PART X.

THE SIGNIFICANCE OF THE CONSTITUENTS OF SOME STICK-LACS.

By C. R. Somayajulu.

Among the many unsolved problems connected with lac-production, that of the physiological mechanism of its formation by the lac insect is not the least interesting. Two views have been put forward in explanation of the process. According to one, lac is a waste product, consisting mainly of unassimilable matter derived from the host-plant and excreted by the insect, which thus acts mainly as a mechanical separator. The second suggestion is that lac is a product of normal secretory activity, the various constituents of lac being derived from different and specific glands. The work described in the present paper was undertaken with the object of deciding, if possible, between these two views which may be termed respectively the excretion and the secretion theories, by the systematic analysis of lac incrustations of various origin.

In the selection of material for analysis, three fundamental factors controlling lac-production were kept in view, namely, the genus of the insect producing the lac, the species of the host on which it is propagated, and the season in which it is grown. If the proportion and nature of the constituents composing lac are largely a variable function of the species of host, the first hypothesis holds good, whilst the second would find support if the genus of the insect is the principal controlling factor.

PLAN OF ANALYSIS.

Since in many cases the quantities of material available for research were small, the micro-chemical methods of examination described by the author[1] in a former paper were used.

As can be seen from the appended table, the different factors were varied in the following manner :—

In section I*a*, the insect and the host remaining constant, analytical data are given for lac produced in the three seasons in Mysore. In I*b*, the insect (*Shorea* brood) and the season (summer)

[1] This *Journal*, 1924, 7, 129.

remaining the same, the hosts were varied. In II, comparative figures are given in three sets for two insects of different genus, the host in each case remaining constant. In III, both the insect and the host were varied, the season only remaining constant.

Having regard to the known composition of stick-lac it was considered sufficient for the purpose of this work to extract the wax and higher alcohols by light petroleum, the fatty acids and certain colouring matters by ether and the resins by alcohol (96 per cent.), the main bulk of lac-dye remaining insoluble in these liquids. Each sample was extracted with the various solvents in the above sequence, the conditions of sampling, time of extraction and other treatment being similar in every case. It was found that by a further extraction with benzene subsequent to alcohol, a hard wax, identified as lacceryl laccerate could be obtained, but as in many cases this was present only in negligible amount it was not examined quantitatively. Besides determining the percentage amount of the above extracts, an endeavour was made to ascertain for each extract, such constants as the saponification value, the acid value, the iodine number, the melting point and the refractive index. In the case of the ether extract, since the residue was highly coloured, the refractive index could not be observed. In the alcoholic extract only the saponification and acid values were determined.

EXPERIMENTAL.

(a) *Sampling.*—Different samples of stick-lac obtained from various parts of the country were analysed. The pieces were first brushed to remove any dirt and loosely adhering wax-filaments, then powdered and passed through a sieve having forty meshes to the inch.

(b) *Extraction.*—One gram of each sample was then mixed with twice its bulk of fine, thoroughly cleaned glass-powder, the mixture placed in a thimble of thick filter-paper and completely extracted in a Soxhlet attached to a small round flask of about 50 c.c. capacity. Six hours' extraction over an electric heating-coil at about 70° C. was found sufficient in each case. The extracts in the flasks, after recovery of the bulk of the solvent, were dried by heating for about a quarter-of-an-hour on a water-bath, in the case of alcohol the last traces being removed by heating in vacuo over an electric bulb.

(c) *Determination of Constants.*—Small quantities of the dry material were scraped gently with a knife into suitable reaction vessels, and the analysis carried out by the micro-methods already described. In all cases the melting point determination was made three days after the introduction of the substance into the capillary tube in order to minimise the effect of previous melting.

The refractive index was determined by the Abbé refractometer at 80°, since many samples of the wax melted only between 70° and 80°.

Discussion of Results.

A careful examination of the results given in the appended table brings out clearly certain broad conclusions.

In section I*a*, where only the season is varied, not much difference is to be observed between the constants for the three extracts. There is little variation even in the proportion of the constituents, excepting that in the case of the summer crop the wax-content is lower and the ether-insoluble resin-content is higher in comparison with the other two seasons. Resin secretion would appear to be more active than wax secretion, but the actual nature of the components does not vary.

The results under I*b*, i.e. from the same insect on different host-plants, indicate some variation in the relative proportions of the constituents, while the figures for the constants of these constituents are of the same order throughout. The constants for the petrol and ether extracts do, however, differ markedly from those obtained with lac derived from *Shorea talura*, the natural host-plant of the Mysore insect.

In the case of the results grouped under II *a*, *b* and *c*, where the host-plant is constant and the insect is varied, the figures show marked contrasts both in the percentage of the various extracts and in their individual constants. This is especially noticeable where *L. mysorensis* and *T. lobata* are both grown on *Acacia Farnesiana*.[1]

Under III, where both host-plant and insect are varied, striking contrasts are observed throughout, lending support to the secretory rather than to the excretory theory of lac-production. Such a conclusion receives striking confirmation from the results of analysis of the lac from *T. lobata*. It will be seen that in every case, independently of the host-plant concerned, the proportion of extractable matter, particularly by alcohol, is extraordinarily low.

Analysis of the residue after extraction showed the presence of large amounts of carbohydrate which give reducing sugars on hydrolysis, thus indicating a comparative deficiency in the digestive and secretive system of this insect. It has further been observed by Mr. Sreenivasaya that *Acacia Farnesiana* grown in water-culture and

[1] The nomenclature of the insects throughout is that suggested by Mr. Mahdihassan.

inoculated with *T. lobata*, does not attract ants as is the case with other species of the lac insect, probably because there is little secretion of honey-dew formed by the breaking down of carbohydrate. This peculiarity of the insect in question is confirmed by the unpublished anatomical studies of Mr. Mahdihassan.

In conclusion, attention may be drawn to the great divergence in the saponification values of the petrol extracts from stick-lac and seed-lac respectively. This is probably due to the effect of washing, which removes the greater portion of the wax-pouches in stick-lac, leaving a smaller proportion of wax with a lower saponification value in the seed-lac.

My thanks are due to Mr. M. Sreenivasaya, who rendered valuable assistance from time to time in the course of this work.

Department of Bio-Chemistry,
Indian Institute of Science,
Bangalore.

Description of Sample			Extracts Per cent		
Genus of Insect.	Name of host and locality	Season	Petrol	Ether	Alcohol
I(*a*) *L. mysorensis* ...	*Shorea talura* (Bangalore)	October '22	9·62	15·52	68·12
Do.	*do.*	March '23	10·38	18·28	63·08
Do.	*do.*	July '23	3·41	19·30	73·54
(*b*) *Do.*	*Acacia Farnesiana* ...	Summer'23	5·40	17·06	77·20
Do.	*A. concinna* ...	...	4·94	21·72	72·35
Do.	*Butea frondosa* ...	...	6·50	22·52	69·46
Do.	*Zizyphus Jujuba* ...	...	4·96	23·40	69·53
Do.	*P. saman* ...	...	4·94	22·38	59·84
II(*a*) *Do.*	*A. Farnesiana* ...	...	5·40	17·06	77·20
T. lobata ...	*do.*	...	2·71	12·16	23·45
(*b*) *L. indica* ...	*Butea frondosa*, (Palamau)	...	3·40	22·66	24·25
L. mysorensis ...	*do.*	...	6·50	22·52	68·45
(*c*) *Do.*	*Zizyphus Jujuba* ...	...	4·96	23·40	69·53
L. indica ...	*do.* (Punjab)	...	2·87	24·68	67·46
III *L. mysorensis* ...	*Shorea talura* ...	...	10·38	18·28	63·08
L. communis ...	*Ficus mysorensis* ...	...	5·00	17·62	68·24
L. nagoliensis ...	*Schleichera trijuga* (C. P.)	...	3·12	12·40	78·74
L. chinensis ...	*Cajanus indicus* (Assam)	...	3·64	21·40	59·80
Do.	*Dipterocarpus* (Indo-China)	...	4·50	21·14	57·42
Metatachardia conchiforata	Ceylon ...	...	1·96	47·82	49·24
IV *T. lobata* ...	*A. Farnesiana* ...	...	2·71	17·06	23·45
Do.	*Santalum album* ...	...	2·82	18·28	21·28
Do.	*Mangifera indica* ...	...	3·10	12·16	19·64
V *L. mysorensis* ...	*S. talura* (Bangalore) Stick-lac	...	9·62	15·52	68·12
Do.	*S. talura* (Bangalore) Seed-lac	...	3·30	33·14	59·20
L. communis ...	*F. mysorensis* Stick-lac ...	...	5·00	17·62	68·24
Do.	*do.* Seed-lac ...	...	4·04	19·96	66·18

Petrol-extract						Ether-extract					Alcohol-extract		
M. P. (degrees C)	Sap. value.	Acid value.	Ester No.	Iodine No.	Refr. Index.	M. P. (degrees C)	Sap. value.	Acid value.	Ester No.	Iodine No.	Sap. value.	Acid value.	Ester No.
69–70	154·2	22·5	131·7	10·4	1·4442	52–53	78·6	51·8	26·8	5·5	196·2	22·5	173·7
68–69	153·4	21·6	131·8	10·5	1·4443	53–54	76·2	51·4	24·8	5·7	194·0	21·8	173·0
69–70	149·4	20·2	129·2	10·3	1·4442	52–53	77·6	51·0	26·6	5·7	198·2	22·2	176·0
75–76	172·4	18·5	153·9	5·3	1·4448	53–54	73·6	46·6	27·0	4·9	195·4	18·2	177·2
74–75	168·5	24·1	144·4	4·7	1·4449	54–55	78·2	44·6	33·6	4·9	193·2	20·8	172·4
75–76	164·2	20·2	144·0	5·0	1 4384	52–53	73·7	42·7	31·0	4·5	194·8	21·2	173·6
75–76	167·9	19·8	148·1	4·3	1.4424	55–56	76·4	45·8	30·6	4·3	196·1	23·8	172·3
74–75	156·4	23·2	133·2	6·5	1·4432	53–54	73·7	46·6	27·1	4·9	195·8	22·4	173·4
75–76	172·4	18·5	153·9	5·3	1·4448	53–54	73·6	46·0	27·6	4·9	195·4	18·2	177·2
78–79	141·2	24·2	117·0	4·0	1·4439	66–67	80·2	24·2	56·0	5·0	199·3	24·1	175·2
65–66	164·1	30·3	133·8	5·4	1·4464	55–56	73·7	50·7	23·0	6·2	202·2	45·8	156·4
75–76	164·2	20·2	144·0	5·0	1·4384	58–59	73·6	33·7	39·9	4·5	196·1	33·6	162·5
78–79	167·9	20·4	147·5	4·3	1·4424	55–56	76·4	45·8	30·6	4·3	198·2	22·5	175·7
79–80	148·0	20·0	128·0	6·5	1·4432	63–64	78·2	35·6	42·6	4·5	194·1	26·8	167·3
69–70	153·4	21·6	131·8	10·5	1·4448	53–54	76·2	51·4	24·8	5·7	194·8	21·8	173·0
76–77	169·8	26·2	143·6	8·5	1·3842	53–54	80·2	49·8	30·4	5·9	199·2	22·4	176·8
64–65	150·2	24·1	126·1	8·6	1·3940	54–55	74·2	56·8	17·4	8·4	196·6	23·2	173·4
80–81	164·2	22·8	141·4	9·8	1·4441	62–63	78·1	62·3	15·8	10·0	195·0	21·2	174·2
81–82	148·6	21·4	127·2	8·7	1·4442	58–59	89·2	56·4	32·8	13·4	199·0	24·0	175·0
79–80	158·3	26·2	132·1	9·4	1·4443	61–62	78·4	43·6	34·8	9·8	192·6	21·6	171·0
78–79	141·2	24·2	117·0	4·0	1·4437	66–67	80·2	24·1	56·0	5·0	195·8	26·4	169·4
79–80	159·2	22·9	136·3	4·2	1·4440	68–69	78·4	26·5	52·0	5·4	197·3	24·9	172·4
78–79	142·4	20·2	122·2	4·2	1·4441	67–68	79·3	25·2	54·1	5·3	196·2	24·2	172·9
69–70	154·2	22·5	131·7	10·3	1·4443	53–54	78·6	51·8	26·8	5·5	198·2	22·8	175 4
68–69	79·8	21·2	58·6	10·2	1·4441	54–55	73·2	49·3	23·9	5·8	200·0	23·4	176·6
76–77	169·8	26·2	143·6	8·5	1·3842	53–54	80·2	49·8	30·4	5·9	199·2	22·4	176·8
64–65	85·9	24·4	61·5	8·6	1·3844	54–55	78·4	48·6	29·8	5·6	198·6	22·0	176·6

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