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STUDIES IN INTRASPECIFIC VARIATION, XI*.
MORPHOMETRIC CHARACTERS, SEX-RATIOS AND EYE-STRIPES IN THE 1955-
POPULATION OF DESERT LOCUST IN INDIA

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(With 7 Plates and Tables Nos. 1—7C

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I—INTRODUCTION

1. *General*

This is a continuation of a series of studies (Roonwal, 1936 *et seq.*) on the population characteristics of the Desert Locust, *Schistocerca gregaria* (Forsk.), in India in relation to swarming cycles. The present study deals with the morphometrical and other characters of the Desert Locust population for the year 1955 in India, and is based on the collections made during that year (which was the last year of the known Locust Cycle of 1949-55 in India, *vide* also Roonwal, 1954). Misra (1952) has given an account of the initial Kakko concentration of the year 1949 in the Bikaner District, Rajasthan, with which that swarming cycle started. In the present account, various aspects of the 1955-population (the last year of the cycle) with relation to population densities, morphometric characters, eye-stripes and sex-ratios are discussed. The present data has also been compared with those of the other known populations in India as given by Roonwal (1945, 1949, 1952), Roonwal & Nag (1951), Roonwal & Misra (1952), Misra (1952, 1953), and Misra, Nair and Roonwal (1952).

2. *History of the 1955-population*

The year 1955 was a critical year for the Ninth (known) Locust Cycle in India, and the most critical *periods* were those when the individual locust activity was at its minimum, thereby causing an unstability in the phase characters. The evidence of this phase transformation was seen in the variability in eye-stripe composition, proportion of sex-ratios and the abundance of extreme *solitaria* forms (7- and 8- eye-striped) in the earlier and later periods of that year.

The locust population remained fluctuating throughout the year. In the first period of 1955 (January to April), the population density (40—480 locusts per square mile) remained very low and was almost zero in April. Except in January, the samples of which were taken from a swarm (1st January), the remaining individuals were collected singly or from scattered population. The specimens were pink and grey in colour. The weather, on the whole, remained less humid, and the temperature was low to moderate.

In the second period (May to August), there was a sudden increase in the population density owing to the usual seasonal influx of immigrants from the western regions (Sind, Baluchistan, southern Iran and southern Arabia). Depending on the movements of swarms, the density was zero to very fairly high* in various places. The individual samples were collected from fairly high densities and from loose swarms. The population in this period was of a mixed nature, *i.e.*, comprising of individuals both from swarms as well as from the scattered local populations. The specimens were pink and grey in colour. The population resembles intermediates tending towards phase *gregaria*. The weather during the period was generally hot and dry, with gusty hot winds. The population in the third period (September to December) remained low (40—1,333 per square mile), but in two localities (Manaksar-Bajju, Bikaner District ; and Basra, Barmer District) it was moderate (3,600 and 8,400 per square mile respectively). Collections were obtained either from solitary specimens or from relatively concentrated populations.

* The expression used in the data supplied by the Plant Protection Adviser was "countless".

We may regard this period as one in which the population was fizzling out ultimately into phase *solitaria*. The weather during the period was cold, and no swarm activity was reported.

It may be pointed out that the individuals of the first two periods (January-April and May-August) had swarming antecedents.

3. Abbreviations used

The following abbreviations have been used :—

A, Length of eye.

B, Width of eye.

C, Width of head at the genal level.

O, Width of head at the ocular region.

P, Length of pronotum.

H, Height of pronotum.

M, Width of pronotum at the constriction.

K, Broadest width of metasternal interspace.

L, Narrowest width of metasternal interspace.

E, Length of elytron.

W₁, Restricted width of elytron.

F, Length of hind-femur. (This should not be confused with the variance-ratio of F statistic of Fisher.)

S.D.P., Sexual dimorphism percentage.

5-, 6-, 7-, 8-striped, 5—8-eye-striped.

6-*gregaria*, or 6-*greg.*, or 6-*gr.*, Typical 6-eye-striped phase *gregaria* individuals.

6-*solitaria*, or 6-*sol.*, Typical 6-eye-striped phase *solitaria* individuals.

ph. greg., Phase *gregaria* population.

ph. sol., Phase *solitaria* population.

Gr. I, Group I of 1955-population (January-April).

Gr. II, Group II of 1955-population (May-August).

Gr. III, Group III of 1955-population (September-December).

C.V., Coefficient of variation.

S.D., Standard deviation.

S.E., Standard error.

N.S., Not significant.

S, Significant.

*, Significant at 5% level of probability.

**, Significant at 1% level of probability.

***, Significant at 0.1% level of probability.

ex., exs., Number of example(s) or individuals.

Inl. conc., see Kakko Concentration below.

Kakko Concentration (or *Kakko Conc.* or *Inl. conc.*), Initial concentration of locusts in 1949 in Kakko (Rajasthan) which initiated the 1949-55 swarming cycle in India (*vide* Misra, 1952).

Ajmer Swarm (or *Ajmer Sw.*), The swarm in Ajmer (Rajasthan) in 1950 (the second year of the 1949-55 swarming cycle in India (*vide* Roonwal & Misra, 1952).

4. Acknowledgements

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II—MATERIAL AND METHODS

1. General

The material for the present study was collected from various localities in Rajasthan (western India) and southern Punjab during the year 1955. A total of 1,179 specimens were measured. They were obtained from 8 districts of Rajasthan and one of the Punjab, as follows, the number available from each district being given within brackets :—
RAJASTHAN : Jaisalmer (112) ; Jodhpur (110) ; Nagaur (63) ; Barmer (8) ; Churu (104) ; Bikaner (713) ; Sri Ganganagar (27) ; Jhunjhunu (19) ; PUNJAB : Mohindergarh (23).

Measurements.—The morphometrical measurements were taken as given in earlier accounts in this series (Roonwal, 1949 *et seq.* ; and Misra, Nair & Roonwal, 1952). In the present account, three new measurements and two new ratios have also been taken, *viz.*, A and B (length and width respectively of the compound eyes) and W_1 (restricted width of elytron) and the ratios E/C (elytron-length/width of head at the genal level) and E/ W_1 (elytron-length/width of elytron). In addition, the phase differences in the metasternal interspace and its ratio w/n (here called K/L, broadest/narrowest width of the interspace), discovered by Roonwal, 1946) has also been utilised.

Statistical procedure.—Various statistical parameters, namely, mean, standard deviation, coefficient of variation, range and their standard errors, etc., were estimated. Where the sample-size was very small it was not worthwhile to calculate the standard error, and in such cases comparisons with other populations, were also not easy to make. Tests of significance were employed to study the difference between two objects. The tests for homogeneity of estimated variances were performed by constructing the variance-ratio (F) statistic (Fisher, 1925). The mean differences were studied for significance, generally by making use of the Large Sample Normal Theory test (Fisher, 1925). Where sample sizes were small and standard deviations equal, the *t*-statistic ("Student", 1908) was computed. In samples having different variances, the more exact test due to Behrens (1925 ; also *vide* Fisher, 1941) was employed. The standard error for Sexual Dimorphism Percentage (S.D.P.) was calculated following the formula employed for the standard error of quotients, ignoring correlation. The difference in Sexual Dimorphism Percentage and in coefficient of variation was also tested for significance by using the Large Sample Normal Theory test.

2. Statistical characteristics of the 1955-population

Random sampling and its reliability.—No selection was made while collecting the samples from the field, and all collections were random. The smallest representative populations were collected between the two periods January-April and September-December, with sample range 1-38 and 1-59 respectively. The maximum number of samples (range 110-335) was collected between May-August.

Homogeneity of the population.—The present population is a homogeneous one in the sense that : (a) The entire collection was made in a single year ; and (b) from contiguous localities of the desert region of Rajasthan and southern Punjab (India).

III—EYE-STRIPE COMPOSITION AND SEX-RATIOS

1. Groupings of the random samples (Tables 1 and 2)

For statistical analysis the 1,179 specimens of the 1955-population were grouped into three natural groups (corresponding with the three periods of the year) as follows, based on considerations of the chronological position of the generation and the well-known seasonal periodicity and immigrations that are known to occur in the Desert Locust in western India :—

(i) *Group I* (44 specimens).—First-generation individuals. Collected between the period January-April, from the over-wintered swarms of 1954 which over-stayed in Rajasthan.

(ii) *Group II* (948 specimens).—Second-generation individuals. Collected during the period May-August when fresh incursions started invading India from the western regions. Population very high.

(iii) *Group III* (150 specimens).—Collected during the period September-December when solitary breeding on a small scale was reported from various "pockets" in Rajasthan.

2. *Eye-stripes*

(Tables 1 and 2)

Except two individuals which had 5 eye-stripes and two which had 8 eye-stripes, the remainder were either 6- or 7-striped. The eye-stripe composition in the three population-groups is discussed below.

(i) *6 and 7 eye-stripes.*—

The proportion of the 6- and 7-eye-striped individuals was as follows :—

Group	Percentage of :		Remarks
	6-striped	7-striped	
I (44 exs.)	93.0±4	7.0±4	—
II (948 exs.)	98.9±0.3	1.1±0.3	Also 2 exs. 5-striped.
III (150 exs.)	56.0±4	44.0±4	Also 2 exs. 8-striped.

(ii) *5 eye-stripes.*—

In Group II, two 5-striped individuals, both females, were found and had the following collection data : (i) Reg. No. 545, ♀, Kharda Rajeran, 14-vii-55. (ii) Reg. No. 677, ♀, Siasar, 9-viii-55. Their morphometry given in the above order, was as follows :—

Size of body-parts (mm.)	Ratios
A, 3.75, 3.75	E/F, 2.37, 2.26
B, 2.25, 2.50	E/W ₁ , 7.99, 7.81
O, 6.5, 6.4	E/C, 7.67, 7.48
C, 7.5, 7.1	F/C, 3.24, 3.31
P, 10.0, 9.8	P/C, 1.33, 1.38
H, 8.2, 8.0	M/C, 0.813, 0.873
M, 6.1, 6.2	H/C, 1.09, 1.13
E, 57.5, 53.2	K/L, 1.25, 1.25
W ₁ , 7.2, 6.8	
K, 1.25, 1.25	
L, 1.0, 1.0	
F, 24.3, 23.5	

(iii) *8 eye-stripes.*—

In Group III, two 8 eye-striped individuals, both females were found, and had the following collection data : (i) Reg. No. 771, ♀, Kumbarwala,

15-ix-55. (ii) Reg No. 774, ♀, Pilab, 16-ix-55. Their morphometry given in the above order, was as follows :—

Size of body-parts (mm.)	Ratios
A, 4.75, 4.50	E/F, 1.98, (?)
B, 3.0, 3.0	E/W ₁ , 7.55, (?)
O, 7.4, 7.4	E/C, 8.02, (?)
C, 8.0, 8.0	F/C, 4.05, (?)
P, 12.0, 12.6	P/C, 1.50, 1.58
H, 10.2, 10.6	M/C, 0.925, 0.950
M, 7.4, 7.6	H/C, 1.28, 1.32
E, 64.2, (?)	K/L, 1.20, 1.25
W ₁ , 8.5, 8.6	
K, 1.50, 1.25	
L, 1.25, 1.0	
F, 32.4, (?)	

(iv) *An asymmetrical eye.*—

In Group II, a female was found (Bhanotar, 1959) which was asymmetrical—the left eye had 7 and the right one 8 stripes. In the 8-striped eye the two most posterior stripes are separated in the top half, but fused together for the rest of the length. The morphometry as well as actual field population indicate that this specimen is a phase *solitaria* one.

3. Sex-ratios

(Tables 1 and 2)

Irrespective of the eye-stripes, the lumped sex-ratios in three population-groups were as follows :—

Group	Sex-ratio (%)	
	Male	Female
I	59	41
II	47	53
III	62	68

The distribution of the sex-ratios in the various eye-stripe groups given below :—

Group	Sex-ratio (%) (with S. E.)			
	6-eye-striped		7-eye-striped	
I	♂ 56 ± 7	♀ 44 ± 7	♂ 100	♀ 0
II	♂ 47.5 ± 2	♀ 52.5 ± 2	♂ 9 ± 9	♀ 91 ± 9
III .	♂ 84 ± 4	♀ 16 ± 4	♂ 33 ± 5	♀ 67 ± 5

4. Discussion

The phase-position may now be discussed in relation to the actual population as well as the Hypotheses of Roonwal (1945). In Groups I and II the high proportion (above 80%) of 6-eye-striped individuals as well as the near 50% sex-ratio among the 6-eye-striped individuals indicate the *gregaria* nature of the population ; this is supported by other morphometrical measurements.

In Group III the low proportion (much below 80%) of the 6-eye-striped individuals and the high proportion of males (much above 50%) in the 6-eye-striped forms indicate a phase *solitaria* facies. This is supported by the occurrence of two 8-eye-striped forms (both females) which is an extreme *solitaria* feature, as well as by other morphometrical characters.

Position of 5-eye-striped individuals.—Individuals with 5 eye-stripes have been recorded in laboratory breedings earlier. But the first record of their occurrence in nature is by Misra (1952, pp. 101-102) who found a single 5-striped form (a male) in the initial Kakko (Rajasthan) concentration of 1949 which initiated the 1949-55 swarming cycle in India. Due to paucity of data the phase-position of the 5-striped form has remained doubtful. Roonwal (1954, p. 516) tentatively placed it in the *solitaria* phase, and remarked as follows :—

“The position of the 5-striped forms is not quite clear. Misra (1952) has reported the first and only example of a 5-striped form taken wild in 1949 which was the first year of a new swarming cycle ; previous records are all from breeding cages. Tentatively I am inclined to place the 5-striped forms with the *solitaria* group and as having evolved from the ‘basic type’ (6-striped *solitaria*) rather than from the 6-striped *gregaria*.”

In view of other morphological characters and their ratios in 5-striped females of the 1955-population and considering the period of its occurrence—in the high initial *Kakko Concentration of 1949* (Misra, 1952) and in the almost swarming period of Group II (present account)—it would appear that the 5-striped forms are in some manner related with the most unstable and critical periods of phase-transformation when the equilibrium of stability in the various biometrical characters, sex-ratios and eye-stripe composition are most shaken in a locust cycle.

IV—MORPHOMETRY (A)—SIZE OF BODY-PARTS

1. General

The following twelve morphometrical characters and their ratios were studied for the three Groups (Gr. I—III) of the 1955-population (the methods of measurements being largely those which will be found defined and illustrated in Rao (1960, pp. 295—300) :—

1. Length of compound eye including the ocular sclerite (A).
2. Width of compound eye including the ocular sclerite (B).
3. Width of head at the ocular region (O).
4. Maximum width of head at the genal level (C).
5. Width of pronotum at the constriction (M).
6. Length of pronotum at the keel (P).

7. Maximum height of pronotum in the distal half (prozona) (H).
8. Broadest width of metasternal interspace (K).
9. Narrowest width of metasternal interspace (L).
10. Length of elytron, from the hollow of the angle formed by costa-subcosta veins to the distal tip of the elytron (E).
11. Restricted width of elytron (in the level of the apex of the >— shaped medio-cubital cross vein, lying roughly about the middle of the elytron-length) (W_1).
12. Length of hind-femur (F).

The following eight ratios of the above mentioned characters were also studied :—E/F, E/ W_1 , E/C, F/C, P/C, M/C, H/C and K/L.

The Sexual Dimorphism Percentage (S. D. P.), first utilised by Roonwal (1949) and subsequently used by Misra (1952), in a population was calculated by the formula :—

$$\left[\left(\frac{\text{Value in } \text{♀}}{\text{Value in } \text{♂}} - 1 \right) \times 100 \right]$$

For inter-population comparison, the three Groups, I—III, of the 1955-population are first compared among themselves (Tables 3A-D), and then each one of them with the following other populations in India in various degrees of phase-transformations whose data are available in the literature (Tables—4A-C) :—

(i) 6-striped males and females of typical *phase solitaria*, 1936-47 (Roonwal, 1949).

(ii) 7-striped males and females of typical *phase solitaria*, 1936-47 (Roonwal, 1949 ; and Roonwal & Nag, 1951).

(iii) 6-striped males and females of typical *phase gregaria*, 1936-47 (Roonwal, 1949 ; and Roonwal & Nag, 1951).

(iv) 6-striped males and females of *Kakko Concentration*, 1949 (first year of the 1949-55 swarming cycle in India). (Misra, 1952).

(v) 7-striped females of *Kakko Concentration*, 1949 (first year of 1949-55 swarming cycle in India). (Misra, 1952).

(vi) 6-striped males and females of *Ajmer Swarm*, 1950 (second year of the 1949-55 swarming cycle in India). (Roonwal & Misra, 1952).

(vii) Groups I, II and III of the 1955-population (last year of the 1949-55 cycle in India). (Present account).

2. Length of compound eye (A)

(Tables 3A-D)

(a) Mean length (in mm.)

The mean length of eye (A) varies, as follows :—

Group (and eye-stripes)	Males	Females
1. Gr. I (6)*	3.76±0.04	3.93±0.03
2. Gr. I (7)*	3.83±0.08	—
3. Gr. II (6)*	3.81±0.01	3.99±0.01
4. Gr. II (7)*	3.75	4.25±0.06
5. Gr. III (6)*	3.88±0.02	4.06±0.09
6. Gr. III (7)*	4.00±0.03	4.41±0.03

* Throughout this paper the figure in brackets, e.g., “(6)”, “(7)”, indicates the number of eye-stripes.

(b) *Inter-group comparison* (Table 3D)

(i) *6-striped males and females.*—*Males* : The values in Gr. I (3.76 ± 0.04 mm.) and Gr. II (3.81 ± 0.01 mm.) are significantly lower than in Gr. III (3.88 ± 0.02 mm.) at the 5 per cent and 1 per cent levels of probability but not so at the 0.1 per cent level. The values in Groups I and II are not significantly different from each other. *Females* : The values in Groups I, II and III are not significantly different from each other.

(ii) *7-striped males and females.*—*Males* : The value in Gr. I (3.83 ± 0.08) is not significantly different from that in Gr. III (4.00 ± 0.03). In Gr. II only one 7-striped male occurred. *Females* : The value in Gr. II (4.25 ± 0.06) is significantly lower than in Gr. III (4.41 ± 0.03) at the 5 per cent level only and not so at the 1 per cent and 0.1 per cent levels. No females occurred in Gr. I.

(c) *Inter-sex comparison*

In each Group, the mean value (in mm.) in males is significantly lower than in females, as follows :—

Group (and eye-stripes)	Males	Females	Difference
1. Gr. I (6)	3.76 ± 0.04	3.93 ± 0.03	0.17 ± 0.05
2. Gr. II (6)	3.81 ± 0.01	3.99 ± 0.01	0.18 ± 0.013
3. Gr. III (6)	3.88 ± 0.02	4.06 ± 0.09	0.18 ± 0.09
4. Gr. III (7)	4.00 ± 0.03	4.41 ± 0.03	0.41 ± 0.04

(d) *Inter-population comparison*

No comparison could be made due to lack of data in other populations.

(e) *Sexual Dimorphism Percentage*

The S.D.P. ($\pm$ S.E.) in the 1955-population varies as follows :—

Gr. I (6)	4.52 ± 1.36
Gr. II (6)	4.72 ± 0.35
Gr. II (7)	13.33
Gr. III (6)	4.64 ± 2.29
Gr. III (7)	10.25 ± 1.19

Within the same eye-stripe category, the values in Gr. I(6), Gr. II (6) and Gr. III (6) are not significantly different from one another, but they are significantly lower than in Gr. III (7) (10.25 ± 1.19) at all levels.

3. *Width of compound eye (B)*
(Tables 3A-D)

(a) *Mean width (in mm.)*

The mean width of eye (B) varies as follows :—

Group (and eye-stripes)	Males	Females
1. Gr. I (6)	2.40±0.03	2.47±0.02
2. Gr. I (7)	2.50±0.0	—
3. Gr. II (6)	2.46±0.004	2.54±0.01
4. Gr. II (7)	2.50	2.70±0.05
5. Gr. III (6)	2.54±0.015	[2.65±0.06
6. Gr. III (7)	! 2.65±0.026	[2.88±0.02

(b) *Inter-group comparison (Table 3D)*

(i) *6-striped males and females.*—*Males* : The values in Gr. I (2.40±0.03 mm.) and Gr. II (2.46±0.004) are significantly lower than in Gr. III (2.54±0.015) at all levels of probability. Between Groups I and II the value in the latter is significantly lower at the 5 per cent level only. *Females* : The value in Gr. I (2.47±0.02) is significantly lower than in Gr. II at all levels and from Gr. III at the 5 per cent level only. The value in Gr. II (2.54±0.01) is not significantly different from that in Gr. III (2.65±0.06) at all levels.

(ii) *7-striped males.*—There is no significant difference between the three groups.

(iii) *7-striped females.*—The value in Gr. II (2.70±0.05) is significantly lower than in Gr. III (2.88±0.02) at the 5 per cent and 1 per cent levels only.

(c) *Inter-sex comparison*

In each Group, the mean value (in mm.) in males is significantly lower than in females, as follows :—

Group (and eye-stripes)	Males	Females	Difference
1. Gr. I (6)	2.40±0.03	2.47±0.02	0.07±0.04
2. Gr. II (6)	2.46±0.004	2.54±0.01	0.08±0.01
3. Gr. III (6)	2.54±0.015	2.65±0.06	0.11±0.07
4. Gr. III (7)	2.65±0.03	2.88±0.02	0.23±0.03

(d) *Inter-population comparison*

No comparison could be made due to lack of data in other populations.

(e) *Sexual Dimorphism Percentage*

The S.D.P. ($\pm$ S.E.) in the 1955-population varies as follows :—

Gr. I (6)	2.92 $\pm$ 1.52
Gr. II (6)	3.25 $\pm$ 0.35
Gr. II (7)	8.00
Gr. III (6)	4.33 $\pm$ 2.60
Gr. III (7)	8.68 $\pm$ 1.30

In the 6-eye-striped category, there is no significant difference between Groups I—III. The values in Grs. I (6) and II (6) are significantly lower than in Gr. III (7) at all levels, but there is no significant difference between Gr. III (6) and Gr. III (7).

4. *Width of head at the ocular region (O)*
(Tables 3A-D)

(a) *Mean length (in mm.)*

The width of head at the ocular region (O) varies as follows :—

Group (and eye-stripes)	Males	Females
1. Gr. I (6)	6.30 $\pm$ 0.05	6.71 $\pm$ 0.07
2. Gr. I (7)	6.27 $\pm$ 0.09	—
3. Gr. II (6)	6.40 $\pm$ 0.01	6.79 $\pm$ 0.01
4. Gr. II (7)	6.10	6.94 $\pm$ 0.10
5. Gr. III (6)	6.24 $\pm$ 0.025	6.75 $\pm$ 0.013
6. Gr. III (7)	6.46 $\pm$ 0.05	7.14 $\pm$ 0.05

(b) *Inter-group comparison (Table 3D)*

(i) *6-striped males and females.*—*Males* : The mean value in Gr. I (6.30 $\pm$ 0.05) is not significantly different from those in Gr. II (6.40 $\pm$ 0.01) and Gr. III (6.24 $\pm$ 0.025 mm.) at all levels of probability. The value in Gr. II is significantly higher than in Gr. III at all levels. *Females* : The value in Gr. I (6.71 $\pm$ 0.07) is not significantly different from those in Gr. II (6.79 $\pm$ 0.01) and Gr. III (6.75 $\pm$ 0.013) at all levels of probability. The value in Gr. II is significantly higher than in Gr. III at the 5 per cent level only but not significantly different at the 1 per cent and 0.1 per cent levels.

(ii) *7-striped males and females.*—*Males* : The value in Gr. I (6.27 $\pm$ 0.09) is not significantly different from that in Gr. III (6.46 $\pm$ 0.05) at all levels. Only one male occurred in Gr. II. *Females* : The value in Gr. II (6.94 $\pm$ 0.10) is not significantly different from that in Gr. III (7.14 $\pm$ 0.05) at all levels of probability. No females occurred in Gr. I.

(c) *Inter-sex comparison*

In each Group, the mean value (in mm.) in males is significantly lower than in females, as follows :—

Group (and eye-stripes)	Males	Females	Difference
1. Gr. I (6)	6.30±0.05	6.71±0.07	0.41±0.08
2. Gr. II (6)	6.40±0.01	6.79±0.01	0.39±0.02
3. Gr. III (6)	6.24±0.02	6.75±0.013	0.51±0.14
4. Gr. III (7)	6.46±0.05	7.14±0.05	0.68±0.07

(d) *Inter-population comparison*

No comparison could be made due to lack of data in the other populations.

(e) *Sexual Dimorphism Percentage*

The S.D.P. (±S.E.) in the 1955-population varies as follows :—

Gr. I (6)	.	6.51±1.36
Gr. II (6)	.	6.09±0.31
Gr. II (7)	.	13.77
Gr. III (6)	.	8.17±2.19
Gr. III (7)	.	10.53±1.16

In the 6-eye-striped category, the values in Groups I—III are not significantly different from one another. The values in Gr. I (6) and Gr. II (6) are significantly lower than in Gr. III (7) at all levels, but Gr. III (6) and Gr. III (7) are not different from each other.

5. Width of head at the genal level (C)

(Plates 2, 5 and 7 ; and Tables 3A-D & 4A-C)

(a) *Mean length (in mm.)*

The width of head at the genal level (C) varies as follows :—

Group (and eye-stripes)	Males	Females
1. Gr. I (6)	7.31±0.07	7.83±0.07
2. Gr. I (7)	6.63±0.14	—
3. Gr. II (6)	7.20±0.02	7.88±0.02
4. Gr. II (7)	6.30	7.63±0.15
5. Gr. III (6)	6.55±0.04	7.42±0.16
6. Gr. III (7)	6.67±0.05	7.70±0.05

(b) *Inter-group comparison* (Table 3D)

(i) *6-striped males and females*.—*Males* : The mean value in Gr. I (7.31 ± 0.07) and Gr. II (7.20 ± 0.02) are significantly higher than in Gr. III (6.55 ± 0.04) at all levels. Between Groups I and II, the value in the latter is significantly higher at all levels. *Females* : The value in Groups I and II (7.83 ± 0.07 and 7.88 ± 0.02 respectively) are significantly higher, at the 5 per cent and 1 per cent level, than in Gr. III (7.42 ± 0.16). The values in Groups I and II are not significantly different from each other at all levels.

(ii) *7-striped males and females*.—*Males* : The value in Gr. I (6.63 ± 0.14) is not significantly different from that in Gr. III (6.67 ± 0.05). Only one male occurred in Gr. II. *Females* : The value in Gr. II (7.63 ± 0.15) is not significantly different from that in Gr. III (7.70 ± 0.05). No females occurred in Gr. I.

(c) *Inter-sex comparison*

In each Group, the mean value (in mm.) in males is significantly lower than in females, as follows :—

Group (and eye-stripes)	Males	Females	Difference
1. Gr. I (6)	7.31 ± 0.07	7.83 ± 0.07	0.52 ± 0.03
2. Gr. II (6)	7.20 ± 0.02	7.88 ± 0.02	0.67 ± 0.02
3. Gr. III (6)	6.55 ± 0.04	7.42 ± 0.16	0.87 ± 0.17
4. Gr. III (7)	6.67 ± 0.05	7.70 ± 0.05	1.05 ± 0.07

(d) *Inter-population comparison* (Tables 4A-C)

The mean values in Groups I, II and III compared with the mean values of other populations are as follows :—

(i) *6-striped males*.—The mean value in Gr. I (7.31 ± 0.07) is significantly lower than those in *6-gregaria* (7.55 ± 0.04) and the *Ajmer Swarm* (7.53 ± 0.08), but is significantly higher than in the *Kakko Concentration* (6.60 ± 0.03 mm.). Similarly, the value in Gr. II (7.20 ± 0.02 mm.) is significantly lower than in *6-gregaria* and *Ajmer Swarm*, but is higher than in the *Kakko Concentration* at all levels. The value in Gr. III (6.55 ± 0.04 mm.) is not significantly different from that in the *Kakko Concentration*, but is significantly lower from other populations.

(ii) *6-striped females* (Grs. I, II and III).—The values in Gr. I (7.83 ± 0.07) and Gr. II (7.88 ± 0.02) are not significantly different from those in *6-gregaria* (7.89 ± 0.07) and the *Ajmer Swarm* (7.90 ± 0.25) but are significantly higher than in the *Kakko Concentration* (7.41 ± 0.04). The value in Gr. III (7.42 ± 0.16) is not significantly different from those in the *Kakko Concentration* and the *Ajmer Swarm*, but is significantly lower than in *6-gregaria* at the 5 per cent and 1 per cent level of probability.

(e) *Sexual Dimorphism Percentage*

The S.D.P. ($\pm$ S.E.) of the 1955- and other populations varies as follows :—

1955-population		Other populations	
Gr. I (6)	7.11 $\pm$ 1.46	6-greg.	4.50 $\pm$ 1.50
Gr. II (6)	9.44 $\pm$ 0.40	Ajmer Sw. (1950)	4.91
Gr. II (7)	21.11	Kakko Conc. 1949	12.27 $\pm$ 0.84
Gr. III (6)	13.28 $\pm$ 2.62		
Gr. III (7)	15.44 $\pm$ 1.18		

Within the three Groups for 1955, in 6-eye-striped individuals the value in Gr. I is significantly lower from those in Gr. III at the 5 per cent level, and from the *Kakko Concentration* at the 5 per cent and 1 per cent levels. The value in Gr. II is significantly higher than in 6-gregaria but is significantly lower than in the *Kakko Concentration*. The value in Gr. III is not significantly different from that in the *Kakko Concentration* but is higher than in 6-gregaria. In the 1955-population, the values in Gr. I (6) and Gr. II (6) are significantly lower than in Gr. III (7), but Gr. III (6) is not different from Gr. III (7).

6. *Width of pronotum at the constriction (M)*
(Tables 3A-D)

(a) *Mean length (in mm.)*

The width of the head at constriction (M) varies as follows :—

Group (and eye-stripes)	Males	Females
1. Gr. I (6)	5.80 $\pm$ 0.05	6.52 $\pm$ 0.07
2. Gr. I (7)	5.80 $\pm$ 0.15	—
3. Gr. II (6)	5.91 $\pm$ 0.01	6.63 $\pm$ 0.02
4. Gr. II (7)	5.70	6.78 $\pm$ 0.12
5. Gr. III (6)	5.84 $\pm$ 0.03	6.67 $\pm$ 0.15
6. Gr. III (7)	5.98 $\pm$ 0.05	7.09 $\pm$ 0.04

(b) *Inter-group comparison (Table 3D)*

(i) *6-striped males and females.*—*Males* : The value in Gr. I (5.80 $\pm$ 0.05) is significantly lower than in Gr. II (5.91 $\pm$ 0.01) at the 5 per cent level only, and is not significantly different from that in Gr. III (5.84 $\pm$ 0.03 mm.) at all levels. Between Groups II and III, the value

in the former is significantly higher at the 5 per cent level only. *Females* : The values in the three Groups are not significantly different from one another at all levels.

(ii) *7-striped males and females*.—*Males* : The value for males in Gr. I (5.80 ± 0.15) is not significantly different from that in Gr. III (5.98 ± 0.05). Only one male occurred in Gr. II. *Females* : The value in Gr. II (6.78 ± 0.12) is significantly lower than in Gr. III (7.09 ± 0.04) at the 5 per cent level only. No females occurred in Gr. II.

(c) *Inter-sex comparison*

In all the Groups, the mean value (in mm.) in males is significantly lower than in females, as follows :—

Group (and eye-stripes)	Males	Females	Difference
1. Gr. I (6)	5.80 ± 0.05	6.52 ± 0.07	0.72 ± 0.08
2. Gr. II (6)	5.91 ± 0.01	6.63 ± 0.02	0.72 ± 0.02
3. Gr. III (6) .	5.84 ± 0.03	6.67 ± 0.15	0.83 ± 0.15
4. Gr. III (7) . .	5.98 ± 0.05	7.09 ± 0.04	1.11 ± 0.07

(d) *Inter-population comparison*

The mean values in Groups I—III compare with *6-gregaria* (data for other populations are not available) as follows :—

(i) *6-striped males*.—The mean value in Gr. I (5.80 ± 0.05) is significantly lower than in *6-gregaria* (5.86 ± 0.04) at the 5 per cent and 1 per cent level only, but the values in Gr. II (5.91 ± 0.01) and Gr. III (5.84 ± 0.03) are not significantly different from that in *6-gregaria* at all levels.

(ii) *6-striped females*.—The values in Gr. I (6.52 ± 0.07) and Gr. III (6.67 ± 0.15) are not significantly different from that in *6-gregaria* (6.36 ± 0.08), but the value in Gr. II (6.63 ± 0.02) is significantly higher than in *6-gregaria* at all levels.

(e) *Sexual Dimorphism Percentage*

The S.D.P. ($\pm$ S.E.) in the 1955-population varies as follows :—

Gr. I (6)	12.41 ± 1.56
Gr. II (6)	12.18 ± 0.40
Gr. II (7)	18.95
Gr. III (6)	14.21 ± 2.58
Gr. III (7)	18.56 ± 1.21

Within the 6-striped category, Groups I, II and III are not significantly different from one another. The values in Gr. I (6) and Gr. II (6) are significantly lower than in Gr. III (7), but Gr. III (6) is not different from Gr. III (7).

7. Length of pronotum (P)
(Plates 2 & 5 ; and Tables 3A-D & 4A-C)

(a) Mean length (in mm.)

The length of pronotum (P) varies as follows :—

Group (and eye-stripes)	Males	Females
1. Gr. I (6)	9.66±0.11	10.47±0.11
2. Gr. I (7)	9.67±0.44	—
3. Gr. II (6)	9.94±0.02	10.86±0.03
4. Gr. II (7)	10.00	11.50±0.29
5. Gr. III (6)	9.86±0.06	10.76±0.29
6. Gr. III (7)	10.20±0.08	11.90±0.10

(b) Inter-group comparison (Table 3D)

(i) *6-striped males and females.*—*Males* : The mean values in Gr. I (9.66±0.11) and Gr. II (9.94±0.02) are not significantly different from that in Gr. III (9.86±0.06) at all levels. But the value in Gr. I is significantly lower than in Gr. II at the 5 per cent level only. *Females* : The values in Gr. I (10.47±0.11) and Gr. II (10.86±0.03) are not significantly different from those in Gr. III (10.76±0.29). But the value in Gr. I is significantly lower than that in Gr. II at all levels.

(ii) *7-striped males and females.*—*Males* : The value in Gr. I is not significantly different from that in Gr. III at all levels. Only one male occurred in Gr. II. *Females* : The value in Gr. II is not significantly different from that in Gr. III. No females occurred in Gr. I.

(c) Inter-sex comparison

In each Group the mean value (in mm.) in male is significantly lower than in females, as follow :

Group (and eye-stripes)	Males	Females	Difference
1. Gr. I (6)	9.66±0.11	10.47±0.11	0.81±0.08
2. Gr. II (6)	9.94±0.02	10.86±0.03	0.92±0.04
3. Gr. III (6)	9.86±0.06	10.76±0.29	0.90±0.30
4. Gr. III (7)	10.20±0.08	11.90±0.10	1.75±0.13

(d) Inter-population comparison (Tables 4A-C)

The mean values in Groups I, II and III compare with those in other populations as follows :—

(i) *6-striped males.*—The value in Gr. I (9.66±0.11) is not significantly different from those in *6-gregaria* (9.87±0.08) and the *Kakko Concentration* (9.76±0.05), but it is significantly lower than in the

Ajmer Swarm (10.01 ± 0.11) at the 5 per cent level only. The value in Gr. II (9.94 ± 0.03) is not significantly different from those in *6-gregaria* and the *Ajmer Swarm*, but is significantly higher than in the *Kakko Concentration* at the 5 per cent and 1 per cent levels. The value in Gr. III (9.86 ± 0.06) is not significantly different from all other populations.

(ii) *6-striped females*.—The values in Groups I (10.47 ± 0.11), II (10.86 ± 0.03) and III (10.76 ± 0.29) are not significantly different from those in the *Ajmer Swarm* (10.78 ± 0.34). The value in Gr. I is significantly lower than in the *Kakko Concentration* (10.94 ± 0.09), but not significantly different from that in *6-gregaria* (10.49 ± 0.13). The value in Gr. II is not significantly different from that in the *Kakko Concentration*, but is significantly higher than in *6-gregaria*. The value in Gr. III is not significantly different from either *6-gregaria* or the *Kakko Concentration* at all levels.

(e) *Sexual Dimorphism Percentage*

The S.D.P. ($\pm$ S.E.) in the 1955-Groups and other populations varies as follows :—

1955-population		Other populations	
Gr. I (6)	8.38 ± 1.74	<i>6-greg.</i>	6.28 ± 1.60
Gr. II (6)	9.26 ± 0.44	<i>Ajmer Sw.</i> (1950)	7.69
Gr. II (7)	15.09	<i>Kakko Conc.</i> (1949)	12.09 ± 1.09
Gr. III (6)	9.13 ± 3.06		
Gr. III (7)	15.67 ± 1.38		

In the 1955-population Groups I—III in the 6-striped category are not significantly different from one another, nor from the “other populations”, except that Gr. II (6) is lower than the *Kakko Concentration* at the 5 per cent level. The values in Gr. I (6) and Gr. II (6) are lower than in Gr. III (7) at all levels, but Gr. III (6) does not differ from Gr. III (7).

8. *Height of pronotum (H)* (Tables 3A-D)

(a) *Mean length (in mm.)*

The height of pronotum (H) varies as follows :—

Group (and eye-stripes)	Males	Females
1. Gr. I (6)	8.03 ± 0.08	8.70 ± 0.11
2. Gr. I (7)	8.13 ± 0.26	—
3. Gr. II (6)	8.14 ± 0.02	8.98 ± 0.03
4. Gr. II (7)	7.70	9.37 ± 0.21
5. Gr. III (6)	8.26 ± 0.04	9.10 ± 0.27
6. Gr. III (7)	8.40 ± 0.09	9.90 ± 0.07

(b) *Inter-group comparison* (Table 3D)

(i) *6-striped males and females*.—*Males* : Within the groups, the values in Groups I—III are not significantly different from one another at all levels. *Females* : The value in Gr. I (8.70 ± 0.11) is significantly lower than in Gr. II (8.98 ± 0.03) at the 5 per cent level only ; and both these values are not significantly different from that in Gr. III (9.10 ± 0.27).

(ii) *7-striped males and females*.—*Males* : The value in Gr. I is not significantly different from that in Gr. III at all levels. Only one male occurred in Gr. II. *Females* : The value in Gr. II (9.37 ± 0.21) is significantly lower than in Gr. III (9.90 ± 0.07) at the 5 per cent level only. No females occurred in Gr. I.

(c) *Inter-sex comparison*

In each Group the mean value (in mm.) in male is significantly lower than in females, as follows :—

Group (and eye-stripes)	Males	Females	Difference
1. Gr. I (6) . .	8.03 ± 0.08	8.70 ± 0.11	0.67 ± 0.13
2. Gr. II (6) . .	8.14 ± 0.02	8.98 ± 0.03	0.84 ± 0.03
3. Gr. III (6) .	8.20 ± 0.04	9.10 ± 0.27	0.93 ± 0.28
4. Gr. III (7) .	8.40 ± 0.09	9.90 ± 0.07	1.58 ± 0.11

(d) *Inter-population comparison*

The mean values in Groups I—III compare with those of *6-gregaria* as follows (no data are available for other populations) :—

(i) *6-striped males*.—The values in Gr. I (8.03 ± 0.08), Gr. II (8.14 ± 0.02) and Gr. III (8.20 ± 0.04) are significantly lower than in *6-gregaria* (8.39 ± 0.05) at all levels.

(ii) *6-striped females*.—The values in Gr. I (8.70 ± 0.11), Gr. II (8.98 ± 0.03) and Gr. III (9.10 ± 0.27) are not significantly different from those in *6-gregaria* (8.92 ± 0.10) at all levels.

(e) *Sexual Dimorphism Percentage*

The S.D.P. ($\pm$ S.E.) of the 1955-Groups is as follows :—

Gr. I (6)		8.34 ± 1.74
Gr. II (6)		10.32 ± 0.43
Gr. II (7)		21.69
Gr. III (6) .		10.98 ± 3.37
Gr. III (7) .		17.86 ± 1.53

The values in Gr. I (6) (8.34 ± 1.74) ; Gr. II (6) (10.32 ± 0.43) and Gr. III (6) (10.98 ± 3.37) are not significantly different from one another. Inter-stripes, the values in Gr. I (6) and Gr. II (6) are significantly lower than in Gr. III (7) (17.86 ± 1.53), but the value in Gr. III (6) is not significantly different from Gr. III (7).

9. *Broadest width of metasternal interspace (K)*
(Tables 3A-D)

(a) *Mean values (in mm.)*

The mean value of K varies as follows :—

Group (and eye-stripes)	Males	Females
1. Gr. I (6)	0.772 ± 0.015	1.167 ± 0.035
2. Gr. I (7)	0.750 ± 0.144	—
3. Gr. II (6)	0.791 ± 0.006	1.244 ± 0.006
4. Gr. II (7)	0.750	1.225 ± 0.058
5. Gr. III (6)	0.722 ± 0.013	1.229 ± 0.021
6. Gr. III (7)	0.750 ± 0.017	1.267 ± 0.021

(b) *Inter-group comparison* (Table 3D)

(i) *6-striped males and females.*—*Males* : The values for Gr. I (0.772 ± 0.015 mm.) and Gr. II (0.791 ± 0.006 mm.) are not significantly different from each other, but both these are significantly higher than those in Gr. III (0.722 ± 0.013 mm.) at all levels. *Females* : The value for Gr. I (1.167 ± 0.035 mm.) is significantly lower than those in Gr. II (1.244 ± 0.006 mm.) and Gr. III (1.229 ± 0.021 mm.) at the 5 per cent level only. The values in Groups II and III are not significantly different from each other.

(ii) *7-striped males and females.*—*Males* : The value for Gr. I (0.750 ± 0.144 mm.) is not significantly different from that in Gr. III (0.750 ± 0.017 mm.). Only one male occurred in Gr. II. *Females* : The values for Gr. II (1.225 ± 0.058 mm.) and Gr. III (1.267 ± 0.021 mm.) are not significantly different from each other. No females occurred in Gr. I.

(c) *Inter-sex comparison*

Within each Group, the mean value (in mm.) in males is significantly lower than in females, as follows :—

Group (and eye-stripes)	Males	Females	Difference
1. Gr. I (6)	0.772 ± 0.015	1.167 ± 0.035	0.395 ± 0.037
2. Gr. II (6)	0.791 ± 0.006	1.244 ± 0.006	0.453 ± 0.009
3. Gr. III (6)	0.722 ± 0.013	1.229 ± 0.021	0.507 ± 0.025
4. Gr. III (7)	0.750 ± 0.017	1.267 ± 0.021	0.617 ± 1.267

(d) *Sexual Dimorphism Percentage*

The values for S. D. P. ($\pm$ S.E.) for the 1955-population vary as follows :—

Gr. I (6)	51.19 $\pm$ 2.43
Gr. II (6)	57.34 $\pm$ 0.53
Gr. II (7)	63.33
Gr. III (6)	70.28 $\pm$ 3.42
Gr. III (7)	68.93 $\pm$ 1.65

The value in Gr. I (6) (51.19 $\pm$ 2.43) is significantly lower than in Gr. II (6) (57.34 $\pm$ 0.53) at the 5 per cent level only, and both these values are significantly lower than in Gr. III (6) (70.28 $\pm$ 3.42) at all levels. The value in Gr. III (7) (68.93 $\pm$ 1.65) is not significantly different from that in Gr. III (6), but is significantly higher than those in Gr. I (6) and Gr. II (6) at all levels.

10. *Narrowest width of metasternal interspace (L)*

(Tables 3A-D)

(a) *Mean values (in mm.)*

The mean value for L varies as follows :—

Group (and eye-stripes)	Males	Females
1. Gr. I (6)	0.587 $\pm$ 0.025	1.00 $\pm$ 0.028
2. Gr. I (7)	0.500 $\pm$ 0.144	—
3. Gr. II (6)	0.531 $\pm$ 0.005	1.003 $\pm$ 0.005
4. Gr. II (7)	0.500	0.950 $\pm$ 0.053
5. Gr. III (6)	0.468 $\pm$ 0.012	1.00 $\pm$ 0.0
6. Gr. III (7)	0.510 $\pm$ 0.021	1.00 $\pm$ 0.012

(b) *Inter-group comparison (Table 3D)*

(i) *6-striped males and females.*—*Males* : The mean value for Gr. I (0.587 $\pm$ 0.025 mm.) is significantly higher than in Groups II (0.531 $\pm$ 0.005 mm.) and III (0.468 $\pm$ 0.012 mm.) at all levels. The value for Gr. II is significantly higher than for Gr. III. *Females* : The values for Groups I, II and III are not significantly different from one another at all levels.

(ii) *7-striped males and females.*—*Males* : The mean values for Groups I (0.500 $\pm$ 0.144 mm.) and III (0.510 $\pm$ 0.021 mm.) are not significantly different from each other at all levels. Only one male occurred in Gr. II. *Females* : The values for Gr. II (0.950 $\pm$ 0.053 mm.) is not

significantly different from that in Gr. III (1.00 ± 0.012 mm.) at all levels. No female occurred in Gr. I.

(c) *Inter-sex comparison*

Within each Group, the mean value (in mm.) in males is significantly lower than in females, as follows :—

Group (and eye-stripes)	Males	Females	Difference
1. Gr. I (6) . . .	0.587 ± 0.025	1.00 ± 0.028	0.413 ± 0.038
2. Gr. II (6) . . .	0.531 ± 0.005	1.003 ± 0.005	0.471 ± 0.007
3. Gr. III (6) . . .	0.468 ± 0.012	1.00 ± 0.0	0.532 ± 0.012
4. Gr. III (7) . . .	0.510 ± 0.021	1.00 ± 0.012	0.490 ± 0.024

(d) *Sexual Dimorphism Percentage*

The value for S.D.P. ($\pm$ S.E.) for the 1955-population varies as follows :—

Gr. I (6)	70.39 ± 3.04
Gr. II (6)	88.67 ± 0.57
Gr. II (7)	90.00
Gr. III (6)	113.54 ± 1.21
Gr. III (7)	96.08 ± 2.13

The values for Gr. I (6) (70.39 ± 3.04) and Gr. II (6) (88.67 ± 0.57) are significantly lower than for Gr. III (6) (113.54 ± 1.21) at all levels. Between Gr. I and Gr. II, the value in the latter is significantly higher than in the former. The value in Gr. III (7) (96.08 ± 2.13) is significantly lower than in Gr. III (6) (113.54 ± 1.21) but is significantly higher than in Gr. I (6) and Gr. II (6) at all levels.

11. *Length of elytron (E)*

(Plates 1, 5 & 6 ; and Tables 3A-D & 4A-C)

(a) *Mean length (in mm.)*

The mean length of elytron (E) varies as follows :—

Group (and eye-stripes)	Males	Females
1. Gr. I (6)	51.01 ± 0.49	57.09 ± 0.72
2. Gr. I (7)	50.23 ± 1.51	--
3. Gr. II (6)	52.48 ± 0.13	59.09 ± 0.14
4. Gr. II (7)	50.20	60.22 ± 0.90
5. Gr. III (6)	52.07 ± 0.31	59.74 ± 0.91
6. Gr. III (7)	52.58 ± 0.43	63.39 ± 0.48

(b) *Inter-group comparison* (Table 3D)

(i) *6-eye-striped males and females*.—*Males*: The values in Gr. I (51.01 ± 0.49) and Gr. II (52.48 ± 0.13) are not significantly different from that in Gr. III (52.07 ± 0.31) at all levels. Between Groups I and II, the value in the latter is significantly higher at the 5 per cent and 1 per cent levels but not at the 0.1 per cent level. *Females*: The value in Gr. I (57.09 ± 0.72) is significantly lower than in Gr. II (59.09 ± 0.14), at the 5 per cent and 1 per cent levels and in Gr. III (59.74 ± 0.91) at the 5 per cent level. Between Groups II and III the values are not significantly different at all levels.

(ii) *7-eye-striped males and females*.—*Males*: The value in Gr. I (50.23 ± 1.51) is not significantly different from that in Gr. III (52.58 ± 0.43) at all levels. Only one male occurred in Gr. II. *Females*: The value in Gr. II (60.22 ± 0.90) is significantly lower than in Gr. III (63.39 ± 0.48) at the 5 per cent and 1 per cent levels. No female occurred in Gr. I.

(c) *Inter-sex comparison*

In each of the Groups the mean value (in mm.) in males is significantly lower than in females, as follows :—

Group (and eye-stripes)	Males	Females	Difference
1. Gr. I (6) . . .	51.01 ± 0.49	57.09 ± 0.72	6.08 ± 0.84
2. Gr. II (6) . . .	52.48 ± 0.13	59.09 ± 0.14	6.61 ± 0.19
3. Gr. III (6) . . .	52.07 ± 0.31	59.74 ± 0.91	7.67 ± 0.96
4. Gr. III (7) . . .	52.58 ± 0.43	63.39 ± 0.48	10.81 ± 0.64

(d) *Inter-population comparison* (Tables 4A-C)

The values in Groups I—III compare with those of other populations as follows :—

(i) *6-eye-striped males*.—The value in Gr. I (51.01 ± 0.49) is significantly lower than those in *6-gregaria* (52.85 ± 0.52), *6-solitaria* (52.15 ± 0.24), the *Kakko Concentration* (51.46 ± 0.29) and the *Ajmer Swarm* (54.16 ± 0.70). The value in Gr. II (52.48 ± 0.13) is not significantly different from those in *6-gregaria* and *6-solitaria*, whereas it is significantly higher than in the *Kakko Concentration* and lower than in the *Ajmer Swarm*. The value in Gr. III (52.07 ± 0.31) is not significantly different from those in other populations, except from the *Ajmer Swarm* where it is higher.

(ii) *6-eye-striped females*.—The value in Gr. I (57.09 ± 0.72) is not significantly different from those in *6-gregaria* (58.01 ± 0.81) and the *Ajmer Swarm* (59.70 ± 1.68), but is significantly lower than in *6-solitaria* (61.56 ± 0.31) and the *Kakko Concentration* (59.73 ± 0.42). The value in Gr. II (59.09 ± 0.14) is not significantly different from the other population except from *6-solitaria* from which it is significantly lower at all levels. The value in Gr. III (59.74 ± 0.91) is not significantly different from those in the other populations.

(iii) *7-eye-striped males*.—The values in Gr. I (50.23 ± 1.51) and Gr. III (52.58 ± 0.43) are not significantly different from that in *7-solitaria* (52.38 ± 0.42) at all levels.

(iv) *7-eye-striped females*.—The value in Gr. II (60.22 ± 0.90) is significantly lower than in *7-solitaria* (62.90 ± 0.26), but is not significantly different from that in the *Kakko Concentration* (61.83 ± 1.41). The value in Gr. III (63.39 ± 0.48) is not significantly different either from the *7-solitaria* or the *Kakko Concentration* at all levels.

(e) *Sexual Dimorphism Percentage*

The S.D.P. ($\pm$ S.E.) varies as follows :—

1955-population			Other populations		
Gr. I (6)	.	11.92 ± 1.78	6-greg.	.	9.76 ± 1.88
Gr. II (6)	.	12.60 ± 0.39	6-sol.	.	18.04 ± 0.80
Gr. II (7)	.	19.96	7-sol.	.	20.08 ± 1.08
Gr. III (6)	.	14.73 ± 1.87	Ajmer Sw. (1950)	.	10.23
Gr. III (7)	.	20.56 ± 1.33	Kakko Conc. (1949)	.	16.07 ± 1.0

Within the 6-eye-stripe category of the 1955-Groups, the values of S.D.P. are not significantly different from one another at all levels of probability, but all these three are lower than in Gr. III (7). The values in Gr. I (6) and Gr. II (6) are not significantly different from that in *6-gregaria*, but are significantly lower than those in the *Kakko Concentration* and *6-solitaria* at the 5 per cent and 1 per cent levels of probability respectively. The value in Gr. III (6) is significantly higher than in *6-gregaria* at the 5 per cent level, but is not significantly different than those in the *Kakko Concentration* and *6-solitaria*. The value in Gr. III (7) is not significantly different from that in *7-solitaria*.

12. *Restricted width of elytron (W_1)*

(Tables 3A-D)

(a) *Mean length (in mm.)*

The width of the elytron (W_1) varies as follows :—

Group (and eye-stripes)	Males	Females
1. Gr. I (6)	6.89 ± 0.07	7.66 ± 0.07
2. Gr. I (7)	6.57 ± 0.43	—
3. Gr. II (6)	7.10 ± 0.02	7.82 ± 0.02
4. Gr. II (7)	6.20	7.67 ± 0.14
5. Gr. III (6)	6.66 ± 0.05	7.36 ± 0.16
6. Gr. III (7)	6.71 ± 0.07	7.84 ± 0.06

(b) *Inter-group comparison* (Table 3D)

(i) *6-eye-striped males and females*.—*Males* : The value in Gr. I (6.89 ± 0.07) is significantly lower than in Gr. II (7.10 ± 0.02) but is significantly higher than in Gr. III (6.66 ± 0.05) at the 5 per cent and 1 per cent levels. Between Groups II and III, the value in the former is significantly higher at all levels. *Females* : The values in Gr. I (7.66 ± 0.07) is significantly lower than in Gr. II (7.82 ± 0.02) at the 5 per cent level only, and is not significantly different from that in Gr. III (7.36 ± 0.16). The value in Gr. II is significantly higher than in Gr. III at the 5 per cent and 1 per cent levels.

(ii) *7-eye-striped males and females*.—*Males* : The values of males in Gr. I (6.57 ± 0.43) and females in Gr. II (7.67 ± 0.14) are not significantly different from those in Gr. III males (6.71 ± 0.07) and females (7.84 ± 0.06), respectively at all levels. Only one male occurred in Gr. II and no female in Gr. I.

(c) *Inter-sex comparison*

Within each eye-stripe category in the various Groups, the mean value (in mm.) in male is significantly lower than in females, as follows :—

Group (and eye-stripes)	Males	Females	Difference
1. Gr. I (6)	6.89 ± 0.07	7.66 ± 0.07	0.77 ± 0.10
2. Gr. II (6)	7.10 ± 0.02	7.82 ± 0.02	0.72 ± 0.03
3. Gr. III (6)	6.66 ± 0.05	7.36 ± 0.16	0.70 ± 0.17
4. Gr. III (7)	6.71 ± 0.07	7.84 ± 0.06	1.13 ± 0.10

(d) *Inter-population comparison*

No comparison could be made due to lack of data in other populations.

Note : The width of elytron (W) in the *Kakko Concentration* (1949) and *Ajmer Swarm* (1950), referred to the entire width of elytron and not to the restricted width (W_1), as taken here in the 1955- population (see Roonwal & Bhanotar, *in Press*).

(e) *Sexual Dimorphism Percentage*

The S.D.P. ($\pm$ S.E.) for the 1955-population varies as follows :—

Gr. I (6)	11.18 ± 1.44
Gr. II (6)	10.14 ± 0.47
Gr. II (7)	23.71
Gr. III (6)	10.51 ± 2.60
Gr. III (7)	16.84 ± 1.61

In the 1955-population, the values of Groups I—III in the 6-eye-striped category are not significantly different from one another at all levels, but all these are lower than in Gr. III (7).

13. *Length of hind-femur (F)*

(Plates 1, 5 & 6 ; and Tables 3A-D & 4A-C)

(a) *Mean length (in mm.)*

The mean length of the hind-femur (F) varies as follows :—

Group (and eye-stripes)	Males	Females
1. Gr. I (6)	23.11±0.26	25.52±0.34
2. Gr. I (7)	25.30±0.64	—
3. Gr. II (6)	24.06±0.07	26.50±0.07
4. Gr. II (7)	25.10	28.63±0.55
5. Gr. III (6)	25.24±0.16	27.97±0.90
6. Gr. III (7)	26.12±0.23	31.21±0.22

(b) *Inter-group comparison (Table 3D)*

(i) *6-eye-striped males and females.*—*Males* : The mean values in Gr. I (23.11±0.26) is significantly lower than in Gr. II (24.06±0.07), and both these values are significantly lower than in Gr. III (25.24±0.16) at all levels. *Females* : The value in Gr. I (25.52±0.34) is significantly lower than those in Gr. II (26.50±0.07) and Gr. III (27.97±0.90). But between Groups II and III, there is no significant difference.

(ii) *7-eye-striped males and females.*—*Males* : The value in Gr. I (25.30±0.64) is not significantly different from that in Gr. III (26.12±0.23). Only one male occurred in Gr. II. *Females* : The value in Gr. II (28.63±0.55) is significantly lower than in Gr. III (31.21±0.22) at all levels. No female occurred in Gr. I.

(c) *Inter-sex comparison*

Within each eye-stripe category, in each of the 1955-groups the mean value in males is significantly lower than in females, as follows :—

Group (and eye-stripes)	Males	Females	Difference
1. Gr. I (6)	23.11±0.26	25.52±0.34	2.41±0.428
2. Gr. II (6) . .	24.06±0.07	26.50±0.07	2.44±0.10
3. Gr. III (6) . .	25.24±0.16	27.97±0.90	2.73±0.10
4. Gr. III (7)	26.12±0.23	31.21±0.22	5.09±0.32

(d) *Inter-population comparison* (Tables 4A-C)

The mean values in Groups I—III compare with those of other populations as follows :—

(i) *6-eye-striped males*.—The value in Gr. I (23.11 ± 0.26) is significantly lower than in *6-gregaria* (24.32 ± 0.20), *6-solitaria* (25.40 ± 0.12), the *Kakko Concentration* (24.92 ± 0.16) and the *Ajmer Swarm* (24.37 ± 0.29). The value in Gr. II (24.06 ± 0.07) is not significantly different from that in *6-gregaria* and the *Ajmer Swarm*, but is significantly lower than in *6-solitaria* and the *Kakko Concentration* at all levels. The value in Gr. III (25.24 ± 0.16) is not significantly different from those in *6-solitaria* and the *Kakko Concentration* but is significantly higher than in *6-gregaria* and the *Ajmer Swarm*.

(ii) *6-eye-striped females*.—The value in Gr. I (25.52 ± 0.34) is not significantly different from that in *6-gregaria* (26.44 ± 0.37). However, it is significantly lower than in *6-solitaria* (29.37 ± 0.18) and the *Kakko Concentration* (28.35 ± 0.25) at all levels, and from the *Ajmer Swarm* (27.28 ± 0.25) at the 5 per cent level only. The value in Gr. II (26.50 ± 0.07) is not significantly different from that in *6-gregaria* and the *Ajmer Swarm*, but is significantly lower than in *6-solitaria* and the *Kakko Concentration* at all levels. The value in Gr. III (27.97 ± 0.90) is not significantly different from that in the other populations.

(iii) *7-eye-striped males*.—The value in Groups I (25.30 ± 0.64) and III (26.12 ± 0.23) are not significantly different from that in *7-solitaria* (26.13 ± 0.21) at all levels. Only one male occurred in Gr. II.

(iv) *7-eye-striped females*.—The value in Gr. II (28.63 ± 0.55) is significantly lower than in *7-solitaria* (30.92 ± 0.13) at all levels, but is not significantly different from that in the *Kakko Concentration* (29.94 ± 0.92). The value in Gr. III (31.21 ± 0.22) is not significantly different from Gr. II and the *Kakko Concentration*. No female occurred in Gr. I.

(e) *Sexual Dimorphism Percentage*

The S.D.P. ($\pm$ S.E.) varies as follows :—

1955-population		Other populations	
Gr. I (6)	10.43 ± 1.94	<i>6-greg.</i>	8.72 ± 1.76
Gr. II (6)	10.14 ± 0.43	<i>6-sol.</i>	15.63 ± 0.89
Gr. II (7)	14.06	<i>7-sol.</i>	18.33 ± 1.07
Gr. III (6)	10.82 ± 3.66	<i>Ajmer Sw.</i> (1950)	11.94
Gr. III (7)	19.49 ± 1.35	<i>Kakko Conc.</i> (1949)	13.76 ± 1.24

In the 1955-population, the values in Groups I—III within the 6-striped category are not significantly different from one another, but all these three are lower than in Gr. III (7). The value in Gr. I (6) is not significantly different from *6-gregaria* and the *Kakko Concentration* but is lower than *6-solitaria* at the 5 per cent level. The value in Gr. II (6) is not different from *6-gregaria*, but is lower than in the *Kakko Concentration* at the 5 per cent and 1 per cent levels, and from *6-solitaria* at all levels. The value in Gr. III (6) is not significantly different from “other populations”. The value in Gr. III (7) is not different from *7-solitaria*.

14. *General conclusions regarding size of body-parts*

1. On the basis of the morphometrical analysis of the twelve body-parts discussed above, it is concluded that Group II occupies a position in between Groups I and III, but shows affinity, in most characters, to the former. Regarding the length of pronotum (P), the height of pronotum (H), width of pronotum at the constriction (M) and the length of the elytron (E), Group II is, however, closer to Group III than to Group I. The characters B (width of eye), C (width of head at the genal level), W_1 (restricted width of elytron) and F (length of hind-femur) have proved to be very sensitive for phase differentiation.

2. The study of the sex-differences in body-parts reveals that the mean lengths for females are definitely larger than those for males. These differences cannot be accounted for by sampling error and a real difference seems to exist. In the case of characters width of eye (B) for Groups I and III and the length of hind-femur (F) for Group I, however, the sexual difference is not as real as apparent from the Student's 't' test based on the classical theory of errors.

3. A detailed comparison of Groups I, II and III have been made with the other previously studied populations. A general conclusion drawn from these comparisons is that Groups I and II have been sampled from identical populations having means similar to typical *phase gregaria* and to the *Ajmer Swarm* of 1950 (the second year of the 1949-55 swarming cycle). Group III shows similar characteristics which are similar to those of *phase solitaria* and the *Kakko Concentration* of 1949 (the first year of the 1949-55 cycle). As usual, the length of elytron (E) for males behaves exceptionally. The *6-striped* females in Group III do not show any definite result when compared with the other populations, but its values are nearer to those of *phase solitaria*. The reason for this may be due to small size of the sample ($n=14$). Among the 1955-Groups, Gr. II shows more consistent results than the other two Groups, possibly due to its large sample size and uniform population density. Among the four characters, namely, E, F, C, P, the length of the hind-femur (F) and the width of the head at the genal level (C), are the two most phase-sensitive characters.

4. Within the 1955-Groups, the Sexual Dimorphism Percentage (S.D.P.) does not show much discriminating power for detecting possible divergences between the Groups, except in the characters broadest (K) and narrowest (L) width of the metasternal interspace, where the values show a high degree of difference. Nevertheless, the S.D.P. with respect to C, P, E and F also in inter-population comparisons, does help, in varying degrees, to place a Group in one of the phases to which it may possibly belong. In this regard the length of the elytron (E) is the most phase-sensitive character and shows the *phase gregaria* characters of Groups I and II and the *phase solitaria* characters of Group III.

V—MORPHOMETRY (B)—RATIOS

1. General

The ratios of values of the sizes of the various pairs of body-parts were first calculated for each individual specimen, and then the means and other statistical constants calculated in the usual way.

2. Rotio E/F

(Plates 3, 5 & 7 ; and Tables 5A-D, 6 & 7A-C)

(a) Mean values

The mean values for E/F in 6- and 7-eye-striped forms are as follows :—

Group	Males	Females
1. Gr. I (6)	2.21±0.018	2.24±0.016
2. Gr. II (6)	2.18±0.004	2.23±0.004
3. Gr. III (6)	2.07±0.010	2.11±0.031
4. Gr. I (7)	1.99±0.013	Nil
5. Gr. II (7)	2.00	2.10±0.021
6. Gr. III (7)	2.01±0.009	2.04±0.008

(b) Inter-group comparison (Table 5A-D)

(i) 6-striped males and females.—*Males* : The value in Gr. I (2.21 ± 0.018) is not significantly different from that in Gr. II (2.18 ± 0.004), but both these values are significantly higher than in Gr. III (2.07 ± 0.010) at all levels. *Females* : The value in Gr. I (2.24 ± 0.016) is not significantly different from that in Gr. II (2.23 ± 0.004). Both these values are significantly higher in Gr. III (2.11 ± 0.031) ; the S.D. is also significantly different at the 5 per cent level of probability.

(ii) 7-striped males and females.—*Males* : The value in Gr. I (1.99 ± 0.013) is not significantly different from that in Gr. III (2.01 ± 0.009) at all levels. Only one male occurred in Gr. II. *Females* : The value in Gr. II (2.10 ± 0.021) is significantly higher than in Gr. III (2.04 ± 0.008) at the 5 per cent level only. No females occurred in Gr. I.

(c) Inter-sex comparison (Table 6)

In Groups II (6) and III (7), marked with an asterisk(*), the values in males are significantly slightly lower than in females. In other groups, however, the sexes do not differ significantly.

Group	Males	Females	Difference
Gr. I (6)	2.21±0.018	2.24±0.016	0.03±0.024
Gr. II (6)*	2.18±0.004	2.23±0.004	*0.05±0.006
Gr. III (6)	2.07±0.010	2.11±0.031	0.04±0.032
Gr. III (7)*	2.01±0.009	2.04±0.008	*0.03±0.01

(d) *Inter-population comparison* (Tables 7A-C)

The mean values in Group I—III compare with those of other populations as follows :—

(i) *6-striped males*.—The values in Gr. I (2.21 ± 0.018) and Gr. II (2.18 ± 0.004) are not significantly different from those in *6-gregaria* males (2.17 ± 0.024) and the *Ajmer Swarm* (2.22 ± 0.023), but are significantly higher than in *6-solitaria* males (2.05 ± 0.012) and the *Kakko Concentration* (2.06 ± 0.010) at all levels of probability. The value in Gr. III (2.07 ± 0.10) is not significantly different from those in *6-solitaria* and the *Kakko Concentration*, but is significantly lower than in *6-gregaria* and the *Ajmer Swarm*.

(ii) *6-striped females*.—The values in Gr. I (2.24 ± 0.016) and Gr. II (2.23 ± 0.004) are not significantly different from those in *6-gregaria* (2.25 ± 0.017) and the *Ajmer Swarm* (2.19 ± 0.035) but are significantly higher than in *6-solitaria* (2.09 ± 0.008) and the *Kakko Concentration* (2.12 ± 0.011) at all levels of probability. The values in Gr. III (2.11 ± 0.03) are significantly lower than in *6-gregaria*, but not significantly different from other populations.

(iii) *7-striped males*.—The values in Groups I (1.99 ± 0.013) and Gr. III (2.01 ± 0.005) are not significantly different from those in *7-solitaria* (2.00 ± 0.006) at all levels of probability.

(iv) *7-striped females*.—The value in Gr. II (2.10 ± 0.021) is significantly higher than in *7-solitaria* (2.03 ± 0.007) at the 5 per cent and 1 per cent levels, (but not so at the 0.1 per cent), but is not significantly different from the *Kakko Concentration* (2.07 ± 0.022) at all levels of probability. The value in Gr. III (2.04 ± 0.008) is not significantly different from either *7-solitaria* or the *Kakko Concentration* at all levels of probability.

(e) *Sexual Dimorphism Percentage*

The S.D.P. ($\pm$ S.E.) varies as follows :—

1955-population			Other populations		
Gr. I (6)	.	1.36 ± 1.10	<i>6-greg.</i>	.	3.69 ± 1.40
Gr. II (6)	.	2.29 ± 0.23	<i>Ajmer Sw.</i>	.	-1.35
Gr. II (7)	.	5.00	<i>kakko Conc.</i>	.	2.91 ± 0.73
Gr. III (6)	.	1.93 ± 1.57	<i>6-sol.</i>	.	1.95 ± 0.45
Gr. III (7)	.	1.49 ± 0.63	<i>7-sol.</i>	.	1.50 ± 0.62

Between the 1955-Groups, the S.D.P. is not significantly different from one another. It is also not significantly different from other populations. It is, therefore, concluded that the ratio E/F is, in this respect, is not a phase-sensitive character.

3. Ratio E/W_1
(Tables 5A—D & 6)

(a) Mean values

The mean values for E/W_1 in 6- and 7-eye-striped forms are as follows :—

Group	Males	Females
1. I (6) .	7.41 ± 0.068	7.45 ± 0.081
2. II (6) .	7.42 ± 0.016	7.57 ± 0.015
3. III (6) .	7.88 ± 0.038	8.10 ± 0.123
4. I (7) .	7.69 ± 0.285	Nil
5. II (7) .	8.10	7.92 ± 0.132
6. III (7).	7.84 ± 0.068	8.12 ± 0.045

(b) Inter-group comparison (Tables 5A—D)

(i) 6-striped males and females.—*Males* : The mean values in Gr. I (7.41 ± 0.068) and Gr. II (7.42 ± 0.016) are significantly lower than in Gr. III (7.88 ± 0.038) at all levels of probability. Groups I and II are not significantly different from each other at all levels. *Females* : The values in Gr. I (7.45 ± 0.081) and Gr. II (7.57 ± 0.015) are significantly lower than in Gr. III (8.10 ± 0.123). Groups I and II are not significantly different from each other at all levels.

(ii) 7-striped males and females.—*Males* : The values in Gr. I (7.69 ± 0.285) and Gr. III (7.84 ± 0.068) are not significantly different at all levels of probability. Only one male occurred in Gr. II. *Females* : The values in Gr. II (7.92 ± 0.132) and Gr. III (8.12 ± 0.045) are not significantly different from each other at all levels. No females occurred in Gr. I.

(c) Inter-sex comparison (Table 6)

In Groups II (6) and III (7), marked with an asterisk (*), the values in males are slightly lower than in females. In other groups the sexes do not differ significantly.

Group	Males	Females	Difference
I (6)	7.41 ± 0.068	7.45 ± 0.081	0.04 ± 0.105
*II (6)	7.42 ± 0.016	7.57 ± 0.015	$*0.15 \pm 0.022$
III (6)	7.88 ± 0.038	8.10 ± 0.123	0.22 ± 0.139
*III (7)	7.84 ± 0.068	8.12 ± 0.045	$*0.28 \pm 0.082$

(d) *Inter-population comparison*

No Comparison could be made due to lack of data in other populations (see *note*, P. 26).

(e) *Sexual Dimorphism Percentage*

The S.D.P. ($\pm$ S.E.) for the 1955-population varies as follows :—

Gr. I (6)	.	0.54 $\pm$ 1.43
Gr. II (6)		2.02 $\pm$ 0.30
Gr. II (7)		—2.22
Gr. III (6)		2.79 $\pm$ 1.63
Gr. III (7)		3.57 $\pm$ 1.07

Between the 1955-Groups, the S.D.P. is not significantly different at all levels.

4. *Ratio E/C*

(Tables 5A-D & 6)

(a) *Mean values*

The mean values in 6- and 7-eye-striped forms vary as follows :—

Group	Males	Females
1. I (6)	6.98 $\pm$ 0.05	7.29 $\pm$ 0.06
2. II (6)	7.30 $\pm$ 0.01	7.50 $\pm$ 0.01
3. III (6)	7.98 $\pm$ 0.04	8.03 $\pm$ 0.14
4. I (7)	7.57 $\pm$ 0.07	Nil
5. II (7)	7.97	7.96 $\pm$ 0.11
6. III (7)	7.92 $\pm$ 0.05	8.23 $\pm$ 0.03

(b) *Inter-group comparison* (Tables 5A-D)

(i) *6-striped males and females*.—*Males* : At all levels, the value in Gr. I (6.98 ± 0.05) is significantly lower than in Gr. II (7.30 ± 0.01), and both these values are significantly lower than in Gr. III (7.98 ± 0.04). *Females* : At all levels the value in Gr. I (7.29 ± 0.06) is significantly lower than in Gr. II (7.50 ± 0.01), and both these values are significantly lower than in Gr. III (8.03 ± 0.14).

(ii) *7-striped males and females*.—*Males* : The value in Gr. I (7.57 ± 0.07) is significantly lower than in Gr. III (7.92 ± 0.05) at the 5% level. Only one male occurred in Gr. II. *Females* : The value in Gr. II (7.96 ± 0.11) is not significantly different from that in Gr. III (8.23 ± 0.03) at all levels.

(c) *Inter-sex comparison* (Table 6)

In Groups I (6), II (6) and III (7), marked with an asterisk (*), the values in males are significantly lower than in females. In Group III (6), however, the sexes do not differ significantly.

Group	Males	Females	Difference
*I (6)	6.98 ± 0.05	7.29 ± 0.06	$*0.31 \pm 0.08$
*II (6)	7.30 ± 0.01	7.50 ± 0.01	$*0.20 \pm 0.02$
III (6)	7.98 ± 0.04	8.03 ± 0.14	0.05 ± 0.14
*III (7)	7.92 ± 0.05	8.23 ± 0.03	$*0.31 \pm 0.06$

(d) *Inter-population comparison*

Due to lack of data regarding E/C in other populations no comparison is possible.

(e) *Sexual Dimorphism Percentage*

The S.D.P. ($\pm$ S.E.) for the 1955-population varies as follows :—

Gr. I (6)		4.44 ± 1.12
Gr. II (6)		2.74 ± 0.25
Gr. II (7)		-0.13
Gr. III (6)		0.63 ± 1.79
Gr. III (7)		3.91 ± 0.75

Within the 1955-Groups, the values for the S.D.P. are not significantly different from one another at all levels. No data for other populations are available.

5. *Ratio F/C*

(Plates 3 & 5 ; & Tables 5A-D, 6 & 7A-C)

(a) *Mean values*

The mean values for F/C for 6- and 7- striped forms vary as follows :—

Group	Males	Females
1. I (6)	3.17 ± 0.04	3.25 ± 0.04
2. II (6)	3.35 ± 0.01	3.36 ± 0.01
3. III (6)	3.86 ± 0.03	3.82 ± 0.09
4. I (7)	3.81 ± 0.02	Nil
5. II (7)	3.98	3.79 ± 0.08
6. III (7)	3.93 ± 0.02	4.04 ± 0.02

(b) *Inter-group comparison (Tables 5A-D)*

(i) *6-striped males and females.*—*Males* : The values in Gr. I (3.17 ± 0.04) and Gr. II (3.35 ± 0.01) are significantly lower than in Gr. III (3.86 ± 0.03) at all levels. The value in Gr. II is significantly higher than in Gr. I. *Females* : The values in Gr. I (3.25 ± 0.04) is significantly lower than in Gr. II (3.36 ± 0.01) at the 5% and 1% levels, but not at the 0.1% level. Both these values are significantly lower than in Gr. III (3.82 ± 0.09) at all levels.

(ii) *7-striped males and females.*—*Males* : The value in Gr. I (3.81 ± 0.02) is significantly lower than in Gr. III (3.93 ± 0.02) at the 5% level only. One male occurred in Gr. II. *Females* : The value in Gr. II (3.79 ± 0.08) is significantly lower than in Gr. III (4.04 ± 0.02) at the 5% and 1% level only. No female occurred in Gr. I.

(c) *Inter-sex comparison (Table 6)*

In Group III (7), marked with an asterisk (*), the value in males is significantly lower than in females. In other groups the sexes do not differ significantly.

Group	Males	Females	Difference
Gr. I (6)	3.17 ± 0.04	3.25 ± 0.04	0.08 ± 0.06
Gr. II (6)	3.35 ± 0.01	3.36 ± 0.01	0.01 ± 0.01
Gr. III (6)	3.86 ± 0.03	3.82 ± 0.09	0.04 ± 0.09
*Gr. III (7)	3.93 ± 0.02	4.04 ± 0.02	* 0.11 ± 0.03

(d) *Inter-population comparison* (Tables 7A-C)

The mean value in Groups I—III compare with other populations as follows :—

(i) *6-striped males*.—The value in Gr. I (3.17 ± 0.04) is not significantly different from *6-gregaria* (3.23 ± 0.03) and the *Ajmer Swarm* (3.23 ± 0.03), but the values in Gr. II (3.35 ± 0.01) and Gr. III (3.86 ± 0.03) are significantly higher at all levels. The values in Groups I and II are significantly lower than in the *Kakko Concentration* (3.79 ± 0.02), but Gr. III is not significantly different from the latter.

(ii) *6-striped females*.—The value in Gr. I (3.25 ± 0.04) is not significantly different from *6-gregaria* (3.32 ± 0.03) and the *Kakko Concentration* (3.82 ± 0.02), but is significantly lower than in the *Ajmer Swarm* (3.45 ± 0.07) at the 5% level only. The value in Gr. II (3.36 ± 0.01) is not significantly different from that in the *Ajmer Swarm* at all levels, but is significantly higher than in *6-gregaria* and significantly lower than in the *Kakko Concentration* at all levels. The value in Gr. III (3.82 ± 0.09) is not significantly different from the *Kakko Concentration*, but is significantly higher than in *6-gregaria* and the *Ajmer Swarm*.

(e) *Sexual Dimorphism Percentage*

The S.D.P. ($\pm$ S.E.) varies as follows :—

1955-population		Other populations	
Gr. I (6)	2.52 ± 1.71	<i>6-greg.</i> . . .	2.69 ± 1.42
Gr. II (6)	0.30 ± 0.33	<i>Ajmer Sw.</i> (1950)	6.83
Gr. II (7)	. —4.77	<i>Kakko Conc.</i> (1949)	0.90 ± 0.96
Gr. III (6)	. —1.04 $\pm$ 2.40		
Gr. III (7)	. 2.80 ± 0.72		

At all levels of probability the S. D. P. is not significantly different either between each of the *1955-groups*, or between these groups and the other populations, except in Gr. III (7), where the value is higher than in Gr. II (6) at the 5 per cent and 1 per cent levels.

6. *Ratio P/C*

(Plates 4 & 5, and Tables 5A-D, 6 & 7A-C)

(a) *Mean values*

Group	Males	Females
1. I (6)	1.32 ± 0.012	1.34 ± 0.011
2. II (6)	1.38 ± 0.003	1.38 ± 0.002
3. III (6)	1.51 ± 0.007	1.47 ± 0.025
4. I (7)	1.46 ± 0.033	Nil
5. II (7)	1.59	1.50 ± 0.027
6. III (7)	1.52 ± 0.011	1.54 ± 0.009

(b) *Inter-group comparison* (Tables 5A-D)

(i) *6-striped males and females*.—*Males* : At all levels the value in Gr. I (1.32 ± 0.012) is significantly lower than in Gr. II (1.38 ± 0.003), and both these values are significantly lower than in Gr. III (1.51 ± 0.007). *Females* : At all levels the value in Gr. I (1.34 ± 0.011) is significantly lower than in Gr. II (1.38 ± 0.002), and both these values are significantly lower than in Gr. III (1.47 ± 0.025).

(ii) *7-striped males and females*.—*Males* : At all levels the value in Gr. I (1.46 ± 0.033) is not significantly different from that in Gr. III (1.52 ± 0.11). Only one male occurred in Gr. II. *Females* : At all levels, the value in Gr. II (1.50 ± 0.027) is not significantly different from that in Gr. III (1.54 ± 0.009). No females occurred in Gr. I.

(c) *Inter-sex comparison* (Table 6)

The sexual differences are given below but in none of the groups are they statistically significant.

Group	Males	Females	Difference
I (6)	1.32 ± 0.012	1.34 ± 0.011	0.02 ± 0.017
II (6)	1.38 ± 0.003	1.38 ± 0.002	0
III (6)	1.51 ± 0.007	1.47 ± 0.025	0.04 ± 0.026
III (7)	1.52 ± 0.011	1.54 ± 0.009	0.02 ± 0.014

(d) *Inter-population comparison* (Tables 7A-C)

The values in Groups I—III compare with other populations as follows :—

(i) *6-striped males*.—The value in Gr. I (1.32 ± 0.012) is not significantly different from those in *6-gregaria* (1.305 ± 0.01) and the *Ajmer Swarm* (1.330 ± 0.011), but is significantly lower than in the *Kakko Concentration* (1.483 ± 0.007) at all levels. The values in Groups II (1.38 ± 0.003) and III (1.51 ± 0.007) are significantly higher than in *6-gregaria* and the *Kakko Concentration* at all levels. The value in Gr. II is significantly higher than in the *Ajmer Swarm*, but Gr. III not significantly different from the latter.

(ii) *6-striped females*.—The value in Gr. I (1.34 ± 0.011) is not significantly different from those in *6-gregaria* (1.324 ± 0.009) and the *Ajmer Swarm* (1.363 ± 0.018), but is significantly lower than in the *Kakko Concentration* (1.477 ± 0.008) at all levels. The value in Gr. II (1.38 ± 0.002) is not significantly different from that in the *Ajmer Swarm*, but is significantly higher than in *6-gregaria* and lower than in the *Kakko Concentration* at all levels. The value in Gr. III (1.47 ± 0.03) is not significantly different from that in the *Kakko Concentration*, but is significantly higher than in *regaria* and the *Ajmer Swarm*.

(e) *Sexual Dimorphism Percentage*

The S. D. P. ($\pm$ S.E.) varies as follows :—

1955-population			Other populations	
Gr. I (6)		1.52 ± 1.27	<i>6-greg.</i>	1.46 ± 1.10
Gr. II (6)	.	Nil	<i>Ajmer Sw.</i> (1950)	2.48
Gr. II (7)	.	-5.66	<i>Kakko Conc.</i> (1949)	-0.40 ± 0.72
Gr. III (6)	.	-2.65 ± 1.73		
Gr. III (7)		1.32 ± 0.96		

Within the *1955-Groups*, the S. D. P. is not significantly different at all levels. The value in Gr. III (6) is significantly higher than in *6-gregaria* at the 5 per cent level only.

7. *Ratio M/C*

(Tables 5A-D and 6)

(a) *Mean values*

The mean values for M/C in the 6- and 7-eye-striped forms are as follows :—

Group					Males	Females
1.	I	(6)	.	.	0.79 ± 0.005	0.83 ± 0.005
2.	II	(6)	.	.	0.82 ± 0.002	0.84 ± 0.001
3.	III	(6)	.	.	0.89 ± 0.003	0.90 ± 0.012
4.	I	(7)	.	.	0.87 ± 0.032	Nil
5.	II	(7)	.	.	0.91	0.88 ± 0.012
6.	III	(7)			0.90 ± 0.006	0.92 ± 0.004

(b) *Inter-group comparison* (Table 5D)

(1) *6-striped males and females.*—*Males* : At all levels the value in Gr. I (0.79 ± 0.005) is significantly lower than in Gr. II (0.82 ± 0.002), and both these are significantly lower than in Gr. III (0.89 ± 0.003). *Females* : At all levels the values in Gr. I (0.83 ± 0.008) and Gr. II (0.84 ± 0.001) are significantly lower than in Gr. III (0.90 ± 0.012), but Groups I and II are not significantly different from each other.

(ii) *7-striped males and females.*—*Males* : The value in Gr. I (0.87 ± 0.032) is not significantly different from that in Gr. III (0.90 ± 0.006) at all levels. Only one male occurred in Gr. II. *Females* : The value in Gr. II (0.88 ± 0.012) is significantly lower than in Gr. III (0.92 ± 0.004) at the 5 per cent and 1 per cent levels only. No females occurred in Gr. I.

(c) *Inter-sex comparisons (Table 6)*

In Groups I (6), II (6) and III (7), marked with an asterisk (*), the values in males are significantly lower than in females. In Group III (6), however, the sexes do not differ significantly.

Group	Males	Females	Difference
*I (6)	0.79 ± 0.005	0.83 ± 0.008	$*0.04 \pm 0.009$
*II (6)	0.82 ± 0.002	0.84 ± 0.001	0.02 ± 0.002
III (6)	0.89 ± 0.003	0.90 ± 0.012	$*0.01 \pm 0.012$
*III (7)	0.90 ± 0.006	0.92 ± 0.004	$*0.02 \pm 0.007$

(d) *Inter-population comparison.*

The values for Groups I—III compare with that for *6-gregaria*, as follows (the data for other populations are not available) :—

(i) *6-striped males.*—The mean value in Gr. I (0.79 ± 0.005) is not significantly different from that in *6-gregaria* (0.779 ± 0.008), but the values in Groups II (0.82 ± 0.002) and III (0.89 ± 0.003) are significantly higher than the latter at all levels.

(ii) *6-striped females.*—The values in Groups I (0.83 ± 0.008), II (0.842 ± 0.001) and III (0.90 ± 0.012) are significantly higher than in *6-gregaria* (0.805 ± 0.005) at all levels.

(e) *Sexual Dimorphism Percentage*

The S. D. P. ($\pm$ S.E.) varies as follows :—

Gr. I (6)	5.06 ± 1.22
Gr. II (6)	2.68 ± 0.23
Gr. II (7)	-2.21
Gr. III (6)	0.90 ± 1.36
Gr. III (7)	2.11 ± 0.82

Within the 1955-Groups values are not significantly different at all levels of probability except that the value in Gr. I (6) is significantly higher, at the 5 per cent level, than in Gr. III (6) and Gr. III (7).

8. *Ratio H/C*
(Tables 5A-D & 6)

(a) *Mean values*

The mean values for H/C in the 6- and 7-eye-striped forms are as follows :—

Group	Males	Females
1. I (6)	1.10 ± 0.008	1.12 ± 0.009
2. II (6)	1.13 ± 0.002	1.14 ± 0.002
3. III(6)	1.25 ± 0.006	1.24 ± 0.016
4. I (7)	1.23 ± 0.014	Nil
5. II (7)	1.22	1.23 ± 0.016
6. III (7)	1.25 ± 0.008	1.29 ± 0.002

(b) *Inter-group comparison* (Table 5A-D)

(i) *6-striped males and females.*—*Males* : At all levels the value in Gr. I (1.10 ± 0.008) is significantly lower than in Gr. II (1.13 ± 0.002), and both these values are significantly lower than in Gr. III (1.25 ± 0.006). *Females* : The value in Gr. I (1.12 ± 0.009) is significantly lower than in Gr. II (1.14 ± 0.002) at the 5 per cent level only, and both these values are significantly lower than in Gr. III (1.24 ± 0.016) at all levels.

(ii) *7-striped males and females.*—*Males* : The value in Gr. I (1.23 ± 0.014) is not significantly different from that in Gr. III (1.25 ± 0.008) at all levels of probability. Only one male occurred in Gr. II. *Females* : The value in Gr. II (1.23 ± 0.016) is significantly lower than in Gr. III (1.29 ± 0.002) at all levels. No females occurred in Gr. I.

(c) *Inter-sex comparison* (Table 6)

In Groups II (6) and III (7), marked with an asterisk (*), the values in males are slightly lower than in females. In the other groups, however, the sexes do not differ significantly.

Group	Males	Females	Difference
I (6)	1.10 ± 0.008	1.12 ± 0.009	0.02 ± 0.012
*II (6) . .	1.13 ± 0.002	1.14 ± 0.002	$*0.01 \pm 0.003$
III (6) . .	1.25 ± 0.006	1.24 ± 0.016	0.01 ± 0.017
*III(7)	1.25 ± 0.008	1.29 ± 0.002	$*0.04 \pm 0.010$

(d) *Inter-population comparison*

(i) *6-striped males*.—The value in Gr. I (1.10 ± 0.008) is not significantly different from that in *6-gregaria* (1.112 ± 0.008), but those in Groups II (1.13 ± 0.002) and III (1.25 ± 0.006) are significantly higher than the latter at the 5 per cent level and at all levels respectively.

(ii) *6-striped females*.—At all levels the values in Group, I (1.12 ± 0.009) and II (1.14 ± 0.002) are not significantly different from that in *6-gregaria* (1.126 ± 0.007), but that in Gr. III (1.24 ± 0.016) is significantly lower than in *6-gregaria*.

(e) *Sexual Dimorphism Percentage*

The S. D. P. ($\pm$ S.E.) for the 1955-population varies as follows :—

Gr. I (6)	1.82 ± 1.10
Gr. II (6)	0.88 ± 0.22
Gr. II (7)	0.82
Gr. III (6)	-0.80 ± 1.35
Gr. III (7)	3.20 ± 0.86

Within the 6-striped category, the values in Groups I—III are not significantly different from one another. The value in Gr. III (7) is higher than in Gr. II (6) and Gr. III (6) at the 5 per cent and 1 per cent levels in both cases, but is not significantly different from Gr. I (6).

9. *Ratio K/L*
(Tables 5A-D & 6)

The phase significance of this ratio :

$$\frac{\text{Broadest width of metasternal interspace}}{\text{Narrowest width of metasternal interspace}}$$

was first pointed out by Roonwal (1946). In the 1955-populations the ratio varies in the manner discussed below.

(a) *Mean values*

Group	Males	Females
1. I (6)	1.35 ± 0.05	1.18 ± 0.04
2. II (6)	1.52 ± 0.01	1.25 ± 0.01
3. III (6)	1.58 ± 0.02	1.24 ± 0.02
4. I (7)	1.61 ± 0.20	Nil
5. II (7)	1.50	1.29 ± 0.03
6. III (7)	1.49 ± 0.04	1.27 ± 0.02

(b) *Inter-group comparison* (Table 5)

(i) *6-striped males and females*.—*Males* : At all levels the value in Gr. I (1.35 ± 0.05) is significantly lower than in Gr. II (1.52 ± 0.01), and both these values are significantly lower than in Gr. III (1.58 ± 0.02). *Females* : The values in Groups I, II and III are not significantly different from each other at all levels.

(ii) *7-striped males and females*.—*Males* : The value in Gr. I (1.61 ± 0.20) is not significantly different from that in Gr. III (1.49 ± 0.04) at all levels. Only one male occurred in Gr. II. *Females* : The value in Gr. II (1.29 ± 0.03) is not significantly different from that in Gr. III (1.27 ± 0.02) at all levels. No female occurred in Gr. I.

(c) *Inter-sex comparison* (Table 6)

In all the Groups, marked with an asterisk (*), the values in males are significantly higher than in females, as follows :—

Group	Males	Females	Difference
*I (6)	1.35 ± 0.050	1.18 ± 0.037	$*0.17 \pm 0.061$
*II (6)	1.52 ± 0.012	1.25 ± 0.006	$*0.27 \pm 0.013$
*III (6)	1.58 ± 0.025	1.24 ± 0.022	$*0.34 \pm 0.033$
*III (7)	1.49 ± 0.035	1.27 ± 0.019	$*0.22 \pm 0.040$

(d) *Inter-population comparison*

Due to lack of data the value of K/L cannot be compared with other populations.

(e) *Sexual Dimorphism Percentage*

The S. D. P. ($\pm$ S.E.) for the 1955-population varies as follows :—

Gr. I (6)	-12.59 ± 4.02
Gr. II (6)	-17.76 ± 0.91
Gr. II (7)	-14.00
Gr. III (6)	-21.52 ± 1.88
Gr. III (7)	-14.77 ± 2.38

The value in Gr. I (6) is significantly lower than in Gr. III (6) at the 5 per cent level only. In all other Groups the values are not significantly different from one another.

10. *General conclusions regarding morphometric ratios*

1. Taking into consideration, the eight ratios, namely, E/F , E/W_1 , E/C , F/C , R/C , M/C , H/C and K/L , it is evident that Group II is intermediate between Groups I and III, and is nearer to the former. Regarding the ratios E/F and E/W_1 , the statistical tests of significance conveys results which are quite in conformity with the theoretical expectation that Group I and II both should differ from Group III. The ratios which include the width of head at the genal level (C) as a denominator are found to be sensitively correlated with different degrees of population densities as evidenced by the highly significant differences among the various Groups. However, in regard to the metasternal index (K/L), Group II is nearer to Group III than to Group I, and whereas the differences between the Groups are all significant in the case of males, this is not so in the case of females. Taken as a whole, the differences observed in most ratios between the Groups are quite marked and the probability of obtaining such large differences by chance causes is negligible. The Groups may thus be considered as having been drawn from populations having different mean values. This in itself justifies the *groupings* of a year's collection for biometrical studies.

2. Regarding inter-sex comparison (Table 6) in the various Groups, I(6), II(6), III(6) and III(7), for all the ratios, except the metasternal interspace ratio (K/L), the males generally have lower values than females, this sexual difference being more marked in the 7-eye-striped individuals (Group III) than in the 6-eye-striped ones (Groups I—III). In respect of K/L , however, the males have *higher* values than females in all the four groups. The ratio P/C is the least sex-sensitive, and no inter-sex differences is noticeable, while the ratio K/L is the most sex-sensitive since not only is the inter-sex difference present in all the four groups but also its magnitude is large.

3. The problem of assigning the 1955-Groups to proper phases has been dealt with on the basis of configuration of three morphometric ratios, viz., E/F , F/C , and P/C . Regarding E/F ratio, Groups I and II show such differences in mean values with *phase solitaria* and the *Kakko Concentration* (of 1949) that it is unlikely that they have been drawn from the same type of populations by random sampling. Group III is significantly different from *phase gregaria* and the *Ajmer Swarm* (of 1950). Values of *phase solitaria* are not available for comparison with the 1955-Groups in regard to the ratios F/C and P/C . These latter ratios also give almost the same result as E/F . Thus, in general terms, it can be remarked that Groups I and II both possess characteristics which are identical with or very close to those of *phase gregaria*, and Group III with those of *phase solitaria*.

4. The Sexual Dimorphism Percentage (S.D.P.) with respect to various morphometric ratios does not convey explicitly the closeness of the Groups to the appropriate phase, as is apparent from the tests of significance.

VI—DISCUSSION AND CONCLUSIONS

Some general conclusions drawn from the data presented above may now be discussed.

(a) *Trend of morphological characters during swarming period*

(Plates 6 & 7)

Roonwal (1954) has shown that with regard to number of eye-stripes and related characters in the Desert Locust the *gregaria* phase is variation-stable (little variation) and there is a flowering of variation in the *solitaria* phase. This situation holds good also for other morphometric characters, such as E, F, C and the ratios E/F, etc.

Furthermore, the characters E, F and C, in both sexes, show almost the same kind of fluctuations, thus suggesting a positive correlation between them. The character E is, however, exceptional in males where the trend is irregular.

(b) *Relative size of eye in the 1955-Groups* (Tables 3A-D)

That vision may play an important role in the maintenance of gregarization was emphasised by Roonwal (1958). In this connection, in addition to variation in the number of eye-stripes and the differential distribution of pigment in the eyes, significant variations also occur in the size (length and width) of eyes in different populations. In the 1955-Groups, the size of eye in Groups I and II (which are close to phase *gregaria* in other characters) is not significantly different from each other, but both these are significantly lower than in Group III which is close to phase *solitaria*.

(c) *Remarks on the Group III population of 1955*

The Group III (September to December) of the year 1955 is of particular interest as it is a "dissocians" population marking the end of the 1949-55 swarming cycle and immediately precedes the non-swarming period of 1956-59. This population reveals the following characters which are likely to be of interest in the study of field populations under similar circumstances :—

(i) The population density was low (about 40—1333 per square mile), except in two localities where it was moderate (3600 and 8400 per square mile).

(ii) Of the 150 specimens available in this Group, 113 (75 per cent) belong to phase *solitaria* (taking the E/F ratio as a phase criterion). In these 113 phase *solitaria* individuals, the proportion of 6- and 7-eye-striped individuals is not very different (6-striped, 52 per cent ; and 7-striped, 48 per cent). The decrease in the relative proportion of 6-striped (52 per cent) forms far below the normal 80 per cent and above level of "*gregaria*" populations (Roonwal, 1945), and the sudden increase of the 7-striped (48 per cent) ones from the normal 20 per cent or lower, along with the presence of 8-striped forms (the extreme *solitaria* form), shows the complete domination of this Group by the *solitaria* features, overshadowing the *gregaria* nature of the two earlier Groups (I and II). Somewhat similar results were reported by Roonwal (1954) in the peak *solitaria* year (1936) of the non-swarming period (1932-39) in an earlier locust cycle, when the percentage of 7-striped individuals was higher than the 6-striped ones, and a few 8-striped forms also appeared.

(iii) In the 6-eye-striped category, the proportion of males and females in Group III is ♂ 84 : ♀ 16, *i.e.*, the males predominate, as postulated for *solitaria* 6-striped populations in Roonwal's Second Hypothesis (1945).

(iv) The mean values of estimated parameters of the morphometric characters E, F, C, P and the ratios E/F, E/C, F/C and P/C of Group III

individuals show a close proximity to phase *solitaria* as defined by Roonwal (1949), and no significant differences between the two are noticeable. Similarly, the values of S.D.P. (Sexual Dimorphism Percentage) for characters E and F and for the ratio E/F do not show any significant differences between the two populations.

(v) Thus, on the basis of the morphometric characters, the unstability in the eye-stripe variability and the inequality in the sex-ratios (in the 6-striped category), it may be concluded that Group III was a true *solitaria* population, initiating the new solitary-cycle (1956 onward).

VII—SUMMARY

1. The random samples of Desert Locust population of the year 1955, consisting of 1,179 specimens, were, for convenience of study, grouped under three natural Groups, I (January-April), II (May-August) and III (September-December).

2. Regarding eye-stripe composition, the high proportion of 6-striped individuals in Groups I (93 per cent) and II (99 per cent), indicates phase *gregaria* features and the relative abundance of individuals with 7-striped (44 per cent) in Group III shows its *solitaria* nature. Two 8-striped females in Group III were obtained. The position of 5-striped forms (obtained in Group II) is discussed.

3. Sex-ratios in relation to eye-stripes are discussed. In the 6 striped category, the proportion of sexes is about equal in Groups I and II, whereas in Group III the males predominate (♂ 84 per cent : ♀ 16 per cent).

4. From inter-group comparisons it is seen that the values of various morphometric characters are not significantly different from each other, and that these two groups must have originated from nearly similar parent populations. The values in Group III differ significantly from those in Groups I and II.

5. From inter-sex comparisons it is seen that within the same Group the values for males, in all characters, are significantly lower than in females.

6. From inter-phase comparisons it is seen that the mean values for various characters for Groups I and II are not significantly different from the corresponding values in phase *gregaria* and the "Ajmer swarm" (1950), whereas the values in Group III are almost similar to that in phase *solitaria*.

7. A remarkably high degree of sexual dimorphism, as expressed in the Sexual Dimorphism Percentage (S.D.P.), is noticed in characters K and L relating to the metasternal interspace.

8. The ratios E/F, E/W₁, E/C, F/C, P/C, M/C, H/C, and K/L generally show results which are similar to those derived from the study of the size of the body-parts.

9. The size of the compound eye (length and width) was studied. Groups I and II do not differ in this respect, but eyes in Group III are significantly larger than in the other two groups.

10. Group I and II are near phase *gregaria*, but Group III (September-December, 1955) is close to phase *solitaria*. The significance of this position is discussed.

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TABLE 1.—*Group-wise and monthly distribution of eye-stripe (6- and 7-striped) composition and sex-ratios in the 1955-population of the Desert Locust in India.*

Group	Month (1955)	Number of individuals in each sex and eye-stripe category				Total	
		6-eye-striped		7-eye-striped		♂	♀
		♂	♀	♂	♀		
I	January	22 (57.9%)	16 (42.1%)	—	—	22 (57.9%)	16 (42.1%)
	February	1 (—)	—	—	—	1 (—)	—
	March	—	2 (—)	3 (—)	—	3 (60%)	2 (40%)
	April	—	—	—	—	—	—
	Total for Group I	23 (56.0%)	18 (44.0%)	3 (—)	—	26 (59.0%)	18 (41.0%)
II	May	130 (51.6%)	122 (48.4%)	—	—	130 (51.6%)	122 (48.4%)
	June	139 (42.0%)	192 (58.0%)	—	4 (—)	139 (41.5%)	196 (58.5%)
	July	114 (46.1%)	133 (53.9%)	—	3 (—)	114 (45.6%)	136 (54.4%)
	August	61 (58.1%)	44 (41.9%)	1 (25.0%)	3 (75.0%)	62 (56.9%)	47 (43.1%)
	Total for Group II	444 (47.5%)	491 (52.5%)	1 (9.0%)	10 (91.0%)	445 (47.0%)	501 (53.0%)
III	September	27 (84.4%)	5 (15.6%)	6 (46.2%)	7 (53.8%)	33 (73.3%)	12 (26.7%)
	October	28 (87.5%)	4 (12.5%)	4 (14.8%)	23 (85.2%)	32 (54.0%)	27 (46.0%)
	November	16 (84.2%)	3 (15.8%)	11 (45.8%)	13 (54.2%)	27 (62.8%)	16 (37.2%)
	December	—	1 (—)	—	—	—	1 (—)
	Total for Group III	71 (84.0%)	13 (16.0%)	21 (33.0%)	43 (67.0%)	92 (62.0%)	56 (38.0%)

TABLE 2.—Sex-ratio and proportion of 6- and 7-eye-striped individuals in Groups I, II and III in the 1955-population of the Desert Locust in India.

Group	Sex	Number of eye-stripes					Percentage by sex-ratio in each type±S.E.*		Percentage of individuals in each type±S.E.*	
		5	6	7	8	Total	6-striped	7-striped	6-striped	7-striped
I						26				
	♂	—	23	3	—	(59.0%)	56.0±7.0	—	—	—
	♀	—	18	—	—	18	44.0±7.0	—	—	—
						(41.0%)				
						44				
Total		—	41	3	—		..	..	93.0±4.0	7.0±4.0
						(100.0%)				
II						445				
	♂	—	444	1	—	(47.0%)	47.5±2.0	9.0±9.0	—	—
	♀	2	491	10	—	503	52.5±2.0	91.0±9.0	—	—
						(53.0%)				
						948				
Total		2	935	11	—	(100.0%)	..	..	98.9±0.3	1.1±0.3
III						92				
	♂	—	71	21	—	(62.0%)	84.0±4.0	33.0±5.0	—	—
	♀		13	43	2	58	16.0±4.0	67.0±5.0	—	—
						(38.0%)				
						150				
Total		—	84	64	2	(100.0%)	..	..	56.0±4.0	44.0±4.0

* Standard Error.

TABLE 3A.—*Values for various morphometric characters in Desert Locust population in India for 1955 (Group I).*

Abbreviations :—
n, Number of individuals.
S. E., Standard error.
S. D., Standard deviation.
C. V., Coefficient of variation.

Sex and number of eye stripes	Group I				
	<i>n</i>	Range	Mean $\pm$ <i>S.E.</i>	<i>S.D.</i> $\pm$ <i>S.E.</i>	<i>C.V.</i> $\pm$ <i>S.E.</i>
1	2	3	4	5	6
1. Length of eye (A)					
1. ♂♂(6)	23	3.25—4.00	3.76 $\pm$ 0.04	0.176 $\pm$ 0.026	4.68 $\pm$ 0.69
2. ♂♂(7)	3	3.75—4.00	3.83 $\pm$ 0.082	0.142 $\pm$ 0.058	3.71 $\pm$ 1.51
3. ♀♀(6)	18	3.50—4.00	3.93 $\pm$ 0.034	0.144 $\pm$ 0.024	3.66 $\pm$ 0.61
4. ♀♀(7)	..	..	..	..	..
2. Width of eye (B)					
5. ♂♂(6)	23	2.00—2.50	2.40 $\pm$ 0.030	0.146 $\pm$ 0.022	6.70 $\pm$ 0.99
6. ♂♂(7)	3	2.50—2.50	2.50 $\pm$ 0.0	..	..
7. ♀♀(6)	18	2.25—2.50	2.47 $\pm$ 0.019	0.080 $\pm$ 0.013	3.24 $\pm$ 0.54
8. ♀♀(7)	..	..	..	..	..
3. Width of head at ocular region (O)					
9. ♂♂(6)	23	5.5 —6.6	6.30 $\pm$ 0.050	0.242 $\pm$ 0.036	3.84 $\pm$ 0.57
10. ♂♂(7)	3	6.1 —6.4	6.27 $\pm$ 0.088	0.153 $\pm$ 0.062	2.44 $\pm$ 1.00
11. ♀♀(6)	18	6.1 —7.1	6.71 $\pm$ 0.067	0.284 $\pm$ 0.047	4.23 $\pm$ 0.70
12. ♀♀(7)	..	..	..	..	..
4. Width of head at genal level (C)					
13. ♂♂(6)	23	6.2—7.7	7.31 $\pm$ 0.071	0.342 $\pm$ 0.05	4.68 $\pm$ 0.69
14. ♂♂(7)	3	6.4—6.9	6.63 $\pm$ 0.144	0.250 $\pm$ 0.102	3.77 $\pm$ 1.54
15. ♀♀(6)	17	7.2—8.5	7.83 $\pm$ 0.074	0.314 $\pm$ 0.052	4.01 $\pm$ 0.67
16. ♀♀(7)	..	..	..	..	..
5. Length of pronotum (P)					
17. ♂♂(6)	23	8.3—10.5	9.66 $\pm$ 0.114	0.548 $\pm$ 0.081	5.67 $\pm$ 0.84
18. ♂♂(7)	3	9.0—10.5	9.67 $\pm$ 0.44	0.765 $\pm$ 0.31	7.91 $\pm$ 3.23
19. ♀♀(6)	18	9.7—11.4	10.47 $\pm$ 0.113	0.479 $\pm$ 0.080	4.57 $\pm$ 0.76
20. ♀♀(7)	..	..	..	..	..
6. Height of pronotum (H)					
21. ♂♂(6)	23	7.1—8.6	8.03 $\pm$ 0.079	0.377 $\pm$ 0.056	4.69 $\pm$ 0.69
22. ♂♂(7)	3	7.7—8.6	8.13 $\pm$ 0.262	0.453 $\pm$ 0.184	5.57 $\pm$ 2.27
23. ♂♂(6)	18	7.8—9.7	8.70 $\pm$ 0.111	0.471 $\pm$ 0.078	5.41 $\pm$ 0.90
24. ♀♀(7)	..	..	..	..	..

TABLE 3A—contd.

Group I					
Sex and number of eye-stripes	n	Range	Mean $\pm$ S. E.	S. D. $\pm$ S. E.	V. $\pm$ S. E.
1	2	3	4	5	6
7. Width of pronotum at Constriction (M)					
25. ♂♂(6)	23	5.3—6.4	5.80 $\pm$ 0.049	0.238 $\pm$ 0.03	4.10 $\pm$ 0.60
26. ♂♂(7)	3	5.6—6.1	5.80 $\pm$ 0.15	0.264 $\pm$ 0.11	4.55 $\pm$ 1.86
27. ♀♀(6)	18	5.9—7.0	6.52 $\pm$ 0.071	0.300 $\pm$ 0.05	4.60 $\pm$ 0.77
28. ♀♀(7)	..	..	..	..	..
8. Length of elytra (E)					
29. ♂♂(6)	23	47.2—56.4	51.01 $\pm$ 0.49	2.33 $\pm$ 0.34	0.046 $\pm$ 0.007
30. ♂♂(7)	3	47.5—52.7	50.23 $\pm$ 1.51	2.61 $\pm$ 1.07	5.20 $\pm$ 2.12
31. ♀♀(6)	17	52.4—63.5	57.09 $\pm$ 0.72	2.98 $\pm$ 0.51	5.22 $\pm$ 0.90
32. ♀♀(7)	..	..	..	..	..
9. Broadest width of metasternal interspace (K)					
33. ♂♂(6)	23	0.75—1.00	0.7717 $\pm$ 0.015	0.072 $\pm$ 0.011	9.33 $\pm$ 1.375
34. ♂♂(7)	3	0.50—1.00	0.75 $\pm$ 0.144	0.25 $\pm$ 0.102	33.33 $\pm$ 13.606
35. ♀♀(6)	18	1.00—1.50	1.1667 $\pm$ 0.035	0.1485 $\pm$ 0.025	12.72 $\pm$ 2.12
36. ♀♀(7)	..	..	..	..	..
10. Narrowest width of metasternal interspace (L)					
37. ♂♂(6)	23	0.50—0.75	0.5869 $\pm$ 0.025	0.1216 $\pm$ 0.017	20.72 $\pm$ 3.055
38. ♂♂(7)	3	0.25—0.75	0.50 $\pm$ 0.144	0.25 $\pm$ 0.102	50.00 $\pm$ 20.402
39. ♀♀(6)	18	0.75—1.25	1.00 $\pm$ 0.028	0.1212 $\pm$ 0.020	12.12 $\pm$ 2.02
40. ♀♀(7)	..	..	..	..	..
11. Restricted width of elytra (W ₁)					
1. ♂♂(6)	23	6.1 —7.5	6.89 $\pm$ 0.067	0.320 $\pm$ 0.047	4.64 $\pm$ 0.68
42. ♂♂(7)	3	6.0 —7.4	6.57 $\pm$ 0.43	0.738 $\pm$ 0.30	11.23 $\pm$ 4.59
4. ♀(6)	18	7.1 —8.1	7.66 $\pm$ 0.066	0.281 $\pm$ 0.047	3.67 $\pm$ 0.61
44. ♀(7)	..	..	..	..	..
12. Length of hind-femur (F)					
45. ♂♂(6)	23	19.9—25.7	23.11 $\pm$ 0.26	1.25 $\pm$ 0.18	5.41 $\pm$ 0.80
46. ♂♂(7)	3	24.2—26.4	25.30 $\pm$ 0.64	1.10 $\pm$ 0.45	4.35 $\pm$ 1.78
47. ♀♀(6)	16	23.3—27.7	25.52 $\pm$ 0.34	1.38 $\pm$ 0.24	5.40 $\pm$ 0.95
48. ♀♀(7)	..	..	..	..	..

TABLE 3B.—*Values for various morphometric characters in Desert Locust population in India for 1955 (Group II).**Abbreviations :—As in Table 3A.*

Sex and number of eye-stripes	Group II				
	<i>n</i>	Range	Mean $\pm$ S. E.	S. D. $\pm$ S. E.	C. V. $\pm$ S. E.
	1	3	4	5	6
1. Length of eye (A)					
1. ♂♂ (6)	443	3.00 —4.25	3.81 $\pm$ 0.01	0.202 $\pm$ 0.007	5.32 $\pm$ 0.18
2. ♂♂ (7)	1	..	3.75 $\pm$ 0.0	..	..
3. ♀♀ (6)	491	3.10 —4.50	3.99 $\pm$ 0.009	0.192 $\pm$ 0.006	4.81 $\pm$ 0.15
4. ♀♀ (7)	10	4.00 —4.50	4.25 $\pm$ 0.065	0.204 $\pm$ 0.046	4.80 $\pm$ 1.07
2. Width of eye (B)					
5. ♂♂ (6)	443	2.00 —2.90	2.46 $\pm$ 0.004	0.075 $\pm$ 0.003	3.04 $\pm$ 0.12
6. ♂♂ (7)	1	..	2.50 $\pm$ 0.0	..	..
7. ♀♀ (6)	491	2.00 —2.75	2.54 $\pm$ 0.008	1.174 $\pm$ 0.006	6.85 $\pm$ 0.219
8. ♀♀ (7)	10	2.50 —3.00	2.70 $\pm$ 0.050	0.369 $\pm$ 0.082	13.18 $\pm$ 2.9
3. Width of head at ocular region (O)					
9. ♂♂ (6)	441	5.4 —7.2	6.40 $\pm$ 0.013	0.265 $\pm$ 0.009	4.14 $\pm$ 0.14
10. ♂♂ (7)	1	..	6.10 $\pm$ 0.0	..	..
11. ♀♀ (6)	490	5.8 —7.5	6.79 $\pm$ 0.015	0.332 $\pm$ 0.011	4.88 $\pm$ 0.16
12. ♀♀ (7)	10	6.4 —7.4	6.94 $\pm$ 0.105	0.333 $\pm$ 0.075	4.80 $\pm$ 1.07
4. Width of head at genal level (C)					
13. ♂♂ (6)	443	5.9 —8.2	7.20 $\pm$ 0.02	0.418 $\pm$ 0.014	5.80 $\pm$ 0.19
14. ♂♂ (7)	1	..	6.30 $\pm$ 0.0	..	..
15. ♀♀ (6)	491	6.5 —8.8	7.88 $\pm$ 0.019	0.427 $\pm$ 0.014	5.42 $\pm$ 0.17
16. ♀♀ (7)	10	7.0 —8.2	7.63 $\pm$ 0.146	0.462 $\pm$ 0.103	6.05 $\pm$ 1.35
5. Length of pronotum (P)					
17. ♂♂ (6)	441	8.2—11.4	9.94 $\pm$ 0.023	0.600 $\pm$ 0.020	6.04 $\pm$ 0.203
18. ♂♂ (7)	1	..	10.00 $\pm$ 0.0	..	..
19. ♀♀ (6)	487	8.7 —12.4	10.86 $\pm$ 0.030	0.663 $\pm$ 0.021	6.11 $\pm$ 0.19
20. ♀♀ (7)	9	10.2 —13.2	11.50 $\pm$ 0.29	0.859 $\pm$ 0.202	7.45 $\pm$ 1.76
6. Height of pronotum (H)					
21. ♂♂ (6)	443	6.8—9.3	8.14 $\pm$ 0.022	0.458 $\pm$ 0.015	6.62 $\pm$ 0.19
22. ♂♂ (7)	1	..	7.70 $\pm$ 0.0	..	..
23. ♀♀ (6)	491	1—10.8	8.98 $\pm$ 0.026	0.576 $\pm$ 0.018	6.35 $\pm$ 0.20
24. ♀♀ (7)	10	8.5—10.5	9.37 $\pm$ 0.207	0.555 $\pm$ 0.146	6.99 $\pm$ 1.56

TABLE 3B—contd.

Sex and number of eyc-stripes	Group II				
	<i>n</i>	Range	Mean ± S.E.	S.D. ± S.E.	C. V. ± S.E.
1	2	3	4	5	6
7. Width of pronotum at constriction (M)					
25. ♂♂(6)	443	5.1—7.1	5.91±0.015	0.319±0.010	5.39±0.181
26. ♂♂(7)	1	..	5.70±0.0	..	..
27. ♀♀(6)	491	5.5—8.3	6.63±0.017	0.373±0.012	5.63±0.18
28. ♀♀(7)	10	6.1—7.2	6.78±0.121	0.386±0.09	5.69±1.27
8. Length of elytra (E)					
29. ♂♂(6)	421	44.5—58.8	52.48±0.13	2.66±0.09	5.07±0.17
30. ♂♂(7)	1	..	50.20±0.0	..	..
31. ♀♀(6)	459	8.6—66.5	59.09±0.14	3.02±0.10	5.12±0.17
32. ♀♀(7)	9	57.0—64.5	60.22±0.90	2.70±6.64	4.48±1.05
9. Broadest width of metasternal interspace(K)					
33. ♂♂(6)	438	0.50—1.25	0.7905±0.006	0.1145±0.0039	14.48±0.489
34. ♂♂(7)	1	..	0.75±0.0	..	..
35. ♀♀(6)	488	1.00—1.50	1.2438±0.006	0.1342±0.0043	10.79±0.3454
36. ♀♀(7)	10	1.00—1.50	1.225±0.058	0.1844±0.0412	15.05±3.366
10. Narrowest width of metasternal interspace (L)					
37. ♂♂(6)	438	0.25—1.25	0.5314±0.005	0.1082±0.0037	20±36±0.6879
38. ♂♂(7)	1	..	0.50±0.0	..	..
39. ♀♀(6)	488	0.50—1.25	1.0026±0.005	0.1039±0.0038	10.36±0.3317
40. ♀♀(7)	10	0.75—1.25	0.95±0.053	0.1581±0.0373	16.64±3.9226
11. Restricted width of elytra (W ₁)					
41. ♂♂(6)	444	6.0—8.7	7.10±0.021	0.451±0.015	6.35±0.213
42. ♂♂(7)	1	..	6.20±0.0	..	..
43. ♀♀(6)	491	6.1—10.1	7.82±0.023	0.514±0.016	6.57±0.210
44. ♀♀(7)	10	7.0—8.4	7.67±0.14	0.0459±0.103	5.99±1.34
12. Length of hind femur (F)					
45. ♂♂(6)	417	19.9—26.9	24.06±0.07	1.32±0.05	5.49±0.19
46. ♂♂(7)	1	..	25.10±0.0	..	..
47. ♀♀(6)	454	21.7—30.5	26.50±0.07	1.58±0.05	5.96±0.20
48. ♀♀(7)	9	26.3—31.6	28.63±0.55	1.66±0.39	5.81±1.37

TABLE 3C.—*Values for various morphometric characters in Desert Locust population in India for 1955 (Group III).*

Abbreviations :—As in Table 3A.

Sex and number of eye-stripes	Group III				
	<i>n</i>	Range	Mean $\pm$ S.E.	S. D. $\pm$ S.E.	C. V. $\pm$ S.E.
1	2	3	4	5	6
1. Length of eye (A)					
1. ♂♂(6)	71	3.50—4.25	3.88 $\pm$ 0.019	0.161 $\pm$ 0.014	4.15 $\pm$ 0.35
2. ♂♂(7)	21	3.75—4.50	4.00 $\pm$ 0.034	0.154 $\pm$ 0.024	3.86 $\pm$ 0.59
3. ♀♀(6)	13	3.25—4.50	4.06 $\pm$ 0.09	0.312 $\pm$ 0.061	7.69 $\pm$ 1.51
4. ♀♀(7)	43	4.00—4.75	4.41 $\pm$ 0.03	0.194 $\pm$ 0.021	4.40 $\pm$ 0.47
2. Width of eye (B)					
5. ♂♂(6) .	71	2.20—2.75	2.54 $\pm$ 0.015	0.127 $\pm$ 0.011	5.01 $\pm$ 0.42
6. ♂♂(7) . .	21	2.50—2.75	2.65 $\pm$ 0.026	0.120 $\pm$ 0.019	4.54 $\pm$ 0.70
7. ♀♀(6) .	13	2.25—3.00	2.65 $\pm$ 0.064	0.231 $\pm$ 0.045	8.73 $\pm$ 1.71
8. ♀♀(7) . .	43	2.75—3.00	2.88 $\pm$ 0.019	0.126 $\pm$ 0.014	4.36 $\pm$ 0.47
3. Width of head at ocular region (O).					
9. ♂♂(6) . .	71	5.7—6.7	6.24 $\pm$ 0.025	0.212 $\pm$ 0.018	3.40 $\pm$ 0.285
10. ♂♂(7)	21	6.1—7.1	6.46 $\pm$ 0.049	0.225 $\pm$ 0.035	3.49 $\pm$ 0.538
11. ♀♀(6)	13	5.6—7.3	6.75 $\pm$ 0.013	0.482 $\pm$ 0.095	7.15 $\pm$ 1.40
12. ♀♀(7)	43	6.4—7.8	7.14 $\pm$ 0.046	0.301 $\pm$ 0.032	4.22 $\pm$ 0.455
4. Width of head at genal level (C)					
13. ♂♂(6) .	71	5.9—7.7	6.55 $\pm$ 0.043	0.359 $\pm$ 0.03	5.48 $\pm$ 0.46
14. ♂♂(7) .	21	6.2—7.2	6.67 $\pm$ 0.053	0.242 $\pm$ 0.037	3.63 $\pm$ 0.56
15. ♀♀(6)	13	6.1—8.3	7.42 $\pm$ 0.165	0.595 $\pm$ 0.117	9.01 $\pm$ 1.57
16. ♀♀(7)	43	7.1—8.4	7.70 $\pm$ 0.050	0.325 $\pm$ 0.035	4.21 $\pm$ 0.45
5. Length of pronotum (P)					
17. ♂♂(6)	71	8.8—11.2	9.86 $\pm$ 0.060	0.508 $\pm$ 0.043	5.16 $\pm$ 0.433
18. ♂♂(7)	21	9.4—11.0	10.20 $\pm$ 0.084	0.383 $\pm$ 0.059	3.77 $\pm$ 0.582
19. ♀♀(6)	13	7.9—12.0	10.76 $\pm$ 0.295	1.063 $\pm$ 0.209	9.88 $\pm$ 1.94
20. ♀♀(7)	43	10.5—13.2	11.90 $\pm$ 0.102	0.667 $\pm$ 0.072	5.60 $\pm$ 0.064
6. Height of pronotum (H)					
21. ♂♂(6) .	71	7.2—9.2	8.20 $\pm$ 0.045	0.375 $\pm$ 0.031	4.59 $\pm$ 0.385
22. ♂♂(7) . .	21	7.7—9.3	8.40 $\pm$ 0.091	0.419 $\pm$ 0.065	5.01 $\pm$ 0.773
23. ♀♀(6) . .	13	7.1—10.2	9.10 $\pm$ 0.272	0.981 $\pm$ 0.192	10.78 $\pm$ 2.17
24. ♀♀(7) .	43	9.1—10.8	9.90 $\pm$ 0.069	0.456 $\pm$ 0.049	4.58 $\pm$ 0.494

TABLE 3C—contd.

Sex and number of eye-stripes	Group III				
	<i>n</i>	Range	Mean ± S.E.	S.D. ± S.E.	C.V. ± S.E.
1	2	3	4	5	6
7. Width of pronotum at constriction (M)					
25. ♂♂(6)	71	5.3—6.4	5.84±0.028	0.235±0.020	4.02±0.337
26. ♂♂(7)	21	5.5—6.5	5.98±0.048	0.220±0.034	3.69±0.57
27. ♀♀(6)	13	5.4—7.2	6.67±0.147	0.530±0.104	7.94±1.56
28. ♀♀(7)	43	6.6—7.6	7.09±0.045	0.293±0.032	4.13±0.445
8. Length of elytra (E)					
29. ♂♂(6)	61	46.3—57.9	52.07±0.310	2.50±0.22	4.80±0.421
30. ♂♂(7)	21	49.2—57.6	52.58±0.43	1.91±0.30	3.64±0.57
31. ♀♀(6)	11	54.3—65.1	59.74±0.91	3.01±0.64	5.04±1.07
32. ♀♀(7)	38	57.9—68.2	63.39±0.48	2.94±0.34	4.64±0.53
9. Broadest width of metasternal interspace (K)					
33. ♂♂(6)	71	0.50—1.00	0.7218±0.013	0.1072±0.0090	14.85±1.2463
34. ♂♂(7)	21	0.50—1.00	0.75±0.017	0.077±0.0119	10.27±1.5842
35. ♀♀(6)	12	1.00—1.25	1.2291±0.021	0.0721±0.0147	5.87±1.1973
36. ♀♀(7)	43	1.00—1.75	1.267±0.021	0.138±0.015	10.88±1.1741
10. Narrowest width of metasternal interspace (L)					
37. ♂♂(6)	71	0.25—0.75	0.4683±0.012	0.1020±0.0086	21.78±1.8278
38. ♂♂(7)	21	0.25—0.75	0.51±0.021	0.095±0.0147	18.56±2.8636
39. ♀♀(6)	12	0.75—1.25	1.00±0.0	0.0±0.0	0.0±0.0
40. ♀♀(7)	43	0.75—1.25	1.00±0.012	0.0768±0.0083	7.68±0.8281
11. Restricted width of elytra (W ₁)					
41. ♂♂(6)	71	5.9—7.8	6.66±0.047	0.394±0.033	5.91±0.50
42. ♂♂(7)	21	6.1—7.4	6.71±0.075	0.345±0.053	5.15±0.795
43. ♀♀(6)	13	6.3—8.2	7.36±0.165	0.595±0.117	8.09±1.59
44. ♀♀(7)	43	7.1—8.6	7.84±0.063	0.413±0.044	5.26±0.57
12. Length of hind-femur (F)					
45. ♂♂(6)	61	21.8—27.7	25.24±0.156	1.22±0.110	4.82±0.44
46. ♂♂(7)	19	24.6—29.0	26.12±0.23	0.99±0.16	3.80±0.62
47. ♀♀(6)	12	21.5—31.9	27.97±0.90	3.14±0.64	11.22±2.29
48. ♀♀(7)	40	28.3—34.1	31.21±0.22	1.41±0.16	4.51±0.50

TABLE 3D.—*Inter-group comparisons of various morphometric characters (within the same sex and eye-stripe group) between Groups I—III of the 1955 Desert Locust population in India (From data in Tables 3A, 3B and 3C).*

Abbreviations :—NS., Not significant at 5 % level of probability.
*, Significant at 5 % level of probability.
**, Significant at 1 % level of probability.
***, Significant at 0.1 % level of probability.

Sex and number of eye-stripes	Significance of difference between the 1955-groups								
	Mean			S.D.			C.V.		
	Gr. I & Gr. II	Gr. I & Gr. III	Gr. II & Gr. III	Gr. I & Gr. II	Gr. I & Gr. III	Gr. II & Gr. III	Gr. I & Gr. II	Gr. I & Gr. III	Gr. II & Gr. III
	2	3	4	5	6	7	8	9	10
1									
1. Length of ey (A)									
1. ♂♂(6)	NS	**	**	NS	NS	**	NS	NS	**
2. ♂♂(7)	..	NS	..	..	NS	..	..	NS	..
3. ♀♀(6)	NS	NS	NS	NS	**	**	NS	*	NS
4. ♀♀(7)	..	..	*	..	..	NS	..	..	NS
2. Width of eye (B)									
5. ♂♂(6)	*	***	***	***	NS	*	***	NS	***
6. ♂♂(7)	..	NS	..	..	NS	..	..	NS	..
7. ♀♀(6)	***	*	NS	***	*	*	***	**	NS
8. ♀♀(7)	..	..	**	..	..	*	..	..	**
3. Width of head at ocular region (O)									
9. ♂♂(6)	NS	NS	***	NS	NS	**	NS	NS	**
10. ♂♂(7)	..	NS	..	..	NS	..	..	NS	..
11. ♀♀(6)	NS	NS	*	NS	*	*	NS	NS	NS
12. ♀♀(7)	..	..	NS	..	..	NS	..	..	NS
4. Width of head at genal level (C)									
13. ♂♂(6)	***	***	***	NS	NS	*	NS	NS	NS
14. ♂♂(7)	..	NS	..	..	NS	..	..	NS	..
15. ♀♀(6)	NS	*	**	NS	**	*	*	*	NS
16. ♀♀(7)	..	..	NS	..	..	NS	..	..	NS
5. Length of pronotum (P)									
17. ♂♂(6)	*	NS	NS	NS	NS	*	NS	NS	NS
18. ♂♂(7)	..	NS	..	..	*	..	..	NS	..
19. ♀♀(6)	**	NS	NS	NS	**	**	NS	*	*
20. ♀♀(7)	..	..	NS	..	..	NS	..	..	NS

TABLE 3D—continued.

Sex and number of eye-stripes	Significance of difference between the 1955-groups									
	Mean			S.D.			C.V.			
	Gr. I & Gr. II	Gr. I & Gr. III	Gr. II & Gr. III	Gr. I & Gr. II	Gr. I & Gr. III	Gr. II & Gr. III	Gr. I & Gr. II	Gr. I & Gr. III	Gr. II & Gr. III	
	1	2	3	4	5	6	7	8	9	10
6. Height of pronotum (H)										
21. ♂♂(6)	.	NS	NS	NS	NS	NS	*	NS	NS	**
22. ♂♂(7)	.	..	NS	..	..	NS	..	..	NS}	..
23. ♀♀(6)	.	*	NS	NS	NS	**	***	NS	*	*
24. ♀♀(7)	.	..	..	*	..	..	NS	..	..	NS
7. Width of pronotum at constriction (M)										
25. ♂♂(6)	.	*	NS	*	*	NS	***	*	NS	***
26. ♂♂(7)	.	..	NS	..	..	NS	..	..	NS	..
27. ♀♀(6)		NS	NS	NS	NS	*	*	NS	NS	NS
28. ♀♀(7)		..	..	*	..	..	NS	..	..	NS
8. Length of elytra (E)										
29. ♂♂(6)		**	NS	NS	NS	NS	NS	NS	NS	NS}
30. ♂♂(7)	.	..	NS	..	..	NS	..	..	NS	..
31. ♀♀(6)		**	*	NS	NS	NS	NS	NS	NS	NS
32. ♀♀(7)		..	..	**	..	..	..	NS	..	NS
9. Broadest width of metasternal interspace (K)										
23. ♂♂(6)	.	1 S	*	***	**	*	NS	***	**	NS
34. ♂♂(7)		..	NS	..	..	***	..	..	NS	..
35. ♀♀(6)		*	*	NS	NS	**	**	NS	**	***
36. ♀♀(7)		..	..	NS	..	..	NS	..	..	NS
10. Narrowest width of metasternal interspace (L)										
37. ♂♂(6)	.	*	***	***	NS	NS	NS	NS	NS	NS
38. ♂♂(7)		..	NS	..	..	**	..	..	NS	..
39. ♀♀(6)	.	NS	NS	NS	NS	..	..	NS	***	***
40. ♀♀(7)	.	..	..	NS	..	..	***	..	..	*
11. Restricted width of elytra (W ₁)										
41. ♂♂(6)		**	**	***	*	NS	NS	**	NS	NS
♂♂(7)		..	NS	..	..	*	..	..	NS	..
43. ♀♀(6)	.	*	NS	**	**	*	NS	***	*	NS
44. ♀♀(6)		..	..	NS	..	..	NS	..	..	NS
12. Length of hind-femur (F)										
45. ♂♂(6)		***	***	***	NS	NS	NS	NS	NS	NS
46. ♂♂(7)		..	NS	..	..	NS	..	..	NS	..
47. ♀♀(6)		**	*	NS	NS	**	***	NS	*	*
48. ♀♀(7)		..	..	***	..	..	NS	..	..	NS

TABLE 4A.—*Values of Mean, S.D. and C.V of the morphometric characters E, F, C and P in the 1955-population (Groups I-III) of the Desert Locust in India.*

Abbreviations :— *n*, Number of individuals.
S. E., Standard error.
S. D., Standard deviation.
C. V., Coefficient of variation.

Statistical constants	Nature of population		
	Group I	Group II	Group III
	1	2	3
1. Length of elytra (E)			
Male (6)			
1. Mean $\pm$ S.E.	51.01 $\pm$ 0.49	52.48 $\pm$ 0.13	52.07 $\pm$ 0.31
(<i>n</i>)	(23)	(421)	(65)
2. S.D. $\pm$ S.E.	2.33 $\pm$ 0.34	2.66 $\pm$ 0.09	2.50 $\pm$ 0.22
3. C.V. $\pm$ S.E.	4.57 $\pm$ 0.68	5.07 $\pm$ 0.17	4.80 $\pm$ 0.42
Female (6)			
1. Mean $\pm$ S.E.	57.09 $\pm$ 0.72	59.09 $\pm$ 0.14	59.74 $\pm$ 0.91
(<i>n</i>)	(17)	(459)	(11)
2. S.D. $\pm$ S.E.	2.98 $\pm$ 0.51	3.02 $\pm$ 0.10	3.01 $\pm$ 0.64
3. C.V. $\pm$ S.E.	5.22 $\pm$ 0.90	5.12 $\pm$ 0.17	5.04 $\pm$ 1.07
Male (7)			
1. Mean $\pm$ S.E.	50.23 $\pm$ 1.51	50.2	52.58 $\pm$ 0.43
(<i>n</i>)	(3)	(1)	(20)
2. S.D. $\pm$ S.E.	2.61 $\pm$ 1.07	—	1.91 $\pm$ 0.30
3. C.V. $\pm$ S.E.	5.20 $\pm$ 2.12	—	3.64 $\pm$ 0.58
Female (7)			
1. Mean $\pm$ S.E.	..	60.22 $\pm$ 0.90	63.39 $\pm$ 0.48
(<i>n</i>)		(9)	(38)
2. S. D. $\pm$ S.E.	..	2.60 $\pm$ 0.64	2.94 $\pm$ 0.34
3. C.V. $\pm$ S.E.	..	4.48 $\pm$ 1.05	4.64 $\pm$ 0.53

TABLE 4A—*contd.*

Statistical constants	Nature of population		
	Group I	Group II	Group III
—	1	2	3
2. Length of hind-femur (F)			
Male (6)			
1. Mean $\pm$ S.E.	23.11 $\pm$ 0.26	24.06 $\pm$ 0.07	25.24 $\pm$ 0.16
(n)	(23)	(417)	(61)
2. S.D. $\pm$ S.E.	1.26 $\pm$ 0.18	1.32 $\pm$ 0.05	1.22 $\pm$ 0.11
3. C.V. $\pm$ S.E.	5.41 $\pm$ 0.80	5.49 $\pm$ 0.19	4.82 $\pm$ 0.44
Female (6)			
1. Mean $\pm$ S.E.	25.52 $\pm$ 0.34	26.50 $\pm$ 0.07	27.97 $\pm$ 0.91
(n)	(16)	(454)	(12)
2. S.D. $\pm$ S.E.	1.37 $\pm$ 0.24	1.58 $\pm$ 0.05	3.14 $\pm$ 0.64
3. C.V. $\pm$ S.E.	5.40 $\pm$ 0.95	5.96 $\pm$ 0.20	11.22 $\pm$ 2.29
Male (7)			
1. Mean $\pm$ S.E.	25.3 $\pm$ 0.64	25.1	26.12 $\pm$ 0.23
(n)	(3)	(1)	(19)
2. S.D. $\pm$ S.E.	1.1 $\pm$ 0.45	—	0.99 $\pm$ 0.16
3. C.V. $\pm$ S.E.	4.35 $\pm$ 1.78	—	3.80 $\pm$ 0.620
Female (7)			
1. Mean $\pm$ S.E.	—	28.63 $\pm$ 0.55	31.21 $\pm$ 0.22
(n)		(9)	(40)
2. S.D. $\pm$ S.E.	—	1.66 $\pm$ 0.39	1.41 $\pm$ 0.16
3. C.V. $\pm$ S.E.	—	5.81 $\pm$ 0.39	4.51 $\pm$ 0.50
3. Width of Head at Genal Level (C)			
Male (6)			
1. Mean $\pm$ S.E.	7.31 $\pm$ 0.071	7.21 $\pm$ 0.020	6.55 $\pm$ 0.04
(n)	(23)	(443)	(71)
2. S.D. $\pm$ S.E.	0.342 $\pm$ 0.050	0.42 $\pm$ 0.014	0.36 $\pm$ 0.03
3. C.V. $\pm$ S.E.	4.68 $\pm$ 0.69	5.80 $\pm$ 0.19	5.48 $\pm$ 0.46
Female (6)			
1. Mean $\pm$ S.E.	7.83 $\pm$ 0.074	7.88 $\pm$ 0.019	7.42 $\pm$ 0.16
(n)	(18)	(491)	(13)
2. S.D. $\pm$ S.E.	0.314 $\pm$ 0.052	0.43 $\pm$ 0.014	0.59 $\pm$ 0.12
3. C.V. $\pm$ S.E.	4.01 $\pm$ 0.67	5.42 $\pm$ 0.17	8.01 $\pm$ 1.57

TABLE 4A—concl*d.*

Statistical constants	Nature of Population		
	Group I	Group II	Group III
	1	2	3
Male (7)			
1. Mean ± S.E. (<i>n</i>)	6.63 ± 0.144 (3)	6.3 (1)	6.67 ± 0.05 (21)
2. S.D. ± S.E.	0.250 ± 0.102	—	0.24 ± 0.04
3. C.V. ± S.E.	3.77 ± 1.54	—	3.63 ± 0.56
Female (7)			
1. Mean ± S.E. (<i>n</i>)	.. (10)	7.63 ± 0.146 (10)	7.70 ± 0.05 (43)
2. S.D. ± S.E.	..	0.462 ± 0.103	0.33 ± 0.04
3. C.V. ± S.E.	..	6.05 ± 1.35	4.21 ± 0.45
4. Length of pronotum (P)			
Male (6)			
1. Mean ± S.E. (<i>n</i>)	9.66 ± 0.114 (23)	9.94 ± 0.029 (441)	9.86 ± 0.06 (71)
2. S.D. ± S.E.	0.548 ± 0.081	0.60 ± 0.020	0.51 ± 0.04
3. C.V. ± S.E.	5.67 ± 0.84	6.04 ± 0.20	5.16 ± 0.43
Female (6)			
1. Mean ± S.E. (<i>n</i>)	10.47 ± 0.113 (18)	10.86 ± 0.030 (487)	10.76 ± 0.29 (13)
2. S.D. ± S.E.	0.479 ± 0.080	0.66 ± 0.021	1.06 ± 0.21
3. C.V. ± S.E.	4.57 ± 0.76	6.11 ± 0.20	9.88 ± 1.94
Male (7)			
1. Mean ± S.E. (<i>n</i>)	6.67 ± 0.44 (3)	10.0 (1)	10.2 ± 0.08 (21)
2. S.D. ± S.E.	0.765 ± 0.31	—	0.38 ± 0.06
3. C.V. ± S.E.	7.91 ± 3.23	—	3.77 ± 1.58
Female (7)			
1. Mean ± S.E. (<i>n</i>)	.. (9)	11.50 ± 0.29 (9)	11.90 ± 0.10 (43)
2. S D. ± S.E.	..	0.859 ± 0.202	0.667 ± 0.072
3. S E. ± S.E.	..	7.45 ± 1.76	5.60 ± 0.60

TABLE 4B.—*Values of the morphometric characters E, F, C and P, in the Desert Locust in India, for "typical" phase gregaria and phase solitaria (Roonwal, 1949 ; Roonwal & Nag 1951) ; the Kakko Concentration(1949) and the Ajmer Swarm (1950).*

Abbreviations :—As in Table 4A.

Statistical constants	Nature of population			
	<i>Phase gregaria</i>	<i>Phase solitaria</i>	Kakko population	Ajmer swarm
—	1	2	3	4
1. Length of elytra (E)				
Male (6)				
1. Mean $\pm$ S.E.	52.85 $\pm$ 0.52	52.15 $\pm$ 0.24	51.46 $\pm$ 0.29	54.16 $\pm$ 0.70
(n)	(14)	(89)	(112)	(10)
2. S.D. $\pm$ S.E.	1.93 $\pm$ 0.36	2.23 $\pm$ 0.17	3.03 $\pm$ 0.20	2.20 $\pm$ 0.49
3. C.V. $\pm$ S.E.	3.65 $\pm$ 0.69	4.28 $\pm$ 0.32	5.89 $\pm$ 0.39	4.0 $\pm$ 0.91
Female (6)				
1. Mean $\pm$ S.E.	58.01 $\pm$ 0.81	61.56 $\pm$ 0.31	59.73 $\pm$ 0.42	59.70 $\pm$ 1.63
(n)	(26)	(63)	(72)	(4)
2. S. D. $\pm$ S.E.	4.12 $\pm$ 0.57	2.49 $\pm$ 0.22	3.53 $\pm$ 0.29	3.37 $\pm$ 1.19
3. C. V. $\pm$ S.E.	7.10 $\pm$ 0.98	4.04 $\pm$ 0.36	5.91 $\pm$ 0.49	5.64 $\pm$ 1.99
Male (7)				
1. Mean $\pm$ S.E.	..	52.38 $\pm$ 0.42	..	55.2
(n)	..	(25)	..	(1)
2. S.D. $\pm$ S.E.	..	2.10 $\pm$ 0.30	..	—
3. C. V. $\pm$ S.E.	..	4.01 $\pm$ 0.57	..	—
Female (7)				
1. Mean $\pm$ S.E.	..	62.90 $\pm$ 0.26	61.83 $\pm$ 1.41	..
(n)	..	(84)	(8)	..
2. S.D. $\pm$ S.E.	..	2.42 $\pm$ 0.19	3.99 $\pm$ 1.00	..
3. C.V. $\pm$ S.E.	..	3.85 $\pm$ 0.30	6.45 $\pm$ 1.64	..
2. Length of hind-femur (F)				
Male (6)				
1. Mean $\pm$ S.E.	24.32 $\pm$ 0.20	25.40 $\pm$ 0.12	24.92 $\pm$ 0.16	24.37 $\pm$ 0.29
(n)	(25)	(89)	(112)	(10)
2. S.D. $\pm$ S.E.	0.99 $\pm$ 0.14	1.12 $\pm$ 0.08	1.64 $\pm$ 0.11	0.91 $\pm$ 0.20
3. C.V. $\pm$ S.E.	4.07 $\pm$ 0.58	4.42 $\pm$ 0.33	6.58 $\pm$ 0.44	7.3 $\pm$ 0.83

TABLE 4B—*contd.*

Statistical constants	Nature of population			
	<i>Phase gregaria</i>	<i>Phase solitaria</i>	Kakko population	Ajmer swarm
—	1	2	3	4
Female (6)				
1. Mean ± S.E. (n)	26.44 ± 0.37 (34)	29.37 ± 0.18 (63)	28.35 ± 0.25 (72)	27.28 ± 0.25 (4)
2. S.D. ± S.E.	2.13 ± 0.26	1.44 ± 0.13	2.14 ± 0.18	1.23 ± 0.43
3. C.V. ± S.E.	8.06 ± 0.98	4.90 ± 0.44	7.55 ± 0.63	4.51 ± 1.59
Male (7)				
1. Mean ± S.E. (n)	..	26.13 ± 0.21 (2)	..	26.9 (1)
2. S.D. ± S.E.	..	1.04 ± 0.15	..	—
3. C.V. ± S.E.	..	3.98 ± 0.56	..	—
Female (7)				
1. Mean ± S.E. (n)	..	30.92 ± 0.13 (84)	29.94 ± 0.92 (8)	..
2. S.D. ± S.E.	..	1.21 ± 0.09	2.61 ± 0.65	..
3. C.V. ± S.E.	..	3.92 ± 0.30	8.72 ± 2.18	..
3. Width of Head at Genal Level (C)				
Male (6)				
1. Mean ± S.E. (n)	7.55 ± 0.045 (34)	..	6.60 ± 0.033 (112)	7.53 ± 0.082 (10)
2. S.D. ± S.E.	0.26 ± 0.032	..	0.35 ± 0.023	0.26 ± 0.058
3. C.V. ± S.E.	3.44 ± 0.42	..	5.30 ± 0.35	3.45 ± 0.77
Female (6)				
1. Mean ± S.E. (n)	7.89 ± 0.074 (40)	..	7.41 ± 0.041 (72)	7.90 ± 0.248 (4)
2. S.D. ± S.E.	0.47 ± 0.053	..	0.35 ± 0.029	0.50 ± 0.176
3. C.V. ± S.E.	5.96 ± 0.67	..	4.72 ± 0.39	6.29 ± 2.22

TABLE 4B—*contd.*

Statistical constants	Nature of population			
	<i>Phase gregaria</i>	<i>Phase solitaria</i>	Kakko population	Ajmer swarm
—	1	2	3	4
Male (7)				
1. Mean $\pm$ S.E.	..	..	..	6.9
(n)				(1)
2. S.D. $\pm$ S.E.	..	..		—
3. C.V. $\pm$ S.E.	..	..	..	—
Female (7)				
1. Mean $\pm$ S.E.	..	..	..	..
(n)				
2. S.D. $\pm$ S.E.		..	..	..
3. C.V. $\pm$ S.E.	..	..	..	..
4. Length of pronotum (P)				
Male (6)				
1. Mean $\pm$ S.E.	9.87 $\pm$ 0.079	..	9.76 $\pm$ 0.054	10.01 $\pm$ 0.108
(n)	(31)		(112)	(10)
2. S.D. $\pm$ S.E.	0.44 $\pm$ 0.056	..	0.57 $\pm$ 0.038	0.34 $\pm$ 0.076
3. C.V. $\pm$ S.E.	4.46 $\pm$ 0.57	..	5.84 $\pm$ 0.39	3.40 $\pm$ 0.76
Female (6)				
1. Mean $\pm$ S.E.	10.49 $\pm$ 0.133	..	10.94 $\pm$ 0.088	10.78 $\pm$ 0.343
(n)	(40)		(72)	(4)
2. S.D. $\pm$ S.E.	0.84 $\pm$ 0.094	..	0.75 $\pm$ 0.063	0.69 $\pm$ 0.244
3. C.V. $\pm$ S.E.	8.01 $\pm$ 0.90	..	6.86 $\pm$ 0.57	6.40 $\pm$ 2.26
Male (7)				
1. Mean $\pm$ S.E.	..	..	..	10.2
(n)				(1)
2. S.D. $\pm$ S.E.	..	..	..	—
3. C.V. $\pm$ S.E.	..	..	..	—
Female (7)				
1. Mean $\pm$ S.E.	..	..	..	—
(n)				
2. S.D. $\pm$ S.E.	..	..	..	—
3. C.V. $\pm$ S.E.	..	..		—

TABLE 4C.—*Inter-population comparison of statistical constants (Mean, S.D. and C.V.) of the morphometric characters E, F, C and P between Groups I-III of the 1955-population (Table 4A) and other populations (Table 4B) of the Desert Locust in India.*

Abbreviations :—NS., Not Significant.

*, Significant at 5 per cent level of probability.

**, Significant at 1 per cent level of probability.

***, Significant at 0.1 per cent level of probability.

Statistical constants	Significant test between various populations at 5%, 1% and 0.1% levels												
	Cols. 1 & 4	Cols. 2 & 4	Cols. 3 & 4	Cols. 1 & 5	Cols. 2 & 5	Cols. 3 & 5	Cols. 1 & 6	Cols. 2 & 6	Cols. 3 & 6	Cols. 1 & 7	Cols. 2 & 7	Cols. 3 & 7	
—	1	2	3	4	5	6	7	8	9	10	11	12	
1. Length of elytra (E)													
Male (6)													
1. Mean±S.E.	.	*	NS	NS	*	NS	NS	**	**	NS	***	*	**
2. S.D.±S.E.	.	NS	NS	NS	NS	*	NS	NS	***	*	NS	NS	NS
3. C.V.±S.E.	.	NS	*	NS	NS	*	NS	NS	NS	NS	NS	NS	NS
Female (6)													
1. Mean±S.E.	.	NS	NS	NS	***	***	NS	**	NS	NS	NS	NS	NS
2. S.D.±S.E.	.	NS	**	NS	NS	*	NS	NS	**S	NS	NS	NS	NS
3. C.V.±S.E.	.	NS	*	NS	NS	**	NS	NS	NS	NS	NS	NS	NS
Male (7)													
1. Mean±S.E.	.	..	..	..	NS	..	NS	..	..	..	..	..	..
2. S.D.±S.E.	.	..	..	..	NS	..	NS	..	..	..	..	..	..
3. C.V.±S.E.	.	..	..	..	NS	..	NS	..	..	..	..	..	..
Female (7)													
1. Mean±S.E.	.	..	..	..	..	**	NS	..	NS	NS	..	..	..
2. S.D.±S.E.	.	..	..	..	..	NS	**	..	NS	NS	..	..	..
3. C.V.±S.E.	.	..	..	..	..	NS	NS	..	NS	NS	..	..	..
2. Length of hind-femur (F)													
Male (6)													
1. Mean±S.E.	.	***	NS	*	***	***	NS	***	***	NS	**	NS	**
2. S.D.±S.E.	.	NS	NS	NS	NS	*	NS	NS	***	NS	NS	NS	NS
3. C.V.±S.E.	.	NS	*	NS	NS	*	NS	NS	*	**	NS	*	N

TABLE 4C—contd.

Statistical constants	Significant test between various populations at 5%, 1% and 0.1% levels											
	Cols. 1 & 4	Cols. 2 & 4	Cols. 3 & 4	Cols. 1 & 5	Cols. 2 & 5	Cols. 3 & 5	Cols. 1 & 6	Cols. 2 & 6	Cols. 3 & 6	Cols. 1 & 7	Cols. 2 & 7	Cols. 3 & 7
—	1	2	3	4	5	6	7	8	9	10	11	12
Female (6)												
1. Mean ± S.E.	NS	NS	NS	***	***	NS	***	***	NS	*	NS	NS
2. S.D. ± S.E.	*	**	*	NS	NS	***	*	***	NS	NS	NS	NS
3. C.V. ± S.E.	NS	*	NS	NS	*	**	NS	*	NS	NS	NS	*
Male (7)												
1. Mean ± S.E.	..	..	..	NS	..	NS	..	..	..	..	..	..
2. S.D. ± S.E.	..	..	..	NS	..	NS	..	..	..	..	..	..
3. C.V. ± S.E.	..	..	..	NS	..	NS	..	..	..	..	..	..
Female (7)												
1. Mean ± S.E.	..	..	..	..	***	NS	..	NS	NS	..	..	..
2. S.D. ± S.E.	..	..	..	..	NS	*	..	NS	**	..	..	..
3. C.V. ± S.E.	..	..	..	..	NS	NS	..	NS	NS	..	..	..
3. Width of Head at Genal Level (C)												
Male (6)												
1. Mean ± S.E.	**	***	***	..	..	..	***	***	NS	*	***	***
2. S.D. ± S.E.	NS	***	**	..	..	..	NS	**	NS	NS	*	NS
3. C.V. ± S.E.	NS	**	**	..	..	..	NS	NS	NS	NS	**	*
Female (6)												
1. Mean ± S.E.	NS	NS	**	..	..	..	***	***	NS	NS	NS	NS
2. S.D. ± S.E.	*	*	NS	..	..	..	NS	NS	**	NS	NS	NS
3. C.V. ± S.E.	*	NS	NS	..	..	..	NS	NS	*	NS	NS	NS

TABLE 4C—concl'd.

Statistical constants	Significant test between various populations at 5 %, 1 % and 0.1 % levels.											
	Cols. 1 & 4	Cols. 2 & 4	Cols. 3 & 4	Cols. 1 & 5	Cols. 2 & 5	Cols. 3 & 5	Cols. 1 & 6	Cols. 2 & 6	Cols. 3 & 6	Cols. 1 & 7	Cols. 2 & 7	Cols. 3 & 7
	1	2	3	4	5	6	7	8	9	10	11	12
Male (7)												
1. Mean ± S.E.	..	..	..	..	..	..	..	..	..	..	..	..
2. S.D. ± S.E.	..	..	..	..	..	..	..	..	..	..	..	..
3. C.V. ± S.E.	..	..	..	..	..	..	..	..	..	..	..	..
Female (7)												
1. Mean ± S.E.	..	..	..	..	..	..	..	..	..	..	..	..
2. S.D. ± S.E.	..	..	..	..	..	..	..	..	..	..	..	..
3. C.V. ± S.E.	..	..	..	..	..	..	..	..	..	..	..	..
4. Length of pronotum (P)												
Male (6)												
1. Mean ± S.E.	NS	NS	NS	..	..	..	NS	**	NS	*	NS	NS
2. S.D. ± S.E.	NS	*	NS	..	..	..	NS	NS	NS	NS	*	NS
3. C.V. ± S.E.	NS	**	NS	..	..	..	NS	NS	NS	*	***	
Female (6)												
1. Mean ± S.E.	NS	**	NS	..	..	..	**	NS	NS	NS	NS	
2. S.D. ± S.E.	**	**	NS	..	..	..	*	***	*	NS	NS	
3. C.V. ± S.E.	**	*	NS	..	..	..	*	NS	NS	NS	NS	
Male (7)												
1. Mean ± S.E.	..	..	..	..	..	..	..	..	..	..	..	
2. S.D. ± S.E.	..	..	..	..	..	..	..	..	..	..	..	..
3. C.V. ± S.E.	..	..	..	..	..	..	..	..	..	..	..	..
Female (7)												
1. Mean ± S.E.	..	..	..	..	..	..	..	..	..	..	..	..
2. S.D. ± S.E.	..	..	..	..	..	..	..	..	..	..	..	..
3. C.V. ± S.E.	..	..	..	..	..	..	..	..	..	..	..	..

TABLE 5A.—*Values for various morphometric ratios in the Desert Locust population in India for 1955 (Group I).*

Abbreviations.— *n*, Number of individuals.
S.E., Standard error.
S.D., Standard deviation.
C.V., Coefficient of variation.

Sex and number of eye-stripes	Group 1				
	<i>n</i>	Range	Mean ± S.E.	S.D. ± S.E.	C.V. ± S.E.
	1	2	3	4	5
1. Ratio E/F					
1. ♂♂ (6)	23	1.97—2.40	2.21±0.018	0.085±0.013	3.85±0.57
2. ♂♂ (7)	3	1.96—2.00	1.99±0.013	0.023±0.009	1.16±0.47
3. ♀♀ (6) . .	15	2.10—2.31	2.24±0.016	0.063±0.012	2.81±0.51
4. ♀♀ (7) . .	..	..	..	..	..
2. Ratio E/W ₁					
5. ♂♂ (6) .	23	6.88—8.12	7.41±0.068	0.326±0.048	4.40±0.649
6. ♂♂ (7) .	3	7.12—8.02	7.69±0.285	0.493±0.20	6.41±2.62
7. ♀♀ (6)	17	6.74—8.01	7.45±0.081	0.333±0.057	4.47±0.77
8. ♀♀ (7) .	..	..	..	..	..
3. Ratio E/C					
9. ♂♂ (6) .	23	6.61—7.61	6.98±0.05	0.238±0.035	3.41±0.50
10. ♂♂ (7) .	3	7.42—7.64	7.57±0.075	0.130±0.053	1.72±0.70
11. ♀♀ (6) . .	17	6.99—7.83	7.29±0.058	0.240±0.041	3.29±0.56
12. ♀♀ (7) .	..	..	..	..	..
4. Ratio F/C					
13. ♂ (6) .	23	2.97—3.85	3.17±0.038	0.184±0.027	5.80±0.86
14. ♂♂ (7) . .	3	3.78—3.83	3.81±0.016	0.028±0.011	0.73±0.30
15. ♀♀ (6) . .	16	3.11—3.72	3.25±0.037	0.15±0.027	4.62±0.82
16. ♀♀ (7) . .	..	..	..	..	..

TABLE 5A—*contd.*

Sex and number of eye-stripes	Group 1				
	<i>n</i>	Range	Mean $\pm$ S.E.	S.D. $\pm$ S.E.	C.V. $\pm$ S.E.
1	2	3	4	5	6
5. Ratio P/C					
17. ♂ ♂ (6)	23	1.24—1.48	1.32±0.012	0.059±0.009	4.47±0.66
18. ♂ ♂ (7)	3	1.41—1.52	1.46±0.033	0.057±0.023	3.90±1.59
19. ♀ ♀ (6)	18	1.24—1.43	1.34±0.011	0.048±0.008	3.58±0.60
20. ♀ ♀ (7)	..	..	..	..	..
6. Ratio M/C					
21. ♂ ♂ (6)	23	0.750—0.887	0.79±0.005	0.023±0.003	2.91±0.43
22. ♂ ♂ (7)	3	0.848—0.891	0.87±0.032	0.056±0.023	6.54±2.63
23. ♀ ♀ (6)	18	0.787—0.889	0.83±0.008	0.035±0.006	4.22±0.70
24. ♀ ♀ (7)	..	..		..	..
7. Ratio H/C					
25. ♂ ♂ (6)	23	1.04—1.23	1.10±0.008	0.037±0.005	3.36±0.50
26. ♂ ♂ (7)	3	1.20—1.25	1.23±0.014	0.025±0.010	2.03±0.83
27. ♀ ♀ (6)	18	1.04—1.21	1.12±0.009	0.039±0.006	3.48±0.58
28. ♀ ♀ (7)	..	..	..	..	..
8. Metasternal index (K/L)					
29. ♂ ♂ (6)	23	1.00—1.50	1.35±0.05	0.220±0.03	16.30±2.40
30. ♂ ♂ (7)	3	1.33—2.00	1.61±0.20	0.348±0.14	21.61±8.82
31. ♀ ♀ (6)	18	1.00—1.50	1.18±0.04	0.156±0.03	13.22±2.20
32. ♀ ♀ (7)	..	..	..	..	..

TABLE 5B.—*Values for various morphometric ratios in the Desert Locust population in India for 1955 (Group II).*

Abbreviations :—As in Table 5A.

Sex and number of eye-stripes	Group II				
	<i>n</i>	Range	Mean $\pm$ S. E.	S. D. $\pm$ S. E.	C. V $\pm$ S. E.
1	2	3	4	5	6
1. Ratio E/F					
1. ♂♂ (6)	399	1.93—2.44	2.18 $\pm$ 0.004	0.073 $\pm$ 0.003	3.36 $\pm$ 0.12
2. ♂♂ (7)	1	..	2.00 $\pm$ 0.0	..	..
3. ♀♀ (6)	429	1.93—2.45	2.23 $\pm$ 0.004	0.072 $\pm$ 0.002	3.22 $\pm$ 0.11
4. ♀♀ (7)	9	2.02—2.18	2.10 $\pm$ 0.021	0.062 $\pm$ 0.015	2.97 $\pm$ 0.70
2. Ratio E/W ₁					
5. ♂♂ (6)	420	6.64—8.38	7.42 $\pm$ 0.016	0.320 $\pm$ 0.011	4.30 $\pm$ 0.150
6. ♂♂ (7)	1	..	8.10 $\pm$ 0.0	..	..
7. ♀♀ (6)	457	6.84—8.71	7.57 $\pm$ 0.015	0.320 $\pm$ 0.011	4.23 $\pm$ 0.14
8. ♀♀ (7)	9	7.11—8.36	7.92 $\pm$ 0.132	0.396 $\pm$ 0.093	4.996 $\pm$ 1.18
3. Ratio E/C					
9. ♂♂ (6)	420	6.51—8.30	7.30 $\pm$ 0.014	0.283 $\pm$ 0.010	3.87 $\pm$ 0.13
10. ♂♂ (7)	1	..	7.97 $\pm$ 0.0	..	..
11. ♀♀ (6)	458	6.48—8.36	7.50 $\pm$ 0.011	0.236 $\pm$ 0.008	3.14 $\pm$ 0.10
12. ♀♀ (7)	9	7.28—8.38	7.96 $\pm$ 0.109	0.326 $\pm$ 0.077	4.10 $\pm$ 0.97
4. Ratio F/C					
13. ♂♂ (6)	416	2.89—4.02	3.35 $\pm$ 0.009	0.179 $\pm$ 0.006	5.34 $\pm$ 0.18
14. ♂♂ (7)	1	..	3.98 $\pm$ 0.0	..	..
15. ♀♀ (6)	454	3.02—4.12	3.36 $\pm$ 0.007	0.145 $\pm$ 0.005	4.32 $\pm$ 0.14
16. ♀♀ (7)	9	3.37—4.16	3.79 $\pm$ 0.079	0.238 $\pm$ 0.056	6.28 $\pm$ 1.48
5. Ratio P/C					
17. ♂♂ (6)	439	1.24—1.63	1.38 $\pm$ 0.003	0.060 $\pm$ 0.002	4.34 $\pm$ 0.147
18. ♂♂ (7)	1	..	1.59 $\pm$ 0.0	..	..
19. ♀♀ (6)	487	1.23—1.69	1.38 $\pm$ 0.002	0.052 $\pm$ 0.002	3.77 $\pm$ 0.12
20. ♀♀ (7)	9	1.39—1.63	1.50 $\pm$ 0.027	0.082 $\pm$ 0.019	5.47 $\pm$ 1.29
6. Ratio M/C					
21. ♂♂ (6)	442	0.743—0.932	0.82 $\pm$ 0.002	0.031 $\pm$ 0.001	3.73 $\pm$ 0.13
22. ♂♂ (7)	1	..	0.905 $\pm$ 0.0	..	..
23. ♀♀ (6)	491	0.768—0.932	0.842 $\pm$ 0.001	0.025 $\pm$ 0.001	3.01 $\pm$ 0.10
24. ♀♀ (7)	9	0.836—0.934	0.885 $\pm$ 0.012	0.036 $\pm$ 0.008	4.06 $\pm$ 0.96
7. Ratio H/C					
25. ♂♂ (6)	446	0.96—1.30	1.13 $\pm$ 0.002	0.040 $\pm$ 0.001	3.54 $\pm$ 0.12
26. ♂♂ (7)	1	..	1.22 $\pm$ 0.0	..	..
27. ♀♀ (6)	491	1.03—1.30	1.14 $\pm$ 0.002	0.036 $\pm$ 0.001	3.16 $\pm$ 0.10
28. ♀♀ (7)	10	1.13—1.30	1.23 $\pm$ 0.016	0.052 $\pm$ 0.012	4.23 $\pm$ 0.95
8. Metasternal index (K/L)					
29. ♂♂ (6)	440	1.00—3.00	1.52 $\pm$ 0.01	0.241 $\pm$ 0.01	15.91 $\pm$ 0.54
30. ♂♂ (7)	1	..	1.50 $\pm$ 0.0	..	..
31. ♀♀ (6)	488	1.00—2.50	1.25 $\pm$ 0.01	0.126 $\pm$ 0.004	10.09 $\pm$ 0.32
32. ♀♀ (7)	10	1.20—1.50	1.29 $\pm$ 0.03	0.085 $\pm$ 0.019	6.56 $\pm$ 1.47

TABLE 5C.—*Values for various morphometric ratios in the Desert Locust population in India for 1955 (Group III).*

Abbreviations :—As in Table 5A.

Sex and number of eye-stripes		Group III				
		n	Range	Mean	S.D.	C.V
				$\pm$ S.E.	$\pm$ S.E.	$\pm$ S.E.
1		2	3	4	5	6
1. Ratio E/F						
1. ♂♂ (6)	.	55	1.97—2.30	2.07 $\pm$ 0.010	0.071 $\pm$ 0.007	3.43 $\pm$ 0.33
2. ♂♂ (7)	.	19	1.95—2.08	2.01 $\pm$ 0.009	0.041 $\pm$ 0.007	2.04 $\pm$ 0.33
3. ♀♀ (6)	.	11	1.95—2.27	2.11 $\pm$ 0.031	0.103 $\pm$ 0.022	4.88 $\pm$ 1.04
4. ♀♀ (7)	.	36	1.96—2.17	2.04 $\pm$ 0.008	0.051 $\pm$ 0.006	2.50 $\pm$ 0.29
2. Ratio E/W						
5. ♂♂ (6)	.	66	6.95—8.46	7.88 $\pm$ 0.038	0.311 $\pm$ 0.027	3.95 $\pm$ 0.344
6. ♂♂ (7)	.	20	7.38—8.61	7.84 $\pm$ 0.068	0.305 $\pm$ 0.048	3.89 $\pm$ 0.62
7. ♀♀ (6)	.	10	7.46—8.97	8.10 $\pm$ 0.123	0.388 $\pm$ 0.087	4.79 $\pm$ 1.07
8. ♀♀ (7)	.	38	7.66—8.82	8.12 $\pm$ 0.045	0.280 $\pm$ 0.032	3.4 $\pm$ 0.39
3. Ratio E/C						
9. ♂♂ (6)	.	65	6.99—8.51	7.98 $\pm$ 0.036	0.294 $\pm$ 0.027	3.68 $\pm$ 0.32
10. ♂♂ (7)	.	20	7.55—8.39	7.92 $\pm$ 0.047	0.21 $\pm$ 0.033	2.65 $\pm$ 0.42
11. ♀♀ (6)	.	11	7.28—8.70	8.03 $\pm$ 0.138	0.457 $\pm$ 0.098	5.69 $\pm$ 1.2
12. ♀♀ (7)	.	38	7.90—8.73	8.23 $\pm$ 0.033	0.205 $\pm$ 0.024	2.50 $\pm$ 0.29
4. Ratio F/C						
13. ♂♂ (6)	.	61	3.04—4.11	3.86 $\pm$ 0.029	0.230 $\pm$ 0.021	5.96 $\pm$ 9.54
14. ♂♂ (7)	.	19	3.74—4.08	3.93 $\pm$ 0.021	0.093 $\pm$ 0.015	3.36 $\pm$ 0.38
15. ♀♀ (6)	.	12	3.23—4.14	3.82 $\pm$ 0.088	0.305 $\pm$ 0.062	7.97 $\pm$ 1.6
16. ♀♀ (7)	.	40	3.78—4.27	4.04 $\pm$ 0.018	0.115 $\pm$ 0.013	2.86 $\pm$ 0.32

TABLE 5C—continued.

Sex and number of eye-stripes	<i>n</i>	Range	Group III			
			Mean ± S.E.	S.D. ± S.E.	C.V. ± S.E.	
1	2	3	4	5	6	
5. Ratio P/C,						
17. ♂♂ (6)	. .	71	1.26—1.62	1.51±0.007	0.062±0.005	4.14±0.348
18. ♂♂ (7)	. .	21	1.46—1.60	1.52±0.011	0.051±0.008	3.35±0.52
19. ♀♀ (6)	. .	13	1.30—1.57	1.47±0.025	0.091±0.018	6.21±1.22
20. ♀♀ (7)	. .	43	1.43—1.68	1.54±0.009	0.06±0.006	3.89±0.42
6. Ratio M/C						
21. ♂♂ (6)	. .	71	0.814—0.950	0.89±0.003	0.027±0.002	3.03±0.25
22. ♂♂ (7)	. .	21	0.838—0.938	0.90±0.006	0.029±0.004	2.24±0.50
23. ♀♀ (6)	. .	13	0.824—0.957	0.90±0.012	0.042±0.008	4.72±0.93
24. ♀♀ (7)	. .	43	0.875—0.972	0.92±0.004	0.023±0.002	2.50±0.27
7. Ratio H/C						
25. ♂♂ (6)	. .	71	1.10—1.33	1.25±0.006	0.051±0.004	4.08±0.34
26. ♂♂ (7)	. .	21	1.16—1.31	1.25±0.008	0.039±0.006	3.10±0.48
27. ♀♀ (6)	. .	13	1.12—1.31	1.24±0.016	0.057±0.011	4.61±0.90
28. ♀♀ (7)	. .	43	1.21—1.38	1.29±0.002	0.041±0.004	3.20±0.35
8. Metasternal index (K/L)						
29. ♂♂ (6)	. .	71	1.00—2.00	1.58±0.02	0.207±0.02	13.11±1.10
30. ♂♂ (7)	. .	21	1.00—2.00	1.49±0.04	0.162±0.03	10.89±1.68
31. ♀♀ (6)	. .	12	1.00—1.33	1.24±0.02	0.078±0.016	6.27±1.28
32. ♀♀ (7)	. .	43	1.00 1.67	1.27±0.02	0.122±0.013	9.65±1.04

TABLE 5D.—*Inter-group comparisons of various morphometric ratios (within the same sex and eye-stripe group) between Groups I-III of the 1955-population of the Desert Locust in India (From data in Table 5A, 5B and 5C).*

Abbreviations :—N, S., Not Significant. at 5% level of probability.

*, Significant at 5% level of probability.

**, Significant at 1% level of probability.

***, Significant at 0.1% level of probability.

Sex and number of eye-stripes	Significance of difference between 1955—groups								
	Mean			S.D.			C.V.		
	Gr. I & Gr. II	Gr. I & Gr. III	Gr. II & Gr. III	Gr. I & Gr. II	Gr. I & Gr. III	Gr. II & Gr. III	Gr. I & Gr. II	Gr. I & Gr. III	Gr. II & Gr. III
1. Ratio E/F									
1. ♂♂ (6)	NS	***	***	NS	NS	NS	NS	NS	NS
2. ♂♂ (7)	..	NS	..	..	NS	..	..	NS	..
3. ♀♀ (6)	NS	**	***	NS	*	*	NS	NS	NS
4. ♀♀ (7)	..	..	*	..	..	NS	..	..	NS
2. Ratio E/W1									
5. ♂♂ (6)	NS	***	***	NS	NS	NS	NS	NS	NS
6. ♂♂ (7)	..	NS	..	..	NS	..	..	NS	..
7. ♀♀ (6)	NS	***	***	NS	NS	NS	NS	NS	NS
8. ♀♀ (7)	..	..	NS	..	..	NS	..	..	NS
3. Ratio E/C									
9. ♂♂ (6)	***	***	***	NS	NS	NS	NS	NS	NS
10. ♂♂ (7)	..	*	..	..	NS	..	..	NS	
11. ♀♀ (6)	***	***	***	NS	**	***	NS	NS	..
12. ♀♀ (7)	..	..	NS	..	..	*	..	..	N
4. Ratio F/C									
13. ♂♂ (6)	***	***	***	NS	NS	***	NS	NS	NS
14. ♂♂ (7)	..	*	..	..	*	..	..	**	..
15. ♀♀ (6)	**	***	***	NS	**	***	NS	NS	*
16. ♀♀ (7)	..	**	..	..	..	***	..	..	*
5. Ratio P/C.									
17. ♂♂ (6)	***	***	***	NS	NS	***	NS	NS	NS
18. ♂♂ (7)	..	NS	..	..	NS	..	..	NS	..
19. ♀♀ (6)	***	***	***	NS	..	***	NS	NS	*
20. ♀♀ (7)	..	..	NS	..	..	NS	..	..	NS

TABLE 5D—concluded.

Sex and number of eye-stripes	Significance of difference between 1955—groups								
	Mean			S.D.			C.V.		
	Gr. I & Gr. II	Gr. I & Gr. III	Gr. II & Gr. III	Gr. I & Gr. II	Gr. I & Gr. III	Gr. II & Gr. III	Gr. I & Gr. II	Gr. I & Gr. III	Gr. II & Gr. III
6. Ratio M/C									
21. ♂♂ (6)	***	***	***	*	NS	*	NS	NS	*
22. ♂♂ (7)	..	NS	..	..	*	..	..	NS	..
23. ♀♀ (6)	NS	***	***	**	NS	***	NS	NS	NS
24. ♀♀ (7)	..	..	**	..	..	*	..	..	NS
7. Ratio H/C									
25. ♂♂ (6)	***	***	***	NS	*	*	NS	NS	NS
26. ♂♂ (7)	..	NS	..	..	NS	..	..	NS	..
27. ♀♀ (6)	*	***	***	NS	NS	*	NS	NS	NS
28. ♀♀ (7)	..	..	***	..	..	NS	..	..	NS
8. Metasternal index (K/L)									
29. ♂♂ (6)	***	***	**	NS	NS	*	NS	NS	*
30. ♂♂ (7)	..	NS	..	*	**	..	..	NS	..
31. ♀♀ (6)	NS	NS	NS	*	**	**	NS	*	**
32. ♀♀ (7)	..	..	NS	..	..	NS	..	..	NS

TABLE 6.—Inter-sex comparison of morphometric ratios in the various Groups of the 1955-population of the Desert Locust.

Abbreviations : —h, Values in males significantly lower than in females.

H, Values in males significantly higher than in females.

x, No significant difference between males and females.

Group (and number of eye-stripes, 6 or 7)	Ratios, and inter-sex comparison							
	E/F	E/W ₁	E/C	F/C	P/C	M/C	H/C	K/L
I (6)	x	x	h	x	x	h	x	H
II (6)	h	h	h	x	x	x	h	H
III (6)	x	x	x	x	x	h	x	H
III (7)	h	h	h	h	x	h	h	H

TABLE 7A.—*Values of Mean, S.D. and C.V of morphometric ratios E/F, F/C and P/C of the Desert Locust population in India for 1955 (Groups I-III).**Abbreviations* :—*n*, Number of individuals.

S.E., Standard error.

S.D., Standard deviation.

C.V., Coefficient of variation.

Statistical constants	Nature of population		
	Group I	Group II	Group III
—	(1)	(2)	(3)
1. Ratio E/F			
Male (6)			
1. Mean $\pm$ S.E. (<i>n</i>)	2.21 $\pm$ 0.018 (23)	2.18 $\pm$ 0.004 (399)	2.07 $\pm$ 0.010 (55)
2. S.D. $\pm$ S.E.	0.085 $\pm$ 0.013	0.07 $\pm$ 0.003	0.07 $\pm$ 0.007
3. C.V. $\pm$ S.E.	3.85 $\pm$ 0.57	3.36 $\pm$ 0.12	3.43 $\pm$ 0.33
Female (6)			
1. Mean $\pm$ S.E. (<i>n</i>)	2.24 $\pm$ 0.016 (15)	2.23 $\pm$ 0.004 (429)	2.11 $\pm$ 0.03 (11)
2. S.D. $\pm$ S.E.	0.063 $\pm$ 0.012	0.07 $\pm$ 0.002	0.103 $\pm$ 0.022
3. C.V. $\pm$ S.E.	2.81 $\pm$ 0.51	3.22 $\pm$ 0.11	4.88 $\pm$ 1.04
Male (7)			
1. Mean $\pm$ S.E. (<i>n</i>)	1.99 $\pm$ 0.013 (3)	2.00 (1)	2.01 $\pm$ 0.009 (19)
2. S.D. $\pm$ S.E.	0.023 $\pm$ 0.009	—	0.041 $\pm$ 0.007
3. C.V. $\pm$ S.E.	1.156 $\pm$ 0.47	—	2.04 $\pm$ 0.33
Female (7)			
1. Mean $\pm$ S. E. (<i>n</i>)	..	2.10 $\pm$ 0.021 (9)	2.04 $\pm$ 0.008 (36)
2. S. D. $\pm$ S. E.	..	0.062 $\pm$ 0.015	0.05 $\pm$ 0.006
3. C. V. $\pm$ S. E.	..	2.97 $\pm$ 0.70	2.50 $\pm$ 0.29
2. Ratio F/C			
Male (6)			
1. Mean $\pm$ S. E. (<i>n</i>)	3.17 $\pm$ 0.038 (23)	3.35 $\pm$ 0.009 (416)	3.86 $\pm$ 0.03 (61)
2. S. D. $\pm$ S. E.	0.184 $\pm$ 0.027	0.179 $\pm$ 0.006	0.23 $\pm$ 0.021
3. C. V. $\pm$ S. E.	5.80 $\pm$ 0.86	5.34 $\pm$ 0.185	5.96 $\pm$ 0.540
Female (6)			
1. Mean $\pm$ S. E. (<i>n</i>)	3.25 $\pm$ 0.037 (16)	3.36 $\pm$ 0.007 (454)	3.82 $\pm$ 0.09 (12)
2. S. D. $\pm$ S. E.	0.15 $\pm$ 0.027	0.145 $\pm$ 0.005	0.30 $\pm$ 0.06
3. C. V. $\pm$ S. E.	4.62 $\pm$ 0.82	4.32 $\pm$ 0.143	7.97 $\pm$ 1.63

TABLE 7A—continued.

Statistical constants	Nature of population		
	Group I	Group II	Group III
—	(1)	(2)	(3)
2. Ratio F/C—contd.			
Male (7)			
1. Mean $\pm$ S. E. (n)	3.81 $\pm$ 0.016 (3)	3.98 (1)	3.93 $\pm$ 0.02 (19)
2. S. D. $\pm$ S. E.	0.028 $\pm$ 0.011	..	0.093 $\pm$ 0.015
3. C. V. $\pm$ S. E.	0.73 $\pm$ 0.30	..	2.36 $\pm$ 0.38
Female (7)			
1. Mean $\pm$ S. E. (n)	..	3.79 $\pm$ 0.079 (9)	4.04 $\pm$ 0.018 (40)
2. S. D. $\pm$ S. E.	..	0.238 $\pm$ 0.056	0.12 $\pm$ 0.01
3. C. V. $\pm$ S. E.	..	6.28 $\pm$ 1.48	2.86 $\pm$ 0.32
3. Ratio P/C			
Male (6)			
1. Mean $\pm$ S. E. (n)	1.32 $\pm$ 0.012 (23)	1.38 $\pm$ 0.003 (439)	1.51 $\pm$ 0.007 (71)
2. S. D. $\pm$ S. E.	0.059 $\pm$ 0.009	0.060 $\pm$ 0.002	0.062 $\pm$ 0.005
3. C. V. $\pm$ S. E.	4.47 $\pm$ 0.66	4.34 $\pm$ 0.147	4.14 $\pm$ 0.35
Female (6)			
1. Mean $\pm$ S. E. (n)	1.34 $\pm$ 0.011 (18)	1.38 $\pm$ 0.002 (487)	1.47 $\pm$ 0.03 (13)
2. S. D. $\pm$ S. E.	0.023 $\pm$ 0.003	0.052 $\pm$ 0.002	0.091 $\pm$ 0.018
3. C. V. $\pm$ S. E.	2.91 $\pm$ 0.43	3.77 $\pm$ 0.121	6.207 $\pm$ 1.217
Male (7)			
1. Mean $\pm$ S. E. (n)	1.46 $\pm$ 0.033 (3)	1.59 (1)	1.52 $\pm$ 0.011 (21)
2. S. D. $\pm$ S. E.	0.057 $\pm$ 0.023	..	0.051 $\pm$ 0.008
3. C. V. $\pm$ S. E.	3.90 $\pm$ 1.59	..	3.35 $\pm$ 0.52
Female (7)			
1. Mean $\pm$ S. E. (n)	..	1.50 $\pm$ 0.027 (9)	1.54 $\pm$ 0.009 (43)
2. S. D. $\pm$ S. E.	..	0.082 $\pm$ 0.019	0.091 $\pm$ 0.018
3. C. V. $\pm$ S. E.	..	5.47 $\pm$ 1.29	6.21 $\pm$ 1.22

TABLE 7B.—*Values of Mean, S.D. and C. V. of morphometric ratios E/F, F/C and P/C, in the Desert Locust in India, for the "typical" phase gregaria and phase solitaria populations, the Kakko Concentration (1949) and the Ajmer-Swarm (1950).*

Abbreviations :—As in Table 7A.

Statistical constants	Nature of population			
	<i>Phase gregaria</i>	<i>Phase solitaria</i>	Kakko population	Ajmer swarm
—	(4)	(5)	(6)	(7)
1. Ratio E/F				
Male (6)				
1 Mean $\pm$ S. E. (n)	2.17 $\pm$ 0.024 (11)	2.05 $\pm$ 0.012 (89)	2.06 $\pm$ 0.010 (112)	2.22 $\pm$ 0.023 (10)
2 S. D. $\pm$ S. E.	0.08 $\pm$ 0.017	0.06 $\pm$ 0.004	0.10 $\pm$ 0.007	0.07 $\pm$ 0.016
3 C. V. $\pm$ S. E.	3.69 $\pm$ 0.79	2.93 $\pm$ 0.22	5.04 $\pm$ 0.34	3.29 $\pm$ 0.73
Female (6)				
1 Mean $\pm$ S. E. (n)	2.25 $\pm$ 0.017 (23)	2.09 $\pm$ 0.008 (63)	2.12 $\pm$ 0.011 (72)	2.19 $\pm$ 0.035 (4)
2 S. D. $\pm$ S. E.	0.08 $\pm$ 0.012	0.06 $\pm$ 0.005	0.10 $\pm$ 0.008	0.07 $\pm$ 0.025
3 C. V. $\pm$ S. E.	3.51 $\pm$ 0.52	2.87 $\pm$ 0.26	4.72 $\pm$ 0.39	3.17 $\pm$ 1.12
Male (7)				
1. Mean $\pm$ S. E. (n)	..	2.00 $\pm$ 0.006 (25)	..	2.05 (1)
2 S. D. $\pm$ S. E.	..	0.06 $\pm$ 0.008	..	—
3 C. V. $\pm$ S. E.	..	3.00 $\pm$ 0.42	..	—
Female (7)				
1. Mean $\pm$ S. E. (n)	..	2.03 $\pm$ 0.007 (84)	2.07 $\pm$ 0.022 (8)	..
2 S. D. $\pm$ S. E.	..	0.06 $\pm$ 0.005	0.06 $\pm$ 0.015	..
3 C. V. $\pm$ S. E.	..	2.96 $\pm$ 0.23	2.90 $\pm$ 0.73	..
2. Ratio F/C				
Male (6)				
1 Mean $\pm$ S. E. (n)	3.233 $\pm$ 0.032 (25)	..	3.790 $\pm$ 0.024 (112)	3.237 $\pm$ 0.036 (10)
2 S. D. $\pm$ S. E.	0.161 $\pm$ 0.023	..	0.254 $\pm$ 0.017	0.113 $\pm$ 0.025
3 C. V. $\pm$ S. E.	4.980 $\pm$ 0.704	..	6.702 $\pm$ 0.448	3.491 $\pm$ 0.781
Female (6)				
1. Mean $\pm$ S. E. (n)	3.320 $\pm$ 0.032 (31)	..	3.824 $\pm$ 0.027 (72)	3.458 $\pm$ 0.079 (4)
2 S. D. $\pm$ S. E.	0.176 $\pm$ 0.022	..	0.226 $\pm$ 0.019	0.157 $\pm$ 0.056
3 C. V. $\pm$ S. E.	5.301 $\pm$ 0.674	..	5.910 $\pm$ 0.493	4.540 $\pm$ 1.605

TABLE 7B—continued.

Statistical constants	Nature of Population			
	<i>Phase gregaria</i>	<i>Phase solitaria</i>	Kakko population	Ajmer swarm
—	(4)	(5)	(6)	(7)
2. Ratio F/C—contd.				
Male (7)				
1. Mean $\pm$ S. E. (n)	..	..	..	3.90 (1)
2. S. D. $\pm$ S. E.	..	..	..	—
3. C. V. $\pm$ S. E.	..	..	..	—
Female (7)				
1. Mean $\pm$ S. E. (n)	..	..	..	..
2. S. D. $\pm$ S. E.	..	..	..	..
3. C. V. $\pm$ S. E.	..	..	..	..
3. Ratio P/C				
Male (6)				
1. Mean $\pm$ S. E. (n)	1.305 $\pm$ 0.011 (31)	..	1.483 $\pm$ 0.007 (112)	1.330 $\pm$ 0.011 (10)
2. S. D. $\pm$ S. E.	0.063 $\pm$ 0.008	..	0.078 $\pm$ 0.005	0.034 $\pm$ 0.008
3. C. V. $\pm$ S. E.	4.828 $\pm$ 0.618	..	5.260 $\pm$ 0.351	2.556 $\pm$ 0.572
Female (6)				
1. Mean $\pm$ S. E. (n)	1.324 $\pm$ 0.009 (37)	..	1.477 $\pm$ 0.008 (72)	1.363 $\pm$ 0.018 (4)
2. S. D. $\pm$ S. E.	0.055 $\pm$ 0.006	..	0.069 $\pm$ 0.006	0.036 $\pm$ 0.013
3. C. V. $\pm$ S. E.	1.54 $\pm$ 0.486	..	4.672 $\pm$ 0.389	2.641 $\pm$ 0.934
Male (7)				
1. Mean $\pm$ S. E. (n)	..	..	..	1.48 (1)
2. S. D. $\pm$ S. E.	..	..	..	—
3. C. V. $\pm$ S. E.	..	..	..	—
Female (7)				
1. Mean $\pm$ S. E. (n)	..	..	..	..
2. S. D. $\pm$ S. E.	..	..	..	—
3. C. V. $\pm$ S. E.	..	..	..	—

TABLE 7C.—*Inter-population comparison of morphometric ratios (E/F, F/C and P/C) between populations of 1955 (Groups I-III) (Table 7A) and other populations (Table 7B), in the Desert Locust in India.*

Abbreviations :—NS., Not Significant.
*, Significant at 5% level of probability.
**, Significant at 1% level of probability.
***, Significant at 0.1 % level of probability.

Statistical constants	Significant test between various populations at 5%, 1% and 0.1% levels											
	Cols. 1 & 4	Cols. 2 & 4	Cols. 3 & 4	Cols. 1 & 5	Cols. 2 & 5	Cols. 3 & 5	Cols. 1 & 6	Cols. 2 & 6	Cols. 3 & 6	Cols. 1 & 7	Cols. 2 & 7	Cols. 3 & 7
1. Ratio E/F												
Male (6)												
1. Mean ± S. E.	NS	NS	***	***	***	NS	***	***	NS	NS	NS	***
2. S. D. ± S. E.	NS	NS	NS	*	**	NS	NS	***	***	NS	NS	NS
3. C. V. ± S. E.	NS	NS	NS	NS	NS	NS	NS	***	***	NS	NS	NS
Female (6)												
1. Mean ± S. E.	NS	NS	***	***	***	NS	***	***	NS	NS	NS	NS
2. S. D. ± S. E.	NS	NS	NS	NS	*	**	*	***	NS	NS	NS	NS
3. C. V. ± S. E.	NS	NS	NS	NS	NS	NS	**	***	NS	NS	NS	NS
Male (7)												
1. Mean ± S. E.	..	..	..	NS	..	NS	..	..	..	..	..	..
2. S. D. ± S. E.	..	..	..	NS	..	*	..	..	..	..	..	..
3. C. V. ± S. E.	..	..	..	**	..	NS	..	..	..	..	..	..
Female (7)												
1. Mean ± S. E.	..	..	..	..	**	NS	..	NS	NS	..	..	..
2. S. D. ± S. E.	..	..	..	..	NS	NS	..	NS	NS	..	..	..
3. C. V. ± S. E.	..	..	..	..	NS	NS	..	NS	NS	..	..	..
2. Ratio F/C												
Male (6)												
1. Mean ± S. E.	NS	***	***	..	..	..	***	***	NS	NS	**	***
2. S. D. ± S. E.	NS	NS	*	..	..	..	*	***	NS	*	NS	**
3. C. V. ± S. E.	NS	NS	NS	..	..	..	NS	**	NS	*	*	**

PLATE 1

Schistocerca gregaria (Forsk.). Diagrams to show the distribution, etc. of the lengths of elytron (E) and hind-femur (F) in various types of populations.

Fig. 1.—Length of elytron (E).

Fig. 2.—Length of hind-femur (F).

Ty. sol. (6), 6-eye-striped typical phase *solitaria*; *Ty. greg.* (6), 6-eye-striped typical phase *gregaria*; *Gr. I* (6), *Gr. II* (6), *Gr. III* (6), 6-eye-striped individuals of the 1955-Groups; *Ini. Conc.* (6), Initial Kakko (Rajasthan) Concentration (Misra, 1949); *Ajm. sw.*, Ajmer Swarm of 1950 (Roanwal & Misra, 1952).

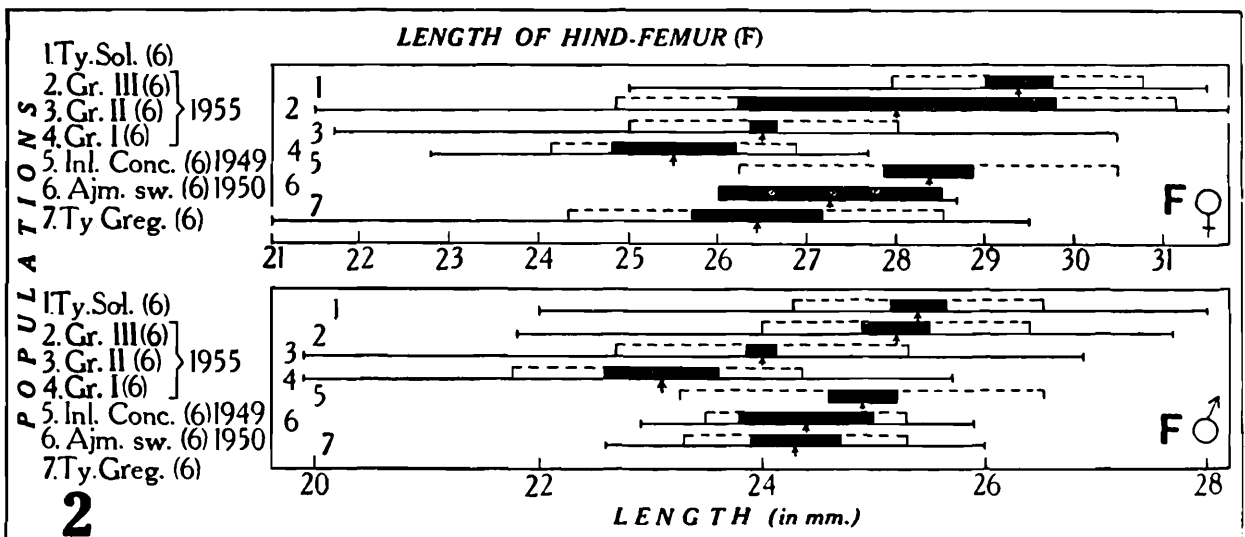
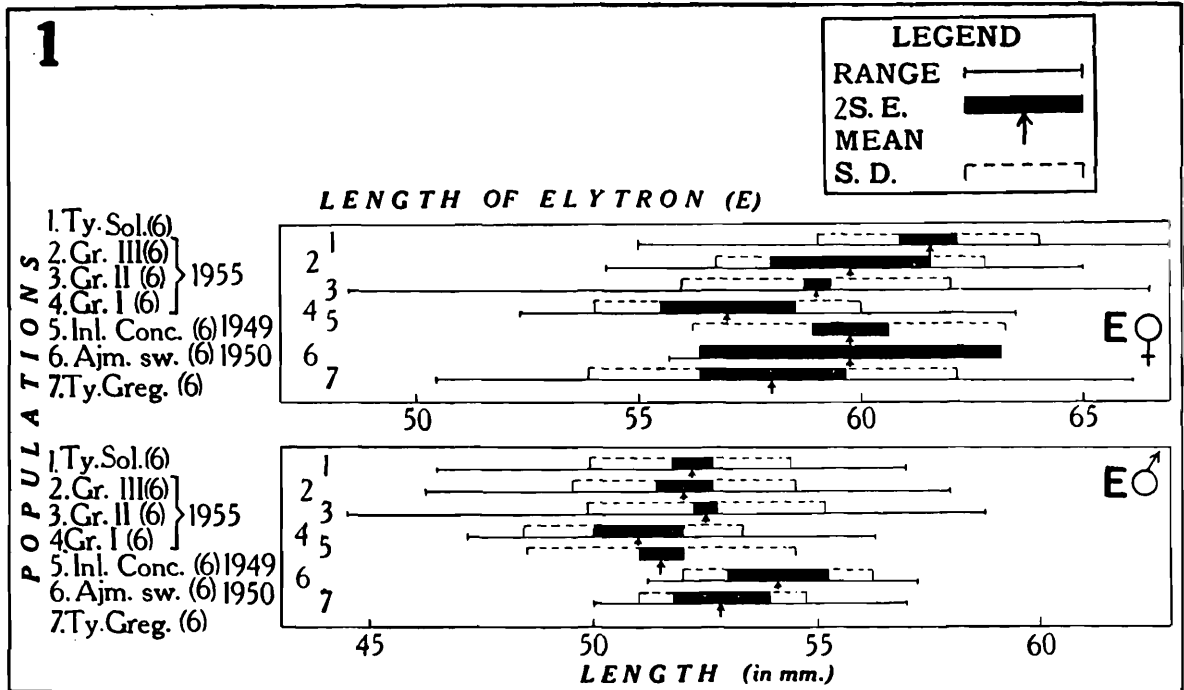


PLATE 2

Schistocerca gregaria (Forsk.). Diagrams to show the distribution, etc. of the width of head (C) and length of pronotum (P) in various types of populations.

Fig. 1.—Width of head (C).

Fig. 2.—Length of pronotum (P).

For explanations, *see* Plate 1.

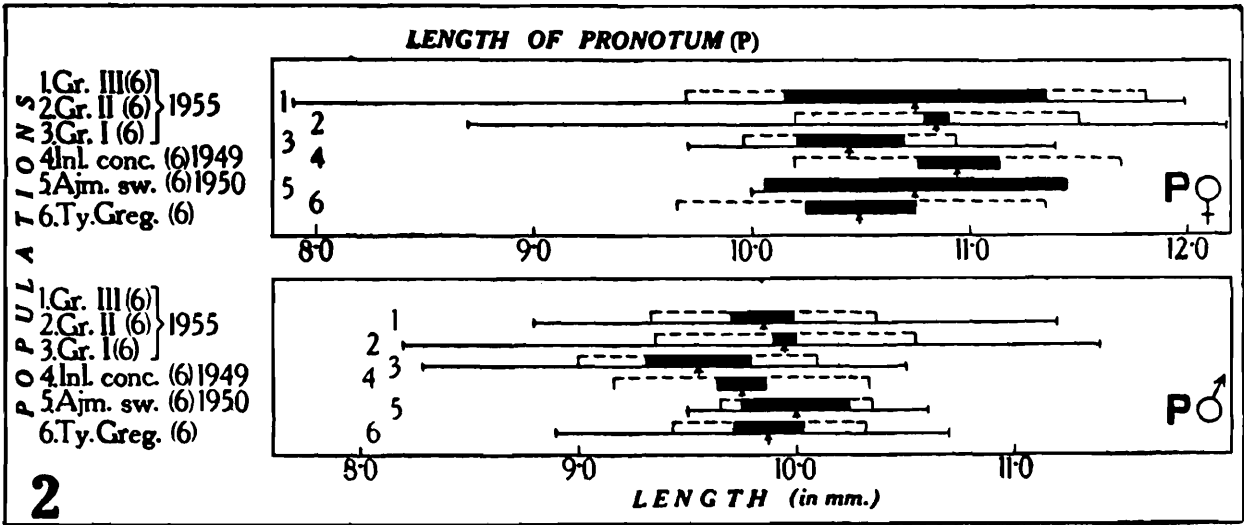
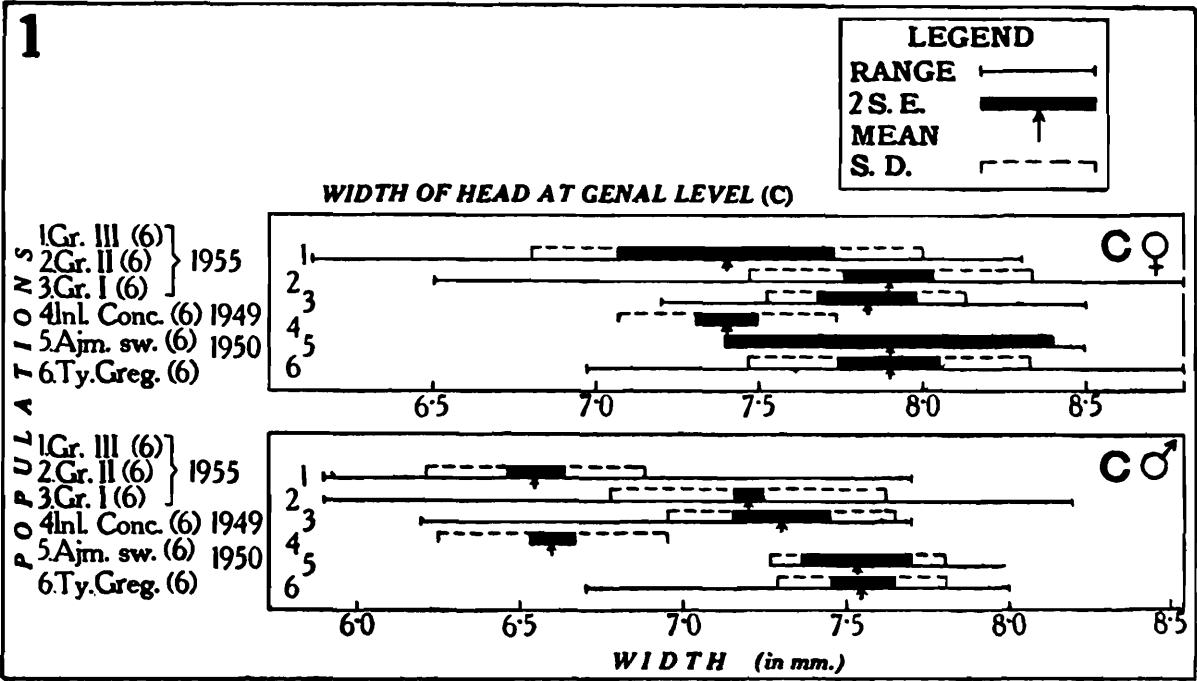


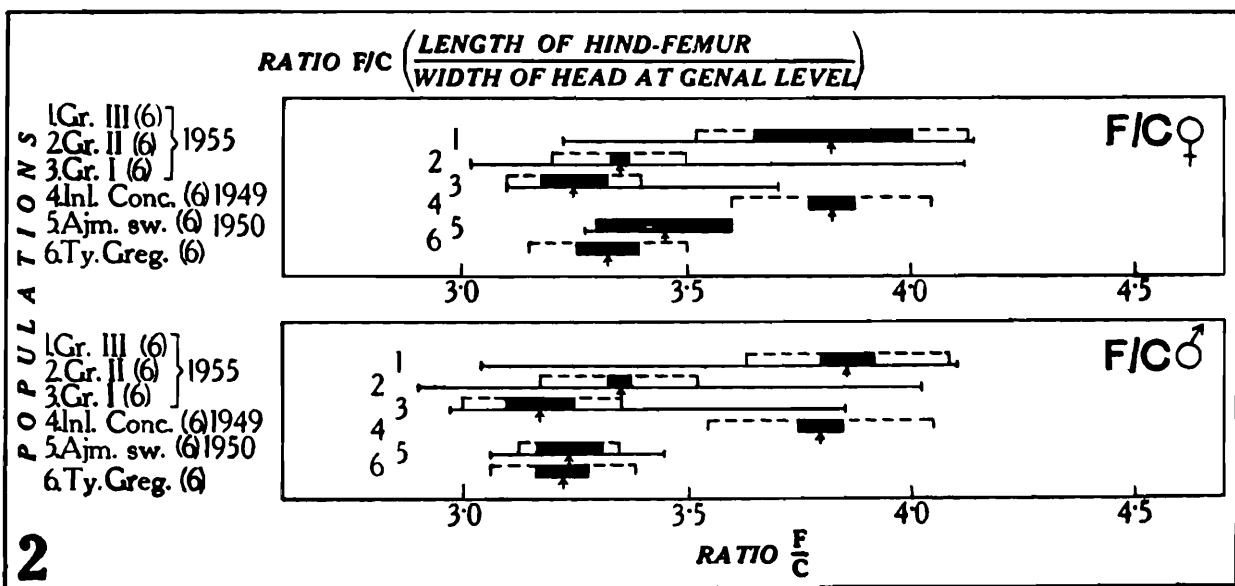
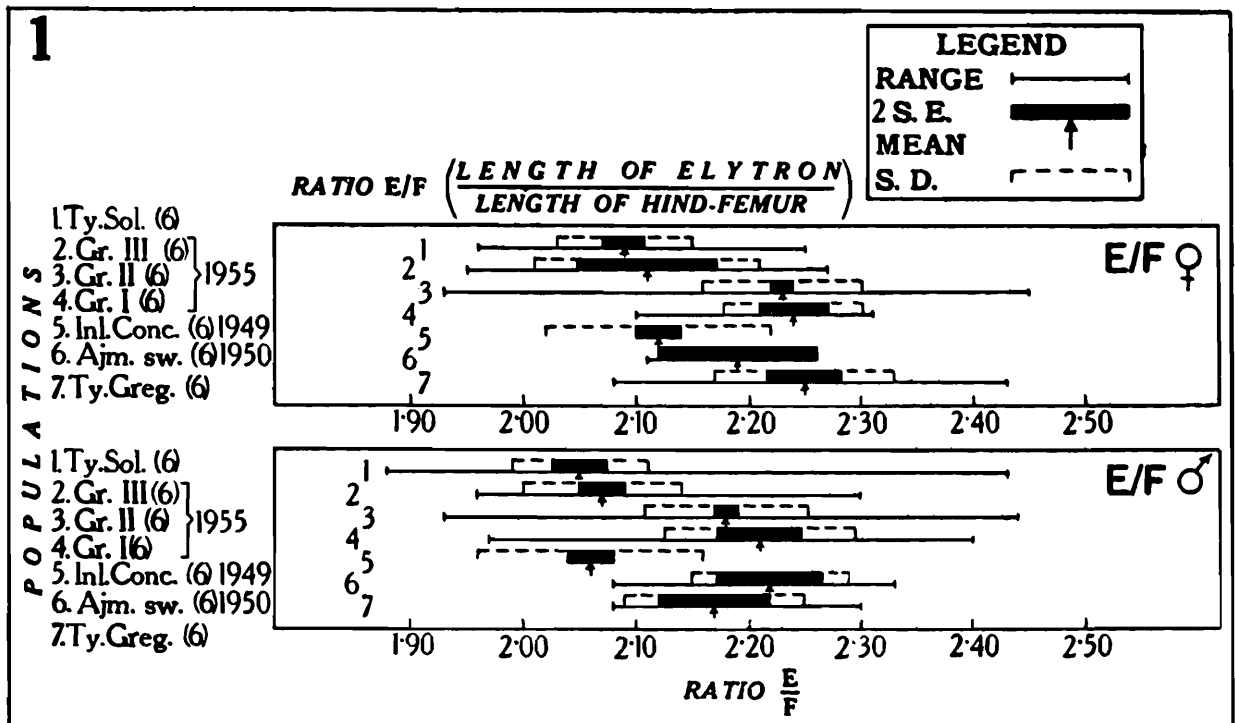
PLATE 3

Schistocerca gregaria (Forsk.) Diagrams to show the distribution, etc. of the ratios E/F (length of elytron/length of hind-femur) and F/C (length of hind-femur/width of head at genal level) in various types of populations.

Fig. 1.—Ratio E/F.

Fig. 2.—Ratio F/C.

For explanations, *see* Plate 1.



80(*d*)

PLATE 4

Schistocerca gregaria (Forsk.) Diagram to show the distribution, etc. of the ratio P/C (length of pronotum/width of head at genal level) in various types of populations.

For explanations, *see* Plate 1.

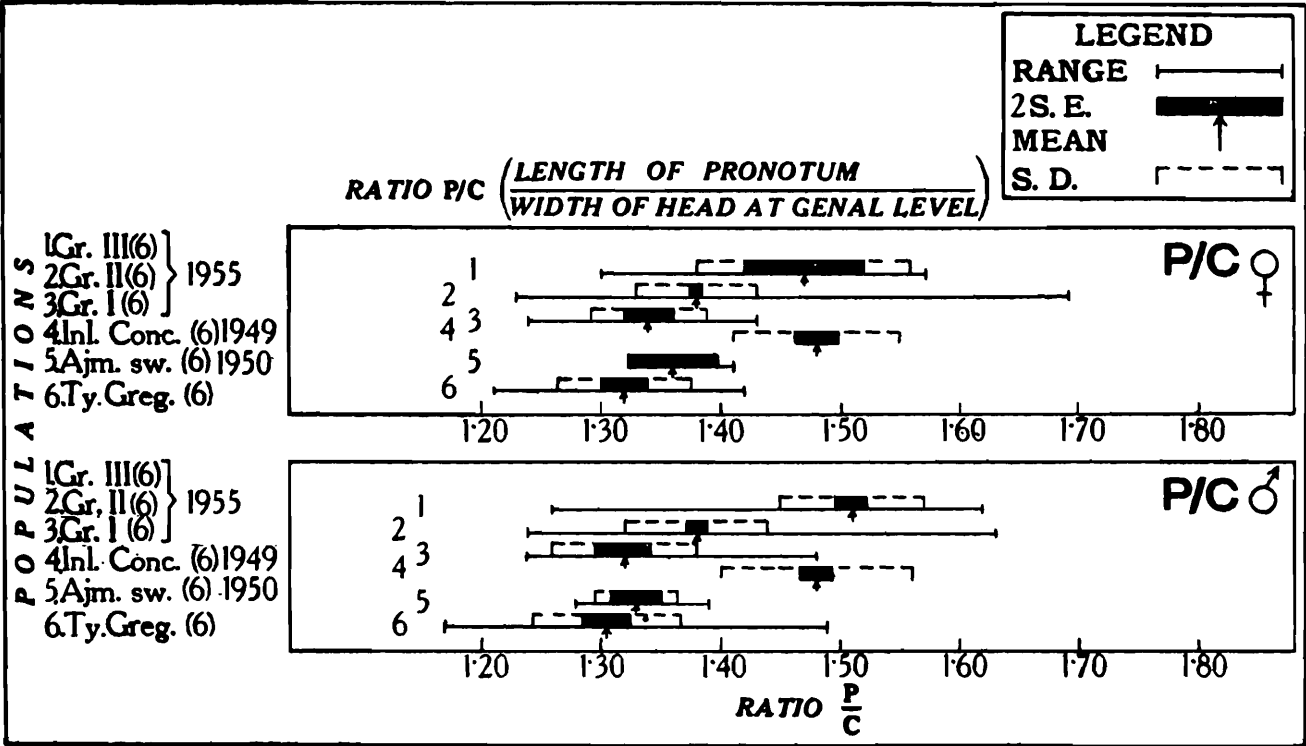


PLATE 5

Schistocerca gregaria (Forsk.) Diagrams to show the comparison, etc. of the characters E, F, C and P and the ratios E/F, F/C, P/C in various types of populations. The difference between the value in two sexes is indicated by the blank space at the top of each column.

Fig. 1.—Characters E, F, C and P.

Fig. 2.—Ratios E/F, F/C and P/C.

For explanations, see Plate 1.

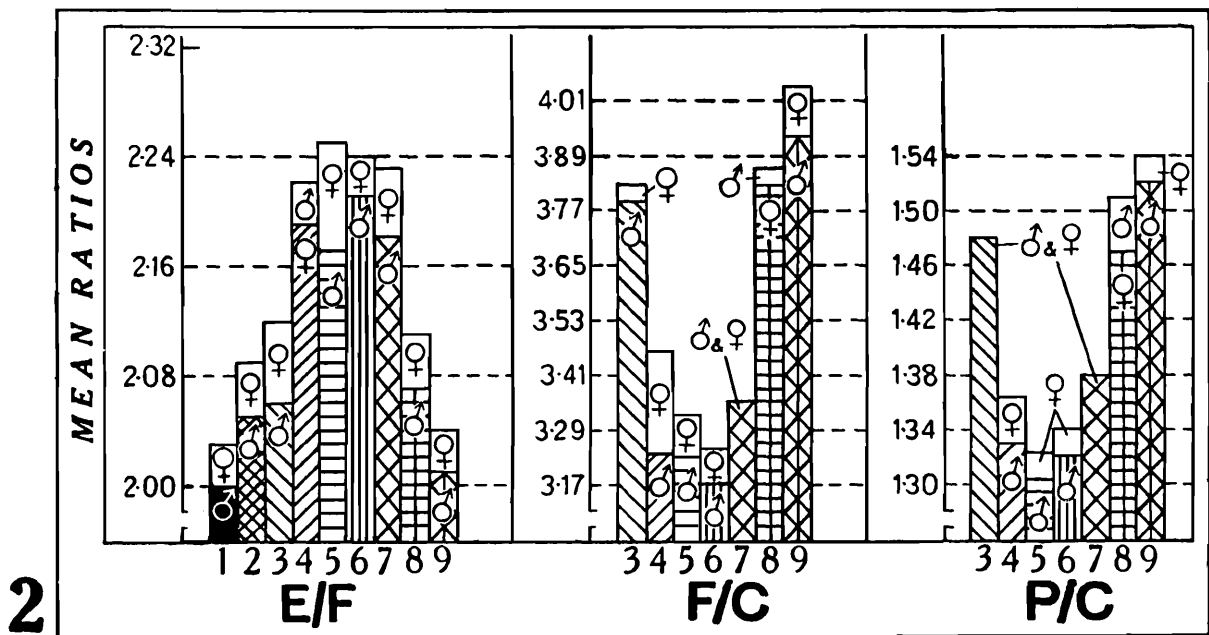
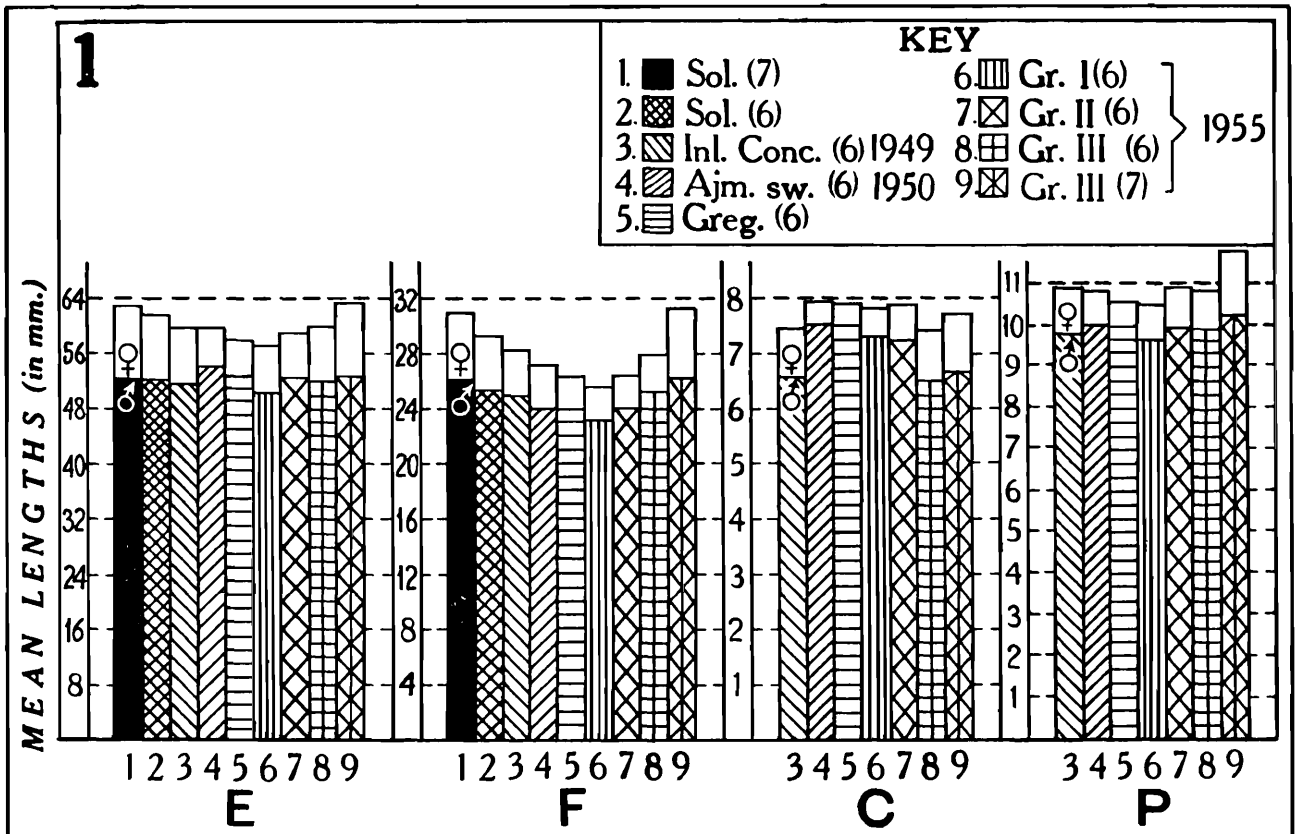


PLATE 6

Schistocerca gregaria (Forsk.) . Graphs showing the trend of variability, etc. in the lengths of elytron (E) and hind-femur (F) for the available years of the Ninth (known) Locust Cycle in India (1949-55). Missing values are shown in broken line.

Fig. 1.—Length of Elytron (E).

Fig. 2.—Length of hind-femur (F).

For explanations, see Plate 1.

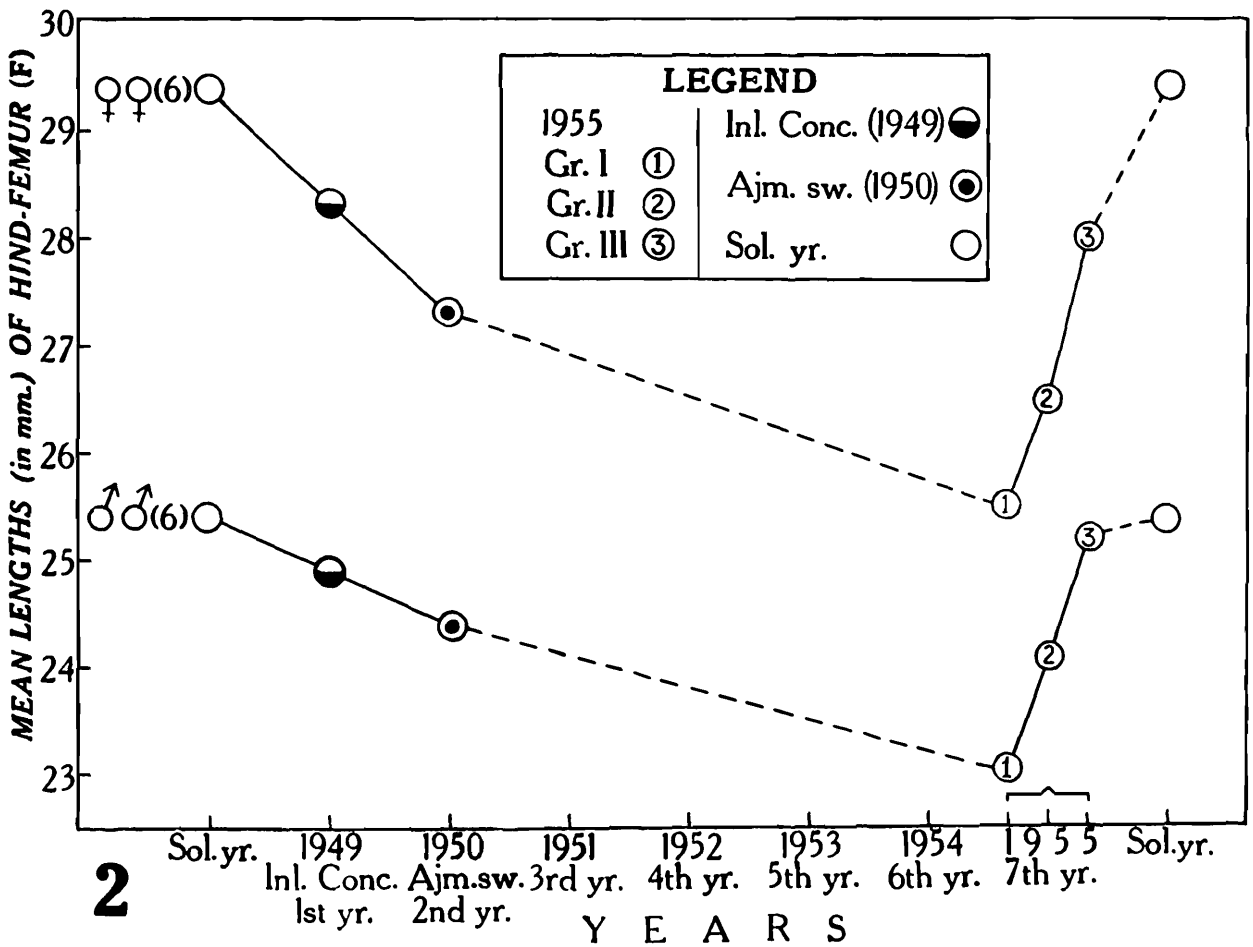
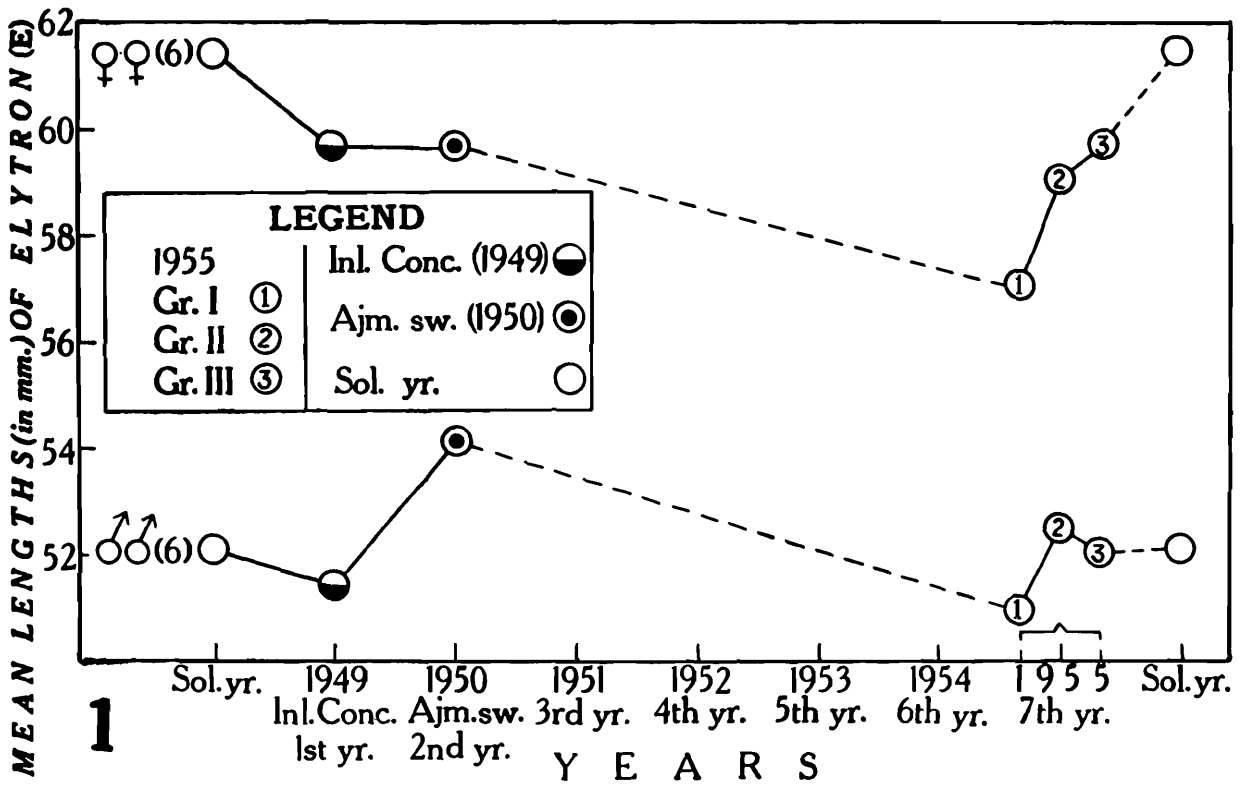


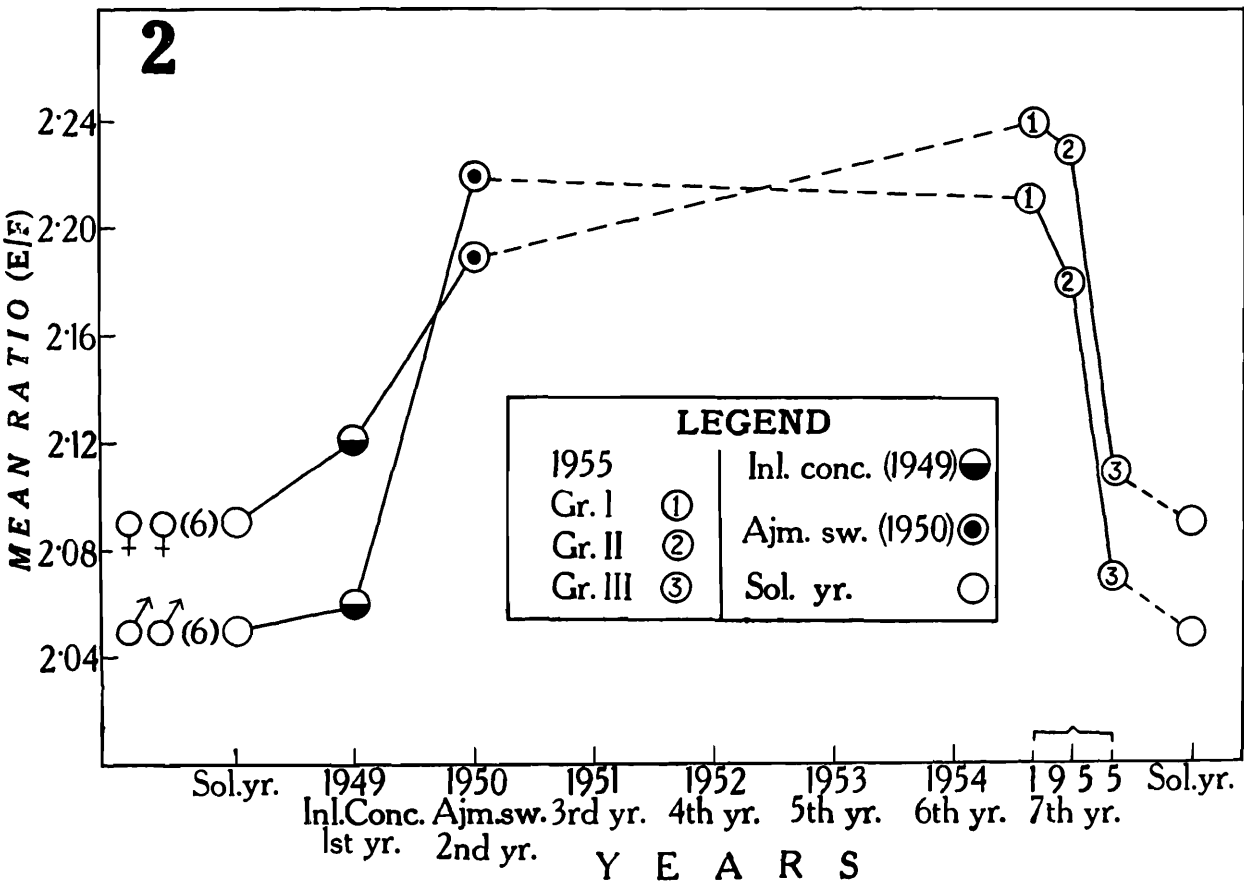
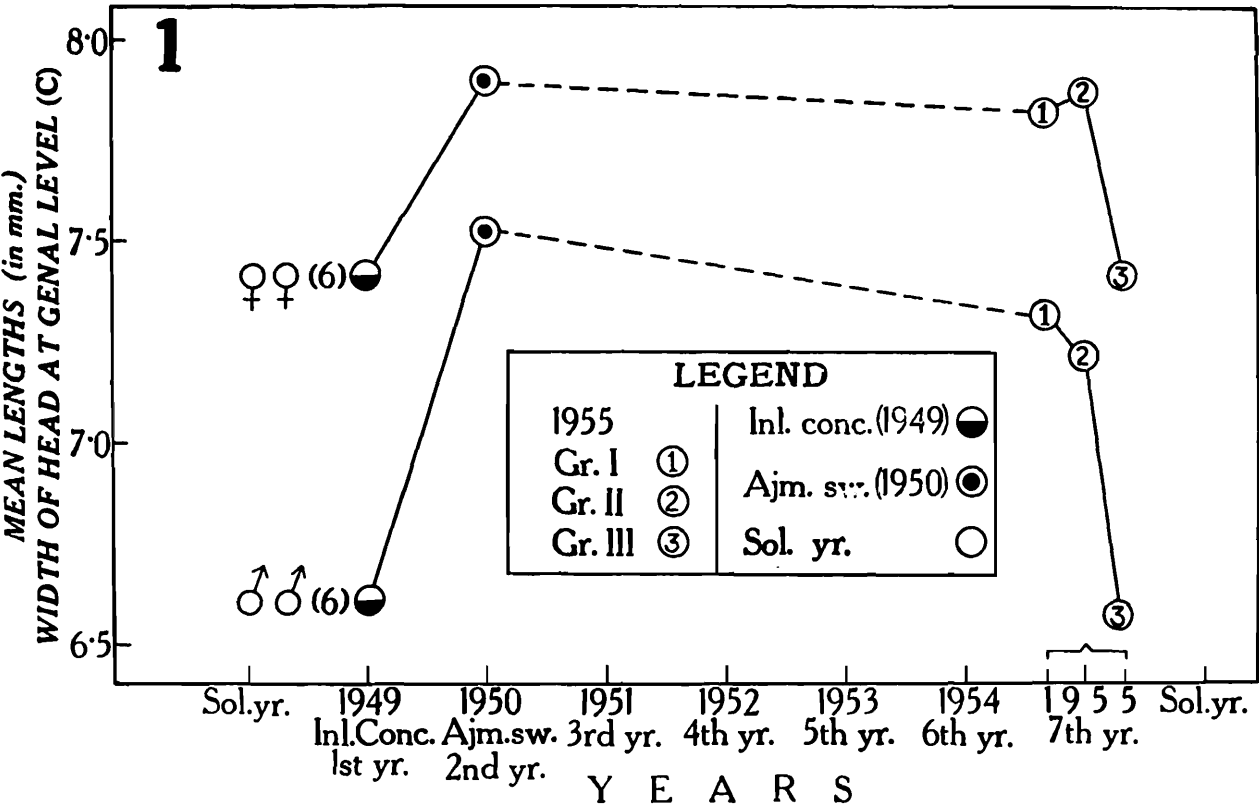
PLATE 7

Schistocerca gregaria (Forsk.) Graphs showing the trend of variability, etc. of the width of head (C) and the ratio E/F for the available years of the Ninth (known) Locust Cycle in India. Missing values are shown in broken lines.

Fig. 1.—Width of head at genal level (C).

Fig. 2.—Ratio E/F

For explanations, *see* Plate 1.



MEASUREMENT OF RODENTS (MAMMALIA), ESPECIALLY THEIR SKULL, FOR TAXONOMIC PURPOSES

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(With 2 Tables and 3 Plates)

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I—INTRODUCTION

(a) *General*

For taxonomic purposes in rodents, especially for the separation of species and subspecies, certain body- and skull-measurements are essential. However, the exact method of measurement, and the precise points of reference between which the measurements are taken, are not readily available in the literature. Authors frequently do not give any details at all, merely mentioning the code name or abbreviated name of a particular measurement, such as : “ Head 83 ; tail 95 ; molar $1\frac{1}{2}$; etc. ” Even the unit of measurement (whether in inches or millimetres) is sometimes not mentioned. As a result, comparison between the measurements of two authors becomes difficult.

Selected measurements which have been found most useful for rodents are discussed in this paper. All measurements are *vertical* distances between two parallels running through the two points of reference mentioned in each case. They are *not* merely straight-line distances between the two points of reference, nor are they taken along the curvatures of the body- or skull-parts. The measurements are best expressed in the metric system, usually in millimetres.

In many cases, indices are often more expressive as measures of differences between two allied forms than the absolute measurements themselves. They may be expressed either as a percentage of one measure against another or as a fraction expressed in the decimal system.

The measurements are best written in a tabular form (Table 1 ; also *vide* Roonwal, 1950, pp. 24-39, for an example) in which the items of measurement are given horizontally and the individual specimens listed serially vertically. Besides the actual measurements, the following particulars should invariably be given for each specimen to enable its individual identity being determined infallibly :—

1. Registration Number (in the collection registers of the institution to which the specimen belongs).
2. Name of the institution (in an abbreviated form) to which the specimen belongs.
3. Field Collection Number (if any).
4. Locality (Give exactly).
5. Sex (Either as : ♂ or M., male ; and ♀ or F., female).
6. Age (Exact age, if known). Also mention whether :
Ad., adult ;
Sub., subadult ; or
Juv., juvenile.
7. State of wear of molars. Mention whether :
N., not worn out ;
S., slightly worn out ;
H., half worn out ; or
M., much worn out.

This gives an indication of the approximate age of the individual,

8. Upper incisor "index". Mention whether :
Opi., opisthodont (bent backward) ;
Ort., orthodont (straight or vertical) ; or
Pro., proodont (bent forward).

For recording the indices, either a separate table may be used ; or, when the indices of the various body- or skull-parts are in terms of a single part, they may be mentioned within brackets below the actual measurement.

(b) *Skull measurements as defined by some previous authors*

In recent literature the definitions of the various skull-measurements of mammals have been provided by the following authors :—

- (i) Pocock (1939, p. 23 for Primates ; and p. 203 for Carnivora).
- (ii) Ellerman (1947*a*, p. 250, for Rodentia ; 1947*c*, p. 259 for the Sciuridae).
- (iii) Chaworth-Musters & Ellerman (1947, p. 479, for *Meriones* : Muridae, Gerbillinae).
- (iv) Roonwal (1950, pp. 2-4, for Rodentia, especially the Muridae)

The definitions of these authors are given below :—

- (i) Pocock (1939, p. 23, Primates ; and p. 203, Carnivora) gave the following eleven measurements for mammalian skulls, and although they refer primarily to the Primates and the Carnivora, some of them can be used for the Rodentia as well :—
 1. *Total length*.—*Primates* : From tip of premaxilla to end of cranium. *Carnivora* : From front edge of premaxilla to tip of occipital crest.
 2. *Condylbasal length*.—*Primates* : From tip of premaxilla to end of occipital condyle. *Carnivora* : From front edge of premaxilla to hind border of occipital condyle.
 3. *Zygomatic width*.—*Primates* : Across zygomata at their widest point. *Carnivora* : Greatest width across cheek-bones.
 4. *Orbital width*.—*Primates* : Across the middle of orbits.
 5. *Postorbital width*.—*Carnivora* : Least width behind the eyes.
 6. *Interorbital width*.—*Carnivora* : Least width between the eyes.
 7. *Maxillary width*.—*Primates* : Across maxilla at the base of canines. *Carnivora* : Width of muzzle just above upper canine teeth.
 8. *Upper cheek-teeth*.—*Primates* : From front edge of canine to hinder edge of last molar.
 9. *Mandibular length*.—*Primates* : From tip of condyle to tip of symphysis. *Carnivora* : Length of lower jaw from condyle to anterior edge.
 10. *pm⁴*.—Greatest length of upper carnassial tooth along its outer side.
 11. *m₁*.—*Carnivora* : Greatest length of lower carnassial tooth.

(ii) Ellerman (1947*a*, p. 250) gave the following definitions of the ten cranial measurements used by him for Indian Rodents he further redefined (Ellerman, 1947*c*, p. 259) the 'orbit' which is a new measurement used by him for the Sciuridae. Except where otherwise stated, all these measurements are "length" measurements :—

1. *Occipitonasal*.—From anterior tip of nasal to back of occiput, or to centre of top of occiput when this projects or slants backwards behind the lambdoidal region, errors, if present, tending to be on the large side.
2. *Palate*.—From the front of the incisors to the back of the palate, ignoring the spinous process if present.
3. *Diastema*.—From a point immediately behind the front incisor to a point immediately in front of the front cheek-tooth.
4. *Palatal foramina*.—From a point immediately in front of the foramina to a point immediately behind it.
5. *Bullae length*.—From a point immediately next to the paroccipital process to the nearest point opposite the inflated part of the bulla, not including the mastoid portion when it is swollen as happens in the Dipodidae or the Gerbillinae.
6. *Tooththrow*.—Is the crown length of upper tooththrow.
7. *Frontals width*.—Is the least interorbital width.
8. *Orbit* (used extensively in the Sciuridae but not elsewhere).—From the lacrymal to a point on the posterior zygomatic root just after this has left the squamosal (Ellerman, 1947*a*). In another paper Ellerman (1947*c*) defined the posterior limit as follows : "To a point on the posterior zygomatic root just after it leaves the brain case" He further added : "With a single exception which occurs in the genus *Lariscus*, I am able to place any genus of squirrel in the Palaearctic and Indo-Malayan regions by the length of this measurement, taken as a percentage against the occipitonasal length."
9. *Occiput* (used only in subterranean Rodents like the Rhizomyidae).—From the top of foramen magnum to the top of lambdoidal ridge.
10. *Condylbasal*.—From the occiput to the front of the incisor.

(ii) Chaworth-Musters & Ellerman (1947, p. 479) used the following five measurements for the genus *Meriones* (Muridae, Gerbillinae), with the same definitions as those of Ellerman (1947*a*, *vide* above), except that the "frontals width" is here called the "least interorbital width", the two measurements being identical :—Occipitonasal length ; palate ; bullae ; tooththrow ; and frontals width.

- (iv) Finally, Roonwal (1950, pp. 2-4) gave definitions of nineteen skull measurements used by him for Rodents, especially the Muridae. The definitions given below in the present account are largely based on that author, with such modifications and additions as are considered necessary.

II—EXTERNAL MEASUREMENTS OF HEAD-AND-BODY

(Plate 8 ; Tables 1 and 2)

These measurements are taken on freshly killed animals before *rigor mortis* has set in and with the body-parts fully relaxed and pressed against a flat surface such as a table or a sheet of glass ; no stretching should be allowed. Four length-measurements are generally taken, viz., head-and-body (H. & B.) ; tail (Tl.) ; hind-foot (H.F.) ; and ear (E). They should immediately be recorded either in the field notebook or on the back of the label (to be tied to the specimen) thus :

H. & B.	224 mm.
Tl.	186 mm.
H.F. ..	41 mm.
E.	23 mm.

The measurements are taken as follows :—

1. *Length of head-and-body* (Pl. 8, Fig. *b*, line FD).
From the tip of the nose to the ventral root of the tail just above the anus.
2. *Length of tail* (Pl. 8, Fig. *b*, line DT).
From the ventral root of the tail just above the anus to the tip of the tail vertebrae, excluding the end-hairs.
3. *Length of hind-foot* (Pl. 8, Fig. *c*, line NN').
From the outer, most prominent surface of the heel to the tip of the longest toe, excluding the claw or nail.
4. *Length of ear* (Pl. 8, Fig. *d*, line HH').
From the most prominent surface of the tragus to the farthest edge of the pinna.

III—SKULL MEASUREMENTS

(Plates 9 and 10; and Tables 1 and 2)

Rodent skulls being rather small, their measurements are best taken under a large magnifying lens of *ca.* 12-15 cm. diameter and mounted on a revolving stand and magnifying about 2 to 3 times. Vernier callipers with a dial graduation reading upto 0.1 mm. should be used. About 19 skull measurements (Roonwal, 1950, pp. 2-4) are generally taken. In addition, Ellerman (1947*a*, p. 250; and 1947*c*, p. 259) has used a few

other measurements which have been found to be of taxonomic value in certain families. These 21 measurements, with their definitions, are given below :—

TABLE 1.—*Example of a Table to be used for recording the measurements of the skulls of rodents for taxonomic purposes.*
Bandicota bengalensis bengalensis (Gr. & Hardw.). Skull measurements (in mm.).

Abbreviations used :

- (i) Molars.—N., not worn out ; S., slightly worn out ; H., half worn out ; M., much worn out.
- (ii) Upper incisor index.—*Opi.*, opisthodont ; *Ort.*, orthodont ; *Pro.*, proodont.
- (iii) Age.—*Ad.*, adult ; *Sad.*, subadult ; *Juv.*, juvenile.
- (iv) Institutions.—A. M. N. H., American Museum of Natural History ; Z. S. I., Zoological Survey of India.

Sl. No.	Registration No.	Institution	Field Collection No.	Locality	Sex	Age	State of wear of molars	Upper incisor index	Occipito-premaxillary length	Condylor-basal length	Occipito-nasal length	Greatest zygomatic width	Cranial width	Etc.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	11200	Z.S.I.	N 1/9-10-45	Imphal (Manipur, Assam)	♂	Ad.	M	Opi.	42.5	42.0	44.6	20.1	16.6	Etc.
2.	F. 1.28.58	A.M.N.H.	283	Kalewa (W. Burma)	♀	Ad.	H	Opi.	45.3	44.5	45.8	21.5	16.8	Etc.

1. *Occipito-premaxillary length* (Pl. 10, Fig. *a*, line PB).

From the most forward point of the premaxilla to the hindmost point of the occipital surface.

2. *Condylbasal length* (Pl. 10, Fig. *a*, line PO).

From the most forward point of the premaxilla to the hindmost point of the occipital condyle.

Ellerman (1947*a*, p. 250) defined this measurement as follows :—“From the occiput to the front of the incisor.” In our opinion the definition given by us is preferable as it is independent of the condition of the incisors whose character, especially with regard to their forward or backward bending, is often variable.

3. *Occipitonasal length* (Pl. 10, Fig. *a*, line AB).

From the most forward tip of the nasals to hindmost point of the occipital surface, or to the centre of the top of the occiput when this projects backwards behind the lambdoidal region. (This is generally the greatest length of the skull.)

4. *Greatest zygomatic width* (Pl. 9, Fig. *a*, line ZZ').

Greatest width across the outer surfaces of the two cheekbones (zygomatic arches) measured at right angles to the long axis of the skull.

5. *Least interorbital width* (Pl. 9, Fig. *a*, line XX').

Least width of the frontal bone between the orbits, as viewed from above.

This is the “frontals width” of Ellerman (1947*a*, p. 250).

6. *Cranial width* (Pl. 9, Fig. *a*, line YY').

Greatest width of cranium just above the squamosal roots of the zygomatic arches.

7. *Occipital breadth* (Pl. 9, Fig. *a*, line RR').

Width of the occipital region just above the external auditory meatus and in front of the mastoid processes of the periotic.

8. *Median depth of occiput* (Pl. 10, Fig. *b*, line KK').

Vertical median height of the occiput from the highest surface of the occipital crest to the lowest surface of the foramen magnum.

9. *Postmolar length* (Pl. 10, Fig. *a*, line WO).

From the hindmost point of the occipital condyle of one side to the hindmost point of the base of the last molar, or m_3 of that side where it emerges from the maxilla.

10. *Auditory length* (Pl. 10, Fig. *a*, line EO).

From the most forward surface of the tympanic bulla to the hindmost point of the occipital condyle of that side.

11. *Length of tympanic bulla* (Pl. 10, Fig. a, line EE').

Maximum length of the tympanic bulla proper from a point immediately next to the paroccipital process to the opposite point on the inflated bulla, excluding the spinous processes and the mastoid portion when swollen, as happens in the Dipodidae and the Gerbillinae.

12. *Length of nasals* (Pl. 9, Fig. a, line AA').

Maximum length of nasals along the antero-posterior axis.

13. *Greatest combined width of nasals* (Pl. 9, Fig. a, line SS').

Greatest width of nasals measured at right angles to their antero-posterior axis.

14. *Length of anterior palatine foramina* (Pl. 9, Fig. b, line UV).

Maximum length along the antero-posterior axis of the foramina. Ellerman (1947a, p. 250) defined this measurement as follows :—From a point immediately in front of the foramina to a point immediately behind it.

15. *Greatest combined width of anterior palatine foramina* (Pl. 9, Fig. b, line JJ').

Maximum width of the two anterior palatine foramina, at right angles to the antero-posterior axis.

16. *Length of upper molars or "cheek tooth row"* (Pl. 10, Fig. a, line CC').

Maximum total length of all the upper molars (excluding the pre-molars) on the crowns.

17. *Length of diastema* (Pl. 10, Fig. a, line GG').

From a point on the ventro-lateral side of the premaxilla where it meets the back or posterior edge of the first incisor, or i_1 , to the most forward point of the base of the first tooth present in the premolar-molar series of that side where it emerges from the maxilla.

Ellerman (1947a, p. 250) defined this measurement as follows :—From a point immediately behind the front incisor to a point immediately in front of the front cheek-tooth.

18. *Palatal length* (Pl. 9, Fig. b, line PP').

From the hindmost edge of the palate, excluding the palatal spine when present, to the most forward point of the premaxilla in front of the incisors.

This is the same as that of Ellerman (1947a, p. 250) who defined this measurement as follows :—From the front of the incisors to the back of the palate ignoring the spinous process if any. Roonwal (1950, pp. 2-4) defined this measurement upto the back of the incisors as follows :—From the hindmost edge of the palate, excluding the palatal spine when present, to the most forward point of the premaxilla on the ventro-lateral side where it meets the back or posterior edge of the first incisor or i_1 .

TABLE 2.—*Reference points to the lines in the illustrations (Plates 8-10) indicating the various measurements of the body and the skull of a Rodent.*

Name of measurement				Reference points to the lines	Plate and Figure No.
1.	Occipito-premaxillary length	.		PB	10a
2.	Condylobasal length	.		PO	10a
3.	Occipitonasal length	.	. . .	AB	10a
4.	Greatest zygomatic width	.	. . .	ZZ'	9a
5.	Least interorbital width	.	. . .	XX'	9a
6.	Cranial width	.	. . .	YY'	9a
7.	Occipital breadth			RR	9a
8.	Median depth of occiput	.	. . .	KK'	10b
9.	Postmolar length	.	. . .	WO	10a
10.	Auditory length	.	. . .	EO	10a
11.	Length of tympanic bulla	.	. . .	EE'	10a
12.	Length of nasals	.	. . .	AA'	9a
13.	Greatest combined width of nasals	.	. . .	SS'	9a
14.	Length of anterior palatine foramina	.	. . .	UV	9b
15.	Greatest combined width of anterior palatine foramina.			JJ'	9b
16.	Length of upper molars (or length of "cheek-teeth row").			CC'	3a
17.	Length of diastema	.	. . .	GG'	3a
18.	Palatal length	.	. . .	PP'	2b
19.	Mandibular length	.	. . .	MM'	3c
20.	Length of occiput			KQ	3b
21.	Length of orbit	.	. . .	LL'	2a
22.	Length of head-and-body			FD	1b
23.	Length of tail			DT	1b
24.	Length of hindfoot			NN'	1c
25.	Length of ear	.	. . .	HH'	1d

19. *Mandibular length* (Pl. 10, Fig. *c*, line MM').

From the hindmost point of the mandibular condyle to the most forward point of the mandible on the ventro-lateral side where it meets the posterior edge of the first incisor or i_1 .

In addition to the measurements listed above, Ellerman (1947*a*, p. 250; and 1947*c*, p. 259) has given two other measurements of rodent skulls which are of taxonomic value and are listed below.

20. *Length of occiput* (Pl. 10, Fig. *b*, line KQ).

From the top of the foramen magnum to the top of the lambdoidal ridge. (This measurement is of importance in the family Rhizomyidae.)

21. *Length of orbit* (Pl. 9, Fig. *a*, line LL).

From the anterior end of the lacrymal where it meets the zygomatic arch to a point on the postzygomatic root just after it has left the squamosal. (This measurement is of importance in the family Sciuridae.)

IV—INDICES

A number of indices may be used according to one's choice. Those which have been found most useful for taxonomic purposes are listed below. As stated earlier, indices may be expressed either as a percentage of one measurement in terms of another or as a proportion of the other which is regarded as unity. For external body-measurements, indices are best expressed in relation to the combined length of head-and-body (minus the tail). Skull indices are best expressed in relation to the occipitonasal length which is generally the greatest length of the skull, but sometimes the condylobasal length may be used with advantage. The indices used are defined below :—

*(a) External body indices.*1. *Tail Index.*

Tail length/Length of head-and-body.

2. *Hindfoot Index.*

Length of hindfoot/Length of head-and-body.

3. *Ear Index.*

Length of ear/Length of head-and-body.

*(b) Skull indices.*1. *Upper incisor Index.*

This differs somewhat from the other indices in the sense that it is expressed qualitatively instead of quantitatively since the tooth-angles are difficult to measure accurately. Three conditions of the upper incisors are met with in the Rodentia, and are indicated as follows :—

Proodont : Teeth projected forwards.

Orthodont : Teeth more or less straight or vertical.

Opisthodont : Teeth bent backwards.

2. *Nasal Index.*
Length of nasal/Occipitonasal length.
3. *Nasal-width Index.*
Combined width of nasals/Occipitonasal length.
4. *Tympanic bulla Index.*
Length of tympanic bulla/Occipitonasal length.
5. *Palatal Index.*
Length of palate/Occipitonasal length.
6. *Zygomatic Index.*
Width of zygomatic arch/Occipitonasal length.
7. *Orbital Index.*
Length of orbit/Occipitonasal length.
8. *Molar teeth Index.*
Length of molar teeth/Occipitonasal length.
9. *Postmolar Index.*
Postmolar length/Occipitonasal length.
10. *Anterior palatine foramina Index.*
Length of anterior palatine foramina/Occipitonasal length.
11. *Diastema Index.*
Length of diastema/Occipitonasal length.
12. *Least interorbital width Index.*
Least width of frontals/Occipitonasal length.
13. *Cranial width Index.*
Cranial width/Occipitonasal length.
14. *Occipital breadth Index.*
Occipital breadth/Occipitonasal length.
15. *Median depth of occiput Index.*
Median depth of occiput/Occipitonasal length.
16. *Mandibular Index.*
Mandible length/Occipitonasal length.

V—SUMMARY

1. The more important body and skull-measurements, and their indices, for Rodents (Mammalia) which have been found useful for taxonomic purposes are discussed.

2. The measurements used by the previous workers are first listed. This is followed by a list, with definitions and illustrations, of 4 external body measurements and 21 skull measurements.

3. The value of indices of these measurements is discussed and 19 indices (3 of the external body measurements and 16 of the skull) are defined.

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VII—ABBREVIATIONS USED IN THE PLATES

<i>abd. m.</i> 1, 2., 1st and 2nd abdominal mammae respectively.	<i>ip.</i> , interparietal.
<i>als.</i> , alisphenoid.	<i>lac.</i> , lacrymal.
<i>an.</i> , anus.	<i>m₁-m₃</i> , 1st to 3rd molars respectively.
<i>ang.</i> , angular process.	<i>mal.</i> , malar bone.
<i>apf.</i> , anterior palatine foramina.	<i>mast.</i> , mastoid.
<i>ao.</i> , auditory orifice.	<i>max.</i> , maxilla.
<i>B.</i> , body.	<i>mou.</i> , mouth.
<i>boc.</i> , basioccipital.	<i>n.</i> , nostril.
<i>bsph.</i> , basisphenoid.	<i>nas.</i> , nasal.
<i>bul.</i> , tympanic bulla.	<i>nl.</i> , nail.
<i>cl.</i> , claw.	<i>oc.</i> , occipital condyle.
<i>cond.</i> , condyle.	<i>orbs.</i> , orbitosphenoid.
<i>cor.</i> , coronoid process.	<i>pal.</i> , palatine.
<i>E.</i> , ear.	<i>Par.</i> parietal.
<i>fl.</i> , forelimb.	<i>pmx.</i> , premaxilla.
<i>fm.</i> , foramen magnum.	<i>poc.</i> , paroccipital process.
<i>fr.</i> , frontal.	<i>ppf.</i> ; posterior palatine foramina.
<i>H.</i> , head.	<i>pt.</i> , pterygoid.
<i>H. & B.</i> , Head-and-body.	<i>so.</i> , supraoccipital.
<i>ham.</i> , hamular process.	<i>sq.</i> , squamosal.
<i>he.</i> , heel.	<i>th.m₁₋₃</i> , 1st-3rd thoracic mammae respectively.
<i>H.F.</i> , hind foot.	<i>Tl.</i> , tail.
<i>hl.</i> , hindlimb.	<i>tr.</i> , tragus.
<i>i.</i> , incisor tooth.	<i>vag.</i> , vagina.
<i>int., tr. n.</i> , intertragal notch.	<i>vib.</i> , vibrissae.
<i>iof.</i> , infraorbital foramen.	<i>zyg.</i> , zygomatic arch.
	<i>zyg. m.</i> , zygomatic process of maxilla.

PLATE 8

Rattus rattus bullocki Roonwal. Adult female, showing body-measurements.

- (a) Ventral view of body.
- (b) Lateral view of body.
- (c) Side view of left hindlimb.
- (d) Pinna of ear, inner view.

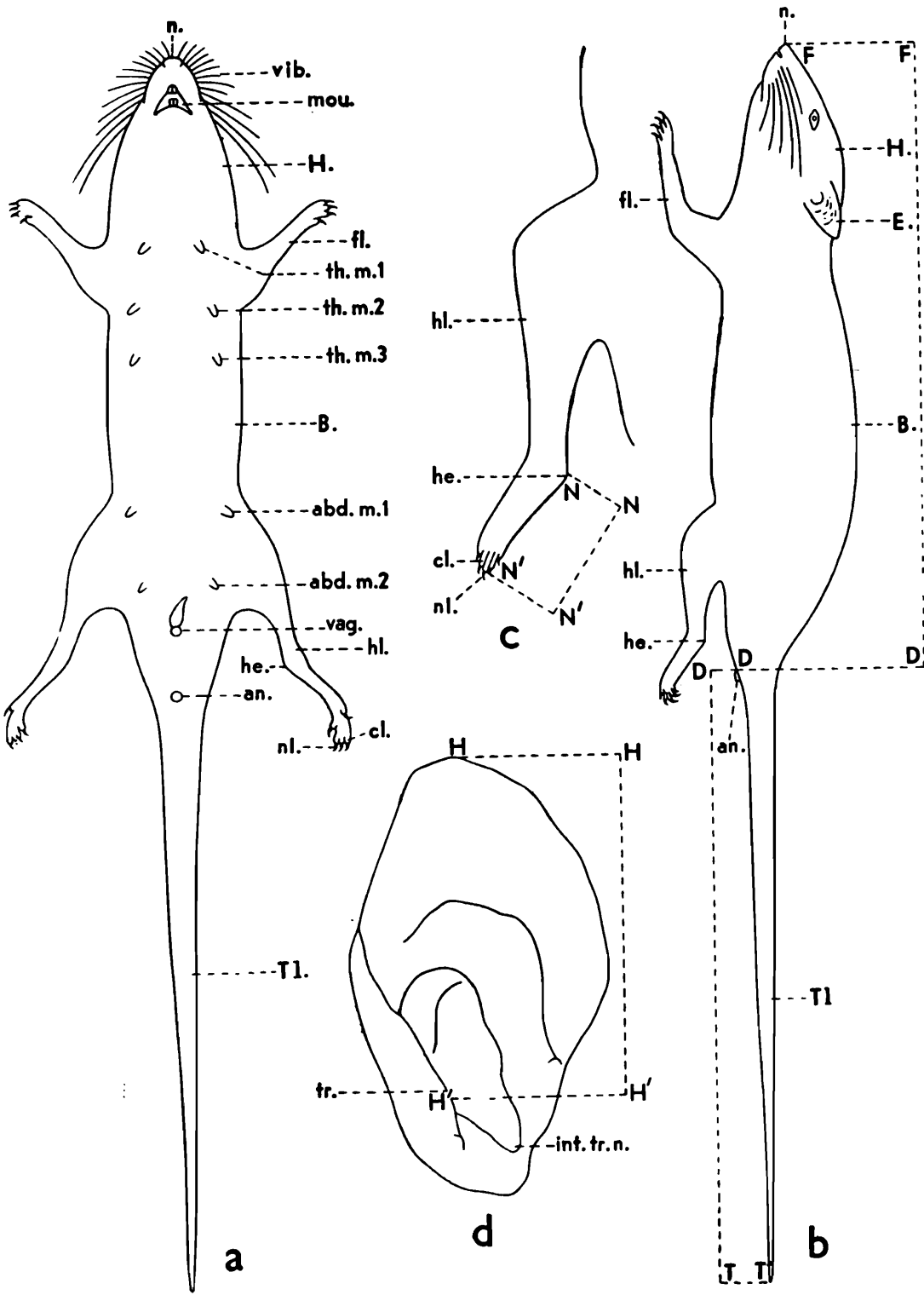
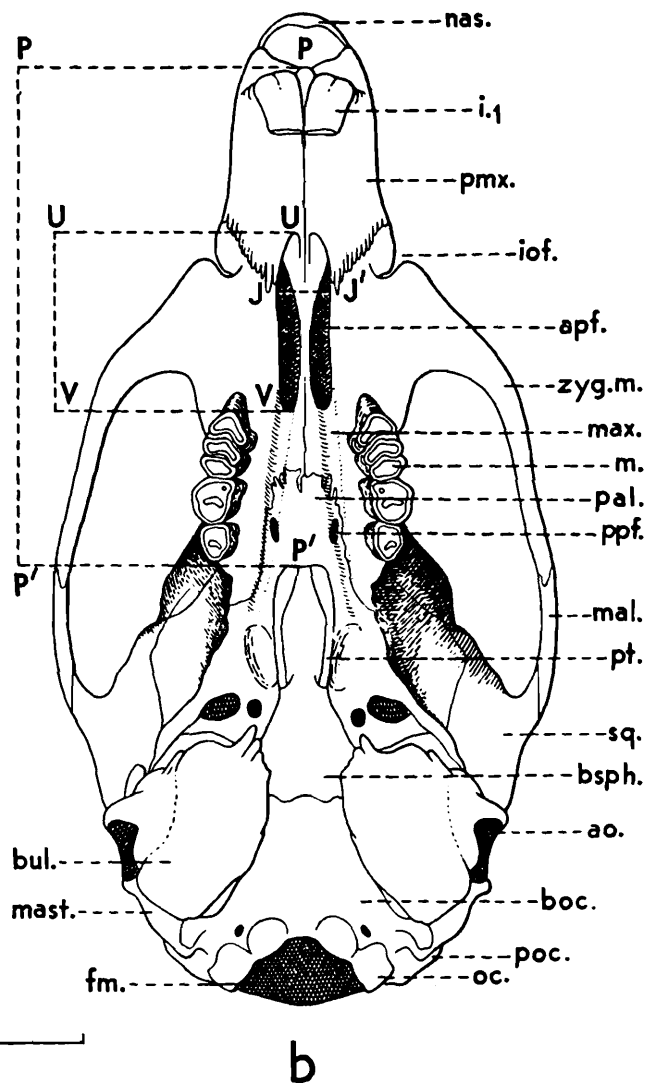
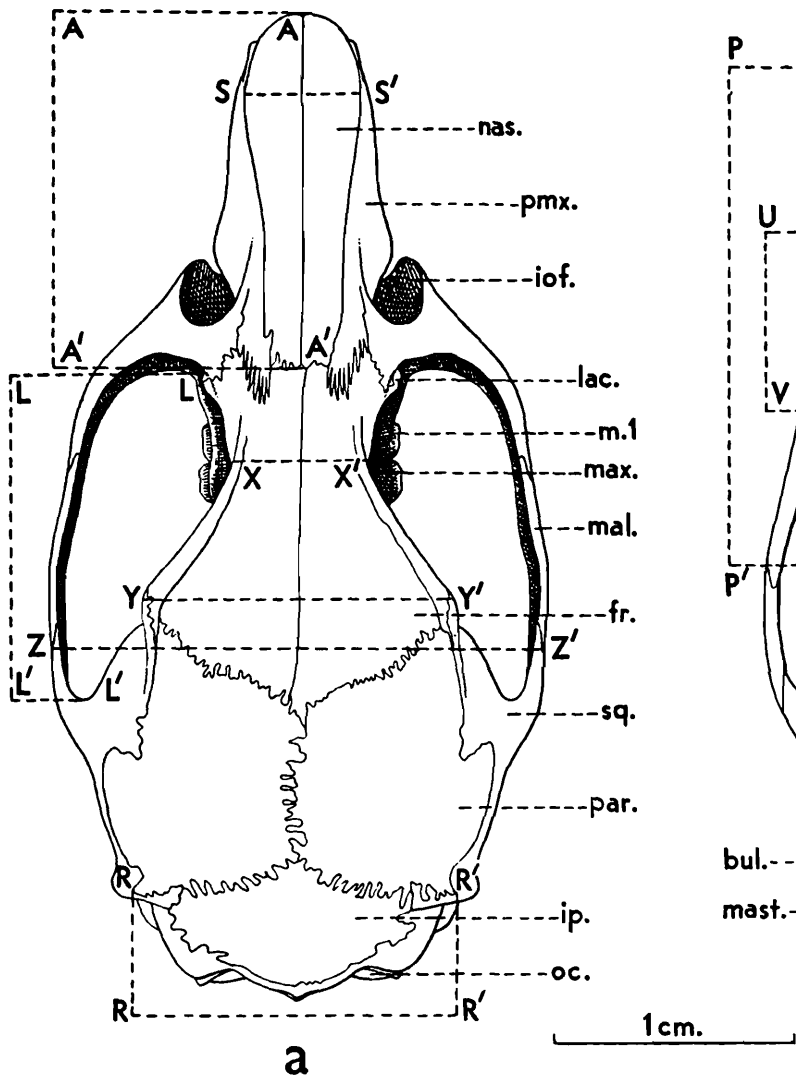


PLATE 9

Rattus rattus bullocki Roonwal. Adult female, (Z. S. I. Reg. No. 11,228). Central Manipur. Skull, showing methods of measurements.

(a) Dorsal view.

(b) Ventral view.



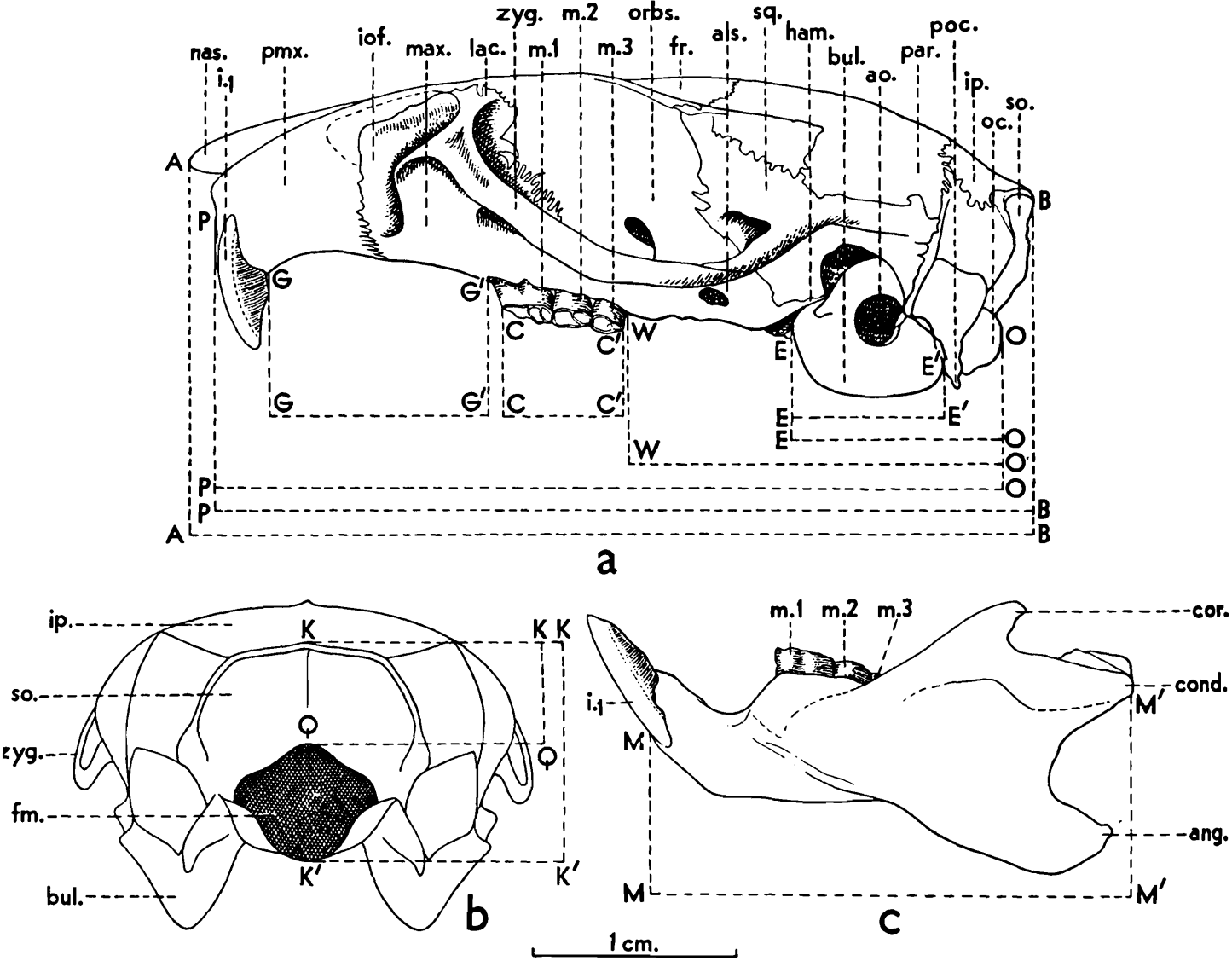


PLATE 10

Rattus rattus bullocki Roonwal. Adult female. (Z. S. I. Reg. No. 11,228). Central Manipur. Skull, showing methods of measurements.

- (a) Lateral view.
- (b) Posterior view.
- (c) Side view of mandible (lower jaw).

STRUCTURE AND POSTEMBRYONIC DEVELOPMENT OF FEMALE REPRODUCTIVE ORGANS IN THE DESERT LOCUST, *SCHISTOCERCA GREGARIA*

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(With 4 Tables, 7 Text-figures and 2 Plates)

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I—INTRODUCTION

The structure of the female genitalia and associated structures of Orthopterous insects of the family Acrididae has been studied and discussed by several workers, notably by Fenard (1896-97), Walker (1919-22), Nel (1929), Heberdey (1931), Nelson (1931-34), Vardé (1934), Snodgrass (1931-35), Roonwal (1935-49), Slifer (1940), Qadri (1940), Karandikar (1942), Gupta (1950) and Agarwala (1952-53). The Desert Locust, *Schistocerca gregaria* Forskal (Family Acrididae), has been studied in this respect by Vardé (1934), Roonwal (1935-49), Slifer (1940), Karandikar (1942), Gupta (1950) and Agarwala (1952*b*). Nevertheless, several questions need investigation, and some of these are discussed in the present paper.

II—MATERIAL AND METHODS

Schistocerca gregaria individuals obtained from swarms in India and bred crowded (and consequently in phase *gregaria*) in the laboratory were used. In most cases careful dissections of the abdomen of females, both in the hopper and adult stages, were made to expose the female reproductive organs. In some cases, especially in the first stage hoppers, the posterior end of the abdomen was cut off, treated with a weak solution of potassium hydroxide in water, stained lightly with alcoholic eosin and mounted flat on a slide. Vertical-longitudinal sections of the first stage female hoppers were cut and examined.

As far as possible, the terminology for the genitalia given by Ander (1956) and Tuxen (1956) has been followed.

III—STRUCTURE OF INTERNAL FEMALE REPRODUCTIVE ORGANS IN ADULT

(Plates 11 and 12 ; Text-figs. 1-6)

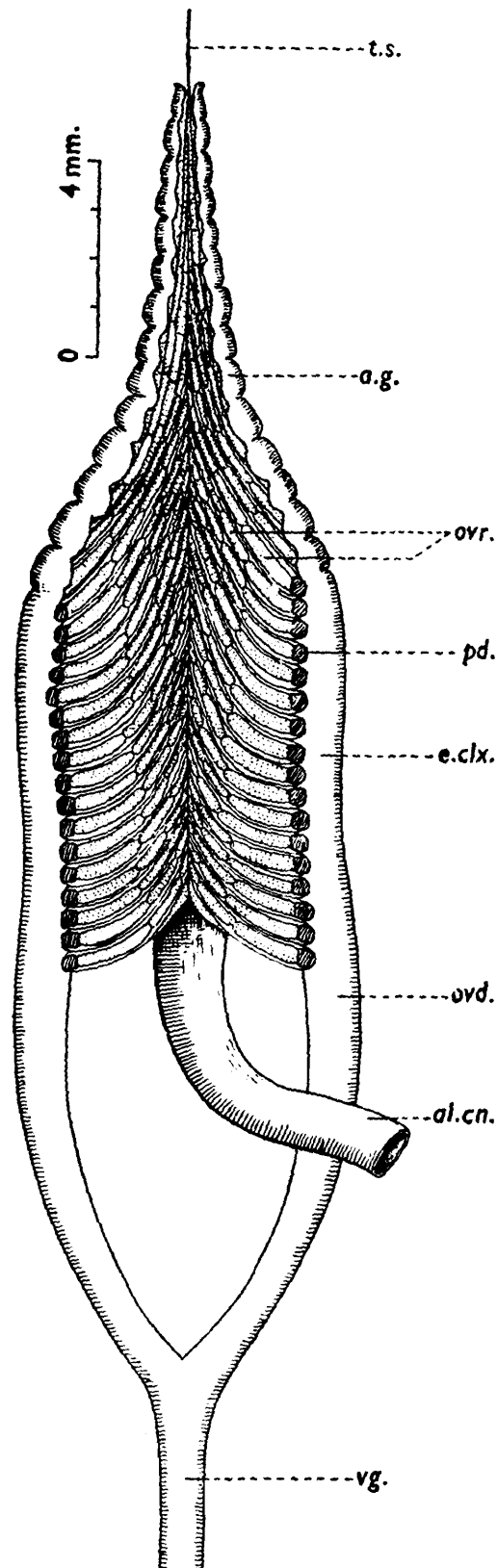
The internal female reproductive organs of *Schistocerca gregaria* consist of the following parts :—

1. The paired ovaries with their ducts.
2. The female accessory glands (*boyau calicial*). Also paired.
3. The spermatheca.

1. *The ovaries and their ducts*

The two ovaries are compact, elongated bodies lying side by side in the cavity of the abdomen above the alimentary canal. In the newly eclosed female they are small, whitish bodies lying in the fourth to sixth abdominal segments and measuring about 7 mm. long and 3 mm. wide. As the female matures, the ovaries increase in size and assume a yellowish colour (due to the presence of yolk in the ripening eggs) until, in a female about to oviposit, the ovaries occupy virtually the whole of the abdomen and also extend into the thorax, are the most conspicuous organs on the dissection of the insect and measure about 26 mm. in length and 11 mm. in width. They are richly supplied with tracheae and on their ventral side they are in intimate connection with fat-bodies.

The ovary of each side is composed of about 40-83 egg-tubes or ovarioles, the total number in the pair varying from about 92-145

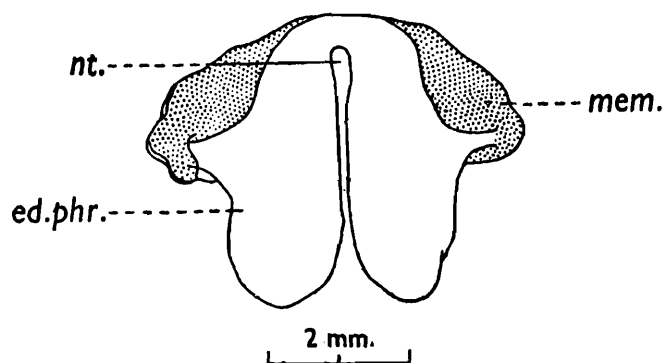


TEXT-FIG. 1.—*Schistocerca gregaria*, adult female. Ovary of a mature individual from a swarm, after egg-laying. Semidiagrammatic.

a.g., female accessory gland (*boyau calicial*) ; *al. cn.*, alimentary canal ; *e.clx.*, egg-calyx ; *ovd.*, paired oviduct ; *ovr.*, ovarioles ; *vg.*, vagina or common oviduct.

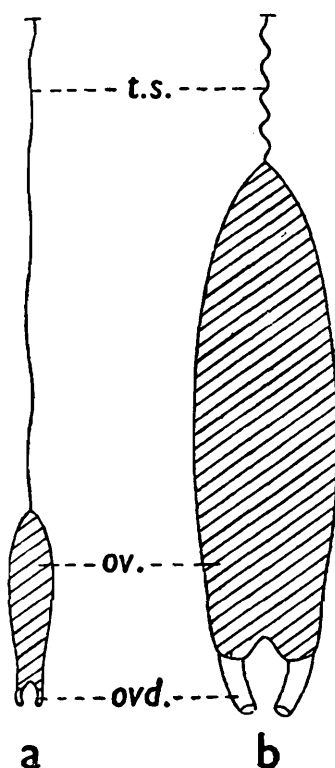
(mean 114.5). The number of ovarioles in an ovary varies in different individuals and also in the right and left ovaries of the same individual.

It is rare to find a female with an equal number of ovarioles in the two ovaries. Roonwal (1947), who studied this variation in phase *gregaria* individuals, found 43-83 (mean 57.3) ovarioles in the right ovary and



TEXT-FIG. 2.—*Schistocerca gregaria*, adult female. Second thoracic phragma to show the notch for the passage of the ovarian suspensorium.
ed. phr., endophragma ; mem., membrane ; nt., notch.

40-81 (mean 57.2) in the left. Thus, while there is no appreciable difference in the mean number of ovarioles in the right and left ovaries, the number in the same individual generally varies, the difference ranging



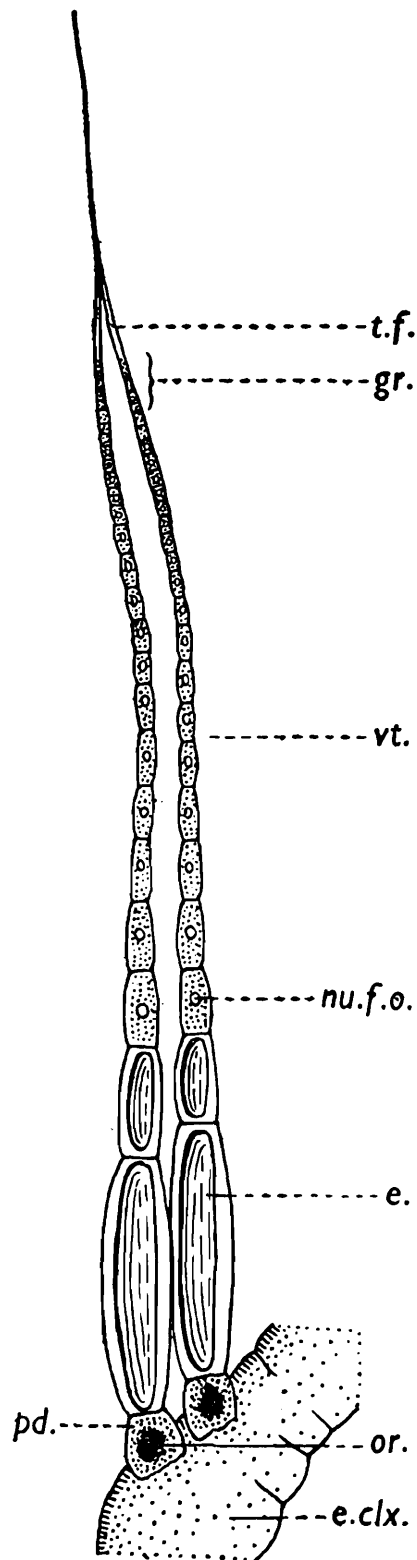
TEXT-FIG. 3.—*Schistocerca gregaria*, adult female. Diagrammatic representation of the ovary and the ovarian suspensorium, to show the sagging of the latter as the ovary grows in size with maturity.

(a) In a young freshly eclosed imago. (b) In a female about to lay eggs.

ov., ovary ; ova., paired oviduct ; t. s., terminal suspensorium of ovary

from 0-30 (mean 6.5). According to Roonwal, there is no apparent relationship between this difference and the total number of ovarioles in a female.

Each ovariole consists of a single chain of developing eggs, the oldest being situated at its base, *i.e.*, the end which abuts against the egg-calyx.



TEXT-FIG. 4.—*Schistocerca gregaria*, adult female. Two ovarioles from the ovary of a half-mature individual. (After Roonwal, 1949.)

e., egg ; *e.clx.*, egg-calyx ; *gr.*, germarium ; *nu. f. o.*, nucleus of future ova ; *or.*, mass of orange-red pigment ; *pd.*, pedicel or basal follicle ; *t. f.*, terminal filament of ovariole ; *vt.*, vitellarium.

The other eggs of the chain show a progressively decreased development as we move towards the tip of the ovariole until, finally, near the lip

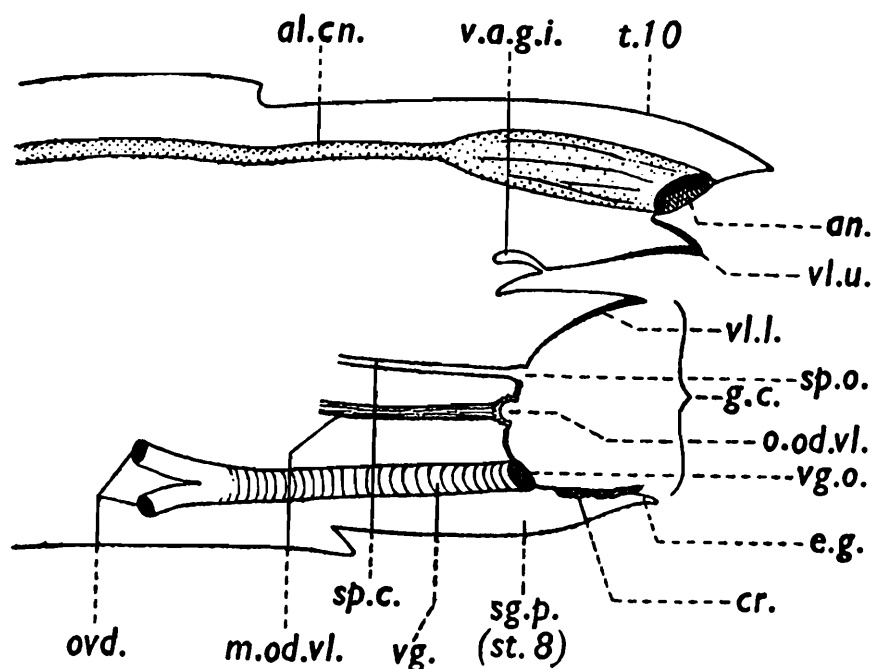
itself they merge into a mass of undifferentiated cells which constitute the *germarium* (*gr.*), the part of the ovariole with differentiated eggs being called the *vitellarium* (*vt.*). At the base of each ovariole, lying between the basal egg-follicle and the egg-calyx, there is a small *basal chamber* or *pedicel* (*pd.*). This chamber often (sometimes in all ovarioles in a female) contains (Text-fig. 4) a granular mass of orange-red pigment (Roonwal, 1945, 1949). Each egg is contained in an ovarian follicle formed by a "dipping in" of the follicular cells surrounding the egg in that region.

The apex of the ovariole is continued forward into a *terminal filament* (*t.f.*), which is a slender thread-like prolongation of the peritoneal layer of the wall of the ovariole, and obliquely meets a common *ovarian suspensorium* which supports all the ovarioles of both the ovaries. It is convenient to distinguish two regions in the ovarian suspensorium, viz., (i) a *median suspensorium* (*m.s.*) where the terminal filaments of the various ovarioles join it, and (ii) a *terminal suspensorium* (*t.s.*) which is merely an anterior prolongation of the former. The terminal suspensorium is attached to the body-wall of the mesonotum just in front of the second thoracic phragma (the phragma between the meso- and metathorax) which has a notch in its body through which the suspensorium passes (Text-fig. 2). The ovarian suspensorium is thin but strong. Its terminal portion, which is about 14 mm. long, is longitudinally folded along a median line and is somewhat V-shaped in transverse section. When the ovary is young and small the terminal suspensorium is taut, but as the ovary matures and increases in size the tension on the suspensorium decreases, and in a ripe female the suspensorium sags considerably (Text-fig. 3).

The ovarioles are of the panoistic type, i.e., they do not possess any special nutritive cells, each egg storing up its own nutriment. Consequently, the ripe egg is large and full of yolk. Freshly laid eggs are about 5.1-8.0 mm. long and about 0.9-1.6 mm. in maximum diameter. With the growth of the embryo they absorb water from the outside and increase in size to about 8.1-9.6 mm. in length and 1.5-2.9 mm. in width (*vide* Roonwal, 1954*b*). Although most of the ovarioles in a ripening ovary are at about the same stage of development, there are others which, due perhaps to want of space, are considerably underdeveloped, and between these two extremes all grades of development are met with. Therefore, the number of ova deposited by a female at any one oviposition may not correspond to the number of ovarioles present and may, in fact, be fewer.

The ovarioles of each side open into a common canalicular chamber, the *egg-calyx* (*e.clx.*). In a female about to oviposit, all the ripe eggs descend into the egg-calyx of its side, having migrated there from their respective ovarioles. Each egg-calyx leads posteriorly into a short (*ca.* 7-9 mm. long) oviduct, which passes beneath the apodeme of the subgenital plate (8th abdominal sternum). It then bends inwards to unite, below the alimentary canal and in the level of the anterior margin of the subgenital plate, with its fellow of the opposite side to form the *common oviduct* or *vagina* (*vg.*). The latter is a short duct, about 3-4 mm. long, and opens to the exterior near the posterior margin of the subgenital plate.

The posterior end of the subgenital plate (morphologically the 8th but actually the 7th sternum) is reflected over itself on the dorsal side (Text-fig. 5). This reflected area has a median-dorsal, chitinous, ridge-like fold which is prolonged posteriorly to form a hollow so-called *egg-guide* (e.g.). The vaginal opening lies at the base of the ridge just dorsal to the anterior margin of this deflection. The opening, therefore, lies in a discrete space, the *genital cavity* (g.c.), whose floor is formed by the chintinised deflection of the subgenital plate, the anterior wall by a vertical membrane (described below), and the roof by the bases of the lower (ventral) ovipositor valvulae. The posterior end of the genital cavity is functionally closed when the female is ovipositing, since the subgenital plate is closely pressed against the bases of the lower valvulae—the eggs come out first at the slit between the lower valvulae and finally at the slit between the upper ovipositor valvulae. The reflected portion of the subgenital plate bears, on its inner side, a pair of frilled, crescentic and strongly chitinised areas (cr.) of problematic function.

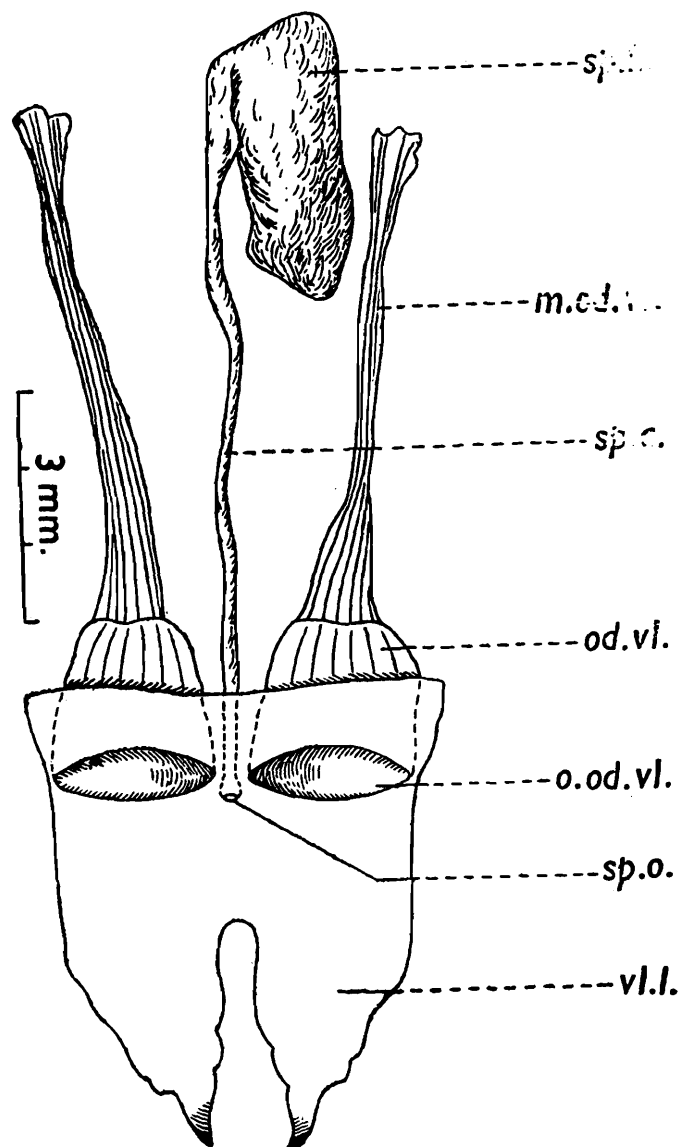


TEXT-FIG. 5.—*Schistocerca gregaria*, adult female. Longitudinal-vertical section of the posterior end of the abdomen, to show the relative position of the opening of the female reproductive organs and associated structures. Diagrammatic.

al. cn., alimentary canal; an., anal opening; cr., crescentic chitinized areas on reflected portion of subgenital plate; g. c., genital cavity; m. od. vl., muscles of oviductary vesicle; o. od. vl., opening of oviductary vesicle; ovd., paired oviduct; sg. p., subgenital plate; sp. c. spermathecal canal; sp. o., spermathecal opening; st. 8., eighth sternum of abdomen; t. 10., tenth tergum of abdomen; v. a. g. i., vestigial accessory genital invagination; vg., vagina or common oviduct; vg. o., vaginal opening; vl. l., lower (ventral or anterior) valvulae of ovipositor; vl. u., upper (dorsal, posterior or lateral) vulvulae of ovipositor.

The inner or anterior margin of the above described reflection joined to the base of the lower valvulae of the ovipositor by means of a membrane which arches dorsally and posteriorly. The vaginal opening may be regarded as an aperture at the base of this membrane. On either side of the vaginal opening, this membrane is folded to form two shallow pits which are divided by a median ridge and open posteriorly.

Since they lie on either side of the female genital opening (andrium), they may be called the *paraandrial pits*. The pits do not appear to be of much morphological significance. Also in the vertical membrane, nearer the top than the base, there are a pair of nearly transverse, slit-like, apertures (Text-figs. 5 and 6) which are the openings of eversible pouches the *oviductary vesicles* (*od. vl.*). Their muscles are attached to the apodemes of the subgenital plate.



TEXT-FIG. 6.—*Schistocerca gregaria*, adult female. Dorsal view of posterior portion of abdomen, dissected to show the spermatheca and the oviductary vesicles *in situ*. Semidiagrammatic.

m. od. vl., muscles of oviductary vesicles ; *od. vl.*, oviductary vesicle ; *o. od. vl.*, opening of oviductary vesicle ; *sp. c.*, spermathecal canal ; *sp. h.*, head of spermatheca ; *sp. c.*, spermathecal opening ; *vl. l.*, lower (ventral or anterior) valvulae of ovipositor.

The oviductary vesicles were first described by Comstock & Kellog (1899) in *Melanoplus femur-rubrum*. Later, they were described in detail by Vardé in *Anacridium aegyptium* (1929) and *Schistocerca gregaria* (1934). Slifer (1936) found that out of 55 species of Acrididae examined by her, these vesicles occurred only in the subfamily Cyrtacanthacrinae, and in none of the Acridinae, Oedopodinae and Pyrgomorphinae. According to Vardé (1929), they are new formations in the Acrididae.

and are not homologous with the coxal glands of the eighth segment in the Thysanura.

2. *The female accessory glands (boyau calicial)*

There is a single pair of *female accessory glands (a.g.)*, called "boyau calicial" by Fenard (1896). Each gland is a colourless, much-coiled "diverticulum" from the apical end of the egg-calyx and bends inwards to touch its fellow of the opposite side at the anterior tip of the ovary. In the young female the accessory glands are, like the ovaries, small and inconspicuous. They grow with maturity, and at the time of oviposition they are large and conspicuous, measuring, in the natural folded condition, about 8-12 mm. long and 0.8-0.9 mm. wide. They produce a whitish mucilaginous substance which is extruded along with the eggs at the time of oviposition and is the material which forms the basis of the "egg-pod" as well as of the "froth" over the eggs. Occasionally, the accessory gland may possess an additional pouch (Roonwal, 1935).

3. *The spermatheca*

The spermatheca is a blind, much-coiled tube which opens externally by means of a long, narrow canal into the genital cavity and serves to receive and store the sperms during coitus. The spermathecal opening (*sp.o.*) lies in a groove, between the bases of the lower ovipositor valvulae near the ventral side of the latter, in the membrane which connects the bases of the lower valvulae. This membrane is continuous with the vertical membrane mentioned previously and in which the oviductory vesicles also open. Over the groove is a chitinous arch formed by a localised thickening of the membrane. The opening leads into a small dome-shaped pouch, the *bursa copulatrix (br.c.)*, which receives the male penis during coitus. From it a narrow, slightly sinuous canal, the *spermathecal canal (sp.c.)*, leads inwards and ends in a coiled-up portion, the "head" (*sp.h.*) which has a tunic of connective tissue over which is a coating of fat. In the coiled condition the anterior end of the spermathecal head reaches up to the posterior end of the seventh abdominal sternum. When the head is uncoiled, the spermathecal canal is seen to end blindly (*sp.b.*), but near its blind end it gives off a blind pouch, the *seminal vesicle (s.v.)* where the sperms are presumably stored. The dimensions of the various portions of the spermatheca in a freshly enclosed female are approximately as follows :—

<i>Portion of spermatheca</i>	<i>Dimensions (approximate)</i>
1. Length of entire, coiled spermatheca (from mouth to anteriormost part of coiled mass)	7 mm.
2. Length of "head"	2.5 "
3. Width of "head"	1.5 "
4. Length of uncoiled spermatheca (from mouth to blind end, along curves, but excluding the seminal vesicle)	13.2 "
5. Length of uncoiled proximal portion (from mouth to opening of seminal vesicle)	11.5 "
6. Length of uncoiled portion distal to opening of seminal vesicle	1.7 "
7. Length of seminal vesicle	1.2 "

The width of the lumen of the spermatheca at various points varies from about 67-286 μ as shown below, and it is of special interest to note that the opening by which the seminal vesicle opens into the spermathecal canal is very narrow, being only about 38 μ wide :—

<i>Portion of spermatheca</i>	<i>Diameter of lumen (approximate)</i>
1. Bursa copulatrix (near opening)	276 μ
2. Portion of seminal duct immediately following bursa copulatrix (for short distance only)	124 μ
3. Portion of seminal duct following No. 2 (for a considerable length)	67 μ
4. Portion of seminal duct following No. 3 (for a short length, posterior to opening of seminal vesicle)	124 μ
5. Seminal vesicle (near its middle)	286 μ
6. Opening of seminal vesicle into spermathecal duct	38 μ
7. Portion of spermathecal duct proximal to opening of seminal vesicle	181—191 μ

IV—POSTEMBRYONIC DEVELOPMENT OF INTERNAL FEMALE REPRODUCTIVE ORGANS

(Tables 1-4 ; Text-fig. 7 ; and Plates 11 and 12)

1. General

Developmentally considered, the female reproductive organs in *Schistocerca gregaria* may, as has been shown in another Acridid, *Locusta migratoria migratorioides* (Roonwal, 1937), and several other insects, be regarded as consisting of two portions : (i) a mesodermal portion which gives rise to all the parts of the ovary, its ducts and glands ; and (ii) an ectodermal portion which gives rise to the common oviduct or vagina and the spermatheca.

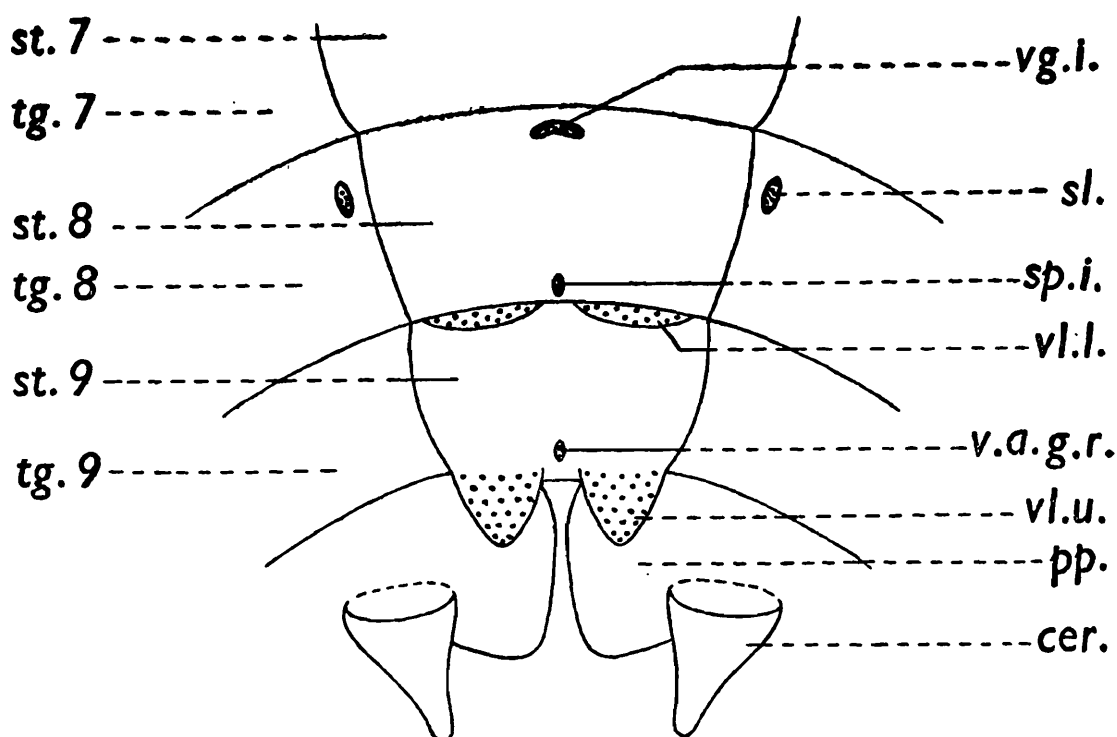
Excluding the “intermediate moult” immediately after hatching, there are normally five moults in *Schistocerca gregaria* and, consequently, five copper instars. Occasionally, one or two extra moults occur (*vide* Roonwal, 1946). The present postembryonic development was studied on the basis of the normal five moults.

2. Condition at the time of hatching

(Text-fig. 7 ; and Plate 11, Figs. 1-3)

At the time of hatching from the egg, the ovaries (*ov.*) consist of a flat, elongated and nearly rectangular plate of tissue, about 0.9 mm. long and 0.2 mm. wide, lying dorsal to the alimentary canal and extending from the

anterior border of the third abdominal segment to the middle of the fifth (Pl. 11, Fig. 2). On either side it is bordered by a strand of tissue, the oviduct. The two oviducts approach and meet each other beneath the alimentary canal in the region of the anterior portion of the eighth sternum. At this point there is also seen the rudiment of an ectodermal invagination, the common oviduct or vagina (*vg.i.*) whose inner end is fused with the junction of the two oviducts. Behind the vaginal invagination, near the posterior margin of the eighth sternum, there lies the rudiment of the spermathecal invagination (*sp.i.*), and behind the latter, at the posterior border of the ninth sternum between the two upper



TEXT-FIG. 7.—*Schistocerca gregaria*. Posterior end of abdomen of a freshly hatched first instar female hopper, treated with KOH and mounted on a Slide, to show the position of the female genital opening and associated structures. Semidiagrammatic.

cer., cercus ; *pp.*, paraproct ; *sl.*, last abdominal spiracle ; *sp. i.*, spermathecal invagination ; *st. 7—st. 9.*, 7th to 9th sterna respectively of abdomen ; *tg.7—tg. 9.*, 7th to 9th trga respectively of abdomen ; *v. a. g. r.*, rudiment of future vestigial accessory genital invagination ; *vg. i.*, invagination of vagina or common oviduct ; *vl. u.*, upper (dorsal. posterior or lateral) valvulae of ovipositor.

ovipositor valvulae, there lies the rudiment (*v.a.g.r.*) of the future vestigial accessory genital invagination (*v.a.g.i.*).

The ovarioles (*ovr.*) have become differentiated and are seen attached to the median suspensorium (*m.s.*), each by means of single row of cells, the terminal filament (*t.f.*) of the ovariole. The terminal suspensorium is also present. The egg-calyx (*e.clx.*) of each side has not yet been fully differentiated from the oviduct, nor has the latter yet become extended anteriorly to form of the female accessory glands.

3. *Position of ovary in the abdomen*TABLE 1.—*Schistocerca gregaria*. *Position of the ovary in the abdomen in various instars*

Stage	Extent and position of ovary in abdomen
1. First instar hopper (just hatched)	Anterior border of 3rd to middle of 5th abdominal segments.
2. Second instar hopper (just moulted)	As in first instar hopper.
3. Third instar hopper (just moulted)	Also as in first instar hopper. (In some cases, however, the anterior end lies about middle of 2nd abdominal segment.)
4. Fourth instar hopper (just moulted).	Hind portion of 3rd to middle of 5th abdominal segments.
5. Fifth instar hopper (just moulted)	Middle of 4th to anterior border of 6th abdominal segments.
6. Imago (just enclosed)	Middle of 4th to middle of 6th abdominal segments.

In the first instar hopper just hatched from the egg, the ovary extends from the anterior border of the third to the middle of the fifth abdominal segments. Thence onwards there is a gradual posterior shifting of the ovary until, in the recently enclosed imago, it extends from the middle of the fourth to the middle of the sixth abdominal segments.

4. *Differentiation of ovarioles, ova, etc.*(a) *Number of ovarioles*

At the time of hatching, the ovary is already differentiated into ovarioles which are disposed in their characteristic position, forming a compact mass. Due to this compactly packed condition of the ovarioles and to their small size, it is difficult to count accurately their number in the first instar hopper. In a recently moulted second instar hopper, however, this number could be easily counted and was found to be 59-63 in each ovary. It was further noted that the disposition of the ovarioles along the oviducts is two or three deep.

As shown by me earlier (Roonwal, 1946), in eight hoppers of 2nd and 5th stages, the number of ovarioles in each of the paired ovaries in an individual varied from 54-68. It is noteworthy (and in striking contrast to the condition occurring in the adult) that in all cases the number in the right and left ovaries was the same in each individual. It was further shown by me that the proportion of symmetrical ovaries (with an equal number of ovarioles in the right and left ovaries) is higher in freshly eclosed young females (42 per cent) than in females nearing maturity (29 per cent). This progressive decrease in symmetry with

maturity (100 per cent in hoppers and 29 per cent in nearly mature females probably arises by an irregular (unequal) resorption of ovarioles in the two ovaries. This view, as shown in the above mentioned paper, finds support from the fact that while in the freshly hatched hopper all the ovarioles in an ovary are of approximately the same size, already in the fourth stage some ovarioles are markedly smaller than the others and in the ripe female about to oviposit for the first time, though the majority of ovarioles are large and contain a ripe egg, there are some which are extremely underdeveloped and do not contain a ripe egg. (For further discussion, see Roonwal, 1947, p. 382.)

(b) *Structure of the ovarioles*

The structure of the ovarioles at the time of hatching is essentially the same as in a fully developed adult female, except that definite ova have not yet been differentiated as such. Even in this early stage, three distinct regions are distinguishable as follows :—

(i) *The vitellarium (vt.)*.—This is the basal part of the ovariole which abuts on the oviduct and contains actively dividing cells with large, lightly staining nuclei, about $13-17\mu$ in diameter. These nuclei (*nu.o.* ; *nu.fol.*), which are the future germinal-vesicles, are arranged irregularly and not in a single row. The egg-cells are not yet differentiated. The nuclei of the follicular cells (*nu.fol.*) in this region are fewer in number and much smaller in size.

(ii) *The germarium (gr.)*.—This is the most deeply staining portion of the ovariole and lies towards the apex. The deep-staining property is due to the presence of a large number of small (diameter *ca.* 6.5μ) nuclei in the cells.

(iii) *The terminal filament (t.f.)*.—The terminal filament consists of a single row of cells connecting the apex of the germarium with the median suspensorium (*m.s.*) of the ovary. The cells of the terminal filament are disc-like and are arranged close to each other in a row, with the nuclei flattened in a direction at right angles to the longitudinal axis of the ovariole. Each nucleus measures about 10μ in its maximum diameter and 4μ in the minimum.

At the time of hatching, the nuclei of the future ova are arranged irregularly and the follicular cells have not yet “dipped in” to enclose each egg separately. By the end of the first instar, however, these nuclei have marshalled themselves into a single file, starting from the base of the vitellarium, and the follicular cells have “dipped in” so as to enclose each nucleus with its surrounding cytoplasm to form a definite, closed sac. Such a body may now be called a “differentiated egg-cell” With the growth of the insect the size of the ovarioles as well as the number of differentiated egg-cells in them increase. This differentiation proceeds from the base of the ovariole upwards. At the beginning of the second instar hopper, 3-5 egg-cells are differentiated in each ovariole, and this number gradually increase with growth until it has reached about 8-12 in the freshly eclosed adult and 14-20 in an actively ovipositing female. The number of differentiated egg-cells, the average length of the ovarioles, the average dimensions of the basal and the subbasal egg-cells and of their nuclei at various stages of development are given in Table 2.

TABLE 2.—*Schistocerca gregaria*. Number of differentiated egg-cells in ovarioles, length of ovarioles, demensions of egg-cells, etc., in various stages of postembryonic development.

Stage	Number of differentiated egg-cells	Average length of ovariole	Average dimensions of basal egg-cell		Average dimensions of subbasal egg-cell		Maximum diameter of nuclei of	
			Length	Width	Length	Width	Basal egg-cell	Subbasal egg-cell
First stage (just hatched)	None. (Differentiation occurs during this instar.)	0.088 mm.	—	—	—	—	Nuclei in vitellarium 13—17 μ	
Second stage (just moulted)	3—5	0.19 mm.	44.4 μ	45.2 μ	35.2 μ	45.9 μ	28.3—32.6 μ	23.9—30.5 μ
Third stage (just moulted)	3—6	0.35 mm.	130.5 μ	73.5 μ	72.2 μ	73.1 μ	43.5—56.6 μ	26.1—41.9 μ
Fourth stage (just moulted)	5—11	0.8 mm.	150 μ	101 μ	107.7 μ	93.3 μ	60.9—67.4 μ	47.9—60.9 μ
Fifth stage (just moulted)	7—11	1.5 mm.	215.2 μ	132.7 μ	180.8 μ	107.7 μ	69.6—80.5 μ	58.7—71.8 μ
Imago (just eclosed)	8—12	2.4 mm.	441.3 μ	151.9 μ	338.5 μ	164.4 μ	69.6—100.1 μ	65.3—100.1 μ
Imago (about to lay its first batch of eggs)	12—17 (mostly 13—15)	ca. 8 mm.	6900 μ	1250 μ	?	?	?	?
Imago which has laid thrice (would probably die in a few days)	14—20 (mostly 16—18)	ca. 8 mm.	6900 μ	1250 μ	?	?	?	?

By the beginning of the second instar hopper the terminal filament of the ovariole no longer consists of a single row of cells, and the nuclei are arranged irregularly. Further growth of the filament consists of an increase in the number of cells.

5. *The ovarian suspensorium*

At the time of hatching, both the median and the terminal portions of the ovarian suspensorium are present. The median suspensorium (*m.s.*) consists of a long, flat strand of tissue lying between the two ovaries. Its nuclei are generally scattered but are specially arranged at the sides where they form a row of deeply-staining bodies along either border of the suspensorium where they are met with by the terminal filaments (*t.f.*) of the ovarioles. The other nuclei stain somewhat less deeply and are slightly oblong in shape. By the beginning of the second instar the nuclei forming the edge of the median suspensorium are not distinguishable as such. Except for simple growth, no further change occurs in the structure of the median suspensorium.

The terminal suspensorium is a mere continuation of the median suspensorium and has much the same structure as the latter. The nuclei are slightly elongate, stain rather lightly and are not specially arranged along the edges. The anterior attachment of the terminal suspensorium appears in all the hopper instars, as in the imago, to be attached to the mesonotum.

6. *The oviducts, the vagina and the accessory glands*

(Table 3 ; Text-fig. 7 ; and Plates 11 and 12)

(a) *The lateral oviducts*

At the time of hatching (Pl. 11, Fig. 1), each oviduct (*ovd.*) is represented by a strand of tissue running along the outer side of the ovary of its side and continuing posteriorly to meet its fellow of the other side in the anterior region of the eighth sternum where they are met by the vaginal invagination (*vg. i.*). The nuclei of these ducts stain deeply and have nearly the same appearance and size as those of the follicular cells of the ovary. There is at first no distinction between the various portions of the ovarian duct. By the beginning of the fourth instar hopper, however, the anterior region of the oviducts (lying alongside the ovaries) is seen to be more densely packed with nuclei than the posterior one and is also somewhat wider than the latter. By the end of that stage this region has become markedly thick and muscular and it ultimately becomes the egg-calyx (*e. clx.*). The posterior portion of the oviducts becomes the right and left oviducts. The entire oviduct, including the egg-calyx, of each side is about 2 mm. long in the first instar hopper and 8.3 mm. long in the freshly eclosed imago (Table 3).

TABLE 3.—*Schistocerca gregaria*. Approximate length of oviduct, vagina and female accessory glands in various stages of postembryonic development.

Stage	Length of oviduct (including egg-calyx portion)	Length of vagina (common oviduct)	Length of female accessory gland
1. First stage (just hatched)	2 mm.	Only a tiny rudiment yet	Not yet differentiated
2. Second stage (just moulted)	2.4 mm.	0.5 mm.	0.05 mm.
3. Third stage (just moulted)	2.9 mm.	0.7 mm.	0.26 mm.
4. Fourth stage (just moulted)	3.9 mm.	1.4 mm.	0.9 mm.
5. Fifth stage (just moulted)	6.1 mm.	2.1 mm.	1.9 mm. (Folds not yet acquired)
6. Fifth stage (about to moult)	—	—	2.2 mm. (Folds acquired)
7. Imago (just eclosed)	8.3 mm.	3.1 mm.	3.1 mm.
8. Imago (about to lay eggs)	2.6 mm	—	8.1 mm.

(b) *The vagina (common oviduct)*

At the time of hatching (Pl. 11) the common oviduct or vagina forms a small median invagination of the body-wall in the anterior region of the eighth sternum and meets the two oviducts in that region. It grows rapidly and measures about 0.5 mm. in length at the beginning of the second instar hopper, about 2.1 mm. at the beginning of the fifth and 3.1 mm. in the just enclosed imago (Table 3). With growth, the position of the vaginal opening (vg.o.) undergoes a shifting posteriorward. While its primary position (at the time of hatching) is in the anterior region of the eighth sternum and about 0.44 mm. distant from the spermathecal opening (which lies near the posterior margin of the eighth sternum), by the beginning of the second instar hopper the distance is reduced to about 0.25 mm. and by the beginning of the third it has shifted to the posterior border of the same sclerite in close proximity to the spermathecal opening.

The first step towards this displacement of the vaginal opening is the backward extension, in the later part of the first instar hopper, of the vaginal tissue as a narrow slip from either side of the original vaginal rudiment. During the later stages this process is simply carried a step farther. However, the exact mode of the posterior shifting of the vaginal opening itself is not clear. By the end of the fourth instar hopper, the opening of the vagina lies on the inner, reflexed border of the eighth sternum—the floor of the future genital cavity. This condition is maintained in the imago. At the beginning of the fifth instar hopper, the portion of the intersegmental membrane between sterna 8 and 9, anterior to the origin of the lower ovipositor valvulae, begins to extend itself, and by the end of that instar the membrane becomes considerably extended. As a result, the proximity of the vaginal and the spermathecal openings is no longer maintained and the two openings again become widely spaced apart.

(c) *The female accessory glands (boyau calicial)*

The female accessory glands or *boyau calicial* (a.g.) are formed as forward outgrowth of each egg-calyx anterior to the base of the first (anteriormost) ovariole. At the time of hatching, the outgrowth is absent ; it is formed during the first instar. At the beginning of the second instar hopper the outgrowth is about 0.05 mm. long, and thence onwards it grows rapidly (Table 3). In the recently moulted fifth instar hopper

the accessory glands have not yet acquired their characteristic folds, but by the end of that instar folds have been developed. The glands attain their maximum development just prior to egg-laying when they measure about 8-12 mm. in length in the "unfolded" condition.

7. *The spermatheca*

(Table 4 ; Text-fig. 7 ; and Plates 11 and 12)

At the time of hatching (Pl. 11, Figs. 1 and 2) the rudiment of the spermathecal invagination (*sp.r.*) is seen as a small, rounded median mass of actively dividing cells on the eighth sternum close to its posterior border and about 0.44 mm. behind the vaginal invagination. By the beginning of the second instar hopper (Pl. 11, Fig. 4), this distance has become reduced to about 0.25 mm. by the backward extension of the vaginal tissue, and the spermatheca has approached the posterior margin of the eighth sternum. At the beginning of the third instar hopper (Pl. 12, Fig. 4) the spermathecal rudiment consists of an anterior ball-shaped portion (*sp.a.*) representing the coiled spermathecal "head" round which a connective tissue coating is evident, and a narrow posterior portion (*sp.p.*) representing the posterior portion of the spermathecal canal. In the natural, coiled position the spermatheca now measures about 0.22 mm. in length. It is to be noted that its position has by now shifted from the posterior margin of the eighth sternum to the intersegmental membrane between sterna 8 and 9. Also, as already stated, due to the backward extension of the vaginal tissue, the vaginal and spermathecal openings have become approximated but remain separate.

By the end of the third instar hopper (Pl. 12, Fig. 5) the spermatheca has become greatly elongated and has also developed a small pouch-like outgrowth, the seminal vesicle (*s.v.*) near its blind inner end (*sp.b.*). The posterior end of the spermathecal canal near its opening to the exterior (*sp.o.*) has also become slightly enlarged to form the bursa copulatrix (*br.c.*). Changes in the fourth (Pl. 12, Figs. 6 and 7) and fifth instar hoppers consist of a lengthening of the spermatheca, a thickening of its internal chitinous lining and a clear differentiation of its connective tissue tunic into an inner muscular and an outer fatty portion. Subsequent development consists in little else but increase in size. Measurements of the spermatheca in various stages are given in Table 4.

TABLE 4.—*Schistocerca gregaria*. Length, etc., of spermatheca and vestigial accessory genital invagination in various stage of postembryonic development.

Stage	Spermatheca		Vestigial accessory genital invagination	
	Length in natural (coiled) condition. (Straight distance from spermathecal opening to the most anterior end of coiled mass.)	Length in uncoiled condition. (Total length along curves, from spermathecal opening to blind end, but excluding the seminal vesicle.)	Length	Width (maximum)
1. First instar (just hatched)	Only a small rudiment	—	A tiny rudiment	—
2. Second instar (just moulted)	0.12 mm. rudiment	—	Very small	—
3. Third instar (just moulted)	0.22 mm. rudiment	—	80 μ	16 μ
4. Fourth instar (just moulted)	8.0 mm. rudiment	2.3 mm.	173 μ	20 μ
5. Fifth instar (just moulted)	2 mm. rudiment	4.8 mm.	400 μ	40 μ
6. Adult (just enclosed)	7 mm. rudiment	13.2 mm.	1360 μ	88 μ

8. *The vestigial accessory genital invagination*

(Table 5 ; and Plate 11, Fig. 1)

Between the upper ovipositor valvulae on the ninth sternum there is seen, in the recently hatched hopper, a mass of cells (*v.a.g.r.*) looking very much like the spermathecal rudiment but much less developed than the latter. It grows very slowly as compared to the spermathecal rudiment and develops an invagination in the beginning of the third instar hopper. It persists in the adult as a small vestigial accessory genital invagination between the inner or middle ovipositor valvulae. Its length is about 80μ at the beginning of the third instar hopper when the invagination is first clear, 400μ at the beginning of the fifth instar and 1960μ in the freshly enclosed imago (Table 4). The structure does not develop further and remains vestigial.

9. *Discussion*(a) *Number of ovarioles*

There is some indication to suggest that the number of ovarioles found in the first instar hopper at the time of hatching represents the full quota for that individual, and subsequent development consists not in an increase in number but rather in a decrease due to resorption of the ovarioles caused presumably by overcrowding. This is suggested by their initially large number and also by their symmetry in the young hoppers. Furthermore, all the ovarioles in the younger hopper stages (first to third) are, in each stage, almost identical in development in each individual. Already in the fourth stage hopper it is seen that some of the ovarioles are distinctly smaller than the others. This phenomenon is accentuated with growth and is very marked in the maturing imago.

(b) *The genital ducts and their openings*

Both Qadri (1940, for *Locusta migratoria*) and Gupta (1950, for *Schistocerca gregaria*) have stated that the median external opening of the common oviduct or vagina is first developed in the intersegmental membrane between the abdominal sterna 8 and 9, but embryos were not studied. On the other hand, I have found in these very insects (Roonwal, 1937 for *Locusta* ; and the present account for *Schistocerca*) that in the freshly hatched first instar hopper the vaginal opening lies at the anterior end of the eighth sternum. It is obvious that this difference can only be resolved by a careful study of embryos. It is, however, clear that subsequently during postembryonic development, the position of the vaginal opening undergoes a shifting posteriorward until it comes to lie at the posterior margin of the eighth sternum. This displacement of the vaginal opening from an initially anterior position was also observed by Nel (1929) in Acridids of the genera *Locustana* and *Colemania*.

(c) *The spermatheca and the vestigial accessory genital invagination*

The spermathecal opening both in *Locusta migratoria* (Roonwal, 1937) and in *Schistocerca gregaria* (Roonwal, 1946 ; and present account ; and Gupta, 1950) is quite separate from the opening of the vagina or common oviduct. The curious statement of Qadri (1940, p. 156) that in *Locusta migratoria* the spermatheca "opens on the common oviduct" is certainly an error.

The vestigial accessory genital invagination on the ninth sternum evidently corresponds to a similar structure described by Nel (1929) in the Acridids *Locustana* and *Colemania* as arising on the ninth sternum and developing slowly, exactly as in *Schistocerca gregaria* where it was correctly described by Gupta (1950).

V—SUMMARY

1. The internal female reproductive organs (the ovaries and their ducts, the female accessory glands and the spermatheca) in the adult of the Desert Locust, *Schistocerca gregaria* Forskal (Orthoptera : Acrididae) are described in detail.

2. The postembryonic development of these structures is also studied from the moment of hatching from the egg to the ripening of the adult female.

3. The ovary, which in the freshly hatched hopper lies from the anterior border of the 3rd to the middle of the 5th abdominal segments, occupies a position from the middle of the 4th to that of the 6th abdominal segment in the freshly enclosed imago.

4. The number of ovaries is already large, about 59-63, in the freshly moulted second instar hopper and probably represents the full quota for that individual. This number in the right and left ovaries in an individual is symmetrical up to the 5th instar hopper, but thereafter a symmetry develops in the imago (due presumably to resorption of some ovarioles) and increases progressively as the female matures.

5. The structure and development of the ovarioles are described. Even in the freshly hatched first instar hopper, three parts are distinguishable in an ovariole, viz., a basal vitellarium, a distal germarium and a terminal filament.

6. The ovary is attached to the dorsal body-wall by a long ovarian suspensorium.

7. The two oviducts are already well developed in the freshly hatched first instar hopper. The portion of the duct abutting on the ovaries becomes differentiated into a thick-walled egg-calyx by the end of the fourth instar hopper.

8. At the time of hatching, the median external opening of the common oviduct or vagina is situated at the anterior end of the 8th abdominal sternum. In subsequent hopper stages it shifts posteriorly and ultimately comes to lie on the posterior margin of that same sclerite.

9. The female accessory glands (*boyau calicial*) are first differentiated in the first instar hopper from the anterior end of the oviducts. The glands attain their maximum development in the adult just prior to egg-laying.

10. The rudiment of the spermathecal invagination is first seen in the freshly hatched first instar hopper on the posterior border of the 8th abdominal sternum. Thereafter it grows rapidly.

11. A vestigial accessory genital invagination is first clearly developed on the 9th abdominal sternum in the 3rd instar hopper though its rudiment, as a cell-mass, is seen in the same position in the beginning of the first instar.

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LETTERING USED IN PLATES

- a.g.*, female accessory glands (*boyau calcial*).
al. cn., alimentary canal.
an., anal opening.
br. c., bursa copulatrix.
cer., cercus.
cr., crescentic chitinized areas on reflected portion of subgenital plate.
c. vg., cells in continuation of vaginal cells.
e., egg or ovum.
e. clx., egg-calyx.
ed. phr., endo-phargma.
e.g., egg-guide.
gan., ganglion of ventral nerve cord.
g.c., genital cavity.
gr., germarium.
ints. 8/9, intersegmental region between abdominal sterna 8 and 9.
mem., membrane.
m.g., mid-gut wall.
m. od. vl., muscles of oviductary vesicle.
m.s., median suspensorium of ovary.
m.t., Malpighian tubules.
nt., notch.
nu. f.o., nuclei of future ova.
nu. fol., nuclei of follicular cells.
nu. o., nuclei of ova.
od. vl., oviductary vesicles.
o. od. vl., opening of oviductary vesicle.
or., mass of orange-red pigment.
ov., ovary.
ova. paired oviduct.
ovr., ovarioles.
pd., pedicel or basal chamber of ovariole.
pp., paraproct.
rt., rectum.
sa. p., supraanal plate.
sg. p., subgenital plate.
sl., last abdominal spiracle.
sp., spermatheca.
sp. a., anterior end of spermatheca.
sp. b., blind end of spermatheca.
sp. c., canal of spermatheca.
sp. h., head of spermatheca.
sp. i., spermathecal invagination.
sp. o., spermathecal opening.
sp. p., posterior end of spermatheca.
sp. r., rudiment of spermatheca.
st. 2.—st. 9, second to ninth sterna respectively of abdomen.
s.v., seminal vesicle.
t.f., terminal filament of ovariole.
tg., tergum.
tg. 4—tg. 9, fourth to ninth terga respectively of abdomen.
t.s., terminal suspensorium of ovary.
t.v.t., transverse-ventral tracheal trunk of its segment, in cross-section.
v.a.g.i., vestigial accessory genital invagination.
v.a.g.r., rudiment of vestigial accessory genital invagination.
vg., vagina or common oviduct.
vg.d., deep-staining portion of vaginal rudiment.
vg.i., invagination of vagina or common oviduct.

vg.l., light-staining portion of vaginal rudiment.

vg.o., opening of vagina or common oviduct.

vg.r., rudiment of vagina or common oviduct.

vi.i., inner (middle) valvulae of ovipositor.

vl.l., lower (ventral or anterior) valvulae of ovipositor.

vl.u., upper (dorsal or posterior) valvulae of ovipositor.

vt., vitellarium.

y., yolk spheres in mid-gut.

y.c., yolk cells in mid-gut.

PLATE 11

Schistocerca gregaria (Forsk.) Postembryonic development of the female reproductive organs.

FIG. 1.—Vertical-longitudinal section of the abdomen of a recently hatched first instar hopper, showing the position of the various structures associated with female reproductive organs. Diagrammatic.

FIG. 2.—Dorsal view of posterior portion of the abdomen of a freshly moulted first instar hopper, dissected open to show the female reproductive organs. The ovarioles are beginning to be differentiated. The oviduct on the right is cut and part of the ovary shifted from the normal position to better illustrate the disposition of the ovarioles. Semidiagrammatic.

FIG. 3.—Two ovarioles from Fig. 2, enlarged to show their structure.

FIG. 4.—Dorsal view of posterior portion of the abdomen of a freshly moulted second instar hopper, dissected open to show the oviducts, the vaginal tissue and the spermatheca. Diagrammatic.

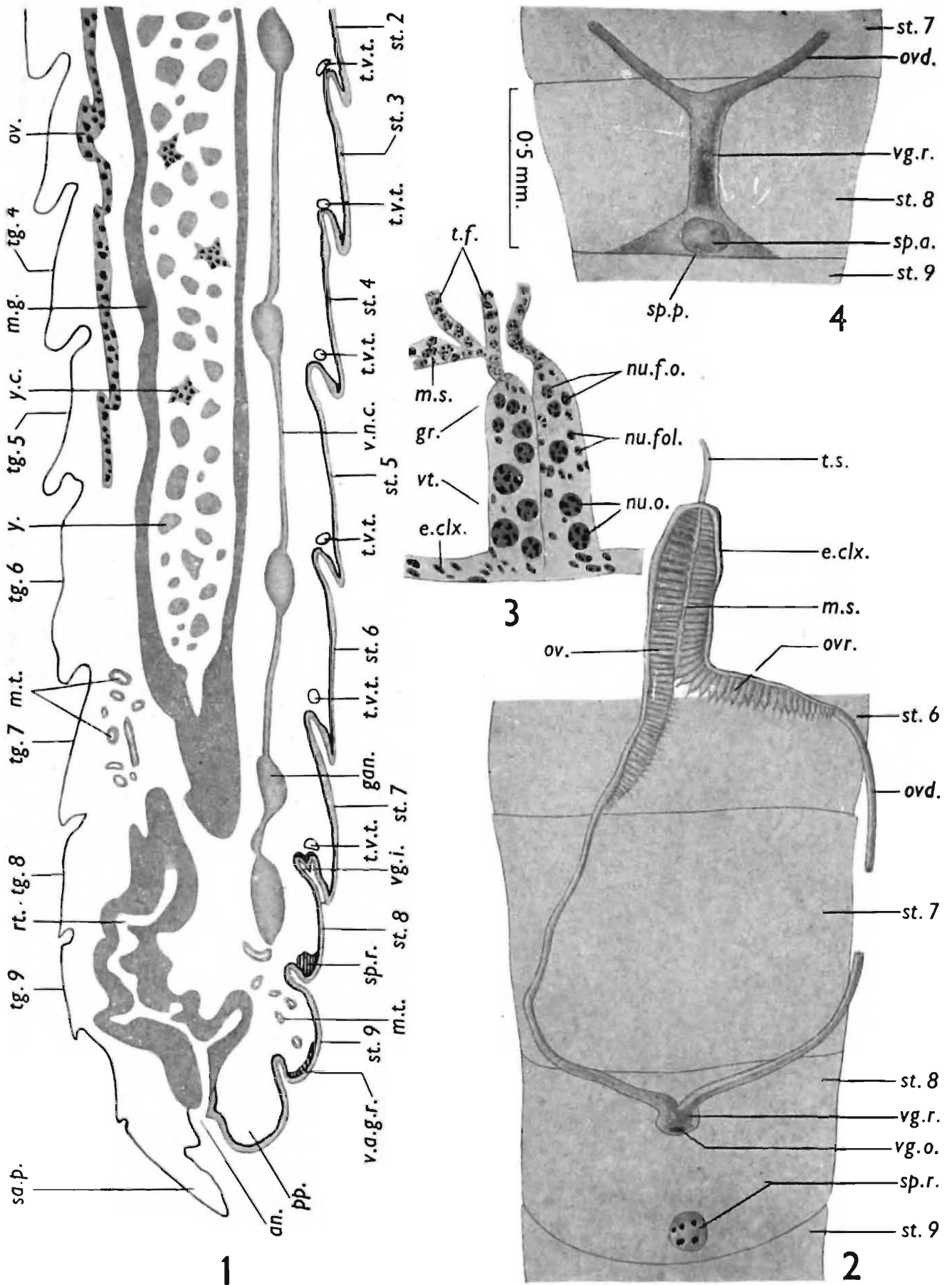


PLATE 12

Schistocerca gregaria (Forsk.). Postembryonic development of the female reproductive organs.

FIG. 1.—Anterior portion of the ovaries of a freshly moulted third instar hopper. Semidiagrammatic.

FIG. 2.—Ditto, of a freshly moulted fifth instar hopper.

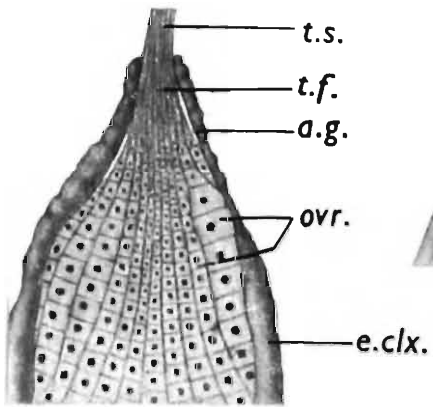
FIG. 3.—Ditto, of a fifth instar hopper about to moult into adult.

FIG. 4.—Dorsal view of the posterior portion of the abdomen of a freshly moulted third instar hopper, dissected open to show the female reproductive organs. Diagrammatic.

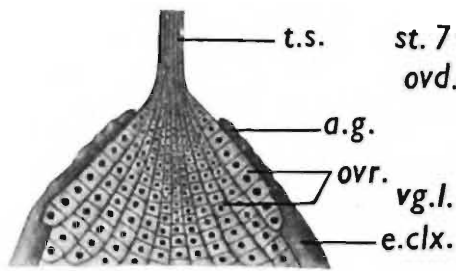
FIG. 5.—Spermatheca of a third instar hopper about to moult into fourth stage, after treatment with KOH, to show the chitinous portion. Semidiagrammatic.

FIG. 6.—Dorsal view of the posterior portion of the abdomen of a freshly moulted fourth instar hopper, to show the oviducts, vagina and spermatheca *in situ*. Diagrammatic.

FIG. 7.—Spermatheca of a fourth instar hopper about to moult into fifth instar. after treatment with KOH, to show the chitinous portion. Semidiagrammatic.

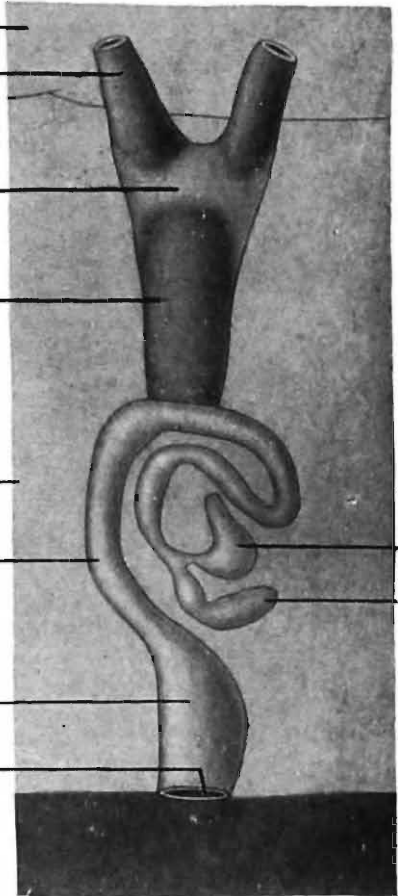


2



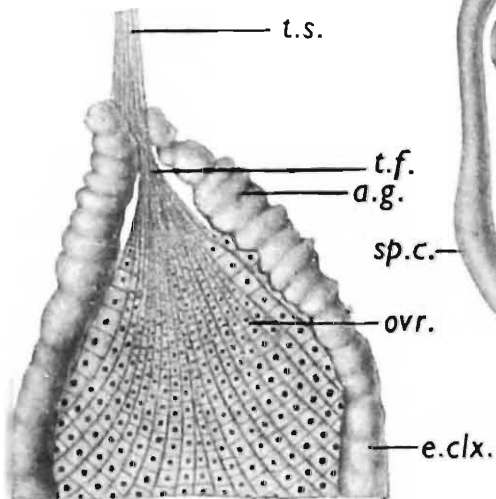
1

st. 7
ovd.
vg.l.
e.clx.
vg.d.



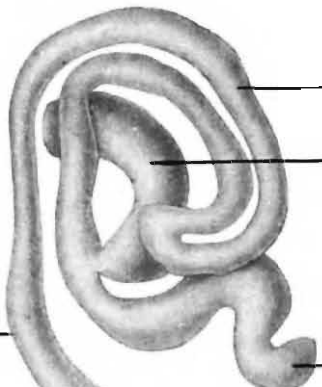
6

0.5 mm.



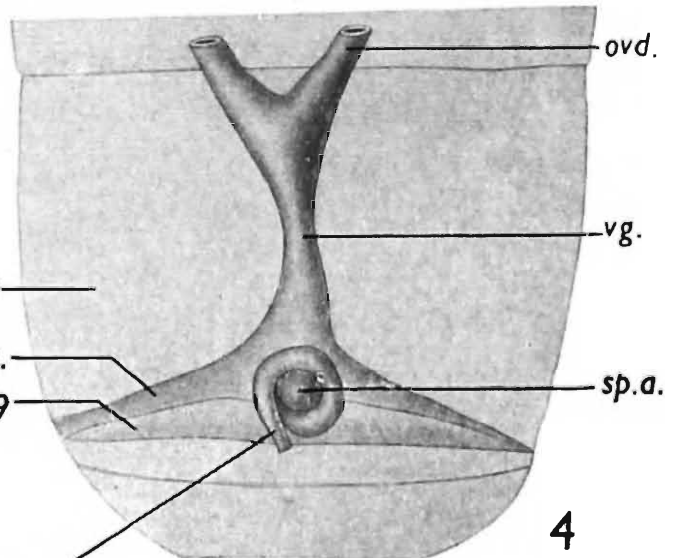
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2 mm.



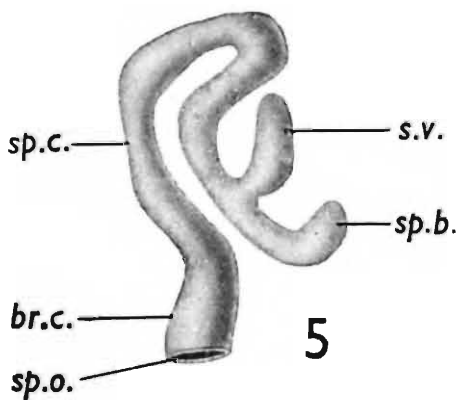
7

sp.o.



4

0.5 mm.



5

0.5 mm.

FIRST RECORD OF PAUROPODA FROM INDIA, WITH DESCRIPTION OF A NEW SPECIES, *DECAPAUROPUS KRISHNANI*

By

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(With 1 Text-figure)

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I—INTRODUCTION

Until now only one species of the Pauropod genus *Decapauropus* Remy, namely, *D. cuenoti* Remy has been known from Wagen forests, Germany (Remy, 1931). Another species belonging to this genus is now recorded from south India. This is the first record of Pauropoda from the Indian Region.

The new species differs from the other known species of *Decapauropus* Remy in having small, sessile globulus and nine tergal plates. In *D. cuenoti* the globulus is large and pedicellate and there are six tergal plates.

Acknowledgment.—The Author wishes to express his thanks and gratitude to Dr. G. Krishnan, Professor of Zoology, Madras University, Extension Centre, Madurai, south India, for his kind guidance and encouragement. Thanks are also due to the authorities of the University of Madras, for the award of a studentship during the tenure of which the present work has been carried out.

II—SYSTEMATIC ACCOUNT

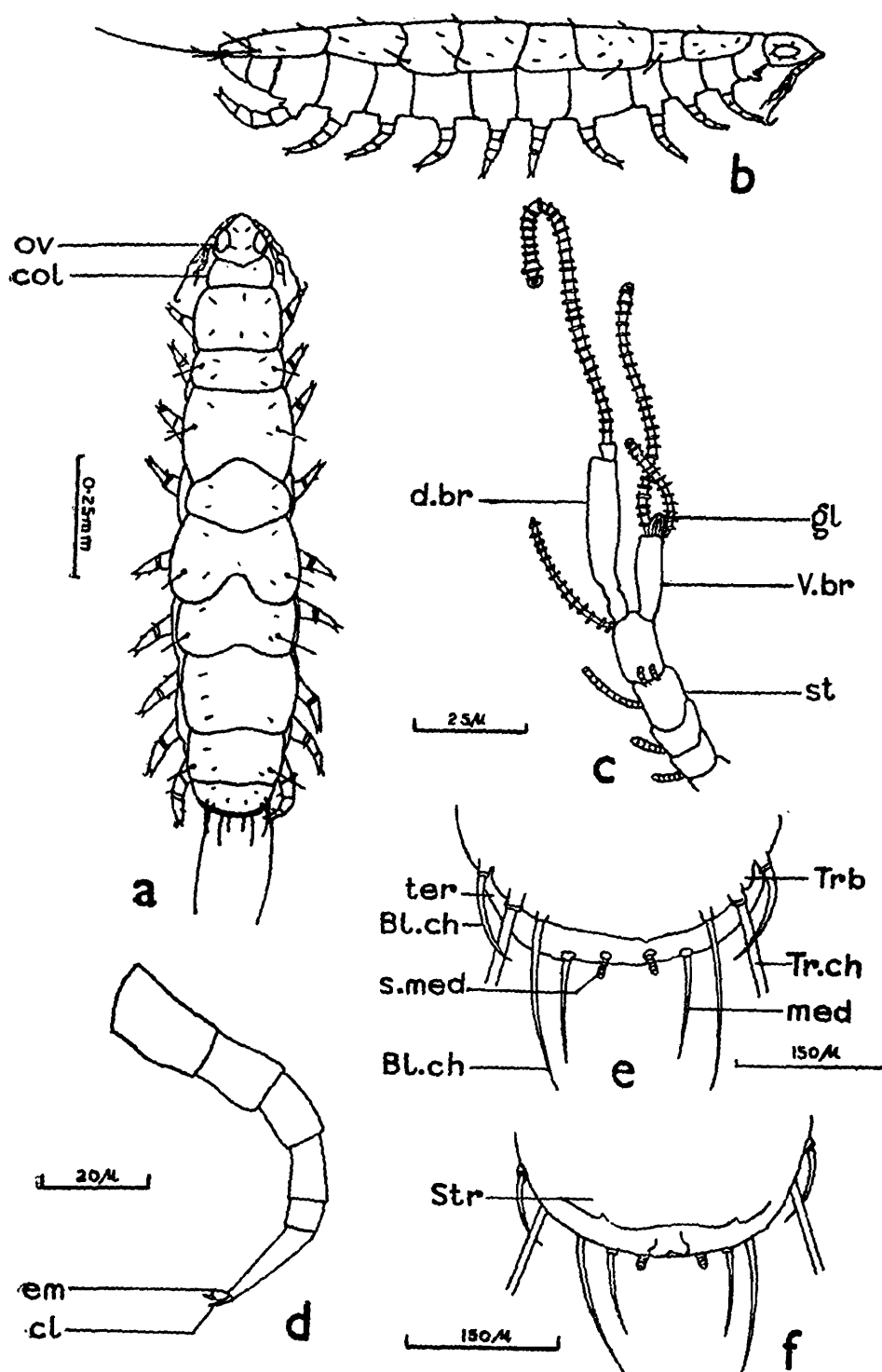
***Decapauropus krishnani* Sundara Rajulu, sp. nov.**

Material.—7 examples, Alagar Koil Hills (Madras State, south India), ca. 9°55' N. latitude and 78° 10' E. longitude ; coll. G. Sundara Rajulu, 1-6-1962, found in soft mud under stones.

¹ Named after Dr. G. Krishnan.

Description.—Adult. (Text-fig. 1).

General.—Body creamy white ; anterior region narrow. Total body-length (without antennae) 1.25–1.75 mm.



TEXT-FIG. 1.—*Decapauropus krishnani* Sundara Rajulu, sp. nov.

(a). Dorsal view of the entire animal. (b). Lateral view of the entire animal. (c) Left antenna. (d) 9th leg. (e) Dorsal view of telson. (f)[†] Ventral view of telson.

Bl. ch., basal chaeta of the trichobothridium ; *cl.*, claw ; *col.*, collum ; *d. br.*, dorsal branch of the antenna ; *em.*, empodium ; *gl.*, globulus ; *med.*, median chaeta of the telson ; *ov.*, oval area on the sides of the head ; *med.*, submedian chaeta of the telson ; *st.*, stalk of the antenna ; *Str.*, sternum of the telson ; *ter.*, tergum of the telson ; *Trb.*, trichobothridium ; *Tr. ch.*, trichobothridial chaeta ; *V. br.*, ventral branch of the antenna.

Head.—Small and conical, with a pair of smooth, clear, oval areas on the sides. *Eyes and ocelli* : Absent. *Antennae* : Borne on the anterior margin of the head ; very conspicuous, with a 4-segmented stalk and two long well-separated apical branches, one dorsal and the other ventral ; the dorsal branch with a single long multiarticulate flagellum at the apex and a similar flagellum at its base ; ventral branch with two flagella, of which the dorsal one longer than the ventral, and a small sessile globulus in between the bases of these flagella (Text-fig. 1c). Shorter flagella borne on the segments of the stalk also.

Trunk.—13-segmented (Text-fig. 1b), including the first segment, the collum, and the last segment, the telson. *Legs* : long ; ten pairs ; the first pair on the second body segment and the last pair on the eleventh ; each leg with six segments, the last segment of the leg bearing a pair of lateral claws and a median empodium (Text-fig. 1d). *Tergites* : Nine tergal plates on the dorsum (Text-fig. 1a) ; tergites 2, 3, 5 and 6 each with a pair of short tactile bristles projecting from the sides of the body. *The collum* with a pair of small papillae on the ventral side ; posterior half of the dorsum covered by the first tergal plate. *Penultimate segment* with a pair of trichobothridia on the dorso-lateral aspects of the posterior margin of the tergum, one on each side ; each trichobothridium with a long stout chaeta at the apex and two smaller chaetae at its base, one on the outer side and the other on the inner side (Text-fig. 1e). *Telson* : The tergum with a pair of short, segmented and flagellar submedian chaetae and a pair of long unsegmented and non-flagellar median chaetae (Text-fig. 1e), the sternum with no chaetae (Text-fig. 1f). The genital opening on the ventral side of the third segment and the anus on the last segment.

Type-specimens.—*Holotype* : An adult, Z. S. I. Reg. No. 2800/18, in spirit in a vial, Alagar Koil Hills (Madras State), 1. vi. 1962, coll. G. Sundara Rajulu, deposited in the National Zoological Collections, Zoological Survey of India, Calcutta.

Paratypes : The same data as for the holotype ; deposited as follows :

(i) Two adults, Z. S. I. Reg. No. 2801/18, in spirit in a vial, in the Zoological Survey of India. (ii) One adult with Dr. G. Krishnan, Professor of Zoology, University of Madras Extension Centre, Madurai.

Type locality.—INDIA : Alagar Koil Hills (Madras State), ca. 9°55' N. latitude and 78°10' E. longitude.

Geographical distribution.—INDIA : Alagar Koil Hills, Madras State. Known only from the type-locality.

Remarks.—*Decapauropus krishnani* Sundara Rajulu is close to *D. cuenoti* Remy, but is easily distinguishable as follows.—(i) Well separated apical branches in the antennae ; (ii) sessile small globulus ; (iii) nine tergal plates ; (iv) presence of basal trichobothridial chaetae ; (v) unsegmented long median chaetae from the tergum of the telson ; and (vi) absence of chaetae from the sternum of telson. In *D. cuenoti* the apical branches of the antennae are very closely placed ; the globulus is large and pedicellate ; six tergal plates on the dorsum ; basal trichobothridial chaetae are absent ; median chaetae from the tergum of telson are short and segmented, and sternum of telson bears chaetae.

III—SUMMARY

1. A new species of genus *Decapauropus* Remy namely, *Decapauropus krishnani* is described from southern India. It is the first record of Pauropoda from the Indian Region.

2. The new species differs from the closely allied *D. cuenoti* Remy in the possession of nine tergal plates, small sessile globulus and in the possession of basal trichobothridial chaetae. In *D. cuenoti* there are only six tergal plates, a large pedicellate globulus and no basal trichobothridial chaetae.

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