LX. THE CHEMICAL CONSTITUTION OF THE GUMS.

PART I. THE NATURE OF GUM ARABIC AND THE BIOCHEMICAL CLASSIFICATION OF THE GUMS.

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PREAMBLE.

THE latest work which has been carried out on gums is not of very recent date, and advances in carbohydrate chemistry which have been made since that time make it desirable that this work should be repeated. The physical difficulties of working with these substances are considerable, and the situation is aggravated by the fact that the natural gums are frequently composed of mixtures of several individual types. Separation of such mixtures is very difficult, and it is probable that physical methods based on their colloidal properties will have to be elaborated.

Early investigators have shown that the hydrogen and oxygen in gums exist in approximately the same proportions as in water, and accordingly the gums were considered to be true carbohydrates. Later, by the action of acids, various sugars were obtained from them by hydrolysis, and the gums were thereupon classified as polysaccharides. Still later, it was demonstrated that they are not of a true polysaccharide nature, since they consist of numbers of sugar molecules united to a central nucleus of a sugar acid nature. The attachment seems to be of an ethereal or glucosidic type, and not an ester type, since the gums retain acidic properties, and are capable of forming salts. In point of fact, they are usually found as salts of calcium, magnesium, or potassium.

It is to be emphasised that the classification of a substance as a gum is as yet mainly an arbitrary one, not being based on any constitutional knowledge, but decided by its origin and physical behaviour, together with the fact that it is of a carbohydrate nature. When the chemical composition of these substances has been determined, it may be possible to suggest a more rational grouping, and also to speculate with some degree of probability as to their rôle in nature.

The first member of this group to be studied was gum arabic, since from the work of previous investigators this appears to be a single substance.

THE COMPOSITION OF GUM ARABIC.

INTRODUCTION.

The early investigators of the composition of gum arabic seem chiefly to have been concerned in attempting to assign to it an empirical formula, and several workers in the first half of the last century gave analyses closely approximating to $(C_6H_{10}O_5)_n$. Neubauer [1854, 1857, 1863] seems to have been the first to record the fact that gum arabic is an acid. He prepared pure salts of this acid, and subjected them to analysis, from the results of which he deduced various empirical formulae for the salts.

O'Sullivan [1884] described some very careful and detailed investigations into the nature of this substance. His methods were, briefly, hydrolysis with acid, preparation of the barium salt of the hydrolysis product, fractional precipitation with alcohol, if necessary, and ultimate analysis of the salt obtained. By these means he concluded that this gum had an empirical formula of $C_{89}H_{142}O_{74}$ and consisted of molecules of four, or possibly five, hexose sugars, termed by him α -, β -, γ -, and δ -arabinoses, linked to a nucleus of a comparatively stable nature to which he assigned the empirical formula of $C_{23}H_{38}O_{22}$, and the name "arabinosic acid." In a later paper, O'Sullivan [1889] recognised the presence of only two sugars in this gum, a pentose, arabinose, and a hexose, galactose, and suggested a more extended formula, which will be quoted later.

EXPERIMENTAL.

A good commercial sample of gum arabic is a light transparent substance, slightly yellowish in colour, in droplets with a vitreous fracture. The ash content varies from 3 to 4 % or more, and there is some moisture present. This gum is found naturally as the salts of calcium, potassium, and magnesium. Pure acid gum arabic is prepared from the natural product according to the method employed by Neubauer [1854].

The gum is dissolved in warm water to give a fairly concentrated solution, which is then made acid by the addition of hydrochloric acid. Insoluble particles are allowed to settle, and the clear liquid is decanted off. The acid gum arabic is then precipitated by the addition of alcohol. Precipitation takes place when the alcohol content is as low as 50 %, but as a general rule this should be raised to 60 % so that precipitation may be complete. The acid gum arabic appears as a thick and curdy precipitate. This is filtered off, re-dissolved in warm water and acidified by the addition of a little hydrochloric acid just previous to precipitation with alcohol as before. This process is repeated at least three times. The final product is dried in absolute alcohol, and in a desiccator over phosphorus pentoxide. By this means an extremely pure product is obtained, the ash content of which is very low.

It was considered likely that the nucleus-acid of gum arabic, termed by O'Sullivan first "arabinosic acid" and later "arabic acid," might be of the

nature of a "uronic acid." Accordingly the yield of carbon dioxide on boiling with 12 % hydrochloric acid was determined in the same way as for pectin products [Nanji, Paton and Ling, 1925].

<i>Acid gum arabic.</i> Sample I.	Ash	0.26 %
Yield of CO ₂ on an ash-free basis	(i)	3.11 %
	(ii)	3.17 %
	Mean	3.14 %
Corresponding to uronic acid anhydride		12.56 %

Since this gum has been shown by many workers to contain pentose, the furfuraldehyde yield was determined by distillation and precipitation as phloroglucide. The precipitated phloroglucide was in each case extracted with absolute alcohol, since the presence of methylpentose in this gum has been suggested. Although by this extraction a considerable amount of substance was removed, concurrent figures were never obtained. Further the alcoholic extract was never of a reddish colour, as it is stated to be in the presence of the phloroglucide of methylfurfuraldehyde, but always a deep green. The substance removed is probably the phloroglucide of ω -hydroxymethylfurfuraldehyde, obtained in small quantities from the hexosan units.

Acid gum arabic. Sample I.

Yield of furfuraldehyde on ash-free basis	(i)	16.45 %
	(ii)	16.01 %
	(iii)	16.25 %
	Mean	16.24 %

Now it is known that the uronic acid anhydride units yield 16.66 % of their weight of furfuraldehyde, and consequently the 12.56 % of uronic acid anhydride which is present in this sample of acid gum arabic accounts for 2.09 % furfuraldehyde; the balance of furfuraldehyde, 14.15 %, being due to pentose.

Many workers have stated that the sugars to be obtained by the hydrolysis of this gum are arabinose and galactose. This statement was confirmed. It is not necessary to describe in detail the procedure, but it is sufficient to say that the characteristic osazones of arabinose and galactose were obtained from the hydrolysis liquid after removal of the acid. Arabinose diphenylhydrazone was prepared by treatment of the syrup with excess of diphenylhydrazine in alcoholic solution according to the method of Neuberg [1900]. The recrystallised hydrazone had a melting point of 202° (Neuberg: 204°). Mucic acid was also obtained by treatment with nitric acid. No trace of xylose could be detected by use of Bertrand's cadmium xylonobromide reaction; neither was any hexose other than galactose traced. It seems, then, that the only sugars formed on hydrolysis are arabinose and galactose.

It is clear then that the furfuraldehyde in the molecule due to pentose may be calculated as arabinose, indicating that there is present 26.31 % anhydro-arabinose (C₅H₈O₄), yielding on hydrolysis 29.89 % of arabinose.

No satisfactory quantitative method has ever been described for the estimation of galactose, the oxidation by nitric acid to mucic acid giving invariably a low result, the production of mucic acid being accompanied also by the formation of oxalic acid.

It is only possible, therefore, to arrive at figures for galactose by difference.

Acid gum arabic. Sample I.

Uronic acid anhydride	12.56 %
Anhydro-arabinose	26.31 %
Anhydro-galactose (by difference)	61.13 %

yielding on hydrolysis, arabinose 29.89 % and galactose 67.92 %.

Much of the work of O'Sullivan is based on the estimation of the barium content of the barium salt, and although this undoubtedly gives a fair indication of the carboxyl groups present, it does not seem that it can be taken as an absolute figure, unlike the determination of carbon dioxide yield in this work. The method followed by him in the preparation of the barium salt of acid gum arabic was exactly to neutralise a solution of the acid with baryta water, and then to precipitate with alcohol, and dry. Since the acid is a very weak one, it is difficult to determine the precise neutral point. The alcohol precipitate is of a bulky nature, and would undoubtedly carry down with it any excess baryta which might be present, and so vitiate the results. Alternatively, if the end-point were not quite reached, the results might be low owing to the presence of free acid gum arabic.

The barium salt of acid gum arabic was prepared by careful addition of baryta as described by O'Sullivan. The amount of baryta to be added was ascertained on a duplicate, using phenolphthalein as indicator. After filtration, the salt was precipitated with alcohol, washed, and dried. A barium estimation was carried out on this preparation, gravimetrically as sulphate.

Barium content of salt of acid gum arabic.

Preparation (i)	5.07 % Ba
„ (ii)	5.27 % Ba

Now, the yield of carbon dioxide from the preparation indicates the presence of carboxyl groups which would only be capable of uniting with 4.89 % barium. There is the possibility, of course, that there might be present in the nucleus of this gum some simple organic acid, not of a uronic type, not yielding carbon dioxide under the conditions of that estimation. This, however, is very unlikely, since no such acid has been discovered in the hydrolysis liquid, and further, the difference between the theoretical barium content and that actually found is only small, and is to be anticipated from the method of preparation. It seems, therefore, that this particular method, the preparation of the barium salt and the subsequent estimation of its barium content, is not reliable as giving an indication of the amount of carboxyl groups present. Very many of O'Sullivan's conclusions are based upon the results

of this determination, and consequently they cannot be accepted as absolute figures, though, as seen above, it is likely that they are fair approximations.

O'Sullivan in his earlier paper on this subject considered all the sugars split off to be of a hexose nature, but after the discovery of the pentose nature of arabinose he assigned to acid gum arabic the following formula:

He described it as "di-arabinan-tetra-galactan-arabic acid," the term "arabic acid" being employed for the nucleus-acid in place of the term "arabinosic acid" employed by him previously. It is necessary to note that the "arabic acid" of other workers corresponds with that which, to prevent confusion, is described in this paper as "acid gum arabic." In the formula above "arabinan" and "galactan" respectively stand for two molecules of arabinose and galactose less two molecules of water.

By calculation, such a molecule consists of

anhydro-arabinose ($\text{C}_5\text{H}_8\text{O}_4$) _n	21.84 %
anhydro-galactose ($\text{C}_6\text{H}_{10}\text{O}_5$) _m	53.60 %
anhydro-"arabic acid"	24.56 %

yielding on hydrolysis, arabinose 24.82 % and galactose 59.57 %.

It will be seen that these figures differ very considerably from those obtained experimentally in this paper, the difference between the anhydro-"arabic acid" of O'Sullivan's formula and the uronic acid anhydride of the preparation being particularly marked. On the other hand, it must not be assumed that all samples of gum arabic are identical in composition. Such is quite definitely not the case, though they appear to be similarly constituted. This means, however, that it is not possible to assign to this substance any definite empirical formula, but only to indicate the constituents and the probable method of linkage.

Sample II of gum arabic, treated as before to obtain the acid gum arabic, gave on analysis the following figures:

Acid gum arabic. Sample II. Ash 0.24 %.

Furfuraldehyde yield on ash-free basis	(i)	14.00 %
	(ii)	13.86 %
	(iii)	13.98 %
	(iv)	13.89 %
	Mean	13.93 %
Yield of carbon dioxide on ash-free basis	(i)	4.36 %
	(ii)	4.42 %
	Mean	4.39 %

By calculation

uronic acid anhydride	17.56 %
furfuraldehyde due to uronic acid anhydride	2.91 %
balance of furfuraldehyde due to pentose	11.02 %

The figures for Sample I, and those obtained by calculation from O'Sullivan's formula, are quoted for comparison.

	Sample I	Sample II	O'Sullivan
Uronic acid anhydride	12.56	17.56	(anhydro-"arabic acid" 24.56)
Anhydro-arabinose	26.31	20.52	21.84
Anhydro-galactose	61.13	61.92	53.60
Yielding on hydrolysis:			
Arabinose	29.89	23.32	24.82
Galactose	67.92	68.80	59.57

By hydrolysis with acids O'Sullivan was able to arrive at conclusions stated to justify his formula. He was, however, largely concerned with the identification of the sugars liberated, and the barium content of the salts of the acid residues isolated. He appears to have chosen concentrations of sulphuric acid for hydrolysis in a rather haphazard way. In the work described here, it was thought desirable to adhere throughout to one concentration, namely, 3 %. The hydrolysis was carried out by O'Sullivan in the following manner. To the acid gum arabic in solution was added the necessary amount of sulphuric acid, and the whole boiled. At the conclusion of the period of hydrolysis the solution was cooled, and neutralised with a hot solution of baryta. The precipitated sulphate was filtered off, and the filtrate evaporated and poured into excess of alcohol. The precipitate was repeatedly dissolved in water and reprecipitated by alcohol.

This method was followed for a time, with the difference that carbon dioxide was passed through after the addition of the baryta to remove any excess. It was found, however, that by this method it was not possible entirely to free the hydrolysis product from the sugars liberated at the same time, and as a result sticky or slimy precipitates were obtained. Also the ash content of those that were obtained in a reasonably friable condition was unduly high.

Accordingly the method was modified. At the close of the period of hydrolysis, while still very hot, the sulphuric acid employed is nearly neutralised by the addition of solid barium carbonate in a very fine condition. After standing for a few moments, the precipitated sulphate is filtered off. Immediately, while the filtrate is still hot, boiling alcohol is poured in until the concentration of alcohol reaches 60 %. The precipitate which forms settles quickly, and the supernatant liquid is poured off before it has cooled. Since hot alcohol of a concentration of 60 % does not precipitate either galactose or arabinose, the end-product obtained by this means is free from these substances. The precipitate is dissolved in water, filtered, heated nearly to boiling and reprecipitated by hot alcohol as before. This is repeated several times. The final product obtained is not sticky, and on being brought into contact with absolute alcohol it becomes white and friable. It will be noticed that by this method the free acid hydrolysis product is obtained in place of the barium salt as by the method of O'Sullivan.

Hydrolyses were carried out for periods of 1, 3, 5, 6, 7 and 10 hours with

3 % sulphuric acid. It is inadvisable to commence with less than 200 g. in each case for the yields are small. Three times the weight of sulphuric acid was employed. No substance remained precipitable by hot alcohol after either 10 or 7 hours' hydrolysis. Only traces precipitable by alcohol were found after 6 hours, the quantity being quite insufficient for analysis.

The following were the analytical figures obtained, in each case being the mean of two or more closely agreeing determinations. All hydrolyses were carried out upon Sample II of gum arabic.

	Acid gum arabic Sample II	Product after 1 hour's hydrolysis	Product after 3 hours' hydrolysis	Product after 5 hours' hydrolysis
	%	%	%	%
Ash	0.24	2.87	3.32	3.91
Furfuraldehyde yield (ash-free) ...	13.93	6.48	5.22	4.28
CO ₂ yield (ash-free)	4.39	5.79	6.13	5.25
Uronic acid anhydride	17.56	23.16	24.52	21.00
Furfuraldehyde due to uronic acid ...	2.91	3.86	4.08	3.49
Balance of furfuraldehyde	11.02	2.62	1.14	0.79
Anhydro-arabinose	20.52	4.93	2.12	1.48
Anhydro-galactose	61.92	71.91	73.36	77.52
Yielding arabinose	23.32	5.60	2.41	1.68
Yielding galactose	68.80	79.91	81.53	86.14

From a consideration of these figures it is possible to obtain some insight into the composition of this gum. The results are even clearer when plotted as a graph. It will be seen from the graph that the arabinose is rapidly removed from the molecule during the first hour of hydrolysis, and the amounts of uronic acid anhydride and of anhydro-galactose rise sharply, proportionately,

Hydrolysis of gum arabic with 3 % sulphuric acid

and approximately evenly. During the second and third hours this condition is maintained at a much slower rate, and by this time practically all the arabinose has been removed. After the third hour it is seen that the uronic acid anhydride tends to diminish a little, and the anhydrogalactose to rise.

It is quite evident, therefore, that the linkage of the arabinose units is different in nature from that between the other units, since it is very much weaker, being ruptured by brief treatment with acid. Knowing that gum arabic is not a reducing body it is probable that the linkage between the arabinose units and the nucleus-acid is an ethereal or glucosidic linkage.

It would seem that the nucleus-acid, the "arabic acid" of O'Sullivan, is composed of galactose and the uronic acid, probably in the proportion of two or three molecules of the former to one of the latter, or some multiple of these figures. This is a little surprising, but even more unusual is the fact that the galactose does not appear to be split off except when the nucleus-acid is completely ruptured. That this must take place continuously during the hydrolysis is evidenced by the fact that galactose in some quantity can be obtained from the hydrolysis liquid after less than 3 hours' hydrolysis. Nevertheless the uronic groups are apparently removed somewhat more easily than the galactose units. The nature of the uronic acid has not been definitely established. It is, however, in all probability, galacturonic acid, since glycuronic acid, although excreted in certain abnormal conditions of animal metabolism, has never been unquestionably proved to be a constituent of plant materials, save possibly in the hemicellulose A isolated by O'Dwyer [1926] from beechwood.

DISCUSSION.

Work which has been carried out on other gums has shown that they also are constructed in much the same general way as gum arabic, namely by linkage of hexose or pentose sugars with uronic acid units. It is possible, therefore, tentatively to suggest a position for the gums in the general field of plant biochemistry. Candlin and Schryver [1928] have suggested the use of the word "polyuronide" to describe a substance which consists of sugars linked to a uronic acid. It is evident, then, that the gums may be described as "polyuronides" if this term be accepted.

Table I. *Uronic acid anhydride content of some plant products.*

Substance	Source	Uronic content %	Sugars present	Authority
Pectic acid	Lemons	70-56	Galactose, arabinose	Nanji, Paton and Ling [1925]
Hemicellulose B	Beechwood	64.0	Galactose, arabinose	O'Dwyer [1926]
Mild oxidation products of pectin	Lemon pectin	60-55	Galactose, arabinose	Norman (unpublished)
Tragacanthin	Gum tragacanth	50.8	Arabinose	Norman (unpublished)
Hemicellulose by alkali treatment	Citrus pectin	37.3	Presumably galactose, arabinose	Candlin and Schryver [1928]
Hemicellulose B	Oats straw	31.8	?	Norman (unpublished)
Bassorin	Gum tragacanth	30.0	Arabinose, galactose, xylose?	Norman (unpublished)
Hemicellulose by alkali treatment	Onion pectin	21.5	Presumably galactose, arabinose	Candlin and Schryver [1928]
Acid gum arabic	(Sample II)	17.56	Galactose, arabinose	Norman
Hemicellulose B	Beechwood	18.8	?	Candlin and Schryver [1928]
Hemicellulose A	Turnip	15.4	?	Candlin and Schryver [1928]
Acid gum arabic	(Sample I)	12.56	Galactose, arabinose	Norman
Hemicellulose A	Beechwood	11.5	?	Candlin and Schryver [1928]
Hemicellulose A	Beechwood	11.0	Xylose (galactose?)	O'Dwyer [1926]
Hemicellulose A	Oats straw	10.8	Arabinose	Norman (unpublished)
Hemicellulose B	Turnip	10.7	?	Candlin and Schryver [1928]

Several recent workers have shown that natural hemicelluloses consist of hexose and pentose sugars linked together and usually in combination with a uronic acid. There does not seem to be, therefore, any essential difference in general structure between the gums and the hemicelluloses, which is rather supported by the fact that they are not dissimilar in physical properties and solubilities. It is rapidly becoming clear that the uronic acids are much more widely distributed in vegetable materials than was previously supposed (see Table I¹).

Candlin and Schryver [1928] have recently demonstrated that pectin may be decarboxylated by treatment with alkali, the degree of decarboxylation depending upon the concentration and temperature of the alkali, with the resulting production of substances of a hemicellulose type, resembling in all respects the hemicelluloses isolated directly from wood. It would seem, then, not unlikely that in nature both hemicelluloses and gums may be produced by partial decarboxylation of pectin. This change may be brought about *in vitro* not only by alkali treatment but also by mild oxidation, on which point details of some work will shortly be published. Such a process as mild oxidation more nearly approaches, of course, the changes which may possibly take place in the living plant.

Both von Fellenberg [1918] and Ehrlich [1927] have suggested the possibility that the pectic substances may undergo transformation to lignin, and O'Dwyer [1928] states that it is not unlikely that hemicellulose may be a transition product. She showed [1926] that unligified tissues contain a much larger amount of pectin than of hemicelluloses, while in lignified tissues the opposite holds, in fact only the merest traces of pectin are usually present. Candlin and Schryver [1928] repeated the suggestion that lignin may be derived from pectin, but their experimental work, which resulted in the artificial production of a hemicellulose from pectin, did not lend support to this theory. It must be admitted that it makes an attractive theory to couple the two substances, pectin and lignin, since the observation that pectin decreases on lignification seems to hold good generally, but nevertheless on purely chemical and constitutional grounds it is not at present easy to see how the transformation may take place. Further, the actual amount of lignin present in lignified tissue is very considerably in excess of the amount of pectin which was present in the same tissue before lignification. On quantitative grounds also, there is considerable support for the view that pectin is converted into hemicellulose as the tissue becomes older. Though this process may be coincident with the development of lignification, it is not possible from present evidence to assume any interrelation.

On purely chemical grounds it is possible to account for the formation of substances of the nature of pectin, hemicelluloses and gums, by the protracted

¹ It is probable, if not certain, that several of the products mentioned in this table, notably the hemicelluloses, are mixtures, and if suitable means of separating them can be elaborated even more significant uronic figures may be obtained.

mild oxidation of linked hexose units. For example, when *d*-glucose is linked in some form as a polysaccharide through its carbonyl groups, mild oxidation will have the effect of converting the terminal carbinol groups to carboxyl, and so, in a simple hypothetical case, forming a conjugated *d*-glycuronic acid, which on complete decarboxylation yields a xylan: similarly *d*-galactose might be supposed to give rise to an araban. If oxidation is only partial, that is to say, if some units of the hexosan are incompletely oxidised, then other complex substances containing hexose, uronic and pentose groups would be formed, akin in all respects to pectin, hemicelluloses and gums. It is undoubtedly a fact that it is the derivatives of galactose, possibly formed in this way, which are met with most frequently in the substances classed as hemicelluloses and gums, and further, each of the units in pectin is derivable from galactose. Xylans and gluco-xylans are relatively less common and widespread than the galacto-arabans. It is curious that galactose thus appears to occupy a place rather more important in this transition to pentosans than does glucose, while it is glucose which is the most widespread unit of hexosans, *e.g.* in starch and cellulose. The change from glucose to galactose is one which must take place readily in plants, and also in animals, as evidenced by the production of lactose on a diet free from galactose. The explanation of this prominence of galactose and its derivatives in plant constituents is not obvious, unless it be that hexose in the form of galactose is less readily respired than as glucose.

It would seem that the first apparent stage in the oxidation of galactans is the production of pectin, and having regard to the flexibility of the process of mild oxidation, it is perhaps remarkable that a substance of such definite character as pectin should appear. The homogeneity of pectin preparations from many sources appears to have been established by the work of Clayson, Norris and Schryver [1921], and of Norris and Schryver [1925]. Recently, however, Ehrlich and Schubert [1926] have claimed that pectin from flax contains xylose, in addition to galactose, galacturonic acid, and arabinose. Henderson [1928], on rather insufficient evidence, has claimed, on the contrary, that pectin from flax contains only galactose and galacturonic acid. In view of this conflict of opinions this form of pectin was re-investigated by Norris [1929], who finds no reason for departing from the original six ring formula put forward by Nanji, Paton and Ling [1925].

The formation of pectin in the plant appears to take place when metabolism is at its highest peak, that is when growth is most rapid. As growth slows down and maturity is reached, so does the production of pectin decrease, and that present is slowly converted into other substances, probably hemicelluloses and gums. It seems likely, if not certain, that the hemicelluloses and gums are not substances definite in composition but are built up on a general plan from the intermediate oxidation products of hexosans. If the oxidation is prolonged, it may be that complete decarboxylation follows, so that true pentosans would be formed. It must be admitted, however, that

it has yet to be demonstrated that such substances as true pentosans have any existence in fact. Examinations of preparations hitherto regarded as being true pentosans have shown that a small quantity of uronic acid is present, and this, it is claimed, is the clue to their formation.

SUMMARY.

1. It is shown that the acid group in gum arabic is of the uronic type.
2. A method of isolation of the acid hydrolysis products is given.
3. The statement that the only sugars present in gum arabic are galactose and arabinose is confirmed; analytical figures are given for these substances, both in the untreated gum and in the hydrolysis products.
4. It is clear that gum arabic is not a substance of definite empirical formula. It is possible, however, to indicate its general composition—a nucleus-acid consisting of galactose and a uronic acid, probably galacturonic acid, to which is linked arabinose by glucosidic linkages. The arabinose is in consequence more easily split off than the other components.
5. There seems to be no essential difference in structure between gums and hemicelluloses, both consisting of hexose and pentose sugars linked to uronic acids.
6. It is suggested that it is by the protracted mild oxidation of linked hexose, and particularly galactose units, that pectin and the hemicelluloses and gums are formed.

In conclusion it is a pleasure to express my thanks to Prof. A. R. Ling and Dr F. W. Norris for their assistance and advice.

Addendum (June 8th, 1929). While the above communication was in the press, Butler and Cretcher (*J. Amer. Chem. Soc.* 1929, **51**, 1519) have published some work on the constitution of this gum. They claim to have isolated an aldobionic acid, galactose-glucuronic acid, corresponding to the nucleus-acid of O'Sullivan. To this are attached galactose, arabinose, and rhamnose. They do not appear to recognise the fact that gum arabic is not a specific substance. Further, it is not possible to agree that all the phloroglucide soluble in alcohol must be derived from methylpentose, for it is well known that under the conditions obtaining in this estimation, hexosan units yield a small but inconstant amount of ω -hydroxymethylfurfuraldehyde, the phloroglucide of which is soluble in alcohol. Accordingly the figure quoted by them for rhamnose is probably much too high. On the other hand it is not unlikely that that for galactose is too low, since the mucic acid method is not strictly quantitative.

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