LX. Comparative analysis of the gum resins

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LX. *Comparative Analysis of the Gum Resins.* By H. BRACONNOT, *Professor of Natural History, &c. &c.**

ANALYSIS OF CAMBOGE.

§ I. IT is generally understood that this gum is procured by incision from the bark of the camboge, a large tree in India, the top of which is extremely woody, and the trunk ten or twelve feet in circumference. This tree, which Linnæus designates by the name of *Cambogia gutta*, requires the greatest heat of our hot-houses when we wish to produce it in Europe by means of its seeds, which are contained in a pulpy acid fruit, of the size of an orange.

Camboge is brought in different-sized rolls from the kingdom of Siam, China, and the island of Ceylon; and was scarcely known in Europe until the commencement of the 16th century. The authors who have mentioned it do not agree respecting its most remarkable physical properties. Thus, while they allow it to be of an orange-yellow colour without smell, some assign to it a slight acid taste, and others on the contrary assert that this taste is very strong: for my own part, (and I have examined a great number of specimens of the best quality,) I found that all of them had an almost insipid taste.

A like difference of opinion has prevailed respecting the analytical results which have been given of the substance in question. According to Cartheuser, it contains more extractive than resinous parts: he gives this, however, only as a conjecture, and thinks it very difficult to separate these two principles. Geoffroy is of a contrary opinion: for he says, in his *Materia Medica*, that camboge contains five-sixths of resinous substances, and one-sixth only of extractive parts soluble in water. But we shall presently see that it contains no extractive at all.

§ II. If we expose camboge to the flame of a candle, it swells and takes fire like resinous matter: on heating it in a cup it exhales a particular smell, softens, and will be decomposed rather than enter into fusion.

Fifty grammes when distilled produced—1st, A brown water in which was empyreumatic acetous acid.—2d, A small quantity of light oil.—3d, There afterwards passed over in considerable quantity another heavy thick oil of a brown colour. There remained in the retort a light coal

* *Annales de Chimie*, tome lxxviii. p. 33.

of the weight of eight grammes, the incineration of which left five decigrammes of ashes, which produced,—two centigrammes of potash partly sulphated, four centigrammes of phosphate of lime, six centigrammes of carbonate of lime, and three decigrammes of quartz sand, containing a little charcoal and some traces of oxide of iron. Lime and the alkalis did not discover any ammonia in the liquid products of this distillation.

§ III. Twenty grammes of camboge were treated with warm alcohol and filtered. There remained on the filter a substance which when well washed with alcohol was a grayish colour, drying with difficulty, and becoming brittle. In this state it weighed exactly four grammes: it had an almost insipid taste, and was entirely dissolved in water, with the exception of one decigramme of impurities. This solution reddened turnsole: when evaporated to dryness, it left a transparent friable residue similar to the coloured gum of the plum-tree, which like the latter burns with little flame, and leaves a good deal of compact charcoal, in which we find phosphate of lime.

The alcoholic solution was of a red colour; when evaporated to dryness it yielded a resin weighing 16 grammes. This resin is transparent, of a red colour, without any marked taste, and having a distinct idio-electrical virtue; when pulverized it gives out a particular smell, and assumes a bright yellow colour.

If into the saturated solution of this resin in alcohol we pour some water, a little heat is produced, and a yellowish milky liquor is formed; whereas most of the other resins precipitated from alcohol by water terminate by becoming partly grumous: it is on account of this easy division of the resin of camboge that it is employed so much in miniature-paintings, &c.

§ IV. The solution of potash acts upon the resin of camboge with great promptitude, particularly when it is warm: there results an oily-like liquor of a deep red, in which the properties of potash are neutralized: on evaporating this combination almost to dryness, it crystallizes like the solutions of aloes.

The soap of camboge resin is of a deep red colour, and almost black: it is soft to the touch, becomes friable when dried, and resembles a resin.

It has the taste of rancid grease, and leaves a slight degree of acrimony on the tongue. It is easily dissolved in water without disturbing it.

The acids make so abundant a deposit in the soapy solution

solution of camboge, that the whole liquor goes into a thick coagulum of a fine yellow colour.

Lime-water produces in this soap a precipitate of a fine orange colour.

The earthy salts also form yellow precipitates in it as well as most of the solutions of white metals. It precipitates the sulphate of iron in brown, and the nitrate of copper in green.

§ V. Ten grammes of camboge were put into a retort with 80 parts of the strong nitric acid used in commerce. As soon as the retort received the impression of the fire, red vapours were produced, the intensity of which soon disappeared. I poured into the retort the first products which had passed during the operation, which was continued until the matter was dissolved, and thickened to the consistency of a syrup*: on cooling, there was formed a mass of lamellated crystals, enveloped in a viscous matter: the whole was diluted with a quantity of water, which produced a sediment which when well washed and dried weighed one gramme three decigrammes.

This substance was of a yellowish colour, of a bitter taste, and was partly dissolved in boiling water: the solution became turbid on cooling, and deposited part of the dissolved matter on filtering the liquor. It is of a reddish yellow colour, becomes frothy by agitation, reddens turnsole tincture, assumes a deeper colour on its mixture with the alkalis, and slightly precipitates at the end of a certain time the sulphate of iron.

When put upon the fire, this matter does not melt so easily as the resin of camboge: it gives out an aromatic smoke, and leaves plenty of charcoal.

It unites very well with potash and spirit of wine, and red transparent solutions result.

The nitric acid when slightly heated with this substance dissolves it without altering it sensibly: water produces in the solution an abundant white coagulum.

From these properties I think myself warranted in regarding this substance as a particular species of soluble factitious resino-bitter, united with a yellowish resiniform matter insoluble in water.

* The produce of this distillation, when well saturated with chalk and distilled again, furnished a liquor slightly acid, of an extremely pungent smell and of a very strong bitter. The alkalis colour it slightly in yellow. On adding sulphate of iron to this mixture, a precipitate is formed entirely soluble in the acids. There is no prussic acid therefore in this liquor, the nature of which is not well known to me.

The acid liquor and the washings were thickened in order to drive off what remained of the nitric acid, and this residue was diluted with water in which had been dissolved a small quantity of potash, which separated four decigrammes of the yellow resiniform substance. The liquor when again thickened, and then treated with alcohol and filtered, left some very white acidulous oxalate of potash, which when dried weighed one gramme. The alcoholic solution furnished on evaporation three grammes of bitter matter soluble in water, and which contained malic acid.

§ VI. I diluted some camboge in fine powder in a certain quantity of water, and passed through it a stream of oxygenated muriatic gas, with the intention of taking away the colour of this resin, which in fact lost its fine yellow colour: the milky liquor, when thickened, afterwards diluted in water and filtered, left on the filter a substance which was washed with boiling water until the latter did not redden turnsole tincture. The following were the properties which this substance presented:—

It is pulverulent, of a pale yellow colour without any sensible taste: it crackles under the teeth like an insoluble salt, nor does boiling water dissolve it. It is very little fusible, and does not give out any smell while it is not decomposed; but when we set fire to it, or when we spread it on burning coals, it exhales pungent vapours of muriatic acid.

The weakened acids give out nothing perceptible from it; but if they are concentrated, there is a production of charcoal and muriatic acid.

When joined with potash this substance yields a compound of an agreeable smell of soap, in the solution of which the nitrate of silver forms a precipitate partly soluble in the nitric acid.

I distilled six grammes of this substance in a small retort which I made red-hot: the produce was collected in some decigrammes of water, which when examined at the termination of the distillation was strongly acid, and had the smell of muriatic acid: I poured into this water some nitrate of silver, which produced an abundant precipitate of muriate of silver. When well dried and washed, this precipitate weighed five grammes four decigrammes, which contain 1 gramme 35 centigrammes of muriatic acid, supposing, according to Bergman, that 100 parts of muriate of silver are formed of 25 muriatic acid and 75 oxide.

There remained in the retort two grammes one decigramme of light charcoal.

It results therefore, that 100 parts of this acid resinous substance are formed of

Dry muriatic acid	22.5
Charcoal	35.0
Oxygen, hydrogen and carbon, in the aëri- form state	42.0

100.0.

It will be seen with surprise that the muriatic acid exists in this substance in the same proportion as in the muriate of potash; for 130 parts of this salt only contain at most 30 of muriatic acid, according to M. Thenard: but on recollecting the excellent researches of this chemist on the union of the principles of alcohol with the muriatic acid, we shall be less astonished upon seeing other hydrogenized substances act in the same manner with this acid.

The great quantity of carbon which exists in this muriated resinous matter authorizes me in thinking that it is not owing to the direct combination of the muriatic acid with the resin of camboge; for the muriatic acid when heated with this resin did not give the same acidiferous substance. It seemed much more probable to me that the resin of camboge has been partly de-hydrogenated by the oxygenated muriatic gas, and that in this state it must have contracted an union with the muriatic acid.

These results also lead me to think that during the decoloration of vegetable substances by the oxygenated muriatic acid, a part of this oxygenated acid enters into combination.

§ VII. It results from these inquiries that camboge is truly a resinous gum in every sense of the word; since we find in it a peculiar resin well characterized, and a gum resembling that which is furnished by several of our fruit-trees. It was formerly used in medicine as a remedy for gout, and hence its French name of *Gomme goutte*; but it has been disused as an anti-arthritic for nearly a century past, and is now only resorted to in order to aid the operation of other drastics: its want of taste seems to infer that its medicinal virtues are not very energetic.

ANALYSIS OF EUPHORBIA.

§ I. Euphorbia flows naturally or by incision from several plants of the same genus. In Malabar, the *Euphorbia antiquorum* still furnishes what is used by the Dutch at the present time; that which is brought into England is extracted from the *Euphorbia canariensis*, a very large species,

species, which grows to the height of 20 feet. The *Euphorbia madagascariensis* also yields a juice which the Indians thicken, and which they use, instead of our vomiting medicines, for small-pox with great success, according to Sonnerat. Other species might also yield euphorbia; but Linnæus observes that the *Euphorbia officinarum* ought to be the only species in use. Upon inspecting a great quantity of euphorbia in fine large tears, I accidentally met with some branches of the plant itself, which gave me an opportunity of ascertaining and determining the species. These branches were rather long, quadrangular, furnished with numerous tubercles ranged longitudinally, and armed at their angles with two black spears short and divergent. These characters by no means belong to the *Euphorbia officinarum*, but evidently to the *Euphorbia canariensis*, which seems to furnish the euphorbia which is brought to France.

The analytical results which the ancients obtained from euphorbia are too vague and incorrect to relate them here.

§ II. The euphorbia which I examined, was in branchy cavernous friable tears, of a pale yellow, and having the semi-transparency of wax. This substance is so acrid that, having put a small quantity on my tongue, my mouth was inflamed, with an ardent inclination to vomit immediately afterwards.

Euphorbia when exposed to a gentle heat softens easily, and loses $\frac{1}{10}$ th of its weight by evaporation. I boiled four grammes of euphorbia with 100 grammes of distilled water: the filtered liquor left an insoluble matter, which when dried weighed three grammes; that which passed over was of an amber colour, and had a bitter taste accompanied with a slight acrimony.

This colour reddened turnsole tincture.

The oxalate of potash produced an abundant sediment of oxalate of lime.

The nitrate of lead forms a white sediment entirely soluble in distilled vinegar.

Lime-water also disturbs this liquor, and produces a yellow precipitate which vinegar dissolves.

§ III. A. I treated by boiling 20 grammes of euphorbia with 90 grammes of alcohol at 36°, which was sufficient for dissolving all the particles which were susceptible of solution. This solution, being filtered while in a boiling state, left on the filter a substance which was well washed with alcohol: this matter when dried weighed 6.4 grammes.

B. The alcoholic solutions were mixed, and they became
turbid

turbid on cooling; and at the end of two days there was deposited an abundant white gelatinous-like matter, which when washed in alcohol and dried weighed 4·7 grammes: it still retained alcohol, which I drove off by melting it at a gentle heat; it did not then weigh more than 3·4 grammes. This substance was semi-transparent, it easily became soft under the fingers, was almost entirely volatilized on hot iron, and acted like bees-wax, of which it even had the smell when melted or burnt.

The wax of euphorbia preserved a little acrimony, without doubt because it had not been sufficiently washed in alcohol. I made a taper of it, which burned with a very pure flame.

C. The 6·4 decigrammes of the matter insoluble in alcohol A were heated to the boiling point with 100 grammes of distilled water. The filtered liquor left small branches of wood and thorns, on which the euphorbia was stuck: after desiccation it weighed 2·7 grammes.

D. The aqueous solution C when evaporated formed a varnish on the surface of the vessel. On thickening it to dryness, we obtained a fragile substance, which was removed in micaceous scales: it did not attract humidity from the air, and weighed 4·1 grammes, which I recognised at first sight as malate of lime. In short, upon heating this substance with sulphuric acid diluted in water, I obtained, 1st, some very white sulphate of lime, which after being washed and dried weighed 1·6 grammes: 2d, an acid which alcohol dissolved, and from which there were separated five decigrammes of sulphate of lime. The solution when evaporated produced two grammes of malic acid, retaining a little sulphuric acid, which was taken from it by means of barytes.

The malate of lime seems to exist therefore in a considerable quantity in the lactiform juice of euphorbia, and it is this which in the euphorbia of commerce was anciently supposed to be a gum, and which has been confounded with the extractive matter by M. Laudet, a late experimenter.

E. The alcoholic solution B, when evaporated to dryness, left a residue weighing 8·3 grammes, which were treated by cold alcohol, and which dissolved the resinous particles, and also separated four decigrammes of wax.

F. This solution was again thickened, and we obtained a resin attracting a little humidity from the air, which must have been owing to a deliquescent salt which I obtained on heating this resin with distilled water. This salt was malate of potash, and weighed four decigrammes when well dried.

G. The

G. The resin of euphorbia is of a reddish transparency, and of an excessive bitterness, which must make it be regarded as a violent poison. It becomes idio-electrical on being rubbed.

The alkalis have no sensible action on it: I heated some with a solution of caustic potash, and I poured nitric acid into the liquor, which was not disturbed: some slight red flakes only were formed after some time, which floated on the surface of the liquor.

Cold sulphuric acid dissolves the resin of euphorbia when treated with the nitric acid at a temperature of 20°. It becomes soft, yellow, and begins to be decomposed: on heating the liquor we obtain a perfect solution, which, on being evaporated, furnishes plenty of yellowish resinous-like matter, besides a soluble resino-bitter substance, and some traces of oxalic acid.

§ IV. It results from the above experiments that 100 parts of euphorbia are composed of the following substances:

Water	5.0
Wax	19.0
Ligneous matter	13.0
Malate of lime	20.5
Malate of potash	2.0
Resin	37.0
Loss	3.0

100.

I think that the juice of the euphorbiæ of India is of the same nature with that which flows from the harmless species of Europe, which I intend to inquire into more minutely.

It is not without reason that euphorbia is regarded as one of the most powerful external cauterics and violent drastics. There is no doubt that if taken even in a small dose it would be capable of producing dangerous inflammations and erosions in the *primæ viæ*.

ANALYSIS OF MYRRH.

§ I. Myrrh, according to Lemery, is a resinous gum which issues on the incision of a thorny tree which grows in Arabia Felix, Egypt, Ethiopia, &c.

This observation concurs with the opinion of Forskal, that the balsam kafal (*Amyris Kafal* Forsk.) may be the tree which produces this gummo-resinous juice, the origin of which is so uncertain. We are inclined to think, at least,

least, that the myrrh used in commerce comes from some species of balsam trees.—Lamarck, *Encyclopédie Méthodique*, art. *Balsamier Kafal*.

The myrrh, which was the object of my researches, was in tears of varied transparency, of a reddish-yellow colour, of an aromatic taste, and slightly bitter. On breaking some of the largest pieces, we frequently remark a white nucleus marked with lines: this part, more or less opaque, burns with a great flame, while the transparent tears act in the fire in the same manner as the gums. We also at times meet with almost colourless pieces, soluble in water, and having the taste of myrrh, and which are not gum arabic as has been supposed; but rather a peculiar gum, similar to that which exists in myrrh, and the properties of which I shall presently detail.

From this physical examination of myrrh it should seem that this substance is very variable in its composition.

§ II. Thirty grammes of myrrh gradually heated until the retort became red, yielded ten grammes of a brown heavy empyreumatic oil, ten grammes of a red liquid which greens the syrup of violets, yields ammonia when we mix potash with it, and acetate of potash mixed with oil if we evaporate the liquor. Hence it follows that this aqueous product is composed of ammonia in excess, acetic acid, and empyreumatic oil.

The charcoal remaining in the retort occupied less space than the myrrh employed: it was compact, irised and brilliant, and weighed seven grammes $\frac{1}{4}$: when incinerated it produced 1.6 gramme of white ashes, which furnished with water seven centigrammes of sulphate of potash containing a small quantity of subcarbonate of potash.

That part of the ashes which was insoluble in water was entirely dissolved in nitric acid with effervescence, owing to an extrication of carbonic acid, which held a little sulphuretted hydrogen, proceeding of course from the decomposition of a small quantity of sulphate of potash by charcoal and lime.

When ammonia was poured into the nitric solution, nothing very remarkable was produced. The subcarbonate of potash separated from it all the carbonate of lime which enters singly into the composition of these lixiviated ashes.

§ III. A. Fifty grammes of myrrh distilled with water yielded a product having the smell of myrrh, and on which there floated a little volatile oil.

B. The residue of this distillation was thrown on a filter,
and

and the liquor was long in passing through it. Care was taken to wash well in boiling water the substance which would not dissolve.

C. The liquor when evaporated to dryness left 23 grammes of a red transparent gum, and of a bitter taste.

1. This gum reddens turnsole tincture.

2. When treated with boiling water, it only dissolved in part, and there remained a substance of a gummy appearance, perfectly insoluble even in the weak acids. It occupied a great deal of room, became brittle after desiccation, and swelled afterwards in boiling water without being dissolved in it. This insolubility which is acquired by gum myrrh seems to be owing to heat.

3. Gum myrrh when distilled, furnished subacetate of ammonia, oil, and a charcoal, which was incinerated very easily in comparison with those of animal substances.

4. When treated by the weak nitric acid, this gum produced with the help of a gentle heat carbonic acid gas mixed with azotic gas: there was deposited a flaky yellow matter which soon disappeared: the liquid when evaporated to dryness left oxalic acid mixed with malic acid, as well as a bitter yellow matter which does not detonate.

5. The oxalate of potash produces a precipitate of oxalate of lime in the solution of gum myrrh.

6. Lime-water in excess does not affect the transparency, which indicates that it contains neither malic acid nor phosphoric acid.

7. The decoction of gall-nuts does not produce any change; and this is the case also with liquid oxygenated muriatic acid.

8. Several metallic solutions, such as those of lead, mercury, tin, precipitate this gum from its aqueous solvent: very abundant white sediments are the result.

The precipitate produced by the nitrate of lead in 23 grammes of this gum dissolved in water, weighed 20 grammes 2 decigrammes, after desiccation. It was of a reddish colour like myrrh, and was semi-transparent: boiling water did not divide it; but upon gradually adding weak sulphuric acid until there was a slight excess, the grumous particles disappeared, and it was filtered. There remained upon the filter well washed and dried 5.3 grammes of sulphate of lead containing 4 grammes of oxide, which was combined with 16 grammes of gum-myrrh, which I obtained by evaporating the liquor separated from the sulphate of lead. This gum, which held an excess of acid, did not give malic or phosphoric acid on treating it with alcohol,

hol, which inclined me to think that the lime contained in the gum-myrrh is saturated with acetic acid, perhaps also with carbonic acid; for, if we pour into the solution of this gum sulphuric acid, a slight effervescence is manifested, and a precipitate of sulphate of lime.

From the above it appears that gum-myrrh is not entirely separated from its solvent by the nitrate of lead; since of the 23 grammes, only 16 were precipitated with the oxide of lead, which could only be owing to the nitric acid set at liberty: for a salt of lead surcharged with oxide, such as the subacetate of lead, precipitates almost entirely the solution of gum-myrrh; and totally, if we add a little alkali to the mixture.

D. What remained on the filter B, when well dried and weighed, was heated with alcohol, which dissolved all the resinous parts, and left a soft transparent matter insoluble in boiling water and weighing six grammes after desiccation. It had all the properties of the gummy matter which I have already described.

E. The alcoholic solution D, when mixed with spirit of wine which had been used in washing the filter, gave upon evaporation 11.5 grammes of a brown resin of a bitter aromatic taste, similar to that of myrrh.

1. This resin easily softens between the fingers, melts at 48° of Reaumur, and does not become idio-electrical.

2. It gives out an aromatic smoke when burning, and yields upon distillation the same product as the resins.

3. With potash it produces a soap, the solution of which in water passes turbid through the filter.

4. Thirty-three grammes of nitric acid at 38° poured upon 5.5 grammes of myrrh-resin made it take a blackish colour: this mixture when distilled emitted some scanty red vapours. After having obtained a product of about 20 grammes of this solution, the retort was removed from the fire: it contained a supernatant resiniformed substance of an orange-colour, which when washed and dried was of a pale yellow; it weighed a gramme and a half: it was pulverulent, bitter, not very fusible, partly soluble in water, furnishing on its union with potash a soapy compound, which is very easily dissolved in water, to which it communicates a red colour without affecting its transparency. This resiniformed substance contains plenty of charcoal, and is not sensibly altered on heating it with nitric acid, which merely dissolves it. It acts in other respects precisely like that of other resins when treated by the nitric acid.

The nitric liquor (above which this substance floated)
when

when evaporated to dryness left a residue, which when well washed still furnished another gramme of the same resiniform substance, which was held in solution by means of the nitric acid. Lime-water in excess, when poured into the water which had been used for washing the substance in question, separated from it 1·2 gramme of oxalate of lime mixed with a small quantity of malate of lime. The supernatant liquor contained a bitter yellow matter.

§ IV. It follows from these experiments that myrrh is composed for the most part of a gum different from any with which we are acquainted,—the chief properties of which are :

1. To acquire cohesion by means of heat, when we thicken its solutions, which renders it partly insoluble in water.
2. To produce ammonia upon distillation, and azotic gas by the nitric acid, which makes it resemble animal substances.
3. To unite with the oxides of lead, mercury and tin, by decomposing the solution of these metals.

Myrrh, besides the above, contains about 23 centiemes of its weight of a bitter resinous matter, very fusible.

ANALYSIS OF FRANKINCENSE.

§ I. I am at a loss to know on what authority Linnæus thought that frankincense was produced by the *Juniperus thurifera*, which is peculiar to Spain and Portugal, and not known in Africa or Arabia, from whence the incense is brought to us. M. Adanson, who has seen the tree that furnishes it, thinks, on the contrary, that it ought to constitute a new genus, and that it is *dioecia octandria tetragynia*. The Moors call it *soukiou*. M. Lamarck thinks this tree very like the *Amyris gileadensis* of Linnæus.

Frankincense, or olibanum, as it is met with in commerce, is a substance of a yellowish white; dry, brittle, slightly acrid and aromatic, in masses of various sizes, semi-transparent, and covered externally with a white farinaceous dust produced by the friction of the tears against each other.

§ II. Frankincense melts with difficulty on the application of heat: if we set fire to it with a candle, it continues to burn by itself, and leaves a white cinder.

Twenty grammes distilled with water furnished about a gramme of volatile oil of a light citrine colour, and having the smell of citrons.

The same quantity when distilled on an open fire yields
a very

a very great quantity of brown empyreumatic oil, and a little aqueous acid liquid. These products did not in any perceptible degree exhale ammonia with lime: nevertheless, on adding a little nitric acid to the mixture, slight white vapours were exhibited, which seemed to indicate the presence of volatile alkali. There remained in the retort a compact charcoal of the weight of 2.5 grammes, which left after its incineration 6.55 grammes of ashes, composed of five centigrammes of potash partly saturated by the sulphuric, muriatic, and carbonic acids, and six centigrammes of phosphate of lime; the rest was carbonate of lime, which forms the greater part of these ashes.

§ III. A. Twenty-five grammes in powder were treated with alcohol and filtered: there remained on the filter an abundant whitish matter, which, when well washed in alcohol and dried, weighed nine grammes.

B. These nine grammes of parts which were insoluble in alcohol were dissolved in boiling water, with the exception of a soft grayish substance, of a gummy appearance, and of the weight of 1.3 grammes. After its desiccation, it burned with a flame and produced a greenish resinous matter on treating it with nitric acid, which might lead us to suspect that some resin had escaped perhaps from the action of the alcohol, although I took great care to wash the residue with boiling spirits of wine.

C. The aqueous solution B, after having been filtered, produced by evaporation 7.5 grammes of a gum having the following properties.

1. This gum (which had been considered as the extractive part by the ancients, although it had no such appearance) was of a yellowish transparency, and had a faint taste.

2. It was easily dissolved in water without leaving any residue.

3. When exposed to the fire, it burnt with little flame, and left white ashes formed in a great measure of carbonate of lime.

4. Its solution in water did not redden turnsole tincture.

5. The oxalate of potash forms a precipitate in the solution of this gum.

6. The acetate of lead does not produce any perceptible change in it; but the nitrate, particularly the subacetate of lead and the nitrate of mercury, occasions very abundant thick white sediments in it, entirely soluble in distilled vinegar*.

7. The

* Schwartz, an apothecary of Jena, having prepared a mixture with the nitrate of mercury and gum arabic, observed a precipitate which Juch ascribed to the gallic acid of the gum. Van Mons, who relates the fact, thinks

7. The decoction of gall-nuts forms a precipitate in the solution of the gum of frankincense, which is not the case with that of myrrh.

8. Lime-water in excess does not affect its transparency even after a length of time.

9. This gum is carbonized by the sulphuric acid, but without giving out acetous vapours on heating the mixture: What substance is it therefore that neutralizes the lime in this gum? I once suspected that it was benzoic acid; but this opinion requires confirmation.

10. The gum of frankincense heated with nitric acid deposits, particularly on cooling, a large quantity of a very white crystalline-like powder: on continuing the evaporation to dryness, we obtained a residue, which, after being well washed and dried, furnished the sacco-lactic acid of Scheele, (the mucous acid of Fourcroy,) forming one-third in weight of the gum employed in the experiment: the water of the washings contained oxalic and malic acid, but in a small quantity.

This action of the nitric acid on the gum of frankincense shows that it differs from gum arabic, which does not afford mucous acid.

D. The liquor produced from the 25 grammes of incense treated by alcohol A, when evaporated to dryness, afforded 14 grammes of resin; whence it results that there is a loss of two grammes, which I ascribe in a great measure to the volatile oil.

1. The resin of the incense is of a reddish-yellow colour, becomes very brittle upon cooling, has no perceptible taste, becomes idio-electrical, and resembles pitch-resin.

2. It softens in boiling water; but it requires a greater degree of heat to melt it. When exposed to a flame it burns, sending out a smell which is not disagreeable.

3. This resin when heated to dryness with a solution of caustic potash left a residue not very soluble, which, after having been well washed, is dilutable in boiling water, producing an emulsive liquid more or less thick. The resin of pitch unites with the alkalis with much more facility*.

4. Cold

thinks, on the contrary, that it is owing to a decomposition of the nitric acid and of the metallic oxide: but the examination of these sediments constantly presented to me a combination of gum and metallic oxide.

Gum arabic is also abundantly precipitated from its solutions by the subacetate of lead: it is the same case with gum adra-canth. These sediments resemble cheese: if we burn them, they leave lead in the metallic state.

* Resinous substances have not been as yet examined with the minuteness and attention which they deserved, as may be easily proved, from the few

4. Cold sulphuric acid, the resin of incense, and water produce a white sediment in this solution, which is of a red colour. If we heat it for some time, the water then separates from it a black resin soluble in the nitric acid, which converts it by evaporation into a brown residue of an astringent bitter taste, and the solution of which in water precipitates gelatine, but not sulphate of iron.

5. The resin of incense when heated to dryness with eight times its weight of nitric acid at 38° , is converted almost entirely into the resiniform matter, the properties of which I have already described. The washings which did not contain oxalic acid furnished by evaporation a residue, which when again heated with nitric acid did not give the tannin substance discovered by Mr. Hatchett, but a bitter soluble substance, which was partly precipitated upon cooling from its solution in boiling water, soluble also in alcohol, and producing precipitates in several metallic solutions.

This substance seems to me to have properties analogous

and frequently inaccurate observations which have been made as to the chemical properties of these bodies. Thus it has been generally supposed that the alkalis exercise no action on the resins. In order to verify this assertion, I made the following experiments on the resins:

To a very weak solution of potash, cold, I added gradually some pitch-resin in powder: there resulted a perfect saponaceous solution, which became thick and thready like the white of an egg. The weakest acids produce very abundant white sediments: it is the same with the alkalis and the neutral salts, on account of their greater affinity for water than that of the resinous soaps. A large quantity of common water also decomposes this soap; the sediment which is the result is only partly soluble in alcohol: that part which cannot be dissolved still contains plenty of resin united to lime.

If we pour muriate of lime into the solution of this resinous soap, the mixture goes into a whitish mass resembling broth, and formed of resin and lime.

All the metallic solutions decompose *in toto* the soap of pitch-resin. The sediments which are produced might in many cases be employed in painting.

Fifty grammes of pitch-resin heated until saturation with solution of potash were entirely dissolved: we obtained by evaporation 69 grammes of solid resinous soap, dry at a cold temperature, of a brown colour, and which I found to be perfectly similar to Starkey's soap. Messrs. Baumé and Legendre had therefore good reason to think that it is only the thick and resinous part of the essence of turpentine which can be really combined with potash: for this alkali acts upon volatile oil, only by favouring its conversion into resin in order to unite with it afterwards.

The volatile alkali greatly diluted in water, also unites with pitch-resin with great facility, and speedily converts it to the soapy state. This combination diluted with water acquires through time the consistence of tar.

I ought not to omit to mention, that the soap made from potash and the above resin might be used instead of common soap for domestic purposes. It produces abundance of froth, and whitens well: only it gives a slight resinous smell to linen, which is dissipated, however, on exposure to the air. The economy and facility with which it might be manufactured would doubtless enhance its properties.

with

with that which I have designated by the name of *resino-bitter*, but it differs from it in the stability and proportion of its elements.

ANALYSIS OF GUM AMMONIA.

§ I. No traveller has ever described the plant which produces gum ammonia; but from the inspection of the seeds which are always found in the leaves of ammonia, it is at least very probable that it flows in a milky form from one of the umbelliferæ, particularly when we recollect that other gummo-resins also flow from the juice of several ferulaceous plants. In fact, the seeds which we meet with in the gum ammonia are oval, compressed, relieved on each side by three longitudinal striæ, and composed of two elliptical seeds laid against each other: these characters belong, as we may be satisfied, to the genus *Ferula*. Hence it seems to me to result that a species of this genus furnishes the gum ammonia which is brought from the deserts of Africa, and from Libya to Alexandria, from whence it reaches us as an article of commerce.

The gum ammonia which I made use of in my experiments was in irregular masses, yellowish externally, slightly transparent on the edges when they are thin, presenting a shell-like fracture, shining, white, sometimes slightly marbled, and having the aspect of certain resiniform silices, particularly the variety known by the name of *cacholong*. It has little smell, at least if it be not pulverized. Its taste is slightly acrid, bitter, and nauseous. It is easily diluted in water, producing a very white milky liquor.

It should seem that the ancients have rather ventured upon conjectures as to the nature of the substance in question, than made any real experiments: thus they say, that boiling water dissolves it almost entirely, which made Cartheuser suspect that the extractive part is more abundant in it than the resinous part; but we shall see that this assertion is unfounded.

§ II. Gum ammonia when exposed to a heat incapable of decomposing it easily becomes soft, and loses $\frac{6}{100}$ of its weight in humidity.

Twenty-five grammes of this substance furnished on being distilled on the open fire twelve grammes of liquid, the greater part of which was a brown empyreumatic oil: this product when mixed with lime set free a smell of volatile alkali. There remained in the retort a charcoal weighing 7.5 grammes, which furnished after its incineration 3.2 grammes of ashes mixed with gravel, which furnished to

the weak nitric acid 1·5 decigramme of phosphate of lime, which was separated from it by ammonia, in addition to 3 decigrammes of carbonated lime, separated by the sub-carbonate of potash.

§ III. A. I boiled 25 grammes of gum ammonia in powder with a sufficient quantity of alcohol at 36°. The liquor being filtered while boiling deposited nothing in cooling: there remained on the filter a white substance, which when dried, and after being washed in alcohol, weighed 5·8 grammes.

B. This substance when heated with water was in a great measure dissolved in it: the liquor when passed through a fine cloth left a grayish, soft, glutinous substance insoluble in water and in spirits of wine, of a black colour after its desiccation, and of the weight of 1·1 gramme. It burns more easily than the gums, produces a grayish cinder, and affords a yellow colour with a little oxalic acid on treating it by the nitric acid.

C. The aqueous solution B when evaporated furnished 4·6 grammes of gum.

1. This gum is transparent, of a reddish-yellow colour, and of a slightly bitter taste; it is tolerably brittle, and is easily dried in comparison with the other gums.

2. It burns without any apparent flame, producing a white cinder which is dissolved with effervescence in the acids.

3. Water dissolves it entirely: this solution scarcely reddens turnsole tincture.

4. It is precipitated in abundance and entirely from its solutions by the subacetate of lead, (but not with the acetate,) by the nitrate of lead and mercury, only the latter renders the liquor milky.

5. Lime-water in excess does not affect the solution of this gum; it does not therefore contain phosphoric acid, but its ashes give a little phosphate: hence it seems to me to result that phosphorus exists in this gum in a state of combination with the other elements which constitute it.

6. The oxalate of ammonia produces in its solution a precipitate of oxalate of lime, but I am ignorant of the acid which neutralizes this lime in the gum*.

7. The solution of gall-nuts does not manifest any thing remarkable.

8. When treated by the nitric acid of commerce, this

* M. Vauquelin, who recognised the phosphate of lime in the ashes of gum arabic and gum tragacanth, thinks that the lime is saturated in a great measure in these gums by the acetic acid.

gum gave nearly the same results with frankincense: *i.e.* a great quantity of mucous acid, oxalic acid, and very little malic acid.

D. The alcoholic solution A when inspissated to dryness furnished 17.5 grammes of a resin, which exhibited the following characters:

1. It is of a reddish-yellow, transparent, and brittle like wax at a cold temperature, having an undulating and glossy fracture, slightly receiving the impression of the nail, and easily becoming soft in the mouth or between the fingers. It has no remarkable taste. It smells like gum ammonia. It does not become idio-electrical.

2. Like wax, this resin melts at a temperature of 43° of the thermometer. At a higher temperature it swells considerably, gives out a particular smell, and leaves a spongy light charcoal occupying a good deal of room.

3. This resin unites easily with the alkalis, even when cold, and soapy solutions of considerable bitterness are produced*.

4. The sulphuric acid dissolves with facility the resin of gum ammonia, particularly at a gentle heat. Water decomposes this solution: if we heat it more, there results a hydrogenated charcoal, which after having been washed was dissolved in the nitric acid, and furnished by evaporation an astringent substance which precipitates glue in brown.

5. The nitric acid when heated on the resin of gum ammonia, at first only gave some white vapours; but suddenly these nitric vapours appeared with great vehemence, and there was produced a yellow resiniform substance, which was dissolved during the operation. On inspissating the liquor I obtained a resinous-bitter substance of a very pure yellow, fusible at a gentle heat, uniting with the alkalis, soluble in alcohol and in boiling water, and depositing a little therefrom upon cooling; partly soluble also in a great quantity of cold water, and communicating to its solutions a very beautiful yellow, which adheres very strongly to the fingers, and may be fixed with great facility to silk and woollen, giving them a superb lustre, unalterable by the oxygenated muriatic acid, and even by the weak alkalis: in solidity therefore it seems to be far superior to any dye-stuff we are acquainted with. I may even add, that so far as œconomy is concerned, this fine colour seems to merit a

* The soap of pitch-resin is also very bitter to the taste; which seems to bespeak very energetic properties as existing in these resins, which ought therefore to fix the attention of medical practitioners.

preference over other yellows, on account of the small quantity of it which is requisite.

When mixed with gum, this substance might give a much purer and much more solid yellow than camboge.

From this examination of gum ammonia, it results that 100 parts are composed as follows :

Gum	18·4
Resin	70·0
Glutinous matter	4·4
Water	6·0
Loss	1·2
Extractive matter	0·0
Total	100.

LXI. Explanation of an Experiment on Tuning, in Reply to a Correspondent. By M.

SIR, **I**t was not till late in April that I had the pleasure of receiving your Number for the preceding month, otherwise I should have sent you the following remarks at an earlier period.

If the author* of art. xxxii. will, uninfluenced by passion, re-examine my letter on modes of tuning, (vol. xxxvii. p. 111), he will not discover any expressions to justify the charge of my having asserted the accuracy and success of a hasty experiment, there faithfully described ; of my having given any estimate of the power of any description of monochord ; nor of my having made a boast of any skill of my own : after due consideration, it will therefore appear that, instead of opposing my assertions, instead of controverting opinions which I have stated, this discerning writer has, in the elegant article referred to, been combating the mere creatures of his own disturbed imagination. We at the conclusion of the experiment, were, I think, as fully sensible as that very ingenious writer may be, of its errors ; and I should have inserted a table of the differences between the scale of sounds produced and the system attempted, had I been disposed to waste your valuable pages on unnecessary schoolboy-calculation. I repeat, that with practice, and by employing longer time, the errors would be

* I shall consider the Rev. C. J. Smyth to be the author, till I am better informed. Perhaps the person who could write it, will not be ashamed to avow himself the author.

less ;