XXI. *Observations and Experiments on a Wax-like Substance, resembling the* Pé-la *of the* Chinese, *collected at* Madras *by Dr.* Anderson, *and called by him* White Lac. *By* George Pearson, *M. D. F. R. S.*

Read May 29, 1794.

1. *Some Observations relative to the natural History of the Insect which secretes a Sort of Wax, called white Lac.*

The matter which is the subject of the following observations and experiments, was first noticed by Dr. Anderson of Madras, about the year 1786, in a letter to the governor and council of that place, when he says, nests of insects resembling small cowry shells were brought to him from the woods by the natives, who eat them with avidity. These supposed nests he shortly afterwards discovered to be the coverings of the females of an undescribed species of coccus; and having noticed, in the Abbé Grosier's Account of China, that the Chinese collect a kind of wax, much esteemed by them, under the name of Pé-la, from a coccus deposited for the purpose of breeding on certain shrubs, and managed exactly in the same manner as the Mexicans manage the cochineal insect, he followed the same process with his new insects, and shortly found means to propagate them with great facility on several of the trees and shrubs growing in his neighbourhood.

On examining the substance, he observed in it a very considerable resemblance to bees wax; and noticed, moreover, that the animal which secretes it provides itself, by some means or other, with a small quantity of honey, resembling that produced by our bees; and he complains in one of his letters, that the children whom he employed to gather it were tempted by its sweetness to eat so much of what they collected, as to diminish materially the produce of his crop. It is also believed that the white lac possesses medicinal qualities.

A small quantity of this matter was sent to the President in 1789; but as there was not enough for the various experiments which suggested themselves to chemists who were consulted on the occasion, he wrote to Dr. ANDERSON for an additional quantity, who in 1792 furnished him with some pounds of it, both in its natural state, and melted into cakes, as also of the insects adhering to the branches on which they had been cultivated.

The curious analogy between the manner in which this insect produces its wax, and the mode in which it is produced by our bees, according to the late Mr. HUNTER'S observation, and the singularity of the animal's producing honey as well as wax, were sufficient reasons, in point of abstract curiosity, to make an analysis very desirable; and moreover the probability of its becoming an object of commerce seemed apparent: for it certainly can be provided at Madras at a much less price than is given for wax, even in the cheapest markets. I therefore, at the request of the President, very willingly undertook the task of examining its chemical qualities, which are the subject of the following paper.

It must be remembered, that all the authors who describe

the true cochineal insect tell us, that the females when nearly perfect are covered thickly with a white down, or meal, which protects them from the sun and rain, and the attacks of certain insects who are their enemies. It is probable that this substance is of the same nature as the pé-la, and that the secretion of wax in more or less quantity is common to the genus of coccus. It is observable, moreover, that the insect which produces lac, a substance resembling wax, provides itself also with a sweet fluid resembling honey. Hence a striking analogy between these three animals is observable; and it is far from improbable that future naturalists may discover them to be species of the same genus; and find the means of making the beautiful red colour produced by the lac insect as useful in dying as that of the true cochineal.

II. *Sensible, and some other Properties of white Lac.*

A piece of white lac, which weighs from about three to fifteen grains, is probably produced by each insect. These pieces are of a grey colour, opaque, rough, and roundish; of about the size of a pea, but with a flat side, by which they adhere to the bark. In this flat side there is a fissure which contains a little black matter, the *exuviæ* of the insect.

White lac, in its dry state, has a saltish and bitterish taste, and in the mouth is soft and tough. It appears however from Mr. ANDERSON's letter, that the taste of this substance recently produced is "delicious;" so that it is difficult to prevent the children and other persons employed to gather it from eating it.

On pressing a piece of this substance between the fingers, a

watery liquid oozes out, which has a slight salt taste; and we are told that the recently gathered lac is replete with juice.

Although the roundish pieces of this substance yield to pressure between the fingers, they may be broken, and then appear to be perfectly white within, and of an uniform smooth texture. White lac has no smell, unless it be pressed or rubbed till it is soft, and then it emits a peculiar odour.

The lac which had been strained through muslin was of a brown colour throughout its whole substance; was brittle, hard, and had a bitterish taste, without any saltness, for its watery liquid had been separated by melting.

The pieces of lac gathered from the tree are as light, or lighter than bees wax; but after being melted and purified by straining, it sinks in water, and therefore is specifically heavier than bees wax generally is.

White lac melts in water of the temperature of 145° of FAHRENHEIT'S thermometer. In boiling water it readily melted, and the black *exuviæ* were thus separated from the lac.

Two thousand grains of white lac were exposed in such a degree of caloric* as was just sufficient to melt them; as they grew soft and fluid, a pretty large quantity of reddish watery fluid, namely 550 grains, which emitted the smell of newly baked bread, oozed out. This liquid was poured off for examination, and the lac was strained through fine cloth repeatedly, till it left no *exuviæ* or other extraneous matter on the filter.

The quantity of purified lac thus obtained was 1220 grains.

* The names of the new system of chemistry are employed in this paper, for which it is presumed a particular explanation is unnecessary, as its nomenclature is now very generally used.

It was yellow like bees wax; hard and brittle as rosin. It had no bitterish or scarcely any other taste. It melted in alcohol, and also in water, of the temperature of between 145° and 146°.

Purified white lac adheres very firmly to wood, tin, paper, &c. so that it is an excellent cement on many occasions.

III. *Experiments to discover some of the Affinities and Combinations of white Lac.*

1. Yellow purified lac above mentioned was spread thin upon a plate of glass, and exposed to the rays of the sun during the whole of the month of July, 1793, but it was not by this means rendered at all less yellow.

2. A bit of white lac, on boiling in water with powdered charcoal, was absorbed, and disappeared.

3. Purified lac was digested in various proportions of ley of pure pot-ash, in different temperatures, but an uniform or soap-like mass could not be formed. The mixture emitted the smell of palm oil. The lac turned to a brown colour, and had the appearance of a coagulated mass, in the liquid as well as dry state. The liquid filtered from these solutions had a sweetish and bitterish taste. Upon the addition of vinegar, it became very turbid and rose-coloured; and by standing it let fall a copious sediment, which being dried was found to be white lac only rendered more brittle.

4. *Ammoniac*, or *caustic volatile alkali* seemed to combine with the white lac. The compound was a tolerably uniform brown soapy substance. It tasted sweet, and had still a weak smell of ammoniac. It rendered water milky, and this solution became curdy on adding to it acetous acid.

5. Candles, of different thicknesses, were made of purified white lac above mentioned, with cotton wicks of different thicknesses; and candles were also made of white lac which had been dissolved in sulphuric æther, and in volatile oil of turpentine. They all burned more rapidly, but I think emitted a less quantity of light, than wax candles, of the same size. The candles made of white lac also smoked and produced a rosinous smell.

White lac burned in oxygen gaz without affording any smoke, and with a beautifully bright flame.

A small piece of purified white lac, in a platina spoon, was exposed to the apex of the violet blue coloured flame of a candle, by means of the blow-pipe; a small quantity of black matter remained in the spoon, which could not be carried off by a long continued application of the flame; but after keeping the spoon red-hot in the fire for ten minutes, nothing but a very small quantity of grey ash was left.

6. From purified white lac nothing could be extracted by water; nor from the lac in its impure state, except a bitterish mucilage.

7. White lac turned to a black coloured substance by boiling it in concentrated sulphuric acid. The mixture was then diluted with water, and by means of the filter a carbonaceous matter was separated, which on being made red hot burnt in the air without flaming. The filtered liquid, upon evaporation to dryness, afforded no alkaline or other residue.

8. Glass covered with a thin coat of white lac was kept immersed in oxygenated muriatic acid gaz, and also in water saturated with this gaz, for several months, without producing any apparent change on the colour of the lac, or in its other properties.

9. On about 100 grains of white lac were poured 400 grains of concentrated nitrous acid. In a few minutes time the acid became of a deep orange colour, and, on making it hot, nitrous gaz was discharged, with an ebullition of the liquid. A fresh discharge of nitrous gaz took place on adding more nitrous acid. On applying caloric, to make the acid boil and to melt the lac, this substance was totally dissolved; but on standing to cool, it seemed to be wholly separated from the acid, and was rendered white. On diluting with water the acid from which the lac had separated itself, a very slight curdy precipitation took place; and the same appearance took place on adding ley of pot-ash. On evaporating this acid to dryness, a very small residue of lac was obtained. I dissolved a little of this substance by boiling it in concentrated nitrous acid, and poured the solution, while hot, into water; upon which a very copious precipitation instantly took place, of the lac rendered quite white.

10. One hundred grains of the substance under examination were totally dissolved, and very readily, in 500 grains of volatile oil of turpentine. While this solution was hot it was clear, but on cooling it grew opaque and white. On evaporation the whole of the lac was recovered.

11. Fifty grains of white lac readily dissolved in 500 grains measure of sulphuric æther, in the temperature of 80°. This solution was not unctuous, or resinous; the lower part of it was like an emulsion, and the upper part was transparent and limpid; but both parts contained the substance dissolved. Upon evaporation the lac was recovered in the form of a light white powder, which on melting became a brittle yellow solid, as heavy as before solution.

12. One hundred grains of white lac being digested in 1000 grains measure of alcohol, the specific gravity of which was as 835 to 1000, about half of the substance soon dissolved; and the solution when cold was opaque, white, and thick, as saturated solution of soap in hot spirit of wine appears on cooling. By repeated affusions of alcohol on the residue of these 100 grains, all but about 15 grains was dissolved; and this residue did not appear to be different from lac which had not been digested in this menstruum. This solution afforded, on evaporation, a light white opaque powder, which on being melted was a brittle, yellow, heavy solid, as the substance was before solution.

Saturated solution of white lac in alcohol spread upon paper, cloth, wood, &c. on evaporation left a thin coat of resinous matter, which was not however bright and smooth; and therefore this solution did not afford a good varnish.

IV. *Experiments to decompound white Lac by Fire.*

I shall only relate particularly one of these experiments, because among several which I made there was no material difference in the result.

Eight hundred grains of purified white lac were put into a glass retort, to which was affixed an adopter with a large bulb to receive condensed vapours, and the hydro-pneumatic apparatus to collect elastic fluids, or gazes. There distilled over 204 grains of yellow strongly empyreumatic oil of the consistence of butter, 400 grains of thin oil which had the smell of tar, near 20 grains of watery liquid containing a little acid, perhaps the pyrotartareous or the sebacic acid; besides 307

cubic inches of gaz. In the retort there remained 37 grains of carbonaceous matter, which was a pretty hard cinder, the under surface of which in contact with the glass had seemingly undergone a partial fusion, and the glass itself to which it adhered appeared to have been a little corroded.

The above distilled gaz contained no oxygen to the test of nitrous gaz; but 32 cubic inches of it were absorbed by milk of lime, and near 86 cubic inches of it were absorbed by yellow oxyd of lead, or massicot, placed in the focus of a lens; during which absorption lead was reduced, and water composed. The remainder of the gaz extinguished flame, and was concluded to be nitrogen or azotic gaz.

The gaz which was obtained by distillation was therefore a mixture of carbonic acid, hydrogen, and nitrogen gaz. This mixture burnt like what has been called heavy inflammable air.

The above 37 grains of carbonaceous matter afforded two grains of muriate of soda, one grain of carbonate of soda, four grains of phosphate of soda. The lixiviated carbonaceous matter being mixed with 300 grains of red oxyd of lead, and exposed to a due degree of fire, yielded about 60 cubic inches of carbonic acid gaz, and a little regulus of lead; but there was a residue of carbonaceous matter which could not be burnt away in the fiercest fire in open vessels. This residue was probably carbon, phosphoric acid, and soda, intimately mixed by fusion.

From this analysis, it appears that 100 parts of white lac purified yield

Butyraceous oil - - -	$25\frac{1}{2}$
Thin oil - - - - -	50
Water containing acid - - -	$2\frac{1}{2}$
Carbonaceous matter, containing phosphoric acid, muriatic acid, and soda - -	$4\frac{1}{2}$
Carbonic acid, by estimation - -	4
Hydrogen, by estimation - -	$1\frac{1}{2}$
Nitrogen or azote, by estimation - -	10
	98
Deficiency by waste and error, by estimation	2
	100 parts.

When this experiment was made with unpurified white lac, the proportion of water and carbonaceous matter was much greater than in the preceding experiment. On account also of the water, it was extremely difficult to prevent the substance boiling over and bursting the vessels.

Charcoal of wood being mixed with white lac, the oil seemed to distil over more readily, with less water, and was paler coloured oil than in the preceding experiment.

White lac was also distilled from pot-ash, without any material difference in the result, excepting that the oils which distilled over were thicker.

v. *Experiments upon the Liquid contained in white Lac.*

(*a*) On pressing, between the fingers, the pieces of white lac, in the state in which they are taken from the tree or shrub (although they are apparently quite dry and brittle, and have been kept several years), a watery liquid oozes out; by which paper stained with turnsole is instantly turned to a red colour.

(*b*) The 550 grains of reddish watery liquid above mentioned to have been separated from 2000 grains of white lac were filtrated through paper in order to separate mucilage.

(*aa*) This filtrated liquid has a slightly saltish taste, with bitterness, but is not at all sour.

(*bb*) When made hot, it smells precisely like newly baked hot bread.

(*cc*) On standing it grows somewhat turbid, and deposits a small quantity of sediment.

(*dd*) Its specific gravity in the temperature of 60° was to distilled water as 1025 to 1000.

(*ee*) A little of this liquid having been evaporated till it grew very turbid, on standing afforded small needle-like crystals in mucilaginous matter.

(*c*) About 250 grains of the liquid (*b*) were poured into a retort which held one ounce measure, to which was joined a receiver containing two shreds of paper, one stained with turnsole, and the other had been dipped in solution of sulphate of iron. As the liquor grew warm, mucilage-like clouds appeared, but when it grew hot they disappeared; and about the temperature of 200° it distilled over very fast. On distillation to nearly dryness, a small quantity of extractive matter remained.

The distilled liquid while hot smelt like newly baked bread, and was perfectly transparent and yellowish. The paper stained with turnsole was not reddened; nor was that which had been immersed in solution of sulphate of iron turned to a blue colour, upon moistening it with ley of pot-ash.

(*d*) The flame of a candle being applied by means of a blow-pipe to the extractive matter (*c*), the whole of it was burnt away, except what produced a black mark upon the spoon; in which no trace of alkali was detected by paper stained with turmeric.

(*e*) About 100 grains of the yellowish transparent liquid (*c*) being evaporated till it grew turbid, after being set by for a night, afforded acicular crystals; which under a lens appeared in a group, not unlike the umbel of parsley. The whole of these crystals could not, probably, have weighed a quarter of a grain. They tasted only bitterish.

(*f*) One hundred grains of the yellowish transparent liquid (*c*) being evaporated, in a very low temperature, to dryness, a blackish matter was left behind, which did not entirely disappear on heating the spoon containing it very hot in the naked fire; but on heating oxalic acid to a much less degree it evaporated, and left not a trace behind.

(*g*) *Carbonate of lime* (chalk) readily dissolved, with effervescence, in the liquid (*c*). The solution tasted bitterish, did not turn paper stained with turnsole to a red colour, and a copious precipitation ensued on adding to it carbonate of pot-ash (mild vegetable alkali). A little of this solution of lime, and also of alkali, being evaporated to dryness, and the residue being made red-hot, nothing remained but carbonate of lime, and carbonate of pot-ash.

(*b*) The above distilled liquid (*c*) did not render nitrate of lime turbid; but

(*i*) It produced turbidness in nitrate and muriate of baryt.

(*k*) To 500 grains of the reddish coloured liquid obtained by melting white lac, I added ley of carbonate of soda, till the effervescence ceased, and the mixture neither reddened paper stained with turnsole, nor turned paper stained with turmeric to a brown colour. The quantity of dry carbonate of soda used in the ley was three grains. A quantity of mucilaginous matter, with a little carbonate of lime, was precipitated during this combination. The saturated solution being filtrated and evaporated to a due degree, it afforded, on standing, deliquescent crystals.

(*l*) A little of the crystallized salt (*k*) by exposure to fire left only a residue of carbonate of soda.

(*m*) The reddish liquid obtained by melting the white lac being filtrated, the following precipitants were added; namely,

1. *Lime-water*, which produced a light purple, turbid appearance, and on standing, there were just perceivable clouds.

2. *Sulphuret of lime* (calcareous liver of sulphur) occasioned a white precipitation; but I could not perceive the smell of sulphurized hydrogen gaz, (hepatic air).

3. *Alcohol of gall nut* (tincture of gall nut) induced a grey precipitation.

4. *Sulphate of iron* (green vitriol) produced a purplish colour, but no precipitation; nor did any precipitation take place on adding to this mixture first a little vinegar, and then a little pot-ash.

5. *Acetite of lead* (sugar of lead) occasioned a reddish precipitation, which re-dissolved on adding a little nitrous acid.

6. *Nitrate of mercury* (solution of mercury in nitrous acid) produced a whitish turbid liquid.

7. *Oxalic acid* produced immediately a precipitation of white acicular crystals.

8. *Tartrite of pot-ash* (soluble tartar) being added, a precipitation took place which much resembled that which takes place on adding tartareous acid to tartrite of pot-ash; but the precipitated matter by the liquid from the white lac did not re-dissolve on adding pot-ash.

With respect to the nature of the liquid contained in white lac, it perhaps belongs to the genus of acids, because it changes turnsole to a red coloured substance, and neutralizes fixed alkali and lime (*g*) (*k*).

This acid liquid is most probably secreted at the same time with the white lac; and therefore the white lac coccus, like the ant, and some other insects, has organs for secreting an acid.

As this acid is destructible by fire (*f*) (*g*) (*l*), and as it affords carbon (*f*), it must be referred to the animal or vegetable acids.

From the precipitation of tartrite of pot-ash (*m*, 8) resembling tartar, this acid might be supposed to be the tartareous; but as this precipitate is not again dissolved on adding pot-ash; as it has no sour taste (*c*); as it evaporates in 200° of caloric (*b*); as the combination with lime is readily soluble in water, and decomposed by pot-ash (*g*) (*m*, 1); and as the combination with soda is a deliquescent salt (*k*), this acid cannot be considered to be the tartareous. Nor does this liquid appear, from the above experiments, to be any one of the other known vegetable or animal acids. The other proper-

ties, shown by the experiments, except the precipitation of tartrite of pot-ash, and the peculiar smell above mentioned, are either those common to every species of acid, or are possessed by several of them. For although this acid possesses several properties common to all acids, and some properties which belong to a few species only, there is not any one of the already known acids that has the smell, when heated, above mentioned; that precipitates tartrite of pot-ash, but does not serve to compose acidulous tartrite of pot-ash; that, besides having these properties, is vapour in the temperature of 200° without decomposition, has not a sour but a bitterish taste, and forms a soluble compound with lime, which is decomposable by pot-ash.

The precipitation by oxalic acid, it is probable, was occasioned by a small quantity of lime which the undistilled liquid of white lac contains.

The other phænomena in the experiments I do not refer to, because they are produced by acids in general.

Whether the above liquid from white lac be a new acid, or one of the acids already known, but disguised by mixture or union with other bodies, I leave to the decision of future experiments, and to the judgment of learned chemists.

VI. *Remarks and Conclusions from the preceding Observations and Experiments.*

1. White lac being unctuous when in a fluid state; having little or no smell and taste, unless heated; being insoluble in water; being inflammable in oxygen gaz; and decompounded by fire alone, in close vessels, before evaporation, it seems to

belong to the genus of *fat*, or *fixed oils*:—but it differs from them, and resembles the volatile oils and resins, in being brittle and semi-transparent; in being soluble in alcohol; in composing an imperfect soap with fixed alkalies; in dissolving readily in sulphuric æther.

2. As bees wax and white lac seemed to be alike in many properties, I extended the comparison by some experiments on bees wax.

Bees wax when first secreted is, I believe, always white, and it is often white when made into the comb. It remains white after being melted.

White lac becomes yellow, on purification by melting and straining.

Bees wax has a peculiar smell when cold. White lac has a smell only when made hot, and it is a different one from that of bees wax.

Bees wax is less brittle and hard than white lac. The former is, generally, specifically lighter than the latter; for bees wax often floated upon cold water, but purified lac fell to the bottom.

Bees wax melts at about 142°, and therefore in a few degrees less caloric than white lac.

Bees wax does not adhere so firmly to different bodies as white lac.

Yellow bees wax can be rendered white by exposure to the solar light, or by oxygenated muriatic acid, but this lac could not be bleached.

Bees wax formed a soap-like mass by union with pot-ash, which was soluble like common soap in water, but this lac afforded an imperfect soap.

It is well known that bees wax burns without affording almost any smoke or smell, and produces a steady light. I did not find that white lac, united with oil of olive, formed a wax little inferior to bees wax, which is said to be the case with the pé-la of the Chinese. By this union I made white lac whiter and as soft as bees wax; but it still afforded smoke, a resinous smell, and an unsteady light, as before.

Water extracted nothing from pure bees wax.

Nitrous acid, in the cold, only rendered it white; but, on boiling, the lac wholly dissolved, and like the white lac, on cooling, it separated, and was rendered white.

Oil of turpentine, and

Sulphuric æther formed compounds with bees wax similar to those with *white lac*. The solution of bees wax in sulphuric æther, on evaporation left a white powdery substance, which on melting was found to be common yellow wax.

Alcohol, the specific gravity of which to water was as 835 to 1000, dissolved bees wax with much more difficulty, and in much smaller proportion, than *white lac*. By digestion in this menstruum, of the temperature of 130° to 140°, it appeared that bees wax was totally soluble; but the same wax by repeated digestions became more and more difficultly soluble; and yet it did not appear that the last portion of wax was different in its other properties from wax which had not been digested.

On evaporation of this solution to dryness, a white substance in a powdery form remained, which being melted was yellow wax.

Bees wax, on decomposition by fire, in close vessels, with the hydro-pneumatic apparatus affixed, yielded resembling or nearly similar substances to those obtained on the analysis of

white lac by fire; for 1800 grains of bees wax gave 1200 grains of white butyraceous oil, with a little thin brown oil, and a very small quantity of water and acid; and a very large quantity of hydrogen and carbonic acid gaz, with which was probably mixed nitrogen gaz; but an accident prevented me determining the presence of this last gaz. In the retort there remained only about ten grains of carbonaceous matter. The smell of the empyreumatic oils was very different from those of white lac.

3. White lac appears to have the same kinds of affinity as bees wax; but many of their combinations are so very different in the two cases, as to determine white lac and bees wax to be different species of substances, although they agree with one another in more properties than they do with any other known bodies. As to the pé-la of the Chinese, we cannot judge of it unless a more particular account had been given of its qualities.

4. White lac and bees wax appear to be homogeneous substances, and to consist of the same kind of constituent parts, but the proportion of these parts is very different in the two substances; and hence the difference in the properties of bees wax and white lac. I consider the phosphate of lime, the soda, and muriate of soda, as extraneous to the composition of lac. The different composition of the two substances may enable us to explain in a probable manner the different action of other bodies upon them. For instance, as it appears that a much greater proportion of carbon enters into the composition of white lac than bees wax, the quantity of oxygen gaz in atmospheric air, applied under the usual circumstances of combustion, is not sufficient to combine with the

whole of the carbon and other components of a given part of white lac, wherefore a portion of carbon remains uncombined, in the form of soot, or a sublimate; but when oxygen gaz is applied, the whole of the carbon is combined with it, and of course no smoke appears.

The smaller proportion of carbon in bees wax than white lac, affords a probable reason why there is less smoke during the combustion of bees wax than white lac.

It appears reasonable to conclude, that white lac might be made to serve for illumination and combustion as well as bees wax, either by diminishing the proportion of carbon, or by increasing the proportion of the other components; but my knowledge of chemistry does not enable me to effect either of these changes.