PART IV.

COMPARATIVE CHEMISTRY OF THE HOST-PLANTS OF LAC.

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Field experiments and observations having clearly shown the eminent suitability of some hosts for lac growth, in preference to others, it was thought that a proximate analysis would reveal the chemical factors which determine the fitness of a plant to bear lac. The various plants experimented upon and kept under observation, differed in their ability to maintain and develop the insect, and also in their power to induce secretion of resin, and to reproduce a virile insect progeny. On some hosts the insect could not maintain itself although inoculated in the most favourable season. On some others the insect could maintain itself but did not grow to maturity. Other hosts like *Butea frondosa* and *Acacia concinna* help the insect to build up appreciable quantities of resin but do not reproduce a virile generation. It is therefore evident that the combination of factors which regulate the four main vital functions of the insect are not the same, and the ideal host is one which harmoniously promotes the four activities :—maintenance, growth, secretion and reproduction.

Selection of hosts for analysis.—A representative selection has been made of the hosts, which fall into the following main groups :—

A. Hosts on which the insects cannot maintain themselves.

1. *Lantana camara.*
2. *Dudonea viscosa.*
3. *Casuarina equisetifolia.*

B. Hosts on which the insect maintains itself but does not grow.

1. *Poinciana regia.* Boger.

C. Hosts which promote the maintenance and growth of the insect but do not induce secretion of appreciable quantities of resin.

1. *Grevilla robusta.*
2. *Pithecalobium saman,*

3. *Ficus mysoriensis.*
4. *Cajanus indicus.*
5. *Ficus bengalensis.*

. Hosts on which the insect does not generate a virile brood.

1. *Acacia arabica.*
2. *Pithacalobium dulce.*
3. *Zizyphus Jujuba.*

E. Hosts on which the insect continues for more than one generation.

1. *Acacia concinna* (4 generations).
2. *Butea frondosa* (6 generations).
3. *Pyrus malus* (3 generations).

F. Ideal hosts.

1. *Acacia Farnesiana.*
2. *Shorea talura.*

Collection and preparation of samples for analysis.—Samples were collected on August 12, 1923. Shoots with a diameter between 0·5 cm. to 1·2 cm., were cut from the host, dried in an electric oven at 70°C, powdered to a mesh of 30 to an inch and preserved in glass stoppered bottles for analysis.

1. *Methods of analysis.*—Moisture was determined by drying two grams of the sample at 110°C for five hours.

2. The total nitrogen was estimated by Kjeldhal's method.

3. The chloroform, alcohol and water extracts were determined by extracting five grams of the substance successively with the above solvents. 95 per cent. (by volume) alcohol was used to extract the alcohol-soluble portion.

4. Total ash was determined by gently incinerating two grams of the substance in a platinum dish over a low Bunsen flame and the ash was utilised for the estimation of silica, phosphoric acid and calcium.

5. Ash from a duplicate analysis was used for the estimation of potassium by the perchlorate method as recommended by W. A. Davis.

6. Reserve carbohydrates were determined by extracting two grams of the sample with 90 per cent. (by volume) alcohol and digesting the residue with 10 c.c. of 1·25 per cent. hydrochloric acid and 90 c.c. of water on a water bath. The reducing sugars were estimated in the resulting solution by Bertrand's method.

DISCUSSION OF THE TABULATED RESULTS.

In a discussion of the tabulated results emphasis should be laid on the fact that the success of a host-plant for lac propagation depends upon four main factors which must be satisfied in a particular order. It should provide the insect with (1) food for its maintenance, (2) growth-promoting constituents for its development, (3) necessary constituents for resin-secretion and (4) substances required to reproduce a virile generation. It is obvious that unless the conditions are satisfied in the above-mentioned sequence, lac-growth will not be possible.

At the outset the following broad generalisations may be pointed out, viz., that the nitrogen and reserve carbohydrates mainly contribute towards maintenance, the proteins (still under investigation) towards growth, the alcohol soluble portion towards resin-producing efficiency, and the mineral constituents, mainly phosphates, towards reproductive capacity. It must however be admitted that there is necessarily an interplay of these constituents to a certain extent, in determining the four principal conditions of lac production.

Nitrogen value is found to be lowest among hosts belonging to group A, and these therefore cannot satisfy the first necessary condition of maintenance. Some host-plants with a high nitrogenous content are not necessarily the best hosts, for example, *Pithecalobium saman.* The explanation probably lies in the availability and nitrogen distribution of the plant proteins associated with different hosts.

Reserve-carbohydrate value expressed in terms of glucose represents the capacity of the host to withstand the drain effected by the sucking lac insect. Hosts with low values are unable to tolerate heavy inoculations.

The chloroform extract value does not appear to determine the suitability of a host-plant for lac growth, although the possible significance of its constituents, under investigation, should not be overlooked.

Alcohol extract values are highly significant. Hosts belonging to the groups B and C have the lowest values, all poor hosts, as regards resin production. The commercial-hosts like *Shorea talura*, *Acacia*

Farnesiana, *Butea frondosa* and *Acacia concinna* have all high values. Those engaged in the study of the biogenesis of the lac-resin should look for its original constituents in the alcohol-soluble portion of the plant. The resin-producing efficiency of the host, given a particular brood, appears to be a direct function of the alcohol extract value.

The water extract values do not appear to be of much importance excepting those of group A; the others have higher values in comparison.

The percentage of ash does not allow of any significant interpretation, but an analysis of its constituents has brought out important facts. Phosphorus appears to be of great significance in regulating the generation of a virile brood, especially in relation to the calcium content of the host. The calcium : phosphorus ratio plays an important part in determining the sex ratio of the brood as found by some unpublished observations. The whole question of the influence of the inorganic constituents particularly on the sex ratio is under active investigation and the results will be published in a later communication.

Host-plants whose calcium : phosphorus ratio lies between 4 and 8 enable the insect to reproduce itself successfully for some generations, provided the growth is not limited by a deficiency of the other three factors. The brood on *Acacia Farnesiana* which is passing through its seventh generation is much more virile, as measured by its low mortality number, than the brood on *Shorea talura* which has been continued for decades. The calcium : phosphorus ratio explains and supports this empirical fact.

The percentages of potash and calcium vary inversely, as has been observed by many experimenters.

TABLE I.

Serial No.	Group	Host-plant	Total nitrogen	Chloroform extract	Alcohol extract	Water extract	Reserve carbohydrates
1	A	*Casuarina equisetifolia...*	0·35	1·22	6·43	4·64	14·8
2	A	*Dudonea viscosa* ...	0·39	0·95	2·59	3·50	15·6
3	A	*Lantana camara* ...	0·34	1·41	2·69	4·42	13·9
4	B	*Poinciana regia* ...	0·55	1·43	9·00	6·60	20·0
5	C	*Grevilla robusta* ...	0·59	1·05	8·76	4·37	19·5
6	C	*Ficus mysoriensis* ...	0·68	2·22	2·33	12·96	15·4
7	C	*Ficus bengalensis* ...	0·84	3·51	1·39	16·13	14·3
8	C	*Cajanus indicus* ...	0·79	1·32	5·60	4·08	15·3
9	C	*Pithecalobium saman* ...	1·13	1·88	7·57	7·38	20·4
10	D	*Acacia arabica* ...	0·96	1·09	6·01	10·67	13·0
11	D	*Pithecalobium dulce* ...	0·76	1·46	13·34	6·80	19·0
12	D	*Zyzyphus Jujuba* ...	1·96	1·36	8·39	8·30	12·2
13	E	*Acacia concinna* ...	1·05	1·20	8·46	6·90	20·2
14	E	*Butea frondosa* ...	0·91	1·72	9·21	8·90	16·0
15	E	*Pyrus malus* ...	0·73	1·33	10·03	8·04	22·4
16	F	*Acacia Farnesiana* ...	0·62	0·935	9·05	5·05	19·4
17	F	*Shorea talura* ...	0·69	1·61	15·62	7·80	20·9

TABLE II.

Serial No.	Group	Host-Plant	Total ash	SiO_2	K_2O	P_2O_5	CaO	$\frac{CaO}{P_2O_5}$
1	A	*Casuarina equisetifolia.*	3·77	4·1	6·1	0·74	43·8	59
2	A	*Lantana camara* ...	2·26	2·3	32·4	0·99	16·7	17
3	A	*Dudonea viscosa* ...	2·86	10·8	15·1	2·94	30·0	10
4	B	*Poinciana regia* ...	4·87	2·1	10·6	2·50	39·5	16
5	C	*Pith. saman* ...	7·62	2·2	10·2	0·89	45·8	51
6	C	*Ficus mysoriensis* ...	9·55	10·3	24·3	1·06	32·7	30
7	C	*Cajanus indicus* ...	3·2	2·6	22·8	2·29	23·9	10
8	C	*Ficus bengalensis* ...	8·93	2·0	36·9	2·82	15·0	5
9	C	*Grevilla robusta* ...	1·81	1·8	20·2	5·43	29·4	5
10	D	*Acacia arabica* ...	4·94	2·0	26·1	1·98	30·5	15
11	D	*Pith, dulce* ...	2·76	9·9	16·8	4·18	30·9	7
12	D	*Zyzyphus Jujuba* ...	4·77	2·5	44·3	2·14	10·7	5
13	E	*Acacia concinna* ...	3·81	4·0	28·3	7·08	26·4	4
14	E	*Butea frondosa* ...	5·47	3·4	32·5	2·25	18·7	8
15	E	*Pyrus malus* ...	2·68	5·9	18·3	7·06	34·8	5
16	F	*Acacia Farnesiana* ...	2·27	3·9	23·5	8·71	31·8	4
17	F	*Shorea talura* ...	3·53	8·5	22·9	4·80	32·0	6