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ABOUT TEN DAYS AGO there appeared in the *New York Sun* a sensational article to the effect that, on account of the depreciation in the value of Baltimore and Ohio stock, and the loss of income from dividends on the stock, Johns Hopkins University was ruined. What the animus of this article was we do not know. It may have been written with the hope that it might further the interests of some stock jobbers, or it may have been written by some enemy of Johns Hopkins bent on doing the university what harm he could. A glance at the article in question showed that it contained nothing but what was perfectly well known months ago, so far as ill was concerned, and that all reference was omitted to the successful efforts of the university's friends to help it at a time when it was temporarily short of ready cash. We were so impressed at the time with the character of the article, that we made no allusion to it last week, supposing it to be evident enough on the surface that it was all published to produce a sensation, and not to record a plain statement of fact. We should not now have any thing to say were it not for the frequent allusions published in our exchanges, showing that some read the *Sun* and accept its fictions as news. All that need be said now is that for years the trustees of Johns Hopkins University knew, as any body of sensible men would know, that, as a good portion of their income-bearing property was in Baltimore and Ohio stock, it would be wise to save up some of the income to provide against any cessation of dividends. This was done. Again, when the dividends stopped some months ago, steps were taken to raise additional funds to cover expenses, and these efforts were rewarded with all the success desired. The result is that the university goes on with ample means to continue as a model to all our American universities, as it has been from the start, with a full faculty on full pay.

THE PREPARATION OF JAPANESE LACQUER AND THE MANUFACTURE OF WAKASA WARE.[1]

JAPANESE lacquer is the product of a tree (*Rhus vernicifera* D. C.) which grows throughout the main island of Japan. It attains a large size, the trunk sometimes measuring a metre in diameter. It is said the tree will live for forty years, but only comparatively young trees are valued for the production of lacquer. Having yielded for several years, they are cut down, the lacquer extracted from the branches, and young trees take their places.

The principal section of the lacquer industry is between the parallels of 37° and 39°, beginning about one hundred miles north of Tokio. The best lacquer, however, comes from much farther south, from Yoshino, in Yamato.

The lacquer exudes from horizontal cuts in the bark, in the form of a rather viscid emulsion, and may be collected from April to the end of October. In the spring it is more watery than in the later months. However, the sap never flows so freely that it can be collected in vessels, as has been stated by writers. It exudes slowly, and is collected by means of a pointed, spoon-like instrument, and transferred to a wooden receptacle or tube of bamboo. Several cuts are made in each tree, the last as high as a man can reach. Having thus prepared a dozen or more trees in rapid succession, the collector begins to collect the juice from the cuts in regular order, beginning with the one first cut.

Having finished the collecting, he takes other groups of trees, and after about four days returns to the first, where, after removing the accumulated yield, he cuts again into the same trees, and repeats the same rôle fifteen or twenty times. Thus the work may go on for eighty to a hundred days. The utmost yield of a single tree is about forty to fifty cubic centimetres of raw lacquer.

As the sap first exudes, it is a grayish-white thick or viscous fluid, which quickly turns yellow, and afterwards black where it is in contact with the air.

The sap thus collected is *ki-urushi*, *urushi* being the general name for lacquer. An inferior kind is obtained from the branches when the trees are cut down. The branches are soaked in water for several months, then taken up and slightly warmed, when a small quantity of sap exudes. This is *seshime urushi.*

The lacquer is strained through cotton cloth to free it from bits of wood and dirt, first being thoroughly stirred to break up lumps and make a uniform mixture. The product thus purified is known as *seshime urushi*; but this name, which has already been used to designate the lacquer from the branches, has now a different meaning, and is applied to the cheaper kinds of raw lacquer, such as are used for the first coats in lacquering. These lacquers have usually lost some of their water by stirring in shallow receptacles exposed to the sun. They have undergone no further preparation.

Many varieties of lacquer are prepared for special purposes, ranging in price from one or two to six or seven dollars per kilogram. These differ in quality and color. There is a famous black lacquer prepared by the addition of iron, which forms a chemical combination to be mentioned further on; while red, green, yellow, and other colors are imparted by addition of various pigments, as cinnabar for red, orpiment and indigo together for green, orpiment for yellow, etc. Ultramarine is decomposed by lacquer, giving off sulphuretted hydrogen. Certain lacquers have a small proportion of a drying oil (perilla oil) added to them. The lacquer known as *shiu urushi* contains from one to ten per cent of this oil. The name "*shiu urushi*" means "cinnabar lacquer," and is applied to this variety because it is commonly used to mix with cinnabar when a red lacquer is required.

The emulsion as it comes from the tree consists of an aqueous

[1] Abstract of a paper read by Romyn Hitchcock before the Chemical Society of Washington, April 11, 1889.

fluid holding in suspension numerous very minute brown globules and a smaller proportion of lighter-colored larger globules. The former are insoluble in water, but soluble in alcohol. The latter dissolve in water.

The raw lacquer is almost completely soluble in alcohol, ether, carbon bisulphide, benzine, and solvents of gum-resins in general. The most important and abundant constituent is urushic acid, which occurs in the form of the minute spherules already mentioned. The acid is obtained by evaporating the alcoholic solution to a sirupy liquid. The evaporation must be carried on over a water-bath. If too much heat be applied, a tough, black, rubber-like substance is obtained, which I found very troublesome to remove from the dish, and only strong nitric acid would affect it in the slightest degree.

As thus obtained, urushic acid is soluble in alcohol, chloroform, etc., but quite insoluble in water. It possesses marked acid properties, turns litmus-paper red, and forms salts with metals. With iron salts it forms a black compound, to which the color of the fine roiro lacquer is due. With plumbic acetate it yields a gray, flocculent precipitate.

Although the drying, or rather the hardening, properties of lacquer are doubtless due to the oxidation of urushic acid, the product extracted by alcohol possesses no drying qualities. This fact was first observed by Professor Rein, in 1874. More recently Korschelt and Yoshida have found that a peculiar albuminoid of lacquer effects the drying by a diastatic or fermentive action. The fact seems to be that the lacquer hardens only when the albuminous substance is present. If heated above 60° C., or above the temperature at which albumen coagulates, the lacquer will not dry. The strongest evidence of the importance of the albuminoid to the hardening process is found in the fact that while the urushic acid will not dry by itself, it immediately hardens if a portion of the unboiled gum and albumen that does not dissolve in alcohol be added to it, and the rapidity of hardening depends upon the proportion added. It is notable that the aluminoid does not lose its peculiar property of effecting this oxidation by treatment with alcohol. Besides urushic acid and the albuminoid, raw lacquer contains a gum resembling gum arabic, which doubtless imparts some useful properties to the lacquer, and a volatile acid, to which Professor Rein ascribes the poisonous effects of lacquer.

We now come to the further preparation of lacquer for use in the manufacture of the several varieties of lacquered articles, and I would say that whoever is sufficiently interested in the subject to spend an hour at the National Museum will find the process of manufacture very fully illustrated there.

A portion of the raw lacquer, about sixteen pounds, is poured into a large circular wooden vessel, and vigorously stirred with a long-handled tool for five or six hours, while the heat of a small charcoal furnace is ingeniously thrown upon the surface to evaporate the water. During the stirring, certain ingredients may be added from time to time. The *roiro*, a fine black lacquer, is made by adding iron at this stage. In Tokio a soluble salt of iron is used, but the Osaka manufacturer objects to that, asserting that it injures the quality of the lacquer. The material used in Osaka is the fine iron dust collected from the grinding of knives. This is added in quantities of about a teacupful of powder mixed with water at a time, until the desired color is obtained. When the work is finished, the lacquer is poured into a vessel to settle, and is afterwards drawn off from the sediment.

The wood generally used for lacquer-work is the light, easily worked *hinoki*, a coniferous wood. It is prepared to receive the lacquer in various ways. For inferior work it is first covered with paper, but in the finer qualities paper is not used. The operations to be described apply to the manufacture of that variety of lacquer known as Wakasa lacquer, and are from personal observation. The wood is first carefully smoothed, and the corners of the boxes strengthened by gluing pieces of cotton or hemp cloth around them with raw lacquer. All joints and imperfections are then filled with *tsugi urushi* (*tsugi*, "to fasten"), which fills like putty. This is a dark-colored mixture composed of rice-flour made into a paste with water, and mixed with *seshime urushi*. It soon hardens so that it can scarcely be cut with a knife. Sometimes finely cut hemp is mixed with the *tsugi urushi*. The work is then covered with *jinoko*, a mixture of *seshime urushi*, and a coarse powder of a yellowish color. The mixture is soft, of a yellowish-brown color, changing to black by exposure to the air. It is spread with a wooden instrument called *hera*. The article is left for a few days in the open air to allow some of the water to evaporate, after which it is placed in a moist-air closet to harden. In this way a very hard, gritty surface is obtained, affording an excellent ground for the succeeding coat.

This process is not applied in making inferior goods. For these a mixture of the powder with glue is sometimes used, and for this reason cheap ware sometimes blisters when used with hot water, the glue swelling if the water reaches it. Similar blistering may also be occasioned by the natural gum of the lacquer if it should be present in excessive quantity.

The next process consists in covering the entire box with two coats of lacquer, containing a finer powder known as *tonoko*, which is a kind of ochre much used in Japan for cleaning and polishing. This is likewise evenly spread with the *hera*. Three coats of this are applied over the joints. The object of this process is to secure an even, smooth-grained surface for subsequent work. The surface is finally rubbed down with a kind of stone called *toishi*.

The parts that are not to receive any decoration are now ready for the finishing applications of lacquer. The other parts are next covered with a black lacquer, *naka muri urushi*. The lacquer used is *shitaji urushi* mixed with a kind of black lacquer known as *honkuro*, probably the best kind of roiro lacquer. It is applied with a brush, and requires to be rubbed down.

Two coats of black lacquer are now applied. The first is roiro put on with a broad brush. This dries with a brilliant reflecting surface. When quite hard, the second application is made, and in this, while still soft, the designs are impressed. I use the word "impressed" because in the Wakasa lacquer there is no painting or drawing, but the figures are produced in a very curious manner. The white decoration is applied by dropping egg-shell powder in patches here and there. This is done very skilfully by the hand. The other designs are made by pressing various forms of leaves into the soft surface. Thus, the radiating or wheel-like pattern is produced by so arranging the needle-like leaves of the pine, the more complex leaf-pattern with the leaves of an evergreen (*Thuya orientalis*), while many other effects are made by scattering over the surface husks of rice, and these mingled with very short pine needles. The mother-of-pearl from shells is also used. The designs become more or less modified by the subsequent operations.

The lacquer retains the impressions thus produced, when, after the leaves, etc., have been embedded about a day, every thing except the egg-shell powder and mother-of-pearl is removed. The article is then put in the moist closet until it is thoroughly hardened, which may require ten days or a fortnight. The egg-shell is in little heaps, the leaf impressions are beneath the general surface. It is now necessary to fill up all depressions and once more secure an even surface. The first step is to rub down the most conspicuous projections until there is much less irregularity of surface, but even after several successive coats of lacquer there will remain some elevations and depressions.

The next application is a transparent lacquer colored yellow with arsenic sulphide. This is put on with a *hake*, and spread as evenly as possible. The object of this is to afford a yellow ground for the gold which is to follow. A thin coat of *shiu-ai urushi* is spread over this, and the whole completely covered with gold leaf. Then successive coats of the same lacquer, which is a transparent red lacquer, are applied until the surface is quite even. The surface then appears entirely black, beneath which all the gold and decorations are concealed.

Instead of a red ground, green is sometimes desired, as in green lacquer. To make this, the *shiu urushi* is mixed with a green pigment. The next operation is to rub down the surface with stone *toishi* or *sai kido* until the design is again visible. The pattern is now revealed in gold with the pure white of the egg-shell powder to relieve the effect. The work is finally rubbed with a special kind of charcoal, which gives a perfect surface, but to make it more brilliant it is covered with a finishing coat of fine lacquer.

To make practical application of these remarks, I would say that the peculiar qualities of lacquer make it seem worthy of more consideration than it has received in this country. It gives a surface to wood much harder than our best copal varnish, without brittleness. It takes a polish not to be excelled, which lasts for centuries, as may be seen in the old treasures of Japan. It is proof against boiling water, alcohol, and, indeed, it seems to be insoluble in every agent known. It is the best possible application for laboratory tables. I have a set of photographer's developing trays that have been in use for more than a year, and I find them excellent and cheap. In Japan it is used for many household articles.

A very serious objection to the use of lacquer in this country is the danger of lacquer-poisoning from the fresh material. I have recently heard of a piano-maker who tried to use it, but it affected his workmen so seriously that he was obliged to give it up. The Japanese are very much in dread of the poison, as I found when I tried to get some of my students to accompany me as interpreters to the places of manufacture. Those who are subject to the poison suffer precisely as patients afflicted by the *Rhus*, or poison-ivy. Of course, those engaged in lacquer-work are not affected by it; but whether one acquires immunity after a time, I am unable to tell. However, if the poison is a volatile acid, it would seem possible to remove it by a heat that would leave the lacquer uninjured, and thus make it available for use in this country.

THE PRODUCTION OF SUGAR.

BEFORE proceeding to describe the processes adopted for the extraction and refinement of sugar, says Ward Coldridge, in a sequel to an article on the same subject reprinted from *Knowledge* in *Science* of Aug. 30, it will be advisable to explain the difference between what a chemist means when he speaks of "a sugar" and what people generally understand by sugar. The chemist uses sugar as a generic term, and includes under it — strange as it may seem — things which have no sweetness, and excludes the sweetest of all substances, the newly discovered saccharine. He subdivides his sugar into two classes, — first, true sugars, which are distinguished by their power of undergoing alcoholic fermentation; and, secondly, bodies which do not suffer fermentation. Recent research has diminished the number of substances of the second class, so that for the purpose in hand this class can be eliminated, and our attention can be fixed on the first group only. These fermentable substances which yield alcohol are typically represented by grape sugar and cane sugar. Now grape sugar is less sweet than cane sugar, and its chemical constitution is different. Grape sugar has the formula $C_6H_{12}O_6$; that is, its molecule contains six atoms of carbon, combined with twelve of hydrogen and six of oxygen. When suitably treated with yeast, it ferments, and forms alcohol, and evolves a part of its carbon and oxygen as carbonic acid, one of the two substances from which the plant originally began to form its sugar. The equation is,

$$\underset{\text{Grape sugar}}{C_6H_{12}O_6} = \underset{\text{Alcohol}}{2\,C_2H_6O} + \underset{\text{Carbonic acid.}}{2\,CO_2}$$

It will be remembered that the plants originally formed their sugar from water and carbonic acid; and now it can be understood that Nature, when she wishes to dispose of an excess of sugar, transforms it into alcohol and carbonic acid. There is thus a reversion to the original type: —

$$\left.\begin{matrix}\text{Water}\\ \text{and}\\ \text{Carbonic acid}\end{matrix}\right\} \longrightarrow \text{Sugar} \longrightarrow \left\{\begin{matrix}\text{Alcohol}\\ \text{and}\\ \text{Carbonic acid}\end{matrix}\right.$$

But alcohol takes the place of water. In the face of the wide difference between the actions of water and alcohol on humanity, it may seem absurd to say that the final products bear any resemblance to the original. Yet, in spite of the physiological difference, the chemical relation of alcohol to water may be summed up in the statement that alcohol is water in which one of the two hydrogen atoms are replaced by a group of carbon and hydrogen atoms, "C_2H_5." Thus,

Water.....................	H. OH
Alcohol.....................	C_2H_5. OH

Nature does not, however, desire to flood the world with alcohol, for she very quickly transforms it, by aid of a countless army of minute living organisms, into vinegar; and thence, in turn, she passes back to what she started from, — to water and carbonic acid. So the cycle of changes runs on; in all stages it is always proceeding.

The conversion of common sugar is not so direct. Cane sugar must drink water before it can form alcohol. But the draught of water acts on it chemically, and converts this form of sugar into two others, one of which is uncrystallizable. When the sugar becomes thirsty at the temperature of the West Indies, it absorbs water with greater eagerness, and as a result a quantity of molasses or treacle is formed.

The older method of extracting the sugar — and in future in this paper the word will be used in its commercial sense only — was to take the canes which had been cut off as near the roots as possible and stripped of their leaves, and to crush them. From the crushed canes the juice exuded. This juice held in solution, besides the sugar, various substances of an albuminoid nature containing nitrogen, and of mineral bodies chiefly that phosphate of lime ($Ca_3 2PO_4$) which is obtained from bones. The object of the process is to remove these foreign substances, so as to have command of a comparatively pure solution of sugar in water. The albuminoids must be removed as quickly as possible, for they soon begin to assert their presence by causing fermentation in a manner analogous somewhat to yeast. The plan adopted is to collect the juice in large tanks, and then to add a small quantity of lime. The liquor is next heated to a suitable temperature; a thick scum forms on the surface. When it is considered that this coagulation of the albuminous substances has proceeded far enough, the clear liquor is drawn off from below. From this solution the manufacturer desires to obtain as much sugar as possible by crystallization. He therefore boils off the water quickly in open copper vessels, and incidentally improves the purity of his product by removing such scum as may form. The thick sirup which remains is run into coolers and allowed to stand until no more sugar-crystals separate. Finally he places the magma of crystals, and the mother-liquor from which the sugar has separated, into casks with perforated bottoms. The uncrystallizable thick brown viscid mother-liquor which draws away is the common molasses or treacle which is chiefly used in the manufacture of rum.

The process which has been thus outlined is far from being economically perfect. In fact, it is extravagant and wasteful. To begin with, the mechanical contrivances generally used by the colonial sugar-planter for crushing his canes are not perfect: he might obtain more juice from a given weight of cane. A somewhat recent invention seems to have a future before it in this direction. The principle is very simple and well known. It utilizes the fact that a body, when rapidly whirled around, will fly off tangentially unless restrained. The machinery is here so arranged that the juice may escape, but the solid pulp is restrained, and at the end of the operation is left in a dry condition.

However, the most serious defect of the above process arises in the actual manner of working up the comparatively pure sugar solution. Above it was said that the manufacturer rapidly boiled off the water; of course economy of time is an element to be considered. Allowing, then, that the water is removed quickly, it may seem at first sight that the process is excellent. But as a fact it is very wasteful. Why it should be so will be understood by realizing the fact that at the temperature used the water is not merely evaporated, but that some enters into combination with the cane sugar and converts it into grape sugar, as given above, and in the final result a large proportion of molasses is formed. So the question has been considered whether it is possible to remove this water under such conditions as will prevent, or at least diminish, the chemical change. The answer has been an affirmative one. The liquor, instead of being concentrated by boiling down under atmospheric pressure, is now heated in vessels from which the air can be exhausted. Consequently, according to the well-known connection between the temperature at which water boils and the pressure on its surface, the temperature of ebullition in a vacuum will be much lower than in air; the sugar solution will thus be kept while concentrating at temperatures below that at which it readily drinks water, and becomes in part uncrystallizable.

At the present time the colonial sugar manufacturer is proving