

the customary way can serve for the economical manufacture of sugar for the general market, can scarcely be entertained any more seriously; the sugar production, from syrup like the above, must remain a mere incidental feature in the amber cane industry, as far as our section of the country is concerned, and so long as the cost of separating the sugar does not offer more substantial advantages.

Amherst, Mass., Feb'y 26, 1879.

X.—NOTES UPON CHICLE.

BY GEO. A. PROCHAZKA, PH. D., AND H. ENDEMANN, PH. D.

Received March 19th, 1879.

The great interest in the search of substitutes for india-rubber and gutta percha, which for some time past has been manifested by technical men, has led us to an examination of a Mexican product, known in the United States for a number of years under the names of *Chicle* or *Sapota*. The latter name would imply that the product were derived from one of the many species of Sapotaceae, one of which is pointed out as the tree furnishing Balata. With the latter product it shares in fact many qualities; the general description given of Balata seeming to apply directly to the product under examination.

Balata is the concrete juice of a tree variously called by botanists *Mimusops Balata* Gaertn., *Achras balata*, *Achras Dissecta* and *Sapota Muelleri*, a Sapotacea which grows in British Guiana, while Chicle is said to be the product of a tree of the same class from Mexico. The difference in the manner of obtaining the material is evident from the chemical composition. While Balata is an almost pure hydro-carbon, with its various products of oxidation; Chicle contains, also, the various impurities of the juice from which it is derived.

The only reference to Chicle that could be found was by J. R. Jackson [Ph. J. Tr. (3) 7.409]. He gives a general description of the material, stating that it resembles gutta percha in appearance, being, however, more friable and brittle. He further mentions that it is probably derived from *Chrysophyllum glycyplacum* of the family Sapotaceae, and that it is also known under the names of *Mexican gum* and *rubber juice*.

In the course of the examination it became frequently necessary to consult the literature of caoutchouc, gutta percha and balata. In the following, we give the sources from which our information has been obtained.

On caoutchouc. Jahresber., 1847 and 1848. 742 ; Payen, Journ. pr. Ch., 55.273 and 56.196 ; S. Cloez and A. Girard, Jahresb., 1868. 494 ; J. Spiller, Jahresber., 1865. 576 ; A. Girard, Jahresber., 1868. 771 ; 1871. 800 ; 1873. 1127 ; Bouchardat, Jahresber., 1875.

On gutta percha. Soubeiran, Jahresber., 1847 and 1848. 743 ; E. N. Kent, Jahresber., 1847 and 1848. 744 ; Arppe, J. pr. Ch., 53.171 ; Payen, J. pr. Ch., 57. 152, and Jahresber., 1859 ; Bleekrode, Jahresber., 1859. 517 ; A. C. Oudemans, Jahresber., 1859. 517 ; E. H. von Baumhauer, J. p. Ch., 78. 277 ; A. W. Hofmann, Ann. Chem. Pharm., 115. 297.

On caoutchouc and gutta percha. Adriani, Jahresber., 1850. 519 and Chem. News, 2. 277, 289, 313 ; C. G. Williams, Jour. Chem. Soc., 15. 110, 121 ; A. W. Miller, J. pr. Ch., 97. 380 ; Berthelot, Jahresb., 1869. 334.

On balata. Bleekrode, Jahresb., 1859. 517 ; Sperlich, Wien. Akad. Ber., 59. (2) 107 ; O. Buchner, Dingl. Journ., 172. 146.

The material examined was in the shape of rectangular cakes, of light chocolate or flesh color, which was more pronounced on the surface, where atmospheric influences had acted more powerfully. The substance can be crumbled between the fingers ; it has, however, a certain degree of softness and tenacity, which is more perceptible after the material has been heated. Taken in the mouth it disintegrates, unites again, however, after chewing, then forming a soft, plastic mass. This latter quality has probably made it a favorite material for chewing-gum. On heating, it first evolves a sweet, caramel odor ; after this has disappeared the peculiar smell becomes perceptible, which is generated when caoutchouc or gutta percha are treated in like manner. The material disintegrates, if it is boiled with dilute acids ; the brown solution contains oxalic acid and saccharine matter. The residue subsequently boiled with dilute solutions of caustic alkalies unites again, and then forms a doughy mass.

The following constituents have been found :

Chicle resin or gum, forming 75 p. c. of the crude material ; oxalate of lime (with small quantities of sulphate and phosphate), 9 p. c. ; arabin, about 10 p. c. ; sugar, about 5 p. c. ; salts, soluble in water (chloride and sulphate of magnesia, small quantity of potash salts), 0.5 p. c. All these figures are, of course, only approximate.

Chicle Resin or Chicle Gum.—The resin, in the crude material, can be completely separated from the other constituents by bisulphide of carbon. If the finely divided material be shaken with about twice its weight of bisulphide of carbon, it will swell and assume a dark chocolate color. After standing for from two to three days, the insoluble residue will settle, leaving the yellow supernatant liquid perfectly clear. By carefully siphoning off the solution, and treating the residue with fresh portions of the solvent about ten times in the same manner, the resin will be completely removed from the insoluble residue, and obtained free from the other constituents of the crude product. Towards the end, when the solvent contains only little in solution, the insoluble residue will settle only very slowly. After distilling off the larger portion of the bisulphide of carbon, and pouring the residue into boiling water, the resin is obtained as a very light, fresh-colored, doughy, tolerably fluid mass, which is heavier than water. On cooling, it becomes hard, and then assumes a wax-like consistence, retaining, however, a certain degree of elasticity as long as it contains water or bisulphide of carbon. Dried at 100° C., it presents lumps, of somewhat granular appearance, which are light yellow inside, darker on the surface. They are brittle. Vulcanized at low temperature and with little sulphur, the resin becomes elastic, at higher temperatures and with more sulphur it becomes hard and brittle. The dried resin dissolves easily in bisulphide of carbon and cold ether, only partially in boiling alcohol. For reasons which will appear hereafter, the above method of obtaining the resin is objectionable, if its further examination is contemplated. Another method for obtaining the resin, at least free from arabin, the soluble salts, and the larger part of oxalate of lime, is by boiling the crude material with water. It then presents chocolate colored lumps, with properties similar to those described, in the resin, arrived at by the other method.

Arabin.—If the residue of the bisulphide of carbon treatment, or the crude material, is boiled with water for some time, milky, chocolate-colored liquids are obtained, which contain the arabin, saccharine matter and soluble salts in solution, and the oxalate of lime in fine suspension. A clear liquid can be obtained only by repeated filtrations. The clear solution is dark brown, almost opaque. In it the arabin can be separated from the other constituents, either by dialysis, or precipitation with four volumes of 97 p. c. alcohol. The floccular precipitate formed is light, chocolate-brown. Dried at 100° it is dark-brown, and then contains 1.68 p. c. CaO, 1.68 p. c. MgO,

and 0.2 p. c. K_2O , and 0.34 p. c. of sulphate of lime. A purer material was obtained by re-dissolving the precipitate in water, acidulating the solution strongly by hydro-chloric acid, and effecting a partial precipitation by the addition of an equal volume of 97 p. c. alcohol. The larger quantity of the coloring matter remains in solution. The jelly, like transparent arabin precipitate, was washed by 97 p. c. alcohol; it became opaque and floccular, and by re-dissolving yielded a light-brown solution. This solution when kept hot may be almost completely decolorized by prolonged treatment with bone-black. Eventually a filtrate is obtained, which is turbid and gray by bone-black suspended in it. Addition of an equal bulk of 90 p. c. alcohol to the solution, will precipitate a portion of the arabin, together with the bone-black and the rest of the coloring matter. By filtration, a clear, light yellow filtrate is obtained, which, on repeated treatment by the method described by Neubauer, *Ann. Chem. Phar.*, 102. 105, will yield arabin as a floccular, almost white precipitate. By dissolving this precipitate in water, evaporating the solution in the water bath, and drying the residue at $100^\circ C.$, the arabin was obtained in the form of a light brown, very brittle glass, which shows all the properties generally ascribed to it. It is soluble in water.

A rough determination of the action on polarized light, gave a rotation to the left of about 37° .

Results of combustion in boat in current of oxygen :

I. 0.2530 gms. gave 0.3968 CO_2 , 0.1384 H_2O , and 0.0015 ash.

II. 0.2388 " " 0.378 CO_2 , 0.1335 " " 0.0012 "

making the per centage of C and H, after the deduction of the ash,

	I.	II.	$C_8H_{10}O_5$ Calculated.	$C_{12}H_{22}O_{11}$ Calculated.
C.	43.03	43.39	44.44	42.10.
H.	6.11	6.24	6.17	6.43.
O.	50.86	50.37	49.39	51.47.
	<hr/> 100.00	<hr/> 100.00	<hr/> 100.00	<hr/> 100.00.

The substance analyzed may be looked upon as a mixture of the two compounds $C_8H_{10}O_5$ and $C_{12}H_{22}O_{11}$. The filtrate of the precipitate that had been the source of the above mentioned purer material, yielded a further quantity of arabin, on addition of an excess of alcohol, in the form of a chocolate-colored powder, which, after drying at 100° , was insoluble in water. It dissolved, however, on the addition of a small quantity of alkali. The residual alcoholic liquid

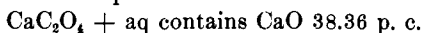
contained the bases as chlorides, produced by the addition of hydrochloric acid, and coloring matter; the latter separates in the form of a dark-brown powder, on removal of the alcohol by distillation.

Saccharine Matter and Soluble Salts.—It has been stated above, that arabin can be separated from the other constituents of the original aqueous solution, either by dialysis or by precipitation with alcohol. In the first case, the sugar and the salts are found in the crystalloid liquids, in the latter they are contained in the alcoholic solution. From the latter solution they are obtained in a purer condition by dialysis. The solutions, on concentration, will yield liquids of caramel odor and color, and bitter sweetish taste. On evaporation to dryness, brown, hard, transparent residues are obtained. The aqueous solution reduces Fehling's solution. Attempts in different directions to further the character of the sugar were unsuccessful. No definite product could be obtained, owing, perhaps, to the large proportion of salts, which form one-tenth of the total quantity of solids in solution. The sugar may possibly be arabinose, derived from the arabin, in the alteration of the raw material.

The soluble salts are inorganic, being mainly chloride and sulphate of magnesium, potassium salts and sulphate of lime.

Oxalate of Lime is easily identified. It remains in the form of a light brown, very fine powder, which runs through the filter easily, on filtration of the aqueous extracts mentioned under arabin (p. 52). By dissolving it in hydrochloric acid and reprecipitating by neutralization with ammonia or carbonate of soda, added till the liquid was only very slightly acid, the oxalate of lime was obtained in the form of a slightly gray powder.

A portion of this was dried at 100°, and then ignited; 0.7972 gms. gave CaO 0.3127 or 39.2 p. c.



The discrepancy is easily explained, as the material examined, contained small quantities of sulphate and phosphate of lime, and silica. Oxalic acid in its pure crystallized form, and various oxalates, were also prepared.

EXAMINATION OF THE CHICLE RESIN.

An examination of the gum, as obtained by either of the methods, above mentioned, showed it to consist notably of four different compounds. All of these, when heated, show a similarity in their behaviour; they evolve a peculiar, not disagreeable gutta odor, become soft and transparent, increasingly so as the temperature rises. A distinct melting point, therefore, cannot be assigned to them.

Two of the compounds, forming 75 p. c. of the resin, contain oxygen and correspond in their formulas, $C_{10}H_{16}O$ and $C_{20}H_{32}O$, as well as in their properties, to those described by Payen and Oudemans, as obtained from gutta percha, and termed by the former, alban and fluavil.

The first of these oxygen compounds, while being only slightly soluble in cold water, dissolves easily and in large quantity, on boiling; the latter dissolves easily in cold alcohol.

The other two constituents of the resin are hydrocarbons, $C_{10}H_{16}$. They are insoluble in boiling alcohol.

By protracted action of boiling alcohol on the chicle gum, only the oxygen compounds go in solution, while the hydrocarbons remain undissolved. A ready means for separation is thus offered.

Oxygen Compounds.—If an excess of 94 p. c. (vol.) or even more dilute alcohol is added to the chicle gum, and its temperature raised to the boiling point, and maintained at or near this point for several hours, it assumes a yellow color. The liquid obtained by decanting, or rapidly filtering off the boiling yellow solution, on cooling, soon becomes turbid, and after standing 24 hours an ample, verrucose crystallization will be deposited both on the bottom, and in more distinct crystals on the sides of the vessel, containing the solution. The supernatant liquid was light yellow and perfectly clear.

Chicle Alban.— $C_{10}H_{16}O$. The warts, measuring from 1 to 2 mm in diameter, were either obtained of a milky opalescence or pure white and opaque. Dried at the air and over sulphuric acid, they all become perfectly white and opaque. Some of the opalescent crystals were carefully selected from the sides of the vessel, thrown on a filter, washed repeatedly with 94 p. c. alcohol, dried over sulphuric acid, and reduced to a fine powder, which was first dried again over sulphuric acid, and eventually at 100° . Thus a light yellow powder was obtained, which baked together slightly at the temperature at which the drying was performed.

Combustion yielded the following results :

- I. 0.305 gms. gave 0.8925 CO_2 and 0.2995 gms. H_2O .
 II. 0.2601 “ “ 0.762 “ “ 0.2525 “ “

	I.	II.
C.	79.81 p. c.	79.90 p. c.
H.	10.91 “	10.78 “
O.	9.28 “	9.32 “
	100.00	100.00

These analyses do not represent the pure alban.

The bulk of the substance prepared for analysis was, therefore, re-dissolved in a small quantity of 94 p. c. (vol.) alcohol, by the aid of heat. On cooling, the whole liquid gelatinized. The gelatinous precipitate, which resembles gelatinous silica in appearance, was thrown on a filter, washed thoroughly by cold alcohol, re-dissolved, re-crystallized, and thus obtained pure. The pure substance, after drying over sulphuric acid, presents a perfectly white, very bulky powder. 100 pts. (wt.) of watery alcohol (0.82 sp. gr. at 13°), dissolve of it 0.66 pts. at 14°, and 0.71 at 17°. Boiling alcohol dissolves it easily, and in considerable quantity, and it is deposited, on cooling, either as a gelatinous mass or in the form of milky opalescent or white warts. It is very easily soluble in ether, chloroform, naphtha, benzol, and bisulphide of carbon.

When heated, it bakes together slightly at 100°, without changing its external appearance; at 106° it unites in a transparent mass, becoming softer as the temperature rises; at 145° it forms a syrupy light brown mass, which, on cooling, solidifies to a light brown transparent, very brittle glass.

A portion of it, heated in a boat in a current of dry carbon dioxide to 100°, unto constant weight, on combustion, yielded the following result:

III.—0.2351 gms. gave 0.6810 CO₂ and 0.2148 H₂O, and no ash.

	III.		C ₁₀ H ₁₃ O. Calculated.
C.....	79.00 per cent.		78.96 per cent.
H.....	10.15 "		10.52 "
O.....	10.85 "		10.52 "

The result of the analysis corresponds closely to the empiric formula, C₁₀H₁₃O.

Chicle Fluavil (C₃₀H₃₃O?).—The substance represented in the analyses I and II, may be looked upon as a mixture of between 2.5 to 3 pts. of pure alban, with 1 pt. of a lower oxygen compound, C₃₀H₃₃O (fluavil?). This assumption is further confirmed by the determination of the total quantity of solids, in the solution, obtained by digesting the substance for some time with a small amount of alcohol. The figures arrived at, are much higher than would correspond to the solubility of pure alban, as represented by analysis III, in alcohol of the same strength. Thus 0.953 gms. digested for some time with 25 gms. of alcohol (0.82 sp. gr.), gave a solution which at 17° contained 1.57 pts. of resin to 100 pts. of alcohol (0.82 sp. gr.). Assuming that the whole quantity of fluavil, contained in the substance, has gone in solution, together with as much alban as corresponds to its solubility in a pure

condition, a similar quantitative ratio, in regard to the supposed constituents, is reached.

The application of the difference in solubility in alcohol to the separation of alban and fluavil, while it admits the preparation of the former in a perfectly pure condition, will yield the latter only in a very approximate state of purity.

The clear, light yellow, supernatant liquid of the alban crystallization, mentioned in an earlier part of this paper, on concentration and standing, will give an additional yield of alban, less pure, however, than the first. The mother-liquor, thus obtained, on concentrating, cooling and standing, will deposit a slightly yellow, translucent, viscid mass, which contains a large proportion of alcohol. The deposit melts at a very low temperature, spreads and covers the plate, to which it was transferred, in an even, thin layer. By protracted heating most of the alcohol can be removed. On cooling, the substance then presents a transparent, brittle glass, of light lemon-yellow color.

The last traces of alcohol offer some difficulty in their removal. A portion of the glassy mass was reduced to a very fine powder; this was very thoroughly mixed, spread out in a very thin layer on a plate, dried at ordinary temperature for some time, and finally for a number of days at 100°. The powder unites and melts much below this temperature. The mass on cooling solidifies again to a light yellow, brittle glass. Pieces of this were directly used for analysis. The combustion was performed in oxygen. Constant results, however, could not be obtained.

I.	0.2462	gms.	gave	0.739	CO ₂	and	0.2465	H ₂ O	; no ash.
II.	0.2483	"	"	0.7333	"	"	0.2403	"	"
III.	0.2579	"	"	0.7565	"	"	0.245	"	"
IV.	0.2866	"	"	0.8335	"	"	0.2710	"	"

	I	II	III	IV.	C ₂₀ H ₃₂ O. Calculated.
C.	81.86 p. c.	80.54 p. c.	80.00 p. c.	79.32 p. c.	83.33 p. c.
H.	11.13 "	10.75 "	10.55 "	10.51 "	11.11 "
O.	7.01 "	8.71 "	9.45 "	10.17 "	5.56 "
	100.00	100.00	100.00	100.00	100.00.

The glassy mass dissolves easily and completely in boiling alcohol. The light, yellow solution on cooling and standing deposits, besides amorphous viscid fluavil, a very ample verrucose crystallization of alban. By the latter fact, and by the above quoted analyses, it would appear that fluavil were capable of further oxidation to alban.

It is to be presumed that the analysis would have yielded a lower per centage of oxygen, if the substance had, at once, after obtaining it, been dried in a current of dry carbondioxide. The compound, however, possesses only few very characteristic properties, and for the present, at least, does not appear of sufficient interest to warrant any further attempts at obtaining it in a perfectly pure condition.

100 pts. (wt.) of alcohol of (0.82 sp. gr.) dissolve at 13.5°, 2.6 pts. of fluavil.

Hydrocarbons $C_{10}H_{16}$.—By long and repeated digestions of the chicle gum with fresh quantities of alcohol, the larger portion of the oxygen compounds may be removed; ultimately, a tolerably liquid residue is obtained, which resists the further action of the solvent. On cooling, this residue assumes a more wax-like consistence. It is of light gray color, if prepared from the resin, obtained by bisulphide of carbon. The gum, resulting from boiling the crude material with water, yields it in the form of a dark, chocolate-colored mass, which contains oxalate of lime. In both cases the residue consists mainly of two hydrocarbons of the empiric formula $C_{10}H_{16}$, and alban and fluavil which boiling alcohol has failed to remove.

The difference in the behavior of the two hydrocarbons to the solvent action of ether, offers a ready means for their separation. One of them, while it is altogether insoluble in cold ether, dissolves easily and in very considerable quantity, on boiling. From this solution it separates completely, and in a crystalline form, on cooling. The other hydrocarbon seems to be amorphous, and is readily soluble in cold ether.

The complete separation of the hydrocarbons from the oxygen compounds, presents some difficulty. The hydrocarbons themselves oxidize very easily. Although they were not obtained in a perfectly pure condition, owing principally to the smallness of their quantity in the raw material, yet certain features in behavior, alike prominent in their different stages of purity, and the steady decrease of the per centage of oxygen in the course of their purification, allowed definite conclusions to be drawn, as to their properties and composition in a pure state.

Hydrocarbon $C_{10}H_{16}$, *soluble in cold ether*.—If the previously mentioned chocolate-colored residue, from which most of the alban and fluavil had been removed by repeated treatment with boiling alcohol, is digested for some time with an excess of boiling ether, the hydrocarbons and remaining oxygen compounds will completely

dissolve ; the liquid obtained is, however, turbid by suspended oxalate of lime and coloring matter. Upon standing for 24 hours at very low temperature the insoluble hydrocarbon will have separated completely in a crystalline form ; the clear light yellow liquid then obtained by filtration, yields no further crystallization on concentration.

In the manner indicated, a solution was arrived at which contained only the soluble hydrocarbon, besides alban and fluavil. This, after concentration, was poured into about four times its bulk of 94 p. c. (vol.) alcohol. A white partly powdery and partly flaky precipitate forms. The mixed liquids were at once heated and distilled to about two-thirds of their original bulk. In this operation, most of the precipitate unites in a light flesh-colored, doughy mass, which attaches itself to the bottom of the vessel ; a portion, however, remains finely suspended in the liquid, giving it a milky appearance.

After the liquid had been distilled to the required bulk, it was decanted off, boiling. The residue was subjected to repeated and prolonged treatment with fresh portions of boiling alcohol, which were always decanted off, boiling. Thus, eventually, a light flesh-colored, soft and very tenacious mass was obtained. A portion of this was dried at 100° in a dry current of carbon dioxide. On combustion the following results were obtained :

0.2365 gms. gave 0.7378 CO₂ and 0.2437 H₂O ; no ash.

C=85.08 p. c. H=11.45 p. c. O=3.47 p. c.

The remaining portion was dissolved in ether, and the solution subjected again to the previously described treatment with alcohol.

The same operations (redissolving in ether, etc.) were repeated with the residue obtained. The substance eventually obtained was not very different, in its general properties, from the one represented in the above analysis. It was soft, very tenacious, of light gray color and somewhat translucent. Its total yield was about one-tenth of the original portion. A quantity prepared for analysis in the same manner as before, on combustion, gave the following results :

0.2967 gms. gave 0.9435 CO₂ and 0.3043 H₂O ; ash visible, has no appreciable wt.

		C ₁₀ H ₁₆ . Calculated.
C	86.73	88.23
H.....	11.40	11.77
O.....	1.87	

Further purification, without doubt, would have eventually yielded the pure hydrocarbon. This, however, had to be abandoned in consequence of the small yield of the substance from the raw material,

still further reduced by the various above mentioned operations. The two analyses given, the constant ratio of carbon and hydrogen in both, allows the inference of the empiric formula $C_{10}H_{16}$ for the pure hydrocarbon. The constant properties of the substance in its different stages of purity, allow the assumption of these same properties for the hydrocarbon in a pure condition.

The principal properties have already been given. The substance is soft, very tenacious and translucent at ordinary temperature. When boiled with alcohol it becomes softer, but retains its tenacity. On heating it becomes softer, but even at 135° it is still gelatinous. It dissolves very easily in naphtha, chloroform and bisulphide of carbon. Cold ether first converts it into a limpid, perfectly colorless mass, which it is very difficult to distinguish in glass vessels, and then rapidly dissolves it. Warm ether dissolves it even more rapidly. From these solutions it could not be obtained in a crystallized or powdery form.

Hydrocarbon $C_{10}H_{16}$, insoluble in cold ether.—The crystalline residue of the solution that had originally yielded the hydrocarbon, contains the entire quantity of the insoluble compound, together with small quantities of oxalate of lime and coloring matter. This residue was thoroughly washed by cold ether and pressed between blotting paper. By re-dissolving in warm ether and filtration, oxalate of lime and coloring matter were completely removed. A solution was thus obtained, which was perfectly colorless and clear, when warm. The filtration of the boiling liquid presents some difficulty; as the ether evaporates, the crystallization begins already on the filter, thus retarding or altogether interrupting further filtration.

The clear, colorless liquid crystallizes on cooling; after standing 24 hours it has become one mass of white microscopic crystals. These were thrown on a filter, thoroughly washed by cold ether and pressed between filtering paper. A portion of the substance thus obtained was dried in the air bath at 110° ; it melts, becomes transparent, and on cooling presents a light brown, not a very homogeneous mass of a consistence, somewhat harder than wax. Pieces of this mass were transferred to a boat and subjected to combustion. The following results were obtained:

- I. 0.3022 gms. gave 0.9215 CO_2 and 0.29 H_2O ; 0.0004 white, amorphous ash.
 II. 0.3036 " " 0.934 " " — " 0.0006 white, " "

Calculated percentages after the deduction of the ash:

- I. C=83.27 p. c. H=10.68 p. c. O=6.05 p. c.
 II. C=84.07 " "

The bulk of the brown mass was re-dissolved in boiling ether. A portion of the white crystalline powder obtained from the filtrate on cooling was at once transferred to a boat and dried at 100° in a dry current of carbon dioxide. On analysis, the following results were obtained :

III. 0.3030 gms. gave 0.93 g. CO_2 and 0.2955 H_2O ; no ash.

C=83.55 p. c. H=10.81 p. c. O=5.64 p. c.

The rest of the crystalline powder, when re-dissolved in boiling ether, re-crystallized and otherwise treated in the same manner as before, on combustion, yielded the following results :

IV. 0.3148 gms. gave 0.9773 gs. CO_2 and 0.3108 H_2O ; no ash.

C=84.67 p. c. H=10.97 p. c. O=4.36 p. c.

The remaining bulk of the substance, obtained from the original etheric solution, was re-dissolved in ether, and an equal bulk of 94 p. c. alcohol added. A white powdery precipitate forms, which unites to a white liquid mass ; a portion of it, however, remains in milky emulsion, even after long continued boiling. The subsequent treatment is essentially a repetition of the method applied for the purification of the soluble hydrocarbon. The residue eventually obtained, on cooling, presents a white brittle mass, which is harder than wax. This was digested for a number of days with renewed portions of ether. It swells, disintegrates to white floccular masses, but does not dissolve. These floccular masses were heated again with alcohol. They unite, melt, and on cooling are obtained in the original white wax-like brittle form. A portion of the substance thus obtained was dried in a current of carbon dioxide. Combustion yielded the following results :

IV. 0.2043 gms. gave 0.6459 CO_2 and 0.2123 H_2O ; 0.0003 ash.

Calculated after deduction of the ash :

C=86.37 p. c. H=11.57 p. c. O=2.06 p. c.

The bulk of the substance was again subjected to the same purifying method, with the only exception that the floccular masses obtained by digestion with cold ether, were at once dried in a current of dry carbon dioxide. The results of the analysis were as follows :

V. 0.2061 gms. gave 0.6560 CO_2 and 0.2152 H_2O ; 0.0002 ash.

		$\text{C}_{10}\text{H}_{16}$.
		Calculated.
C.....	86.89	C..... 88.23
H.....	11.61	H..... 11.77
O.....	1.50	

The results are not materially different, if the drying has been performed in hydrogen.

What has been said about the further purification of the soluble hydrocarbon, might be justly repeated here. The analyses permit the same inferences to be drawn. In the present case the purification is even more difficult. The substance is very oxydizable. An analysis of the same material represented in analysis V, which was made on the day following, yielded the following results :

0.3689 gms. gave 1.158 CO₂ and 0.3742 H₂O ; 0.001 ash, or,
 C= 85.84 p. c. H= 11.3 p. c. O = 2.86 p. c.

In this case the drying of the substance was done in hydrogen. The analysis shows that it is absolutely necessary to perform the analysis directly after obtaining the substance. The substance approaches very closely, or is, perhaps, identical with the gutta examined, and obtained from gutta percha by V. Baumhauer. The crystalline substance, as obtained from the warm ether solution, on cooling, presents a white powder, on drying at ordinary temperature ; in this form it oxydizes even more rapidly. The air in the bottles-in which it was kept, contained ozone in considerable quantity. Occasionally the hydrocarbon was also obtained in the form of white verrucose masses, about 0.2 mm. in diameter. The substance represented in analysis V, is a white, slightly translucent mass, which is brittle at ordinary temperature. At 45° it becomes soft and transparent, and evolves a very strong and agreeable gutta odor ; it is syrupy at 125°. At no temperature does it show the tenacity, peculiar to the soluble hydro-carbon. It dissolves easily in benzole and chloroform. In cold ether and naphtha it swells, and dissolves on boiling, and is deposited again in a crystalline form, on cooling.

It may not be amiss, in this place, to mention again that the chicle resin dissolves easily in cold ether, which shows that the hydro-carbon is readily soluble in cold ether in the presence of an excess of the oxygen compounds.

Vulcanized products.—The chicle resin, obtained by bisulphide of carbon, yields, on exhaustive treatment with boiling alcohol, a light gray residue (p. 58) which dissolves readily on digestion with boiling ether. Only a very slight floccular precipitate remains. The clear light yellow solution thus obtained, gelatinizes to a mass of white crystals upon cooling and standing. Evaporation of the mother liquid, obtained by filtration, yielded a residue which, on drying at 100°, presented a light brown, slightly transparent elastic mass. This residue was almost utterly insoluble in ether, naphtha, bisulphide of carbon and chloroform, even on boiling. It becomes gelatinous, translucent and light yellow on digestion with ether, and

swells to about twenty times its original bulk, and only very little is dissolved. This peculiar behavior at once suggests that the residue may be a vulcanized product which was fully confirmed, on further examination. A portion of the substance, which had been repeatedly treated with boiling ether and alcohol, and then dried at 100° , proved to contain 1.77 p. c. of sulphur and about 8 p. c. of oxygen.

The waxy mass obtained by drying the previously mentioned white crystals at 100° , after they had been thoroughly washed by cold ether and pressed between blotting paper, consists largely of the insoluble hydro-carbon, but contains also a similar vulcanized product which remains behind undissolved on digestion with boiling ether.

The source of the sulphur in the vulcanized products is readily comprehensible. It is a well-known fact that bisulphide of carbon will alter on standing, exposure to light and air, and then contain free sulphur. (Compare, also, Gmelin, *Handbuch der anorg. Ch.*, 6te Aufl., Vol. I. (2), p. 224.) The complete extraction of the chicle resin from the raw material is naturally a lengthy operation, and atmospheric influences on the bisulphide, have ample time to exert themselves. Hence the hydro-carbons were obtained first contaminated with sulphur, and finally in a vulcanized condition.

The descriptions given of gutta are somewhat conflicting, and it has been assumed that gutta percha may exist in different modifications. The presence of these two modifications, in the same sample, has never been proven.

The properties given to gutta by various authors are such, that they seem to describe as gutta, either a hydro-carbon soluble in cold ether, or a hydro-carbon soluble in warm, but insoluble in cold ether.

From the manner in which these investigations were made, it remains doubtful whether the authors, after finding one, really looked for another hydro-carbon.

The hydro-carbons found by us in chicle correspond, in many respects, to these different guttas, and must be classed in the same group with them, if they are not actually identical—a fact, the proof of which would have necessitated a direct, comparative examination of guttas from various sources.

Similar comparative examinations are also necessary to establish the identity or difference of the alban and fluavil found by us, with or from those described by others.

While we found the melting point of chicle alban at about 145° C., Oudemans gives the melting point of gutta percha alban at 140° C., and Payen at 160° C.

The authors who have described and examined gutta percha, have looked upon the compounds containing oxygen as secondarily derived from the hydro-carbons, and have assumed that the original juice contained only these. From the properties of the hydro-carbons and from observations made by us, we have come to similar conclusions, as regards chicle.

The chicle resin which we have examined, contains the above described constituents in about the following proportions :

Alban.....	45 per cent.
Fluavil	30 “
Insoluble hydro.....	17 “
Soluble carbon.....	8 “

From the above, it is evident that but little of the original hydro-carbon has escaped oxidation ; and the difference in the properties of the resin from the properties of the original hydro-carbon, is readily comprehensible.

The crude chicle contains besides, 75 per cent. of chicle resin of the above given composition :

Arabin.....	10 per cent.
Sugar.....	5 “
Soluble inorganic salts.....	0.5 “
Oxalate of lime (sulphate and phosphate).....	9 “

From this it is evident that chicle is merely the product of direct evaporation of the juice, without attempt of separation, as is practised in the case of gutta percha and india rubber.

There is no doubt in our minds, that by proper treatment of the raw juice a far more valuable product would be obtained than the chicle gum which is now in the market.

Whether the product, then obtained, will be one similar to gutta percha, balata or india rubber, must be left to future examination of the raw juice, which so far we have been unable to obtain.