POPULATION DYNAMICS AND MORPHOMETRY OF THE 1956 AND 1957 DESERT LOCUST POPULATIONS IN INDIA IN RELATION TO EYE-STRIPE COMPOSITION AND SEX-RATIOS

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(With 10 Tables and 15 Text-figures)

CONTENTS

I—INTRODUCTION

1. *General*

The ninth (recorded) cycle of the Desert Locust *Schistocerca gregaria* (Forskal) (Orthoptera: Acrididae) in India started in the year 1949 and ended in 1955. The study of the population immediately succeeding this swarming cycle of 1949–1955 is of considerable biological interest, and may throw light on the processes of phase transformation. This is attempted here for the non-swarming population for the years 1956 and 1957 in India which are for convenience and because of small sample—size ($n = 93$) treated here together (also *vide infra* under Material and Methods).

It has been shown by Roonwal and Bhanotar (1966) that the population of the last period (Group III) of the 1955-population was "dissocians" in nature. The 1956-57 population is compared with immediately preceding population (1955-Gr. III), and with other known populations in various degrees of phase-transformation, in order to ascertain its correct phase status.

The 1956-57 population is analysed in regard to size of body-parts, morphometric ratios, sex-ratios and eye-stripe composition.

2. *History of the 1956-57 population*

The specimens for the 1956-57 population were collected either singly from scattered populations or from thin concentrations. The populations remained fluctuating throughout the year. The maximum population density during the early period (January–April) in each year was 960 individuals per square mile. During the second period (May–August), the maximum population density was 5,040 per square mile, except for a few localities where the population became "countless" During the last or third period (November and December), no locusts were found, and the population was zero.

3. *Abbreviation used*

Except where otherwise stated, the following abbreviations have been used throughout:—

O,   Width of head at ocular level.

C,   Width of head at genal level.

P,   Length of pronotum.

H,   Height of pronotum.

M,   Width of pronotum at the constriction.

E,   Length of elytron.

W_1,   Restricted width of elytron.

F,   Length of hind-femur.

S.E.,   Standard error.

S.D.,   Standard deviation.

S.D.P.,   Sexual dimorphism percentage.

6-*gregaria* or 6-*greg.* or *greg.*, or *greg.* (6), typical 6-striped phase *gregaria* individuals.

6-7—*solitaria*, 6-*sol.*, or *sol.* (6) or *sol.* (7), Typical 6- or 7-striped phase *solitaria* individuals.

6-7—striped, 6- or 7- eye-striped.

5-8—striped, 5- or 8- eye-striped.

Group I Gr. I, 1954 Group I populations.

Group II Gr. II, 1954 Group II populations.

Group III Gr. III, 1954 Group III populations.

1955-Gr. I, 1955 group I populations.

Gr.I(6) or Gr.I(7), 6- or 7- striped individuals of Group I.

Gr.II(6) or Gr.II(7), 6- or 7- striped individuals of Group II.

Gr.III(6) or Gr.III(7), 6- or 7- striped individuals of Group III.

Kakko pop., *Kakko Conc.* or *K* or *Inl. Conc.*, Initial concentration of locusts Kakko village (Rajasthan) in 1949 (Misra, 1952).

Ajmer Sw., or *Ajm.sw.* or *Ajm.*(6), Ajmer Swarm population of 1950 (Roonwal & Misra, 1952).

K (6) or K (7), 6- or 7- striped individuals of initial or *Kakko Concentration* (1949)

N S,   not significant.

n,   number of examples.

*,   Significant at 5% level.

**,   Significant at 1% level.

***,   Significant at 0.1% level.

4. *Acknowledgements*

II—MATERIAL AND METHODS

1. *General*

The material for the 1956-57 population was obtained mostly from contiguous localities in Rajasthan, Western, India. A total of 93 specimens were obtained (69 for the year 1956 and 24 for the year 1957).

The 93 individuals were collected from eight Districts of Rajasthan as follows:—

	District	Number of samples
1.	Jaisalmer	22
2.	Bikaner	41
3.	Jodhpur	16
4.	Churu	1
5.	Barmer	6
6.	Ganganagar	4
7.	Suratgarh	2
8.	Sikar	1

Measurements: Morphometric measurements of eight body parts were made and were taken according to method laid down in Third International Locust Conference, London (1934); and as taken earlier by Roonwal *et. al.*, (1945, 1947, 1949, 1952 and 1966).

2. Statistical procedure

Technique: For comparison with "typical phases" and other previously studied populations, statistical comparison was made in respect of a number of morphometric characters and ratios. The common mean and dispersions (standard deviation), along with their standard errors, were computed as usual. The difference in mean values was tested for significance by expressing it as a ratio to the standard error of difference and referring the same to Normal Distribution table, if the sample size was fairly large. Where the sample-size was small and the hypotheses of equality of variances true as judged by Variance-Ratio Test, Student's *t* distribution was employed. In case of samples size being small but variances unequal, a more exact test procedure was adopted by finding a weighted average of level of significance for the two samples, the weights being the squares of standard errors of respective mean values. The level of significance was chosen at the 5% point of probability, but the significance of difference was examined at 1% and 0.1% points also.

The populations were also compared by the graphical method.

3. Characteristics of 1956-57 population

The adult samples were randomly collected from a non-swarming periods of a short duration of two consecutive years. This period of two years have not been separately dealt with for two reasons: (i) They both belong to a similar populations; and (ii) To increase the precision of statistical tests by including all the specimens in one sample. Classification of population of any year into seasonal groups, as was done in previous studies, was not made due to the non-availability of sufficient number of specimens in all the months. It is justifiably assumed that the data are homogeneous and truly represent the field population.

III—Eye-stripe composition and sex-ratios

(Table 1)

TABLE 1.—*Schistocerca gregaria.* Number and distribution of samples, regarding sex-ratios and eye-stripes in the 1956-57 population in India.

Abbreviations: As in text.

Eye-stripe category	Number of individuals			Sex-ratio (%)±S.E.		Proportion (%) of eye-stripes±S.E.		
	Males	Females	Total	Males	Females	Males	Females	Total
6-striped	42	14	56	75±6	25±6	75±6	38±8	60±5
6-striped	14	23	37	38±8	62±8	25±6	62±8	40±5
Total	56	37	93	60±5	40±5	—	—	—

1. General

The sample size being small, the lumped population for the entire 1956-57 period was analysed, and the results are given below:—

2. Eye-stripes (Table 1)

Only two types of specimens, the 6- and 7- eye-striped, were observed; the proportion of the two varying as follows:—

Number of eye-stripes	Number *(and %) of individuals*		
	Males	Females	Total
6-	42 (75±6%)	14 (38±8%)	56 (60±5%)
7-	14 (25±6%)	23 (62±8%)	37 (40±5%)

3. Sex-ratios (Table 1)

The sex-ratios among the 93 individuals were: Males 56 (60.2%), females 37 (39.8%).

The percentage of sex-ratios in relation to the eye-stripe categories varied thus:—

Eye-stripes	Males	Females
6- eye-striped	75±6%	25±6%
7- eye-striped	38±8%	62±8%

4. Discussion

The eye-stripe composition and sex-ratio may now be discussed in relation to population and phases in the light of Roonwal's hypotheses (1945).

The 6- eye-striped individuals constitute less than 80% of the population (60±5%) and indicate *solitaria* affinities. In the 6- striped category, the high proportion of males (75±6%), instead of 50% which is characteristic of phase *gregaria*, indicates *solitaria* affinities. In the 7- striped category, the predominance of females over males (♀♀ 62±8%: ♂♂38±8%) further confirms the *solitaria* nature of the population.

IV—MORPHOMETRIC CHARACTERS (SIZE OF BODY-PARTS)

(Tables 2, 3, 7 and 8; and Text-figs. 1–8)

TABLE 2.—*Schistocerca gregaria*. Range, mean±S.E. and S.D.±S.E. for various morphometric characters O, C, P and H in the 1956-57 population in India.
Abbreviations: As in text.

Sex (and eye-stripes)	Statistical measures	Morphometric characters (symbols)			
		O	C	P	H
♂ (6)	Range (mm.)	5.7—6.6	5.9—7.1	8.4—10.8	7.0—8.3
	(n)	(42)	(42)	(42)	(42)
	Mean±S.E. (mm.)	6.13±0.032	6.40±0.043	9.82±0.078	7.86±0.047
	S.D.±S.E. (mm.)	0.211±0.023	0.280±0.030	0.503±0.05	0.304±0.033
♂ (7)	Range (mm.)	6.1—6.9	6.4—7.0	9.4—11.1	7.5—8.8
	(n)	(14)	(14)	(13)	(14)
	Mean±S.E. (mm.)	6.421±0.059	6.75±0.064	10.24±0.149	8.25±0.086
	S.D.±S.E. (mm.)	0.219±0.041	0.238±0.045	0.538±0.106	0.323±0.061
♀ (6)	Range (mm.)	6.3—7.2	7.0—7.9	10.7—12.7	8.5—10.1
	(n)	(14)	(14)	(13)	(14)
	Mean±S.E. (mm.)	6.72±0.076	7.39±0.088	11.46±0.176	9.13±0.142
	S.D.±S.E. (mm.)	0.286±0.054	0.328±0.062	0.633±0.124	9.530±0.100
♀ (7)	Range (mm.)	6.4—7.5	6.8—8.5	10.7—13.0	8.4—10.4
	(n)	(23)	(23)	(22)	(23)
	Mean±S.E. (mm.)	7.04±0.003	7.74±0.090·	12.10±0.129	9.57±0.116
	S.D.±S.E. (mm.)	0.302±0.044	0.433±0.604	0.604±0.091	0.558±0.082

1. *General*

Only the more sensitive morphometric characters were studied, namely:

1. Width of head at the ocular level (O).
2. Width of head at the genal level (C).
3. Length of pronotum at the keel (P).
4. Height of pronotum at the prozona (H).
5. Width of pronotum at the constriction (M).
6. Length of elytron (E).
7. Restricted width of elytron (W_1).
8. Length of hind-femur (F).

TABLE 3.—*Schistocerca gregaria.* Range, mean$\pm$S.E. and S.D.$\pm$S.E. for various morphometric characters M, E, W_1 and F in the 1956-57 populations in India.

Abbreviations: As in text.

Sex (and eye-stripes)	Statistical measures	Morphometric characters (symbols)			
		M	E	W_1	F
♂ (6)	Range (mm.)	4.9—6.0	45.3—55.4	5.5—7.7	23.2—27.2
	(n)	(42)	(42)	(42)	(40)
	Mean$\pm$S.E. (mm.)	5.54$\pm$0.038	50.85$\pm$0.365	6.47$\pm$0.066	25.56$\pm$0.152
	S.D.$\pm$S.E. (mm.)	0.247$\pm$0.027	2.364$\pm$0.258	0.425$\pm$0.046	0.960$\pm$0.107
♂ (7)	Range (mm.)	5.4—6.6	50.2—56.8	6.1—7.3	25.7—28.4
	(n)	(14)	(14)	(14)	(14)
	Mean$\pm$ S.E. (mm.)	5.89$\pm$ 0.080	53.25$\pm$0.578	6.76$\pm$0.093	27.09$\pm$0.253
	S.E.$\pm$S.E. (mm.)	0.297$\pm$0.056	2.164$\pm$0.409	0.348$\pm$0.066	0.947$\pm$0.179
♀ (6)	Range (mm.)	6.2—7.1	55.1—64.3	7.0—8.3	27.9—32.4
	(n)	(14)	(13)	(14)	(14)
	Mean$\pm$S.E. (mm.)	6.55$\pm$0.069	59.62$\pm$0.823	7.52$\pm$0.100	29.92$\pm$0.389
	S.D.$\pm$S.E. (mm.)	0.259$\pm$0.051	2.968$\pm$0.582	0.372$\pm$0.070	1.455$\pm$0.400
♀ (7)	Range (mm.)	6.3—7.5	56.4—68.1	7.3—8.4	29.0—34.2
	(n)	(23)	(23)	(23)	(22)
	Mean$\pm$S.E. (mm.)	6.85$\pm$0.066	62.94$\pm$0.584	7.94$\pm$0.065	31.73$\pm$0.288
	S.D.$\pm$S.E. (mm.)	0.316$\pm$0.047	2.801$\pm$0.413	0.311$\pm$0.046	1.351$\pm$0.204

TABLE 4.—*Schistocerca gregaria.* Range, mean$\pm$S.E. and S.D.$\pm$S.E. for the morphometric ratios P/C, M/C, H/C and E/W_1 in the 1956-57 population in India.

Abbreviations: As in text.

Sex (and eye-stripes)	Statistical measures	Morphometric-ratios			
		P/C	M/C	H/C	E/W_1
♂ (6)	Range	1.40—1.68	0.80—0.93	1.14—1.32	7.19—8.92
	(n)	(42)	(42)	(42)	(42)
	Mean$\pm$S.E.	1.54$\pm$0.010	0.87$\pm$0.005	1.23$\pm$0.006	7.87$\pm$0.063
	S.E.$\pm$S.E.	0.066$\pm$0.007	0.031$\pm$0.003	0.040$\pm$0.004	0.407$\pm$0.044
♂ (7)	Range	1.40—1.66	0.80—0.98	1.16—1.28	7.30—8.27
	(n)	(13)	(14)	(14)	(14)
	Mean$\pm$S.E.	1.52$\pm$0.020	0.87$\pm$0.013	1.22$\pm$0.010	7.89$\pm$0.076
	S.E.$\pm$S.E.	0.071$\pm$0.014	0.048$\pm$0.009	0.036$\pm$0.007	0.286$\pm$0.054
♀ (6)	Range	1.48—1.70	0.80—0.92	1.18—1.28	7.61—8.58
	(n)	(13)	(14)	(14)	(13)
	Mean$\pm$S.E.	1.56$\pm$0.019	0.89$\pm$0.009	1.24$\pm$0.009	7.96$\pm$0.067
	S.D.$\pm$S.E.	0.069$\pm$0.014	0.032$\pm$0.006	0.033$\pm$0.006	0.242$\pm$0.048
♀ (7)	Range	1.46—1.71	0.84$\pm$0.94	1.13$\pm$1.29	7.52$\pm$8.47
	(n)	(22)	(23)	(23)	(23)
	Mean$\pm$S.E.	1.57$\pm$0.014	0.89$\pm$0.007	1.24$\pm$0.009	7.93$\pm$0.048
	S.D.$\pm$S.E.	0.064$\pm$0.010	0.032$\pm$0.005	0.041$\pm$0.006	0.228$\pm$0.034

TABLE 5.—*Schistocerca gregaria.* Range, mean±S.E. and S.D.±S.E. for the morphometric ratios E/F, E/C and F/C in the 1956-57 population in India.

Abbreviations: As in text.

Sex (and eye-stripes)	Statistical measures	Morphometric ratios		
		E/F	E/C	F/C
♂ (6)	Range	1.92—2.06	7.39—8.59	3.70—4.25
	(n)	(40)	(42)	(40)
	Mean±S.E.	2.00±0.005	7.95±0.041	3.98±0.021
	S.E.±S.E.	0.032±0.004	0.266±0.029	0.131±0.015
♂ (7)	Range	1.88—2.05	7.30—8.27	3.76—4.27
	(n)	(14)	(14)	(14)
	Mean±S.E.	1.97±0.012	7.89±0.067	4.02±0.038
	S.D.±S.E.	0.045±0.008	0.250±0.047	0.143±0.027
♀ (6)	Range	1.86—2.04	7.76—8.49	3.93—4.25
	(n)	(13)	(13)	(14)
	Mean±S.E.	2.00±0.013	8.07±0.050	4.05±0.024
	S.D.±S.E.	0.047±0.009	0.179±0.035	0.089±0.017
♀ (7)	Range	1.92±2.10	7.56±8.83	3.91±4.55
	(n)	(22)	(23)	(22)
	Mean±S.E.	1.99±0.008	8.14±0.058	4.11±0.033
	S.D.±S.E.	0.039±0.006	0.281±0.041	0.157±0.024

TABLE 6.—*Schistocerca gregaria.* Intra-population comparison of various morphometric characters and ratios (within same sex and eye-stripe category) in the 1956-57 population in India.

Abbreviations: As in text.

Characters and ratios	Significance of difference between sexes		Significance of difference in eye-stripes (6 & 7)	
	6-striped	7-striped		
O	***	***	***	**
C	***	***	***	**
P	***	***	*	**
H	***	***	***	*
M	***	***	***	**
E	***	***	***	**
W_1	***	***	*	***
F	***	***	***	***
P/C	NS	*	NS	NS
M/C	NS	NS	NS	NS
H/C	NS	NS	NS	NS
E/W_1	NS	NS	NS	NS
E/F	NS	NS	*	NS
E/C	NS	**	NS	NS
F/C	*	NS	NS	NS

TABLE 7.—*Schistocerca gregaria*. Inter-population comparison of mean±S.E., for the morphometric characters O, C, P and H between the 1956-57 population and other known populations.

Abbreviations: As in text.

Populations with eye-stripes (6- or 7-)	Significance of difference from the 1956-57 population in mean values for characters							
	O		C		P		H	
	(6)	(7)	(6)	(7)	(6)	(7)	(6)	(7)
Males								
greg. (6)	–	–	***	***	NS	*	***	NS
Cal.Sw.(6) 1961	–	–	***	***	*	NS	–	–
Ajm.Sw.(6) 1950	–	–	***	***	NS	NS	–	–
Sol.(6)	–	–	–	–	–	–	–	–
sol.(7)	–	–	–	–	–	–	–	–
Gr.III(6) 1955	*	**	*	**	NS	*	***	NS
Gr.III(7) 1955	***	NS	***	NS	**	NS	***	NS
Kakko Conc.(6) 1949	–	–	***	*	NS	**	–	–
Females								
greg. (6)	–	–	***	NS	***	***	NS	***
Cal.Sw.(6) 1961	–	–	***	*	***	***	–	–
Ajm.Sw.(6) 1950	–	–	NS	NS	NS	***	–	–
sol.(6)	–	–	–	–	–	–	–	–
sol.(7)	–	–	–	–	–	–	–	–
Gr.III(6) 1955	NS	*	NS	NS	*	***	NS	NS
Gr.III(7) 1955	***	NS	*·	NS	*	NS	***	**
Kakko Conc.(6) 1949	–	–	NS	NS	**	***	–	–
Kakko Conc.(7) 1949	–	–	–	–	–	–	–	–

TABLE 8.—*Schistocerca gregaria*. Inter-population comparison of mean±S.E., for various morphometric characters M, E, W_1 and F between the 1956-57 population and other known populations.

Abbreviations: As in text.

Populations with eye-stripes (6- or 7-)	Significance of difference from 1956-57 population in mean values for characters							
	M		E		W_1		F	
	(6)	(7)	(6)	(7)	(6)	(7)	(6)	(7)
Males								
greg.(6)	***	NS	**	NS	–	–	***	***
Cal.Sw.(6) 1961	–	–	***	NS	–	–	**	***
Ajm.Sw.(6) 1950	–	–	***	NS	–	–	***	***
sol.(6)	–	–	**	NS	–	–	NS	***
sol.(7)	–	–	**	NS	–	–	*	**
Gr.III(6) 1955	***	NS	*	NS	*	NS	NS	***
Gr.III(7) 1955	***	NS	**	NS	*	NS	NS	**
Kakko Conc.(6) 1949	–	–	NS	**	–	–	**	***
Females								
greg.(6)	NS	***	NS	***	–	–	***	***
Cal.Sw.(6) 1961	–	–	NS	***	–	–	***	***
Ajm.Sw.(6) 1950	–	–	NS	NS	–	–	***	***
sol.(6)	–	–	*	*	–	–	NS	***
sol.(7)	–	–	***	NS	–	–	*	*
Gr.III(6) 1955	NS	NS	NS	**	NS	***	*	***
Gr.III(7) 1955	***	**	***	NS	**	NS	**	NS
Kakko Conc.(6) 1949	–	–	NS	***	–	–	***	***
Kakko Conc.(7) 1949	–	–	NS	NS	–	–	NS	NS

TABLE 9.—*Schistocerca gregaria*. Inter-population comparison of mean±S.E., for the morphometric ratios P/C, M/C and H/C between the 1956-57 population and other known populations.

Abbreviations: As in text.

Population with eye-stripes (6 & 7)	Significance of difference from 1956-57 population in mean values for ratios					
	P/C		M/C		H/C	
	(6)	(7)	(6)	(7)	(6)	(7)
Males						
greg.(6)	***	***	***	***	***	***
Cal.Sw.(6) 1961	***	***	–	–	–	–
Ajm.Sw.(6) 1950	***	***	–	–	–	–
sol.(6)	–	–	–	–	–	–
sol.(7)	–	–	–	–	–	–
Gr.III(6) 1955	*	NS	***	NS	*	*
Gr.III(7) 1955	NS	NS	***	NS	*	*
Kakko Conc.(6) 1949	***	NS	–	–	–	–
Females						
greg.(6)	***	***	***	***	***	***
Cal.Sw. (6) 1961	**	***	–	–	–	–
Ajm.Sw.(6) 1950	***	***	–	–	–	–
sol.(6)	–	–	–	–	–	–
sol.(7)	–	–	–	–	–	–
Gr.III(6) 1955	*	**	NS	NS	NS	NS
Gr.III(7) 1955	NS	NS	***	***	***	***
Kakko Conc.(6) 1949	***	***	–	–	–	–
Kakko Conc.(7) 1949	–	–	–	–	–	–

TABLE 10.—*Schistocerca gregaria*. Inter-population comparison of mean=±.E. for the morphometric ratios E/W_1, E/F, E/C and F/C between the 1956-57 population and other known populations.

Abbreviations: As in text.

Populations with eye-stripes (6 & 7)	Significance of difference from 1956-57 population in mean values for ratios							
	E/W_1		E/F		E/C		F/C	
	(6)	(7)	(6)	(7)	(6)	(7)	(6)	(7)
Males								
greg.(6)	–	–	***	***	–	–	***	***
Cal.Sw.(6) 1961	–	–	**	***	–	–	***	***
Ajm.Sw.(6) 1950	–	–	***	***	–	–	***	***
sol.(6)	–	–	***	***	–	–	–	–
sol.(7)	–	–	NS	*	–	–	–	–
Gr.III(6) 1955	NS	NS	***	**	NS	NS	***	**
Gr.III(7) 1955	NS	NS	NS	**	NS	NS	NS	*
Kakko Conc.(6) 1949	–	–	***	***	–	–	***	***
Females								
greg(6)	–	–	***	***	–	–	***	***
Cal.Sw.(6) 1961	–	–	**	**	–	–	***	***
Ajm.Sw.(6) 1950	–	–	***	***	–	–	***	***
sol.(6)	–	–	***	***	–	–	–	–
sol.(7)	–	–	*	***	–	–	–	–
Gr.III(6) 1955	NS	NS	**	***	NS	NS	*	**
Gr.III(7) 1955	*	**	**	***	**	NS	NS	NS
Kakko Conc.(6) 1949	–	–	***	***	–	–	***	***
Kakko Conc.(7) 1949	–	–	**	***	–	–	–	–

The data were compared among the sexes and the eye-stripe categories, and also with the conditions obtaining in the following known populations for which data are available:—

(i) 6- and 7- eye-striped individuals of "typical" phase *solitaria* and phase *gregaria* (Roonwal, 1949; Roonwal and Nag, 1951).

(ii) 6- eye-striped (males and females) and 7- eye-striped (females only) individuals of the Initial or Kakko Concentration of 1949, *i.e.*, the first year population of the 1949–55 Swarming cycle (Misra, 1952).

(iii) 6- eye-striped individuals of the Ajmer Swarm of 1950 *i.e.*, the second year of the 1949-55 swarming cycle (Roonwal and Misra, 1952).

(iv) 6- eye-striped individuals of the Calcutta Swarm of 1961, *i.e.*, the third year population of the 1959–63 swarming cycle (Roonwal and Bhanotar 1962, and in Press).

(v) 6- and 7- eye-striped individuals of the 1955-Gr.III population (the last year of the 1949–55 cycle) (Roonwal and Bhanotar, 1966).

2. *Width of head at the ocular level* (O)
(Tables 2, 6 and 7; and Text-fig. 1)

(*a*) *Mean width* (mm.) (Table 2): This varies as follows:—

Sex (and eye-stripes)	Mean width (mm.) ± S.E.
Males (6)	6.13±0.032
Males (7)	6.42±0.059
Females (6)	6.72±0.076
Females (7)	7.04±0.063

(*b*) *Inter-sex comparison* (Table 6): In both the 6- and 7- striped categories, the value is significantly higher (at all levels) in females than in the corresponding males.

(*c*) *Inter-eye-stripe comparison* (Table 6): In both males and females, the value in 6-striped forms in significantly lower than in 7- stripes ones at all levels.

(*d*) *Inter-population comparison* (Table 7): Comparison was made with the 1955-Gr.III population (data given below); no comparison could be made with other population for want of data.

1955-*population* (and eye-stripes)	Mean width (mm.) ± S.E. Males	Females
Gr.III (6)	6.24±0.025	6.75±0.013
Gr.III (7)	6.46±0.05	7.14±0.05

In 6-striped males, the mean value is significantly lower than in 1955-Gr.III at the 5% level only. In all other cases (*i.e.*, 6-striped females and 7-striped males and females), the values in the 1956-57 population do not differ significantly from the 1955-Gr.III,

(e) *Sexual dimorphism percentage:*   The S.D.P.±S.E. varies as follows:—

1956-57 population	*S.D.P.*	1955-*population* (*and eye-stripes*)	*S.D.P.*
6- eye-striped	9.62±1.38	1955-Gr.I (6)	6.51±1.36
7- eye-striped	9.66±1.40	1955-Gr.II (6)	6.09±0.31
		1955-Gr.III (6)	8.17±2.19
		1955-Gr.III (7)	10.53±1.10

In the 6- eye-striped category, the value is not significantly different from those in the 1955-Grs.I and III, but is higher than in the 1955-Gr.II at the 5% level. No significant difference is noticed in the 7-striped categories.
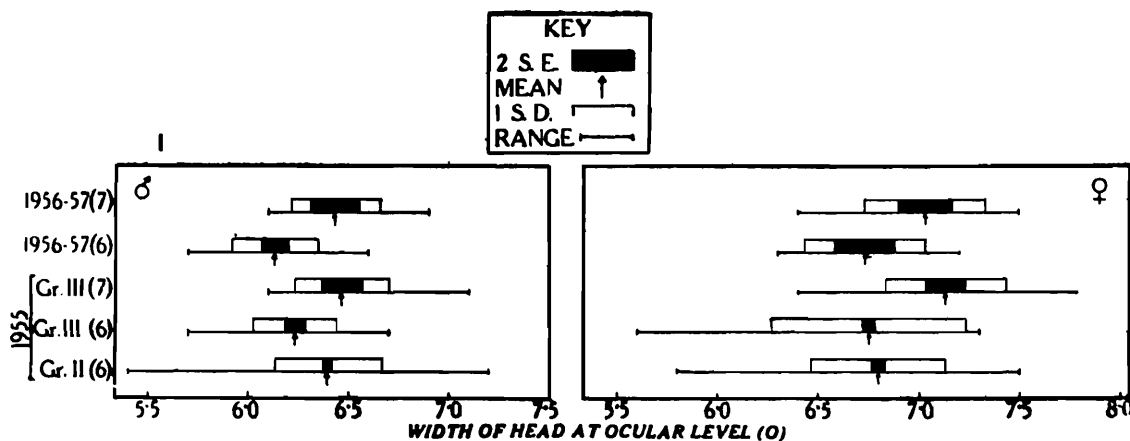
Text-fig. 1.—*Schistocerca gregaria.* Dicegram to show variance of range, mean and its confidence limits (2 S.E.) and standard deviation (S.D.) in various populations regarding width of head at ocular level (O). (For explanations *see* text.)

3.   *Width of head at the genal level* (C)
(Tables 2, 6 and 7; and Text-fig. 2)

(a) *Mean width* (*mm.*) (Table 2):   This varies as follows:—

Sex (*and eye-stripes*)	*Mean width* (*mm.*)±*S.E.*
Males (6)	6.40±0.043
Males (7)	6.75±0.064
Females (6)	7.39±0.088
Females (7)	7.74±0.090

(b) *Inter-sex comparison* (Table 6):   In both the 6- and 7- eye-striped categories, the value in females is significantly higher than in corresponding males at all levels.

(c) *Inter-eye-stripe comparison* (Table 6):   In both males and females, the value in 6-striped forms is significantly lower than in 7-striped ones at all levels.

(d) *Inter-population comparison* (Table 7): The 1956-57 population is compared with other known populations (data given below), as follows:—

Other populations (and eye-stripes)	Mean (mm.) ± S.E. Males	Females
6-*greg.*	7.55±0.045	7.89±0.074
Ajm. Sw.(6)	7.53±0.082	7.90±0.248
Cal.Sw.(6)	7.43±0.040	8.00±0.050
Kakko (Inl.)Conc.(6)	7.60±0.033	7.41±0.041
1955-Gr.III(6)	6.55±0.04	7.42±0.16
1955-Gr.III(7)	6.67±0.05	7.70±0.05

6-*striped males*:—The value in the 1956-57 population is significantly lower than in the 6-*greg.*, the *Ajm.Sw.*, the *Kakko Conc.* and the *Cal.Sw.*, at all levels, and the 1955-Gr.III at the 5% level only.

6-*striped females*: The value is significantly lower than in 6-*greg.* and *Cal.Sw.* at all levels, but is not different from those in the *Ajm.Sw.*, the *Kakko Conc.* and the 1955-Gr.III.

7-*striped males and females*: The values are not significantly different from those in the corresponding sex of 1955-Gr.III at all levels.

(e) *Sexual dimorphism percentage*: The S.D.P.±S.E. varies as follows:—

1956-57 population	S.D.P.	Other populations (and eye-stripes)	S.D.P.
6-eye-striped	15.47±1.58	1955-Gr.I(6)	7.11±1.46
7-eye-striped	15.67±1.72	1955-Gr.II(6)	9.44±0.40
		1955-Gr.III(6)	13.28±2.62
		1955-Gr.III(7)	15.44±1.18
		6-*greg.*	4.50±1.50
		Ajm.Sw.(6)	4.91
		Kakko Conc.(6)	12.27±0.8
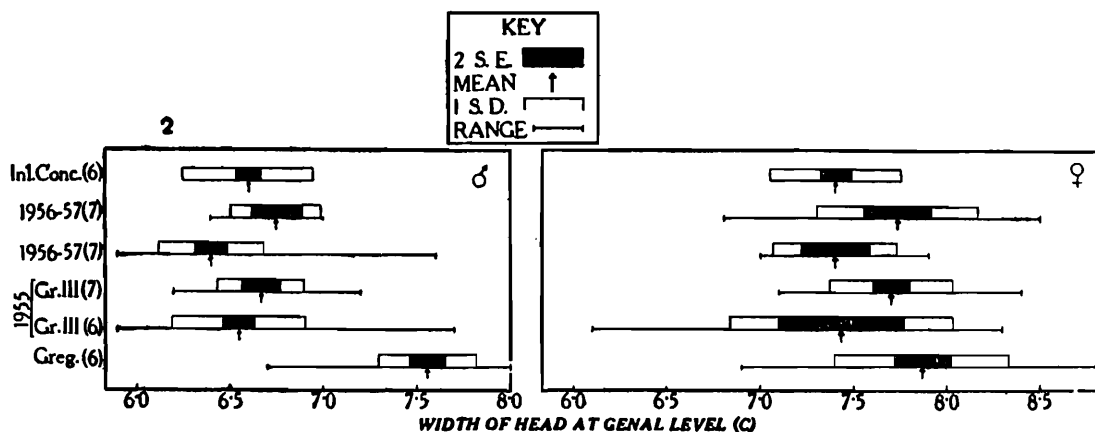
Text-fig. 2.—*Schistocerca gregaria.* Dicegram to show variance in range, mean and its confidence limits (2 S.E.) and standard deviation (S.D.) in various populations regarding width of head at genal level (C).
(For explanations *see* text.)

In the 6- eye-striped category, the value in the 1956-57 population is significantly higher than in the 6-*gerg.* and the 1955-Grs.I and II, at all levels, but is not different from those in the 1955-Gr.III and the *Kakko Conc.* No significant difference is noticed in the 7- eye-striped category.

4. *Length of pronotum at the keel* (P)

(Tables 2, 6 and 7; and Text-fig. 3)

(*a*) *Mean length* (*mm.*) (Table 2): This varies as follows:—

Sex (and eye-stripes)	Mean length (mm.) ± S.E.
Males (6)	9.82 ± 0.078
Males (7)	10.24 ± 0.149
Females (6)	11.46 ± 0.176
Females (7)	12.10 ± 0.129

(*b*) *Inter-sex comparison* (Table 6): In both the 6- and 7- eye-striped categories, the value in females is significantly higher than in corresponding males, at all levels.

(*c*) *Inter-eye-stripe comparison* (Table 6): In both males and females, the value in 6-striped forms is significantly lower than in 7-striped ones, at all levels.

(*d*) *Inter-population comparison* (Table 7): The 1956-57 population compare with other populations (data given below), as follows:—

Other populations (and eye-stripes)	Mean length (mm.) ± S.E. Males	Females
6-*greg.*	9.87 ± 0.079	10.49 ± 0.133
Cal.Sw.(6)	10.07 ± 0.090	10.79 ± 0.090
Ajm.Sw.(6)	10.01 ± 0.108	10.78 ± 0.343
Kakko Conc.(6)	9.76 ± 0.054	10.94 ± 0.088
1955-Gr.III(6)	9.86 ± 0.06	10.76 ± 0.29
1955-Gr.III(7)	10.20 ± 0.08	11.90 ± 0.10

6-*striped males*: The value in the 1956-57 population is not significantly different from those in 6-*greg.*, the *Ajm. Sw.*, the *Kakko Conc.* and the 1955-Gr.III, at all levels, but is significantly lower than in the *Cal.Sw.* at the 50% level only.

6-*striped females*: The value is significantly higher than in 6-*greg.* and the *Cal.Sw.* at all levels, the 1955-Gr.III at the 5% level, and the *Kakko Conc.* at the 1% level, but is not significantly different from that in the *Ajm.Sw.* at all levels.

7-*striped males and females*: For each sex the values are not significantly different from those in the 1955-Gr.III at all levels.

(e) *Sexual dimorphism percentage:* The S.D.P.±S.E. varies as follows:—

1956-57 population	S.D.P.	Other populations (and eye-stripes)	S.D.P.
6- eye-striped	16.70±2.01	1955-Gr.I(6)	8.38±1.74
7- eye-striped	18.16±2.13	1955-Gr.II(6)	9.26±0.44
		1955-Gr.III(6)	9.13±3.06
		1955-Gr.III(7)	15.67±1.38
		6-*greg.*	6.28±1.60
		Ajm.Sw.(6)	7.69
		Kakko Conc.(6)	12.09±1.09

In the 6- eye-striped category, the value in 1956-57 population is significantly higher than in 6-*greg.*, and the 1955-Gr.II at all levels, and 1955-Gr.I at the 1% level, and the 1955-Gr.III and the *Kakko Conc.* at the 5% level. No significant difference is seen in the 7-striped category.
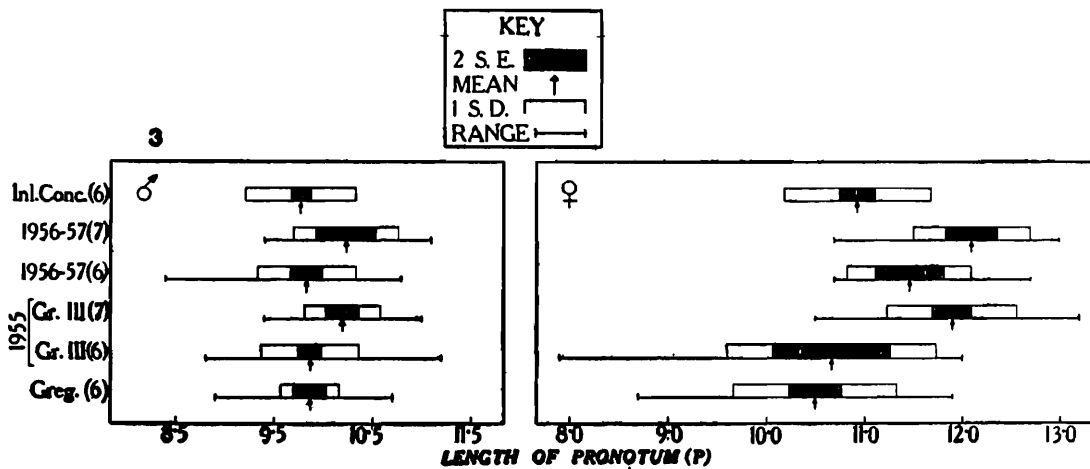
Text-fig. 3.—*Schistocerca gregaria*. Dicegram to show variance in range, mean and its confidence limits (2 S.E.) and standard deviation (S.D.) in various populations regarding length of pronotum (P).
(For explanations *see* text.)

5. Height of pronotum at the prozona (H)

(Tables 2, 6 and 7; and Text-fig. 4)

(a) *Mean height (mm.)* (Table 2): This varies as follows:—

Sex (and eye-stripes)	Mean height (mm.)±S.E
Males (6)	7.86±0.047
Males (7)	8.25±0.086
Females (6)	9.13±0.142
Females (7)	9.57±0.116

(*b*) *Inter-sex comparison:* (Table 6): In both the 6- and 7- eye-striped categories, the value in females is significantly higher than in corresponding males at all levels.

(*c*) *Inter-eye-stripe comparison* (Table 6): In both males and females, the value in 6-striped forms is significantly lower than in 7-striped ones at all levels.

(*d*) *Inter-population comparison* (Table 7): The 1956-57 population compare with other known populations (data given below) as follows:—

Other populations (and eye-stripes)	Mean height (mm.)$\pm$S.E. Males	Females
6-*greg.*	8.39$\pm$0.05	8.92$\pm$0.10
1955-Gr.III(6)	8.20$\pm$0.04	9.10$\pm$0.27
1955-Gr.III(7)	8.40$\pm$0.09	9.90$\pm$0.07

6-*striped males:* The value is significantly lower than in 6-*greg.* and the 1955-Gr.III at all levels.

6-*striped females:* The value is not significantly different from that in 6-*greg.* and the 1955-Gr.III at all levels.

7-*striped males and females:* For each sex the values are not significantly different from those in the 1955-Gr.III at all levels.

(*e*) *Sexual dimorphism percentage:* The S.D.P.$\pm$S.E. varies as follows:—

1956-57 population	S.D.P.	Other populations (and eye-stripes)	S.D.P.
6- eye-striped	16.16$\pm$1.93	1955-Gr.I(6)	8.34$\pm$1.74
7- eye-striped	16.00$\pm$1.86	1955-Gr.II(6)	10.32$\pm$0.43
		1955-Gr.III(6)	10.98$\pm$3.37
		1965-Gr.III(7)	17.86$\pm$1.58

In the 6- eye-striped category, the value in the 1956-57 population is significantly higher than in the 1955-Grs.I and II at all levels, but is not significantly different from that in the 1955-Gr.III. No significant difference is seen in the 7-striped categories.
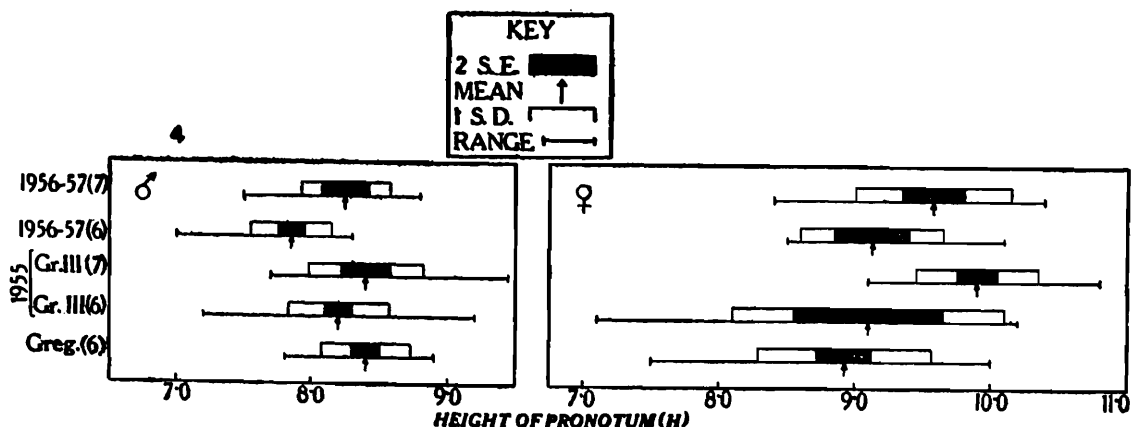
Text-fig. 4.—*Schistocerca gregaria.* Dicegram to show variance in range, mean and its confidence limits (2 S.E.) and standard deviation (S.D.) in various populations regarding height of pronotum (H).
(For explanations *see* text.)

6. Width of pronotum at the constriction (M)

(Tables 3, 6 and 8; and Text-fig. 5)

(*a*) *Mean width* (Table 3): This varies as follows:—

Sex (and eye-stripes)	Mean width (mm.) $\pm$S.E.
Males (6)	5.54$\pm$0.038
Males (7)	5.89$\pm$0.080
Females (6)	6.55$\pm$0.069
Females (7)	6.85$\pm$0.066

(*b*) **Inter-sex comparison** (Table 6): In both the 6- and 7- eye-striped categories, the value in females is significantly higher than in corresponding males at all levels.

(*c*) **Inter-eye-stripe comparison** (Table 6): In both males and females, the value in 6-striped forms is significantly lower than in 7-striped ones at all levels.

(*d*) **Inter-population comparison** (Table 8): The 1956-57 population compare with other populations (data given below), as follows:.—

Other populations (and eye-stripes)	Mean width (mm.) $\pm$S.E. Males	Females
6-*greg.*	5.86$\pm$0.04	6.36$\pm$0.08
1955-Gr.III(6)	5.84$\pm$0.03	6.67$\pm$0.15
1955-Gr.III(7)	5.98$\pm$0.05	7.09$\pm$0.04

6-*striped males:* The value is significantly lower than in 6-*greg.* and the 1955-Gr.III at all levels.

6-*striped females:* The value is not significantly different from those in 6-*greg.* and the 1955-Gr.III at all levels.

7-*striped males:* The value is not significantly different from that in the 1955-Gr.III at all levels.

7-*striped females:* The value in 1956-57 population is significantly lower than in the 1955-Gr.III at all levels.

(*e*) *Sexual dimorphism percentage:* The S.D.P.$\pm$S.E. varies as follows:—

1956-57 population	S.D.P.	Other populations (and eye-stripes)	S.D.P.
6- eye-striped	18.23$\pm$1.50	1955-Gr.I(6)	12.41$\pm$1.56
7- eye-striped	16.30$\pm$1.92	1955-Gr.II(6)	12.18$\pm$0.40
		1955-Gr.III(6)	14.21$\pm$2.58
		1955-Gr.III(7)	18.56$\pm$1.21

In the 6- eye-striped category, the value in the 1956-57 population is significantly higher than in 1955-Gr.I (at 1% level) and 1955-Gr.II

8

(at all levels), but is not significantly different from that in 1955-Gr.III at all levels. No significant difference is seen in the 7-striped categories.
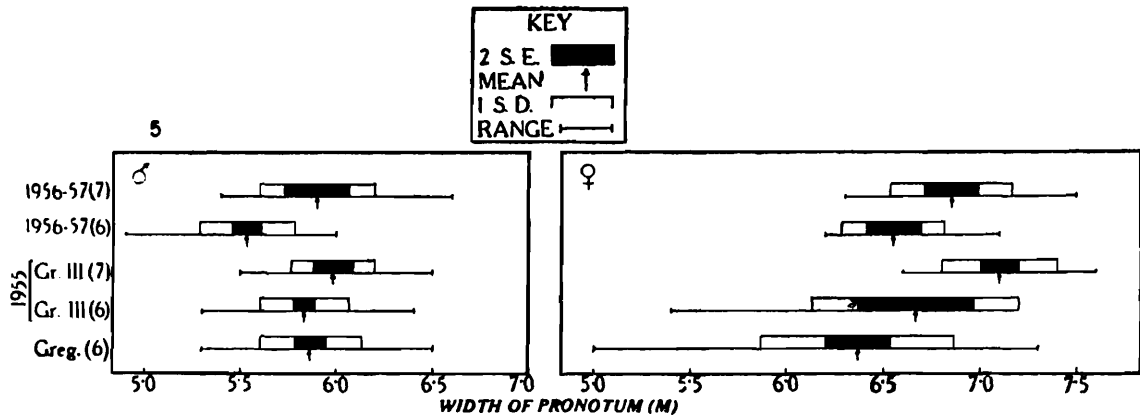
Text-fig. 5.—*Schistocerca gregaria*. Dicegram to show variance in range, mean and its confidence limits (2 S.E.) and standard deviations (S.D.) in various populations regarding width of pronotum (M).
(For explanations *see* text.)

7. Length of elytron (E)

(Tables 3, 6 and 8; Text-fig. 6)

(*a*) *Mean length* (Table 3): This varies as follows:—

Sex (and eye-stripes)	Mean length (mm.) $\pm S.E$
Males (6)	50.85 ± 0.365
Males (7)	53.25 ± 0.578
Females (6)	59.62 ± 0.823
Females (7)	62.94 ± 0.584

(*b*) *Inter-sex comparison* (Table 6): In both the 6- and 7- eye-striped categories, the value in females is significantly higher than in the corresponding males at all levels.

(*c*) *Inter-eye-stripe comparison* (Table 6): In both males and females, the value in the 6- striped forms is significantly lower than in 7-striped ones at all levels.

(*d*) *Inter-population comparison* (Table 8): The 1956-57 population compare with other known populations (data given below), as follows:—

Other populations (and eye-stripes)	Mean length (mm.) $\pm S.E.$ Males	Females
6-*greg.*	52.85 ± 0.52	58.01 ± 0.81
Cal.Sw.(6)	53.82 ± 0.45	59.36 ± 0.82
Ajm.Sw.(6)	54.16 ± 0.70	59.70 ± 1.68
6-*sol.*	52.15 ± 0.24	61.56 ± 0.31
7-*sol.*	52.38 ± 0.42	62.90 ± 0.26
Kakko Conc.(6)	51.46 ± 0.29	59.73 ± 0.42
Kakko Conc.(7)	—	61.83 ± 1.41
1955-Gr.III(6)	52.07 ± 0.31	59.74 ± 0.91
1955-Gr.III(7)	52.58 ± 0.43	63.39 ± 0.48

6-striped males: The value in the 1956-57 population is significantly lower than in 6-*greg.* and the *Ajm.Sw.* at 1% level, the *Cal.Sw.* at the 0.1% level, and the 6-*sol.* and the 1955-Gr.III at the 5% level; it is not significantly different from that in the *Kakko Conc.* at all levels.

6-striped females: The value is not significantly different from those in 6-*greg.*, the *Cal.Sw.*, the *Ajm.Sw.*, the 1955-Gr.III and the *Kakko Conc.*, at all levels, but is significantly lower than in 6-*sol.* at the 5% level.

7-striped males: The value is not significantly different from those in 7-*sol.* and the 1955-Gr.III at all levels.

7-striped females: The value is not significantly different from those in 7-*sol.*, the 1955-Gr.III and the *Kakko Conc.* at all levels.

(*e*) *Sexual dimorphism percentage:* The S.D.P.$\pm$S.E. varies as follows :—

1956-57 population	*S.D.P.*	*Other populations (and eye-stripes)*	*S.D.P.*
6- eye-striped	17.25$\pm$1.84	1955-Gr.I(6)	11.92$\pm$1.78
7- eye-striped	18.20$\pm$1.74	1955-Gr.II(6)	12.00$\pm$0.39
		1955-Gr.III(6)	14.73$\pm$1.87
		1955-Gr.III(7)	20.66$\pm$1.33
		6-*greg.*	9.76$\pm$1.88
		Ajm.Sw.(6)	10.23
		Kakko Conc.(6)	16.07$\pm$1.04
		6-*sol.*	18.04$\pm$0.80
		7-*sol.*	20.08$\pm$1.08

In the 6-striped category, the value in the 1956-57 population is significantly higher than in 6-*greg.* and the 1955-population (Grs.I and II) at the 1% and 5% levels respectively, but is not significantly different from those in the 1955-Gr.III, 6-*sol.* and the *Kakko Conc.*, at all levels. No significant difference is seen in the 7-striped categories.
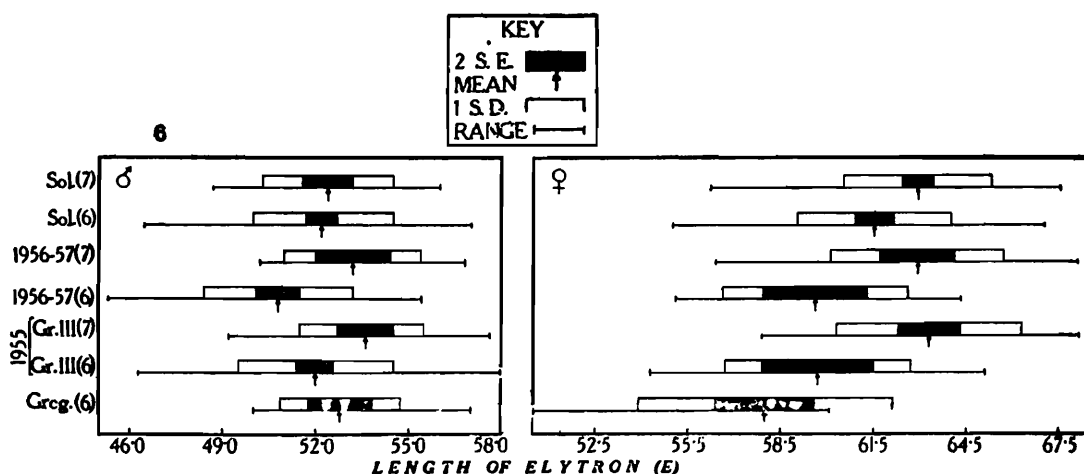
Text-fig. 6.—*Schistocerca gregaria.* Dicegram to show variance in range, mean and its confidence limits (2 S.E.) and standard deviation (S.D.) in various populations regarding length of elytron (E).
(For explanations *see* text.)

8.   Restricted width of elytron (W₁)

(Tables 3, 6 and 8; and Text-fig. 7)

(*a*) *Mean width* (Table 3):   This varies as follows:—

Sex (and eye-stripes)	Mean width (mm.)±S.E.
Males (6)	6.47±0.066
Males (7)	6.76±0.093
Females (6)	7.52±0.100
Females (7)	7.94±0.065

(*b*) *Inter-sex comparison* (Table 6):   In both the 6- and 7- eye-striped categories, the value in females is significantly higher than in corresponding males at all levels.

(*c*) *Inter-eye-stripe comparison* (Table 6):   In males and females, the value in 6-striped forms is significantly lower than in 7-stripes ones at the 5% and 0.1% levels respectively.

(*d*) *Inter-population comparison* (Table 8):   The 1956-57 population compare with other populations (data given below), as follows:—

Other populations (and eye-stripes)	Mean width (mm.)±S.E. Males	Females
1955-Gr.III(6)	6.66±0.05	7.36±0.16
1955-Gr.III(7)	6.71±0.07	7.84±0.06

6-striped males: The value in the 1956-57 population is significantly lower than in the 1955-Gr.III at the 5% level.

6-striped females: The value is not significantly different from that in the 1955-Gr.III at all levels.

7-striped males and females: In the corresponding sex the value is not significantly different from that in the 1955-Gr.III at all levels.

(*d*) *Sexual dimorphism percentage:*   The S.D.P.±S.E. varies as follows:—

1956-57 population	S.D.P.	Other populations (and eye-stripes)	S.D.P.
6- eye-striped	16.23±1.94	1955-Gr.I(6)	11.18±1.44
7- eye-striped	17.46±1.88	1955-Gr.II(6)	10.14±0.47
		1955-Gr.III(6)	10.51±2.60
		1955-Gr.III(7)	16.84±1.61

In the 6-striped category, the value in the 1956-57 population is significantly higher than in the 1955-Grs.I and II at the 5% and 1%

levels, but is not significantly different from that in the 1955-Gr.III. No significant difference is seen in the 7-striped category.
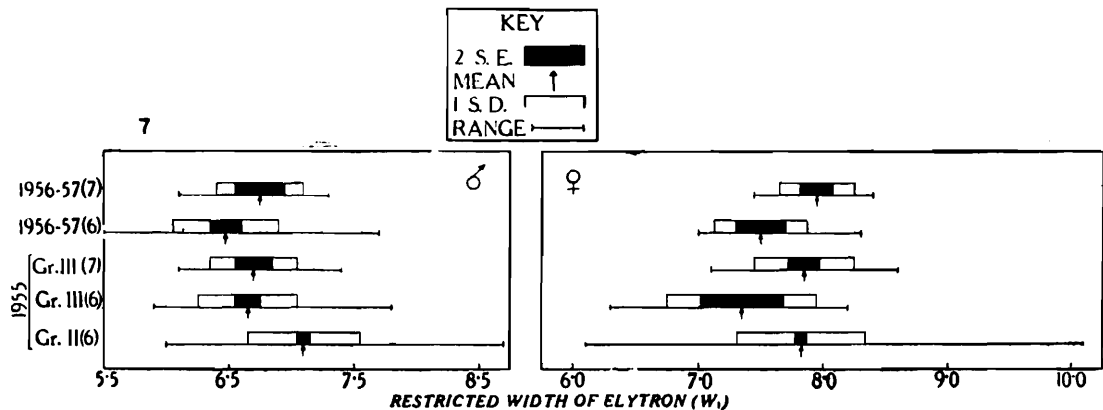
Text-fig. 7.—*Schistocerca gregaria.* Dicegram to show variance in range, mean and its confidence limits (2 S.E.) and standard deviations (S.D.) in various populations regarding restricted width of elytron (W_1). (For explanations *see* text.)

9. Length of hind-femur (F)

(Tables 3, 6 and 8; and Text-fig. 8)

(*a*) *Mean length* (Table 3): This varies as follows:—

Sex (and eye-stripes)	Mean length (mm.) $\pm$ S.E.
Males (6)	25.56 $\pm$ 0.152
Males (7)	27.09 $\pm$ 0.253
Females (6)	29.92 $\pm$ 0.389
Females (7)	31.73 $\pm$ 0.288

(*b*) *Inter-sex comparison* (Table 6): In both the 6- and 7- eye-striped categories, the values in females are significantly higher than in the corresponding males at all levels.

(*c*) *Inter-eye-stripe comparison* (Table 6): In both males and females, the value in 6-striped forms is significantly lower than in the 7-striped ones at all levels.

(*d*) *Inter-population comparison* (Table 8): The 1956-57 population compare with other populations (data given below), as follows:—

Other populations (and eye-stripes)	Mean length (mm.) $\pm$ S.E.	
	Males	Females
6-*greg.*	24.32 $\pm$ 0.20	26.44 $\pm$ 0.37
Cal.Sw.(6)	24.82 $\pm$ 0.23	27.32 $\pm$ 0.33
Ajm.Sw.(6)	24.37 $\pm$ 0.29	27.28 $\pm$ 0.61
6-*sol.*	25.40 $\pm$ 0.12	29.37 $\pm$ 0.18
7-*sol.*	26.13 $\pm$ 0.21	30.92 $\pm$ 0.13
Kakko Conc.(6)	24.92 $\pm$ 0.16	28.35 $\pm$ 0.25
Kakko Conc.(7)	—	29.94 $\pm$ 0.92
1955-Gr.III(6)	25.24 $\pm$ 0.16	27.97 $\pm$ 0.90
1955-Gr.III(7)	24.92 $\pm$ 0.16	31.21 $\pm$ 0.22

6-striped males: The value is significantly higher than in 6-*greg.* and the *Ajm.Sw.* at the 0.1 % level, and the *Cal.Sw.* and the *Kakko Conc.* at the 1 % level, but is not significantly different from that in 6-*sol.* and the 1955-Gr.III.

6-striped females: The value is significantly higher than in 6-*greg.*, the *Cal.Sw.*, the *Ajm.Sw.*, and the 1955-Gr.III at the 0.1 % level, but is not significantly different from that in 6-*sol.* and the *Kakko Conc.*

7-striped males: The value is significantly higher in 7-*sol.* and the 1955-Gr.III at 1 % level.

7-striped females: The value is significantly higher than in 7-*sol.* at the 5 % level only, but is not significantly different from those in the 1955-Gr.III and the *Kakko Conc.*

(*e*) *Sexual dimorphism percentage:* The S.D.P.$\pm$S.E. varies as follows:—

1956-57 population	*S.D.P.*	*Other populations (and eye-stripes)*	*S.D.P.*
6- eye-striped	17.06$\pm$1.66	1955-Gr.I(6)	10.43$\pm$1.94
7- eye-striped	17.13$\pm$1.54	1955-Gr.II(6)	10.14$\pm$0.43
		1955-Gr.III(6)	10.82$\pm$3.66
		1955-Gr.III(7)	19.49$\pm$1.35
		6-*greg.*	8.72$\pm$1.76
		Ajm.Sw.	11.94
		Kakko Conc.(6)	13.76$\pm$1.24
		6-*sol.*	15.63$\pm$0.89
		7-*sol.*	18.33$\pm$1.07

In the 6-striped category, the value is significantly higher than in 6-*greg.*, the 1955-Grs.I and II, at the 0.1%, 1% and 0.1% levels respectively, but is not significantly different from those in 6-*sol.*, the *Kakko Cong.*, and the 1955-Gr.III. No significant difference is seen in the 7-striped categories.
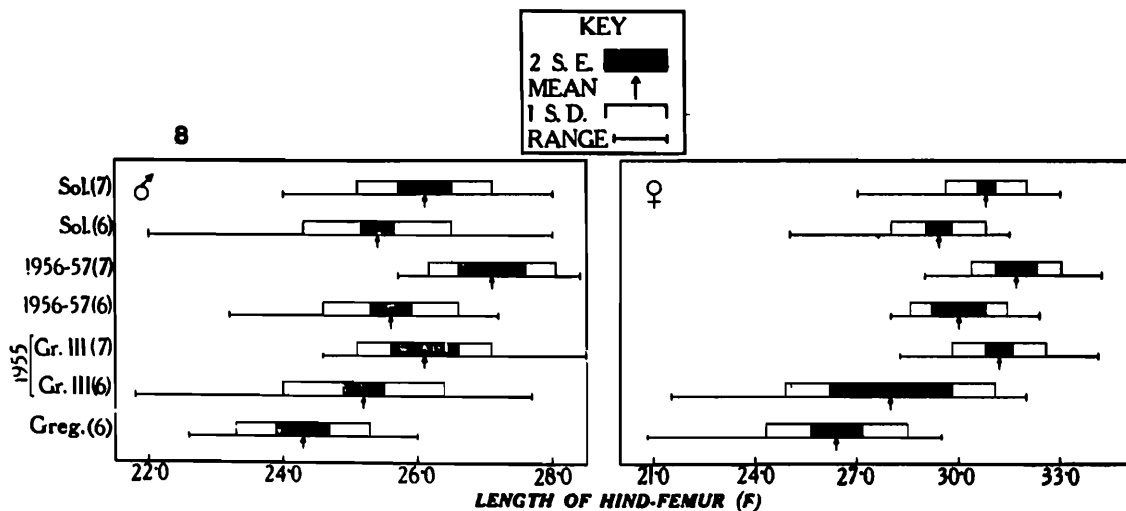
Text-fig. 8.—*Schistocerca gregaria*. Dicegram to show variance in range, mean and its confidence limits (2 S.E.) and standard deviations (S.D.) in various populations regarding length of hind-femur (F). (For explanations *see* text.)

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

All the morphometric characters in the 1956-57 population demonstrate uniformly high degrees of differences between the sexes and the eye-stripe groups.

The four characters, namely, O, H, M, and W_1 (the data for which were not available for "typical" *solitaria* population) were compared with the 1955-Group III, which is considered here as a close approximation to *solitaria* (Roonwal and Bhanotar, 1966).

For the 1955-Gr.III, the 6-striped males (in all the above characters *i.e.*, O, H, M and W_1) and the 7-striped females (in H and M only), show divergence, *i.e.*, the mean values are significantly higher from the corresponding eye-stripe and sex-groups of the 1956-57 population. It may be pointed out that though both the populations are of the *solitaria* facies, one (1955-Gr.III) is heading towards it and the other (1956-57) has possibly attained that phase so that some difference between the two is to be expected. The values in the 1956-57 population are nearer the typical *solitaria* than those of the 1955-Gr.III population.

Four other characters (C, P, E and F) were two utilized. Thus, for C, in the 6-striped males of the 1956-57 population, the value is significantly lower from *gregaria* population (*viz.*, the "typical" *gregaria*, the *Ajmer Swarm* and the *Calcutta Swarm*) and from the 1955-Gr.III (*solitaria facies*) and the *Kakko Conc.* (1949). A significantly higher value in the 1956-57 population is noticed in P for females from those in *gregaria* populations, where as for males no significant difference is seen in this respect, except for the *Calcutta Swarm* (of 1961), where the value is significantly lower at the 5% level. In respect of E, the value in 6-striped males in the 1956-57 population is significantly lower than in both *gregaria* (at all levels) and *solitaria* (at 5% level) populations, except for the *Kakko Conc.* (of 1949). For 6-striped females, E in the 1956-57 population is not significantly different from *gregaria* populations, but is significantly higher from phase *solitaria* at the 5% level.

Regarding F, the 6-striped categories in both sexes have significantly higher values than the *gregaria* populations and the *Kakko Conc.*, but are not significantly different from the "typical" *solitaria* and other *solitaria* facies populations (1955-Gr.III). In 7-striped females, the 1956-57 population retains its affinity to phase *solitaria* by not being different from the 1955-Gr.III(7) and the *Kakko Conc.*(7). However, in males, the value is significantly higher than in phase *solitaria*(7) and the 1955-Gr.III(7).

V—MORPHOMETRIC RATIOS

1. *General*

The following seven of the more sensitive ratios were studied for the 1956-57 population:—

    1. Pronotum—Head Ratio (P/C)
    2. Pronotum—Head Ratio (M/C)
    3. Pronotum—Head Ratio (H/C)

4. Elytron Ratio (E/W₁)
5. Elytron—Femur Ratio (E/F)
6. Elytron—Head Ratio (E/C)
7. Femur—Head Ratio (F/C)

The mean values of these ratios were calculated separately for each individual and then a single mean was derived collectively.

2. Ratio P/C

(Tables 4, 6 and 9; and Text-fig. 9)

(*a*) *Mean ratio* (Table 4): This varies as follows:—

Sex (and eye-stripes)	Mean ratio ±S.E.
Males (6)	1.54±0.010
Males (7)	1.52±0.020
Females (6)	1.56±0.019
Females (7)	1.57±0.014

(*b*) *Inter-sex comparison* (Table 6): 6-*striped*: The value in females is not significantly different from that in males at all levels. 7-*striped*: The value in females is significantly higher than in males at the 5% level only.

(*c*) *Inter-eye-stripe comparison* (Table 6): In both sexes the value in the 6-striped category is not significantly different from that in the corresponding 7-striped one at all levels.

(*d*) *Inter-population comparison* (Table 9): The 1956-57 population compare with the other populations (data given below) as follows:—

Other populations (and eye-stripes)	Mean ratio ±S.E. Males	Females
6-*greg.*	1.305±0.011	1.324±0.009
Cal.Sw.(6)	1.35 ±0.007	1.35 ±0.008
Ajm.Sw.(6)	1.330±0.011	1.363±0.018
Kakko Conc.(6)	1.483±0.007	1.477±0.008
1955-Gr.III(6)	1.51 ±0.007	1.47 ±0.025
1955-Gr.III(7)	1.52 ±0.011	1.54 ±0.009

6-*striped males and females*: The values are significantly higher than in 6-*greg.*, the *Cal.Sw.*, the *Ajm.Sw.*, and the *Kakko Conc.* at all levels, and in the 1955-Gr.III at the 5% level only.

7-*striped males and females*: The values are not significantly different from those in the 1955-Gr.III population at all levels.

(e) *Sexual dimorphism percentage:* ⎨The S.D.P.±S.E. varies as follows:—

1956-57 population	S.D.P.	Other populations (and eye-stripes)	S.D.P.
6- eye-striped	1.30±1.40	1955-Gr.I(6)	1.52±1.27
7- eye-striped	3.29±1.60	1955-Gr.III(6)	−2.65±1.73
		1955-Gr.III(7)	1.32±0.96
		6-*greg.*	1.46±1.10
		Ajm.Sw.(6)	2.48
		Kakko Conc.(6)	−0.40±0.72

In the 6- and 7- eye-striped categories, the values in the 1956-57 population are not significantly different from those in the other known populations.
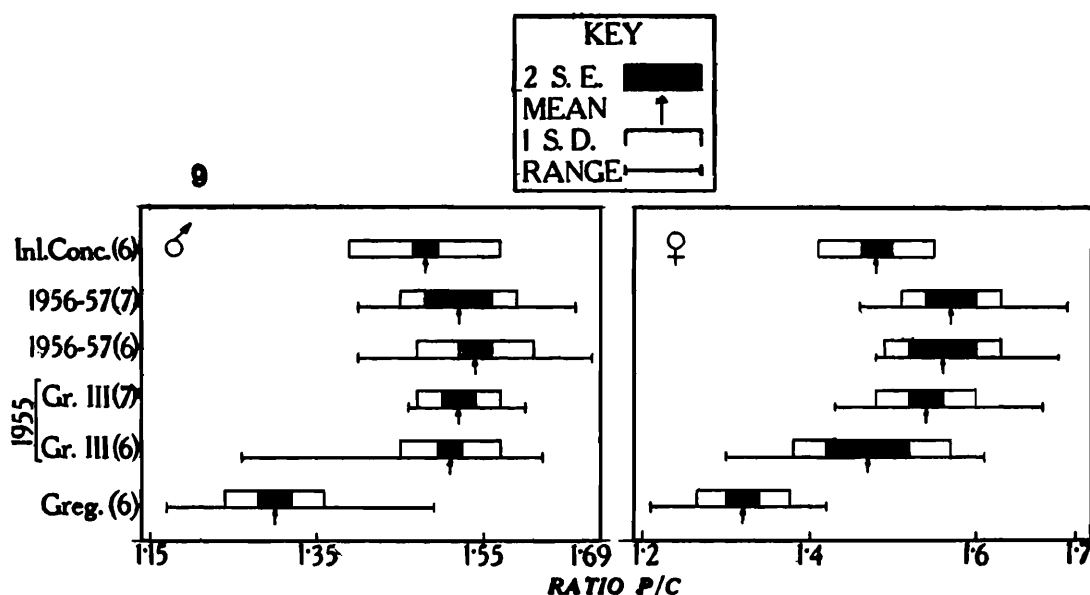
Text-fig. 9.—*Schistocerca gregaria.* Dicegram to show variance in range, mean and its confidence limits (2 S.E.) and standard deviation (S.D.) in various populations regarding the ratio P/C (Length of pronotum/width of head at genal level).

(For explanations *see* text.)

3. Ratio M/C

(Tables 4, 6 and 9; and Text-fig. 10)

(a) *Mean ratio* (Table 4): This varies as follows:—

Sex (and eye-stripes)	Mean ratio±S.E.
Males (6)	0.87±0.005
Males (7)	0.87±0.013
Females (6)	0.89±0.009
Females (7)	0.89±0.007

(b) *Inter-sex comparison* (Table 6): In both 6- and 7-striped categories, the values in females are not significantly different from those in corresponding males at all levels.

(c) *Inter-eye-stripe comparison* (Table 6): Within each sex-group, the value in the 6- eye-striped category is not significantly different from that in the 7-striped one all levels.

(d) *Inter-population comparison* (Table 9): The 1956-57 population compare with other populations (date given below) as follows:—

Other populations (and eye-stripes)	Mean ratios$\pm$S.E. Males	Females
6-*greg.*	0.779$\pm$0.008	0.805$\pm$0.005
1955-Gr.III(6)	0.89 $\pm$0.003	0.90 $\pm$0.012
1955-Gr.III(7)	0.90 $\pm$0.006	0.92 $\pm$0.004

6-*striped males:* The value is significantly higher than in 6-*greg.* and lower than in the 1955-Gr.III at all levels.

6-*striped females:* The value is significantly higher than in 6-*greg.* at all levels, but is not significantly different from that in the 1955-Gr.III.

7-*striped males:* The value is not significantly different than in the 1955-Gr.III at all levels.

7-*striped females:* The value is significantly lower than in the 1955-Gr.III at all levels.

(e) *Sexual dimorphism percentage:* The S.D.P.$\pm$S.E., varies as follows:—

1956-57 population	S.D.P.	Other populations (and eye-stripes)	S.D.P.
6- eye-striped	1.15$\pm$1.11	1955-Gr.I(6)	5.06$\pm$1.22
7- eye-striped	1.64$\pm$1.06	1955-Gr.II(6)	2.68$\pm$0.23
		1955-Gr.III(6)	0.90$\pm$1.36
		1955-Gr.III(7)	2.11$\pm$0.82
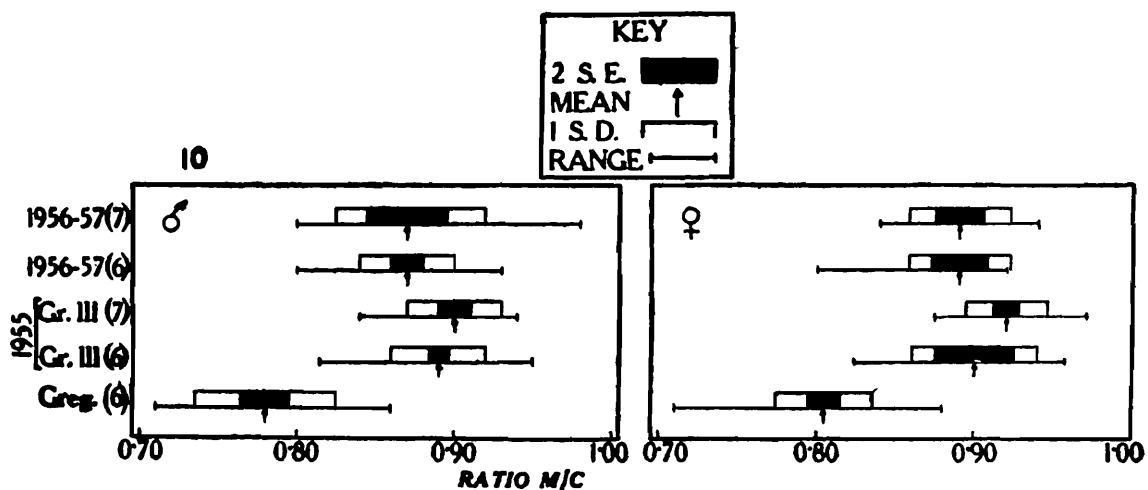
Text-fig. 10.—*Schistocerca gregaria.* Dicegram to show variance in range, mean and its confidence limits (2 S.E.) and standard deviation (S.D.) in various populations regarding the ratio M/C (width of pronotum/width of head at genal level).
(For explanations *see* text.)

In the 6- and 7- eye-striped categories, the value is significantly lower than in the 1955-Gr.I(6) and the 1955-Gr. III(7), but is not significantly different from other populations.

4. *Ratio H/C*

(Tables 4, 6 and 9; and Text-fig. 11)

(*a*) *Mean ratio* (Table 4): This varies as follows:—

Sex (and eye-stripes)	Mean ratio $\pm$ S.E.
Males (6)	1.23 ± 0.006
Males (7)	1.22 ± 0.010
Females (6)	1.24 ± 0.009
Females (7)	1.24 ± 0.009

(*b*) *Inter-sex comparison* (Table 6): In both 6- and 7- eye-striped categories, the value in females is not significantly different from that in the corresponding males at all levels.

(*c*) *Inter-eye-stripe comparison* (Table 6): In either sex, the value in 6-striped individuals is not significantly different from that in the corresponding 7-striped ones at all levels.

(*d*) *Inter-population comparison* (Table 9): The 1956-57 population compare with other populations (data given below) as follows:—

Other populations (and eye-stripes)	Mean ratio $\pm$ S.E. Males	Females
6-*greg*.	1.112 ± 0.008	1.126 ± 0.007
1955-Gr.III(6)	1.25 ± 0.006	1.24 ± 0.016
1955-Gr.III(7)	1.25 ± 0.008	1.29 ± 0.002

6-*striped males*: The value is significantly higher than in 6-*greg*. at all levels, but lower than in the 1955-Gr.III at the 5% level.

6-*striped females*: The value is significantly higher than in 6-*greg*. at all levels, but is not significantly different from that in the 1955-Gr.III.

7-*striped males and females*: The value is significantly lower than in the 1955-Gr.III at the 5% level in males and at all levels in females.

(*e*) *Sexual dimorphism percentage*: The S.D.P. $\pm$ S.E. varies as follows:—

1956-57 population	S.D.P.	Other populations (and eye-stripes)	S.D.P.
6- eye-striped	0.81 ± 0.88	1955-Gr.I(6)	1.82 ± 1.10
7- eye-striped	1.64 ± 1.06	1955-Gr.II(6)	0.88 ± 0.22
		1955-Gr.III(6)	0.80 ± 1.35
		1955-Gr.III(7)	3.20 ± 0.86

In the 6- and 7- eye-striped categories the values in the 1956-57 population are not significantly different from other populations in the corresponding categories.
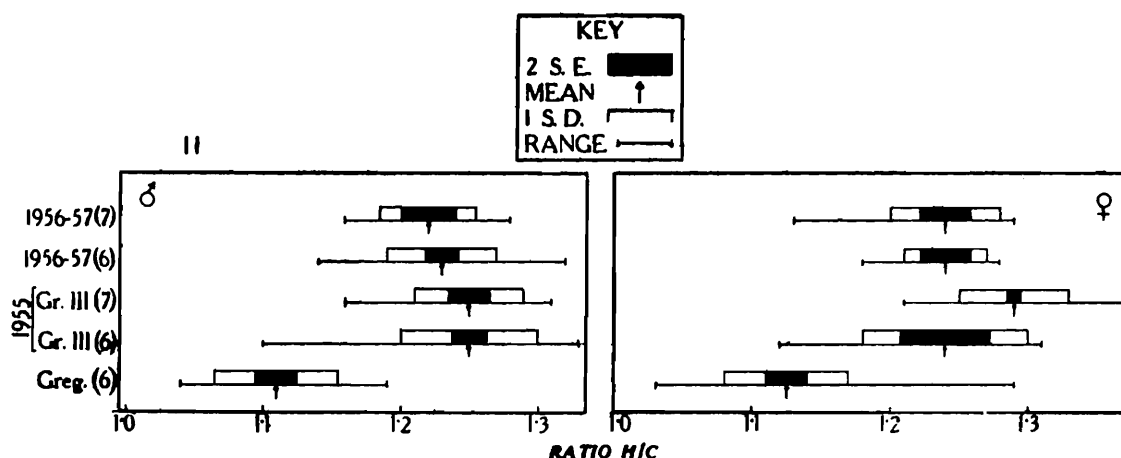
Text-fig. 11.—*Schistocerca gregaria*. Dicegram to show variance in range, mean and its confidence limits (2 S.E.) and standard deviation (S.D.) in various populations regarding the ratio H/C (Height of pronotum/Width of head at genal level).

(For explanations *see* text.)

5.   Ratio E/W_1

(Tables 4, 6 and 10; and Text-fig. 12)

(*a*) *Mean ratio* (Table 4):   This varies as follows:—

Sex (and eye-stripes)	Mean ratio $\pm$ S.E.
Males (6)	7.87$\pm$0.063
Males (7)	7.89$\pm$0.076
Females (6)	7.96$\pm$0.067
Females (7)	7.93$\pm$0.048

(*b*) *Inter-sex comparison* (Table 6):   In both the 6- and 7-striped categories, the value in females is not significantly different from those in corresponding males at all levels.

(*c*) *Inter-eye-stripe comparison* (Table 6):.   In both sexes, within each sex-group, the values in the 6-striped categories are not significantly different from those in the corresponding 7-striped ones at all levels.

(*d*) *Inter-population comparison* (Table 10):   The 1956-57 population compare with other populations (data given below) as follows:—

Other populations (and eye-stripes)	Mean ratio $\pm$ S.E.	
	Males	*Females*
1955-Gr.III(6)	7.88$\pm$0.038	8.10$\pm$0.123
1955-Gr.III(7)	7.84$\pm$0.068	8.12$\pm$0.045

6-*striped males and females:* In both sexes, the value is not significantly different from that in the 1955-Gr.III in the corresponding sex, at all levels.

7-*striped males:* The value is not significantly different from that in the 1955-Gr.III population.

7-*striped females:* The value in the 1956-57 population is significantly lower than in the 1955-Gr.III at the 1% level.

(*e*) *Sexual dimorphism percentage:* The S.D.P.$\pm$S.E. varies as follows:—

1956-57 population	S.D.P.	Other populations (*and eye-stripes*)	S.D.P.
6- eye-striped	1.14$\pm$1.18	1955-Gr.I(6)	0.54$\pm$1.43
7- eye-striped	0.51$\pm$1.14	1955-Gr.II(6)	2.02$\pm$0.30
		1955-Gr.III(6)	2.79$\pm$1.63
		1955-Gr.III(7)	3.57$\pm$1.07

In the 6- and 7- eye-striped categories, the values in the 1956-57 population are not significantly different from other populations in the corresponding eye-stripe groups.
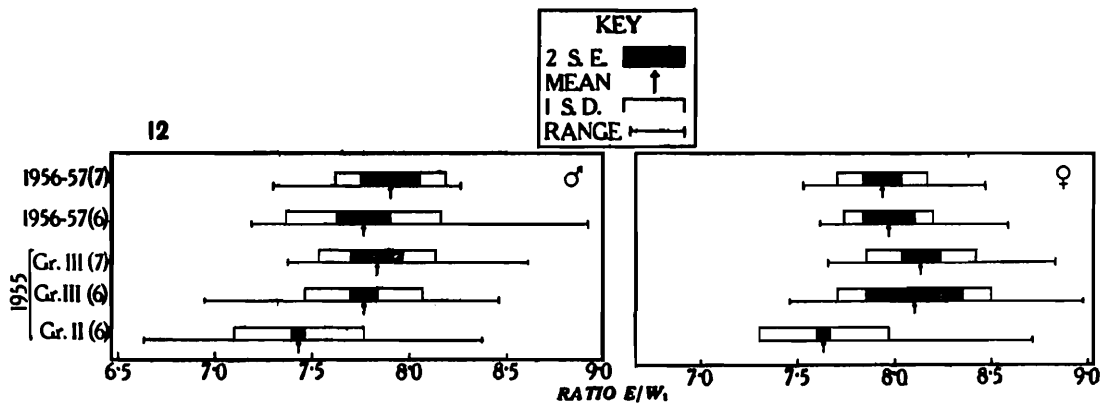
Text-fig. 12.—*Schistocerca gregaria.* Dicegram to show variance in range, mean and its confidence limits (2 S.E.) and standard deviation (S.D.) in various populations regarding the ratio E/W$_1$ (Length of elytron/Restricted width of elytron).

(For explanations *see* text.)

6. *Ratio E/F*

(Tables 5, 6 and 10; and Text-fig. 13)

(*a*) *Mean ratio* (Table 5): This varies as follows:—

Sex (*and eye-stripes*)	Mean ratio$\pm$S.E.
Males (6)	2.00$\pm$0.005
Males (7)	1.97$\pm$0.012
Females (6)	2.00$\pm$0.013
Females (7)	1.99$\pm$0.008

(*b*) *Inter-sex comparison* (Table 6): In both the 6- and 7-striped categories, the values in females are not significantly different from that in corresponding males at all levels.

(*c*) *Inter-eye-stripes comparison* (Table 6): The value in 6-striped individuals is significantly higher than in 7-striped ones (at the 5% level only) in males, but is not significantly different in females.

(*d*) *Inter-population comparison*: The 1956-57 population compare with other populations (data given below) as follows:—

Other populations (and eye-stripes)	Mean ratio±S.E.	
	Males	*Females*
6-*greg.*	2.17±0.024	2.25±0.017
Cal. Sw.(6)	2.18±0.010	2.21±0.070
Ajm. Sw.(6)	2.22±0.023	2.19±0.035
6-*sol.*	2.05±0.012	2.09±0.008
7-*sol.*	2.00±0.006	2.03±0.007
Kakko Conc.(6)	2.06±0.010	2.12±0.011
Kakko. Conc.(7)	—	2.07±0.022
1955-Gr.III(6)	2.07±0.010	2.11±0.031
1955-Gr.III(7)	2.01±0.009	2.04±0.008

6-*striped males and females*: In both sexes, the values are significantly lower than those in corresponding sex in the 6-*greg.*, the *Cal.Sw.*, the *Ajm.Sw.*, the *Kakko Conc.*, the 6-*sol.* and the 1955-Gr.III at all levels.

7-*striped males*: The value is significantly lower than in 7-*sol.* and the 1955-Gr.III at the 1% level.

7-*striped females*: The value is significantly lower than in 7-*sol.*, the 1955-Gr.III and the *Kakko Conc.* at all levels.

(*e*) *Sexual dimorphism percentage*: The S.D.P.±S.E. in the 1956-57 population and other populations varies as follows:—

1956-57 population	S.D.P.	Other populations (and eye-stripes)	S.D.P.
6- eye-striped	0.00±0.70	1955-Gr.I(6)	1.36±1.10
7- eye-striped	1.02±0.74	1955-Gr.II(6)	2.29±0.23
		1955-Gr.III(6)	1.93±1.57
		1955-Gr.III(7)	1.49±0.63
		6-*greg.*	3.69±1.40
		Ajm.Sw.(6)	−1.35
		Kakko Conc.(6)	2.91±0.73
		6-*sol.*	1.95±0.49
		7-*sol.*	1.50±0.62

In the 6- eye-striped category, the value in the 1956-57 population is not significantly different from those in 1955-Gr.I(6) and 1955-Gr.III (6) at all levels, but is significantly lower than in 1955-Gr.II(6), 6-*greg.*, *Kakko Conc.*(6), 6-*sol.* at all levels. No comparison could be made with *Ajm.Sw.*(6), firstly S.D.P. being negative in *Ajm.Sw.* and secondly the data of S.E. is lacking. No significant difference is noticed in the 7-eye-striped category.
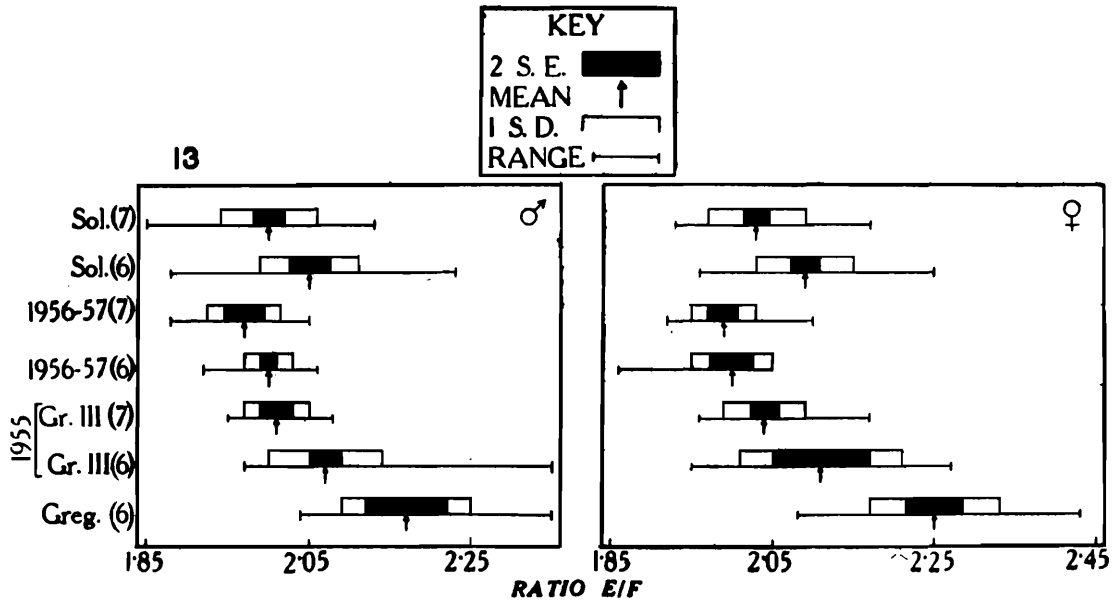
Text-fig. 13.—*Schistocerca gregaria*. Dicegram to show variance in range, mean and its confidence limits (2 S.E.) and standard deviation (S.D.) in various populations regarding the ratio E/F (Length of elytron/Length of hind-femur).

(For explanations *see* text.)

7. Ratio E/C

(Tables 5, 6 and 10; and Text-fig. 14)

(*a*) *Mean ratio* (Table 5): This varies as follows:—

Sex (*and eye-stripes*)	Mean ratio $\pm$ *S.E.*
Males (6)	7.95$\pm$0.041
Males (7)	7.89$\pm$0.067
Females (6)	8.07$\pm$0.050
Females (7)	8.14$\pm$0.058

(*b*) *Inter-sex comparison* (Table 6): The value in females is not significantly different from that in the corresponding males in the 6-striped category, but is significantly higher in the 7-striped category at the 1% level.

(*c*) *Inter-eye-stripe comparison* (Table 6): In both sexes, the value in the 6-striped category is not significantly different from that in the corresponding 7-striped one at all levels.

(*d*) *Inter-population comparison* (Table 10): The 1956-57 population compare with the 1955-Gr.III population (data given below) as follows (the data for other populations are not available):—

Other populations (and eye-stripes)	Mean ratio ± S.E. Males	Females
1955-Gr.III(6)	7.98±0.04	8.03±0.14
1955-Gr.III(7)	7.92±0.05	8.23±0.03

In both sexes, and in both 6- and 7-striped forms, the value in the 1956-57 population is not significantly different from that in the corresponding 1955-Gr.III population at all levels.

(*e*) *Sexual dimorphism percentage:* The S.D.P.±S.E. varies as follows:—

1956-57 population	*S.D.P.*	*Other populations (and eye-stripes)*	*S.D.P.*
6- eye-striped	1.51±0.82	1955-Gr.I(6)	4.44±1.12
7- eye-striped	3.17±1.15	1955-Gr.II(6)	2.74±0.25
		1955-Gr.III(6)	0.63±1.79
		1955-Gr.III(7)	3.91±0.75

In the 6- eye-striped category, the value in the 1956-57 population is significantly lower than in the 1955-5Gr.I one at the 5% level, but is not significantly difference from other populations. No significant difference is seen among the 7-striped categories.
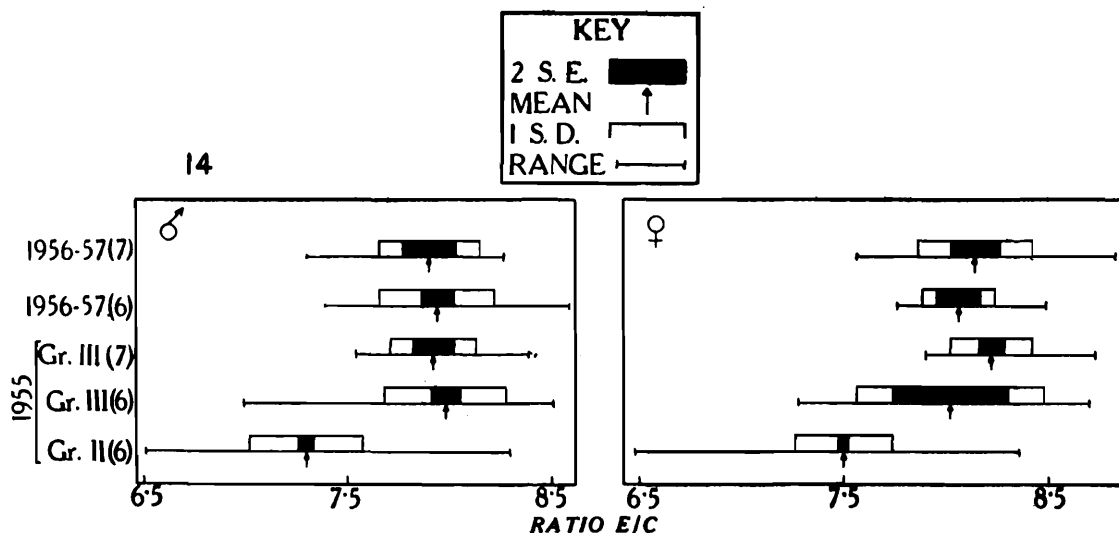
Text-fig. 14.—*Schistocerca gregaria.* Dicegram to show variance in range, mean and its confidence limits (2 S.E.) and standard deviation (S.D.) in various populations regarding the ratio E/C (Length of elytron/Width of head at genal level).

(For explanations *see* text.)

8. *Ratio F/C*

(Tables 5, 6 and 10; and Text-fig. 15)

(*a*) *Mean ratio* (Table 5): This varies as follows:—

Sex (*and eye-stripes*)	Mean ratio $\pm S.E.$
Males (6)	3.98±0.021
Males (7)	4.02±0.038
Females (6)	4.05±0.024
Females (7)	4.11±0.033

(*b*) *Inter-sex comparison* (Table 6): In 6-striped forms the value in females is significantly higher than in males at the 5% level only, but in 7-striped ones there is not significant difference between the sexes at all levels.

(*c*) *Inter-eye-stripe comparison* (Table 6): In both sexes, the value in 6-striped individuals is not significantly different from that in the corresponding 7-striped ones at all levels.

(*d*) *Inter-population comparison* (Table 10): The 1956-57 population compare with other populations (data given below) as follows:—

Other populations (*and eye-stripes*)	Mean ratio $\pm S.E.$ Males	Females
6-*greg.*	3.223±0.032	3.320±0.032
Cal.Sw.(6)	3.35 ±0.010	3.41 ±0.020
Ajm.Sw.(6)	3.237±0.036	3.458±0.079
Kakko Conc.(6)	3.790±0.024	3.824±0.027
1955-Gr.III(6)	3.86 ±0.03	3.82 ±0.09
1955-Gr.III(7)	3.93 ±0.02	4.04 ±0.02

Within the 6-striped category in both sexes, the value in the 1956-57 population is significantly higher than the individuals of the corresponding sex in 6-*greg.*, the *Cal.Sw.*, the *Ajm.Sw.*, the *Kakko Conc.* and the 1955-Gr.III at all levels. In 7-striped males the value in the 1956-57 population is significantly higher than in the 1955-Gr.III at the 5% level only, but in females there is no significant difference at all levels.

(*e*) *Sexual dimorphism percentage:* The S.D.P.±S.E. in the 1956-57 population and other populations varies as follows:—

1956-57 population	S.D.P.	Other populations (*and eye-stripes*)	S.D.P.
6- eye-striped	1.76±0.79	1955-Gr.I(6)	2.52±1.71
7- eye-striped	2.24±1.28	1955-Gr.II(6)	0.30±0.33
		1955-Gr.III(6)	−1.04±2.40
		1955-Gr.III(7)	2.80±0.72
		6-*greg.*	2.69±1.42
		Ajm.Sw.(6)	6.83
		Kakko Conc.(6)	0.90±0.90

In both the 6- and 7- eye-striped categories, the value in the 1956-57 population is not significantly different from other populations in the respective eye-stripe groups.
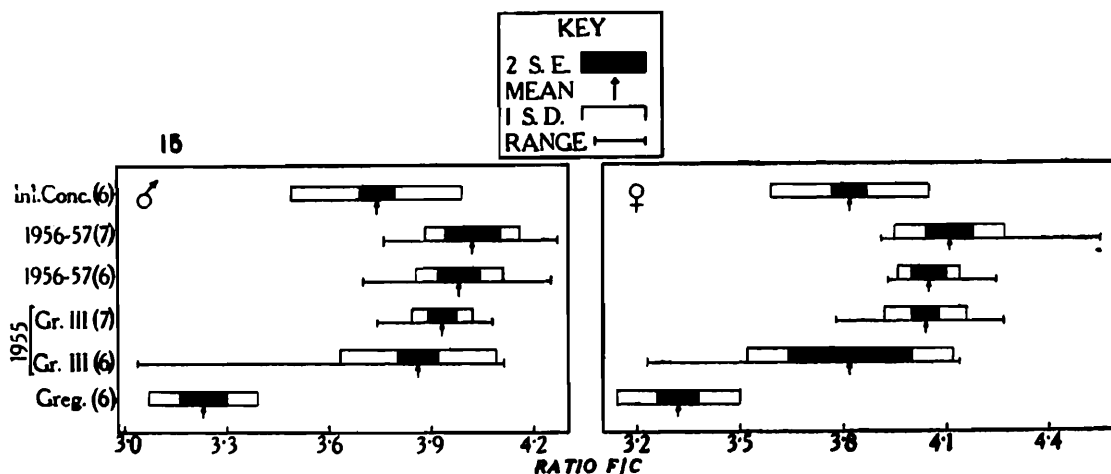
Text-fig. 15.—*Schistocerca gregaria*. Dicegram to show variance in range, mean and its confidence limits (2 S.E.) and standard deviation (S.D.) in various populations regarding the ratio F/C (Length of hind-femur/Width of head at genal level).

(For explanations *see* text.)

9. General conclusions regarding ratios

Within the 1956-57 population, with the exception of a few ratios, the sexual and eye-stripe differences remain invariant.

In respect of the ratio P/C, the 6-striped males and females in the 1956-57 population have significantly higher ratios than those in populations of the typical *gregaria* facies, the 1955-Gr.III(6) and the *Kakko Conc.* (1949) (the latter two populations tending towards phase *solitaria* but not quite attaining the stage). Regarding the ratios M/C and H/C, significantly higher values are recorded in the 1956-57 population than in typical *gregaria* for both sexes, but the difference from the 1955-Gr.III(6) population is not so marked, particularly in females.

The ratio E/W_1 does not show any appreciable difference from the 1955-Gr.III(6) population. It is interesting to note that the ratio E/F shows significantly lower values in the 1956-57 population than in both the "typical" phases *gregaria* and *solitaria*. Since it has attained values even lower than in phase *solitaria*, the *solitaria* nature of this ratio may not be doubted. Values for the ratio E/C are available only for the 1965-Gr.III and a comparison of the 1956-57 population with it does not reveal any difference of note.

Regarding the ratio F/C, considered now as the most sensitive ratio, the 1956-57 population differs from the typical *gregaria* population to a great extent and is almost identical with the typical *solitaria* populations.

VI—DISCUSSION AND CONCLUSIONS

We may now summarise some general conclusions regarding the phase status of the 1956-57 population.

With respect to the composition of eye-stripes and sex-ratios, the 1956-57 population reveals, in general, its similarity with the "typical" phase *solitaria* and other *solitariform* populations.

The nearly equal percentages of the sex-ratios ($\male$50: $\female$ 50) in the 6- eye-striped individuals, which is a condition usually associated with *gregaria* populations (Roonwal's Hypotheses, 1945), is here completely disturbed. Sex-ratio in 6-striped individuals is $\male$75$\pm$6: 25$\pm$6. In the 7-striped category, females predominate ($\male$ 38$\pm$8%: $\female$ 62$\pm$8%), thereby further indicating the *solitaria* nature of the population. The same nature is shown by the eye-stripes proportions; a shrinking in the number of 6-eye-striped individuals to under 80%, and a relative abundunce of the 7-striped individuals, characters which show the *solitaria* nature of the population.

In 6-striped males, the characters P, E and F show their closeness to the *solitaria* condition. The character O, C and W_1 though differing from *solitaria* values, do so to a small extent only. Only characters H and M differ considerably from the *solitaria* values. In 6-striped females, the characters O, C, H, M, E, W_1 and F have values close to typical *solitaria* ones; but character P shows significant difference at the 5% level. In the 7-striped category, in both males and females, all the characters, except F in males, show their close affinity with the *solitaria* condition.

With respect to ratios, in 6-striped males, E/W_1 and E/C show no difference from the *solitaria* condition, but ratios P/C and H/C differ to a small extent. The ratio E/F is smaller than the typical values for both phases. F/C has values closer to *solitaria*. Only the ratio M/C does not indicate any definite affinity to either of the phases. In 6-striped females, the ratios M/C, H/C, E/W_1 and E/C have values similar to those in the typical *solitaria* populations. In the ratios P/C and F/C, the difference is less pronounced from the typical *solitaria* than from the typical *gregaria*. The ratio E/F differs from the typical values in both the phases, but is closer to the *solitaria*.

In 7-striped males, P/C, M/C, E/W_1 and E/C do not show any difference from the *solitaria* values, but the other ratios have values which are either significantly lower (H/C and E/F for both sexes) or higher (F/C for males only) from those in typical *solitaria* populations. In 7-striped females, P/C, E/W_1, E/C and F/C have values as in phase *solitaria*. The remaining ratios do not indicate any definite affinity to either of the phases.

Thus we may say that while generally, the 1956-57 population shows affinity to the *solitaria* phase, in some respect it behaves in a peculiar way. Females have been found to be more phase sensitive than males, the latter, in many characters, retaining a *gregaria* or a near *gregaria* characteristic.

VII—SUMMARY

1. A random sample of 93 individuals of a Desert Locust population in Rajasthan, western India, obtanied during the non-swarming

period 1956-57, was analysed for morphometrically and for eye-stripes and sex-ratios for ascertaining its phase status.

2. The sex-ratio in the 6-eye-striped individuals ($\male 75\%$: $\female 25\%$) reveals a phase *solitaria* nature.

3. The eye-stripe proportions (6-striped population 75% *i.e.*, under 80%; and 7-striped one abundant, $62\pm8\%$ also suggests the *solitaria* nature of population.

4. From inter-sex and inter-eye-stripe comparisons, it is seen that a high degree of sexual and eye-striped differences are demonstrated in the 1956-57 population for morphometric characters (size of body-parts) but such differences are not marked in the ratios.

5. The values of the morphometric characters P, E and F in males and O, C, H, M, E, W_1 and F in females, show affinity with *solitaria* phase values. The ratios E/W_1, E/C, E/F and F/C in males and E/F, M/C, H/C, E/W_1 and E/C in females also show affinity with the *solitaria* phase values.

6. Taken as a whole, the 1956-57 population has phase *solitaria* character.

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