other organic matter	10·67
Ash	3·20
Theine	2·13

Kola, then, in the dry state, somewhat resembles coffee, but differs in not containing tannin, in possessing but little fatty matter, and in the presence of much starch. Indeed, so far as its analysis indicates, if the fresh nut did not possess peculiar virtues, which apparently are lost on drying, it might be advantageously substituted by coffee. For when made up into a beverage it is thick and mucilaginous like cacao, but is tasteless, inodorous, flavourless ; nor is it improved in these respects by roasting.

An examination of the fresh nut would probably add greatly to the interest of this already interesting material.—'Pharmaceutical Journal.'

Obituary.

THE LATE SIR ROBERT H. SCHOMBURGK.

We have the melancholy duty of writing an obituary notice of one of our oldest and most esteemed friends, Sir Robert Hermann Schomburgk. He was endeared to all who knew him by his kindness of heart, amiability, and courteousness. For nearly a quarter of a century he was one of our most frequent correspondents on scientific matters in the various publications with which we have been connected. It seems but as yesterday that, at our request, he sent home a valuable collection of Siamese products and manufactures to the International Exhibition of 1862. One of his latest literary efforts was the account of the manufacture of Siamese books and paper, with illustrations of the raw materials sent us, and published in the September number of the Technologist last year. He arrived in England soon after in ill health, and, after a short stay at the Tavistock Hotel, Covent Garden, left for Berlin, where he died on the 11th of March.

Although he had reached to threescore years, his constitution had been much broken by long residence in tropical countries. In the years 1835 to 1839 he undertook expeditions into the interior of British Guiana under the directions of the Geographical Society of London, and in the years 1840 to 1844 as Her Majesty's Commissioner for surveying the boundaries of British Guiana between Brazil and Venezuela; on the latter occasion, after enduring much fatigue and great privations with his small party, he completed the circuit of the colony, from its sea boundary to within forty-two miles of the equator, in the course of nearly three years. An abstract account of this expedition was given in Simmonds's 'Colonial Magazine,' vol. i., p. 40, 1844. For these services he was knighted by Her Majesty, and it was in these explorations that he discovered, and introduced into Europe, the beautiful and gigantic water lily, which he named after the Queen, and which he assumed for his crest.

Sir Robert was well known to the scientific world as an eminent naturalist and geographer, and a good geologist and surveyor.

The following is a list of some of the numerous papers contributed by Sir Robert to the scientific publications of the day:—"On the Lake Parima, the El Dorado of Sir Walter Raleigh, and the Geography of Guiana," 'Simmonds's Colonial Magazine,' vol. v., p. 381; "A Description of the Murichi, or Ita Palm of Guiana (*Mauritia flexuosa*), and its Uses by the Aborigines," *ibid.*, vol. vi., p. 43; "On the Geological Structure of Barbados," *ibid.*, vol. vii., p. 470; "A Visit to Turner's Hall Wood, Barbados, in 1846," *ibid.*, vol. viii., p. 482; "On the Commercial Statistics of the Republics in South America," *ibid.*, vol. xiii., p. 260, and vol. xiv., p. 40.; "On the Manufacture of Beet-root Sugar in the Zollverein," *ibid.*, vol. xiv., p. 134; "On a Comparative Vocabulary of Eighteen Languages and Dialects of Indian Tribes inhabiting Guiana," *ibid.*, vol. xv., p. 46 ; "On the Heavy Swell along some of the West Indian Islands, called the Ground Sea or North Sea," 'Journal Royal Geog. Soc.', vol. v., p. 23 ; "On the Currents and Tides of the Mona Passage," 'Nautical Magazine,' 1850, p. 585 ; "On the Vegetable Products of Siam," 'Technologist,' vol., i., p. 355 ; "On Siamese Products," *ibid.*, vol. ii., p. 444 ; "On the Tonk-hai, or Paper-tree of Siam (*Trophis aspera*)," *ibid.*, vol. vi., p. 337. The 'Transactions of the British Association for the Advancement of Science' also contains many able papers from his pen.

Sir Robert was also a frequent contributor to the 'Athenæum,' to the 'Annals and Magazine of Natural History,' and other journals. His published works comprise the following :—'A Description of British Guiana, Geographical and Statistical,' with map, 155 pp. Simpkin and Marshall, 1840. 'Views in the Interior of British Guiana,' folio, 52*s.* 6*d.* ; coloured, 84*s.* Ackermann, 1841. 'Journal of an Expedition from Parima to the Upper Corentyne, and from thence to Demerara, executed by Order of Her Majesty's Government,' with maps. Reprinted from the 'Journal of the Royal Geographical Society.' 1845. 'The History of Barbados, &c.' Royal 8vo., with an accompanying map of the island. 722 pp. 31*s.* 6*d.* Longman and Co., 1848. 'Reisen en British Guiana, en de Jahren 1840-44.' 3 vols., imp. 8vo., 70*s.* Williams and Norgate, 1849.

Sir Robert was a Ph.D., Knight of the Royal Prussian Order of the Red Eagle, of the Royal Saxon Order of Merit, and of the French Legion of Honour ; corresponding member of the Royal Geographical, Zoological, and Ethnological Societies of London, of the Ethnological Society of Paris, Member of the Imperial Academy, Leop. Carol. Natural Cur., &c.

In the close of 1845, Sir Robert, then acting as Chairman of the Barbados General Railway Company, originated by the writer, to establish a system of railways in the island of Barbados, was deputed by the directors to proceed to that island to thoroughly examine and report on its resources and requirements. During a lengthened sojourn there, he made a thorough topographical survey of the island. Soon after his return to England, he was appointed British Consul at San Domingo, and subsequently Consul-General in Siam. His official reports to the Board of Trade on the indigenous resources and trade of those countries were full of valuable scientific and commercial information. Sir Robert, owing to advanced age, retired from official duties last year, and passed the whole winter confined to his bed. His funeral at Berlin was attended by a large concourse of scientific men.—Editor Technologist.

Scientific Notes.

New Silkworm.—The disease which has attacked the Mulberry Silkworm has for some time past attracted the attention of the Government and of the learned societies in France; and the discovery of a new silkworm in Senegal has been one of the results of the inquiries instituted to remedy the distress caused by the disease. A note on this insect, the *Saturnia bauhinia* of Guérin, has recently been presented to the French Academy of Sciences by M. Guérin-Méneville, who proposes to found thereon a new sub-genus under the name of *Faidherbia*, in honour of General Faidherbe, the commander of the French military expedition in the district of the Senegal, through whose instrumentality the silk-producing qualities of the insect have been made known. Specimens have been sent to Europe; and from a report addressed to the Academy, it appears that the Senegal silkworm will live in France, and that the silk produced by it is much more rich than that produced by any silkworm hitherto known. A cocoon spun by one of these silkworms contains 633 milligrammes of silk, those of the common mulberry silkworm containing only 290, and those of the silkworms of the *Ailantus* and *Ricinus* only 255 and 175 respectively. It is proposed to introduce the cultivation of this new silkworm into Algeria.

Paper in California.—The local paper manufactories are totally insufficient to supply the large amount of the article consumed in the country, there being only three paper-mills in existence there, without any prospect of a speedy increase of their number, while the call for paper is becoming daily more pressing. Of the three paper-mills, one makes paper for journals and for packing, the second only makes straw paper, and the third has only just begun, but cannot work all the year round for want of a sufficient supply of water. The San Francisco newspapers alone absorb 350,000 dols. worth of paper per annum, and nearly all the paper used on the coast of the Pacific, from Mazatlan to Victoria, and including the whole of California, Oregon, Nevada, and the Sandwich Islands, is sent from San Francisco, which generally gets it from New York and Boston, where it is very dear. Now, China and Japan manufacture an incalculable quantity of paper, which might be easily sent over to San Francisco at much less cost than it could come from New York. Chinese paper, though different from that of America, is very good, smooth, and strong, taking the impression of types beautifully and not transparent. Its greatest defect is its not being very white, owing to its being made of the fibres of the bamboo and mulberry-tree. Again, its size is too small, a serious drawback in the case of newspaper printing, especially in America. But if European paper machines were introduced into China, as some speculators are talking of doing, the supply that might be drawn from that country would amply suffice for all present calls and those in the future for many years to come.

THE TECHNOLOGIST.

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THE CULTURE OF COTTON IN NORTHERN PERU.

BY RICHARD SPRUCE, PH.D.

I have now to describe all the kinds of cotton I saw cultivated at Monte Abierto, under the name by which they are known there. It matters little whether we call those kinds species, or varieties, or races. They are easily distinguished in the living state, and differ much from one another in the period of maturity and in the quantity and quality of their yield; nor are new forms readily produced, even where many kinds are grown side by side. It is therefore necessary to discriminate between them, and to give them some kind of name by which we may talk about them; but all the kinds I have to describe (except the last) appear to deserve no higher rank than varieties—namely, of the species called by authors *Gossypium barbadense.* I begin with the common cotton of the country, known as—

Algodon criollo, Algodon de Piura, or *Algodon de Payta* (Piura, or Native Cotton).

Descr.—A bushy shrub or tree. *Ramuli* and *petioles rough with tubercles*, and bearing a few sparse hairs. *Leaves* 8 × 9 inches, full green, thinnish, rugose, *cloven to more than* $\frac{3}{4}$ *of their length; lobes* 3 or 5, sharply acuminate, *keeled*, nearly naked above, subpubescent beneath. *Involucral leaves* 3·4 × 2·6 inches, scarcely paler than the leaves, nearly smooth, laciniated in the upper half, rarely nearly down to base, *each wit ι a large round red basal gland;* apical laciniæ very long, subulate acuminate. *Calyx* slightly sinuate at margin. *Capsule* 3 or 4-celled, ovate, not acuminate or very slightly, 2 × 1·7 inches (when 4-celled), 2 × 1·4 inches (when 3-celled). *Seeds*, 7 or 8 in a cell, *quite naked* (when divested of the cotton), rarely with a very little fuzz at the base. Cotton moderately long, soft, rather silky.

The contents of a 4-celled pod of average size weighed 129 *grs.*, *whereof the* 30 *seeds weighed* 75 *grs., and the cotton alone* 54 *grs., or nearly* 42 *per cent. of the gross weight.**

Obs.—This cotton is generally considered to require from 9 to 10 months to mature its first crop. We have seen in Mr. Garland's experiment that in 236 days from the time of sowing the seed, the first pods were ripe ; but as they ripen in slow succession—the lowest on a branchlet first—at least three months elapse before the harvest is completely gathered in. Afterwards the trees produce every six months, the two crops being called by the natives the *consecha de la Natividad* (Christmas), and the *consecha de San Juan,* both epochs a few days after the solstices ; but in reality the plants are often only in flower at those dates, and the actual harvest begins at least a month later, so that Mr. Duvall is nearer the mark when he assigns the equinoxes as the period of maturity. In 1863 very few pods were ripe, even in September, but the following crop began to come on in January. On some trees odd capsules may be seen ripening all the year round. A similar perpetual production is observable in the Amazon region, but there the cotton that ripens in the rainy season is almost certain to be wasted ; I have, indeed, seen a crop beaten down to the earth by a single heavy rain.

The first crop of the Piura cotton is small, rarely so much as a pound per plant, but under favourable circumstances succeeding crops become far more productive. When from two to three years old, good plants have yielded in one crop from 8 to 12 lbs. of clean cotton, and at Monte Abierto there was some large old plants on the vega which I was assured had in one season yielded as much as 50 lbs. of seed cotton, or 18 lbs. of clean cotton each. Latterly there have been so many bad seasons that crops like these have become excessively rare, and I have not myself had the pleasure of seeing any such.

The plants usually stand about 15 feet apart, kidney beans or some other annual crop being raised in the interspaces the first year, and sometimes the second also. In three or four years, if the plants have prospered, they already begin to interlock. From the fifth year the yield degenerates in quantity and quality, so that, at the sixth or seventh year, the bushes are generally stubbed up and the ground resown.

Taking the plants at 15 feet apart would give 193 plants to the English acre, and if each of those plants be assumed to yield every half-year from 8 to 12 lbs of clean cotton, that gives from 1,544 lbs. to 2,316 lbs. for the acre ; certainly a very fine crop, even at the lowest figure cited. Unfortunately, such crops are now almost unknown.

The cotton, known in the market as Payta cotton, has always been much esteemed, and has fetched good prices in England. It is very white and soft, with a fair length of staple, and the yellowish stains it

* The pods of this and other kinds selected for weighing were of average size, and perfect in all their cells. It will be understood that the percentage of cotton obtained by ginning is rather less than that given here, because a little cotton is always wasted in that process.

sometimes gets from the cotton-bug are removable by soap and water. The perennial yield, and the great quantity of cotton contained in each pod, 50 grains or more, so that it takes only about 130 pods to produce a pound of cotton, will always make it a desirable plant to cultivate.*

2. *Algodon de Ica* (Ica Cotton).—So called from having been brought from the valley of Ica (lat. $13\frac{1}{2}°$ S.), where it is grown on the farms of Don Diego Elias and others.

DESCR.—Habit of the Piura cotton. *Leaves* 8 × 9·2 in. (and even broader), very deeply 3-5-cleft, sometimes *down to* $\frac{4}{5}$; lobes ovato-lanceolate, with a long distinctly acuminate point. *Involucral leaves large*, overtopping both flower and pod, laciniate all round the margin; *gland obsolete. Pod* ovato-oval subacuminate, rather longer than in the Piura cotton, 3- (rarely 4-) celled. *Seeds* 10, 11, *or even* 12 *in a cell, partially beset with short fuzz*, which is greenish towards the apex, white at the base, very rarely naked. Cotton scarcely distinguishable from that of the Piura.

The contents of a 3-celled capsule weighed 125 *grs.; viz.*, 31 *seeds*, 65 *grs.; cotton* 60 *grs., or* 48 *per cent. of gross weight.*

OBS.—This produces the largest pods, with the most numerous seeds, and consequently the greatest quantity of cotton in each cell, of all the kinds of cotton cultivated in Peru. As an average pod yields 60 grains of clean cotton, it would take not quite 120 such to give a pound weight of it.

3. *Algodon de Egypto* (Egyptian Cotton).—But by no means the sort usually cultivated in Egypt, which has smooth seeds, while this has them clad with fuzz. It is so-called on the Chira, because raised from seeds sent to Mr. Garland by the Manchester Cotton Supply Association, and purporting to be from Egypt. It appears to me a sort of short-stapled Georgia.

DESCR.—*Of humbler growth than the preceding, and more pyramidal. Ramuli* and *petioles subpilose*, often purplish. *Leaves* 3·5 4·4 inches, *when 3-lobed (as they mostly are)*, 3·5 × 4·8 inches, when 5-lobed, *cloven only to about the middle, nearly flat*, firmish, dull green, *with grey pubescence* on the veins above *on the entire surface beneath;* lobes ovate subabruptly acuminate. *Involucral leaves* 1·8 × 1·3 inches, greyish-green or purplish, laciniated almost all round, hairy on margin and veins; *gland obsolete*, or at least small and colourless. *Calyx with five rather large triangular acute lobes*, and acute sinuses. *Petals* exceeding the involucre, *of a pale sulphur colour* (almost white) *in the morning, changing to a beautiful rose towards evening. Pod* 3-5-*celled*, oval (scarcely at all ovate), when 3-celled about 2·2 × 1·5 inches. 4-celled 1·9 × 1·5 inches, 5-celled 1·9 × 1·6 inches. Seeds, 8 or 9 in each cell, *densely clad with white or greyish fuzz.*

* Mr. Stirling grows at Amotape a kind of cotton, of which the seeds were procured from the valley of Zama, in South Peru. It is scarcely distinguishable from the Piura, and yields at least an equally good cotton.

The contents of a 5-celled capsule weighed 153 *grs.—viz.,* 44 *seeds,* 102 *grs.; cotton* 51 *grs.; or* $33\frac{1}{3}$ *per cent. of gross weight.*

Obs.—This kind is readily distinguished by its humbler size, its small flat grey-green leaves, cloven only about halfway into 3 (very rarely 5) lobes, its nearly white flowers, by its pods being very frequently 5-celled, and then much rounder than in any of the other varieties, and by the densely fuzzy seeds. When the leading shoot is broken off, the branches spread horizontally, and the lowest, when laden with ripe pods, often trail on the ground and even bury the pods therein, which would be a great disadvantage in a rainy country; but in this dry region only a little loose dust gets into the cotton when the capsules burst, and it is got rid of in the ginning.

Of all the cottons which have been tried in the valley of the Chira, this has proved by far the best adapted to the climate and soil, and is apparently much less susceptible to blight, or *heladas*. It is a small plant and so takes up but little room, and it ripens its first crop in less than five months; yet each plant gives as much cotton as any other kind at the same age. Mr. Garland had an experimental plot made of it, of about two acres, close by his house, where its progress could easily be watched. The rows were made only 6 feet apart, and the seeds put in at the same or even a less distance. Having been sown on the 14th of March, the first pods were ripe at the end of July, or in $4\frac{1}{2}$ months, but the whole crop was not gathered in until the end of November, when it produced 12 quintals of clean cotton, or 600 lbs. to the acre. Scarcely another month had elapsed when an after crop came on, which was picked during my stay at Monte Abierto in December and January, and would yield, perhaps, a couple of quintals. By the end of January the bushes had again become covered with flowers and young pods, and it was calculated the next harvest might be about April. When that was gathered in, it was proposed to stub up every alternate plant, so as to give more room for the remainder; for being planted so close their branches had soon begun to interlock. It was doubtful whether it would answer to cultivate this cotton as a perennial, for the pods that were coming on seemed punier than those of the first crop, although more numerous, so that their produce would probably be rather inferior in quality if not in quantity, and succeeding crops might be expected to go on deteriorating. But if, by resowing every year, two crops could be obtained, yielding together from 1,000 to 1,500 lbs. per acre, its cultivation would be amply remunerative. Experience will soon decide whether it is more profitable to cultivate it as an annual, a biennial, or a perennial.

It takes 150 well-formed pods of the Egyptian cotton to yield a pound of clean cotton, which is very white and strong, but of rather short staple.

4. *Algodon de Georgia* (Georgia Cotton). Raised from seeds brought from the United States.

DESCR.—Rather low and bushy. *Ramuli* and *petioles* nearly naked, smooth (*not tuberculate*). Leaves 6·2 × 5·8 inches, *greyish-green, nearly flat*, naked above save a few scattered hairs on veins, beneath stellato-puberulous, 3—5-*cleft to a little beyond the middle*, segments ovate, sub-abruptly and sharply accuminate. *Involucral leaves* green, 2 2 × 1·85 inches, shorter than the sulphur-coloured petals, laciniated all round, *bearing a red gland at base. Calyx-lobes shortly triangular, mostly with rounded sinuses. Pods* ovate 3-4 (very rarely 5-) celled. *Seeds* 7 or 8 in a cell, *densely clad with green* (rarely brown) *fuzz.*

Contents of a 4-celled capsule 110½ *grs—viz.*, 29 *seeds*, 73½ *grs.; cotton* 37 *grs.*, or 33½ *per cent. of gross weight.*

OBS. — Grows taller than the preceding, but has much the same aspect, and the leaves, though larger, are flattish and shortly lobed as in the Egyptian. The cotton is long and silky, scarcely inferior to Sea Island, in this respect surpassing the Egyptian, but far inferior in the amount of yield. The crop is rather precarious, and it is rare to find a perfect capsule, the cotton being generally injured or imperfectly developed in one or more of the cells.

5. *Algodon de Imbabura* (Imbabura Cotton). The produce of seeds brought from the Andes of Ecuador.

DESCR.— *Whole plant clad with short soft pubescence. Ramuli* very long, sometimes twelve inches to the first leaf. *Leaves* 7 × 9·5 inches, 3-5-cleft down to ¾, segments ovato-lanceolate subacuminate, *keeled* or subplicate *on the ribs*, stoutish, puberulous above, tomentellous and *hoary* beneath. *Involucral leaves* 2·5 × 2 inches, deeply laciniate nearly all round the margin, bearing a broad basal gland. *Calyx-lobes* very short, obtuse. *Petals sulphur-yellow, much exceeding involucre* (twice as long as the latter without the laciniæ). *Pod*, narrow, ovate, or oval, *with a short* acumen or *beak*, 2·6 × 1·4 inches (beak 3 to 4 inches) *protruding beyond the involucre. Seeds* about 8 in each cell, *clad with greenish-grey fuzz.*

Contents of a 3-*celled capsule* 83 *grs.—viz.*, 23 *seeds* 51 *grs.; cotton* 32 *grs., or about* 38½ *per cent. of gross weight.*

OBS.—This is the common cotton of the Equatorial Andes, where I have seen it cultivated in sheltered spots up to 8,000 feet. Humboldt, and after him Boussingault, seem to have met with it at a still greater elevation. It is most extensively grown in temperate valleys of the Province of Imbabura, between Quito and Pasto. I take it to be the *Gossypium tomentosum*, H.B.K., a name which well expresses its difference from the ordinary forms of *G. barbadense*, to which species I refer it as a variety, for the other characters are very slight, and even the tomentosity is a common accident to plants which climb the hills from the plains. A patch of Imbabura cotton is readily distinguished from other kinds growing near it by the hoary appearance of the tall well-grown plants, and by its showing its clear sulphur flowers and long beaked pods farther beyond the involucres than any other kind. No cotton plants on Mr. Garland's farm looked handsomer in the month of January, when they were well hung with pods just beginning to open and show the fine white cotton, which has the good property of puffing up into a light mass on exposure to the air, as it does in the Georgia and Egyptian, whereas in many kinds it is apt to remain hard or knotty, so as to be intractable to the gin.

Although the Imbabura ripens its first pods two months earlier than the Piura cotton, it seems afterwards to fall into the same custom of half-yearly crops. The same is plainly the case with all the other kinds, except perhaps the Egyptian, which has not yet shown it distinctly.

The cotton most cultivated around Guayaquil, and known there as *Criollo*, or Creole, seems a small seeded variety of the Imbabura.

6. *Algodon de Nueva-Orleans* (New Orleans Cotton).

Descr.—*Petiole* smooth, nearly naked. *Leaves* 5·5 × 8 inches, full green, nearly naked above, pubescent beneath, 3-5-cleft *to below* $\frac{3}{4}$; *laciniæ narrow*, ovato-lanceolate subacuminate acute, *keeled, with very gibbous sinuses. Involucral leaves* laciniated not quite all around; *laciniæ comparatively short*, sometimes divaricating; *gland obsolete. Calyx* slightly indented. *Capsule* about 1·9 × 1·2 inches when 3-celled, 1·8 × 1·3 inches when 4-celled, narrow ovato-oval with a very short acute acumen. *Seeds* 7 in each cell, *naked except a little greenish fuzz at the base.*

Contents of a 4-*celled capsule* 78½ *grs.; cotton* 28 *grs., or* 35⅔ *per cent. of gross weight.*

Obs.—This has much the habit of the Piura cotton-tree, but is more laxly branched, and the lobes of the leaves are narrower and more strongly keeled, in which characters it contrasts strongly with the Egyptian and Georgia cottons. The cotton is of a very good quality, but there is so little of it in proportion to the space occupied by the plants, that a plot of New Orleans does not produce half as much cotton as one of Egyptian.

7. *Algodon de seda ó de Sea Island* (Silk or Sea Island Cotton).

Descr.—*Petiole* subpapillose upwards. *Leaves* 5·8 × 8 inches, 3-(rarely 5-) cleft *scarcely to* $\frac{3}{4}$; segments ovato-lanceolate subabruptly acuminate, keeled, with gibbous sinuses, subglabrous above, subpuberulous beneath. *Involucral leaves* 2·6 × 2·15 inches, laciniate from a little above base; *laciniæ comparatively short and broad*, glabrous. *Calyx* shortly lobed. *Pod* 1·8 × 1·1 inches, ovate subacuminate, 3-4-celled. Seeds 5 to 7 in each cell, *black*, remaining *quite naked* after the cotton is removed.

Contents of a 3-*celled capsule* 50½ *grs.; viz.,* 19 *seeds,* 37½ *grs.; cotton* 13 *grs., or* 26 *per cent. of gross weight.*

(8. There is a *variety* of Sea Island, which has *fuzzy seeds*, but is otherwise totally undistinguishable. *A* 4-*celled capsule contained* 70½ *grs.; whereof the* 20 *seeds weighed* 50 *grs., and the cotton* 20½ *grs., or* 28½ *per cent. of gross weight.*)

Obs.—Notwithstanding the extraordinary length and fineness of the staple of this cotton, the plant is plainly a degenerated form of the New Orleans, with the pods still smaller, fewer, and more capricious in their ripening. Mr. Garland had a small plot of ground devoted to it, and although the plants seemed to thrive perfectly, the yield was so small that at four times the price it would not have paid so well as the Egyptian cotton.

9. *Algodon Riñon* (Kidney Cotton).

Descr.—A spreading tree or shrub. *Petioles* nearly smooth. *Leaves* 6 × 9 inches, full green, *thin, flat, or very slightly rugose,* smooth above, with a few scattered hairs on veins beneath, *cloven only half-way; segments, broadly ovate,* with a short very acute acumen. *Involucral leaves, very large,* 3·3 × 2·2 inches, *pale yellow-green,* with a reddish or colourless basal gland, laciniated only in upper half, the terminal lacinia equalling or surpassing the sulphur-coloured corolla. Pod, 2 × 1·4 inches, broadly ovate, tapering to a short acute point, 3-celled; valves spreading horizontally, and bearing each a short compact gore of cotton and seeds. *Seeds,* 7 or 8 in each cell or gore, where they are *firmly agglutinated in two ranks into a kidney-shaped mass* (whence the name), *nearly naked* or with a little fuzz adhering.

Contents of a 3-celled capsule 93½ *grs.; viz.,* 23 *seeds,* 58 *grs.; cotton* 35½ *grs. or* 38 *per cent. of gross weight.*

Obs.—This is easily recognised among other sorts by the largish flat leaves with broad short lobes, by the large pale involucres which are conspicuous from a distance, and by the concrete seeds; characters so striking and constant as to warrant us in keeping it a distinct species from all the foregoing. It is the *Gossypium Peruvianum* of Linnæus (or at least of modern authors); how it got that appellation is to me a mystery, for although it is found cultivated in small quantity in many parts of South America, it is nowhere, not even in Peru, the common cotton of the Indians. I must, however, confess that I have perhaps nowhere seen a cotton plant truly wild. In ravines running down to the sea at Chanduy and St. Elena, there are a few stunted cotton bushes, which are leafless great part of the year, or sometimes for years together; but although they look wild enough, they have been derived from seeds of plants which the Indians grow near their houses in the adjacent villages, and render productive by constant watering. The cottons grown by the Indians of the Amazon valley are varieties of *G. barbadense,* and so are those of the Andine valleys, where there is no tradition of the plant having been introduced; and yet a truly wild specimen is nowhere to be met with.

The *Riñon* yields a very fine silky cotton, of a fair length, but the crop is considered uncertain. In the middle of January the bushes looked beautiful at Monte Abierto, round and spreading, and laden with pods, of which I counted 400 on one plant. This was the first crop, on plants nearly a year old, and the pods earliest to ripen were excellent;

but I learnt afterwards that many of the succeeding ones had been destroyed by blight.

I subjoin a tabular view of the weight of the contents of an average pod of each of the kinds of cotton grown at Monte Abierto :

Kind of Cotton.	Weight.	
	Cotton.	Seeds.
	grs.	grs.
Ica	60	65
Piura	54	75
Egyptian	51	102
Georgia	37	73½
Riñon	35½	58
Imbabura	32	51
New Orleans	28	50½
Sea Island { woolly seeded . . .	20½	50
Sea Island { smooth seeded . . .	13	37½

I regret being unable to give the most important element for estimating the value of different kinds of cotton, viz., *the annual yield on a given area*, for the materials to determine it were still incomplete. It seemed that, on a very moderate estimate, the average produce of all the kinds might be safely reckoned at 1,000 lbs. per acre per annum, and that, under favourable circumstances, it might surpass double that amount; but some time must yet elapse before that estimate can be tested.

As I have already stated, there had, strictly speaking, never been any *cultivation* of cotton in North Peru—nothing beyond sowing the seed and gathering in the crop. The methods now in use at Monte Abierto, and in Mr. Stirling's plantation of Santa Lucia, near Amotape, are still scarcely more than experiments awaiting the sanction of results, so that I shall need to say very little about them beyond the hints already given. The cotton-plant can be cultivated in almost any warm climate, moist or dry, but every modification of climate and soil seems to necessitate a peculiar treatment, only to be decided upon after experience of many varied trials. "Cotton Planters' Guides," detailing the methods pursued by the most able cultivators in the Southern States of North America, have proved very fallible guides on the Chira, so very distinct are the conditions of growth of the cotton-plant in the two regions. The valley of the Chira is, in some respects, a miniature Egypt; but there is no periodical wide-spreading inundation of its little Nile, leaving a thick deposit of fertilising alluvium.

The method of sowing at Monte Abierto is to dibble the seeds, dropping from three to six into each hole. In three or four days the seeds germinate, and if more than one plant spring up from a hole, the less vigorous have to be weeded away. This seems to answer better than sowing the seeds in beds and transplanting the seedlings, for the cotton-plant never thrives well if the point of its long slender tap-root gets broken off.

As to the width between the rows and between the plants in each row, all distances from 6 to 18 feet have been tried. The Egyptian cotton-plants above spoken of as standing only 6 feet apart, had, at the end of nine months, completely covered the ground, which was thus kept constantly cool and moist—an obvious advantage in the hot weather, but with the drawback of the ends of the branches getting continually broken or trampled upon by the irrigators and cotton-pickers. On another plot of the same kind of cotton, where the plants stood farther asunder, kidney beans were sown between them, and ripened their fruit and were cleared away before they interfered with the extension of the cotton-plants. The Indians sometimes alternate maize with cotton, but that draws up the plants too much. In general, to cultivate the plant as a perennial, plenty of room must be allotted to it, either from the first sowing or by thinning out the alternate plants when they begin to encumber each other; and it is scarcely necessary to add, that the leading shoots require to be nipped off when a few feet high, to make the plants spread laterally, and to keep them from growing beyond the reach of the cotton pickers.

As irrigation is everything to the cotton-plant at Monte Abierto, various methods of applying it have been tried, and what has been found to answer best is, a canal or furrow along each side of the ridge whereon the cotton is planted. By turning the water into the furrows, a sufficient amount of moisture reaches the roots of the plants, which is hardly the case when there is but one furrow to each ridge, or ridges and furrows alternate, unless the rows or ridges be so near together as to leave no room for the plants to spread. Planting in the furrow itself, or even in a hole on one side of the furrow, has not turned out well; for, when the base of the stem of a cotton-plant is frequently wetted, it is apt to waste its vigour in root-suckers, or even sometimes to rot.

As to the amount of water required by each plant, and the frequency with which it should be applied, that is still in the domain of experiment. Young plants seem to be better for a little water every day, but as they grow up less is required, and adult plants thrive perfectly when watered only once a week. Some variety of treatment is evidently needed to meet the varying amount of heat (which extends to a difference of 20° between the hottest and coldest months), and also the stage of maturity which the crop may have reached; and this is what remains to be determined. Between the crops—when it is usual for most plants in the wild state to rest for a certain period of time—it might be advisable to withdraw altogether the stimulus of moisture, even to the extent of allowing the leaves to fall off, for they would soon be renewed when water was readmitted to the roots.

It is presumed that water alone will always supply all the nourishment the plants require, and that, therefore, no manure will be needed. When they reach an age to be no longer productive, it is proposed to uproot them, burn them on the ground, and plough in the ashes. No ploughing between the rows has yet been attempted, and very little weeding has had to be done; so that the trouble and expense of keeping the plantation in order are probably less than in any other part of the world.

We have just seen with what ease cotton may be grown—the seed speedily germinates, in any kind of soil, if it only have moisture—the plant grows rapidly and is easily kept alive—it is even patient of injury so long as it gets sufficient nourishment, and I have seen cotton bushes that seemed to thrive all the more from being broken and trodden upon; and yet to secure a certain and abundant crop of the peculiar product of the plant—the beautiful cotton—no kind of agriculture is more precarious, for there are enemies to be contended against whose attacks no amount of foresight can ward off. Of all these enemies, none is more baneful in Northern Peru than blight, which (as we have seen) the inhabitants persist in calling *heladas* or frosts. For many years past its ravages appear to have been on the increase, and of the two crops produced annually, one at least has been an almost total failure. I was informed by the small holders of land along the vega at Monte Abierto and Tangararà that for a long while back they had invariably lost their Christmas crop from *heladas*. As I witnessed the same effect last Christmas on the Chira, I noted the symptoms, which are as follows:—When the lowest pods on the branchlets were nearly ripe, and the upper ones only half-formed or so, they suddenly began to turn brown at the point, as it is only natural for them to do when perfectly mature. At the same time the upper pedicels, especially where the terminal one still bore only a flower, began to disarticulate, and fell off with a touch, or when shaken by the wind. The larger pods still hung on, but ceased to increase in size, became more embrowned, and after a few days burst open, disclosing the cotton welded together into a hard mass, not to be broken up by the gin, and, in fact, rendered quite useless for the loom. In a very few of the pods that happened to be quite or nearly ripe, the cotton, after a few days' exposure to the atmosphere, puffed up into its normal state, and could then be gather and ginned; but the great bulk of the produce of the plants attacked was entirely wasted. In most cases (but not in all) part of the leaves of those plants turned yellow and fell off; and in short the general aspect of the plants and of their dried-up fruits was precisely the same as I have seen in fruit trees in England suffering from the drought in a summer. I cannot help referring the blight of the cotton-plant to a similar cause, especially when I consider the meteorological conditions that accompanied its appearance. Through the latter part of December there was a rapid increase of heat, and on the 28th the thermometer rose to 85°, having been only

82° the day before. It was on the 31st that I first noticed the discoloured pods at Monte Abierto—elsewhere in the valley I was told they had been observed earlier; but there can be no doubt that the augmented heat and dryness of the atmosphere were, in all cases, the origin of the mischief.

It must be noted here, that all the taller-growing cottons suffered from this infliction, and the Creole or Piura most of all, the crop of it throughout the country being an utter failure. From causes already specified, this kind of cotton seems to have got into a pathological state predisposing it to suffer from blight. The Imbabura and Riñon cottons suffered less than the Piura, but even those were far from escaping entirely. The Egyptian cotton, however, was not the least affected, chiefly, perhaps, from some idiosyncrasy fitting it for enduring with impunity the atmospheric influences which acted so injuriously on the other kinds, but also (I cannot help thinking) from the plants standing so close together as to completely overshade the ground and keep it cool, and from their having been liberally watered at the precise period of the access of heat in December, while plots of some of the other kinds had had no water for full two months. I am not so sure of the influence of the last cause, for a few Piura plants that had no lack of water remained verdant enough, and sent out suckers from the root, and yet the pods turned brown and dried up as in the others that had no water given them. Perhaps moisture supplied to the roots alone did not suffice, and only daily rains could have mollified the effects of the sudden heat. Syringing daily a large cotton plantation seems utterly impracticable, especially as to be beneficial it should be used only in the early morning or evening hours, and yet it seems indicated in this case.

Although I consider that, in the instance just described, the malign influence may clearly be traced to drought, *that* is by no means the only cause of blighted crops. *Garua*, or drizzle, is accused, and not unjustly, of sometimes injuring the plants; and it injures them in this way—when, after a morning's slight garua has just sufficed to sprinkle the leaves, pods, &c., with minute drops, the sun suddenly shines out blazing hot upon them, each drop becomes a lens or burning-glass, and on drying up leaves a discoloured spot in its place. The respiratory organs being thus injured, the whole plant suffers, and is apt to fall into a sickly state, so that it ripens little or no fruit.

An aphis also sometimes attacks the leaves, causing them to swell up here and there in reddish blisters, and of course hindering the development of the flowers and fruits. The same or a similar insect often makes great havoc of the leaves of water-melons and other ground plants, leaving them shrivelled and strewed with a black powder, the animal's excrement. Drought, drizzle, and insects are all laid by the Peruvians to the account of one common plague, *heladas*.

The crop of cotton, especially that which is gathered in the hot season, is often disfigured with unsightly yellow stains caused by a sort of bug ; but they are easily removed by soap and water, leaving the cotton quite uninjured. Some people fancy these bugs to be a chief cause of blight, by clustering on the pods and thus causing them to turn brown, and by inserting their probosces in the sutures, so as to make the valves open prematurely. I do not believe there is any ground for this accusation, for the bug was just as abundant on the Egyptian cotton, which did not suffer at all from blight. It is attracted by a slight moisture of a sweetish mucilaginous nature, which suffuses the inner face of the valves and the outer surface of the cotton ; but it has too weak a proboscis to be able to penetrate the sutures of the pod before they open naturally.*

In the valley of Piura the failing crop has sometimes been that of July to September, instead of that of January to March. Possibly a rapid refrigeration of the atmosphere, such as is sometimes experienced after the great heats of March, may have a deleterious effect on the opening flowers and ripening fruits, equally with such an augmentation of temperature as we have just been taking account of. To counteract that effect some people have lighted fires on the clear cold nights between the rows, with the prunings of the cotton plants and other rubbish, it is said with the desired result.

The cotton-plant has other insect enemies worse than the bug. The seedlings are sometimes destroyed by being cut through underground by the larva of a beetle, which is probably similar to the cutworm of the United States. It is fortunately rare as yet in Peru. *Grillos* (or crickets) nip off the tops of very young plants, apparently for the sake of sucking the juice. They work by night, and the holes one sees in the morning recently scratched in the leaves of adult plants are also probably made by crickets. But the greatest pest of this present year has been a caterpillar, which has multiplied beyond all precedent, the unwonted humidity having evidently favoured its increase. It is generated by a greyish moth of diurnal habits, and of very rapid reproduction. Some caterpillars I kept and fed on cotton leaves came out perfect moths on the eighth day from entering the chrysalis state. Caterpillars caused sad havoc in the months of February and March, completely stripping the leaves from large flats of cotton, and choosing the youngest and tenderest plants first, but ending by feeding on all indiscriminately. It is true the plants were not destroyed thereby ; but one crop would be lost or at least retarded. No remedy has yet been tried against these insects, and no bird seems to feed on them except a

* This bug is known by the name of *el ensartado* or *el arrebeteado ;* because the male and female are nearly always coupled. A similar hemipterous insect infests the cotton on the Amazon, where it is called *Piolho do algodaõ*, or cotton louse. Mr. H. W. Bates informs me that it is a species of *Dysdercus*, of the family *Lygæidæ*.

small vulture called *Huára-huára*, which will sit patiently picking them off for hours together ; but it exists in too small numbers to cause any sensible diminution of the pest.*

Parrots destroy the half-grown pods for the sake of the tender seeds ; but as they feed in flocks, and by day, when the overseers always have their guns ready for them, they have little chance to cause any damage at Monte Abierto. Mice are far greater pests, for they carry off the gores of cotton to pick thereout the ripe seeds. On the steep river bank at Monte Abierto the growth of woody and bushy plants of various kinds is encouraged, to prevent the soil from being washed away ; but the bushes afford shelter to hordes of mice, and it is pitiful to see what a quantity of cotton those little animals will carry thither and waste in a night.

It only remains to speak of the financial results of the cultivation of cotton by irrigation on the Chira, in which I shall be very brief, for the experiments are still too recent to afford positive data. The wages of machinists and handicraftsmen are pretty high there, ranging from 60 dols. to 125 dols. per month (say from 9*l.* to 19*l.* or 20*l.*), but only one of the former and two or three of the latter are required at Monte Abierto. Mayordomos, or overseers, receive something less, Peones, or labourers, gain 5 reals (= 1s. 11d.) per day, but those who have charge of the irrigation are paid as much as 7 reals (= 2s. 8½d.) not including food in either case. Cotton-pickers, who are boys and girls, children of the workmen, receive 1 real (= 4½d.) for every arroba (= 25 lbs.) of seed cotton they pick, and at that rate gain about 9d. per day. I understood from Mr. Garland that his total outlay up to the end of 1863 had been about 80,000 dols., and that his monthly expenses at Monte Abierto (those of his household included) rarely exceded 800 dols. At the end of January, 1864, about 200 acres of land were covered with plants that already yield cotton, and about 100 acres more were being planted, chiefly with Egyptian cotton, and might be expected to begin to yield their first crop about June or July. About 200 quintals (= 20,000 lbs.) of clean cotton had already been ginned and packed for exportation, and the first crop of the taller growing kinds had only just begun to be gathered in. We have seen that these latter had been much damaged by blight, especially the native Piura cotton, but the Riñon and other kinds still bore many healthy pods capable of yielding some thousands of pounds weight of cotton. After the fertilizing rains that had fallen, it was reasonable to expect that the next crop, which comes on after the southern solstice, would be exceedingly abundant. I calculated, therefore, that the total yield of the 300 acres for the year 1864 could not be less than 1,000 quintals, and might reach 3,000 quintals. Deducting the cost of freight to England, and taking the average of the

* Mr. Bates tells me that the cotton-moth is a species of *Graphiphora* (Fam. *Noctuidæ*), very closely allied to *Graphiphora Baja,* a species found in Europe, North America, and Rio Janeiro.

prices that have been obtained there, we may assume that each pound of cotton would leave about two shillings net to the producer, and therefore that the whole quantity would be worth to him from 10,000*l.* to 30,000*l.* (say 65,000 to 195,000 Peruvian dollars). Comparing this with the outlay, we have—

	Dollars.
Interest on 80,000 dols. at 10 per cent. .	8,000
Expenses of working the farm, 800 dols. per month, or per year	9,000
	17,600

If we add to this the rent of the land (which, however, was almost *nil*, for the whole estate of Tangarará, before Monte Abierto was dedicated to cotton growing), and a further sum for unforeseen contingencies, it may bring up our estimate of the annual expenses to 20,000 dols.; and even if we say 30,000 dols., there is still a wide margin left for profit, at the lowest yield of cotton I have supposed possible—namely, 1,000 quintals, of net value 65,000 dols.

Mr. Stirling's plantation near Amotape is of about the same extent as Monte Abierto, and has at this time from 300,000 to 400,000 cotton-bearing plants on it. Besides these two plantations, there are many small plots all along the river, on lands rented by people of colour from the large proprietors; and on the tributaries of the Chira and Piura, at from 1,000 to 2,000 feet elevation, where there is no need of machinery to raise the water for irrigation, several landowners have begun plantations on a considerable scale. All over the country there are spots where the rains of the present year have penetrated sufficiently to assure a crop of cotton from plants raised thereon. On the farms of Mancora there are ravines running down to the sea, and here and there expanding into basin-shaped hollows (like the *Ouads* of Africa), which the rains have watered so well that the owner has sown cotton there, chiefly of the Egyptian kind, to the extent of near a million plants. When I left Peru, on the 1st of May, they were thriving well and promised to yield an abundant harvest. Of course only a single crop could be expected from them, unless they should be revivified by another rainy season, contrary to all past experience that such seasons never occur in consecutive years. If all the projects prosper, the quantity of cotton exported from Payta this year may be very far in excess of that of any previous year; and next year's exportation will probably be still greater.

There has been no lack hitherto of labour, at a fair rate of pay, in the department of Piura; but the actual extent of cotton growing will no doubt tend to make it scarcer and dearer. People of mixed race prefer to work for themselves rather than for a master, and this is most notable where the negro element predominates; the free African in

South America being usually far more energetic and independent than the Indian, and, though less apathetic, inclined to be lazier. Near Guayaquil, where the sambos have generally much more of the African than the Indian in their blood, very great difficulty is often experienced in getting hands to work the farms; and yet the sambo will work zealously on his own account on a plot of ground rented from the white man, although his gains are often far below what he might earn by working for his patron as a day labourer. Nearly the whole of the famed tobacco of the river Daule, which is largely consumed in Ecuador and the neighbouring republics, is grown on small holdings along the vega, rented and cultivated by sambos and mulattos. Cotton also is raised by the same class of men, in small patches, which I understand have been this year much multiplied; although it might be impossible to obtain the hands needed for working any large plantation of either cotton or tobacco. I think that, by a similar plan, much work might be got of the people of colour in our West Indian colonies, if they had only an object to work for. At Guayaquil the sambo is ambitious of being well drest,—no white man puts on a more finely-embroidered or a more spotlessly white shirt than he does on Sundays and holidays, and his straw hat has perhaps cost him an ounce of gold. He likes, too, to see his wife and daughters dressed in gay silks, and decked with gold ornaments. With this taste for luxury, he is content to inhabit a miserable rancho. If he could be brought to feel the need of a neat house and a comfortable home, and of a little more education (of which he is by no means wholly destitute), he would have to exert all his powers to enable him to acquire them, and would rise immensely in the scale of civilisation. As it is, he cannot obtain the luxuries he covets without working to some extent, and his industry—like all industry rightly applied—tends to increase the comforts and luxuries of the whole human race.

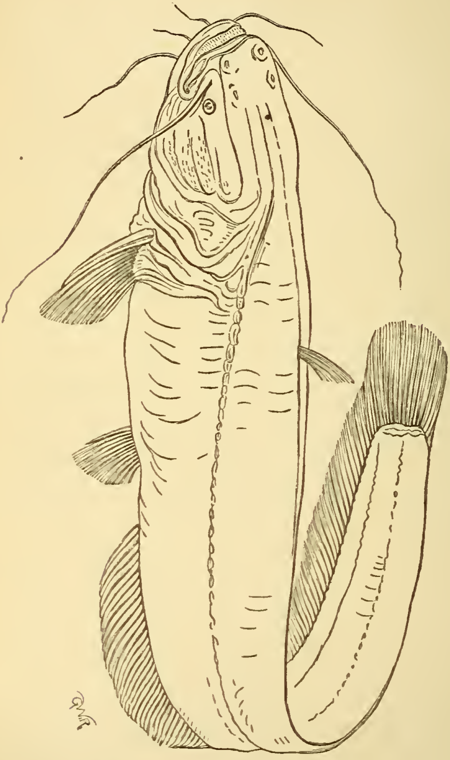
THE EUROPEAN SILURUS.*

BY M. C. COOKE.

A NEW fish has been introduced into our waters from Wallachia. The Acclimatisation Society has received fourteen living specimens from Sir Stephen Lakeman's estate at Kapochein, or rather from the river Argich which flows past that nobleman's Wallachian domain. A brief notice of these visitors may prove acceptable as an adjunct to the portrait which is on the next page. It should be premised that this

* From "Science-Gossip," a new and very interesting publication.

species is noticed in Yarrell's "British Fishes"; not that this author believed it a native, but because it had the reputation of having been found here, on the faith of a paragraph in Sibbald's "*Scotia Illustrata.*" There is no doubt that the conclusion arrived at was a wrong one, not



THE EUROPEAN SILURUS (*Silurus glanis, Boie*).

admitted by Cuvier and Valenciennes in their great work on the "Natural History of Fishes," who state that its distribution in Europe does not extend to the British Isles.

The *Silurus* was originally classed by Cuvier between the pike and salmon families. To the former of these it may be supposed to claim kindred by its voracious habits, and to the latter, if all accounts be true, by the excellence of its flesh as an article of food. Notwithstanding these somewhat poetical affinities, it has another position assigned to it now. One evident characteristic in this fish is the absence of true scales, a feature which characterises the group to which it belongs. Another important difference will be noticed in the great length of the anal fin, which extends to the tail; but, above all, the barbules will attract attention. Whether or not these are to be considered as substitutes for beard and moustaches, probably the *Silurus* finds them equally useful, and regards them as highly ornamental. The two longest barbules have their origin, one on each side just above the angle of the mouth, the four others tend downwards from beneath the lower jaw. This will certainly be the largest of our fresh-water fishes, for Cuvier states that it is sometimes upwards of six feet in length, and is said to weigh three hundred French pounds. In the course of four years, if food is plentiful, it will attain the weight of fifty-six pounds. In appearance it is anything but prepossessing—the large flattened head, broad capacious mouth, and frog-like eyes, may perhaps earn for it the name of frog-fish, which its known partiality to frogs may serve to strengthen.

Mr. Yarrell says, "The *Silurus* is represented as sluggish in its habits, and a slow swimmer, taking its prey by lying in wait for it, in a manner somewhat similar to the angler (*Lophius*); hiding itself in holes or soft mud, and apparently depending upon the accidental approach of fishes and other animals, of which its long and numerous barbules may be at the same time a source of attraction to the victims, and the means of warning to the devourer. From its formidable size, it can have but few enemies in the fresh water, and from them its dark colour, in addition to its habit of secreting itself either in holes or soft mud, would be a sufficient security. In spring the male and female may be seen together, about the middle of the day, near the banks or edges of the water, but soon return to their usual retreats. The ova when deposited are green; and the young are excluded between the sixteenth and nineteenth days. The flesh is white, fat, and agreeable to many persons as food, particularly the part of the fish near the tail; but on account of its being soft, luscious, and difficult to digest, it is not recommended to those who have weak stomachs. In the northern countries of Europe the flesh is preserved by drying, and the fat is used as lard."

The *Silurus* finds its food in the frogs that pass into the rivers, and the small fish that abide there, but it is not very "dainty" in its tastes, if all accounts be true. The authors of the "Natural History of Fishes" state that it is so voracious that "it has been known in several instances to devour children; and in one instance the body of a woman was found in one of these fishes." To this account we can only add, that either the fish must have been "a mighty large one," or the woman uncommonly small. Old Izaak says, "The mighty luce, or pike, is taken to be the tyrant, as the salmon is the king, of fresh waters," but here is a tyrant before whom the pike would be obliged to succumb. Should the *Silurus* take kindly to his new home in the bosom of Father Thames, and increase, multiply, and replenish the waters, we may well inquire, "What would old Izaak Walton say?"

THE CANNEL COAL OF FLINTSHIRE.

UPON more than one occasion we have directed the attention of our readers to the circumstances attendant upon the introduction into commerce of the various liquids now so well known under the name of mineral oils. The manufacture and use of these oils forms an era in commerce, both on account of the effect which has been thereby produced upon certain other branches of trade, and from the magnitude of the transactions that have arisen in connection with the substances themselves. Not more than twelve or thirteen years have elapsed since the mineral oils began to be first known in trade. In 1850, Mr. James Young took the patent which has since been the subject of, perhaps, the most expensive litigation that ever attended the maintenance of patent rights, and between the date of that patent and the present moment the whole commercial history of these oils is comprehended.

As the term "mineral oil" scarcely carries with it an explanation of the character of the liquid to which it is applied, it may be as well to explain that the liquids which bear this application are all extracted either from a variety of petroleum, or bitumen, or from coal; it is more particularly in reference to the latter kind of mineral oil that we propose to offer some brief remarks. The Leeswood cannel coal, of Flintshire, is particularly interesting. At the time when Mr. Young obtained his patent, the question of usefully applying the various liquids produced by the chemical treatment of some natural petroleums was beginning to excite considerable attention. Mr. Young had himself succeeded in utilizing a petroleum in Derbyshire, until, indeed, he finally exhausted the supply; and, both in France and in England, many attempts had been made to turn to profitable account the products of the distillation of the schales of Autun and Dorsetshire. About 1851 or 1852, a fresh impulse was given to this subject by the importation of the Burmese or Rangoon petroleum, which, although it had been known from the earliest times, and had been seen and chemically examined in Europe, had never before then been introduced in any commercial quantity; and the discovery of the now noted mineral, known as the Boghead cannel coal, near Bathgate, in Scotland, added another very important element to the question, both on account of its yielding a larger quantity of oily products than any other coal or schale then known, and because there is reason to believe that similar oils had never been before obtained in quantity by the distillation of coal. The Boghead coal and the Rangoon petroleum constituted the first great staples from which commercial mineral oils were produced in England, and before the introduction of the American petroleum, within a comparatively late period, they were, indeed, the great sources of supply, the manufacture of the Boghead coal being principally, if not entirely, in the hands of James Young and Co., in Scotland, and that of the Rangoon petroleum in those of the house of Sir Charles Price and Co., of London. For many years the Boghead coal was the only substance of the kind from which oils of the desired quality could be extracted. True, the patent of Mr. Young was prohibitory to much enterprise in this direction ; but the known great value of this mineral and the profit attending its manufacture, had excited attention, and many kinds of coal schale had been made the subject of experiment without much success, when, in 1858, a new variety of cannel coal was discovered at Leeswood Green, in Flintshire, only a few miles distant from Mold.

The Flintshire coal-field appears to have been worked from a remote period, as both tradition and documentary evidence prove that coals were raised from it as far back as the reign of Edward the Third ; but the extent of the coal-field is limited, as it is estimated to possess not more than about 60,000 acres of area. The coal-seams are comparatively near the surface of the ground, that of the main coal, which is the principal, and also the deepest worked before the discovery of the cannel coal, not being more than 125 yards below the surface. Indeed, before this discovery it was a rare thing for a coal-pit in this district to exceed 150 yards in depth.

The discovery of this valuable cannel coal is a remarkable instance of what some may be disposed to regard as a consequence of a general law, that the productions of Nature always present themselves at the moment when the necessity for them begins to be pressing ; and the manner of the discovery was as singular as it was fortunate.

It seems that the owner or lessee of the Leeswood Green coal-pits, in pursuing some investigations in the old workings, drove a small gallery in a point where there had been a complete dislocation of the coal strata, with a rise or upthrow of twenty-five yards in the strata which had been broken away from those in which the gallery was driven. The consequence of the disruption of the coal-seams was to place in opposition, in the point at which the gallery terminated, a series of strata of a different character, and in the lower of these was distinguished a peculiar kind of schale, which, from its remarkable appearance, led to a further examination ; and, finally, it proved to be the overlaying schale of a series of cannel strata, together making up a seam several feet in thickness, of, perhaps, the most valuable cannel coal ever discovered in

Britain. It is still a question *sub judice,* whether the Boghead coal of Scotland is really a coal or a schale. Courts of law have declared it to be coal, at least commercially, but many eminent scientific men still maintain that it is only a highly-bituminous schale. However this may be, no question of the kind can arise concerning the Leeswood cannel coal, which is in every respect a true cannel, but yielding liquid products when distilled as abundant and as good in quality as those obtained from Boghead cannel. One of the principal characters upon which the advocates of the schale doctrine concerning the Boghead mineral rely, is the peculiar nature of the coke or residue left when the mineral is distilled.

This, like the coke from acknowledged schales, contains a very large percentage of aluminous ash, which renders it totally worthless for fuel ; but the Leeswood cannel coal is free from this defect, and yields, after distillation, a compact coke, which, from one variety of the cannel, is almost unequalled in quality. In 1859-60, this coal was placed in the hands of the late Dr. Fyfe, of Aberdeen, and Mr. Keates, of London, for thorough chemical examination. Lengthened reports were made by these chemists as to the quality of the coal, both as a gas coal and in respect to its oil-producing capabilities ; and these reports were of such a character, that since that period the coal seems to have been gradually more and more highly appreciated.

The principal characteristic of the Leeswood cannel coal is its extreme bituminousness, to coin a word. A small piece, thrown into a fire, immediately ignites, and burns with a bright white flame, throwing off at the same time an abundance of separated carbon, and when distilled at the gas-making temperature, it yields a large quantity of gas of the highest illuminative power. The seam of cannel, altogether about six feet in thickness, is divided into four strata of coal of different qualities, but all valuable as oil-yielding coals. There are—above, a kind of coal-schale, highly bituminous, and yielding, when distilled at a low temperature, from thirty-two to thirty-five gallons of crude oil per ton ; below that, what is called the smooth cannel, yielding forty to forty-five gallons of crude oil per ton ; and a coke of very peculiar and valuable quality, resembling the charcoal from a very hard wood. Next in the series—what is looked upon as the most valuable of all the strata—the curly coal, so called on account of its remarkable twisted fracture, which yields seventy-five to eighty gallons of oil per ton ; and lastly, what is known as bottom cannel, very similar in character to the smooth cannel above, excepting that the coke is of inferior quality. These four strata make up the entire seam of the cannel, which lies at about two hundred yards below the surface, upon a stratum of good iron-stone, with fire-clay. The discovery of this coal was a fortunate circumstance in relation to the manufacture of these mineral oils. Before this discovery, as we have already stated, the only indigenous substance largely used was the Boghead coal ; and as the contracts for that coal were in few hands, the manufacture of the oils was, irrespective of Young's patent, almost a monopoly. The discovery of the Flintshire cannel has altered all this ; and although the supply of coal is, and probably will remain, limited, it has nevertheless opened the trade, and so far broken down the monopoly, to the advantage of the trade at large, and also of the public, who are the consumers.

The mineral oils which are obtained, both from the Boghead coal and the Flintshire cannel, are of the kind known as paraffin oils, and differ entirely in their chemical constitution from the oils which are produced by the distillation of common bituminous coal, or coal tar. Their leading feature is, that they contain the peculiar crystalline substance called paraffin, now employed for sperm in candle-making, with which they are identical in composition, although different from it in physical structure. The manufacture of these oils is now a great established branch of industry, employing large capital and a great amount of business energy.

The discovery of the liquid petroleum of North America had at one time apparently placed the trade in the hands of the Americans ; but extended experience has shown that the oils can be produced at a cheaper rate from our own coals, provided a supply of the latter, of the proper quality, can be obtained. This problem the discovery of the Flintshire cannel has favourably solved so far, and there can be little doubt that the commercial enterprise which it has directed into the district will succeed in keeping us independent of foreign supplies to that extent which is necessary to the maintenance of the trade in a state of wholesome freedom from the trammels which a close market never fails to impose.

GOLD AND ITS ALLOYS.

The following particulars on the subject of gold, with special reference to the trade in that metal, are supplied for popular information.

Pure or fine gold is distinguished by its rich yellow colour, in connexion with a high degree of softness and malleability; it is heavier than any substance in nature except platina, gold being 19·4, and after hammering or pressure 19·6, heavier than water, whereas platina is 21·5.

An alloy of silver renders it pale and greenish, and a small proportion of that metal is sufficient to produce the effect in a remarkable degree, hence the paleness of gold found in California and New South Wales. Copper on the other hand deepens the colour, and by an alloy of copper and silver together, a colour approximating to that of pure gold may be retained ; both these metals, however, confer a great degree of hardness, the absence of which, together with the weight, will readily distinguish the pure metal from the alloy. Such an alloy is scarcely affected by aquafortis unless below 14 carats. An alloy of lead, even in minute proportion, say 1-2000th, causes gold to be brittle; it has repeatedly occurred that the accidental mixture of two or three shots in a parcel of gold dust has rendered it, when melted down and cast into an ingot, incapable of being stamped without cracking. Some other metals, as bismuth, antimony, &c., in a less degree produce a similar effect.

The crude gold of Victoria, though remarkably pure compared with the produce of other countries, contains more or less silver. This metal, together with a variable mixture of iron, stone, quartz, clay, and other earthy matter, and in the case of the Ovens gold, tin ore, are the usual impurities of our crude gold.

In the operation of melting down, which is performed in crucibles or melting-pots of the best quality that can be procured, with the aid of fluxes, such as borax, soda, nitre, &c., all the earthy impurities, and in part also the *base* metals, are separated.

The ingot or bar of gold, which still retains the silver, resulting from this operation will, of course, be less in actual weight than the crude gold before melting; but as the real waste of precious metal, when the process is skilfully conducted, is trifling and unimportant, the difference is referable to the separation of impurities only, and the improvement in quality and value is proportioned to the diminution in quality.

In the process of assaying, accurately weighed samples, usually 12 grains each, are taken from the different parts of the bar or ingot; these are submitted to two operations.

First—Cupellation or melting with lead, by which all the *base** metals are separated.

Secondly—Parting by nitric acid, by which the silver is removed, leaving nothing but pure gold. [The details of these operations are described in technical works on assaying.]

The weight of the pure gold remaining after these operations being accurately ascertained decides the fineness of the sample, but the correctness of the assay is confirmed by the results of two or more distinct assayers corresponding to within about 1-32nd of a carat, or 1-768th of the whole weight of the sample.

There are several ways in which the degree of fineness or purity of gold is expressed in commerce.

1st. Fine gold is said to be 24 carats fine, and every carat is divided into 32 parts. Thus, gold combined with an equal quantity of alloy would be 12 carats fine. British standard gold, as used for coinage, is

* Gold, silver, platina, and some other rare metals, have been distinguished as *noble*, and copper, iron, and other metals, as *base*. In this instance, the term *noble* is synonymous with fireproof.

22 carats fine, *i.e.*, it contains 22 parts of pure gold combined with 2 parts of alloy, which is either copper or copper and silver.

2ndly. The division of the carat into 32 parts is expressed by dividing each carat into 4 (carat) grains, and each grain into eights, and then reporting any particular sample as B (better) or W (worse) than standard, by the number of carats, grains, and quarters which it may contain more or less than standard, or gold of 22 carats fine—thus, an alloy of 641 parts of gold with 127 parts of silver would be W 1 car. $3\frac{7}{8}$ grs., and pure gold would be B 2 car. 0 grs.

3rdly. The decimal system of expression has recently been exclusively adopted at the Bank of England, and their assays are reported accordingly. Fine gold being taken as 1000·0, an alloy containing half gold and half copper would be 500·0, and standard gold will of course be 916·6, &c., or 22-24ths of 1000·0.

The London price of standard gold is fixed by law at 3*l.* 17*s.* $10\frac{1}{2}$*d.* per ounce; fine gold is consequently worth 4*l.* 4*s.* 11-45*d.* per ounce.

French coin contains one-tenth of alloy.

Nuggets, especially those of large size, often contain in their interior a large unknown quantity of earthy matter, and their value cannot be ascertained until after they have been melted down and assayed; but a very rough approximation may be obtained on the following principle:—Supposing, for example, the specific gravity of gold of the quality contained in the nugget to be estimated as 19·0, and the earthy ingredient to consist of quartz and clay of which the specific gravity is 2·4; the specific gravity of the nugget itself, ascertained by experiment to be 10·7, and its actual weight 21·4 ounces. Then by the arithmetical rule of alligation

$$19 - 10{\cdot}7 = 8{\cdot}3 \times 2{\cdot}4 = 19{\cdot}92$$
$$19 - 2{\cdot}4 = 16{\cdot}6 \times 10{\cdot}7 = 177{\cdot}62$$

Then as 177·62 : 21·4 : : 19·92 : 2·4 the weight of quartz, &c.

ON THE RAVAGES OF ANTS.

BY THE REV. M. J. BERKELEY.

WE have just received the first report of the Committee of Inquiry on the Ravages of the White Ant in St. Helena, instituted by the present Governor, Sir Charles Elliott. We have little experience in this country of the destructive powers of ants, though they prove occasionally a source of considerable annoyance in houses where they are difficult to extirpate. It is mostly in our woods that we see what powers of destruction they have when once they attack a tree, which they soon reduce to the appearance of a coarse honeycomb. In one or two localities, however, on the coast of France, a very small species has proved extremely destructive to wooden structures, so much so as to cause very serious apprehensions; and *Myrmica domestica*, an exotic species accidentally introduced, has occasionally taken possession of houses at Paris.

In James Town, St. Helena, the white ant has prevailed to an extent seldom heard of in countries abounding with that scourge. It appears to have been introduced into the island about twenty years ago, but it is only within the last ten years that its ravages have increased to such an extent as to make some attempt at extirpation a matter of necessity. Churches, schools, offices, and dwelling-houses of both rich and poor have been equally attacked. Goods in warehouses of various kinds are destroyed continually. The Customs' House is invaded—wine casks are destroyed; the corks of wine, beer, and spirit bottles eaten out; books, clothing, and furniture in dwelling-houses are nowhere safe, and the loss to the inhabitants of the island is of an immense amount, and the expense continually incurred is enormous.

Under such circumstances it was obvious that full inquiry ought to be made as to the most probable means of prevention, and the kinds of wood most likely to escape. For this purpose information was obtained from various quarters by the standing committee, and amongst others Sir W. J. Hooker sent specimens of various woods most likely to resist the plague. All the softer woods, as might be expected, more or less rapidly fell a sacrifice; or if, from some accidental or unknown circumstance, some particular piece had escaped for years, when removed to another situation it was quickly destroyed. Teak seems less subject to attack than other woods, and in the course of the experiments Myrtaceæ seem in general to have resisted better than woods belonging to other natural orders, though some, as the Blue Gum (*Eucalyptus globulus*), perished. A few hard Brazilian woods also escaped, together with some other kinds, as *Mammea*, *Hymenæa Courbaril*, and *Cedrela odorata*. In some cases, where specimens were not attacked at first, they did not endure a longer trial.

It was hoped that the processes which have been adopted with a view to prevent dry rot, as those of Sir W. Burnett, Jackson, Kyan, &c., might either prove destructive to the insects from the large quantity of poisonous metallic salts with which the wood was impregnated, or, at least, be distasteful; but in general complete impregnation proved no less inefficacious than partial coating. Sulphate of copper, chloride of zinc, sugar of lead, arsenic, corrosive sublimate, carbolic acid, and creosote, all in turn proved useless, and in some cases the destruction was total. Mr. Langton's charring process was not more successful. One of the most hopeful appears to be a process suggested by Lieut.-Colonel Baker, late Garrison Engineer at Lahore, which consisted of rosin and earth oil rubbed into charred wood while hot. Col. Baker recommended also, but less successfully, sulphate of copper, in the proportion of a pound to 8 gallons of water. Deal and ash, which are peculiarly subject to attack, escaped completely when treated according to the first process, but the solution of sulphate of copper, though at first apparently hopeful, failed.

The hard woods which seem the most capable of resistance are in general expensive. The great point is to find something which will render the softer woods, such as deal or pitch pine, safe ; and it is to be hoped that some modification of Col. Baker's process, in which the wood may be impregnated after Boucherie's method, combined with external charring, will prove a perfect remedy. Metallic salts seem useless, and resinous matters with petroleum and its allies, on the contrary, afford the best hope of protection, though all have occasionally failed.

KASHMIR SHAWLS FROM THE EAST AND IMITATIONS THEREOF.

Such is the importance of this beautiful fabric, and of its valuable trade, that a sketch of its origin and of its rapid European development may well precede remarks upon its present position.

The source from which the article has sprung is well known to be the ancient and beautiful fabric of the Valley of Kashmir, where the excellence of the raw material stands, to this day, unequalled, although its manufacture has been, and is still, carefully prosecuted in many parts of the world. The great beauty of the Eastern tissue, considering the rudeness of the means of machinery employed as compared with those which are now available to the European manufacturer, is a marvel in the eyes of the most experienced.

The superiority of the woollen fabrics of Kashmir is to be found recorded in many ancient Eastern works. In the Mahábhárath, where narrating the transactions taking place at the palace of Gundeshthira, then eldest of the Panda princes, about the period of 200 years before Christ, it is stated (vol. ii., p. 140) "that the people of Kaneboja (the northern districts surrounding Kashmir) brought cloths and skins as a tribute." The former were made cf wool and embroidered with gold, being, in fact, shawls and brocades.

Again, in the Ayeen Akberry (vol. i., p. 105), being the institutes of the Emperor Jitaleddeen Mohamed Akbur, sixth in descent from Timur (Tamerlane the Great), proclaimed Emperor in 1556, we find the following interesting account of shawls :—

"His Majesty has ordered four kinds of shawls to be made.

"1st. Toos affee (grey affee), which is the wool of an animal of this name, whose natural colour, in general, is grey, inclining to red, though some are perfectly white; and these shawls are incomparable for lightness, warmth, and softness. Formerly they were made of the wool in its natural state, but his Majesty has had some of them dyed, and it is surprising that they will not take a red colour.

"2nd. Sufed alcheh (white alcha), which they also call 'terehdar.' The natural colours of the wool are white or black, and they weave three sorts—white, black, and grey. Formerly there were not above three or four different colours for shawls, but his Majesty has made them of various hues.

"3rd. Zerdozee (gold-leaved) and others, which are of his Majesty's inventions.

"4th. From being short pieces, he had them made long enough for jamehs (gown-pieces). The shawls are classed according to the day, month, year, price, colour, and weight; and this manner of classing is called 'missel.' The mushrifs, after examination, mark the quality of each upon paper affixed to its corner. All those brought into the palace on the day Ormuzd of the month Ferirdin (10th of March) are preferred to those received afterwards of the same fineness, weight, and colour; and each is written down in order.

"Formerly shawls were but rarely brought from Kashmir, and those who had them used to wear them over the shoulders in four folds (*vide* ancient sculptures), so that they lasted for a long time.

"His Majesty has introduced the custom of wearing two shawls, one under the other, which is a considerable addition to their beauty. By the attention of his Majesty, the manufacture in Kashmir is in a very flourishing state, and in Lahore there are upwards of a thousand manufactories of this commodity. They also make an imitation of shawl with the warp of silk and the woof of wool, and this kind is called *mayar.* Of both kinds are made turbans, &c."

With this account before us, it is reasonable to suppose that varieties of every kind were introduced about this period; and the widest encouragement given to these improvements doubtless tended much to the progress of this trade, while these shawls continued to be a favourite article of dress during the Mahommedan dynasties in particular.

After their decline it is probable that the troubled state of Upper India, and the general turbulence of the mountain character, had its effect in retarding the progress of a trade involving the labour of so many hands; but its absolute necessity as an article of wearing apparel to every well-dressed native of India, Persia, and parts of Turkey, effectually prevented the manufacture from falling into decay, even at the worst of times. It was once said that there were upwards of 30,000 looms at work, but Strachey, who visited the country in 1809, gives 16,000 as the number at that time. The value of the whole produce was estimated at 35 lacs of rupees (350,000*l.*), but Moorcroft, who was there in 1822-23, says it had declined to half that sum. A renewed vigour has been instilled into it within the last forty years by the constantly increasing demands of the European markets, and the present improved state of government, of social rights, and intercourse in that part of India will, of course, add greatly to the energies of persevering and painstaking peole, and will most probably give early proof that its resources have never been fully developed.

Umritsur and Lahore are already showing rapid progress in this trade, and there is no reason why their productions should not equal in all respects those of Kashmir; while the demand for Europe is actively promoted by European agents residing there, for the express purpose of encouraging perfection in design, colour, and texture.

To India we are still indebted for the supply of novelty of design, and a new combination of colourings. It is the great head from which springs an important industry. It will be seen by the annexed statements that the trade in Kashmir shawls is very extensive; for the quantity imported and sold at half-yearly sales from 1851 to 1861 was :—

1851 . .	6,700	shawls,	value	£94,700
1852 . .	8,138	,,	,,	113,000
1853 . .	7,666	,,	,,	104,000
1854 . .	5,698	,,	,,	106,500
1855 . .	8,095	,,	,,	173,900
1856 . .	10,979	,,	,,	250,600
1857 . .	8,418	,,	,,	147,900
1858 . .	10,420	,,	,,	247,600
1859 . .	10,532	,,	,,	217,500
1860 . .	14,222	,,	,,	264,586
1861 . .	14,394	,,	,,	222,360

independently of a large number of cases imported by merchants, and which are not put up for sale.

The Valley of Kashmir and its surrounding mountains is the seat of an important branch of industry, which is the principal occupation of a persevering and painstaking people. Here the finest shawls are made. Many of those shown in 1862 deserve particular notice for artistic design, perfection of colouring, and high art weaving.

Umritsur and Loodiana contributed collections which show progress, but more caution should be observed by the manufacturers in the selection of their yarns. They should be warned also to mix neither wool from common sheep, nor Kirmanee Thibet, nor, as they sometimes do, country lambs' wool, with the "pushum," as we find in all the square long striped and jamavars, which are manufactured in those cities. We make these remarks in the hope that the manufacturers may continue in their progress, and turn their attention to the fact which makes the mountain shawl retain former, if not higher prices, and, when perfect and free from imperfection, always command extreme prices. This is owing to the excellence of its raw material, the tissue being unequal for its beauty and softness.

The value of the Kashmir shawls exported from India to all parts was as follows, for the years specified :—

1851 . . .	£171,709	1857 . . .	£290,640
1852 . . .	146.270	1858 . . .	227,618
1853 . . .	215,659	1859 . . .	310,027
1854 . . .	170,153	1860 . . .	252,828
1855 . . .	197,890	1861 . . .	351,093
1856 . . .	209,279		

This is now by far the most important manufacture in the Punjab; but thirty years ago it was almost entirely confined to Kashmir. At the period alluded to a terrible famine visited Kashmir, and in consequence numbers of the shawl-weavers emigrated to the Punjab, and settled in Umritsur, Nurpur, Dinangar, Tilaknath, Jelalpur, and Loodiana, in all of which places the manufacture continues to flourish. The best shawls, of Punjab manufacture, are manufactured at Umritsur, which is also an emporium of the shawl trade. But none of the shawls made in the Punjab can compete with the best shawls made in Kashmir itself —first, because the Punjab manufacturers are unable to obtain the finest species of wool; and secondly, by reason of the inferiority of the dyeing, the excellence of which, in Kashmir, is attributed to some chemical peculiarity in the water there. On receipt of the raw "pushum," or shawl wool, the first operation is that of cleansing it. This is done generally by women. The best kind is cleaned with lime and water, but ordinarily the wool is cleaned by being shaken up with flour. The next operation is that of separating the hairs from the pushum; this is a tedious operation, and the value of the cloth subsequently manufactured varies with the amount of care bestowed upon it. The wool thus cleaned and sorted is spun into a thread with the common "churka" or native spinning machine. This is also an operation requiring great care.

White pushumeea thread of the finest quality will sometimes cost as much as 2*l.* 10*s.* a pound. The thread is next dyed, and is then ready for the loom.

The shawls are divided into two classes:—

1. Woven shawls, called "Teliwalah."
2. Worked shawls.

Shawls of the former class are woven into separate pieces, which are, when required, sewn together with such precision, that the sewing is imperceptible. These are the most highly prized of the two. In worked shawls the pattern is worked with the needle upon a piece of plain pushumeea, or shawl-cloth.

A woven shawl, made at Kashmir, of the best materials, and weighing seven pounds, will cost there as much as 300*l.* Of this amount, the cost of the materials, including thread, is 30*l.*; the wages of labour, 100*l.*; miscellaneous expenses, 50*l.*; duty, 70*l.*

Besides shawls, various other articles of dress, such as chogas, or outer robes, ladies' opera cloaks, smoking caps, gloves, &c., are made of pushumeea.

Latterly, great complaints have been made by European firms, of the adulteration of the texture of Kashmir shawls ; and there is no doubt that such adulteration is practised, especially by mixing up Kirmanee wool with real pushum. In order to provide some guarantee against this, it has been proposed that a guild, or company of respectable traders, should be formed, who should be empowered to affix on all genuine shawls a trade-mark, which should be a guarantee to the public that the material of the shawl is genuine pushum, especially as the Indian penal code provides a punishment for those who counterfeit or falsify trade-marks, or knowingly sell goods marked with counterfeit or false trade-marks.

At Delhi, shawls are made up of pushumeea, worked with silk, and embroidered with gold lace. A very delicate shawl is made of the wool of a sheep found in the neighbourhood of Ladak and Kulu. The best wool is procurable in a village near Rampur, on the Sutlej ; hence the fabric is called "Rampur chudder." Other woollen manufactures in the Punjab are Peshawur Chogas, made of the wool of the Damba sheep and of camel's hair, and chogas made of patti, or the hair of the Kabul goat.

In 1802 a commencement was made in Paris ; and it is related that the enormous expense of 60,000 francs, expended in setting the loom prepared for the purpose, induced the immortal Jacquard to invent his wonderful process of working intricate designs with facility. In 1819 great success had been reached upon looms à la Tire, with Kashmir wool imported for the purpose, and spun with great skill in France. Not earlier, however, than 1834 was the present process called "épouline," which is the exact imitation of the Kashmirean, so introduced for working intricate designs, that one man, with a Jacquard loom, can produce the excellence now obtained in Paris. In fact, we find the true Indian shawl there produced, but perfected by this addition of machinery, and sold at about a quarter of the cost in India, their range of prices being, for squares of full size, 25 to 600 francs, and for long shawls of full size, 50 to 1,500 francs.

In 1851, 4,000,000 francs was given as about the value of the total production of these fabrics in France. Besides real Kashmir shawls sold there to the extent of about seven or eight million francs, France has continued in its endeavour to accomplish the production of shawls made on the principle of those of India. Great changes have taken place by the French manufacturers adopting the many improvements in weaving in the last ten years. Those who formerly made only a superior shawl now also make a medium quality, while there are many instances of those who formerly made the medium style having attempted the superior with success. The consumption has therefore increased, and the public receive the benefit of this competition. France has eighty-seven shawl manufacturers, many of them very extensive producers.

Shawls made by Harness or Jacquard Looms.—In this branch of industry no country has made so great progress in the last ten years as the United Kingdom. Shawls are truly high art weaving, and our Scotch manufacturers, one and all, show a marked improvement, which, if continued, must rival the Paris productions. The late Exhibition proved that in some instances their prices are the same, if not less than the French or Austrian manufacturers. It would be desirable (to avoid apparent sameness) if each country could form its own school ; each might derive his style of design from the "Indian," for it possesses a continuance of novelties both in colouring and new type of patterns.

Shawl industry gives extensive labour to many classes ; the greatest improvements in the Jacquards are, however, due to the shawl manufacturers. In the production of a shawl a great variety of labour is requisite, each stage requiring different operatives. There is the process of washing, carding, spinning, bundling, carting, singeing, cropping, clipping, picking, pressing, and weaving ; the preparation of the web for staining, and the beaming and entering the web, and winding the pirns, all are separate departments. In designing also, there is the same division of labour, such as needling, cutting, and lacing the cards. It is the same in dyeing, a process which usually takes upwards of a day and a half, some colours requiring even a longer time.

The manufacture of shawls is throughout very intricate. The warp contains a very fine thread of silk twisted with a thread of wool, wool alone being insufficient to bear the strain upon it in the working. The warp is stained according to the pattern and the colour of the centre. When the fringe is variegated and the dyer dyes red, all the rest of the web is enclosed and tightly clasped, so that the red dye may not reach it; the small part to be dyed being left loosely hanging from the machine, and it is thus dipped into the dyeing vat.

In giving these details, the purpose is to explain the extensive labour attending the production of a woven shawl. More than twenty manufacturers are engaged in shawl weaving in the United Kingdom. The weaving of the cheapest shawl takes about half a day, while one of a first-class production, as manufactured by Messrs. Kerr, Scott, and Kilner—a square—will occupy a clever weaver four weeks, and a long shawl double this period. The prices of weaving vary from one-third to three-fourths the value of its cost.

The value of the shawl production in Scotland cannot so easily be ascertained ; but it is very large, though the shawls are chiefly of a cheaper description, ranging from 7*s.* 6*d.* to 5*l.* per square, and 1*l.* to 15*l.* for long shawls.

We have dwelt somewhat at length upon the productions of France and England, because of the greater development of the manufactures in these countries, where it had been first introduced, but of late years, Austria, the States of the Zollverein, and Belgium have been setting their looms upon similar productions ; and with such excellent material at command, and such ingenious and industrious artizans, they may soon vie with any of their predecessors in the trade.

Austria has followed progress by adopting every improvement, and the manufacturers are maintaining their just reputation for judicious selections of wool yarn. There are eighty-nine manufacturers in Vienna ; six of the largest of them have their own finishing departments, and there are eight establishments for finishing only. Other nations have devoted their industry to the production of woollen fancy and tartan shawls, but the three countries of France, Austria, and Great Britain are the chief producers.

There is a peculiarity in the character of a real Kashmir shawl, as well in originality of design as in solidity and durability, which, notwithstanding the enormous difference of cost, will retain its value in the eyes of those who can afford to pay it. The finer description cannot be purchased in the Valley under 300 to 1,500 rupees for squares and 450 to 2,000 rupees for long.

MATERIA MEDICA OF BAGHDAD AND THE PUNJAB.

BY M. C. COOKE.

In further illustration of my communication (vol. iv., p. 537), "On the Vegetable Materia Medica sold in the Bazaars of Baghdad," I am glad to be enabled to add some very valuable notes, which I have since received, in a communication from J. L. Stewart, Esq., Officiating Conservator of Forests at Lahore. "The study of native Indian drugs, as drugs, is an unprofitable one, but I have been led to pay some attention to them for years past in connection with botanising, my own pursuit. My observations have been confined to the North-west Provinces and Punjab, and so far as regards locality my notes only refer to them.

Abhul.—*Juniperus communis* is common in parts of the Himalayas, and the *Abhul* or *Huber* of our bazaars is probably its fruit.

Anisun is always applied only to *Pimpinella*, in India.

Asarun.—Every bazaar specimen examined is the root of *Valeriana*, of which several species are common in the Himalayas.

Ashbeh, sometimes translated sarsaparilla, is *very* rare in our bazaars ; supposed by some to be a *Smilax.*

Asl-es-sus.—*Glycyrrhiza* extract is brought from the West. The liquorice root is generally, I believe, that of *Abrus precatorius*, a common wild plant in the North-west Provinces and Bengal.

Babunej.—Our *Babuna* is generally *Matricaria suaveolens*, common in gardens, but several wild species are also used.

Barbin.—*Baklut-ul-hukima*, probably *Portulaca oleracea*, common in waste parts of gardens, &c.

Hanzal.—Our colocynths and colocynthoids are in confusion. *C. colocynthis* is, I believe, found wild in India. There are several names for these ; *Hanzal* is the Arabic.

Jauz-el-Kagy.—"Vomit-nut," generally *Kuchila* in India.

Jentiana.—*Pakhan-bed* of Northern India. It has been variously identified. This season I was able to determine, part at least of what is sold, as the rhizome of *Saxifraga ligulata.*

Kasab-el-Felus.—*Kharnub nubb* is *Ceratonia siliqua* pods and *Kharnub* alone, galls of *Prosopis spicigera* in these parts.

Kotuniya.—I doubt *Plantago psyllium* here. Several species grow wild in the Himalayas and plains, and probably seeds of several are used besides the cultivated *Plantago Ispaghula.*

Ofsentin.—*Afsuntin* is almost always *Artemisia Indica* here. This is the commonest species in most parts.

Rabb-ruind.—*Rab-i-rewand* and *Usari-rewand* are the same and applied to gamboge.

Sinbel et Tib.—*Sumbul* merely means "flower," and *Sumbul-ul-tib* (literally "medicinal flower") is always applied to *Valeriana* (Nardostachys) *Jatamansi.* The unidentified *Sumbul* is not known here.

Sulinjan.—*Kholinjan* with us. The kernels of *Trapa* would probably be too easily detected here, [I have certainly picked them out of a sample of *Sulinjan*, received from Upper India through Bombay, possessing the unmistakeable triangular shape, but must confess the fraud to be a gross one.—M. C. C.] and *Baklat-ul-maberik* = *Portulaca quadrifida* occasionally wild.

Bezr-al-benj is henbane, *not* hemlock seed.

Bezr Hindeba.—*Cichorium intybus*, cultivated for medicinal seeds, and wild in Upper Punjab, generally called *Kasni.*

Bezr Khetmi.—*Khatmi* is *Althæa rosea.*

Bezr-el-Khujar.—*Khujar* in India is applied to the cucumbers of which *Cucumis sativus* and *utilissimus* are cultivated, and their seeds used medicinally.

Bezr-el-Rihan.—*Rihan* and *Tulsi* and *Faranj mushk* are all applied to the various species of *Ocymum*, and apparently without much discrimination. The seeds are medicinal.

Bezr-safarjal.—*Hubusufirjul* is merely the word for "seed" prefixed to the name of the quince.

Bodyan Khatai.—In India this name is always applied to the star-anise, and *Badian* alone to fennel.

Dam-al-akhuwayn, or *Khunisiawashan*, is dragon's blood.

Eklib-el-malek.—*Aklil-ul-malik* ("King's crown") is certainly not rosemary (*Aklil-ul-jibbal* even is disputed), but the fruit of an *Astragalus* (*A. hamosus ?*).

Franje mushk (see *Bezr-el-rihan*).—Doubtless applied to several *Labiatæ*. *Nepeta agrestis* occasionally sold for this.

Gheznaij.—*Kushniz* is coriander. Our only carraway is *Carum* (*gracile?*), of which I have recently collected fresh specimens in Kunawar and in the bazaars, called *Zirah sujah*, "black cummin."

Werd Benefsheh.—*Banafsha* is a favourite remedy in India, the plant of a *Viola*, probably, generally, *Viola serpens*, which is common in the Himalayas.

Zafaran, or more generally *Kisar*, in India is mostly used as a condiment, I believe. Supplied from Kashmir, in one part of which it is largely cultivated.

By the aid of the foregoing notes, corrections and additions may be made to the list of Baghdad Materia Medica already referred to, and the latter applied also to the North-western Provinces of India. Undoubtedly, there is an almost entire identity between the Materia Medica of the bazaars of Baghdad and those of Lahore, and other parts of Northern India. There are still some interesting points to be settled, to which a botanist in favourable circumstances for acquiring the information would do well to apply himself. I may name two, which at this moment occur to me. What is the botanical source of the Punjab *Saleb misree?* and, Is Red Behen root the produce of *Salvia hæmatodes*, as has recently been affirmed?

ON THE FORESTS OF SEQUOIA (*WELLINGTONIA GIGANTEA*) OF CALIFORNIA.

BY PROFESSOR W. H. BREWER,*

STATE GEOLOGICAL SURVEY OF CALIFORNIA.

An interesting discovery this year (1864) has been made of the existence of the big trees in great abundance on the western flanks of the Sierra Nevada, in about latitude 36° or 37°. They are very abundant along a belt, at 5,000 to 7,000 feet altitude, for a distance of more than twenty-five miles, sometimes in groves, at others scattered through the forests in great numbers. You can have no idea of the grandeur they impart to the scenery when at times a hundred trees are in sight at once, 15 feet in diameter, their rich foliage contrasting so finely with their bright cinnamon-coloured bark. I found trees larger than they occur further north (in the Calaveras and Maipura groves). The largest tree I saw was 106 feet in circumference, at four feet from the ground. It had lost some buttresses by fire; it must have been at least 115 feet or

* In a letter to Sir W. J. Hooker.

120 feet when entire; it is 276 feet high. The Indians tell of a much larger tree, which I did not see.

There seems no danger of the speedy extinction of the species, as it is now known in quite a number of localities; and, contrary to the popular notion, there are immense numbers of younger trees of all sizes, from the seedling up to the largest. There has been much nonsense and error published regarding them.

I have no doubt of the true generic relations. I think that no one who is familiar with both species *in situ* would separate them generically from the *Sequoia sempervirens*, also abundant in this State, and fully as restricted in its distribution; nor do I think the names of *Wellingtonia* and *Washingtonia* would be insisted on with such zeal, were it not for seed-dealers and plant-collectors. I may remark that the seed-collectors on this coast have created endless confusion by naming species, more for profit than from any honest conviction that they were new species.

I enclose a photograph, by Watkins, of the "Grizzly Giant," the largest tree in the "Maipura Grove" of Sequoias. It is a very characteristic tree, and is about eighty-seven feet in circumference, at three feet from the ground. During the past summer some five photographs have been taken of the "Calaveras" big trees, the first-discovered grove.

OIL FOR WATCHES.*

BY DAVID MEEK.

It is quite superfluous to say that it is of the greatest importance that the oil used in a watch should be good. The disadvantages attending the use of bad oil are so many and so great, that after once the watchmaker has experienced them, they leave an impression on his mind which is quite indelible. What, then, characterises good watch-oil? Good oil does not dry up readily. Although this is not so serious a matter to the watchmaker as the oil getting gummy, it is nevertheless more serious for the watch: in the former case, the watchmaker feels the disadvantage; in the latter, the watch is the chief sufferer. Another property of good oil is, that it remains in the countersinks. Some oils seem to be of such a searching nature, that they are found to spread considerably after being applied to the watch. This generally happens with very thin oils; and although it is not a serious evil, seeing it does not entirely leave the pivot, still there are disadvantages connected with it which render the oil that remains in the sink to be preferred. Some

* Abstract of a paper read before the Edinburgh Horological Society, Jan. 11, 1864.

consider that oil, to be good, must always retain the same colour after being applied to the watch; probably, more judge by this than any other thing. If it is found to turn green after ten or twelve months, it is considered as bad. Now, in some cases, it may be a sign of badness, but in others it is quite fallacious ; for although it will be found that the thick, gummy oil is always green, it will also be found that oil which becomes green does not always get into a thick state, but may keep quite liquid.

In all my experiments with oils, I have never yet got one which will remain on a piece of brass for a year without becoming green ; and knowing that the colour of the oil cannot have the least effect on the going of a watch, I have given up considering the changing of colour as a sign of badness. Oil to be good should not freeze too readily. If an oil get thick before the thermometer reaches freezing-point, I consider it congests too easily, but if at that degree of cold it retains its fluidity, it is all that is needed ; for, although during winter the cold is often below freezing-point, a watch movement being not only kept within a case, but having also various other shelters, will seldom or ever be surrounded with air so cold as 32 deg.

The requisite conditions of good oil are then—first, that it does not get into a gummy state when applied to the watch ; second, that it does not dry up ; third, that it does not spread over the plate ; fourth, that it does not freeze too readily.

The next question is, What are the best tests for ascertaining good oil ? Some will say, "Apply it to a watch, and try it." This, no doubt, is a very good plan, but it involves a considerable amount of attention ; it cannot be decided in a week or a month, unless it be notoriously bad It is too serious a matter to term this a wise plan for ascertaining the quality of an oil. There seems to be considerable difference of opinion amongst watchmakers as to the best test for oils. Some test it by its colour ; if it is clear, it gains their confidence. Others, again, prefer it with colour. Some like it thick, others very thin. Some taste it ; others smell it; while some try it by taste, smell, and colour. Others, again, who find that their oil does not freeze in snow consider it perfect. Such are the various tests which are employed by watchmakers to ascertain whether oil is good or bad.

Having experimented for many years with watch-oils, I consider the best and safest plan to test the quality is to take several pieces of brass ; make small countersinks in each piece, put a little oil into each sink ; then place the pieces of brass away where they will be free from dust ; and if at the end of twelve months the oil remains fluid, it may be used with all safety. This may seem a very tiresome way of testing oil, but I know of no other sufficient to attain the object ; a shorter time will not suffice. I have found some oils keep very well for eight or nine months, and after that period they rapidly become thick and bad. It will be found that oil keeps better on a gilt watch-plate than on a piece of ungilt brass; the difference, however, is not so great after all, and it is erring on the safe side to use ungilt brass when testing oil.

The next thing to consider is, Where may we obtain good oil? This is a very important question, and one easier asked than answered. The animal, vegetable, and mineral kingdoms have all in their turn been explored by the various oil manufacturers; and while some give the preference to vegetable oils, others again prefer those which are obtained from the animal kingdom. Amongst watchmakers I have found the following oils most generally used—1st, olive oil; 2nd, nut oil, from Barcelona, almond, and hazel nuts; 3rd, neat's foot oil; 4th, fish oil. In endeavouring to obtain a good watch-oil, I have tried all these. I first turned my attention to olive oil, but after a year or two's experimenting, I gave it up, not because I consider it impossible to get a good oil from it, but from the difficulty of obtaining the oil in this country. A French watch-oil manufacturer, in a book lately published, states, that after experimenting for many years upon various kinds of oils, he has come to the conclusion that the olive is the best from which to obtain a good oil for watches. He states that it is only a certain kind of olive from which the good oil is obtained, that the berry must be plucked at a certain stage of ripeness, and then only the virgin oil extracted from it. I have little doubt but that the French manufacturer will obtain good oil from olives on complying with the foregoing conditions, but to us, who must first take the oil in its adulterated state, it is a difficult matter to manufacture good watch-oil from it. Having been advised by several watchmakers to try nut oil, I next turned my attention to it. Amongst the various kinds tried were walnuts, brazil, hazel, and almond nuts. The best oil was obtained from the hazel nut, and the worst from the walnut. I found hazel oil to keep liquid on a piece of brass for ten months, and on a gilt plate rather longer; it is certainly the best of all nut oils, but still is not up to the mark, as I shall afterwards explain. Having failed to obtain a good vegetable oil, my attention was next directed to animal oil. I first tried neat's-foot oil. Having put it through the various processes necessary for purifying it, I put a little of it on brass; after lying past for a year, I found it in a far better condition than any vegetable oil I had tried. My next experiment was with fish oils. Of these I have found none to equal sperm oil. I have kept it lying for three years on a piece of brass, and it is as fluid as when first placed there; it has, however, the fault of spreading. As this oil seemed to possess the chief property of a good watch-oil in a much greater degree than any other, I endeavoured to prevent it spreading when applied to a watch by mixing it with a small portion of beeswax.

The proposed remedy, however, was worse than the disease. I then mixed with it a little of the neat's-foot oil, which I found to answer the purpose very well; and for some years I have used this oil upon watches, and find it the best oil I have ever employed. Its colour and smell will not recommend it to those who judge by these tests ; but, as I before stated, neither of these objections will affect the watch, and possibly both could be removed by some process, with which I am unacquainted, without destroying its good properties. I therefore give the preference to animal oil, for from it I obtain a really excellent watch-oil. I have not arrived at that conclusion from any preconceived notions of its superiority, but from the results arising from my various experiments. My great objection to nut oils, and more especially to hazel oil, is their tendency to cause rust. Nut oils have a good look, a nice smell, and a fine taste ; bury them in snow, and they will come out as liquid as when put in ; use them on watches, and at the end of twelve months they are either getting thick or very red in colour, thus indicating an early stopping of the watch.

The methods of preparing watch-oil are numerous and diversified ; what the best mode is I am not prepared to say. For filtration, I pass the oil through either blotting-paper or charcoal. To remove the acid, some use lead filings, others carbonate of soda mixed with distilled water. The fatty matter is generally taken out by freezing and again filtering to purify it ; some boil it in water, some in alcohol. In endeavouring to procure a good watch-oil, I have given up all hopes of being able to make an oil to please every watchmaker. This is impossible, owing to the grounds on which they base their judgments. Oil may be rendered bad by other causes entirely independent of anything connected with the oil ; as, for instance, there are certain kinds of brass which will destroy the quality of good oil. Cedar-wood, if used for any part of a clock-case, will cause every oil applied to the movement to thicken in a few months.

ON THE USE OF COCA LEAVES.

BY DR. ABL, OF ZARA *

The Novara expedition enables me to speak of one of the most proved narcotic substances, well qualified to become to soldiers and sailors as faithful a companion as tobacco is now.

It is the coca, the leaves of different varieties of *Erythroxylon coca*, Lam., a shrub which is cultivated to a great extent in South America, especially in Brazil, Bolivia, Peru, Ecuador, Venezuela, New Granada, Guiana, as well as in the East and West Indies. These leaves have rather a good taste, and several very distinguished travellers, as Pöppig (see Sir William Hooker's "Journal of Botany"), Weddell, Von Martius,

* From an article on Troops' Beverages, in the "Austrian Military Journal.' Translated by E. Goeze.

&c., have pronounced very favourably as to the effect of chewing them. It has been proved that they show in flavour as well as in taste some analogy to the inferior kinds of tea. At the same time, they are somewhat bitter-aromatic, not inconsiderably exciting the secretion of saliva.

But Von Tschudi and Dr. Scherzer give the most remarkable accounts of the stimulating effects of the coca.

The former informs us that, during his stay in Peru, he employed an Indian in some very fatiguing digging, for five days and five nights, and that this man did not partake of any food during the whole time, and rested even only two hours in the night; but he constantly chewed coca leaves, consuming an ounce in every two or three hours. After the work was done, the same individual accompanied Von Tschudi during a ride of twenty-three leguas (sixty-three English miles) over elevated plains, keeping pace with his mule, and taking only a short rest for his "Chacchar" (coca-chewing). After all these hardships, he was quite willing to go through them again, without eating anything, provided he had plenty of coca.

A similar case is reported by Dr. Scherzer (who accompanied the Novara expedition), where an Indian accomplished a journey of 83 leguas (243 English miles), from La Paz to Tama, in four days. After resting for one day, he set out for his return, on which he was obliged to pass a mountain of 13,000 feet in height. He actually returned on the fifth day, and during the whole journey there and back he had only taken a little roasted maize and plenty of coca. Those who once take to coca-chewing can scarcely abstain from it, and in this respect coca shows even a greater power on human habit than tobacco does.

After all the observations lately made, a moderate use of coca does not appear to be injurious to health, and Von Tschudi even feels inclined to think the contrary. He supports his opinion by showing that many Indians attain a very great age without losing any of their mental faculties. If a moderate use were really injurious, an age of 130 years, which is often met with amongst the Indians of Peru, would seem to contradict it.

Von Tschudi was, I think, the first to assert the fact, and Dr. Scherzer, only a few years since, also tried to show that the importation of coca leaves to Europe would very likely be accompanied with favourable results. Both propose to apply them where human strength is subjected to extraordinary hardships. Coca, in the hands of cautious captains, will very probably put a stop to the much more disgusting habit of chewing tobacco, and would certainly diminish the number of those who, after shipwreck, perish from want of food.

Coca would prove equally useful in war, as there can be but little doubt that the unhappy results of a lost battle must very often be attributed to the exhaustion of the soldiers after a great many privations, and in not being properly provided with food.

Although the above-mentioned remarkable effects of coca have at least been partially known in Europe for some time, it cannot be said that even a superficial chemical examination of these leaves has been made. This may be attributed to the fact that the coca, notwithstanding the immense consumption in its native country, has but very seldom been brought to Europe. A few travellers brought away small samples, to give away afterwards as curiosities for museums, &c.

Dr. Scherzer, during the circumnavigation of the Novara, bought a good quantity of coca leaves in Lima, which were in a perfect condition, and after his return to Europe he sent them to Mr. Wöhler, Professor of Chemistry in Göttingen. This gentleman trusted his assistant, Dr. A. Niemann, with the chemical analysis, referring to its qualitative and quantitative nature ; and to the careful examination of the latter, we are indebted for the cocaine, a new organic base in the coca leaves (analogous to caffeine, the operative principle in coffee, to theine, the theobromine, &c.).

ON THE COMPOSITION AND NUTRITIVE VALUE OF PALM-NUT KERNEL MEAL AND CAKE.

BY DR. AUGUSTUS VOELCKER.

THIS, comparatively speaking, new feeding-material is the residue obtained on submitting to strong pressure the oleaginous kernels of the palm-nut. These kernels are incased in a thick brown shell of woody matter, and this is surrounded by a deep orange-coloured pulp, from which the palm-oil of commerce is produced by gentle pressure.

The bulk of palm-nut kernels, which is nearly white, is covered by a thin brownish layer of woody fibre, and in consequence of which palm-nut meal has a light brown or dirt-coloured appearance.

The size of these kernels varies from that of a hazel-nut to that of a small pigeon-egg ; they are very hard, nearly inodorous, rather insipid to the taste, and very rich in fatty matters, possessing the consistency of butter and useful property of not readily burning rancid. The extraction of the fatty matters necessitates the reduction of the kernels into a tolerably fine powder, and the application of powerful crushing machinery and gentle heat. Notwithstanding these means, the cake or meal left in the presses contains usually a larger proportion of fat than is found in linseed, rape, and most other kinds of oil-cakes.

I first became acquainted with this meal in the spring of 1861, when a sample was sent to me for analysis by Messrs. Alexander Smith and Co., Kent-street Oil Mills, Liverpool.

The analysis furnished the following results :—

Moisture	7·49
Fatty matters	26·57
* Albuminous compounds (flesh-forming matters)	15·75
Starch, mucilage, sugar, and digestible fibre .	37·89
Woody fibre (cellulose)	8·40
Mineral matters (ash)	3·90
	100·00
* Containing nitrogen . . .	2·52

It appears from these results,—

1. That this meal is very rich in ready-made fat. In the best linseed-cake the percentage of oil rarely amounts to 12 per cent., and 10 per cent. may be taken as a fair average. The palm-kernel meal analysed by me thus contained more than twice as much fatty matter, and theoretically is much superior to oil-cakes, as a direct supplier of fat.

2. The proportion of flesh-forming (nitrogenous) matters is fully as large as in the best barley meal, but much less than in linseed, rape, or cotton-cake; nor is it equal to that found in peas, lentils, and other leguminous seeds.

3. The amount of indigestible woody fibre is but small.

4. It contains about as much mineral matter as cereal grains, and thus is not particularly noted for bone-producing qualities.

From these remarks, it may be gathered that palm-nut kernel meal is not so well adapted for the rearing of young stock as for fattening animals, and that it surpasses almost all other articles of food in its theoretical value as a fat producer. The proximate composition of articles of food unquestionably affords useful indications of their properties, but such indications are insufficient to determine with certainty the real nutritive value of food. Analysis may point out the existence of a large amount of oil or fat in a substance, but it does not decide whether these matters, as in the castor-oil beans or croton seeds, possess medicinal properties, or whether, like linseed or rape oil, they are available in the animal economy for the production of fat. On these and other points that readily suggest themselves to feeders of stock desirous of using a hitherto untried food, practical experience has to be appealed to for a final decision. Fully impressed with the propriety of submitting palm-nut meal to a sufficient decisive experimental test before giving a definite opinion of its economical value, I procured a supply from Messrs. Smith, which I placed in the hands of Mr. Coleman, the late manager of the farm attached to the Royal Agricultural College, Cirencester. I expected in the course of three or four months to have reported on the result; however, more than a year elapsed before the feeding experiments could be said to have been fairly concluded.

Well-fed animals, liberally supplied with succulent, sweet roots, good linseed cake, hay, and other palatable food, it is well known, do not relish a change, if the substituted food happens to be less palatable than that to which they have been accustomed. Palm-nut meal is certainly not so nice to the taste as linseed cake or Swedes and hay; some difficulty consequently was experienced in inducing animals to eat it; and neither the cowman nor the person in charge of the pigs possessed the requisite patience to give the meal a fair trial, and both declared it to be little better than sawdust. After repeated attempts to overcome the prejudice of the cow- and pig-man, the meal was consigned to the granary, where it remained for nearly ten months. By that time the store of oil-cake was almost consumed, the supply of roots ran short, and the price of all feeding-materials was very high. Under these circumstances, an application for a fresh supply of oil-cake for the use of the sheep was not very favourably received by Mr. Coleman, who gave the shepherd liberty to use the despised palm-nut meal. Probably somewhat stinted in food, the sheep took to the palm-meal at once, and after a few days ate it up greedily, and, what is more, throve upon it remarkably well. All who had seen the sheep before they had received palm-nut meal, and after they were fed upon it for only a short time, were unanimous in attaching a very high value to this meal. The shepherd, indeed, soon learned to prefer it to the best linseed cake, and had the satisfaction of getting the first prize for fat sheep at the Gloucestershire Agricultural Society's show.

The success in the sheep-feed paved the way to a more favourable reception of the palm-nut meal than it received at the outset on the part of our cow-man, who now found that 3 to 4 lbs. a day not only increased the quantity of milk, but likewise greatly enriched its quality. I need hardly say that, in consequence of this favourable experience, large quantities of palm-nut meal were subsequently consumed on the College farm.

By degrees this meal found its way amongst agriculturists, and all who have given it a fair trial speak in the highest terms of its fat- and milk-producing properties.

During the last year a good many samples were sent to me for examination from various parts of the country. The table in the following page shows the composition of six samples of palm-nut kernel meal.

It will be seen that all six samples are very rich in fatty matter, which accounts for the marked effect which the meal has upon the production of a rich milk; moreover, the fatty matter has about the same consistency as butter, and hardly any smell, which probably explains why a good tasting and sufficiently hard butter is produced from the milk of cows fed upon it.

The two first-mentioned samples contained no less than 26½ per cent. and the other four from 20 to 24 per cent. of ready-made fat.

Palm-nut Kernel Meal.

	No. 1	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
Moisture	7·49	6·91	6·69	7·52	7·02	7·21
Fatty matters . . .	26·57	26·50	23·92	22·68	19·95	22·79
* Albuminous compounds (flesh-forming matters)	15·75	14·93	15·25	16·75	17·01	15·56
Mucilage, starch, sugar, and digestible fibre .	37·89	31·20	40·62	32·14	33·76	36·24
Woody fibre (cellulose) .	3·40	16·13	10·40	17·49	18·70	14·90
Mineral matters (ash) .	3·90	4·33	3·12	3·42	3·56	3·30
	100·00	100·00	100·00	100·00	100·00	100·00
* Containing nitrogen .	2·52	2·39	2·44	2·68	2·72	2·49

This is a very large percentage of the most valuable of all food-constituents in an economical point of view. If it be borne in mind that one part of ready-made fat or oil is equivalent to two and a half parts of starch, and that good wheat or barley seldom contains more than 60 to 65 per cent. of heat and analogous heat- and fat-producing constituents, the superiority of palm-meal as a fattening food will clearly be recognised.

Taking 24 per cent. as the average proportion of fat, and multiplying this by 2½, we obtain 60 per cent. as the starch-equivalent for the fat in palm-kernel meal. Add to this, 35 per cent. in round numbers of other heat- and fat-giving matter, such as sugar, gum, mucilage, &c., and we shall get that which is equivalent to 95 per cent. of fat-producers against 65 in wheat or barley.

Neither is this meal deficient in flesh-forming matters; and although, for young growing stock, the admixture in an equal proportion of beans, peas, or other leguminous food rich in nitrogenous matters is advisable for fattening stock, the 15 or 16 per cent. of flesh-forming matter occurring in palm-meal are quite sufficient for carrying on the fattening process successfully.

At the present time, palm-nut meal sells at 6*l.* a ton, in quantities of two tons and upwards, delivered at Liverpool, or at 6*l.* 17*s.* per ton or upwards delivered by rail in London, and is produced in England, as far as I know, only by Messrs. Alexander Smith and Co., Kent Street Oil Mills, Liverpool. Palm-kernels appeared also to be crushed at Hamburg, from whence the residue left in the presses is occasionally imported into England, in the shape of cake and of meal. All the samples of foreign palm-kernel meal and cake which I had occasion to analyse, I found greatly inferior to the Liverpool meal, as will appear from the following analysis, showing the

Composition of Foreign (Hamburg) Palm-nut Cake and Meal.

	Cake.		Meal.	
	No. 1.	No. 2.	No. 1.	No. 2.
Moisture	12·91	8·84	10·77	10·84
Fatty matters	9·48	11·27	13·79	12·49
* Albuminous matters (flesh-forming substances)	18·25	17·93	13·75	14·06
Mucilage, starch, sugar, and digestible fibre	39·16	40·79	42·67	43·56
Woody fibre (cellulose)	16·90	16·85	15·17	15·32
Mineral matters (ash)	3·30	4·32	3·85	3·73
	100·00	100·00	100·00	100·00
* Containing nitrogen	2·92	2·87	2·20	2·25

The chief difference between the English-made and imported samples of palm-nut meal consists in the very much larger proportion of fatty matter that occurs in the former samples.

Foreign palm-nut meal sells at a lower price than English, but will generally be found the dearer of the two, if the quality be duly taken into account. The Hamburg meal has lately been the subject of feeding experiments in Germany, by Professor Stockhard, of Tharandt, who gives a most favourable report of its fattening properties. This distinguished agricultural chemist also speaks highly of it as a food for milch-cows.

The experience of English and Continental feeders thus confirms the opinion which I first expressed on the strength of an analysis with some degree of diffidence, and leaves no doubt of the fact that, in palm-kernel meal, we possess a most valuable and economical addition to the lists of feeding-stuffs.*

11 Salisbury Square, Fleet Street, E.C.

* From the Journal of the Royal Agricultural Society of England.'

TEA CULTIVATION IN INDIA.

Perhaps the most interesting feature of the current history of Bengal is the progress in outlying and hitherto uncultivated tracts of country. Foremost among such tracts are Sylhet, Cachar, and Assam. In Sylhet the progress last year has been great beyond all precedent. The first tea garden was laid out in 1857, but English enterprise did not take root in the province till 1860, when the first of the existing plantations was started. In 1862 more than 1,000 acres were already under cultivation, and in 1863 the number had increased, in round numbers, to 2,500. In 1863 the yield was 31,200 lbs. of tea and 526 maunds of seed, and last year these numbers have suddenly risen to 81,200 lbs. of tea and nearly 1,500 maunds of seed. This increase is made in spite of the greatest scarcity of labour, nearly one-third of the coolies being imported. In this province at least the Government seems satisfied that the coolies have no serious grievance to complain of. The labourers are allowed extra remuneration for doing more than their allotted task, and their average earnings, according to the report, amount to five rupees a month each cooly. The wages of such men in a Bengal district do not exceed seven pice a day, or something less than three rupees, counting six days to the week. Applications for 75,000 acres await disposal by the collector. In Cachar the cultivation is on a larger scale. Some of the plantations have been in operation for seven years, and cultivation is in progress in 110 estates, aggregating more than 250,000 acres. At the end of 1863 the capital expended was close on 40 lacs, producing a return of 418,243 lbs. of tea and 1,019 maunds of seed; but during the past year the yield has more than doubled, and the estimated turn-out is 823,380 lbs. of tea with 2,573 maunds of seed. The difficulty in procuring labour is even greater in Cachar than in Sylhet. In the latter nearly one-third is imported, in the former the proportion is fully three-quarters. In Assam nearly 200,000 acres have been taken up, affording employment to 28,000 labourers, and sending about 300,000*l.* worth of tea to England, besides what is consumed in India. From Darjeeling no precise information appears to have been obtained for the year 1864, but the purchasing of estates is going on rapidly. The out-turn during 1863 was close on 100,000*l.* The Ramgurgh Tea Company have more than doubled their land under cultivation last year in Chota Nagpore; another company is busy in a range of hills to the south-east of Hazareebaugh, and tea-planting in Central India is now a *fait accompli.* The young plantations are said to be vigorous and healthy, and the very large proportion of seed that has germinated proves, more conclusively than any geological report, that the soil is well adapted for tea. Labour is cheap, abundant, and to be found on the spot. Taking this into consideration, Col. Dalton observes that, even if the leaf-producing powers of the plant were only half as great in Central India as in Assam and

Cachar, the profits of plantations would be equally good. In Chittagong, too, the soil is reported well adapted for tea and coffee cultivation. During the past financial year several tea-planters visited the district and applied for grants. Some difficulty is anticipated in making new allotments, "owing to the rather loose and haphazard way in which large tracts of land were, so to speak, given away rent-free for long periods at the settlement of the district." It will be remembered that a sample of Chittagong tea won a medal in the Agricultural Exhibition at Alipore. A small estate has been in cultivation for many years near the Sudder Station, and a considerable number of acres has recently been broken up for the plant in the hill tracts. We find that in one province this portion of British enterprise has trebled itself during the past official year, and in another has doubled itself. The returns of only two tea-growing districts are given in full, but we believe that the same proportion holds good in all. This single branch, tea-planting, has changed the destiny of whole provinces greater in area than England, and turned vast tracts of unhealthy, unprofitable wastes into revenue-paying and life-supporting land. It has belted our North-Eastern frontier with a ring of gardens, and placed an advance guard of Englishmen between the plains and the hill tribes. But this is not all. It has furnished an accessible and profitable vent for the overcrowded population in Bengal proper, and done much to ameliorate the condition of the labouring classes throughout the whole country.—*Calcutta Englishman.*

THE COMB MANUFACTURE.

There are few important industrial operations that are so independent of mechanical contrivances and appliances as the comb manufacture.

The nature of the horn material worked up is such, that, in few of the processes through which it must be put, are the manipulations of a continuously identical character. Consequently, the hand, the eye, and the judgment, with a small number of simple tools, must still produce those beautiful horn specimens of civilization—so useful in common life, so adorning to beauty, and astonishing to all, for accuracy and fineness of finish.

The comb manufacture is pre-eminently conducive to our national wealth, because therein the value of the raw product is greatly multiplied. The skilled labour placed on tortoiseshell increases it in value about 40 per cent., while horn (the generally used product) so favoured advances 200 per cent. This latter, rough, uncouth, unattractive, fresh from the head of its occupant, is split, and heated, bent and planed, triturated and polished, pressed and carved and fretted, till at length it is sent forth into polite society reduced to the most fairy-like proportions, elegant in its surroundings, having a highly polished exterior, a beautiful set of teeth, a graceful bend, and an elastic spring, betokening youth and spirit.

It is the laminatory character of horn that prevents the economical use of mechanical aid to any large extent. The difficulties hitherto insurmountable are an erratic and diversely running grain, the raising up of the fibres after every use of the file, saw, plane, or other cutting instrument, and therefore the necessity for constant removal of *débris* and dust from the product-face, and of continual polishing and guaging. This latter care is needed, because the original start has to be made with a thickness of horn much stouter than is needed for the perfect comb, to allow for the waste of manufacture. In addition, is the requirement of heat in all the processes, and that continually. These and other difficulties have ever prevented the use of what may be termed perfect mechanical appliances in this trade industry, in order to elegant, complete, and rapid production.

Let us first enter the press house. All around on our right and our left lie heaps of horns, with the tips cut off, or divided lengthwise; while the ammoniacal smell of burnt oil is touching up our eyes, palates, and nostrils. On one side of this shed, or out-house, is an ordinary furnace, a sort of Tubal-Cain improvisation; and close by, in front, is a huge hammer, or kind of movable anvil, working between upright iron guides, the hammer or anvil raisable by a pulley. The process thus goes on. The workman in front of the furnace takes one of the tipless horns (after it has been rendered pliable by heat) and with a common [strong ripping knife rips open the horn lengthwise in the direction of the varying grain—in other words, he merely divides the horn by the grain throughout. For to cut across the grain would be objectionable. The split-up horns are then again warmed (in hot water and by fire), are opened out pretty flat, laid between cold iron plates, and pressed quite level by aid of the before-mentioned hammer, a few iron wedges and an oblong iron-bound space sunk in the furnace-floor, in which plates and horn are placed. The above plan is adopted in the case of "non-stained" goods. When the goods are to be stained afterwards (in imitation of tortoiseshell it may be), the heated, ripped-up, and opened out horn (and please to remember that reheating has to be constantly gone through in every stage of the manufacture) is placed between *hot steel* plates, and more highly pressed so as to reduce the horn-plates in thickness, and to destroy the grain of the material. Then, by the aid of other processes, the horn will take the staining requisite in the subsequent operations.

The machine-room may be called the laboratory of a comb works. Blazing fires, revolving lathes, choking dust, and horny abominations and smells of all kinds greet your entrance. Here the horn may be seen in all shapes and progress of development—receiving its direction, contour, polish, or other commands to go on its way rejoicing. The cutting apparatus works like a simple copying machine. Place the horn-plate on the bench beneath, put over the plate a cutter of the shape, size, and outline of any comb you may subsequently require, strike down the press, and the piece is stamped out immediately. Many pieces may, of course, be struck out by one die, and at one operation, the comb-plate being as economically used as possible. More pressing and straightening succeed, then grinding, ready for the "teeth." The mode of operation here depends on the kind of product you are manipulating. For a lady's back or side-comb the "parting-engine" is put in requisition. This is a clever little contrivance, that cuts the teeth as it draws the horn-plate through the machine; working by a top-handle also, like a copying machine. Each forward or backward motion of the handle brings down a tooth-cutter, and by means of a cogged wheel shifts on the bed on which the plate lays one tooth-distance further till all the teeth are cut. Various sized cutters may be used at one machine. The last tooth at each end of the comb or combs is separated by hand, and then you have two perfect combs, the just-cut teeth fitting into and drawing away from each other, as the fingers of each hand, if they be placed the one between the other, for purposes of illustration. The teeth of horse and other combs, and of those finer ones for the dressing-table, are cut by the circular saw. Suppose one or more very fine-toothed saw to be fixed on a rapidly-revolving shaft (lathe fashion) having a frame in front to hold the horn-plate or plates to be toothed (for several in thickness may be done simultaneously, one lot in front of each saw fixed on the one shaft). This frame is centred or pivoted, so that it can be pressed close to, or be moved further from, the saw-edges; and has also a lateral motion, acted on by a ratchet-wheel. Now take, say, a dressing-comb, put on the ratchet-wheel that will produce the number, or width and size of teeth you need (for all such wheels are numbered at so many teeth to the inch, and are made to suit the various sizes and shaped products), turn the handle, press down the horn pieces against the revolving saw, and (the pressure being regulated by the mechanism) the teeth are just cut as you want them—in depth, size, &c.—each backward motion of the frame from the saw sending the frame sideways just the distance needed to determine the width of the teeth: thus this repeated action produces perfect teeth.

When the back of the comb is half-straight and half-curved, or in any other similar form out of the straight line, and the depth of the teeth has therefore to vary in accordance, the pressure of the frame (which holds the horn in process of "toothing") is *in*creased or *de*creased against the saw, and so the cut is made deeper or less deep by causing the frame, in its lateral progress, to be affected (in its proximity to the edge of the circular saw) by a projecting arm, that is raised or depressed by its passage over a curved block or comb-back of the shape of the one in manipulation.

The fretwork in the back combs is all done by hand, the patterns being marked on the products and cut out by a very fine saw, a steady hand, and keen eye. The grooving and indentations on the comb-back are produced by the revolution of edged, grooved, serrated, and feathered wheels, against which the product is pressed to any required depth, exactly as the glasscutter deals with his product. So out come flowers and fruit, leaves put forth their sweet and varied outlines; there are the signs of nobility and loyalty, the Anchor of Hope, the Birds of Paradise, the Scroll of Fame, the Crown of Empire, for lovely women! Thus also are the comb-backs of our dressing products channelled, grooved, roached, and otherwise adorned—the warmed and plastic horn being most obedient to every "good word and work."

There seems scarcely an end to the rasping, planing, smoothing, and polishing, till, in the case of "stained" goods, the products are placed in a solution of weak aquafortis (as it appears, but the practice is a secret), and they are dotted with a red paint-like composition, to be subsequently chemicalised and washed off, when the stains will remain *a la* Tortoiseshell! And so our horn and shell products are introduced to a competitive, struggling world.

Horns, horn-tips, and pieces of horn are extensively used in the manufacture of handles for knives, of spoons, combs, buttons, toys, &c. The value of those imported in 1863 was about 100,000*l.* The buffalo and deer horns come chiefly from India and Ceylon; the ox and other horns from the River Plate, South Africa, Australia, and the Continent. The tortoiseshell imported comes from a great variety of quarters. In 1853, 34,000 lbs. were imported, valued at 14*s.* to 15*s.* the pound.

Colonial Gold Fields.—The quantity of gold exported from New Zealand from 1861 to the end of 1864 was 1,814,026 ounces troy, of the value of 6,250,000*l.*, of which the province of Auckland produced 10,000 ounces; Nelson, 80,000; Marlborough, 30,000; Canterbury, 2,500; Otago, 1,691,526—total, 1,814,026 ounces, or 103 cubic feet of solid gold, which was represented at the New Zealand Exhibition this year by an obelisk of that size. The total yield of the Nova Scotia gold-fields for the year 1864 was 20,022 oz. 13 dwts. 13 gr., against 14,001 oz. 14 dwt. 17 gr. for 1863. A gilded pyramid at the Dublin Exhibition is to show the quantity of gold obtained in Nova Scotia in the last three years—161,000*l.*

THE TECHNOLOGIST.

USEFUL PLANTS OF NEW ZEALAND.

In the Official Catalogue of the New Zealand Industrial Exhibition, opened at Otago, in January last, we find some interesting information on the trees and plants of the Province, from which we make the following extracts. We look forward also with interest to the publication of a series of special reports on the resources of the colony by the most competent men, which will contribute much to our stock of knowledge.

Drimys axillaris.—A very handsome, small tree; whole plant aromatic and stimulant; wood very ornamental in cabinet work. This is the pepper-tree of the colonists. Native name, Horo pito.

Melicytus ramiflorus.—An angular-stemmed, ornamental tree, and nourishing as food for cattle. Native name, Mahol or Hinau-ini.

Pittosporum, sp.—White and black Mapau. The wood of some of the trees of this genus is adapted for wood engraving. They exude a gum resin, which has not been examined.

Plagianthus Botulinas (Ribbon-wood).—The bark, which is thick and fibrous, might be employed in the manufacture of ropes or paper, but no quantity of it could be procured. *Hoheria populnea* and *Pennantia corymbosa* are also called ribbon-wood. The wood of the lace-tree (*Plagianthus Lyallii*) is also fibrous, and both wood and bark might be used for paper-making, if the expense of procuring it were not too great.

Coriaria ruscifolia (the Tutu) is an ornamental shrub with poisonous seeds and leaves, probably on account of their containing an alkaloid similar to strychnine. It has medicinal properties, and has been used in epilepsy with supposed success. The whole plant is very astringent, and might be used for tanning leather. Tannate of quinine prepared from this plant was shown at the New Zealand Exhibition, the plant containing tannic acid in large quantities. The wood, though soft, is beautifully marked in the grain, and might be introduced with effect in light cabinet work.

Sophora grandiflora, Kohwai.—A splendid tree, with laburnum-like flowers. The wood is highly durable, and adapted for cabinet work.

Fuschia excorticáta.—A very crooked, but ornamental tree. The wood might be used as a dye-stuff, if rasped up and boiled in the usual way ; and by using iron as a mordant, various shades of purple may be produced, even to a dense black, that makes good writing ink. Its juice, which is astringent and agreeable, might perhaps yield an extract that would be useful in bowel complaints ; its fruit is pleasant, and forms the favourite food of the wood-pigeon.

Metrosidoros lucida et robusti, Rata.—A very ornamental tree, especially when covered with dark crimson flowers. The timber is very valuable as a cabinet wood, and can be procured in quantity from the West Coast. It is also likely to come into demand for all purposes where durability and strength are required, such as for beams and knees in shipbuilding, bridges, and the like.

Leptospermum ericiodes, Manuka.—A highly ornamental tree, more especially when less than twenty years old. It is largely used at present for fuel and fencing. The old timber, from its dark-coloured markings, might be used with advantage in cabinet work, and its great durability might recommend it for many other purposes.

L. scoparium is sometimes large enough to be called a tree ; the bark is papery. Both these species have very astringent saps ; one has been tested for its strength as a building timber, and found to bear a greater transverse strain than any of the Australian or other New Zealand woods.

Carpoditus serratus, White Mapau.—A very ornamental shrub-tree ; the wood is tough, and might be used in the manufacture of handles of agricultural implements.

Weinmannia sylvicola, Kamai. —An ornamental timber tree, with handsome flowers ; its wood is close-grained and heavy, but rather brittle. It might become useful for building purposes, being very similar to beech and sycamore, and might be used for the same purposes, such as plane-making and other joiner's tools, block-cutting for paper- and calico-printing, besides various kinds of turnery and wood-engraving.

Panax crassifolia, Grass-tree or Lancewood.—The wood is close-grained and tough, and if kept dry might be used in building.

Coprosina lucida.—An ornamental shrub-tree. Wood close-grained and yellow ; might be used in turnery.

Olearia nitidæ has also a close-grained wood with yellow markings, which might be used for cabinet wood. *O. dentata* in the vicinity of Dunedin often attains eighteen inches in diameter, and is also well marked for cabinet work. *O. Forsteri* and *O. avicennifolia* are also suited for the same purpose.

Dracophyllum longifolium is an ornamental shrub-tree, with long grassy leaves. The wood is white, marked with satiny specks, and is adapted for cabinet work. One species in the vicinity of Dunedin attains a diameter of ten to twelve inches.

Myrsine urvillia, Red Mapau.—An ornamental tree, with dark red wood useful for cabinet work. Juices very astringent.

Veronica salicifolia, the New Zealand willow, is used by the Maories as tonic and purgative.

Fagus Menziesii.—The red birch is a lofty timber tree, one of the most valuable in New Zealand, attaining a diameter of two or three feet; yielding boards long enough for any purpose. It is durable, and adapted for cabinet work. It is also well fitted for masts and oars, and perhaps no tree in New Zealand, except the *Dammara* or *Kauri Pine*, can be applied to so many useful purposes. It is the only wood likely to be used for cooper's work in the country excepting the *Fagus Solandri.*

The black birch (*Fagus fusca*) is one of the largest timber trees in New Zealand, often attaining a diameter of twelve feet. Wood clear-grained, splits freely, and may be as generally useful as the last.

Libocedrus Bidwellii, Cedar.—A very ornamental tree; its wood light and clear-grained, but only adapted for inside work, as it is not durable when exposed to the weather.

Fagus Solandri, White Birch.—A large, ornamental, timber tree, attaining a diameter of from three to five feet. Wood white, straight, tough, not durable under exposure, but well adapted for cooper's work.

Podocarpus ferruginea, Matai.—A large, ornamental, and useful timber tree, attaining a diameter of three to four feet. Wood close-grained, hard, reddish, very durable, unequalled for barn or granary floors; useful also in bridges and fencing.

P. spicata, Mira.—A large timber tree; wood white, tough, and durable. These two species are called Black Pine in Otago.

P. Totara.—One of the largest timber trees in New Zealand, attaining a diameter of ten feet. Wood clear-grained and well adapted for carpenter's work, splits freely, and is durable as fencing and shingles.

Dacrydium cupressinum, Red Pine or Rima.—A large timber tree, attaining a diameter of three to four feet. Wood clear-grained, reddish, useful for all building purposes. The wood of old trees is highly ornamental for cabinet work. The sap of these pines is agreeable to drink, and can be manufactured into spruce beer. (See Capt. Cook's 'Voyages.') A varnish is made from the resin of this tree.

Phyllocladus alpinus.—A small, very ornamental tree; the bark is used for dyeing red.

Other Useful Plants.

Rhipogonum scandens.—A climbing shrub, reaching the tops of trees. The stems are used when split for the manufacture of strong baskets. The root has been used in the same manner as sarsaparilla.

Phormium tenax, New Zealand Flax.—Two varieties of this plant exist in Otago—one with dark-red flowers, and triangular, erect capsules, strong, broad, erect leaves; the other with smaller flowers, inside petals greenish, capsules round, four inches by one inch, twisted, drooping leaves, narrower, finer fibre, drooping. Whatever may be the success in the invention of means to prepare the fibre for the manufacturer, it ought to be always borne in mind that the supply of the raw material will be very soon dependent upon cultivation. It is a great mistake to suppose that an unlimited supply exists in the native state ; and perhaps this is not to be regretted, as cultivation will improve the fibre, and those varieties possessing the finest fibre only will be cultivated. It is understood that the Maories cultivated this plant on the North Island, and it would be a subject worth inquiring into, in order to discover which is the best variety for producing a fine quality of fibre, and if there is any peculiarity in the system of cultivation. Also, minute information is much required connected with the method and substances used in dyeing the flax with those brilliant fast colours, in which art the Maories have excelled. The difficulty in producing a good fast colour on vegetable fibre is well known, and many tedious and expensive processes are used to animalise (as it is termed) the vegetable fabrics, so as to enable the dyer to fix the colours. If we are to improve on the Maories' method of dressing the flax, we should not be behind them in its adornment.

The gum of the flax is used for the same purpose as gum arabic. The root is purgative, and said to have the properties of sarsaparilla.

Cordyline Australis, Ti or Cabbage-tree.—Whole plant fibrous, and might be made into paper. The juice of the roots and stems contains a small amount of sugar, and has been used for procuring alcohol.

The fibre of the trunk of *C. indivisa* is used by the Maories in the manufacture of mats.

Among the grasses in the genera *Triticum*, *Agrostis*, *Arundo*, and *Danthonea*, are several species well adapted for paper-making. They are abundantly spread over the grassy hills of Otago, at altitudes over 1,000 feet. If the article should become one of export, the cost of conveyance to port would be heavy, unless means could be applied to compress it into bales. At some future time, however, machinery could be erected, where water-power is convenient, and the manufacture of an inferior description of paper could be carried on in the country. There is a so-called cotton-plant in Otago (*Celmosia coriacea*) the dressed fibre of which is shown, and it has been made into cloth by the natives.

SUGAR FROM THE ARENGA PALM.

The following suggestions on the regular cultivation of the Arenga palm for the more general manufacture of sugar are by Dr. J. E. de Vry. In vol. iv., p. 281, will be found a note on Palmyra palm-sugar.

"When I went from Holland to Java, in 1857, I sojourned a month in Ceylon, and there became acquainted with the *Borassus flabelliformis*, vulgarly called Palmyra palm, by the Englishmen living in Ceylon, and among the products of indigenous industry I remarked, as taking a first rank, the sugar sold by the natives under the name of *jaggery*. The great number of these palms induced me, in a conversation with persons having interests in Ceylon, to express the idea that it would be possible to put them into regular cultivation for obtaining a good sugar crop from them. But my sojourn in Ceylon was but temporary; and, moreover, I had not the required apparatus for making the necessary researches. I occupied myself more closely with this question, when, having penetrated in the interior of Java, my attention was drawn to the great amount of sugar the Javanese living in the districts called *Preanger Regentschappen* obtained from the Aren palm (*Arenga saccharifera*). Professor Reinwardt had affirmed that this sugar was only glucose; but I recognised that, although the natives extract it by a very rude and entirely primitive mode, it contains a great proportion of cane-sugar. Their process is as follows:—As soon as the palm-tree begins to blossom, they cut off the part of the stem that bears the flower; then flows from the cut a sap containing sugar, which they collect in tubes made of bamboo cane, previously exposed to smoke, in order to prevent the fermentation of the juice, which, without this precaution, would take place very quickly under the double influence of the heat of the climate and the presence of a nitrogenous matter. The juice thus obtained is immediately poured into shallow iron basins, heated by fire, and is thickened by evaporation, till a drop falling on a cold surface solidifies; the degree of concentration attained, the contents of the kettle is put in forms or great prismatic lozenges. Several thousand pounds of sugar are thus obtained yearly. I have collected some of the sap in a clean glass bottle, and I found that the unaltered juice does not contain any glucose, but a nitrogenous matter, which, by the heat of the climate, quickly converts a part of the cane-sugar in glucose. In order to prove, without employing any artificial means, that the juice exuding from the tree contains pure cane-sugar, I collected a sample directly in alcohol; the nitrogenous principle is thus eliminated by coagulation; a mixture of equal parts of juice and alcohol has been, after filtration, evaporated on the sand-bath to the consistence of syrup. I brought this syrup with me on returning from Java, and during the voyage the syrup became solid, presenting very fine and well-defined crystals of cane-sugar, immediately recognised as such by all the experts. At the

Congress of Giessen, I spoke of the preparation of sugar from palms as the only rational mode of obtaining sugar in the future, basing my opinion on the following grounds:—Sugar, by itself, being only composed, in state of purity, from carbon, hydrogen, and oxygen, does not take anything from the soil; but the plants now mainly cultivated for extracting sugar, viz., the *Beta vulgaris* and the *Saccharum officinarum*, require for their development a great amount of substances from the soil in which they grow, whence it follows that their culture exhausts the soil. But this is not the only evil; what is worse is, that the space now occupied by beet-roots in Europe, and by sugar-cane between the tropics, might and ought to serve for the culture of wheat or of forage in Europe, and for rice under the tropics; and it is my opinion that, considering the increase of population, the time is not far distant when it will be absolutely necessary to devote to the culture of wheat or rice the lands now employed for beet-root or cane. While the cane and beet-root want a soil fit for cereals, the Aren palm prospers on soils entirely unfit for their culture, so unfit, indeed, that one might try in vain to grow on them rice or cereals; the Aren palm leaves the profound valleys of Java, in some parts of the island extends from the shores of the sea to the interior, where the tree is found in groups, and it is very possible to make rich plantations of that fine tree. There is one drawback, but not a very serious one: the tree must be eleven or twelve years old before it will yield sugar. When, however, it commences, the operation can be repeated during several years, and the preparation of the sugar becomes a continuous industry and not an interrupted one, as it is now. According to my average, a field of thirty acres (¾ acre) planted with those trees should produce yearly 2,400 kilogrammes of sugar on a soil quite unfit for any other kind of culture."

The following further details respecting the uses of this palm are from Seeman's "Popular History of the Palms":—

The *Arenga saccharifera*, Labill.; *Saguerus Rumphii*, Roxb.; *Borassus Gomutus*, Lour.; *Gomutus saccharifera*, Spr.; occurs in great abundance in a wild state throughout the islands of the Indian Archipelago, but is more common in the interior, principally in the hilly districts, than on the sea-coast, and it is also very generally cultivated by the various people who inhabit that region. It has been called one of the most useful of all the palms; and how well it deserves that epithet may be judged from a perusal of the accounts published by Roxburgh, Griffith, Marsden, Low, and, above all, by Crawfurd. Like all plants enjoying a wide geographical distribution, this tree is distinguished by names as numerous as the languages of the countries which claim it as a member of their flora. With the usual copiousness of these languages on similar occasions, each useful part of the plant is distinguished by a special name. In Malay, the tree is called *Anoa* (*Anowe* according to Griffith, and *Anan* according to Bennet), the liquor (toddy) obtained from it, *Tuwak* or *Nera*, the soft brown scurf found at the base of the petioles, *Baru*, and the horsehair-like material covering the latter, *Ejoo* or *Egu*, or *Gomuti*. It is this last name which some botanists have applied as a genuine, others as a specific one, to the whole plant. In Javanese, the tree is called *Aser*, the material like horsehair, *Duk* (occasionally spelt *Dok*), the gossamer-like substance, *Kawul*, and the sap, *Lagu*, which means the sweet material, by distinction. In the Amboynese language, the tree is called *Nawa*, the horsehair-like material, *Makse*. In the Ternate language, the tree is called *Seho*, in the Bali, *Jahaka*, and in the Bina, *Naun*. In the Macassar language, the tree is termed Monchono, the sap or toddy, Juro ; and in the Mandar, the former *Akel* and the latter *Ki*. The Portuguese and other European nations following their example, call the tree and its liquor *Sagwire*, though no one knows for what reason.

The Sagwire or Gomute—we had better adopt the latter name, as being the most euphonious—attains a height of thirty or forty feet, is without spines, and bears a dense crown of pinnatescent leaves, which have rather a sombre aspect ; their segments are generally fasciculate, the middle ones five feet long, about four inches broad, linear ensiform, dark green above, white underneath, with distant spinescent teeth, and a bilobed or bifid croso-dentale apex. When very young, they are eaten, like those of the American cabbage-palm (*Oreodoxa oleracea*, Mart.). The petioles are very stout, and it is at the base of these and completely embracing the trunk of the tree, where the horsehair-like material, which co-operates to render this palm so valuable, is produced. This fibrous substance, superior in quality, cheapness, and durability to that obtained from the husk of the cocoa-nut, and removed for its power of resisting wet, is used by the natives of the Indian islands for every purpose of cordage, domestic and naval, a practice in which Europeans have of late years initiated them. The coarser parts, or small twigs, as some authors call them, found with this "vegetable horsehair," are used by all the tribes who write on paper as pens, and they are the arrows used by others to discharge, poisoned or otherwise, from blow-pipes or arrow-tubes. Underneath this material is found a substance of a soft gossamer-like texture, which is imported into China. It is applied as oakum in caulking the seams of ships, and more generally as tinder for kindling fire. It is for this latter purpose that it is chiefly in request among the Chinese.

Marsden, in his "Sumatra," says, "It is bound on as a thatch, in the same manner as we do straw, and not unfrequently over the *galoonpye* (bamboo thatch) ; in which case the roof is so durable as never to require removal, the Ejoo being of all vegetable substances the least prone to decay ; and for this reason it is a common practice to wrap a quantity of it round the ends of timbers or posts which are to be fixed in the ground. The Ejoo exactly resembles coarse black horsehair, and it is used like it, among other purposes, for making ropes, and mixing with mortar." Low, in his "Borneo," whilst corroborating this statement, adds :—"The hairy filaments are plaited by the natives into ornaments for the arms, legs, and neck, which are more pleasing in their deep black hue and neat appearances (at least, to eyes of Europeans) than the beads and brass with which these people are fond of adorning their persons." Bennett, in his "Wanderings," also gives a highly favourable description of this fibre, and throws out the suggestion that it may be the same as that called "Cabo negro" by the Spaniards at Manila. The principal production of the Gomute palm is the toddy, which, according to Crawfurd, is produced in the following manner :—

"One of the spadices is, on the first appearance of fruit, beaten on three successive days with a small stick, with the view of determining the sap to the wounded part. The spadix is then cut off a little way from its root (base), and the liquor which pours out is received in pots of earthenware, in bamboo, or other vessels. The Gomute palm is fit to yield toddy when nine or ten years old, and continues to yield it for two years, at the average rate of three quarts a day. When newly drawn, the liquor is clear, and in taste resembles fresh must. In a very short time it becomes turbid, whitish, and somewhat acid, and quickly runs into the vinous fermentation, acquiring an intoxicating quality. In this state great quantities are consumed ; a still larger quantity is immediately applied to the purpose of yielding sugar. With this view the liquor is boiled to a syrup, and thrown out to cool in small vessels, the form of which it takes, and in this shape it is sold in the markets. This sugar is of a dark colour and greasy consistence, with a peculiar flavour ; it is the only sugar used by the native population. The wine of this palm is also used by the Chinese residing in the Indian islands in the preparation of the celebrated Batavian arrack.

"In Malacca, the Gomute, there termed Kabong, is cultivated principally for the juice which it yields, for the manufacture of jaggery (sugar). The "Journal of the Indian Archipelago" for November, 1849, says :—"Like the cocoa-nut tree, it comes into bearing after the seventh year. It produces two kinds of mayams or spadices—male and female. The female spadix yields fruit, but no juice, and the male *vice versâ*. Some trees will produce five or six female spadices before they yield a single male one, and such trees are considered unprofitable by the toddy collectors ; but it is said that in this case they yield sago equal in quality, though not in quantity, to the *Cycas circinalis*, although it is not always put to such a requisition by the natives ; others will produce only one or two female spadices, and the rest male, from each of which the quantity of juice extracted is the same as that obtained from ten cocoa-nut spadices. A single tree will yield in one day sufficient juice for the manufacture of five bundles of jaggery, valued at two cents each. The number of mayams shooting out at any one time may be averaged at two, although three is not an uncommon case. When sickness or other occupation prevents the owner from manufacturing jaggery, the juice is put into a jar, where, in a few days, it is converted into excellent vinegar, equal in strength to that produced by the vinous fermentation of Europe. Each mayam will yield toddy for at least three months, often for five, and fresh mayams make their appearance before the old ones are exhausted; in this way a tree is kept in a state of productiveness for a number of years, the first mayam opening at the top of the stem, the next lower down, and so on, until at last it yields one at the bottom of the trunk, with which the tree terminates its existence."

The fruit, according to Crawfurd, is about the size of a medlar, and produced in such abundance that a single spadix is more than a load for a man. The fleshy outer covering of the fruit affords a juice of a highly stimulating and corrosive nature, which, when applied to the skin, occasions great pain and inflammation. The inhabitants of the Moluccas were in the practice of using, in their wars, in the defence of posts, a liquor afforded by the maceration of this fruit, which the Dutch appropriately denominated "hell water." The seed, or rather the albumen, freed from this noxious covering, is made into sweetmeat by the Chinese.

"Like the true sago-palm," continues the last-quoted author, "the Gomute affords a medullary matter, from which a farina is prepared." In Java, it is the only source of this substance, which in the western and poorer part of the island is used in considerable quantity, and offered for sale in all the markets. It is smaller in quantity than the pith of the true sago-tree, more difficult to extract, and inferior in quality, having a certain peculiar flavour, from which the farina of the true sago is free.

Griffith, who has given a good description and figure of this palm, says:—"Mr. Lewis informs me that trees that have died after the ripening of the whole crop of fruit—which is the natural course of events—are almost hollow, and particularly adapted for making troughs, spouts, or channels for water, and that they last extremely well underground. In short, it is so valuable a palm, that it early attracted Dr. Roxburgh's attention, who introduced it largely into Hindostan. The natives of Bengal, however, have never taken to it, preferring the coir of the cocoa-nut, and the toddy and sugar of *Phœnix sylvestris*."

The following are Dr. Roxburgh's words:—"With respect to the various important uses of this most elegant palm, I have nothing to offer myself, but refer to what Rumphius and Marsden have written on the subject. At the same time, I cannot avoid recommending to every one who possesses land in India, particularly such as is low and near the coasts, to extend the cultivation thereof as much as possible. The wine itself, and the sugar it yields, the black fibres for cables and cordage, and the pith for sago, independent of many other uses, are objects of very great importance.

"From observations made in the Botanic Gardens at Calcutta, well-grown, thriving trees produce about six leaves annually, and each leaf yields from eight to sixteen ounces of the clean fibre. In the same garden there are now (1810) many thousand plants and young trees, some of them of above twenty years' growth, with trunks as thick as a stout man's body, and from twenty to thirty feet high, exclusive of foliage. They are in blossom all the year; one of them was lately cut down, and yielded about 150 lbs. of good sago-meal."

ON MAGNESIUM.

The existence of magnesium was revealed by Sir Humphry Davy. By means of large electric batteries at the Royal Institution, Albemarle Street, London, he succeeded in decomposing sundry earths and alkalies, and demonstrated their metallic bases. Thereby he opened a new continent to scientific exploration—a continent as yet virgin in many regions, as America or Australia.

Magnesium dates from Davy, in 1808, but for half a century it stood for little but a name in the catalogue of elements. In combination with oxygen, as the medicine magnesia, it was familiar to everybody, but as a metal it has been a very great rarity, preserved in bottles and sold in grains at fancy prices, and even then but seldom pure. Indeed, in several manuals of chemistry it is so incorrectly described, that it is evident the authors have never seen the metal in simplicity.

It would appear that Davy did little more than indicate the existence of magnesium. His discoveries were too numerous for him to track out each in detail, and twenty years elapsed ere any one was tempted to resume the study of magnesium from the point where he left it. In 1827, Woehler, having obtained aluminium by the decomposition of the chloride of aluminium by potassium, it occurred to Alexander Bussy, the Parisian chemist, that it would be possible to divorce magnesium from its combination with chlorine in the same way. He tried and succeeded. He fused some globules of potassium in a glass tube with anhydrous chloride of magnesium, and to his delight obtained globules of the metal. In 1830 he made the process the subject of a memoir addressed to the Royal Academy of Sciences.*

* "Journal de Chimie Medicale," March, 1830, and "Annales de Chimie et de Physique," vol. xlvi., page 434.

Bussy is sometimes credited with the discovery of magnesium, but though that honour is unquestionably Davy's, he was certainly the first to exhibit it in anything beyond microscopic quantities, and to describe its properties.

With Bussy progress ceased for another series of years. Becquerel, by electrolysis, from a solution of the chloride of magnesium, procured the metal in minute octohedral crystals. Bunsen, likewise by electrolysis, obtained the metal, and further modified Bussy's process by adding chloride of sodium or of potassium to the anhydrous chloride of magnesium. Matthiessen in turn tried to improve upon Bunsen by adding chloride of ammonium, also reducing the compound by electrolysis. He afterwards succeeded in pressing some grains of magnesium into wire.

It was reserved, however, for Deville and Caron to make the first grand advance on the labours of Bussy. They, about 1856, effected the reduction of the chloride of magnesium by sodium in clay crucibles, using the fluoride of calcium as a flux ; and so obtained magnesium in larger quantities than any of their predecessors. But their chief discovery was the volatility of the metal ; they distilled a few grammes at a time in a gas carbon retort tube enclosed in a porcelain tube.*

So far magnesium had been produced on a laboratory scale ; none of the methods made any pretence to commercial application. In 1859, M. Bunsen, of Heidelberg, and Professor Roscoe, of Manchester, after a variety of experiments, published their opinion of the high value of magnesium as a source of light for photographic purposes owing to the close affinity of its chemical properties to those of sun-light ; and offered at the same time some excellent suggestions as to the mode of its combustion—suggestions which have since been wrought into practice.

The memoir of Bunsen and Roscoe was read by Mr. Edward Sonstadt—a young Englishman with a name derived from Swedish ancestry—and it set him thinking whether it would not be possible to make magnesium cheap enough for at least some practical purposes. The ore was abundant. Surely some means might be devised for releasing the silvery treasure from the elements which held it in obscurity and idleness !

The question started, was quickly attacked with vigour, pertinacity, and ingenuity. For many months, day after day, far into the night, and often until the dawning of the morning, did Sonstadt, without cessation, first in Nottingham, and subsequently at Loughborough, strive, through multitudinous and costly experiments, to compass his end. In November, 1862, he had so far succeeded, that he felt

* MM. Deville and Caron's labours are described with that exquisite clearness which is peculiarly French, in the "Comptes Rendus" of the 27th February, 1857, page 394, and with enlarged experience in the "Annales de Chimie et de Physique," 1863, vol. lxvii., page 347.

warranted in taking out his first patent for "Improvements in the Manufacture of the Metal Magnesium." His success was at the same time attested by the circulation amongst his acquaintances of specimens of the new metal from the size of a pin's head to that of a hen's egg.

The metal in this state burnt freely enough, but it contained slight impurities, and demanded further treatment to render it ductile and malleable. Again Sonstadt set to work, and after another arduous series of experiments, devised a process of purification by distillation, which he secured by patent in May, 1863. One of the first lumps of the distilled metal was presented to Professor Faraday at the Royal Institution—the spot where magnesium was first introduced to human knowledge. "This is indeed a triumph!" exclaimed the great philosopher as he poised the shining mass in his hand.

Not yet, however, had the time arrived for working magnesium on a commercial scale. Many details had to be brought still nearer practical perfection, and the summer and autumn of 1863 were consumed in experiments. At last, with the close of the year, Mr. Sonstadt considered it safe to commence manufacturing. The Magnesium Metal Company was organized, and operations commenced in Manchester.

The aim with which Mr. Sonstadt set out was, a ready method for the extraction of magnesium from its ore, and his merit is to be measured by its achievement. The methods of his predecessors were only practicable in the laboratory, indeed, they made no pretence to practise elsewhere; they required complicated apparatus and delicate manipulation, and, with all care, frequently resulted in failure. His method, on the contrary, is so simple, that it can be accomplished by the hands of ordinary workmen, and on a scale only limited by the convenient size of vessels and furnaces. At Loughborough, at Midsummer, 1863, we saw some pounds of magnesium made by a labourer and his boy with perfect ease.

The manufacture of magnesium, as conducted in Manchester, may be conveniently described under three heads:—I. The preparation of anhydrous chloride of magnesium. II. The release of the magnesium from the chlorine. III. The purification of the magnesium by distillation.

I. Lumps of rock-magnesia (carbonate of magnesia) are placed in large jars and saturated with hydrochloric acid. Chemical action at once ensues; the union of carbon and oxygen with magnesium in the rock is dissolved; the magnesium combines with the chlorine of the acid, forming the desired product—chloride of magnesium, but in solution.

The water is next evaporated from the salt. The liquor is poured into broad open pans, which are placed over stoves. When the drying is sufficiently advanced, the salt is collected into a crucible and subjected to heat until perfectly melted and the last traces of water driven off, when it is stowed away in air-tight vessels.

II. In the second stage, that curious metal—sodium, used likewise in the reduction of aluminium, comes into play. Common table salt is sodium *plus* chlorine—released from chlorine we have sodium. It is a white metal, but quickly grows dim on exposure to the moisture of the atmosphere. If cast upon water it floats and burns fiercely, almost like potassium. Such is its affinity for oxygen, that it has to be kept in air-tight vessels or under oil. It may be cut with a knife, somewhat like tough cheese.

In a crucible are deposited five parts of the dry chloride of magnesium, with one part of sodium. The crucible is covered and heated to redness, when the chlorine deserts the magnesium and flies over to the sodium. The crucible is allowed to cool and its contents removed in block, which when broken up reveals magnesium in nuggets of various sizes and shapes, like eggs, nuts, buttons, and in minute granules. This product is styled crude magnesium.

III. The distillation of the crude magnesium is effected in a crucible through which a tube ascends to within an inch of the lid. The tube opens at the bottom into an iron box placed beneath the bars of the furnace, so that it may be kept cool. The crucible is filled with the crude metal to the level of the mouth of the tube, the lid is carefully luted down, and the atmospheric air expelled by the injection of hydrogen. As the crucible becomes heated, the magnesium rises in vapour freed from any impurities, and descends through the upright tube in the centre into the box below, where, on the completion of the operation, it is found in the form of a mountain of drippings. It is subsequently melted, and cast into ingots, or into any other form that may be desired.

In this broad sketch of the process of manufacture, the reader will perceive how fully Mr. Sonstadt's ideal has been realized. Scarcely a month elapses in which some detail is not reduced to greater simplicity and some new economy discovered in the works of the Magnesium Metal Company. The new art has made great progress since its establishment; experience suggests constant improvements: as the old copy-head runs—Practice makes perfect.

When the magnesium company commenced manufacturing, the question presented itself, In what form should the metal be offered to the public? As there was no known use for it except as a light, it was determined to vend it in the form of wire; but here arose a difficulty—How to make wire. The metal was not ductile, and could not, like iron or copper, be drawn out. Dr. Matthiessen and others had pressed small quantities into wire, but when experiments were made on a large scale, the magnesium was found capricious; sometimes it worked readily, but at others it resisted enormous pressure, and the rams broke down under the strain. Mr. William Mather, of Salford, had taken the matter in hand, and with admirable resolution declined to be baffled; through costly disasters he persevered, tried, and tried again, and finally overcame. Now, by machinery of his contrivance, the metal is pressed into wire of various thickness, and a spectator might wonder, as the silver threads stream forth, how that which now seems so easy should have cost such pains. Mr. Mather improved on the wire by flattening it into ribbons, in which form, as a larger surface is exposed to the air, combustion takes place more completely. Mr. Mather likewise made the first lamp for burning magnesium. In it the end of the wire or ribbon was presented to the flame of a spirit-lamp to ensure perfect combustion. As the wire burnt, it was paid out by hand from a reel, and propelled between rollers through a tube, which conducted it to the flame. A concave reflector diffused the light forwards and afforded shade to the eyes of the operator.

To few could the introduction of the new metal to commerce yield such lively satisfaction as Professor Roscoe, whose hint had been, as it were, the spark which set Mr. Sonstadt's energy afire. It was Dr. Roscoe's lot, moreover, to introduce magnesium to the scientific public. In doing so, he was fortunate in having the assistance of Mr. Brothers, of Manchester, who in the spring of 1864 was the first to take a photograph by the magnesium light. At the Royal Institution in May last year, Professor Roscoe delivered a lecture on light, and among his illustrative experiments, burned some magnesium, and calling forth Professor Faraday from the audience, had him photographed on the spot by Mr. Brothers, and the negative being inserted in the magic lantern a gigantic likeness of the venerable savan was projected on the screen. The same experiment was repeated, with Sir Charles Lyell for a subject, in the Bath Theatre, when Professor Roscoe lectured on light to one of the evening assemblies of the British Association.

To photographers the magnesium light will prove an inestimable advantage. Smoke, fog, and night need no longer interfere with their operations. A busy man, who cannot afford to lose a forenoon in order to catch the sunshine, may have his likeness taken in the quiet and leisure of an evening at home. Photographs under such circumstances are much more likely to possess that ease and naturalness, which are so difficult to attain under the ordinary conditions of out-of-door costume, an ascent to a house-top by a tedious flight of stairs, and a pose in the glare of a glass-house amid theatrical furniture. As a Quarterly Reviewer observes—

"The new magnesium light promises to dispense with the necessity of a glass studio with all its discomfort for the sitter, and all the temptation to meretricious decoration which it appears to hold out to the photographer. The metal magnesium, the oxide and carbonate of which is a familiar medicine, is itself rare. It will burn like a candle,* and it emits a light peculiar for its wonderful richness in chemical

* No; not quite like a candle. Magnesium wire should be held downwards, say at an angle of 45° in burning. No more than a paper spill or a wood match will magnesium burn with certainty if the lighted end be held upright.

rays ; but until recently the cost of isolating it has been so great, that its capabilities have never advanced beyond the rank of a chemical curiosity. Recent discoveries have, however, facilitated its manufacture, and it has come into partial use among photographers. A negative of Sir Charles Lyell was taken at the recent meeting of the British Association. A slight further reduction in cost" [a reduction which has been made since this was written] will enable photographers to use it for the purpose of taking likenesses in the houses of their sitters ; and the sitter's gain in personal comfort will be duly registered in the improved expression of the picture." *

Nor are portraits taken by magnesium light in any sense makeshifts. It is quite within the truth to say, that they are equal to, and undistinguishable from, sun-pictures. Of course the skilful handling of the new light is only to be acquired after some practice.

The light will probably develope a melancholy branch of art—the portraiture of the dead. We say melancholy, but more in a conventional than a sincere sense. The faces of the dead frequently assume a sweet, a saintly, a severe, a statuesque beauty rarely present in life. By the aid of magnesium this beauty may readily be perpetuated and divested of painful accessories. Some such memorials we have seen, and they have only to be known to become common.

As soon as it was discovered that photography was possible by magnesium, it was suggested that the interiors of the Pyramids, of catacombs, caves, and other underground and dim regions might be revealed in faithful pictures, and studied under the stereoscope. The suggestion was soon acted upon. Professor Piazzi Smyth, the Scottish Astronomer-Royal, having gone upon an exploring expedition to the Pyramids, took with him a quantity of magnesium wire, and thus reports on its use to his friend Mr. Spiller, of Woolwich Arsenal :—

"East Tomb, Great Pyramid, Feb. 2, 1865.

"My dear Sir,—We have been here now about three weeks, and are settled down at last to the measuring ; the chief part of the time hitherto having been occupied, in concert with a party of labourers furnished by the Egyptian Government, in clearing away rubbish from important parts of the interior, and in cleansing and preparing it for nice observation.

"The magnesium wire light is something astounding in its power of illuminating difficult places. With any number of wax candles which we have yet taken into either the king's chamber or the grand gallery, the impression left on the mind is merely seeing the candles and whatever is very close to them, so that you have small idea whether you are in a palace or a cottage ; but burn a triple strand of magnesium wire and in a moment you see the whole apartment and appreciate the

* Article "Photography" in "The Quarterly Review" for October, 1864, page 517.

grandeur of its size and the beauty of its proportions. This effect, so admirably complete, too, as it is, and perfect in its way, probably results from the extraordinary intensity of the light, apart from its useful photographic property, for, side by side with the magnesium light, the wax candle-flame looked not much brighter than the red granite of the walls of the room. There come parties—often many parties—of visitors to see the Pyramid every day without fail, and they come amply provided, too, with all sorts of means and appliances to enjoy the sight, *i. e.*, with everything but the needful magnesium wire; and one waistcoat-pocket of that would be worth a whole donkey-load of what they do bring up to enable their souls to realize the ancient glories of the internal scene.

"I remain, yours very truly,

"C. Piazzi Smyth.

"John Spiller, Esq., Chemical Department,
Royal Arsenal, Woolwich."

M. Nadar is said to be engaged on a series of photographs of the Catacombs of Paris; various artists are busy practising on monuments in obscure recesses of Continental churches; and Mr. Brothers, we believe, contemplates undertaking the caves of Derbyshire. The crypt of St. Stephen's Palace of Westminster, recently restored and decorated under the direction of Mr. E. M. Barry, has been lighted up for an hour and a half with the magnesium lamp, and the exquisite elaboration of its moulded and carved doorways and the bosses of the groyning displayed in vivid detail. By the same means the vast recesses of the Outfall Sewer Works at Crossness have been illuminated.

In surgery the magnesium light is now freely used in examinations with the speculum. In a recent number of "Galignani" we read—

"This powerful light has just received a new application in connection with the laryngoscope, a small apparatus consisting of two mirrors by means of which the lower parts of the larynx may be conveniently brought to view. M. Maisonneuve, being desirous of showing his students the manner of using this apparatus, requested Dr. Fournié, the inventor of the improvement we are about to describe, to attend a late clinical lecture of his. Dr. Fournié did so, bringing a patient with him who was suffering from a polypus situated deep in the throat. This tumour, of the size of a filbert, not only impeded the free articulation of sound, but might in the end, by its growth, have rendered respiration impossible, and consequently caused death by suffocation. In order to render this pathological phenomenon visible to the students and physicians who crowded the lecture-room, M. Fournié made use of the magnesium light. By means of M. Mathieu-Plessy's lamp, especially constructed for the magnesium light, strong luminous rays were projected on the mirror placed at the furthest end of the fauces, and thence reflected into the larynx and the trachea. These parts being thus powerfully illuminated, were visibly depicted on the mirror; but the image was necessarily small, the mirror not being more than two centimetres square But on a bi-convex lens being placed before the patient's mouth, the image became so enlarged, that every one could distinguish it from a distance of a few metres. These two applications of important scientific discoveries and contrivances combined are highly interesting; in the first place, by the aid of the magnesium light, the exact site of the slightest sore in the upper respiratory organs may be discovered by physicians; and in the second place, the same may be rendered visible to a numerous audience."

One of the peculiarities of the magnesium light is, that it displays colour as in sunshine. This may be tested, and a very interesting effect produced, by burning some wire in a garden or conservatory at night. This peculiarity we learn, from the 'British Journal of Photography,' is being turned to practical account.

"The magnesium lamp promises quickly to become a regular article of furniture in every silk mercer's show-room. A dyer, of Paris, some months ago, saw the magnesium light for the first time, and discovering at once that its rays left colours unaffected, exclaimed, 'This is just what we have long wanted.' Even in Paris there are many days in winter when those who deal with delicate shades of colour are utterly at a loss to discriminate between tint and tint, but the magnesium light has completely removed the difficulty. Now, whether it be fog or night, any question as to colour is in a moment set at rest in the flame of a bit of magnesium wire."

The strength of the magnesium light coupled with its easy production qualifies it for extensive employment in commerce and war. Unlike the electric and oxy-hydrogen lights, it involves no cumbrous and troublesome apparatus. With a coil of the wire in his waistcoat pocket and a few matches, an Alpine explorer has instant means for making his whereabouts known at night. The light has been seen at a distance of twenty-eight miles at sea; how much further remains to be determined. Commissions under several Governments are investigating its capabilities, and there is reason to believe that it will very soon be adopted for ship signals and lighthouses. It has been suggested that rockets primed with magnesium in powder and thrown up at uncertain intervals would effectually prevent a night surprise, as they would light up the country for miles around. By the same means many of the secrets of an enemy's works and position might be discovered. Had the United States' Navy possessed the light sooner, the hazards of blockade-running would have been indefinitely increased. Its merits were only revealed when the opportunities for its employment were passing away. We read in 'The Times' of 20th February of the present year—

"It appears that, according to Federal anticipations, blockade-running is likely to suffer a check by the introduction into the American Navy of the new magnesium light, of which metal the Washington Government has ordered a supply. Several of the European Governments, it is also said, are engaged in experiments with a view to its adaptation to light-houses and coast and sea signals."

An American Magnesium Company has been formed to work Sonstadt's Patents in Boston; and it will be singular if that enterprise, ingenuity, and fertility of resource, which have placed the name of New England in the highest rank in the arts alike of peace and war, do not quickly surprise us with some bold applications of the metal.

It is hardly necessary to describe magnesium. In wire or ribbon it has become a common object in shop windows. It is white—brilliant as silver when pure and clean. In dry air it preserves its lustre, but in moisture it oxidizes and gets dull as zinc. Its specific gravity is 1·75, or about one-fifth that of copper, which is 8·96. Aluminium is a very light metal, but its specific gravity is 2·56—much denser than magnesium. Silver 10·50; an ounce of magnesium is therefore six times the bulk of an ounce of silver.

We have confined ourselves to the uses of magnesium as a light-giver That use has been so obvious, and pregnant with so many advantages, that it has absorbed all attention; but it is scarcely probable that magnesium will continue to be made for burning only. It has surely other merits; but much, very much, remains to be learnt about it. What is its value as a conductor of electricity? Under what conditions is it ductile?—under what fragile? What is the degree of its tenacity—its strength under tension? What is its specific heat? What are the characters of its alloys? These, and scores of other questions have yet to be answered with scientific precision.

People are constantly drawing conclusions from the present price of magnesium. Reasoners were last summer deciding that this and that could never be done because it was selling in wire at 3d. per foot, Now that it is selling at 1d. where are their conclusions? Arguments from such premises are idle. No one can tell at what price magnesium may be produced. Many improvements in the processes of production have been effected since the Magnesium Company commenced working, and their experience will beget others; their art is young—not yet two years old. Price, moreover, is largely dependent on the scale of production. If iron was worked on the present scale of magnesium, at what price would iron wire be retailed per foot? Whenever magnesium is demanded in large quantities its price will fall. The Magnesium Company look wistfully for great consumers, for various economies at their command are only practicable on extensive plans. They could, and they desire earnestly, to produce cheaply; they only await opportunity. Dr. Percy informs us, that no one need think of smelting copper with less capital than 50,000*l.*; the requisite economies are impossible on smaller means. Should magnesium ever be used as freely as copper, who can predict what may be its price?

A NEW OIL-SEED FOR THE COLONIES.

Madia is a genus of South American herbaceous plants, belonging to the natural order of Compositæ, one of the species of which, *Madia sativa*, is of value for the oil yielded by its seeds upon pressure. It is a native of Chili, where it has long been cultivated for the sake of its oil, which is of excellent quality. It grows like the aster; the blossom is yellow, and put together in clusters; the stalk is from three to five feet high, grows compact, and requires a sandy soil. The seed is like that of the sunflower, but much smaller.

In Chili the oil is used instead of olive oil, the finer quality for edible and the grosser for illuminating purposes. It was introduced from Chili into Asia Minor with great success, thence into Algeria and the south part of France, and into some warm parts of Germany, and is said to be more abundant in oil than any plant introduced into Europe. It attracted attention in Europe previously to 1839, in consequence of Mr. Bosch, the superintendent of the gardens of the King of Wurtemberg, having successfully cultivated it in Germany on a large scale. He found that, as compared with rape and poppies, the amount of oil yielded per German acre was as follows:—

Rape	yields	240	lbs. oil per German acre.
Poppies	„	264	„ „
Madia	„	242	„ „

This oil does not congeal at 19 deg. below zero of Reaumur, but only becomes a little less fluid, which makes it a valuable material for keeping machines in order.

In Europe, the seeds are sown in October, and from four to six pounds are required per German acre. The crop is of the easiest management, and the only precaution to be taken by the cultivator, which it is important to notice, is, that the seeds must be thrashed out soon after the crop is cut, otherwise the glutinous stalks, when heaped up, ferment and injure the seeds.

The Madia is known in Germany as the "Olbegende Medikraut," or "Olmud," and seed may be had of Messrs. Booth's successors, No. 32, Grosse Reichenstrasse, Hamburg.

NOTES ON EGYPTIAN AGRICULTURE.

Amongst all the cotton-growing countries called to sudden prosperity by the American war, none have succeeded better in the art, whether for quality of staple or quantity grown per acreage of arable surface, than modern Egypt. Old Mehemet Ali had already prepared the fellaheen for the present demand by his various enactments for the cultivation; and amongst all his various schemes for making Egypt great, glass manufactories, spinning, weaving, dyeing establishments, salt-pits, arsenals, foundries, sugar factories, &c., cotton-growing will prove most important, and cotton will pay for all the other failures. For the cotton crop of 1863 Egypt received over twelve millions, for that of 1864 she will receive over twenty millions, as the notices in the 'Times' of "gold withdrawn for Alexandria" daily testify.

In the autumn of 1863 things were very queer in Egypt; the extraordinary inundation of the Nile, spreading for miles on each side of the river's natural bed, had drowned the crops and broken the railway communications. Besides this, a violent murrain, that seemed like a second Mosaic plague, desolated the country; the native oxen and buffaloes, as well as those hastily imported from the coasts of the Black Sea, Trieste, Spain, Portugal, and France, were all seized; scores of dead beasts were floating down the swollen waters of the Nile; carcases lay in every road, and in every field and ditch. In fact, so rapid was the course of the malady, that even the polyglot European speculators of Alexandria neglected for a little while to buy up the hides and hoofs for export.*

The natives were in despair, and bewailed their splendid oxen with many bitter tears; the only available animals left were the camel and the donkey, both better suited for carrying than for draught, as the Arab horses, all thoroughbred, are little fit for agricultural purposes. A sight pretty commonly seen at this time was the patient camel (about as vicious a beast as ever stepped) and the much-enduring Egyptian donkey yoked together (the yoke at an angle of about 60°), dragging the simple Egyptian plough, the industrious fellah encouraging them from the plough handle, who would, indeed, have scratched up the land with his fingers rather than miss his crop. Meanwhile, the Government of the Viceroy set to work on the right things; double pay was offered to

* With reference to the murrain, a well-known literary Bey of Cairo related the following, which has passed from coffee-house to coffee-house all over the country:—A Sheikh-el-Beled, or chief of a village, rendered public praise to Allah, for that it had pleased him to confound the infidel cotton-growers of America (might their tombs and beards be ever defiled!) in a bloody war, whereby the cotton grown by his servants in Egypt, the true believers, fetched a high price from those sons of dogs and pigs, the English; but Allah, displeased at the selfishness of the Sheikh and his people, as a punishment sent the murrain.

all the railway *employés* to get the line in working order within a certain time; the drowned cotton was dragged up, and the land replanted with flax, Indian corn, wheat, and burseem, or Indian clover; and as no draught animals were forthcoming, large orders were given to Howard and Fowler for steam ploughs.

In these brief notes, modern agricultural Egypt will be described under the four following heads:—1. The Soil; 2. The Produce; 3. The Animals; 4. The Men.

1. *Soil.*—The arable land all over Egypt is for the most part loam, entirely free from stone, with a heavy clay subsoil, the latter strongly impregnated with salt; yet in some parts, for instance Shoubra, belonging to His Highness Halim Pasha, the whole soil is a heavy clay, and makes very superior bricks.

It is generally supposed that the water from the Nile during its rise deposits the rich fertilising mud wherever it flows: this is far from the case. It is only for a short distance on each side of the banks that the deposit takes place, and the rent of land there is exceedingly high compared to that at a greater distance; the water conveyed by canalisation to the lands of the Delta is perfectly limpid, and merely used for simple irrigation. It is only on the immediate banks of the Nile that the fellah may be seen when the waters recede, wading up to his armpits, sowing his seed broadcast on the ooze, casting his bread upon the waters which he will find after many days. It is frequently supposed that the land is inexhaustibly fertile; it is not so, however, as has been amply demonstrated by the liberal-minded prince and agriculturist before named, who planted two fields side by side with flax, the one dressed with superphosphate, the other left without manure. It is no exaggeration to say that the flax treated with the manure, grown under the superintendence of His Highness's English gardener, Mr. William Chapman, had double the thickness of stalk and was nearly double the height of the other; in fact, the difference between the two samples was as striking as anything could be. This enlightened prince has since ordered three hundred tons of guano and superphosphate for his different estates in Egypt.

The fellaheen are also alive to the value of manure, and spread on their fields dust from old ruins abounding in the Delta, which contain a great deal of lime. The dung of the camels, oxen, buffaloes, horses, and donkeys is collected by the women and children, who compress it with their hands into a bun-like shape, and stick it on the walls of their huts, where it dries and is used for fuel, there being little wood and no coal or lignite in the country. The land is broken up to a depth of about three inches with the Egyptian plough, partly from the want of proper implements to go deeper, partly for fear of bringing up the salt subsoil. The Egyptian plough is like that used in India, Spain, and Portugal, a mere iron point or pick adapted to a wooden framework, which scratches up the land as a one-tined scarifier would do, so that to get anything like a tilth the fellaheen must plough and cross plough at least five times. They then drag a large, flat, smooth framework of wood, on which the fellah stands, over the land to level and pulverise it, after which, with a small, short-handled, broad-bladed hand hoe, the blade making an angle of 45° with the heft, they set up the land in ridges and arrange their water furrows for irrigation, at which they are very clever. This hand-hoe, called a "fass," is the national implement, and suits well the national habit of squatting when at work.

About the only other implement in use is the native threshing machine, a wooden framework or chariot, running on sharp iron discs or skeiths, which they drive over the grain and straw in a circle ; the action of the discs and of the animals treading bruises and cuts up the straw in short lengths and insufficiently threshes the grain, the whole is then piled up in the middle of the circle, and a fresh supply strewn in the track of the charioteer. To winnow the grain, they take a heap of the mixture and toss it up in the air with a wooden shovel, when the wind blows the straw chaff and shavings to a little distance, the grain falling straight to the ground. The chopped, bruised straw, &c., with a good deal of grain in it, is given to the animals for fodder, whilst the grain, with a good deal of dirt in it, is garnered or sold without further operation. The Arabs had carried the same methods to Spain and Portugal, where they are in use to the present day, so that, owing to the demand for chopped bruised straw, our makers of threshing machines (all warranted to produce a market sample) must adjust their wares accordingly.

It may be broadly stated that, with good cultivation and water, the soil of Egypt will grow anything. It is the old story : to make a good seed bed, the land must be pulverised to a good depth. With a fine climate and soil a crop may be got, as in Peru, by one man scratching a furrow, another following dropping in the seed and stamping the earth over with his foot, but only inferior crops are obtained in this way under the most favourable conditions.

What can be done by properly pulverising and deep stirring the soil in Egypt has been shown by the use of the steam-plough ; the steam-grown cotton of His Highness the Viceroy and His Highness Halim Pasha fetching far higher prices in the market than any other. It is worth mentioning that, in April last, within sight and at a short distance from the Pyramids, there was a peaceful contest between Howard's and Fowler's steam-ploughs, very near the spot where took place the battle between the Mamelukes and the French troops under Napoleon, known as the Battle of the Pyramids.

With regard to the saltness of the subsoil the following is interesting :—A gentleman of standing at Suez, finding when the French company made the cutting for the Suez water-canal (the supplement of the great work) that though a good coating of sand was on the top of the land, clay was the subsoil, conceived the idea of bringing the clay to the surface by deep ploughing, thus rendering it fit for cultivation, and converting the arid, barren port of Suez into a flourishing agricultural district. When the Nile water was let into the cânal all Suez rejoiced and glorified the French who had made it. They sent their horses and asses to drink, and congratulated themselves that for the future, instead of buying water by the skinful from Moses' Well, nine miles away, they would have it at their doors gratis. Soon, however, it began to be brackish, and shortly became so salt as not to be potable.

Every day as the water evaporated, the Nile running low ceasing to feed the canal, thick incrustations of salt were found on the banks, which the Arabs stole and sold. It is still, however, an open question whether some salt-absorbing plants might not be found which, being constantly grown and ploughed in, would after a time produce a soil fit for cultivation.

2. *Produce.*—The agricultural produce of Egypt is illimitably varied, as of old. Gourds, succulent roots, melons, onions, and the like are predominantly excellent. For oranges and lemons Egypt might rival Seville and the Azores; the large blood oranges grown in Shoubra Gardens are particularly delicious, and would fetch a high price in Covent Garden. Peaches, apricots, nectarines, figs, bananas, prickly pears, grow in profusion, and are plucked hot from the tree, owing to the powerful sun. Grapes and pine apples do not succeed so well, on account of the sudden fall of temperature during the night, the thermometer frequently sinking 10° in a very short space of time: glass-houses have been, however, ordered out by some of the princes. Dates are produced in enormous quantities, and whether fresh, dried, or mashed, form a large part of the native food, notably of the Bedouins. Each date-bearing palm pays a tax of 3d. a year to the Government; they are frequently seventy feet high, the dates growing in clusters under the tuft of leaves; the natives easily climb up with their bare hands and feet to gather them. Though the palm grows to such a height, it has little root, and is frequently blown down; its wood is tough, and makes capital crates. Sycamore figs are sold in large quantities. An alley of these trees above three miles long, leading from Cairo to Shoubra, forms a complete arcade and yields a good revenue; it looks 200 years old, though it was only planted forty years ago by Mehemet Ali.

The staple products of the country are wheat, Indian corn (so-called), or doura (of which the native loaves or flat jacks are made, one or two of a man's wives grinding sufficient meal every day before the mud-hovel door), burseem or Egyptian clover, flax, sugar-cane, chiefly in Saeed or Upper Egypt, rice in Lower Egypt, and mighty cotton everywhere—all these crops are grown on ridges, so that they can be easily irrigated. For cotton the ridges are set out from 3 ft. 6 in. to 4 ft. apart, centre to centre; the seed is dibbled in at distances of 1 ft. to 1 ft. 6 in. apart, the plants being afterwards hoed. The seed is all in by the end of

March, the young plants appearing a few days afterwards; the water-wheel and pump then begin work, the fields being irrigated every ten or twelve days, though at greater intervals when the plant is high. The fellaheen are very careful of the water, and when their fields are too small for a water-wheel, they will irrigate by skins or baling. In September the cotton plant is nine feet high, full of pods and beautiful yellow flowers, between which time and the end of December four pickings take place, the average weight gathered being 5 to 7 cwt. per acre. All the boys and girls of the villages turn in to pick. The harvest is ginned as soon as possible at the numerous English, French, German, Italian, Maltese, Greek, Syrian, Armenian, Albanian, native, and even American ginning factories, where the cotton is ginned for the seed and a small sum per cantar or cwt.—in times of competition for the seed only. The clean cotton then goes to Minet-el-Bassel, the well-known cotton-market of Alexandria, where it now fetches from 9*l.* to 12*l.* per cwt. The produce of an acre of cotton may be valued at 50*l.* on an average, so that supposing the rent of the land, seed, cultivation, hoeing, picking, irrigation, "*firdeh*" or land-tax of 16*s.* per acre, to come to 15*l.*, a very high estimate, the clear profit per acre is 35*l.*—presuming there are no poll tax, ship money, benevolencies, or viceregal invitations to take shares in Egyptian companies, which it is not yet quite safe to ignore. Many of the ginning factories above named have from 150 to 200 gins, with hydraulic presses for baling the cotton, oil presses for extracting oil from the seed, and producing the now well-known cotton-seed cake. The greatest difficulty the proprietors have is the cost of labour, which is nearly as high as in England. Cotton-seed oil is now largely used in the soap trade, and its refined extracts for lubrification.

The cotton shrub will bear for three years, but as the roots are very strong, deep searching, and exhausting for the soil, they are generally pulled up by the end of December—the wood, which is wonderfully tough, is sold for fuel, the leaves for fuel and manure; the land is then rapidly worked over for Indian corn, which is sown and harvested within ninety days, or with flax or Egyptian clover. This clover or burseem is one of the fellah's best helps, and when properly irrigated it may be cut fifteen times before the great heats come on—it grows as high as flax.

The camels, horses, oxen, and donkeys, goats, and sheep, are all put on burseem in the spring; its rich juices fortify and fatten them wonderfully, their nature becomes renovated, and they are enabled to withstand the summer heat. A good deal of burseem seed has been sent to England at various times—it would be advantageous to know how it has succeeded. It is possible with irrigation to obtain four crops a year on the banks of the Nile—flax, Indian corn, burseem, and melons.

Of the varieties of sugar-cane, the yellow and the purple and white, as well as rice, space will not permit to treat, but should the present price for cotton abate, the European capital in the country may be then attracted by these important staples.

Weeds growing on a fallow field perish completely in the summer from the heat. Hasheesh, "the weed," is well known; when dry it looks like a bunch of thyme. The natives smoke a few of the leaves on their pipes, and after a few whiffs become affected and start for pleasant dreamland. The weed when green is pressed, and its inspissated juice made up into little sticks and sweetmeats. It is taken after meals to produce its full effect, but it is best never to touch it. Flowers are little grown and cared for, the practical fellah seeing no utility in what cannot be eaten or sold.

3. *Animals.*—The chief animal of modern as of ancient Egypt is the camel; far from being the affectionate creature represented, it is exceedingly morose and dangerous, biting viciously, and kicking when provoked in every possible direction, which, from its peculiar conformation, it is enabled to do. An enraged camel tearing about is by no means rare in the streets of Cairo. In their excesses of passion they frequently dangerously wound and sometimes kill people. As a carrying animal in the desert its utility is unbounded, but its merits in towns are not so shining; it often slips on the wet roads when loaded, breaking its back. Transport, moreover, by camels in towns is not so cheap as cartage, though the loads they will carry are tremendous; four bales of cotton, weighing 300 lbs. to 380 lbs. each, being frequently seen. The camel is a very shy animal, only fully understood by the Bedouins; it does not breed in towns. The price of a camel averages from 10*l.* to 12*l.*; their food is principally chopped straw with a little burseem hay. The dromedary bears the same relation to the camel as the race-horse to the cart-horse; they have a very easy eight to ten miles an hour pace, and cost about 20*l.*

The oxen and buffaloes are fine, large-sized, strong, draught animals, and make good beef, though producing little milk. They have the swaying neck, drooping sidelong gait of the camel, and are very docile. They do not draw from the head but from the neck, the yoke passing in front of a bony hump peculiar to them. Buffalo butter is white and hard, with little flavour. Milk is chiefly obtained from a hardy little race of goats, whose unnaturally distended udders are kept in bags by the careful natives, so that no stray kids should milk them.

The horses as companions and steeds are admirable, but of little use comparatively for draught, being small and fiery. The Arabs spoil the stride by training them to stop suddenly when at full gallop, pulling them on their haunches and checking them with a very cruel curb. To show their skill they will dash at full speed against a dead wall, reining up and turning suddenly when a few inches from it. The Arab horse's paces are the walk, amble, canter, and gallop—trot they have none; many are trained to walk in the camel fashion, by having each fore and hind leg roped together. Horses with this pace are much sought after by effete old Turks. The price of horses has now gone up considerably; formerly they could be obtained for riding purposes at from 6*l.* to 10*l.* The sheikhs and principal people ride mares. The Egyptian donkey reaches a development both of mind and body unknown in less favoured climes; he can live on less food, sustain greater and more continuous fatigue than the horse, and carry almost as heavy a burthen; his only deficiency is want of speed. He, too, has the camel motion, and his paces are the same as those of the horse. Owing to his endurance and strength it is found cheaper to wear him out than use him well. If a European riding a donkey in the intricate streets of Cairo loses his way (one takes a donkey in Cairo as a "Hansom" in London), the best thing is to give his steed the rein, and without fail it will find the nearest way back to its station. The price of a good donkey with saddle is now 12*l.* Some fetch a high price, however; for instance, a white Meccan ass, ridden by the Sultan in the Garden of Shoubra during his visit to Egypt, cost 500*l.* It will be remembered that the prize was taken at the Donkey Show by His Highness the Prince of Wales, with an animal given by His Highness the Viceroy during the royal visit to Egypt. The sheep are small and poor. Last year the English Government sent out twenty-five picked sheep, of best races, bought for 400*l.*, to cross with the native breed, under the superintendence of a member of one of our well-known Norfolk sheep-breeding families; but when the Arabs saw the big Leicesters and compact Southdowns contrasting so strangely with their own diminutive race, "Wullah," said they, "this is a device of the Christians to make us eat pork; these are no sheep, but pigs with wool on them." These splendid animals, thus despised, cooped up in an old stable, soon began to suffer from too great a growth of hoof for their heavy bodies, which superinduced foot rot, so that they gradually drooped and died. This scheme, that if properly carried out would have increased the wealth of the country, there being no difficulty from the climate, was thus rendered abortive.

The black pig would flourish, but religious prejudice is opposed to his increase. Dogs are under the same law, but numerous instances of sneaking kindness to these animals on the part of the natives show that they possess the human friendliness for the race, although opposed to their creed. White turkeys, fowls, pigeons, doves, and plover, abound. Snipe, quail, wild ducks, and geese are plentiful in their season, though the latter have a sardine-like flavour, only to be subdued by abundant sprinkling of lemon juice. The Bedouins also bring desert hares to market, which have little flavour.

4. *Labourers.*—Taking everything into consideration, an English farmer with capital would soon make a fortune in Egypt after studying the climate for a time, provided he could make sure of labour. The fellaheen are naturally a mild, gay, inoffensive race, with plenty of

Mahomedan bigotry, yet understanding the general laws of humanity; they have been, however, so ground down by centuries of oppression, that a low cunning has been developed painful to note. Gratitude they are unacquainted with; it is quite unknown to them, and this failing often disappoints Europeans; they are lazy, except in agriculture, sensual, dirty, and obstinate; on the other hand, they are wonderfully hardy, working out in the fields during the full heat of the sun, with nothing on them save a covering for the loins, and a camel's-hair bonnet; not revengeful, and considering their religious feelings against Christians can be got to work pretty well by those who study their character. The best way to manage them is by fear, being at the same time just and truthful. The women and children work almost as much as the men, and bear fatigue wonderfully. It is just to say that the English workmen who have gone out to work steam-ploughs, cotton-gins, &c., have generally acted badly, beating the natives, getting drunk, and working little, though many earn from 20*l.* to 30*l.* a month, besides board and lodging. Say the Arabs, "These Christians eat our dates, and throw the stones in our faces."

The greatest nuisance in dealing with the natives is the system of backshish which pervades all classes. European intercourse is, however, improving this state of things.

Labonr might be obtained from Greeks and Maltese, but they are a treacherous and unsafe people to deal with, though they have the advantage of working on Friday, which the native has not.

MINERAL SUBSTANCES FOR WRITING ON.

BY means of writing mankind record their fleeting thoughts; they engrave them on stone and metal, and thus from the remotest ages does the information reach us of what once existed. Long since have those nations passed away, who first trod the path of civilisation and raised themselves to refinement and power; scarcely a vestige or a trace of their existence remains, yet do they still speak to us on stones and rocks, and what they engraved with hammer and chisel has been reserved for all ages. But these records are mysterious and obscure, and their interpretation an art calling for all the ingenuity of man to effect. On the Obelisks, which rear their pinnacles on high among the ruins and Pyramids of Egypt, is engraved in hieroglyphics the history of an extinct age. While wandering among the gigantic ruins of Persepolis, the City of the ancient Persian Kings, the eye of the explorer will especially dwell upon the inscriptions on the dilapidated walls. For a long time these cuneiform inscriptions were a mystery, but now their obscure meaning is solved and they speak to us as witnesses of an age upon which, with all its grandeur and splendour, the silence of the grave has rested for thousands of years. The new world also has its memorials cut in the rocks, and these rock inscriptions tell us even in our days of the grandeur, wealth, and cultivation which once existed in the Inka's golden land under the mild sway of the Sons of the Sun.

Thus are recorded on these stones and ruins the life of nations and the events of history; the common every-day life, however, also required some means of communication, and this could not express its thoughts in sculptured inscriptions. The obscure hieroglyphics sufficing no longer, this want led to the invention of letters, which of course brought other materials into use for their ideal inscription.

Previous to the formation of language man required no writing materials; with language he created the art of writing. Their first rude forms were tokens and monuments composed of mounds of earth, heaps of stones, stakes, and such like. Wedges and chisels were the instruments used in Babylon and China, those earliest seats of human cultivation, for writing upon flat burnt tiles and thin slate-like flakes of stone. Then pointed stones and still later metal styles were used to write with. Stone was succeeded by plates of metal, then tablets of wood upon which the letters were engraved by bones and copper. Then the wooden tablets were covered with wax and horn or silver styles used for writing with: these waxen tablets were in great favour among the Greeks and Romans for daily use, and they offered the advantage of being used over and over again, as all that was inscribed by the point of the style could easily be effaced with the other flat end of the same.

To the same period belongs the use of the skins of beasts and leaves of trees, those of the palm being first used by the Egyptians. The leaves were soon supplanted by the bast or inner bark of trees, especially of the lime, birch, elm, and maple, in which the letters were scratched with needles and subsequently with the style. The ancient Germans first wrote upon the bark of the birch-tree. From bark to linen or cotton tissues was but a step, and pencil and colour became style and ink.

About the time of Alexander the Great (336—323 B.C.) the papyrus-plant, which has given paper its name, came into use. This remarkable plant flourishes on the banks of the rivers of Calabria, Sicily, and especially on those of the Nile in Egypt, and like our reed it forms in those regions perfect forests or jungles on the banks. The paper was made of the inner skin of the stalks of plants still in sap, by ripping it from the stalk with fine needles or sharp-edged shells, several such leaves being then fastened together with Nile water, dried, and finally polished with teeth; the paper thus prepared being called "Biblos."

Shortly afterwards, about the year 200 B.C., parchment was invented, being so called after the city of Pergamus, the place of its origin, and proved such a superior writing material as to inaugurate a new era, supplanting the papyrus plant together with the silver and other styles, introducing the goose-quill instead of the latter, and even retaining its position as general writing material throughout the middle ages. The ancients wrote the immortal works of their genius upon parchment rolls, and in subsequent periods the industrious monk, sitting in his lonely cell, by transcribing them, rescued them from annihilation. His laborious work preserved the light of a new cultivation upon yellow parchment.

The use of the Egyptian paper survived until the eleventh century and was then entirely superseded by the invention of paper made from cotton, which was introduced into Europe by the Arabians. At last the Germans, about the year 1270, hit upon the idea of using flax and hemp, and the result was the production of our present paper. The first paper-mill was erected at Nürnberg in the year 1330, and it was soon found that worn-out linen, clothes, and rags were the proper materials for paper-making. Since then the manufacture of paper has remained essentially the same down to the present time, only that by means of machinery alone are we now enabled to meet the enormous annual demand of some 500,000,000 lbs. of paper.

This cursory glance illustrates how many changes writing-material has undergone from its first rude beginnings, from the original use of the natural rock, burnt tiles, and slaty stones, down to the paper we now use. It is also remarkable that the most ancient, primitive, and simple writing-material, the thin slatey stone, after being laid aside and forgotten for thousands of years, should now in more modern times find an universally extending demand. And this demand is a more peaceful and friendly one. Whereas the ancient Greeks in their public tribunals and ostracisms availed themselves of small stone tablets or tiles in awarding their sentences of life and death, our children now practice with the slate-pencil upon the slate the first rudiments of education, for they belong to a period that endeavours to render education an instrument for the common good of mankind.

Lithography, or writing on stone, is one of the most useful modes of making facsimile copies of letters, circulars, &c., in use.

The materials of the mineral kingdom require, however, the treatment of the engraver rather than the writer.

Metal tablets, coated with wax, have been found in the ruins of Pompeii and Herculaneum. On these the ancient Romans wrote with the style, a sharp-pointed instrument several inches long; indeed, the same kind of pen which is used by reporters of the present day, when making their "flimsy" for the Press, or manifold copies on tissue with inked leaves between.

The ancient Jews also engraved records which they wished to be permanent directly on metal plates. Metal tablets or books, consisting of massive leaden leaves, must have been not only among the most clumsy, but among the most expensive of the ancient materials for writing. The Russians have printed on very thin sheets of iron.

A letter recently received at Birmingham from the Sligo Ironworks, Pittsburgh, Pennsylvania, was written on a thin sheet of rolled iron, very flexible, which did not weigh more than twice the weight of an ordinary sheet of paper of the same size. The maker challenged all England to surpass it for strength and tenacity.

This is no novelty; for at the Exhibition in 1851, the Baron von Kleist, of Neudick, in Bohemia, received a Council Medal from the Jury for his iron-paper, which was remarkable for its extreme thinness, flexibility, and strength, and was entirely without flaws. A book of this iron-paper was shown.

A lively competition in iron-rolling ensued among British iron manufacturers, excited by the above challenge from America as to the thinness to which steel could be rolled cold. Mr. Gillott rolled sheets, the average thickness of which was the 1,800th part of an inch. In other words, 1,800 sheets piled upon each other would collectively measure an inch in thickness; whilst the thinnest tissue paper to be purchased in the stationers' shops measures the 1,200th part of an inch. These very thin iron sheets are perfectly smooth and easy to write on, although porous when held up to a good light.

"It may not be out of place," observes the 'Mining Journal,' "considering the great interest that is taken by those connected with that great branch of industry, the iron trade, to give a few curious particulars relative to the extent that iron can be welded, and the thin sheets which can be rolled out. Brother Jonathan little thought what a hubbub would be created in the old country when from Pittsburgh he sent that wonderful letter, written on a sheet made from iron, which took no less than 1,000 sheets to make 1 inch in thickness; the dimensions being 8 in. by 5½ in., or a surface of 54 in., and weighing 69 grs. The fact had no sooner made its appearance in print but that Britain's sons began to work, and soon we heard of a sheet containing the same number of surface inches, but weighing only 46 grs., had been made at the Marshfield Ironworks, Llanelly, Carmarthenshire, being exactly one-third less in weight. But soon the Welsh leek had to give way to the rose of England, for Staffordshire was anxious to take its wonted lead. The Hope Ironworks succeeded in making a sheet of 118 surface in., weighing but 89 grs.; which, reduced to the American and Welsh standard of 44 in., gives about 33 grs.; Messrs. R. Williams and Co., 69 in., 49 grs.; reduced to the same standard, about 31 grs. For a time Staffordshire wears the belt; but Wales becomes very restless, and is anxious for the honour of St. David, so further attempts must be made. No sooner said than done. Marshfield comes again into the field, and through the Press is wafted to the reader. They succeeded in making one sheet, 8 in. by 5½ in., or a surface of 44 in., of the astounding weight of 23½ grs. only, which required no less than 2,853 sheets to make 1 in. in thickness: another sheet, 8 in. by 6 in., or 48 surface inches, weighed 25 grs.; but, brought to the standard of 44 in., gives but 23 grs., and requires 2,950 sheets to make 1 in. in thickness. The Pontardawe Tinworks next come into the field with a sheet of 15¾ in. by 7 5-16ths, or a surface of 115·17 in., weighing 60 grs.; but, being reduced to 44 in., is 24½ grs.—a trifle heavier than the Marshfield; but Pontardawe claims 3,799 sheets to make 1 in. in thickness. We now come to the climax. The mill manager of Messrs. W. Hallam and Co., of the Upper Forest Tinworks, near Swansea, has succeeded in making a sheet of the finest appearance and thinnest that has ever yet been seen by mortal eye. The iron from which the sheet was rolled was made on the premises. It was worked in a finery with charcoal, and the usual blast; afterwards taken to the hammer to be formed into a regular flat bloom; from thence conveyed to the balling-furnace, and when sufficiently heated, taken to the rolls, lengthened, and cut by shears into proper lengths, piled up, and transferred to the balling-furnace again: when heated, it was passed through the rolls, back again into the balling-furnace, and when duly brought to the proper pitch was taken to the rolls, and made into a thorough good bar. Such is its history in connection with the forge department. It was then taken to the tin mills, and rolled and rolled till it was supposed to be thinner than 23 grs., afterwards passed through the cold rolls to give it the necessary polish, and now it stands on record as the thinnest sheet of iron ever rolled. The sheet in question is 10 in. by 5½ in., or 55 in. in surface, and weighs but 20 grs., which, being brought to the standard of 8 in. by 5½ in., or 44 surface inches, is but 16 grs., or 30 per cent. less than any previous effort, and requires at least 4,800 sheets to make 1 in. in thickness. That calculation is made in a rough way, without any inch guage, but, if anything, is considerably under the mark. For the curious, I will give them a calculation, which, if it does not give them any instruction, may tend to amuse. A sheet of IC tin-plate measures 10 in. by 14 in., or a surface of 140 in., and weighs ½ lb. A box is made up of 225 sheets, but as many as 245 can be pressed in; the depth of the box is 3½ in. The latter number of sheets being taken as our guide, we have 70 sheets to the inch. In order to make the matter more clear, we will raise the 55 in. of 20 grs. to the ordinary 10 in. by 14 in., or 140 in., the weight being 50 10-11th grs. We now find that ½ lb. avoirdupois contains 3,500 grs. troy weight; we now multiply 3,500 grs. by 70, the number of sheets of IC thicknes to 1 in., and ÷ by 50 10-11ths grs., being the weight of 140 in. of the thin sheet in question, which gives us as answer 4,812½, that number, therefore, being required to make 1 in. in thickness. I would just add that the gravity of the iron in question, from which the thin sheet was rolled, was from 7·8 to 7·9, and was not made in what is generally considered the most superior—that is, hollow fires. The plan answers admirably for tin-plates, and, in the present instance, fully corroborates that view of the question; for had not the iron been of a very superior quality, it could never have stood the stretching, for it is no less than 68¾ times thinner than the ordinary IC tin-plate. Of course, in a mercantile view, it would never answer to make such thin sheets; in fact, it is hardly worth while making even taggers; and most makers of tin-plates would rather be without such orders, unless in large quantities. For the present, Messrs. William Hallam and Co., of Swansea, stand at the top of the tree.

The slate is one of the most indispensable auxiliaries in our schools, nor can it be thoroughly superseded in them by any other writing-material. Spite of its common appearance, it deserves our notice and attention, especially as its production forms a not unimportant branch of trade.

Opinions are divided as to whether granite or slate compose the primitive rocks of our globe. The slate, being originally a glowing, molten mass, enveloped in a dense gaseous atmosphere, underwent a diminution of its heat, at least on the surface, by the continuous radiation of heat into infinite space. Gradually chemical compounds so difficult of fusion began to disengage themselves in the shape of finely-laminated crystals, and, the cooling process still continuing, to attach themselves to the surface of the earthy globe, thus forming a thin covering, a slight crust over the glowing globe, separating the same from its vaporous atmosphere. Such was the origin of the crust of our globe, which could now more rapidly increase in strength, as the immediate influence of the internal heat was obstructed, and the vapoury combinations present could begin to deposit themselves, at least partially in a fluid form, upon the crust of our earth.

This lowest formation is termed primary rocks, and upon them the subsequent strata, known as secondary rocks, were deposited. It is to this period of the Neptunian formations, and more particularly to its earlier portion, that slate belongs. Thus slate is always and everywhere the lowest and oldest rock, and would consequently be found in every part of the world, were it not so often overlaid by other enormous superincumbent strata. It also forms the principal element in numerous mountain ranges. Veins of other substances frequently intersect the slate, especially greenstone, porphyry and granite causing the slate strata very often to be much dislocated, curved in the most varied manner, and, as a rule, giving them a considerable inclination. Metallic veins are likewise frequently found in these strata.

The three chief elements in this group are: clay-slate, mica-slate, and gneiss.

Clay-slate, which is the subject matter of these remarks, is a confused mixture of very fine particles of mica, some quartz, felspar, and talc, sometimes mixed with coaly particles, hornblend or chlorite, generally of an uniform appearance. In its purest form it is used as slate for roofing, tablets, and pencils, the latter being a curious and distinct species, cleavage taking place in two directions instead of one. Clay-slate is not quite so extensively found as the other two sorts, mica-slate and gneiss. It is met with in Germany in the Yeschken-Gebirge in Bohemia, on the southern flanks of the Riesen-Gebirge, in several parts of the Erzgeburg, and in the Forest of Thuringia, where the slate-quarries of Lehesten are the most important. It is also met with in rich abundance in England, in several departments of France, as also in the State of Pennsylvania in North America.

The uses of slate are very manifold; it being not only applied to roofing, but also, in larger and stronger slabs, to the pavement of apartments, mantel-pieces, and other purposes. In the peasants' houses in the Thuringian forests tables are often seen formed of this material. Next to the roofing slate, however, the writing slate is chiefly of importance, for which, however, only such slate is fitted as will split evenly and finely, being free from all foreign substances, not too hard, and of a nice dark colour. This slate is cut according to the sizes of the tablets, and assorted at the quarries. The further manufacture consists in smoothing the uneven surface, which is effected by means of a planing machine; then the slate is set in a wooden frame, and thus we have the writing-slate, an article of commerce.

The writing-slate is an invaluable writing material for public schools. We have most of us, probably, made our first feeble attempts at writing upon it, and, slate-pencil in hand, covered its dark surface with strange hieroglyphics, until gradually the strokes grew steadier, and, assuming the wavy form of the line of beauty, approached nearer to perfection.

There is by no means any lack of paper nowadays, yet for thousands of the poorer classes it is too expensive a material, whereas a cheap slate, lasting as it does for many years, saves a quantity of paper. It has certainly been asserted that children learn writing better upon paper, acquiring thereby a lighter hand, and at the same time accustoming themselves to guide the pen, whereas the slate with its rough surface and the slate-pencil, wanting as it is in elasticity, tend to form a heavy hand. This is, however, only true of the slate and pencil as they have been hitherto. A perfectly smooth slate and a soft pencil permit of the finest distinction between up- and down-strokes; while you are just as able to draw well as to write well upon them, besides which there is this advantage, that a child, unpractised in handling the pen, is at once enabled to use the slate-pencil, while writing on paper, for which ink and a well-made pen, or at least a steel one, are requisite, is much more inconvenient. After a little practice on the slate, the child easily exchanges it for pen, ink, and paper.

The chief advantage of the slate, however, is, that the writing is very easily effaced, and thus the scholar is enabled to continue his exercises at pleasure, which is a very great advantage in many branches of learning in public schools, such as arithmetic, mathematics, writing, and such like, as also in the rudiments of drawing. Thus the slate is eminently adapted for all exercises, as it allows of a continued use and saves quantities of paper. Our school-teachers would undoubtedly find it a hard matter to get on nowadays without this so useful article, and yet it is not so very long ago that writing-slates were altogether unknown in our schools. It is scarcely a hundred years old, being the most recent of all the writing materials at present in use among us, while the raw material itself, the slate-rock, was used in the very earliest ages, and that they, in spite of their hardness and rigidity as compared with the pliant white smooth paper, should have met with acceptance and rapid diffusion, is a proof of their manifold advantages. It may be confidently asserted that they first came into use in the latter half of the last century; their use was rapidly extended, and by this time they are to be found well-nigh all over the world.

But the very look of the slate tells us that it is still in its infancy. Its manufacture is almost the same as it was at first, nor has any machinery as yet dared to supplant the hand-labour or to produce a better and more suitable article instead of the old clumsy one, and that in any quantity. For a whole century scarcely any improvement or perfection!

Slates are manufactured in the manner above mentioned both in Germany, England, and France, all being much about the same with respect to quality. The writing-slate in use in the present day, though certainly no longer the clumsy unsightly thing it once was, is yet capable of vast improvement. It is so often wanting in the proper smoothness, or the colour is too light and greyish, so that writing does not stand out sufficiently plain. Then, again, the slate may be too hard, precluding the light use of the pencil; while the frame, being made of common deal, soon gets dirty, and nowhere is a tasty elegant article pleasant to the eye to be met with. On account of their brittleness, it has often been attempted to supersede them by slates made of tin, wood, or paste-board, which, though possessing the advantage of lightness, on the other hand are attended by so many disadvantages, such as warping, destruction of their enamel coating, which either chips, cracks, or gets washed off, and is always sooner or later entirely worn off, as to render it impossible for them to supplant the true slate.

If the manufacture of slates has been hitherto in its infancy, our age demands an attempt at perfecting them, and thus to develope this branch of industry by means of the assistance our times afford. Slate and black-lead are first cousins; the same age has called them both into existence. Black-lead has become an indispensable writing material for our age, and the manufactory of A. W. Faber at Stein, near Nürnberg, produces an article in this branch which is acknowledged throughout the whole civilised world to be a most excellent one, and now the same manufacturer intends to attempt to raise the more humble brothers of black-lead, slate, and slate-pencil to a more honourable position.

The situation of this factory offers every advantage for this new branch of trade. Until recently, industry was at a very low ebb in the forest of Franconia, which abuts on that of Thuringia ; its iron and mining works had pretty well gone to decay, and, with the exception of its scanty agriculture and still more unremunerative weaving, the timber trade alone formed an important staple.

On leaving the railway at the little town of Kronach, the road enters the ever-narrowing valley of Rodach, with its steep slopes covered with forest. By degrees agriculture disappears and one sawmill after another is seen on the banks of the little river. Pursuing the road as far as the watering-place of Steben, you traverse a woodland mountain district the whole distance surrounded by the deepest and entirely unbroken silence. You are ascending a verdant valley, watered by a murmuring brook, the soft foliage of the beech intermingling with the dark branches of the firs. For hours neither habitations nor human beings are met with. Then a pretty forester's hut, built in the Swiss style, peeps out from among the trees ; while further on a mineral spring gushes forth, and forest and sky are reflected in the serene, glittering surface of some secluded pool. This is Langenau (Long Meadow), and from this point the road, still ascending, brings you to Geroldsgrün, a village situated on the other side of the mountain and surrounded by hills. The extensive premises of A. W. Faber's manufactory first strike the eye, causing no little surprise by thus abruptly reminding you, in the very heart of the solitary forests and Nature's otherwise uninterrupted sway, of the great, busy, industrial life of modern times with its steam and machinery.

The manufactory is situated about eighteen miles from Kronach, and the railway with which it is connected by a good and passable road. A poor but industrious population inhabits this region, a portion of whom, especially during the winter season, had been in the habit in former times of devoting themselves to the manufacture of slates. The new manufactory, however, has already largely increased the rate of wages in their vicinity and infused new life into their otherwise lonesome region. This will be still more the case in time, as the most favourable conditions for carrying on the trade in the most extensive manner are here met with. The immense forests of Franconia furnish a supply of the most useful hard as well as soft wood from trees which have seen more than one century, and whose old and completely full-grown timber is of an excellence scarcely to be met with anywhere else. The slate-quarries belonging to the factory itself, and the neighbouring ones of Lehesten, the former rivalling the latter in every respect, both as regards extent and grandeur, yield an excellent and unsurpassable material in rich abundance.

These slate quarries are of themselves so interesting that a glance at the deep gloom of their subterranean recesses will well repay the trouble. If the valley of Langenau is distinguished by its idyllic loveliness, the valley of Dürrenwaid, on the other hand, which must be entered upon in order to reach the chief slate quarries of "Lothar Heil," two miles distant from the manufactory, possesses a picturesque character of its own. On one side stands the gloomy forest, while on the other naked masses of greenstone-rock rear their heads aloft in a threatening manner over the road which they seem to block up, other detached masses having fallen into the narrow bed of the stream, which dashes in foam over them. Alexander von Humboldt, who was employed as mining officer in the mining district of Steben in the year 1807, in writing about these valleys, of which there are so many in the forest of Franconia, in one of his later works especially mentions the so-called "Höllengrund" (Hell-gulf) as one of the finest valleys of Europe. After passing through the finest part of the valley of Dürrenwaid the road begins to ascend, until on attaining its highest point the slate-quarry with its mine buildings comes in sight, surrounded by magnificent beeches, pines, and firs.

The open works first attract attention, for here the bed of slate manifests itself in great richness and on account of its freedom from pyrites and other impurities. This slate not only affords an excellent material for roofing, but also for the manufacture of furniture, tables, &c., and objects of luxury which are turned out by the Slate Manufactory of A. W. Faber.

But the subterranean works are the most interesting. At a depth of 120 ft. below the open works the adit's dark mouth is seen. Here the underground world is entered upon with its impenetrable gloom, while the miner's candle throws its dim light upon the wet rock, and the close walls seem ready to crush you with their vast rocky masses. Proceeding thus along the dark passage with its death-like stillness, you suddenly perceive little sparks of light glittering from various points. In a straight line you have penetrated to a distance of 400 ft. and reached the underground works. Towards the west and north vast halls open out in which the work is proceeding busily. Monotonously do the hammer strokes assail the ear while workmen are continually ascending and descending, carrying loads of the material won to the opening of the adit, where they are rapidly forwarded on an iron tramway. Immense surfaces of slate meet the eye, which have been opened up to the great height of 40 ft. and stand ready to be worked.

You breathe more freely on quitting these subterranean recesses and on reaching the open air soon find your way back to the manufactory, in whose spacious and pleasant premises, the erection of which was the work of years, a great activity is displayed.

On entering the workshops novel and peculiar machines attract your attention. The institution of the manufacture offered many difficulties; many things had to be invented expressly, while experience yielded no data on which to proceed, nor showed how this or that difficulty was to be overcome, or how the whole process might be arranged so as to be in every respect the most practical when in action. A steam-engine sets the whole of the machinery, consisting of sawing-, planing-, scraping-, and polishing-machines in motion.

The manufactory, however, not only embraces the production of writing-slates, but works the slate into the most varied forms. The rough slab of slate which was formerly used for flooring, without any finer manipulation, will now decorate the most elegant saloons in the form of handsome marble; the simple slab forming the peasant's table will now be converted into an elegantly wrought work of art. The most ingenious work now finds a rival in the humble slate, which being used for washing-stands, chess- or card-tables, will prove an excellent imitation of the finest mosaic work. Silver and mother-of-pearl will ornament these articles, the colours of which are unchangeable, while their polish is of an indestructible hardness and brilliancy.

If thus a new and rich field is opened for comfort, enjoyment, luxury, and the ornamental, the useful, on the other hand, is also represented and combined with the ornamental in the chief business of the manufactory, the production of an excellent writing slate. To the attentive observer the new article at once evidences progress and perfection. The smoothness of the surface of the slates leaves nothing to be desired; while their uniform dark colour causes the writing to stand out very plainly, and their softness allows of a stroke of any quality from the thickest downstroke to the finest upstroke. They are also ruled in a manner in exact keeping with their size and the various branches of education, as also with the requirements of household and commercial life. The frames, some of soft wood, some of hard, are well, durably, and tightly jointed together, considerably diminishing the chance of breaking the slate; finally, a coating of varnish protects the wood from becoming dirty; and even the ornamental is not lost sight of, as they are decorated with small and tasteful arabesque devices.

THE KOLA-NUT OF TROPICAL WEST AFRICA.—(THE GURU-NUT OF SOUDAN.)

BY W. F. DANIELL, M.D., F.L.S.

It would probably prove a futile task to attempt the discovery, throughout the vegetable kingdom of tropical West Africa, of any analogous product that occupies such an exalted position in the social or dietetic economy of the negro tribes, or constitutes such an important article of traffic in Soudan, as the seeds of the Kola-tree (*Cola acuminata*, R. Br.). With the majority of the aboriginal races populating that vast extent of territory comprehended between Senegambia to the north, and the province of N'gola southward of the equator, these fruits have from time immemorial been held in inestimable value, and their virtues so highly prized, that their employment has become an indispensable and permanent luxury. Within the last few centuries, however, their use has been even still more extensively diffused, and to such a degree as to excite a large commercial intercourse to spring up between the coastal districts and the regions of Central Africa, or Soudan. This profitable trade has been carried on both by Pagan and Mahomedan merchants, by the latter especially into more remote countries beyond the Sahara, so that for many years these valuable commodities have been offered for sale in the markets of Fes, Tripoli, and other local depots, on the shores of the Mediterranean.

The first Portuguese adventurers, in their exploration of the coasts of Western Africa, were soon made aware of the great repute in which this produce was regarded, and taking advantage of the circumstance, they without delay commenced collecting considerable quantities of these seeds, from their stores in the Congo and Isle of St. Thomas, and supplying various trading factories in other portions of the coast; and thus by retailing them at a great increase of price, managed to secure a monopoly for a long succession of years, which perhaps, of all the indigenous products of local commerce, proved to be the most lucrative.

Implicitly crediting the assertions of the natives that their usage was viewed as a luxury, exclusively reserved for the chiefs and richer classes of people, and merely as a means for rendering water sweet and palatable, when drunk before or after meals (a fact confirmed from their being observed masticating the seeds, more or less throughout the day), they (*i.e.*, the Portuguese) never entertained the most remote idea of investigating the causes of this extraordinary uniformity of demand, or rather special craving of the human system, for a nitrogenous substance, that would tend to compensate for the void caused by the deficiency of animal food; for in West Africa, as in other countries, the flesh of animals is scarce, and difficult to procure. Hence the induction of a peculiar instinctive law, which has led the negro and other uncivilised races to select, as if by intuition, such products of the vegetable kingdom as contain a predominance of highly azotized elements, to supply the waste of the human frame; and to this inordinate desire for a diet, chiefly composed of nitrogenous constituents, they appear to have been guided by an importunate constitutional want.

Prior to entering into any general details, we may briefly advert to a few of the more prominent aboriginal customs which, from their ordinary occurrence, could not but fail of attracting the attention of Europeans to the marked popularity attending the use of these nuts.

Should a white trader or native personage of rank visit any chief, whether of ceremony or otherwise, the presentation of a few seeds, or even the half of one, constitutes the highest compliment he could receive, as conveying an assurance of friendly welcome and protection.

If a chief or man of property residing at some distance from another felt inclined to perform an act of courtesy to the latter, the transmission of a few Kola-nuts was esteemed as the most grateful indication of friendship, and was almost invariably reciprocated by a similar exchange or acknowledgment.

In countries where the Kola-tree was not indigenous, and the fruit therefore difficult of attainment, being more restricted to the chiefs and higher inhabitants, no business could be transacted without a few of the nuts being previously eaten ; and so high was their appreciation, that formerly no marriage gift of the bridegroom to the father would be deemed acceptable for the purchase of his daughter, unless it comprised a considerable amount of the Kola-seeds.

The fetishman or necromancer, desirous of raising the shadow of the dead from its earthy tabernacle, to satisfy the caprices of some importunate votary, completed the potency of his spells, by the addition of the food it loved best when in the human body.

In all propitiatory offerings made to the malign god of the earth, to avert disease, misfortune, or ensure a bountiful harvest, they formed by far the most important ingredient in these magic oblations.

When two belligerent tribes were on the eve of war, prior to the committal of any act of hostility, the Kola-nut often acted the part of a mediator or herald, to determine the future intentions of one or both parties. On the centre of an elevated mound of earth, on some neutral boundary or piece of land, two red, and one white Kola-nut, the latter divided into two pieces, were deposited. If one of the red nuts was taken by either tribe, it was a declaration of war ; but if only half of the white was removed, it was deemed as an indication of peace, and thus answered all the purposes of a proclamation, which, being officially promulgated, was regarded of most sacred import by either party, and both therefore subsequently mingled freely, to adjust their dispute, without the danger of treachery.

Again, on the departure of any guest, the host was bound to bestow on him a farewell gift of Kola's. To not a few of these visitors, induced by commercial or political objects to traverse great distances, no present could be more deeply valued ; for experience had already demonstrated, that their use not only supported the strength, allayed an inordinate appetite, assuaged thirst, and promoted digestion, but in fact rendered them more capable of sustaining the fatigues of their homeward journey than any other product that could be obtained.

It is somewhat curious that the Portuguese, Dutch, and at a later date the English, voyagers imperceptibly fell into the negro predilections for this fruit ; and eventually, from continual addiction, their urgency as a stimulus became so habitual, that the due gratification of this want was established as a matter of imperative necessity. Indeed, in later years, it was thought they were endowed with the flavour and qualities of the Peruvian bark.

E. Lopez, one of the earliest Portuguese adventurers, writing on this product, avers that it was the fashion in his day for the negroes "to hold them in their mouths, and chew, or at least eat, them for the quenching of their thirst, and better relishing of their water. They comfort and preserve the stomach, but, above all other virtues, they are singularly good against diseases of the liver. And it is said the liver of a hen, or any other bird that is putrefied and stinketh, being sprinkled with the matter of this fruit, returneth to its former state, and becomes fresh and sound again." * In further evidence of the popular esteem they commanded at apparently such a distant age, we may allude to the custom mentioned by a Capuchin missionary, Jerome de Sorrento, in his voyage to the Congo, that when any gentleman of St. Paul de Loando (the metropolis of the Portuguese possessions in South-West Africa) was desirous of paying a compliment to any lady he met in the streets, he offered her a present of a few of these nuts. It was evident even at this date that some peculiar stimulant property was manifested, otherwise it would be difficult to account for the subtle influence they exercised on the human economy. That the taste for them was acquired there can also be but slight doubt, for the bitter astringency of the nuts was far from being pleasant or palatable, at first, to those unaccustomed to their use.

Another point should always be kept in view, viz., that they were not specially reserved for meals or bad water, but usually carried in the hand of the owner whilst pursuing his ordinary avocations ; small fragments being masticated at intervals, and the pulp, after the extraction of their juice, thrown away. This addition to their daily habit brought under their cognizance the remarkable faculty they possessed in causing insomnia, or want of sleep, and this property the natives probably rendered available in protracting the festivities of their midnight orgies. In other respects, the best, if not the most useful, application the Portuguese made in a practical point of view was the extraction of a beautiful yellow dye from the fresh seeds, by a process still in vogue among several aboriginal tribes, in proximity to their ancient colonial settlements.

Another interesting feature connected with the primitive nomenclature of this plant is the origin of the term Kola, and its widely-spread diffusion along the shores of Western Africa by this designation, —a fact which did not escape the notice of that celebrated botanist, Robert Brown. From the earliest records relative to the discovery of the Congo in which we find the seeds and tree being described by this name, we might reasonably infer that it was either of Congoese or Portuguese derivation. Respecting the latter, I may remark that during a long residence in the districts of the Congo, I never knew their inhabitants to acknowledge any other title than that of *Makasso* or

* Pigafetta, 'Relatione del Reame di Congo,' &c., 1591.

Makatso, that of *Kola* being unknown. I had formerly been under the impression that this appellation might claim its descent from a M'bunda source, but ample inquiries since instituted among the people of N'gola have satisfied me that my surmises were destitute of foundation. It must, however, be expressly understood that this designation is only recognised by European traders, and negro tribes in the immediate vicinity of colonies, originally founded by the Portuguese. It is neither appropriated nor employed by any other of the populations of the most distant, or even adjoining countries, each of which has its own vernacular name, distinctive from any other. Perhaps, the most feasible explanation is that furnished by the Foula traders, who occasionally visit Sierra Leone, and which, to me, appears to be the real source of the term. They candidly affirm that it is simply a vernacular negro corruption, *Gola* or *Kola* being deduced from that of *Guro* or *Goro*, a Foula and Soudan designation. Many centuries since, a very lucrative commerce was established in this article, large trading caravans coming from the interior of the Timmané markets to purchase this commodity; hence the tribes in the maritime regions, unable from physical defects of the vocal apparatus to articulate the letter "*r*," were compelled to adopt that of "*l*;" so that the word *Guro*, or *Goro*, became converted into that of *Gola* or *Kola*, the substitution of these, and in fact other letters, being of proverbial occurrence to those conversant with the African languages. This modified term was ultimately adopted by the Portuguese, first in the neighbourhood, but long antecedent to the foundation, of the colony of Sierra Leone, and within a brief period, after the discovery of the river of the same name. In this locality they were actively engaged in accumulating cargoes of the Kola-nut by means of numerous small vessels detached to different portions of the coast for this purpose,—a custom continued so late as the commencement of the present century, and mentioned by Afzelius, in his report on the vegetable resources of the infant settlement of Sierra Leone for 1794.

From the great reputation these nuts had acquired, previous to the sojourn of the English in West Africa, we may suppose that no length of time elapsed before they adopted the example of their predecessors. In the old books of travels, we may observe various descriptive details, in which their virtues and qualities are conspicuously extolled. Premising that the following remarks pertain more to the Senegal and Gambia rivers, where this production is not indigenous, as affording perhaps the most appropriate illustration of what may be termed the most invaluable of all the negro luxuries. It had been noticed by the English traders, among the Mandingo's of the Gambia, that in their limited traffic with the inhabitants of the interior they carried with them large quantities of salt, either of native or foreign manufacture, and received in exchange gold dust and a roundish, compressed, bitter nut resembling a European chestnut, and known by the appellation of *Gola*, or *Kola*. They were purchased, after a toilsome journey, a great distance inland. They were considered of such inestimable value that ten were thought to be a gift worthy of a king, and that for the moderate number of fifty a man might purchase a wife out of the best families of the kingdom. Nay, the elder and wealthier people, rather than be deprived of this luxury from loss of teeth, proceeding from the decrepitude of advanced age, carry with them a small pestle and mortar, by the aid of which they reduced the nuts into a form of powder, and by occasionally placing small portions on their tongue thus secured all the benefits which would have accrued if the nut had been eaten entire.

Jobson, an English merchant, who was a resident in the Gambia about 1620, launches forth into fulsome encomiums on their properties, especially so when he relates that, after mastication, they rendered river water so sweet as to make it resemble white wine mixed with sugar, and that its dulcificant powers extended equally to tobacco. Modern experience, however, has not indorsed such extravagant assertions. He further states that six of these seeds were esteemed a present of special consideration, when transmitted to European factors on the Gambia. He also appears to be acquainted with the fact that the Portuguese, even in his day, furnished the inferior course of the river through communicating creeks with this fruit from their factories at Bissao and Cadico, these again being supplied by imports from the fertile regions in the neighbourhood of Sierra Leone and elsewhere.

Afzelius, in the botanical report previously alluded to, includes among the medicinal plants of the colony the "famous fruit" of the Kola, which, he observes, was so highly prized by the natives that they attributed similar remedial virtues to it as to the Peruvian bark; and a subsequent official report of the African Institution announces that the tonic qualities of these nuts had become so well-known, that the travelling merchants in the vicinity of Sierra Leone had exported them to every portion of the Continent, even into such remote countries as Egypt and Abyssinia?

Since that time, few volumes of travels or discoveries in West or Central Africa have been published which do not contain a casual reference to or brief description of its popular appliances, gleaned in most instances from secondary authorities, being merely the old stereotyped phrases referring to its employment to alter or correct the taste of bad and unwholesome water, and allay the sensations of hunger.

It is certainly remarkable that the Kola-nut, endowed with such a distinctive frame, and such a widely-spread popularity throughout a considerable portion of the African continent, should have gained merely a trivial appreciation, or be so slightly noticed in our botanical treatises. What little they do mention consists, for the most part, of reiterations of worn-out and often incorrect statements, culled from the works of old travellers and others. Some of these authorities go so far as to confidently declare that half-putrid water, by means of the entire or half-chewed seeds deposited in jars, had been converted into a pure and agreeable liquid. No statement could be so far from the truth. This error had doubtless proceeded from the circumstance that it is necessary, for their preservation, to retain them for a short period daily in water, otherwise they would become dried up and lose their essential qualities. With the object, therefore, of testing the value of this supposed purificatory influence in the West Indies, I placed a few of the fresh seeds in a large tumbler of stinking river-water ; no change was perceived until after a few days, when a quantity of ropy mucus was generated, which, so far from assisting in the removal of the fœtid effluvia, had quite the reverse effect, the incipient decomposition of the seeds themselves increasing the offensive odours.

The introduction of the Kola- or Guru-nut into the kingdoms of Northern Africa may be assumed to be of a comparatively modern epoch, for little, if any, mercantile connection was held with the pagan tribes until after their conversion to Mahommedanism by the Arab or Berber invaders. The first mention I can trace relative to this plant, is in the travels of Leo Africanus, who explored a large extent of Central Africa, about the middle of the sixteenth century. He briefly adverts to the fact that no trees were observed in the territory through which he passed, but a few of great size, yielding a bitter fruit resembling a chestnut, and denominated by the inhabitants *Goro* or *Guro*.*

From this period until that of Lucas's visit to Northern Africa in 1797, no valid information respecting their intervening history has been promulgated worthy of credit. Lucas's account of these nuts teems with descriptive errors, so that but little reliance can be placed on his statements, evidently gained from secondary sources. Under the Soudan term of Guru-nuts, he enumerates them with gold dust, slaves, and other products, among the usual articles of commerce imported by the Fezzan merchants from the negro states south of the Niger. They were esteemed a pleasant bitter, and became so grateful to those familiar with their employment, as the means of changing the brackish and unwholesome waters of Fez into a more palatable drink, as to be considered of essential importance to the comforts of life.

Lyons, and subsequently other travellers, supply far more accurate and trustworthy knowledge of this product. By the designation of *Goor, Guru, or Kolla*, they were brought to the markets of Mourzuk for sale from Dagumba, Ashanti, and other circumjacent regions, in parcels, enwrapped by a peculiar kind of leaf, which, by being occasionally moistened by water, retained their freshness, and thus maintained their value for months. This mode of preservation is like-

* "Ma no v' ha frutto di niuna sorte; eccetto alcuni frutti che producono alberi molti grandi, iquali si assomighano, alle castagne ma tengouo alquanto dell' amaro. Questi arbori si discontano dal fiume verso la terra ferma ; il frutto, ch' io dico, e chiamato nella lor lingua Goro."—Della Descrittione dell' Africa, &c., per Giovan Africano : Viaggi da Ramusio, part 1, page 9. Edit. Venice, 1613.

wise pursued by the caravan returning from the coastal districts to Kano and other marts of Central Africa, the leaf of a species of *Phrynium*, or other succulent plant, being resorted to for a similar purpose. For it is well known that if they are permitted to become dry and shrivelled, they lose, not only their mercantile demand, but a considerable portion of their bitterness. In this condition they are termed in Tripoli, *Kowda*, and are held to be of inferior estimation. According to Lyons, the seeds in their fresh state sell in Fezzan at the rate of four per dollar, a price that virtually precludes their enjoyment by the poorer classes of people. These so valued luxuries are offered to visitors as a substitute for coffee, being handed round on salvers ; hence the frequent application of the title, the coffee of the blacks, or of Soudan, bestowed on them. If some of the native reports be trusted, when, in former years, a great scarcity of this fruit prevailed, owing to a long-continued dearth, so difficult was it to procure a few of the nuts, that a slave was frequently given in exchange for one.

Denham, Clapperton, and the more recent travellers Richardson, Barth, &c., who have traversed many extensive kingdoms of Central Africa, likewise furnish incidental notices of this popular tonic and stomachic. The last-named traveller has, however, entered more fully into the details of the subject, stating that they were considered the greatest luxuries that negro-land, or Soudan, could afford, and, as articles of trade, were daily increasing in importance, as might be gleaned from the fact that they comprehended, with gold-dust and salt, the three staple commodities that supplied and governed the markets of Timbuktu. A few imperfect outlines respecting their botanical origin renders it necessary that I should revert to his statements in a future portion of this paper.

My knowledge of the tonic and astringent properties of the Kola-seeds commences so far back as 1850, when in garrison at Fort Christiansburg, on the Gold Coast, West Africa, then but recently transferred to the British Crown. With other diseases endemic to the settlement, a particular form of diarrhœa often prevailed among the European population, caused more by local relaxation of the mucous membranes, and other visceral structures, than from constitutional debility. For its cure, the white inhabitants were in the habit of administering a decoction of the fresh seeds, and with apparent benefit. Experiencing a similar form of attack, I was relieved by resorting to the same remedy.

This affection having supervened whilst recently residing in Jamaica, I followed the same system of treatment ; but, much to my surprise, on taking the medicine late, two evenings in succession, found that I was deprived of sleep during the remainder of the night. Uncertain whether this insomnia proceeded from some temporary constitutional idiosyncrasy or an inherent peculiarity belonging to the fresh seeds, I intermitted taking the decoction for a few days, and with the intermission the natural rest returned ; on again continuing the medicine in the evening I invariably found its administration attended, more or less, with loss of sleep. I was then reminded how practically verified (after the lapse of two centuries) were the quaint remarks of Dapper, one of our enterprising African voyagers, who announced that the seeds, "as experience teacheth, eaten in the evening hindreth sleep."* This singular and well-developed phenomenon, the result of a powerful stimulant on the brain and nervous system, produced by some elementary principle analogous to caffeine or theine, led me to infer from physiological induction, that an analysis of the seeds would readily determine this point in the affirmative. Following the process commonly in vogue for obtaining theine from other plants—viz., by mixing with a strong decoction of the fresh nuts acetate of lead to precipitate the astringent principle, and then transmitting sufficient sulphuretted hydrogen, to remove the excess of lead, after the gradual evaporation of the liquid, numerous long needle-like crystals became deposited in the glass. These, on comparison with a large sample of this alkaloid in Kingston, proved to be identical. As, however, it was deemed desirable to have a more elaborate chemical examination of the ultimate constituents of these seeds, and also to determine fully the character of the theine previously procured, a quantity of the broken dried nuts were placed in the hands of a practical chemist, Dr. Attfield, at the same time intimating to him that I had already obtained theine as one of the chief elements, and the result of his labours hitherto has been to establish the validity of my discovery, and the correctness of the estimate I had formed respecting the true nature of this alkaloid.

In the preceding introductory statements, I have endeavoured, so far as consists with the importance of the subject, to condense within restricted limits various characteristic details of interest, such as might tend to elucidate the origin of that constitutional craving which induced the negro tribes to select this in preference to other vegetable products for dietetic purposes. A concise historical summary of their aboriginal appliances is at the same time supplied, in allusion to those primitive usages existing long anterior to the visits of the "children of God" † to the shores of Western Africa.

The discovery of theine as a constituent of the seeds affords a ready physiological solution of several of those otherwise obscure effects manifested by their therapeutic influence on the human constitution.

One remarkable feature worthy of mention, is the marked avidity displayed in modern days by the negro inhabitants of Sierra Leone, and Portuguese colonies, for the nuts in preference to the beverages of tea and coffee, although each contains the same elementary alkaloid. I have

* Ogilvy's Africa, p. 494.

† *I.e.* Europeans,—a term by which they were designated when first seen by the negroes, and applied even at the present day in some of the regions of tropical West Africa.

occasionally observed that even the coffee-tree, more or less under culture in their farms or gardens, is neglected, and on the whole they are indifferent to the stimulant properties of its fruit, so long as the Kola-nuts are attainable; nay, they indulge in the luxury of chewing them, even when gathering the ripe purple-coloured berries of the former for sale or domestic use. Nevertheless, the semi-civilized negro enjoys his cup of tea and coffee with the same *goût* as a European.

Wherever the slave trade prevailed, the *Cola acuminata* appears, sooner or later, to have been introduced as a necessary sequence to the importation of slaves to their new homes; and, in countries where they became located in large numbers, it was studiously imported, and cultivated for their advantage and benefit. Hence the introduction of the tree into the Mauritius, several of the West Indian Islands, Brazil, Mexico, and other extensive regions on the continent of America.

In Jamaica the young plants were brought over and naturalized from the Gold Coast, between the early epochs of 1630-40, by a Guinea trader, under the local appellation of *Biche*, or *Bissai*, a name still retained throughout the island. Its importation has been ascribed to the urgent request of an agent of large sugar estates, exclusively worked by the Coromantyn, or Gold Coast negroes. Similar to the grains of Paradise (*Amomum Malegueta*, Rosc.), it was specially intended to act either as a medicinal prophylactic agent, or as an ordinary article of food, to avert, as far as practicable, those attacks of constitutional despondency to which this class of negroes were peculiarly liable. By thus allowing them the means of participating in those favourite condiments in general use in Africa, that predisposition to epidemic outbreaks of suicidal mania (an inevitable propensity for which ran like infection through several contiguous estates) became gradually diminished, and ultimately checked, after narrowly entailing an almost total depopulation in not a few of them.

Scientific Notes.

SOUTH KENSINGTON MUSEUM.—The annual report on the administration of this central repository for examples of science and art states that the general condition of the pictures and drawings is most satisfactory. Mr. Redgrave, the Inspector-General for Art, is able to report that the national collection of water-colour paintings gradually increases in importance. Several purchases have been made in the past year, and the collection has been enriched by gifts of water-colour paintings from the Rev. T. Raven, Mr. R. Sasse, jun., and the Rev. J. Sheepshanks. A further development of the system of loans has taken place in this class of art through the liberality of Mr. Walter M.P., who has lent a collection of fifty-seven pictures by the old masters, principally of the Dutch school. They have been exhibited together in one of the rooms contiguous to the Sheepshanks Gallery. But in the new galleries the whole water-colour collection will be arranged chronologically ; it will form a most interesting and historical series. A number of valuable additions have been made to the art collections. The principal purchases of the year have been a Spanish "retable" or altar-piece, a work of great size and importance, of the date of the first half of the fifteenth century, originally in a church at Valencia, now destroyed ; a casket in coloured enamel, the work of Jean Limousin ; a missal-case in gold, ornamented with translucid enamel, said to have been formerly the property of Henrietta Maria, consort of Charles I. ; a candlestick of Henry II. ware ; the Syon cope, a remarkable example of early English needlework ; and a collection of objects illustrative of Spanish work in the fifteenth and sixteenth centuries. Among the gifts of the year should be mentioned a collection of articles, such as watches, needlework, wearing apparel, &c., illustrative of the manners and tastes of the seventeenth and eighteenth centuries, presented by the Rev. R. Brooke. The regular collection of objects on loan continues also to be well supported. Many valuable and interesting objects have been contributed by Mr. Gladstone, M.P., and others. Considerable progress has been made in the arrangements for the systematic interchange of reproductions of works of art with foreign Governments. An understanding has been come to with the trustees of the British Museum in relation to the purchase of works of art ; those which belong to classical epochs are to be considered as the especial province of the British Museum. The necessary works which have been going on at South Kensington have caused some inconvenience to visitors, but this is unavoidable while the new buildings are in progress ; at the present rate of proceeding about eight more years will be required to carry out the plan of building which was submitted to the Select Committee in 1860. Attention is called to the approaching loan exhibition of miniatures, and the exhibition (likely to be annual) of stained glass and English mosaics. The visitors to the Art Library have increased in number. All the collections have been improved in the course of the year. The responsibility for the lighting and custody of the museum at night increases with its growth ; the organization and arrangements for preventing accidents and remedying them are as complete as possible. The cost for the consumption of gas for the Museum only is a shilling a minute. The attendance of the public in Easter week (1864) was 27,518 ; Whitsun week, 16,005 ; Christmas week, 35,984 ; the whole year, 653,069. This number much exceeded that of any previous year, except that of 1862, the Exhibition year, and 1863, when the wedding presents of the Princess of Wales were shown, and attracted 229,425 persons in seventeen days. The inner circle of metropolitan railways will have a station within 200 yards of the Museum, to which there will probably be a covered passage of communication.

ROYAL POLYTECHNIC INSTITUTION.—We have much pleasure in bearing testimony to the liberality of the directors of this institution, where youth and age alike can be instructed and amused, in providing such an intellectual entertainment as can there be obtained. To enumerate the varied attractions of this school of science would occupy too much of our space, but we would especially invite attention to the new optical illusion, called "Proteus; or, We are here, but not here," the joint inventors of which are Mr. J. H. Pepper, the indefatigable manager of the institution, and Mr. Tobin, as being something truly marvellous, surpassing all other efforts in the same direction. The lecture entertainment in which the illusion is produced is illustrative of Captain Richard K. Burton's pilgrimage to Mecca and Medinah, besides some of the remarkable incidents in the life of Mahomet. An exhibition of models and drawings of inventions calculated to promote the saving of life in railway travelling is worthy of attention, the subject of safety in travelling over our iron roads occupying so much attention at the present time.

USE OF NEW SUBSTANCES.—The rate at which we have been discovering new elements of late suggests some considerations respecting the uses of new substances, which may have interest for readers to whose minds it may not have occurred. When the existence of iodine was discovered in 1812, and that of bromide in 1826, who could have conceived of those elements as likely ever to become of industrial importance? At the dates of their discovery, no arts to which they were capable of any application were as yet known (unless the medical art may be regarded as an exception); but their discoverers have lived to see grow up an entirely new art, to which these elements are essential, and which was not long in attaining dimensions causing so great an industrial demand for these new substances as to render the discovery of new sources of them of very great economic importance. To meet the demand for bromine, manufactories are about to be established on the shores of the Dead Sea, the waters of which have been lately discovered to be richer in bromides than any others known, while the demand for iodine is such that he who shall first bring to this country a few hundred tons of the Chilian mineral recently discovered, may realize, by only one cargo of it, a really considerable fortune. Is not this of bromine and iodine a representative example, which ought to lead us to regard the discovery of previously unknown substances as prophesying the coming birth of new arts, for which these new substances are the ordained materials? It must surely be that everything in the world exists for man, and that, while every element has one set of uses in the economy of nature, it has another set also in the economy of art.—'Meçhanics' Magazine.'

THE TECHNOLOGIST.

THE PROGRESS OF THE TELEGRAPH.

BY THE LATE PROF. GEO. WILSON.

MAN has been defined as a laughing, a cooking, a naked animal, but never so far as I know, as a telegraphic one. In truth, when we watch the proceedings of any of the social or gregarious creatures, we cannot fail to acknowledge that they have carried the art of telegraphy to wondrous perfection, ages ago.

We may, or we may not excel them in speaking face to face, but who shall say that we are their superiors in asking or answering across spaces far removed from each other, or comfort us with the thought that our system of signalling is better than theirs? We nicely discuss whether *telegraph* is a proper word or not, and invoke the Heroes of Homer to side with us, for or against a term which would have tried every Greek tongue in its utterance, and vexed every Greek tongue in its hearing. And all the while the bees who rejoice amidst the sugar plantations of our heather, warn and welcome each other in songs which the bees of Hymettus sang to each other; and the grasshoppers signal from meadow to meadow as they did of old, when the musical shiver of their wings rang over Greece as its cradle psalm. It is scarcely necessary to particularise animals, for all the social ones have from the beginning constituted themselves joint-stock telegraph companies with limited liability, and their shares are now below par. For one, I am lost in wonder and reverence, when I consider the telegraphic doings of the humblest creatures. Whether it be a legion of locusts bent on a war of extermination, or a cohort of caterpillars seeking forage, or a bevy of butterflies arranging for a dance: in some mysterious silent way the signal passes, and all understand it, and all obey it.

I watch a troop of crows, who by some "own correspondent" of theirs have learned that farmer Blyth's neighbours will hold a ploughing match on his grounds, and have in consequence summoned their brethren to a Diet of Worms. How unconcerned they look, as if worms were nothing to them! How grave as if it were an ecclesiastical convocation, and they had no thoughts of the earth, earthy! Yet point a gun, or anything like it towards them, and in a moment the very birds whose backs seem turned to you will give a flutter of their wings, which appears an involuntary struggle, but in reality is as significant a danger-signal as a red flag on a railway, and is sufficient to clear the field. Nor are those wise crows exceptionally wise. All their feathered brethren have made a sacred compact that never with their consent shall salt be put on their living tails, and there are not many unfeathered bipeds who will boast of having salted them. The sparrows are not so idle that they do not pass the word to each other when crumbs are falling thick from some rich man's table. The doves though they look so innocent, do not spend all their time in cooing love songs and cradle-lullabies, or in preening their rainbow feathers.

They have a 'Mark Lane Express' of their own, and by a peck, or a ruffle of their feathers, can direct each other to the fields where the autumn wheat is germinating best, or the gardens where the green peas are fullest and sweetest.

The first bird that awakes in the branches quivers its feathers, and in a moment all join in chaunting their *Te Deum.* The lark takes up the parable of the Prodigal Son, and sings again his lesson for the day, "I will arise and go to my Father;" and the birds obedient to the signal join in their Hallelujah chorus, and separate to their labour till the nightingale summons them to the evening song. And does not the "stork in the heaven know her appointed times, and the turtle and the crane and the swallow observe the time of their coming?" and where the carcase is, are not in some wondrous way the eagles gathered together?

I speak specially of birds because they are so swift and so vocal, that least of all creatures, excepting always their fellow-vocalists and fliers, the insects, they might seem to need a means of transmitting intelligence to a distance by a system of signals; and yet none use it more. Consider only the swallows who have recently been holding their annual autumn reviews, before marching into winter—or rather new summer quarters. I have seen some of them, as you may have done, perched in long rows on the telegraph-wires, and have fancied them saying, as they swayed their graceful bodies up and down, and wagged their pretty heads:—"These poor, foolish men with their nonsensical wires, a clumsy imitation of the spider's webs, what would they not give to know our telegraphic system! But their hearts are so wicked, that as one of themselves confesses, God has given them speech to conceal their thoughts; so, with a flutter of thanks for these convenient perches, let us be glad it is not so with us, and bid them farewell."

In truth, is there any creature that grudges us speech or does not think it a noisy superfluity? If you plot murder against but a colony of mice who have entered your newly-built house before the plaster was dry, and have eaten up, besides much else, your very title-deeds, so that to the nine-tenths of possession they have added the one-tenth of law, see what it comes to! So long as the toasted cheese and baked meats are innocent of poison, all are bidden to the feast; but the moment one of the colony feels poorly from a taste of arsenic or strychnia, the supper-table is deserted, and the mouse-telegraph signals danger, till you confess yourself guilty of a blunder, and consent to pay the rogues their black-mail anew.

Is it otherwise with larger animals? the deer-stalker, the elephant-hunter, the chamois-shooter, the lion-slayer have a similar tale to tell us of their mightier prey. The field-naturalist more than corroborates all that they tell. There is not a single tribe of social gregarious animals, great or small, which has not some swift, subtle but perfect system of signals, by which the wants of the community are expressed and its woes cured. And even among solitary creatures, who that has seen the geometric spider (to name none other) sitting at the central bureau and receiving station of his extensive telegraphic system, and as signal succeeds signal along the radii of his spoke-like lines, has not thought he heard him reading off the symbols "fly market tight," "blue-bottles looking up," "midges easy," "thunder in the air."

Man then is not distinctively a telegraphic *animal*, neither is he preëminent as such. But he is a telegraphic *creature* in a way no mere animal is or can be. If you sum up the motives which lead the lower animals to practise their telegraphy, I imagine that you will concur with me in thinking, that they are mainly three, namely, hunger, love, and war. Of the first, take as one example, as good perhaps as any, the organised mode in which a pack of wild dogs hunt down an antelope swifter than any one of them. The whole pack follows, but not at a common pace. The hard running is done by a few swift-footed leaders who relieve each other at intervals, signalling for help in a very effective, though rather mysterious way.

Of love need I say anything? who is there that has watched the birds from St. Valentine's day onwards, through their courtships, weddings, lovers' quarrels, house-buildings, welcoming of the small strangers, nursing the heirs and heiresses, and sending the young people forth into the world, and is not familiar with the wondrous ways in which they silently speak to each other?

As for war, let the stags at this moment fighting with each other, and belling defiance across the Highland hills, and all the other pugnacious male animals in the world testify, that without trumpet or drum, herald's flag, or champion's gage of battle, they can throw down and take up the gauntlet, announce a *Casus Belli*, and proclaim peace and war as perfectly, and with far less needless diplomacy than we. Take however, as still more striking that strange military proceeding, that *Coup d'Etat* of the bees, when they put their hives under martial law, and slaughter the drones. How the matter is managed, no one I suppose exactly knows, but there is plainly perfect concert among the slayers, and utter disconcert among the victims. What massacre of St. Bartholomew, Indian mutiny or the like, can vie with this as an act of effective, premeditated murder!

Such then are the leading motives to animal telegraphy, and we share them to the full; but our telegraphy cannot be understood, till, in addition to hunger, love, and war, you have counted religion and commerce among the motives which lead men to communicate with their distant brethren.

To religion I make but a passing reference, for this is neither the place nor the time for dwelling on it; but let me remind you, that from the beginning no cause has been more operative in at once dividing and uniting men. All history, sacred and profane, the legends of all nations civilised and barbaric, abound in references to the mighty influence which man's recognition of himself as an immortal, has had upon his journeyings and his intercommunings.

In whatever other aspects the children of Adam have differed from him, they have all taken up the pilgrim's staff, and wandered through the world, seeking the lost Eden which in this earth none of them has found. Babylonian, Assyrian, Egyptian, Hebrew, Greek, Chinese, Indian, African, European, American, all have gone to distant shrines, to sacred temples, to spots favoured by the Divinities, to seek peace, to offer thanksgivings, to propitiate wrath, to call down judgment on the oppressor, to avenge the innocent, to punish the impious. Take the Crusades, a neutral example of this, midway in time between the most ancient and the most modern religious missions, half-Pagan, half-Christian in character, and nearly barren of direct result, and consider what an immense effect they nevertheless have had in quickening the communication of ideas on all subjects between the Northern and Southern, the Eastern and Western worlds.

The other peculiarly human, supra-animal parent of the telegraph—namely, commerce, is one on which I, as professor of industrial science, have a peculiar call to dwell. But at present I would only urge, that although the gigantic development of commerce which our eyes have witnessed, was undreamed of by our fathers, it did as much in degree for them as for us.

To myself, indeed, few considerations are more striking than that almost all the famous voyages of the world have been industrial in character. They were warlike because they could not help being so, for the Ark was the only memorable ship that sailed unarmed. They were religious, for no nation, however strongly it believed that the devil cheated Adam out of Paradise, gave Satan the credit of putting a spade into the exile's hand, and bidding him earn his bread by the sweat of his brow ; and none of them have been ashamed to ask God's blessing on them when they ventured on the sea. Nevertheless, I think I am not wrong in stating, that purely warlike, and purely religious naval expeditions, have been much more accessory, and episodical, than leading events in the history of the world.

Strangely enough that most aristocratic badge and symbol of lordly leisure, the order of the Golden Fleece, which emperors wear and kings covet, is the memorial of that almost archaic Argonautic expedition which the semi-mythical Jason led forth to the nearest gold-nugget land, the California of his day. Great Britain is now the light and envy of the world, not because foreign priest or warrior foresaw and ministered to its destiny, but because the Phenicians, the most adventurous sailors of classical antiquity, had discovered that it produced the best of tin and the best of oysters.

The Hebrews did not voyage much. But the sacred chronicles do not count it beneath them to tell us that they did make industrial voyages. "King Solomon's ships went to Tarshish with the servants of Hiram. Every three years once came the ships of Tarshish bringing gold and silver, ivory and apes, and peacocks." (2 Chron. ix. 21.)

Vasco di Gama sailed from Portugal round the Cape of Storms in search of a new route to the treasures of the East. The greatest perhaps of admirals, Columbus, a most noble, brave and religous man, went forth avowedly to seek an El Dorado and to enrich Europe with the gold which the far West contained.

Lastly, though for the time its fame is under eclipse, let us not forget the ever memorable voyages of the Agamemnon and the laying of the Atlantic cable. It has been likened to a sea-serpent, and to many seems at present to have nothing living in it but a sting in the head and a sting in the tail. But even a dead serpent is a wondrous thing, and the inanimate body, if it be inanimate, of this one, will serve, like the bones of perished camels in the desert, to show others the path of safety. The serpent's teeth which Cadmus sowed, have borne this serpent among other things, and by-and-by it will coil round the world, increasing by its abolition of Time, its ancient claim to be the symbol of Eternity.

If then, we add all these motives together, and look upon man as the paragon of animals on the one hand, and as but a little lower than the angels on the other, our wonder will be, not that he does telegraph, but that he has been so long of bringing telegraphy to its present perfection.

On this point, suffer me to make two remarks. In one respect our forefathers were more telegraphic than we are, and mankind are more telegraphic than all the animals taken together. The circle within which animal intelligence busies itself, is strictly limited to this earth ; but we, and most of all in ancient times, have instinctively realised that there were other worlds in space than our globe, and other intelligences in the universe than ourselves. That they should be utterly indifferent to us, that they should be devoid of all power of communication with us, is not a thought that has ever been welcome to men. They have rather gone to the opposite extreme, and assuming as certain that from all the regions of the universe telegrams are ever proceeding to this earth, have only busied themselves with inquiring in what language the signals are sent, and how they may be deciphered. Take as an example the world-wide faith in astrology. We speak of it as an extinct science ; yet, let but an eclipse of the sun happen, or a comet visit the evening sky, and in a moment we are all astrologers. In vain do you tell the gazers on such spectacles, that a solar eclipse is only the moon acting for the time as a candle-extinguisher to the sun, and give them bits of smoked glass to look through, and draw diagrams on the blackboard to explain it all. They listen composedly, with blackened noses, and seem convinced, but in their secret hearts they are saying, "what though you can see it through a glass darkly and draw it on a blackboard, does that show that it has no moral significance? You can draw a gallows or a guillotine, or write the Ten Commandments on a blackboard, but does that deprive them of meaning?" And so with the comet. No man will believe, you do not yourselves believe, that the splendid stranger is hurrying through the sky solely on a momentous errand of his own. No! he is plainly signalling with that flashing sword of his, something of importance to men. "A good vintage-year," say some ; "a warm winter," think others ; "a star-making, a sun burning done," guess the wise ; —something at all events that, if we could make it out, would be found of huge concern to us.

Nay, what is astrology to wonder at, when you recognise the fact that there are men, otherwise shrewd and sober-minded, who believe and teach that disembodied spirits in the invisible world spend part of their leisure in learning Mr. Morse's dot-and-dash alphabet, and are at all times haunting about houses, like Edgar Poe's raven—

> Tappping, gently rapping,
> Tapping at your chamber door,

seeking permission to rap on your table, and to reveal to you secrets of the world of spirits, which seem in general, when revealed, not worth the learning! This is the very madness of telegraphy. I refer to it as proving the insatiable desire which man has to place himself in communication with every other intelligence in the Universe, a far higher form of telegraphic instinct than that which actuates the lower animals, and a proof, in spite of all its aberrations, of his greatness.

This feeling was far stronger in the elder races than it is in us. We are impatient of the symbolism which they cherished. We grope in the dark, and miss or mock at the meaning, where all was light and brightness to them. The symbolism of the Hebrews alone is clear to us, for the thing signified has been revealed as well as the sign. The Star in the East was a telegraphic signal which the Chaldean Magi knew how to interpret, and did not fail to obey ; and from the day that

Abraham set forth from his Patriarchal home till Jerusalem fell, the chosen people were taught by God, at sundry times and in divers manners, till all other signs were swallowed up in the Cross, and the very stars shaped themselves into it in the Southern sky.

But for us, in these later times and northern regions, telegraphy is a concrete, unsymbolical, articulate thing. When the deluge assuaged, God uttered His telegram, that earlier form of the *Gloria in Excelsis* which we call the rainbow, and Noah sent forth his telegraphic messenger, the dove, which returned with the olive leaf in its mouth. To us, that first of carrier-pigeons is more significant than the rainbow, though even the Ethnic Greek saw in it a divine lesson, and made Iris the messenger of the gods.

Nevertheless, our telegraphy is a divinely ordained, divinely blessed thing. The thousands of miles of electric wire which already span our globe, cannot fail to strike every one as the equivalents of those nerves which unite in sympathy all the members of the body. The analogy is no far-fetched one, but presses itself upon every thoughtful man's notice. But the nervous system is the last and highest development of every organism, and it shows how the world is ripening and advancing, that its telegraphic wires are multiplying so fast.

First in time, we had in our earth but the granite skeleton with its ribs of basalt and flinty bones. Then the flesh-like clay and turfy sward covered these, and all the arterial rivers and compensating vapours flowed to and from the heart-like sea, and the respiration of the mighty winds stirred the waters by their breathing. But not till now have we seen the nerves sprout thick and fast, and change the half sentient organism into a universally sympathetic, and as it were boundlessly intelligent being.

What mighty things the metallic nerves of the world already are you will judge from a few data. Telegraph lines now stretch from Norway to the shores of Africa; from Nova Scotia to the Gulf of Mexico; from Great Britain they spread westwards to Newfoundland, and eastwards to India; the greater part of Europe and North America is netted over with them; a considerable part of Asia and Australia; and a portion of Africa. Every week some addition is made, and the day is not far distant when all the cities of the world shall be as near each other in time as the churches are in one of these cities, and "the electric shock of a nation's gratitude" shall be reckoned a bare fact, and not a poetical simile.

The telegraphic lines I have named, extend over more than a hundred thousand miles, and include many hundred thousand miles of wire. The metal in them would constitute, if massed together, a mountain weighing more than fifty thousand tons. The subterranean and submarine lines consume many hundred tons of gutta percha, besides accessories. On the air lines we must count the poles as well as the glass and stoneware insulators, by millions. The batteries amount to thousands, and demand a lake or river of sulphuric acid to excite them. The magnets are not less numerous than the batteries, and of lesser instruments the name is legion.

The materials employed in the construction of these components of the telegraphic brain, and spinal cord and nerves of the world, represent all the quarters of the globe. Norwegian and Canadian wood, Swedish steel, English iron, Australian copper, Silesian zinc, Singapore gutta percha, Russian hemp, Sicilian sulphur, African palm oil, South American platina, and other ingredients from every region of the world.

The arts involved, who can patiently enumerate? Consider for yourself what felling of forests there must have been! What quarrying, and mining, and dressing of metallic ores! What smelting and working of metals! What tapping of gutta-percha trees! What digging of coal and sulphur, and blazing of brimstone to make oil of vitriol! What loading of ships and guiding them safe across the seas of the world! and all this but the preparation of the raw material!

Add its elaboration and application! The navvy work of laying lines, spinning cables, erecting posts, and otherwise fitting together the ruder components of the telegraph; and the multiplied artistic skill in constructing batteries, dials, alarums, and other refined apparatus required upon the line; and the staff of officials needed night and day to make all this dead machine a wakeful, working thing! Consider all this, and some one better at ciphers than myself must take the census, and reduce to figures the mighty army and navy who at every moment are unconfounding the confusion of Babel and solving the problem of a universal tongue.

Lastly, do justice to the authors of all this, and consider how vast is the genius which our telegraph represents. All that the world knows of electricity since first there was a thunderstorm; all that the world knows of magnetism, since first a loadstone was seen to lift iron dust! All that the world knows of a science, whose name chemistry has left its first meaning in the forgotten darkness of antiquity! All, moreover, to be brief, that the entire circle of the sciences unfolds since first history recorded their number, and gave us the means of predicting their progress!

In saying this much, however, there is some anticipation. What, after all is a telegraph? So far it speaks for itself. As its name implies, it is a device for effecting the communication of knowledge between distant places, and enabling mankind to overcome the obstacle which space presents to their speaking eye to eye. In addition, however, it carries with it the conception of such intercommunication being effected *swiftly*, and, in a word, seeks to annihilate, so far as may be, time as well as space. The practical aim of the telegraph is thus to enable two persons, each at the antipodes of the other, to converse together as rapidly as if they were sitting side by side.

Now to approximate even afar off to such a result, still more to realise it, in other words to telegraph, however slowly and restrictedly, requires three agents:—1. A message-sender. 2. A message-carrier. 3. A message-receiver.

All are of equal *importance*, but the second is of greatest interest, inasmuch as it is the most variable of the three, and one which has been most largely changed in the progress of time, since men first systematically telegraphed to each other. A sure, swift messenger, able to carry on each journey a reasonable burden of messages, is plainly the great desideratum. The medium, the cipher, or symbol in which the information to be sent, shall be imbedded by the sender, and from which it shall be liberated or interpreted by the receiver, is as plainly of far less moment. There is in truth but this restriction, that the latter shall witness a *visible* or *audible* signal, something that speaks to the eye or speaks to the ear. No doubt signals addressed to the organ of touch might be used, as in truth they are sometimes employed, but their application is very limited, compared with that of a sight or a sound.

Accordingly, in all ages and countries, men have addressed their telegraphic signals to the eye, or the ear, or to both. Two important professions specially employ one of these organs. The sailor, famous for his long-sight, deals preëminently in visible signals. The soldier, whose ear never sleeps, deals in audible ones. The flag is the symbol of the one. The bugle or drum the other.

It would be very instructive, had we time for the enquiry, to notice how essential to the art of navigation is an elaborate system of telegraphy. From the moment he sets sail from one port, till he furls his canvass in another, the sailor is constantly looking out for, and receiving telegrams. Church-steeples and towering cliffs, floating buoys, and harbour-lights beckon him forth, and guide him out to sea. In mid-ocean his eye is constantly scanning the horizon, watching for sister ship, or floating wreck, or the surf breaking on a rock unmapped in his chart. The barometer is for him a telegraphic dial, telling by its fall, of the far distant storm which is signalling thereby its rapid approach. The thermometer is a telegraphic dial, telling by *its* fall, of the unwelcome neighbourhood of the invisible iceberg. The plummet is a telegraphic dial, telling by its shortened line that land is ahead. At midday the sun telegraphs to him his place on the earth's surface. At midnight the north star warns him if his compass needle is wrong, and all the planets help him in his course. If he is sailing in unknown seas, the wind brings him as it did to Milton's voyagers the smell of spices from some Araby the Blest, or the waves carry, as they did to Columbus, a fruit-bearing branch to his vessel; or a singing bird alights on his shrouds, and repeats the story of Noah's dove, and though the dialect is strange, every sailor knows that the song is of the hidden woods; or a carved stick drifts by, and the pilot can tell that to windward there is an invisible land with fruit-bearing trees, and melodious birds, and strange industrial men. When he passes a sister ship, he silently flutters some flags from his mast-head, whilst the stranger does the same, and the landsman wonders to see the faces of those on board brighten or sadden as the streamers blow out in the wind. And at length, when at midnight he nears his own shores, he looks anxiously forth till the lighthouse appears, and its revolving lamp sweeping the horizon, fixes on him for a moment like the eye of a mother, and welcomes him back to his native land.

No telegraphic message which electric wires have transmitted, is more memorable than that famous one which Nelson sent round the English fleet before Trafalgar, when the flags signalled "England expects every man to do his duty." None is sadder than that displayed when a Greenland whaler returns to one of our Northern ports undressed in flags, and the weeping mothers and wives, the sisters and daughters and sweethearts know afar off that some dire calamity has befallen the vessel! None begets more gloom, than when a ship at sea, about to be visited by the boat of another, hoists the yellow flag to tell of pestilence aboard! None is more exasperating to brave seamen than when a manifest slaver telegraphs through a false flag a cowardly lie, and escapes justice for a season! None is more painfully startling than when the waves cast ashore that strangest, saddest, slowest and most uncertain of message-carriers, a corked bottle, with some scrap of pencil-writing inside, placed there just before the ship from which it was flung went down. All across the Atlantic and back again, round and round in the whirl of the Gulf stream, some such telegraphic bottles have floated, and for long, like the spectre Dutchman, have sought a haven in vain, but in the end they have reached a port, and delivered their news of a far country and a forgotten time.

It would be easy to draw a similar picture of the significance and value of audible signals from the church bell to the cannon boom,—but you can draw it for yourselves. Assuming, then, that special sights and sounds shall be the letters, the words, or the full utterances of our telegraphic alphabet and language, we may divide telegraphs into two great classes—

1. Fixed or stationary.
2. Locomotive or propulsory.

Of the first, we cannot stop to consider—the finest example perhaps, is the lighthouse, with its stately tower, through the day *passively* warning and guiding the mariner, and its bright lamp through the night *actively* keeping watch and ward over the sea; now glaring with menacing crimson eye on some ship wilfully rushing to destruction, and then its eye, no longer blood-shot, piloting with affectionate encouraging glance the home-returning mariner, who has gone so slowly round the world that he scarcely knows his first harbour again.

The second, or moving telegraph demands a twofold division, according as the telegraphic message-carrier is itself, on the one hand, a travelling or locomotive man, animal, or engine; or, on the other, an imponderable physical agency or mechanical force.

A symbol carried by conscious or unconscious living agents is perhaps the oldest form of telegraph; and when we replace the living carrier, human or animal, by a locomotive machine guided by man, we have the most modern form but one before reaching the electric telegraph.

Although, however, the distinction is arbitrary and shadowy, it is convenient to exclude from our definition a *spoken* message, whether it has been orally delivered by a traveller who has singly marched with it from its utterer to its receiver, or has been carried by relays of men from the one to the other; and also to exclude a written message similarly conveyed or transferred by a locomotive machine, which constitutes our modern postage system. In reality, to telegraph is to speak *to* a distance, or to write *to* a distance, and so is essentially a division of language; but for the sake of brevity it is desirable to omit spoken words and written epistles from our present consideration.

The rapid transmission of a symbol has been the practice of all nations. As illustration, take that striking example from the history of the Hebrews recorded in the close of the Book of Judges, where the wronged Levite whose wife has been foully abused and murdered, cuts her dead body into twelve pieces, and sends one to each tribe of Israel to summon it, sword in hand, to avenge the crime. Or take that ancient custom of our own country, celebrated by Sir Walter Scott in the Lady of the Lake, where the Fiery Cross was sent through the Highlands to summon the Clans to arms. Or take that current custom in the East, perhaps at this moment in vogue, which roused the Sepoys to mutiny by sending from district to district a piece of bread, or a particular flower, and which nearly won the day against our electric telegraph.

Examples might be multiplied endlessly, for it has never been difficult for men to devise or interpret symbols, which in the absence of written or spoken words should convey their meaning to each other.

The great difficulty is to traverse space and time with the symbol; to give meaning to the first four, not the last five, letters of the word tele-graph.

Now the swiftness of man's foot can do much for us, and still more the swiftness of the horse, or the camel, as witness the feat of the Tartar couriers in carrying to Europe the news of the Chinese treaty. And when these fail us we can employ the wings of the carrier-pigeon, and when it flags the steamer and the railway locomotive will take up the running for us. But all are too slow for a generation so fast as ours. We will not give our kingdom for a horse, not even a horse with wings. The only agents that can tempt us are sound, or light, or electricity; and the first is so much slower than the last two, that we use it only for short distances

Light is no laggard. If we could raise a luminous signal to such a height above the earth as the nearest star, or even the nearest meteor, we might make it, like the comet, speak to a whole hemisphere at once. But we could not even thus speak round the globe in the fairest weather. Accordingly, when luminous or illuminated signals, such as rockets and moving arms, have been employed, as they were in our Admiralty semaphore and in the French telegraph till recently, it has been necessary to repeat the signal from station to station, for the curvature of the earth's surface hid comparatively near points from each other, even in the clearest atmosphere; whilst, worst of all, illuminated signals were nearly useless at night, and they as well as luminous ones were totally so in fogs or cloudy weather.

Electricity is free from those objections. It is far swifter than sound or light. It is not afraid of the dark; it is not alarmed at the sea, and it can travel in all weathers. One could almost imagine that our old ballad writers, such as the author or authors of Gill Morice, prefigured it in their half-goblin messenger, of whom we are told—

"And when he came to broken bridge,
He bent his bow and swam;
And when he came to grass growing,
Set down his feet and ran.

And when he came to Greenwood Hall,
Would neither knock nor call;
But set his bent bow to his breast,
And lightly leaped the wall."

The highway for this subtle spirit, which, together with the generating and propelling electromotive apparatus at the one end, and the receiving and recording instruments at the other, constitutes the electric telegraph, is in one sense the lineal descendant of the older methods of speaking and writing to a distance.

Directly it is the child of the penny post, and the grandchild of the railway locomotive, to which it shows its affinity by clinging to the railway. The locomotive is the child of the river-steamer, which is the child of the mining steam-pump, which is the child of the thermometer and the air-pump, and that brings us to the early part of the XVIIth century. If we go further back we shall find in its genealogical line, the printing press, the mariner's compass, and gunpowder.

Let no one suppose that this most imperfect genealogy is offered as explaining why the world had to wait till the middle of the nineteenth century for its electric telegraph. It might have come centuries sooner, or centuries later, and by a totally different descent from that which it followed. History is the record of the one possibility out of thousands, which God selected and made the actual fact, and we must ever regard it with the eyes of optimists, and believe it to have been the best. But this opinion is often more a matter of faith than of sight, and we continually cheat ourselves into the belief that we have explained the genesis of a thing, because we have placed it last in a procession of events. By so doing we at least succeed in putting the difficulty to a distance ; but we often only render it the more perplexing, like the Hindoo astronomer, who places the world on the back of an elephant, and the elephant on the back of a tortoise, and stops there, leaving the tortoise to explain, if it will, how it rests upon nothing.

I would avoid this error, but I cannot be wrong in affirming that whatever in past ages led to the wide dispersion of men over the globe, and increased their means of communication with each other, contributed to the birth of the telegraph. And therefore Bacon's three marvels, gunpowder, compass needle, and the printing press, must be regarded as not merely antecedents in time, but as casual antecedents of the electric wires ; and so must those three modern but equal marvels, the steam ship, the steam carriage, and the railway. Bacon, you know, put on the title-page of the 'Novum Organon' in 1642, the words of the prophet Daniel : *Multi pertransibunt, et augebitur scientia,* "Many shall run to and fro, and knowledge shall increase," writing the words below a ship sailing beyond the pillars of Hercules, the gates of the Mediterranean. These words, like all great prophesies, are still as significant as ever, and might be inscribed above every dock gate, railway station, and telegraph office.

But besides the social antecedents and parents of the telegraph, we must consider the purely scientific ; and we find their common starting point in the compass needle. As the guide of Vasco di Gama to the East Indies, and of Columbus to the West Indies and the New World, it was preëminently the precursor and pioneer of the telegraph. Silently, and as with finger on its lips, it led them across the waste of waters to the new homes of the world ; but when these were largely filled, and houses divided between the old and new hemispheres longed to exchange greetings, it removed its finger and broke silence. The quivering magnetic needle which lies in the coil of the galvanometer, is the tongue of the electric telegraph, and already engineers talk of it as *speaking.* The electricity sent along the line is the silent Moses with his wonder-working rod ; the magnetism in the needle is the vocal Aaron speaking as his brother wills. Altogether the magnet is a wondrous twofold bridge over time and space. It is truly named a *needle,* for it has threaded together by an invisible line forgotten centuries and the century that is, and has woven together the north and the south, the eastern and the western worlds ; and not less truly is it named a *compass,* as compassing the most distant epochs and the widest horizon.

The magnet, however, did not till 1820 directly aid the telegraph, the chief steps in the progress of which are as follows. We strike sharply, in beginning, on a definite date, 1600, when Gilbert of Colchester studied the electrical relations of the magnet, and introduced the *word* electricity. Whether we call ourselves nominalists or realists, we have double faith in a thing when we are able to give it a name. The recognised and titled electricity made rapid progress. The lump of amber was changed for a fragment of sulphur, which soon grew into a globe, and was by-and-by replaced by a glass sphere, a cylinder, or a plate, whirled rapidly, and constituting an electrical machine. To make this advance took men an whole century, which we may call the epoch of the electrical machine. By the beginning of the eighteenth century, however, they knew well how to produce electricity but not how to manage it.

In little more than a quarter of a century they had learned that some bodies *conduct*, and others do *not* conduct electricity, and were in possession of the essential halves of an electrical highway or telegraphic line, namely, conductors free through half their length, and insulated through the other half by non-conductors.

Four years before the half-century (1745), the Leyden jar was stumbled on. It was literally an electrical condenser, and did as much to enhance the power of the friction machine, as Watt's steam condenser did to enlarge that of the steam-engine.

Provided with the Leyden jar, the next two important telegraphic discoveries were speedily made : the one that electricity traverses a metallic wire with inconceivable rapidity; the other that it travels with equal celerity through earth or water. Here, then, were two-thirds of the telegraph supplied ; the message-sender was there, and so was the message-carrier. Why did no one think of providing a message-receiver, the easiest part of the business ? In truth men did provide one, but his office was a sinecure. Scarcely a message reached him, and the few that did were too confused to admit of interpretation.

The fault lay with the sender. Friction electricity is so brief in duration, and so intense and impetuous, that it cannot be induced to take a long journey. The best conductors in their best state of insulation are still unwelcome to it. If there is the least obstacle in any part of its path, it turns off, as it were, at a side station, and returns by the shortest route with its message undelivered.

No improvement was made for half a century on the conductors, and electrical telegraphy remained at a stand-still till the beginning of the nineteenth century. It should have dated from exactly the second centenary of the naming of electricity ; for in 1800 the voltaic battery, already some years in use, was ascertained to produce chemical decomposition, and in that instrument we have a machine producing a continuous stream of electricity far less impetuous and reluctant to travel than the electricity of the friction machine, and still more able by its decomposing power to produce record signals. A voltaic battery as message-sender, wires as message-carriers, and a ribbon of chemical paper on which the current carried by the wires prints signals in Prussian blue, as message-receiver, is one of the best and most common arrangements now in use.

We had to wait, however, twenty years longer, till two famous additional discoveries were made, the one that the electrical current deflects the compass-needle, the other that the electrical current developes magnetism. Our earliest electric telegraph, and to this day the majority of telegraphs are electro-magnetic ; in other words employ electricity to produce signals, either by moving a permanent magnet, or by making a temporary one.

But one statement needs be added. The land telegraph was now in essentials complete, but a sub-aqueous telegraph was still impossible for want of a good insulator. Great historical importance, accordingly, attaches to the importation, in 1843 of gutta-percha, which enabled us to have a submarine cable as early as 1850.

On the submarine telegraph I will only say that the peculiar electrical difficulties which have vexed the Atlantic cable engineers, arise from our having as it were stumbled again, as our forefathers did in 1745, on the Leyden jar. They were trying to electrify water, and in so doing, converted unwittingly, and much to their astonishment, a wet bottle into what we now call a Leyden jar. We were trying to cross water electrically, and as unwittingly converted a wet wire into a Leyden jar. But the explication of this second Leyden arrangement is likely to do as much for submarine telegraphy, as that of the first did for the land telegraph.

In spite however of all difficulties, we have done wondrous things already with our telegraph, and we need not be surprised nor lose heart, if we have to make as many voyages as Columbus did, before we rival him in bringing the old and new worlds together.

Let me offer you two feebly outlined word pictures of events which were transacted on the same arena, at the interval of nearly four centuries. The epoch of the first is the autumn of 1492. The scene is the mid-Atlantic, and on its bosom floats the frail caraval of Columbus. It is midnight, and the astonished pilots are gazing with awe on the compass-needle which has ceased to point to the north-star, and has veered round to the west, and they ask the great admiral what this unheard-of variation may mean. To him it is a mystery as well as to them, but he has an explanation which contents them, and for himself, however mysterious it may be, it is anew the finger of God bidding him sail westward still, and he follows its new pointing, till it lands him on the shore he has so often seen in his dreams.

The time of the second picture is 1858, the scene as before, is the mid-Atlantic, and on its bosom a great English steam-ship is silently gliding with every sail furled. It is midnight again, and the sailors, as in the caraval four centuries ago, are gazing with intense eyes upon a quivering needle. It is not however, a mere compass-needle ; but armed with a tiny mirror, it lies in the centre of a coil of wire looped to the great cable which, as electric signals pass along it, is every moment bringing the old and new worlds nearer each other in time. Every quiver to east and west that the needle makes, as the voltaic current sweeps round the coil, flashes from the mirror a spot of light on a screen, and marks a step in progress; and all watch the face of the electrician, William Thomson, the Columbus of this voyage, to whom alone these spots of light are intelligible and eloquent of success. And so the mirrored, flashing galvanometer sways about, till the voyage ends, and then *Gloria in excelsis* is literally quivered in light, as it was by its first singers, the angels, and in unconscious repetition of its chaunt by the kneeling crews of Columbus, four centuries ago.

It would be foolish to speak of the second voyage as equalling the first; and the name William Thomson has a homely sound beside that of Christopher Columbus; but four centuries hence the former will sound less harsh, and the scene over which he presided will appear no unworthy counterpart to that in which Columbus stands as the central figure.

Let us wish all success to the telegraph everywhere. The best interests of the world are bound up in its progress, and its mission is emphatically one of peace. It does not merely speak swiftly but softly, and it offers men a common speech in which all mankind can converse together.

If you stand at any time beside a telegraph-post, you will hear the wind playing on the Eolian harp of the stretched wires, and evoking from them the sweetest music. They sing at their work. Whatever the message may be, *Death of Czar Nicholas, Wedding of Princess Royal, Relief of Lucknow*—they speed it along the line: but all the while they sing, and these are the words I last heard them singing:—

Men have spoken, men have dreamed
Of a universal tongue;
Universal speech can be
Only when the words are sung:
When our harp has all its strings,
And its music fills the air,
In a universal tongue
All the world shall share.

ON DYEING.

BY W. EDMUNDS.

So numerous and of such importance are the applications of chemistry to the art, that scarcely any of them can be successfully or profitably carried on without the assistance of this science, as it indicates the nature and inherent properties of all material substances, and points out as the result of experiment the laws regulating their composition and decomposition. Though the science of chemistry is daily becoming more and more perfect, yet many arts attained, when chemical science was in its infancy, great excellence—an excellence which, in some arts cannot be surpassed in the present day by the most experienced manufacturers—and in some cases processes have been entirely lost and cannot be recovered by our most skilful chemists. That many chemical phenomena should have been discovered in ancient times, and afterwards lost, is not to be wondered at, for in the early periods of chemical science, many of these phenomena were the result of chance experiments, the chemical laws governing the various changes being unknown, and consequently were lost as time lapsed.

To every seat of the arts chemistry descends, where it changes the forms and the qualities of the productions of nature, enabling them to be appropriated in a thousand different ways to our wants. The dyer, tanner, distiller, bleacher, the soap and candle-maker, the manufacturer of glass, porcelain, and sugar, the brewer, gas-factor, photographer, the etcher upon copper and steel, the lithographer, and many others, are all more or less beholden to this science for the perfection to which their several arts have arisen. By its aid we learn how to extract the metals from the combinations with which they are found in nature—how to fuse, purify and alloy them. It gives to waste materials new and increased value, for the chemist, by research and experiment, points out the application of matters supposed to be effete and useless, to some beneficial purpose. In the present day the manufacturer must possess a certain amount of chemical and scientific knowledge, so vastly are the arts indebted to chemistry for all improvements in their various processes, and especially if he would compete successfully with others in his productions. The manufacturer, by pointing out new processes, and discovering new materials, which cheapen the products of his art, is enabled to bring within the reach of the many the comforts and luxuries which otherwise would have been confined to the few. How necessary it is for the manufacturer of soap, if he would successfully and economically carry on his manipulations, that he should understand the affinities existing between the various oils and alkalies ; to the candle-maker, that he should understand the decomposition of fats and oils into their acids and bases—he must learn the nature of fatty bodies, and know how to separate the superfluous matters of fats and oils from those parts which he requires in his art. The extraordinary improvements that chemistry has effected in this one manufacture is surprising. Before 1811, the candle manufacturer had only tallow, wax, and spermaceti at his disposal, and the great desideratum was to obtain substances possessing a certain amount of hardness and compatibility; the great objection to tallow, besides its disagreeable odour, is its want of uniformity in consistence—tallow being formed of two fatty bodies, one oily and soft, the other firm and hard ; consequently, when burning the soft portion melts first, and we have what is known as guttering. In 1811, a French chemist, M. Chevreul, by his researches, explained the true nature of fats, their composition, &c., which up to this period had been veiled in obscurity; he separated fat into solid and liquid constituents, and placed at the disposal of the manufacturer the solid ingredients of fat, stearine, and margarine, possessing the required properties, and as the result, we see in the present day the tallow candle almost entirely superseded by a variety of candles called palm, composite, Belmont sperm, stearic acid, and many others, which almost equal wax and spermaceti in appearance and illuminating power, and from the cheap rate at which they can be manufactured the best varieties are open to all.

In very few cases has chemistry been more successful in its application than in those of dyeing and calico printing. Dyeing is strictly a chemical art. The great object of the dyer is to be enabled to impart to fabrics of various materials, whether of silk, cotton, or wool, certain colouring matters, the colours being derived either from the animal vegetable, or mineral kingdom, and so imparting these colours that they cannot be removed by washing. This art being so dependent upon chemical science, we shall expect to find that its development has taken place of late years only, and that amongst the nations of antiquity it existed in a very imperfect state. Amongst the Greeks and Romans indigo was known, but was used only as a pigment, not as a dye, the nations being ignorant of its proper solvent, it being insoluble in water, though in Egypt and in India this dye was known and used. Madder was also used as a dye, and the kermes insect, for the production of a crimson colour, by these nations; but it is well known the most renowned dye in ancient times was the imperial Tyrian purple, a most costly colour, and worsted dyed with this in the time of Augustus, sold for 36*l.* the pound weight; it was used in dyeing the imperial robes, and exclusively employed for that purpose. It was procured from two shell fish, *buccinum* and *purpura;* a puncture was made in the neck of the animal, and when squeezed two or three drops exuded; or the entire shell-fish was pounded in a mortar, and the fluid thus obtained, collected, mixed with water, and used. The fluid thus extracted was at first colourless, but by exposure to air and light, became yellow, then green, afterwards red, and in twenty-four hours, of a beautiful purple colour. By adding to this dye various alkalies, &c., the Tyrians managed to get shades of this colour. The process for obtaining the Tyrian purple was kept secret and lost, but of late years some French chemists have obtained from these shell-fish, the beautiful purple of ancient days. When America was discovered, several dyeing materials were added to the list, such as logwood, arnatto, cochineal, Brazilwood. and quercitron. But the great improvement in modern times in dyeing, (and this improvement owing to the rapid strides of chemistry) is the addition of colours derived from the mineral kingdom. Thus, about the end of the 17th century, Prussian blue, chrome yellow, chrome orange, manganese brown, prussiate of copper, green, &c., &c., were added to the list, and the use of Mordants became general. We do not, as would naturally be supposed, derive our dyes from the brilliant, and varied colours of plants, for it is found that in those parts of the plant exposed to free air and light, though the colour is brilliant yet it is small in quantity and soon lost. Most vegetable dye colours are obtained from the roots, bark, and berries of plants, which exhibit in their natural state but little of the beauty which is obtained from them by the chemist and dyer. The colours obtained from plants are chiefly yellows, browns, and blues; no proper black has yet been obtained. These are not soluble in water, but require spirits of wine, alkalies, or acids, to dissolve them.

Animal and vegetable tissues and fabrics possess a great attractive power for all colouring matter, whether animal, vegetable, or mineral. The common iron-mould stain is a very good example of the attractive influence of fibre for mineral colour—the iron having combined with the vegetable fibre remaining fixed, no washing will remove it. Dyeing materials may be classified into two groups:—1st. Colours capable of imparting permanent tints to various textures without the assistance of any other substance, these being called *substantive* colours. 2nd. Colours which cannot be permanently imparted without the assistance of a second body, these being termed *adjective* colours.

METALLIC COINS TO SUPERSEDE COWRIES IN AFRICA.

THE following letter from Lord Alfred Churchill to the Secretary of State for the Colonies, deals with an important subject:—

The Council of the African Aid Society have had under their consideration the necessity and advantage of finding some metallic substitute for the cowries, hitherto in use among the natives.

A currency ought to be adapted to all the wants and habits of the people for whose use it is intended. Cowries, as a circulating medium, have been for a long time in use in the countries of the Bight of Benin and the Niger territories. Since the annexation of Lagos to the British Crown, all the English coins have been introduced there. They are coming into use among the natives, but do not suffice for the general wants of that portion of the community. The lowest English coin in circulation is the farthing. The value of this is thirty cowries. But a great many articles of daily consumption are purchased much below that price. Unless, therefore, some smaller coin be introduced, cowries cannot be abolished or replaced as a circulating medium. In the interests of progress and civilization, of which Lagos is an outpost, it is desirable that the currency should be solely metallic.

The Council of the African Aid Society have had an opportunity of seeing the small coins—one mil each—now being struck at Her Majesty's Mint in London, for Hong Kong. Those coins being each one-twentieth of a penny, or one-fifth of a farthing, would be of the value of six cowries. As nothing worthy of mention can be bought for a lower sum than six cowries, those coins would respond to all the minor wants of the native Africans ; while their being perforated, so as to enable them to be strung as cowries are now strung, would render them equally safe and convenient as cowries, while they would not be more than one-seventh of the average weight of the smallest cowries used in the interior trade.

The Council of the African Aid Society beg leave, therefore, to suggest to Her Majesty's Government that it would be advisable, and of great general advantage, to introduce perforated coins of a similar size and value into the currency of Lagos, Cape Coast, &c. The Council also beg leave to suggest that the perforation, in a similar manner, of other coins intended for circulation in native Western Africa, would tend greatly to facilitate their use and favour among the people.

PROGRESS IN SILK CULTURE.

A native silkworm has been discovered in New England, and is now in the way to be extensively reared and disseminated to the great advantage of the country. Mr. L. Trouvelot, as we learn from 'Silliman's Journal' for March, a gentleman living in the town of Medford, near Boston, has succeeded in rearing successfully, and in great numbers, the native worm known scientifically as *Attacus polyphemus*, and in preparing from its cocoon an excellent quality of silk, possessing great lustre and strength, and pronounced superior to Japanese and all other silks, except the best Chinese, by competent judges. The silk is unwound by a simple process perfected by Mr. Trouvelot, each cocoon yielding about 1,500 yards.

This insect is very hardy, being found throughout the Northern States and Canada ; and as it feeds upon the leaves of the oak, maple, willow, and other common forest trees, may be easily reared in any part of the country. Mr. Trouvelot has gradually increased his stock from year to year, by raising young from the eggs of the few individuals first captured, until he has at present seven wagon-loads of cocoons, the entire progeny of which he proposes to raise during the coming season.

The following report was read before the Victorian Board of Agriculture, by the judges on the specimens of silk for which the Victorian Government premiums was offered :—"The undersigned have the honour to report to the Board of Agriculture, the result of their examination of the samples of silk sent in competition for the Government premiums. They are happy to be able to state that, after careful inspection, they are unanimously of opinion that the specimens exhibited were superior to their anticipations, and such as to justify a belief that silk of a superior order may, in time, be expected to be produced in Australia. Only four persons competed, but the quantity shown by one was considerable, and the quality of two of the four very fair. The strength of the tissue was sufficiently good to render the silk fairly marketable, although not equal to the European standard; which is attributable chiefly to there not being as yet a superior class of silkworms in the country. The reeling, likewise, had been carefully done; but, from want of experience and a trained instructress, it was not executed in the manner required to sell the silk in the French and Italian markets. These are merely the defects incidental to every new industry inaugurated by volunteers, which are easily removable, and in no respect affect the success of this, the first systematic attempt to ascertain the sericultural capabilities of Australia. To proceed to the award. In recommending the premium of 20*l.* to be allotted to Mrs. Timbrell, the judges do so on account of a good average quality being, in this instance, combined with quantity. The quality was not superior to that of the specimens exhibited by Mrs. Lewis, but the quantity was far greater. The industry and care manifested by this lady appeared to give her justly the preference. At the same time, as the quality of the specimen exhibited by Mrs. Lewis is equally satisfactory, the judges would respectfully recommend a second prize of 5*l.* to be assigned to her, if the funds are available, and the board should acquiesce. The specimens exhibited by Mr. Ross were, upon the whole, good, but were deficient in quantity; and the quality was likewise not equal to that of the two first exhibitors. They do not attribute this either to want of skill or care in Mr. Ross; and, as that gentleman has displayed a laudable activity in the promotion of sericulture, they beg to recommend him for an honourable mention. The fourth lot was inferior in quality, but not so much so as to discourage the exhibitor from future attempts. The undersigned would respectfully submit to the board the following recommendations, in case of a similar or larger sum being granted for the encouragement of sericulture in the year 1865":—1. That the number of premiums be increased and the amount diminished, as it is probable that the quality of future samples will closely approach each other. 2. That exhibitors of cocoons may be equally entitled to the premiums with those of spun silk, as the export of cocoons is easy and practicable. 3. That the board would be pleased to exercise its influence in favour of the introduction of a superior class of silkworm from Italy, France, Persia, and China. 4. That the board would, if they approve, recommend the renewal, and, if possible, an increase of the Government grant.—(Signed.) M. L. King, A. Martelli, J. J. Stutzer, Jas. Reid."

NOTES ON THE CANTHARIDES OF THE ARGENTINE PROVINCES.

BY DR. HERRMANN BURMEISTER.

Cantharides belong to a family of *Coleoptera Heteromera*—*i.e.*, of that section of *Coleoptera* which have five joints in the four fore feet, and only four in the hind feet; and this family is easily distinguished from others of the same section by its soft body, less horny on its surface; as also by the form of the hind part of the head, and the cloven claws.

The celebrated Latreille, the first entomologist of his time, has called the family of cantharides "*Vesicifica*," alluding to the caustic properties possessed by many (although not all) of the species. This property seems to reside, not in the fluids, but in the solids of the body, and chiefly in the horny covering; and it is stronger in proportion as that covering is rougher and more metallic. On this account, the European Cantharis is probably one of the most efficacious, for it is most resplendent in its golden-green metallic lustre.*

The family of the *Vesicifica* is divided into two principal sections, viz., *Meloides* and *Cantharides*. The former have no wings, and the elytra are usually short; but the latter have no elytra, and are furnished with wings.

Amongst the *Meloides* there is one species *Meloë Proscarabœus*, which was at one time considered an antidote to hydrophobia. We have in this country (the River Plate) only a single species of this section, viz., *Meloë miniaceo-maculatus*, figured in D'Orbigny's 'Voyage to South America' (*Insect* tab. 15, fig. 6). I have found this insect (which is easily recognised by the red spots on its small elytra) a few times in the interior of the province of Buenos Ayres. Another species, the *Meloë Klugii*, described and figured by Brandt and Erichson, in the 'Transactions of the Acad. Cæsar. Leop. Car.,' vol. xvi., pl. i., p. 103, t. 8, is found in the Banda Oriental. I have myself collected, during my travels in the Argentine Provinces, two new species,—the one in Mendoza (*M. sanguinolentus*, nob.), the other in Catamarca (*M. ebeninus*, nob.). These four species are hitherto only known to exist in this part of South America.

The *Cantharides* are far more numerous, not only in other countries, but also in the Argentine Republic. Entomologists divide them into various genera, of which I have met with the following in this country:—

1. *Horia maculata*, Fabr.—This lives with the great bees which make

* [It may be observed, however, that *Mylabris Cichorii*, Fabr., which is devoid of metallic brilliancy, has vesicating powers quite equal to those of the common cantharis.]—Ed.

their nests in the trunks of vines, and are called *Mangangas* (*Xylocopa*). The beetle destroys the bee by eating up its food, and even the bee itself in the grub state. It is the largest of all our native cantharides, being above an inch long. It is of a yellow colour, with black spots on the elytra.

2. *Tetraonyx*, Latr.—This has the body more robust, shorter, and proportionally broader, than the other genera of the same family; it has also the antennæ less elongated and rather thicker; and the tarsi short, with broad triangular articulations. I have collected three Argentine species of this genus, one in Tucuman, two in Mendoza.

3. *Cantharis*, Latr. (Lytta, *Fabr.*)—Body longer or shorter, narrow; antennæ long, slender; feet elongated, with narrow slender articulations; these characters distinguish the true Cantharides from the allied genera. It is the most numerous group of all, containing above 100 species. I have collected in the Argentine Provinces, up to this date, eight species, of which only three were previously known. I shall confine myself to naming these three, which are:—

Cantharis adspersa (Lytta adspersa, 'Klug, Nova Acad. C.L.C.Ac.,' vol. xii., pl. 2, p. 434, t. 25).—It is this species which is known here as the *Bicho moro*, and is so abundant in our gardens, where it does great damage by eating seedling plants. I have found it also in the Banda Oriental and in the province of Mendoza.

Cantharis punctata (Lytta punctata, 'Germar, Spec. Insect Nov.,' i., 175, 287).—Very like the *Bicho moro;* but the elytra are more strongly marked with black dots, and the feet are of the same brownish black as the rest of the body. I have found this in the Banda Oriental and in Entre-Rios near the Paraná.

Cantharis vittigera, (Pyrota vittigera, *Bl.*, *D'Orbigny*, 'Voy. Entom.,' 200, t. 15, f. 7).—Collected on the Paraná.

The last of these three species is naked on the surface; the other two have a very fine brown pubescence, with naked points. The remaining species are clothed in the same way, except one very small one from the Banda Oriental, and another very large one from Catamarca, and Mendoza, and probably along the whole western side of the Republic (La Rioja, San Juan) at the foot of the Cordillera. This species, which I call *Cantharis viridipennis*, is one of the largest of all, being nearly an inch long, of a black colour, with yellow feet, and metallic-green elyta. It is probably, also, the most efficacious of the Argentine species, being the only one that has a metallic lustre like the European species. The apothecaries of Mendoza employ it with very good effect.

4. *Nemognatha*, Illig.—This genus is easily distinguished by the prolongation of the lower mandible into a longish thread. I have one species, hitherto unknown, of a yellow colour, with black antennæ and tibiæ, from the Paraná. I shall call it *N. nigricornis*.

PEPPER.

BY JOHN R. JACKSON.

OF all the senses with which we are endowed, that of taste is, perhaps, the most fastidious ; unlike the senses of sight and hearing, it is not so varied or widely affected by the force of education. To hear and appreciate the eloquence of an oration, needs some cultivated refinement, and is, in consequence, the belonging of a class. As applied to the sight, the same may be said of a fine picture or other work of art ; but with the senses of taste and smell the case is different, though refinement and education undoubtedly lend a helping hand to the full appreciation of both. With the former, however, the likes and dislikes are more affected by nations than classes, and this, in a great measure, is doubtless to be attributed to the diversity of the products of each clime, the love for which is inherent in its people. For example, where can an Englishman find fare so well suited to his palate as in his own land? And a similar question may be asked of other nations, and yet there are countless productions of foreign lands, the uses of which have not become general with us solely through prejudice, and this applies not alone to articles of food, but also to materials useful in the arts and manufactures. It needs a persevering energy to bring new products into the English markets, and it needs even more to persuade the British public to give a fair trial to such products, many of which might become a source of commercial profit besides being advantageous to the consumer. As an example of this, the most familiar illustration is tea, which but 200 years since was scarcely known in this country. The Dutch East India Company having sent, in 1664, two pounds as a present to the king. When, however, an importation of a few pounds took place three years later, there was probably some prejudice against its general adoption. We venture to doubt that, as a new commodity in our own day, the pure aroma of theine would find little favour at first with the general public, though now, thanks to the energy and enterprise of modern commerce, the tea trade employs upwards of 60,000 tons of British shipping besides bringing an enormous revenue to the government. What we have said of tea, might also be said of many other products, including pepper, with which we now propose to deal ; even Pliny of old expresses some surprise that an article, as he says, possessing neither flavour nor appearance to recommend it, should become of such general use as it had in his day.

In a commercial sense, the word pepper has scarcely any restrictions or limit, nearly everything hot or pungent comes under the designation. Thus, we have cayenne pepper, which in reality is produced from various species of capsicum ; melagueta pepper, the seeds of *Amomnum Melagueta*, and Ethiopian pepper, the fruits of *Habzelia Æthiopica.* These in the customs returns, are all classed under the head "pepper," so that it is difficult to tell the exact amount of true pepper imported; but in a botanical sense, pepper is known as the product of one plant only, and that the *Piper nigrum.* To show the importance of this article in British commerce, as well as the large revenues it brings to the Treasury, we cannot do better than briefly trace the history and development of the pepper trade. It seems pretty clear that its uses were well known to the ancient Greeks; as a medicine it was also early known, being employed as such by Hippocrates. We quote the following interesting paragraph from Simmonds's 'Commercial Products of the Vegetable Kingdom':—"Pliny, the naturalist, states that the price of pepper in the market of Rome in his time was, in English money, 9s. 4d. per pound, and thus we have the price of pepper at least 1,774 years ago. The pepper alluded to must have been the produce of Malabar, the nearest part of India to Europe that produced the article, and its prime cost could not have exceeded the present one, or about 2d. per pound. It would most probably have come to Europe by crossing the Indian and Arabian Ocean with the easterly monsoon, sailing up the Red Sea, crossing the Desert, dropping down the Nile, and making its way along the Mediterranean by two-thirds of its whole length. This voyage, which in our time can be performed in a month, most probably then took eighteen. Transit and customs' duties must have been paid over and over again, and there must have been plenty of extortion. All this will explain how pepper could not be sold in the Roman market under fifty-six times its prime cost. Immediately previous to the discovery of the route to India by the Cape of Good Hope, we find that the price of pepper in the markets of Europe had fallen to 6s. a pound, or 3s. 4d. less than in the time of Pliny. What probably contributed to this fall was the superior skill in navigation of the now converted Arabs, and the extension to the islands of the Eastern Archipelago, which abounded in pepper. After the great discovery of Vasco de Gama, the price of pepper fell to about 1s. 3d. a pound, a fall of 8s. 1d. from the time of Pliny, and of 4s. 9d. from that of the Mahomedan Arabs, Turks, and Venetians." The pepper plant (*Piper nigrum*, L.), is a native of the Coast of Malabar and the southern parts of India, but is now largely cultivated in the East and West Indies, Sumatra, Borneo, Siam, and other places within the tropics. It is a perennial with a climbing, shrubby stem; the berries or fruit are borne upon a spadix that is arranged in dense clusters round a central stalk, each of these spadices contain from twenty to fifty berries. The propagation of the pepper plant is chiefly by cutting, though they will grow well from seed, but of course the plants take longer time before they come into bearing, which is a great consideration when pecuniary profit is the aim. The richer the soil the better the plants thrive. In forming a plantation, the grower will take his cuttings and plant them perhaps from seven to twelve feet apart. The climbing habit of the plants renders it necessary to provide some support for them to trail upon. Each individual plant is supplied with some kind of prop, but in many plantations these supports are cuttings of some spiny or thorny tree, which, striking in the ground and throwing out its leaves above, furnishes at once both a support and shelter for the young pepper plant. If grown on a rich soil the plants will bear fruit in a small proportion even in the first year, increasing their produce annually till the end of the fifth year, when they yield abont eight or ten pounds per plant, and this is about the average produce up to fifteen or twenty years, after which the plants begin to decline, seldom or ever surviving beyond the thirtieth year. A pepper plantation has a peculiar yet picturesque appearance, the regular intervals between the plants and the plants themselves carefully trained against their props, gives to it an air of remarkable uniformity seldom seen in the cultivation of other crops. The plants, which, on account of their climbing habits are technically called pepper "vines," are allowed to run up their supports to a height of three or four feet; the tops are then bent down to the ground, and the young shoots which spring from these are tended with great care and neatly trained upwards. The plantations in Sumatra are said to be models of neatness and cleanliness, all weeds and refuse being carefully removed. The fruits when first formed are green, changing to red, and finally to black. When they make their first change from green to red, they are considered fit for gathering, for if left longer on the plants they are apt to drop off, besides losing a portion of their pungency. After gathering, the berries are spread on mats and exposed to the sun to dry; they are then rubbed between the hands to remove the short stalks. This constitutes black pepper, bnt both black and white pepper are the produce of the same plant, with this difference that the white is the largest picked berries, gathered at the fullest state of maturity, and denuded of its black outer husk by soaking in water. White pepper, as we all know, fetches a higher price in the market than black, not on account of its greater pungency, for, as we have seen, it has less, losing, as it does, much of that most important principle in the husk of which it is deprived, and also in the process of steeping and bleaching. A good story is told in Mr. Cameron's new book upon 'Our Malayan Possessions,' illustrating the ignorance of the directors of companies of the products or basis of the company's operations. The story runs somewhat in the following manner:—The directors of a Bencoolen pepper plantation, alert, as they should be to the interests of the shareholders, finding that white pepper, which commanded a higher price than black, had as ready a sale and was therefore more profitable, immediately sent orders to the manager of their plantation for greater care to be bestowed upon the plants yielding white pepper than those yielding black. This must have been highly amusing to the growers themselves.

The black pepper vine is indigenous to the forests of Malabar and

Travancore. Its cultivation is very simple, and is effected by cuttings or suckers put down before the commencement of the rains in June. The soil should be rich, but if too much moisture be allowed to accumulate near the roots, the young plants are apt to rot. In three years the vine begins to bear. They are planted chiefly in hilly districts, but thrive well enough in the low country, in the moist climate of Malabar. They are usually planted at the base of trees which have rough or prickly bark, such as the jack, the erythrina, cashew-nut, mango tree, and others of similar description. They will climb about twenty or thirty feet, but are purposely kept lower than that. During their growth it is requisite to remove all suckers, and the vine should be pruned, thinned, and kept clear of weeds.

The berries must be plucked before they are quite ripe, and if too early they will spoil. The pepper vine is very common in the hilly districts of Travancore, especially in the Cottayan, Meenachel, and Chengaracherry districts, where, at an average calculation, about 5,000 candies (of 500 lbs. each) are produced annually. It is one of the Sircar monopolies. It may not be irrelevant to mention here the *P. trioicum*, Roxb., which both Dr. Wight and Megnel consider to be the original type of the *P. nigrun*, and from which it is scarcely distinct as a species. The question will be set at rest by future botanists. The species in question, was first discovered by Dr. Roxburgh growing wild in the hills north of Samulcottah, where it is called in Téloo-goo the "Merial-tiga."

It was growing plentifully about every valley among the hills, delighting in a moist, rich soil, and well shaded by trees; the flowers appearing in September and October, and the berries ripening in March. Dr. R. commenced a large plantation, and in 1789 it contained about 40,000 or 50,000 pepper vines, occupying about fifty acres of land. The produce was great, about 1,000 vines yielding from 500 to 1,000 lbs. of berries. He discovered that the pepper of the female vines did not ripen properly, but dropped while green, and when dried had not the pungency of the common pepper, whereas the pepper of those plants which had the hermaphrodite and female flowers mixed in the same amount was exceedingly pungent, and was reckoned by the merchants equal to the best Malabar pepper.

Several varieties both of black and white pepper are known in commerce. Of the black the most valuable comes from Malabar, and is known as Malabar pepper. It is very clean, and free from dust and stalks. Penang and Sumatra pepper are also varieties of black, known in the markets, the former has, perhaps, a larger berry than the Malabar, but, unlike that, is very dusty. Sumatra pepper is the commonest, and consequently the cheapest; it is very dusty, and has a large proportion of stalks mixed with it. Of the white kinds, Tellicherry pepper is the most valuable, fetching a much higher price than any other of the white varieties: the berries are also larger, and of a purer white. The common white pepper of our shops is imported chiefly from Penang, and varies in price, according to size and whiteness, much of the white pepper, however, as seen in trade, is nothing more than the black Penang sort, bleached in England. Besides these varieties, there is a kind of bleached black pepper, the bleaching of which is effected by chlorine.

Great as is the consumption of pepper, the high rate of duty imposed upon it tends to cripple the full development of a trade which might become of vast proportions. An ample illustration of this fact is found in the increased consumption of pepper in the years following a reduction of the duty. In the early part of the present century the impost levied was as much as a 1s. to 2s., and even 2s. 6d., per pound, while the cost price in Singapore ranged no higher than from 6d. to 8d. In proportion as the duty was lowered, so the price of pepper fell, and the consumption became likewise proportionately greater. The prime cost of Singapore pepper at the present time does not exceed 1d. or 1½d. per pound, and that from Malabar, Sumatra, and Penang, about 4d., while white pepper fetches from 9d. to 1s., and perhaps 1s. 6d. In Singapore, where immense pepper plantations exist, the cultivation is chiefly carried on by Chinese settlers, who, owing to the heavy impost in this country, to which the bulk of their produce is shipped, find it a very poor, and scarcely profitable speculation, requiring, as the plants do, so much care and attention. From the foregoing facts it is easy to see that, were the present duty of 6d. per pound reduced, we might expect a corresponding increase in our importations, which would probably add to, rather than diminish the public revenue, for we might safely depend upon the use of pepper becoming more extended, so generally appreciated as it is.

The plant which furnishes melaguetta pepper, or grains of Paradise, now pretty well known to botanists, seems remarkable for its variable size, especially as shown in its fruit. According to Dr. W. F. Daniell, the variety grown at Accra is the largest. The smaller, which grows on higher ground, is called in Fernando Po, *Toholo M'Pomah*, or M'Pomah pepper.

Specimens of the flowers of each variety are desirable to ascertain if they belong to one and the same species.

Of bastard or false melaguetta peppers there are several beautiful species quite distinct and different from each other, and very imperfectly known to botanists. The fruit of some of them is used by the blacks for the sake of its acid pulp, which is agreeable to the taste. They are tall, flag-like plants, with handsome flowers and fruits produced near the roots.

Melaguetta pepper, true or false, belongs to the botanical genus, *Amomum.*

SISAL HEMP.

BY WILLIAM C. DENNIS, OF KEY WEST, FLORIDA.

Dr. Henry Perine, who was for a time consul at Yucatan, among many other exotic plants, introduced into the southern part of Florida the Sisal hemp (*Agave sisalana*). He also introduced two other species of the Agave, which, from their hardy, self-propagating nature, not only survived the effects of the change of climate, but increased rapidly, until they were destroyed by the Indians in 1846. One of them was the "Pulque plant," from which is manufactured, in Mexico, the celebrated domestic drink of that country; and the other was the "Great American Aloe," or "Century plant" (*Agave Americana*), the fibre of which is manufactured into cordage and various other articles of use. Of these three kinds of Agave, so far as I know, the Sisal hemp is the only one which appears to be of much importance to us in an economical point of view, although further acquaintance and experiments may prove the other two likewise valuable, especially the latter.

The gigantic plant out of which Sisal hemp is made, delights in arid, rocky land, which contains a superabundance of lime. This is precisely the condition of the soil of these Keys and the extreme southerly part of the peninsula of Florida, where alone it could be cultivated in the absence of frost. It requires less culture than other products, but is much benefited by keeping down the weeds ; and although it thrives best on lands which have the deepest soil, yet it grows well where there is but little soil that appears among the rocks, sending its long, penetrating roots into the clefts and crevices of the rocks in search of black, rich, vegetable mould. In fact, the lands on these Keys, and much of it on the southern point of the peninsula, are nearly worthless for every other agricultural purpose, so far as is known ; yet there are thousands of acres in this region, where a ton of cleaned Sisal hemp can be made to the acre yearly, after the plant has arrived at such an advanced stage as will allow the lower leaves to be cut from it, which takes, in this climate, from three to five years to grow, according to the goodness of the soil, and the attention given to keep the land clear of weeds, grass, &c. It is no longer an experiment here as to the growth of the plant, nor of the amount of the product ; nor is there any longer a doubt as regards the value of the fibre, a number of tons of it having already been collected and sent to market, where it readily brought within a half-cent. to a cent. per pound as much as the best kind of Manila hemp ; that is, in the neighbourhood, of 250 dols. per ton. About a thousand plants should be set on an acre, and from many young ones coming up from the long lateral roots, if these be kept at proper distances, it will be seen that the same land will require no replanting, if coarse vegetable manure be applied from time to time. After the plant is of sufficient growth, the lower leaves are cut off, at proper times, leaving enough on the top to keep it healthy. These leaves are composed of a soft, watery pulp, and are from two to six feet long, and in the middle from four to six inches wide, being frequently three inches thick at the butt, having the general shape of the head of a lance. They contain a gum, which is the chief cause of their being rather troublesome in separating the fibres from the pulp. Neither the epidermis nor this pulp is more than a powder after becoming dry, if the gum be entirely crushed and washed out. This is a most important fact in relation to the manner to be adopted to cleanse the fibres from the pulp. As these are continnous and parallel, and embedded in it, I feel certain that a system of passing the leaves through a series of heavy iron rollers, firmly set, something like those used in grinding sugar-cane, and throwing water upon the crushed leaves in jets or otherwise, in sufficient quantities to wash out the gum (which is perfectly soluble in it), will thoroughly clean the fibres without any loss; so that, after they are dry, and have been beaten to get out the dust, they will be fit for market. At any rate, the right plan for separating the fibres has not yet been discovered, although there has been enough done at it to show that they can be got out at a profit. Here the people either preserve the primitive plan which is practised in Yucatan, of beating and scraping the leaves or simply crush them in a pair of rollers, afterwards steeping the crushed ones in an alkaline solution for a few days and then clean the fibres by a kind of combing process. But either scraping or combing destroys too many of the fibres by breaking them, which would not be done by a system of rolling and washing out the gum. In Yucatan, they ferment the beaten leaves in water or mud, but this stains and weakens the fibres so as to reduce their value, I believe, more than half. Even steeping the crushed leaves in an alkaline pickle, although it may not weaken the fibres much, as the juice of the leaves is acid, destroys that silky gloss which they possess when got out of the fresh leaves with the aid of pure water alone; besides, it needlessly increases the expense, if it can be dispensed with.

A good deal of attention is being paid to setting out the plant on this Island, and on some others along the Reef. I have some fifty acres, and continue to increase the quantity as I have opportunity. About three acres have a good crop now, and fifteen acres have been planted nearly three years, so that it will be necessary for me soon to turn a part of my attention to cleaning this pulp. I have made up my mind to try the rolling system, and wash out the gum with water. This last article, in a pure state, will be the most difficult to get in carrying out the plan on these Keys.

OIL OF CALOPHYLLUM INOPHYLLUM.

BY DR. SEEMANN.

The most valuable oil produced in Fiji is that extracted from the seeds of this tree, the Dilo of the natives, the Tamanu of Eastern Polynesia, and the Cashampa of India. It is the bitter oil, or woondel of Indian commerce. The natives use it for polishing arms, and greasing their bodies, when cocoa-nut oil is not at hand. But the great reputation this oil enjoys throughout Polynesia and the East Indies rests upon its medicinal properties, as a liniment in rheumatism, pains in the joints, and bruises. Its efficacy in this respect can hardly be exaggerated, and recommends it to the attention of European practitioners. The oil is kept by the Fijians in gourd flasks, and there being only a limited quantity made, I was charged about sixpence per pint for it, paid in calico and cutlery. The tree is one of the most common littoral plants in the group; its round fruits, mixed with the square-shaped ones of *Barringtonia speciosa*, the pine-cone-like ones of the Sago palm (*Sagus vitrensis*, Wendl.) and the flat seeds of the Walai (*Entada scandens*, Benth.) densely cover the sandy beaches. Dilo oil never congeals in the lowest temperature of the Fijis, as cocoa-nut oil often does during the cool season. It is of a greenish tinge, and a very little of it will impart its hue to a whole cask of cocoa-nut oil. Its commercial value is only partially known in the Fijis, and was found out accidentally. Amongst the contributions in cocoa-nut oil which the natives furnish towards the support of the Wesleyan missions, some Dilo oil had been procured, which, on arriving at Sydney was rejected by the broker who purchased the other oil, on account of its greenish tinge and strange appearance. On being shown to others, a chemist, recognising it as the bitter oil of India, purchased it at the rate of 60*l.* per tun; and he must have made a good profit on it, as the article fetches as much as 90*l.* per tun. The Dilo grows to the height of sixty feet, and the stem is from three to four feet in diameter, generally thickly crowded with epiphytal orchids and ferns. The dark foliage forms a magnificent crown, producing a dense shade; and when, during the flowering season, it is interspersed with numerous white flowers, the aspect of the whole tree is truly noble. "The leaves are torn in small pieces, soaked in water for a night, and then used for washing inflamed eyes."—(Storck). The exudation from the stem is, according to G. Bennett, the Tacamahaca resin of commerce, used by Tahitians as a scent. Carpenters and cabinet-makers value the wood on account of its beautiful grain, hardness, and red tinge. Boats and canoes are built of it, and it is named with the Vesi (*Afzelia bijuga*, A. Gray) as the best timber produced in Fiji. In order to extract the oil, the round fruit is allowed to drop in its outer fleshy covering, and rot on the ground. The remaining portion, consisting of a shell, (*putamen*) somewhat of the consistency of that of a hen's egg, and enclosing the kernel, is baked on hot stones in the same way that Polynesian vegetables and meat are. The shell is then broken, and the kernel pounded between stones. If the quantity be small, the macerated mass is placed on the fibres of the Van (*Hibiscus tiliaceus*, and *tricuspis*) and forced by the hand to yield up its oily contents. If large, a rude level press is constructed by placing a boom horizontally between two cocoa-nut trees, and appending to this perpendicularly the fibres of the Van. After the macerated kernels have been placed in the midst, a pole is made fast to the lower end of the fibres, and two men taking hold of its end, twist the contrivance round and round till the oil, collecting into a wooden bowl placed underneath, has been extracted. Of course the pressure thus brought to bear upon the pounded kernels is not sufficiently great to express the whole of the oil, and there is still much waste.

[The resin and oil of this tree will be found fully described under the name of "Tamaner," which it bears in the Society Islands, in vol. 3 of the Technologist, p. 84, in an article by G. Cuzent.—Ed.]

Scientific Notes.

DYSODILE OR TASMANITE.—Tasmanite, a new material of organic origin, is described by Professor Church, in a recent number of the 'Philosophical Magazine.' In the Tasmanian Court of the International Exhibition of 1862, a very remarkable kind of fuel was shown by the "Dysodyle Company," catalogued as "resiniferous shale." In the Jermyn street Museum of the School of Mines, a specimen of the same mineral is termed "combustible shale," River Mersey, north side of Tasmania. The true dysodile, from Glimbach, near Giessen, analysed by Delesse, does not seem to be identical, either in chemical or physical constitution, with the Tasmanian mineral. The so-called "resiniferous shale" is distinctly laminated; the organic matter, which occurs in scales, being disposed in planes parallel to the lamination, and probably causing it. These scales are of a reddish brown colour, and form from 30 to 40 per cent. of the rock. The average diameter of the discs is about ·03 of an inch, while their thickness at the centre is sometimes as much as ·007. As none of the ordinary solvents of resinoids and similar bodies seemed capable of dissolving out the carbonaceous constituent of the mineral, the following plan of effecting the separation was adopted :—A large quantity of the mineral was crushed to a coarse powder, placed in a Phillip's precipitating-glass, and strong hydrochloric acid poured upon it. A trace of carbonic anhydride was thus set free from the small quantity of carbonate of calcium present, while the aluminia and ferric oxide of the mineral were partly dissolved. These chemical actions served to break up the mineral, and the organic "scales" became for the most part disengaged, and floated, owing to the high gravity of the hydrochloric solution which has been further increased by the addition of chloride of calcium. The scales were collected from the surface by a strainer, and washed repeatedly by decantation. By this method of purification the inorganic matter in them was reduced to a minimum. The substance thus prepared presented such remarkably distinct chemical and physical characters, as to lead to its receiving quite a distinct name. When Tasmanite is heated in the air it burns readily, with a very smoky flame and offensive odour. Submitted to destructive distillation, it fuses partially, and yields oily and solid products having a disagreeable smell, recalling that of some specimens of Canadian petroleum. One is tempted to suggest that the natural rock oils may in some instances originate in the action of heat upon substances similar to Tasmanite shale. Qualitative analysis of Tasmanite showed it to contain, not only a large quantity of carbon and hydrogen, but also a very considerable proportion of sulphur ; and it was found that the most careful mechanical treatment of the specimens fail to separate from them completely the mineral impurities. That the sulphur detected was an integral part of the carbonaceous matter itself, and was not owing to the presence of an inorganic sulphide or sulphate, was proved in several ways, and was further confirmed by the observation that the more completely the mineral matter had been removed the more sulphur was found in the specimen of Tasmanite operated upon.

Fibre of the Arrowroot Plant.—A colonial paper states that another and important discovery has been made, arising out of the manufacture of arrowroot. A Mr. Cole, whilst pursuing his ordinary method of detaching the farinaceous bulb from the stem, had been in the habit of throwing the latter to his pigs, who appear to have fed voraciously upon the succulent matter which the stems and leaves contained, but leaving a residue in the form of a "quid" in many instances, which the discriminating animal appeared to reject as unfit for porcine delection. The attention of Mr. Cole being attracted by this circumstance, his curiosity led him to examine minutely the components of these rejected pellets of matter, and finding that they chiefly consisted of a stringy fibrous substance, the stamina of the plant, he proceeded upon this hint to institute a series of experiments upon the hypothesis that the stem of the plant might be made to yield a material of value as an article of commerce, as well as the farina derived from the bulb at the root. By a process of maceration in water the soft parts become detached from the fibre, which, thus denuded of their former adherents, presented a sheath of distinct filaments running the entire length of the plant, which on the Tomago soil averages from five or six feet. Thus, by a process of simple observation and deductive experiment, Mr. Cole arrived at a given result without the aid of scientific knowledge or appliances other than those acquired and extemporised for the occasion. What may be the value of this discovery when submitted to a scientific and commercial test we do not pretend to say; but *prima facie*, it appears to us that if the fibre yielded by this plant can be applied to textile purposes, or to the manufacture of paper, this, taken together with the produce of its bulb, must render it a valuable addition to the catalogue of useful husbandry and of manufacture. The filaments of this fibre are exceedingly fine, with a soft, silky appearance, and such as, we should infer, are admirably suited for the manufacture of paper, even if they should prove of insufficient tenacity for the production of woven fabrics. Arrowroot manufacture is carried on in many of the West India Islands, in India, Australia, and Natal.

Skilled Female Labour in the rural districts of France forms an important feature in the industry of the country. There are in the neighbourhood of Arras 6,000 lace-makers, who earn about a franc a day, without neglecting their household duties. Glove-making also is gradually leaving the towns to settle definitely in the country. Thus, in the Haute-Marne, a single firm gives employment to upwards of 2,000 hands; in the Isere there are 15,000 needlewomen engaged in the trade, and around Greenoble there are about 1,200 cutters who turn out

600,000 pairs of gloves a year, which, at the rate of 30f. a dozen, represent a sum of from 1,600,000f. to 1,700,000f. The Greenoble manufactory employs about 600 women in putting the glove on the pattern, then under the cutting press, and preparing it otherwise for the needle. Such women, when clever, earn from 70f. to 80f. a month. The remuneration for sewing gloves is at the rate of about 4f. 50c. a dozen with one button and 4f. 75c. with two, but the sewer must find her own thread. The cutting of precious stones, whether genuine or imitation, is a trade that has taken up its abode on the heights of the Jura, at Septmencel (except the diamond, which is cut by machinery at Amsterdam). At the place we have mentioned the women are constantly employed in making imitation jewels, in drilling holes into rubies for watchmakers, &c., and they earn thereby about 75c. per day, the earnings of the men in the same sort of work being 4f. 50c.

In making *hollow* gold chains, the gold is put round copper links, and the copper is afterwards extracted by making a small incision in each link and laying the chains for a time in aquafortis.

Manufacture of Gold-leaf.—It is found that a minute percentage of silver and copper is necessary to give the gold for gold-leaf a proper malleable quality—a percentage of perhaps one in seventy or eighty. The refiner manages this alloy, and brings the costly product to a certain stage of completion ; he melts the gold and the cheaper alloys in a black-lead crucible ; pours the molten metal into an ingot mould, six or eight inches long, removes the solidified and coated ingot from its mould, and passes it repeatedly between two steel rollers until it assumes the thickness of a ribbon ; and this ribbon—about one-eight-hundredth of an inch in thickness, and presenting a surface of about five hundred square inches to an ounce—passes now to the hands of the goldbeater. The working tools, the processes, and the products of a goldbeater are all remarkable. That puzzling material, "goldbeaters' skin," is an indispensable aid to him ; it is a membrane of extreme thinness and delicacy, but yet tough and strong, procured from the intestines of the ox. Eight hundred pieces of this skin, four inches square, constitute a packet with which the goldbeater labours ! A hundred and fifty bits of ribbon-gold, an inch square, are interleaved with as many vellum leaver four inches square; they are beaten for a long time with a ponderous hammer on a smooth marble slab, until the gold has thinned and expanded to the size of the vellum. The gold is then liberated from the vellum, and each piece cut into four ; the hundred and fifty thus become six hundred, and these are interleaved with six hundred pieces of goldbeater's skin, which are then packed into a compact mass. Another beating then takes place—more careful, more delicate, more precise than the first—until the gold has expanded so that it requires to be again released. The leaves are again divided into four, by which the six hundred become twenty-four hundred, and these are divided into three parcels of eight hundred each, and each parcel is subjected to a third beating. In the first beating a sixteen-pound hammer is used; in the second, a twelve-pounder; in the third, a ten-pounder.

ON YELLOW DYE EXTRACTED FROM THE BERBERIDACÆ, OR BARBERRY ORDER.—The French papers have lately spoken several times of the utilisation of the berries of *Mahonia illicifolia* for the production of alcohol; (they yield 87°) the root and the bark of this plant can also receive an useful application; they contain, like those of many berberidaceæ, a yellow dye, (berberine). Several barberries are employed in different countries for dyeing. The *Berberis vulgaris* or common barberry, grows abundantly in the Alps of Savoy; the decoction of its bark, and of its root is used there for dyeing leather, and woven fabrics; the same is done in Poland, in Nuremburg, in the manufacture of toys. The same decoction is employed for giving to wood a fine yellow colour, which is enhanced by varnish. The chloride of tin, or tin liquor, gives very fine tints with the Barberry root. In China, the *Berberis thunbergi* is employed under the name of Siao-pe. In East India the *Berberis Asiatica*. *Pure berberine* is prepared in several places in Bavaria. In the Pharmaceutical Institute of Büchner, at Munich, it costs about 15*l.* a kilogramme. Some plants of neighbouring families contain also berberine; it can, for instance, be extracted from Colombo root (*Cocculus palmatus*), of the Moon-seed order, or Menispermaceæ, and from the bark known as "Abeokuta bark," or "yellow bark of Gbeido," (*Cœloclyni polycarpa*) Custard apple order, or Anonaceæ. The latter bark is used on the Western coast of Africa for the dyeing of skins and mats.—BERNARDIN.

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