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checked and the damage done greatly slowed down. At the same time, the efficiency of the litter cover must be regarded as having been reduced by the damage done in the few years of exposure in the early stages of opening the land. At the same time, it must be pointed out that it is not easy to point to coffee areas in South India where a reasonable shade policy has been followed, which show serious signs of deterioration from soil erosion. Individual cases may occur on small areas where special circumstances play a part but speaking generally, I think it would be agreed by those familiar with South Indian coffee areas, that soil erosion plays a small part in determining the productivity of the land under this crop

Conclusion. In conclusion, therefore, it may be said that the system followed on most coffee areas in South India affords a substantial degree of protection against soil erosion. There seems no great need for elaborate measures for its control and on the whole, it seems that attention to the improvement of control by the use of vegetation will meet most of the needs of coffee cultivation. This requires most emphasis in connection with the opening up of land for coffee or the replanting of old land. Most of all, planters require education on the question of soil erosion so that special cases can receive prompt attention and that cultivation methods, especially trenching and draining, shall be carried out with the dangers of badly designed work in mind. There is no question that much can be done in opening new clearings by the effective disposal of debris along contours, carrying out weeding and other works along contours and by raising green manure crops at a very small cost to check the losses during the years before the shade and its litter become effective.

Some Correlations in the Appendages of the Indian Honey Bee.

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Introduction. That variations in honey bees are displayed not only in the average dimensions of their various appendages, but in the coefficients of correlations between such measurements as well, was indicated by Alpatov (1929). In the present paper are furnished the coefficients of correlation of the measurements of tongue, right forewing and right hind leg of four colonies of *Apis indica*, the variations in the biometry of which were reported previously (Ratnam, 1939). The data used for the present paper are the same as those used for the previous one.

Material and Method. The data relate to four colonies of *Apis indica*, which differed in the number of supers each had and in their honey storing abilities. About 50 nectar gathering bees from each hive were collected separately within a period of six days and killed immediately in cyanide bottles. They were numbered serially noting also the number of hive from which each bee was collected. Wings and leg were removed immediately

and kept mounted on separate slides and labelled properly. The heads of the bees were macerated in a five percent solution of potassium hydroxide as described by Alpatov (1929). The tongues were then dissected and kept mounted in glycerine jelly, the slides being labelled properly.

The slides for the right forewing, right hind leg and tongue pertaining to each individual bee were handled together. The following measurements were recorded from these slides: (1) lengths of submentum, mentum and ligula each separately; (2) the proximal and distal length of the right forewing measured separately; (3) the breadth of the right forewing; (4) lengths of femur, tibia and metatarsus taken separately; and (5) the breadth of metatarsus. For purposes of measuring, a Leitz micrometer eyepiece calibrated previously with an object micrometer was used. Initially all measurements were noted in terms of the number of divisions in the micrometer eyepiece. For purposes of computing all correlation coefficients, the metric measurements were not used, but frequencies were tabulated as per the micrometer eyepiece readings only, since the unit of measurement adopted in all cases is identical. The figures presented in Table II below were first arrived at in terms of micrometer readings, and then converted into millimetres.

Appendages. In Table I, the correlations of the lengths of any two of the three appendages, namely tongue, right forewing and right hind leg are presented. It will be seen that the tongue length is not correlated to either the wing length or the leg length. To this extent the observations of Grout (1937) who obtained a significant positive correlation between tongue length and wing length in the European bee does not obtain confirmation in the present study. In the case of leg length, significant positive correlations have been noticed in all the hives except hive IV, and these correlations do not also differ significantly.

TABLE I. Appendages.

Correlation between	Hive No. I	Hive No. II	Hive No. III	Hive No IV
1. Tongue length and length of right forewing.	0·0602 ± 0·0974 (43)	0·0632 ± 0·1007 (45)	0·1631 ± 0·1126 (34)	-0·2396 ± 0·0959 (44)
2. Tongue length and length of right hind leg.	0·1774 ± 0·0974 (45)	0·1420 ± 0·1007 (43)	0·1895 ± 0·1054 (38)	0·0768 (48)
3. Length of right hind leg and length of right forewing.	<u>0·4170 ± 0·0893</u> (39)	<u>0·5495 ± 0·0778</u> (41)	<u>0·5581 ± 0·1105</u> (47)	0·2160 ± 0·0967 (44)

Note:—1. The numbers within brackets indicate the number of pairs of observations (n) from which the correlations have been computed.

2. The correlations underlined are highly significant. The others are not significant.

In Table II the calculated length of right hind leg for a given length of right forewing in the case of hives I to III respectively is furnished for the sake of comparison. These have been computed by the use of the usual regression formula. It is observed that the bees of hive III possess relatively longer legs as compared with those of the other hives. These observations further confirm the previous findings (Ratnam, 1939) wherein judging from the mean leg lengths alone it was stated that the bees of hive III have long legs.

TABLE II. Calculated length of right hind leg for a given length of right forewing (in millimetres).

Wing length.	Leg length		
	Hive No. I	Hive No. II	Hive No. III
7·301	5·490	5·855	6·137
7·371	5·714	6·009	6·220
7·441	5·939	6·150	6·402
7·511	6·164	6·304	6·571
7·582	6·388	6·458	6·753

The Tongue and its parts. In Table III are furnished the coefficients of correlation of the tongue and its parts for the four hives under study. The existence of a very high positive correlation amounting to over 0·9 between the length of ligula and the total tongue length in all the hives indicates that the ligula almost solely contributes to the length of the tongue. Grout (1937) observed in the European bee that the length of proboscis correlates significantly with its integral parts. In the present study, however, the submentum does not correlate at all with the total tongue length while mentum correlates significantly with the tongue length only in the case of hive I. Whether this correlation is merely spurious or whether it should be taken as indicative of an inherent variation in this colony, it is not possible to conclude definitely with the available data, and further work would be necessary. Ligula length is not correlated either with the length of the mentum or of submentum, nor is there any correlation between the latter parts. In a previous communication (Ratnam, 1939) it was pointed out that the mean aggregate length of submentum plus mentum in the four hives showed less variations despite the existence of remarkable variations in the mean lengths of each one of these parts and a conclusion was attempted to be drawn that the bees from those hives having short mentum have relatively long submentum and *vice versa*. The present study indicates that as between the length of submentum and of mentum of each bee no significant correlation exists in any of the hives showing that these dimensions are independant of each other. This perhaps points to the fact that the occurrence of short submentum coupled with a long submentum or *vice versa* noticed in particular hives is a case of inherent variation. A further study with a larger number of hives would alone confirm this observation.

TABLE III. Tongue and its parts.

Correlation between	Hive No. I	Hive No. II	Hive No. III	Hive No. IV
No. of pairs of readings	50	49	50	49
1. Total tongue length and length of				
(a) Submentum	0·1886 ± 0·0921	0·1868 ± 0·0914	−0·1248 ± 0·0939	0 0626
(b) Mentum	0·5265 ± 0·0690	0·2106 ± 0·0921	0 0198	—
(c) Ligula	0·9604 ± 0·0074	0 9781 ± 0·0041	0 9190 ± 0·0146	0 9647 ± 0·0067
(d) Submentum plus mentum	0 5195 ± 0·0697	*0·3228 ± 0·0863	−0·1448 ± 0·0934	−0·0102
2. Length of ligula and length of				
(a) Submentum	0 2199 ± 0 0908	0·0684	−0·2100 ± 0·0888	0·0807
(b) Mentum	0·2480 ± 0 0891	0·2128 ± 0·0920	− 0 0741	0·0820
3. Length of mentum and length of submentum	0·1147 ± 0 0942	0·1398 ± 0·0945	− 0·1303 ± 0·0938	− 0·2577 ± 0·0900

Note:— The correlations underlined are highly significant, while those marked with * are significant only at the 5% level. The others are not significant.

TABLE IV. Wing and its parts.

Correlation between	Hive No. I	Hive No. II	Hive No. III	Hive No. IV
No. of pairs of readings	43	45	34	45
1. Length and breadth of right forewing.	0 0142 ± 0·0747	0·5070 ± 0 0757	0·5032 ± 0·0864	0·3804 ± ± 0 0860
2. Proximal length and distal length	0·2251 ± 0·0971	0·2847 ± 0·0924	*0·3569 ± 0·1009	0·2071 ± 0·0962
3. Proximal length and breadth	0·2795 ± 0·0948	*0·3250 ± 0·0899	0·4822 ± 0 0888	*0·2998 ± 0·0915

Note:—The correlations underlined are highly significant, while those marked with * are significant only at the 5% level. The others are not significant.

Wing and its parts. Alpatov (1929) has arrived at a correlation of 0·593 between the length and width of the right forewing. This is comparable with the highly significant positive correlation amounting to 0·5142, 0·5070, 0·5032 and 0·3804 observed in the present study in the case of the four hives (vide Table IV). The last mentioned correlation does not differ significantly from the others. The proximal and distal lengths of wing do not appear to be correlated and the correlation coefficient of 0·3569 obtained for hive III which is significant only at the 5% level cannot be taken as fully indicative of the existence of any special variation in this hive till further confirmation is available. Further, this hive gives a highly significant positive correlation between the proximal length and breadth of the wing. Hives II and IV have furnished correlation between

the lengths of these parts which are significant only at the 5% level. Further studies may be necessary to conclude if the proximal length of the wing is at all correlated to its breadth and if hive III is a case where exists a variation from the others in respect of this relationship.

The Leg and its parts. The correlation of the dimensions of the leg and its parts namely, femur, tibia and metatarsus are presented in Table V. The lengths of these parts generally exhibit a significant positive correlation to the total length of the leg, and it therefore appears that every one of these parts individually and severally contribute to the relative shortness or otherwise of the leg. Nevertheless as between these parts, the existence or otherwise of a correlation does not seem to be consistent. For instance the length of femur is correlated to the length of metatarsus only in the case of hives I and III while the tibia length is correlated to that of metatarsus only in hive I. The data appear to be too meagre for spotting out any special variation in any colony or for generalising on the existence of relationships between the lengths of these parts.

TABLE V. Leg and its parts.

Correlation between	Hive No. I	Hive No. II	Hive No. III	Hive No. IV
No. of pairs of readings	45	43	41	49
1. Total length of leg and length of				
(a) Femur	0·6519± 0·0578	0·5109± 0·0760	0·5355± 0·0751	*0·3518± 0·0844
(b) Tibia	0·8341± 0·0306	0·7920± 0·0383	0·6317± 0·0631	0·8119± 0·0328
(c) Metatarsus	0·7811± 0·0392	0·7358± 0·0472	0·7049± 0·0530	*0·3458± 0·0848
2. Length of femur and length of				
(a) Tibia	0·1811± 0·0973	0·0450	−0·2050± 0·1009	0·2776± 0·0889
(b) Metatarsus	0·4384± 0·0813	0·2319± 0·0974	0·7696± 0·0430	0·1452± 0·0943
3. Length of tibia and length of metatarsus	0·5641± 0·0686	*0·3413± 0·0909	0·1592± 0·1027	—
4. Breadth of metatarsus and length of				
(a) Femur	*0·3318± 0·0895	0·0135	0·1930± 0·1014	0·1573± 0·0940
(b) Tibia	0·5755± 0·0673	0·1548± 0·1004	0·2084± 0·1008	0·2027± 0·0924
(c) Metatarsus	0·0594	0·2565± 0·0961	0·0335	0·3784± 0·0826
(d) Total leg length	0·2282± 0·0938	0·1334± 0·1011	*0·3545± 0·0921	0·8778± 0·0221

Note:—The correlations underlined are highly significant, while those marked with * are significant only at the 5% level. The others are not significant.

Discussion. Correlation is not "the key to all the secrets of nature. In reality its utility as a statistical method is narrowly limited. The correlation coefficient measures association accurately only when the relation is linear. If non-significant correlations occur in the course of an investigation, interpretations should be made only tentatively". These words of Snedecor (1938) are as true for the present study on the Indian Honey Bee about which so little is known, as they are for any other biological investigation.

The scope of the present paper is indeed very limited. The data under consideration are admittedly too meagre to justify the drawing up of any general conclusions. The correlations obtained perhaps serve more as an indicator to what may be the expected trends and are to some extent different from those obtained by previous workers on the European bee.

The usefulness of correlation coefficients rests not only in spotting out variations as between colony and colony, but also in serving to conclude as to which particular appendages of the bee could be most efficiently used for biometric studies. The utility of the coefficients ultimately rests in their contributing to the isolation of useful races of bees. Our knowledge of such correlations is at present very meagre, and a carefully planned detailed study of the characteristics of bees available in different localities seems to be urgently necessary.

Summary and Conclusions. Some of the correlations in the dimensions of tongue, right forewing and right hind leg determined in four colonies of *Apis indica* are presented in this paper. The data considered are admittedly rather meagre for drawing any general conclusions. Significant positive correlations have been noticed between leg-length and wing-length, but no such correlations have been noticed between tongue-length and wing-length or between leg-length and tongue-length. The length and breadth of wing are highly correlated positively and so also the total length of leg and that of its integral parts. Again the tongue length is also correlated highly with the length of ligula. It is concluded that further work would be necessary to draw general conclusions.

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