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ON MUDARINE,

THE ACTIVE PRINCIPLE OF THE BARK OF THE
ROOT OF THE CALOTROPIS MUDARII, *Buch*,
AND
THE SINGULAR INFLUENCE OF TEMPERATURE
UPON ITS SOLUBILITY IN WATER.

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[BRIEF notices of the *mudar powder*, of which *mudarine* is one of the constituents, have appeared on two or three occasions in THE LANCET, but we have not hitherto had the opportunity of presenting to our readers any elaborate account of this rather singular, and, apparently, very valuable substance. We willingly, therefore, transfer to our columns, from the "Transactions of the Royal Society of Edinburgh" for the present year, the subjoined Essay on *mudarine*, by Dr. Duncan. The Doctor's investigations into the chemical and therapeutic properties of this substance will be read with considerable interest. The *mudar*, it will be seen, offers the commercial and medicinal advantages of being a perfect substitute for, ipecacuan, growing in a province of British India, from which its exportation to the mother country would prove a matter of great facility and emolument.—ED. L.]

To the professional zeal and liberality of my lamented friend Dr. Adam, late Secretary to the Medical Board at Calcutta, I am indebted for many interesting specimens of the *materia medica* of Hindostan. Among these was a large supply of the powder of the bark of the *mudar*, or *mudhar*, the *calotropis mudarii* of Dr. Hamilton, which, with a nearly-allied species, had been formerly referred to the genus *asclepias*, under the trivial name of *gigantea*.

The high reputation which the *mudar powder* enjoyed among the natives of India,

as a specific for the cure of various cutaneous diseases, induced Mr. Playfair, Mr. Robinson, and Dr. Vos, to investigate its action as a medicine. These gentlemen gave favourable reports of its effects in India in cutaneous diseases, syphilitic affections, and tape-worm.

Dr. Adam was desirous that it should be tried in the diseases of this country, and that it should be subjected to chemical analysis, in order to ascertain the nature of its active constituent principles. I lost no time in proceeding with both investigations. The results of my first experiments were accordingly communicated to the public, in a paper published in the *Edinburgh Medical and Surgical Journal*, in July 1829. Since that time, greatly-enlarged experience has satisfied me, that *mudar* possesses no specific virtue, but that it is infinitely more valuable from its common medicinal properties, which correspond in every respect, both in kind and in degree, with those of ipecacuan. Indeed I have no doubt, that, from the facility with which any quantity may be supplied from the province of Bahar, the use of the Brazilian root may be altogether dispensed with in our East India settlements, and that *mudar* may even become, in a commercial point of view, a valuable export from Bengal to Europe. As such I feel myself justified in recommending it to the notice of the Honourable East India Company, and to the private merchants trading to India.

In the paper to which I have already alluded, I gave an account of the analysis of *mudar*, so far as I then carried it. I merely indicated the singular property possessed by one of its constituents, *mudarine*, which it is the object of this paper to explain more fully. In a note, I mentioned that I had discovered it to possess the very singular property of being very soluble in cold water, and gelatinizing when the solution was heated to 85 or 90 degrees Fahrenheit. Since that time I have frequently repeated and varied my experiments upon the *mudar powder*: but I have not yet completed my general analysis, which, upon the whole, coincides with what I published from my first experiments in 1829. Having,

however, satisfied myself that the principle to which I gave the name of mudarine possesses a property which has not been observed in any other principle, organic or inorganic, and constitutes a very striking exception to the general law of the power of solvents being increased by increase of temperature, I have thought it deserving of being communicated to the Royal Society, and, through the medium of its Transactions, of being made known to scientific chemists, as it is not improbable that it is possessed, in a greater or less degree, by some other organic principles, and that its discovery may lead to considerable modifications in our methods of analysing organic substances.

Mudarine is very easily obtained, in a state of considerable purity, from the tincture of mudar, made by macerating the powder of the root in cold rectified spirit. The greater part of the spirit may be recovered by distillation, and the remaining solution, which requires a much deeper colour, but remains perfectly transparent, is then allowed to cool. As the temperature declines, a white granular resin is deposited by a species of crystallisation, from a transparent coloured solution. The whole is now allowed to dry spontaneously, that all the resin may concrete. The dry residuum is then treated by water, which dissolves the coloured portion, and leaves the resin untouched. It is to this principle, dissolved by cold water from the resinous extract, that I have given the name of mudarine.

By exposure to the air it dries readily, forming a mass of a pale-brownish colour, perfectly transparent and homogeneous in appearance, having no tendency to crystallise, but becoming full of cracks, diverging from the centre, exceedingly brittle, and having no adhesion to the capsule containing it, from which it peels off spontaneously. It has no smell, and is intensely bitter, with a very peculiar nauseating taste. It is exceedingly soluble in cold water, at the ordinary temperature of the atmosphere. On the contrary, it is insoluble in boiling water. It is also soluble in alcohol, but the power of this solvent is increased by increase of temperature. It is insoluble in sulphuric ether, oil of turpentine, and olive-oil. It is in the solution in water, when nearly saturated, that the peculiar property of mudarine is most easily exhibited.

At ordinary temperatures this solution is quite fluid and transparent. When heat is gradually applied, already at 74°, a change in its constitution begins to be observable, indicated by a slight diminution of transparency and limpidity. As the temperature is raised, these changes increase, and at 90° it has in a great degree lost its transpa-

rency, and has acquired the consistence of a tremulous jelly. If the heat be now withdrawn, and the vessel allowed to cool, the jelly gradually, but very slowly liquifies, so that a day or two elapses before it has entirely recovered its original limpidity and transparency. If, instead of withdrawing the heat when it has risen to 90°, we continue to raise it, further changes occur. At 95° it is fully gelatinised, and now there appears to be a separation taking place into two parts, a soft brownish coagulum and a liquid nearly colourless, not unlike the separation of the serum from the crassamentum of the blood, as it spontaneously contracts. At 98° the coagulum is evidently contracted in size, while the fluid increases in proportion. At 130° the coagulum seems to dissolve; probably, however, it only is reduced in size by contraction. At 185° the coagulum is very small, and has a tenacious pitchy consistency. At 212° little further change.

The alterations which in this state it undergoes on cooling, are next to be observed. At 140° the fluid is very turbid. The coagulum has not diminished in size, and is now very hard and brittle. At 110° fluid less turbid, coagulum remarkably brittle, with a resinous fracture. At 100°, fluid more transparent, with thin detached pellicles on the surface. When cooled down, even to the freezing temperature, the coagulum remains unaltered, and very much resembles colophony; but, after the lapse of several days, it gradually liquifies in the portion of fluid in contact with it, without passing through the intermediate form of a jelly.

The coagulum, when separated from the fluid, is a transparent brown mass, exceedingly brittle, not deliquescent, fragments angular, lustre resinous, taste bitter, nauseous, adhering to the teeth. In this state it seems at first not to be soluble in distilled water, but after some days it is dissolved in it, with the same phenomena as in the fluid from which it was separated by boiling, and the solution has acquired its original properties. The dry mudarine is readily soluble in rectified spirit, and is not precipitated from the alcoholic solution by the addition of water. As long as any considerable proportion of spirit remains, it is not coagulated by increase of temperature, but, on allowing the spirit to evaporate by exposure to the air, it remains dissolved in the water, and has reacquired its original properties. It would therefore seem that its tardy solubility, after being contracted, is owing to the state of increased aggregation, for when this is removed by alcohol, its solubility is quickly restored.

Mudarine is also extracted, by the action of cold water, from the powder, but it is

not so easily separated from a gummy matter, also dissolved, as from the resin extracted along with it by rectified spirit. Its presence is, however, sufficiently demonstrated by the cold infusion gradually losing its transparency as its temperature is increased, and in this case it regains its former transparency, even after having been subjected for some time to the boiling temperature. We therefore see that, in this instance, a very active principle is more readily dissolved by cold than by boiling water; and it is probable that there are other instances in which heat is improperly employed, with the view of extracting the active principles of vegetable substances.

The influence of temperature upon the power of solvents is exceedingly curious and interesting. It has long been recognised as a general law, that the proportion of solid principles which are dissolved in fluids, is more or less increased by the assistance of heat. Hence water, by decoction and digestion, commonly dissolves more speedily and more abundantly than by cold maceration, the soluble principles of compound bodies. Various exceptions, however, to this general rule, have successively been discovered. Sea-salt has long been known to be equally soluble in cold and in boiling water. Afterwards, it was found that lime and magnesia were actually more soluble in cold than in boiling water; and a still more remarkable relation between the solubility of certain saline substances and heat has more recently been discovered. Sulphate of soda, and the nitrate and muriate of barytes, by successive augmentations of temperature, have their solubility first slightly increased, then greatly diminished, and again very rapidly increased. This phenomenon is the less likely to be soon explained, that each salt follows in this respect a different law, or that the curve of their solubilities in relation to temperature in each is different. All the known exceptions to the general law have been observed in the mineral or inorganic kingdom, and from analogy we may conjecture that many others exist in similar bodies, although not yet detected. It is also necessary to remark, that when, in consequence of the diminished power of the menstruum, whether by increase or diminution of temperature, the solvent is separated by precipitation or crystallisation, its nature is not altered, and it is equally soluble in the menstruum as before, by diminishing or increasing the temperature, or by adding an additional quantity of the solvent.

But, in regard to the organic kingdom, the law of increased solubility, by increase of temperature, has been hitherto held to be universal, except when the nature of the solvent is altogether altered

by heat, so that it has become no longer soluble in the menstruum, either by restoring the original temperature, or by increasing the quantity of the menstruum. Thus albumen, once coagulated by heat, is rendered permanently insoluble in water. In all other instances, the solubility of organic principles is supposed to be increased by increase of temperature. By heating the menstruum, it commonly acts more quickly and more completely, the soluble principles are more speedily extracted from organic compounds, and in larger quantity, and the solution is more liquid and perfect; while, on the contrary, on cooling, the principle dissolved separates from a hot saturated solution either by precipitation or crystallisation, or by becoming viscid, or forming a jelly, and in all these cases the principle thus separated is redissolved by again increasing the temperature, showing that its nature is not altered, and that they are simple examples of the rule that the solubility of bodies is increased by increase of temperature. The relative solubility of animal gelatine and of pectic acid, at different temperatures, may be specified with peculiar propriety as forming a striking contrast with the subject of this paper. Gelatine is sparingly soluble in water at the ordinary temperature of the atmosphere, so that cold water is incapable of extracting it from bones, horn, membranes, tendons, or even flesh. By increase of temperature it becomes rapidly more soluble, and most of these substances yield it very readily to boiling water. Nay, by increasing the temperature of water above the boiling point in Papin's digester, it becomes progressively still more soluble; and, accordingly, this method is employed by D'Arcet to extract gelatine from the hardest bones. On cooling, the water is no longer capable of retaining the whole gelatine dissolved, and the solution, by reduction of temperature, forms a tremulous jelly, more or less solid in proportion to its concentration, which is again readily dissolved into a fluid by the application of heat, properties very nearly the reverse of those I have stated to belong to mudarine. Nearly the same phenomena are observed with regard to pectic acid.

I must postpone to another opportunity the changes which mudarine undergoes from various chemical reagents, as well as the general analysis of the mudar powder, because I think that by limiting the present communication to the singular exception which mudarine presents to the solubility of organic principles being increased by increase of temperature, it is more likely to attract the notice of scientific chemists, and to lead to the inquiry whether other vegetable principles possess any analogy in this respect.