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Population ecology of *Schizodactylus monstrosus* (Drury) (Orthoptera) along the sand bed of Damodar river, West Bengal, India

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Abstract. The paper deals with the findings on some aspect of ecology of *Schizodactylus monstrosus* Drury. Studies on vertical distribution showed that the highest total density was in the 0 to 20 cm depth. Maximum concentration of the species was found in the first horizontal row. Monthly population structure on vertical distribution was also studied. Statistical analysis showed a significant correlation between the relative humidity and the distribution. Biomass of both the sexes and nymphal populated was estimated.

Keywords. *Schizodactylus monstrosus*; sampling unit; vertical distribution; biomass.

1. Introduction

Schizodactylus monstrosus is a large, robustly built, ferocious looking burrowing nocturnal insect (Khattar 1972) and is commonly found in the sand bed of Damodar river. The morphology and anatomy of this peculiar orthopteran have been studied (Ragge 1957; Khattar 1965, 1972) as also its sub-social and other behaviour (Choudhuri and Bagh 1974). However the ecology of this insect has not been studied. The present paper reports the population dynamics in *S. monstrosus*, influence of its physical factors on the distribution pattern and estimation of biomass and its fluctuation in different months of the year (both adults and nymphs) in the sand bed of Damodar river.

2. Location and characteristics of the sampling sites

The Damodar river flowing along the south of Barsul village is located in the Burdwan District (~ 23°-24°N 87°-88°E) 80 km west of Calcutta and 5 km south from Saktigarh Railway Station. The sand bed consists of light brown coarse sand, some sparsely distributed creepers and few patches of grass, the only vegetation on the sand bed.

3. Material and methods

3.1 *Layout of the sampling sites*

The stratified random sampling method with some modifications for sand bed was adopted (Yates and Finney 1942; Healy 1962; Abrahamsen 1969). The study area

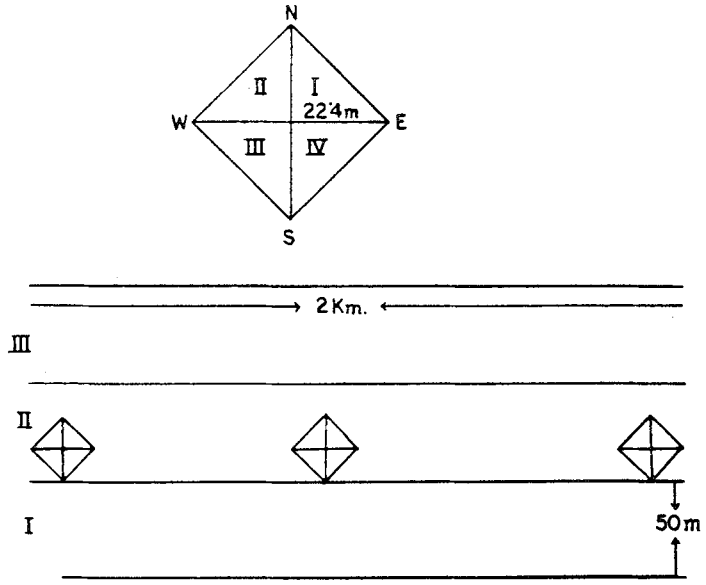

Figure 1. Layout of the sampling sites (each sample unit (NWSE) represents 1 ha).

extended for about 2 km from Barsul to Palla, the entire area of which was divided into three horizontal rows, parallel to each other, starting from the shore line to the bank of the river. The width of each horizontal row was 50 m and collections made from 162 sample units throughout the study period.

The area of the each sample unit was 0.1 ha and the sample unit was laid out on the sand bed with 22.4 m distances as half diagonals in all the four directions from the sampling unit with a nylon rope. For systematic data collection, the sample unit was divided into four quadrats (figure 1). The number of holes in each quadrat was counted from I and complete in quadrat IV *via* II and III. All the holes and the number of specimens collected from each burrow were serially numbered.

3.2 *Collecting techniques*

Collections were made in the morning at monthly intervals from June 1979 to November 1980. Nine units were collected per month *i.e.* at the rate of three randomly selected units from each row. The specimens were collected by digging both open and sand-plugged burrows in each sample unit. Separate sample unit was taken once a month in each row for vertical distribution study from June 1979 to May 1980. Relative humidity and temperature of the sand were recorded by a dial hygrometer and soil thermometer respectively. pH was determined by a digital pH meter.

4. Observations

4.1 *Horizontal distribution*

A total of 7227 specimens were collected during the study of which 60.63% was made up by the first row whereas the third row comprised only 8.15%. Numerically

Table 1. Relative density of *S. monstrosus* in each row in the sand bed of Damodar river at Barsul area.

Rows / Months	I			II			III		
	M	F	N	M	F	N	M	F	N
Jun. 1979	0.83	0.59	2.12	0.76	0.90	0.26	0.48	0.65	—
Jul.	1.13	1.08	2.10	0.62	0.80	0.21	0.51	0.32	0.01
Aug.	2.35	3.35	3.00	1.41	1.27	1.00	0.66	0.25	0.12
Sep.	2.21	2.10	3.49	0.72	0.72	0.69	0.18	0.37	0.07
Oct.	0.58	0.53	2.32	0.39	0.57	0.42	0.11	0.18	0.07
Nov.	0.29	0.44	1.00	0.64	0.62	0.37	0.08	0.14	0.06
Dec.	0.24	0.28	0.53	0.39	0.35	0.22	0.14	0.03	—
Jan. 1980	0.21	0.24	0.29	0.31	0.11	0.15	0.06	0.04	—
Feb.	0.71	0.62	0.32	0.42	0.46	0.24	0.14	0.06	—
Mar.	0.73	0.53	0.62	0.43	0.51	0.28	0.14	0.18	—
Apr.	0.66	0.58	0.66	0.35	0.30	0.04	0.12	0.14	—
May	0.82	0.83	0.72	0.28	0.42	0.48	0.14	0.17	—
Jun.	0.65	0.73	1.25	0.79	0.83	0.72	0.11	0.07	—
Jul.	1.34	1.04	2.28	0.94	1.13	0.24	0.54	0.15	0.03
Aug.	2.01	1.34	1.27	1.22	1.22	1.43	0.14	0.24	0.26
Sep.	1.59	1.26	2.46	0.42	0.62	1.08	0.32	0.26	0.14
Oct.	0.44	0.30	1.96	0.35	0.33	0.43	0.07	0.07	0.03
Nov.	0.30	0.35	0.94	0.25	0.29	0.36	0.11	0.10	—
Total	17.10	16.19	27.34	10.67	11.84	8.61	4.05	3.40	0.79

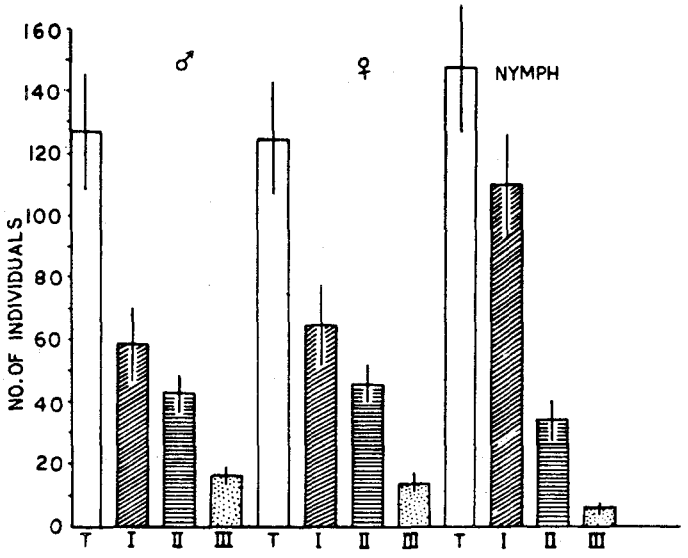

Figure 2. Mean of total male, female and nymph of *S. monstrosus* in three rows with standard error.

the nymphs represented the highest percentage of the total population recorded (36.76%) (table 1). Maximum number of nymphs were obtained from the first row (figure 2) and minimum from the third row.

The data obtained from monthly samples were plotted as monthly running means, together with the standard error of the mean (figure 3). The population of

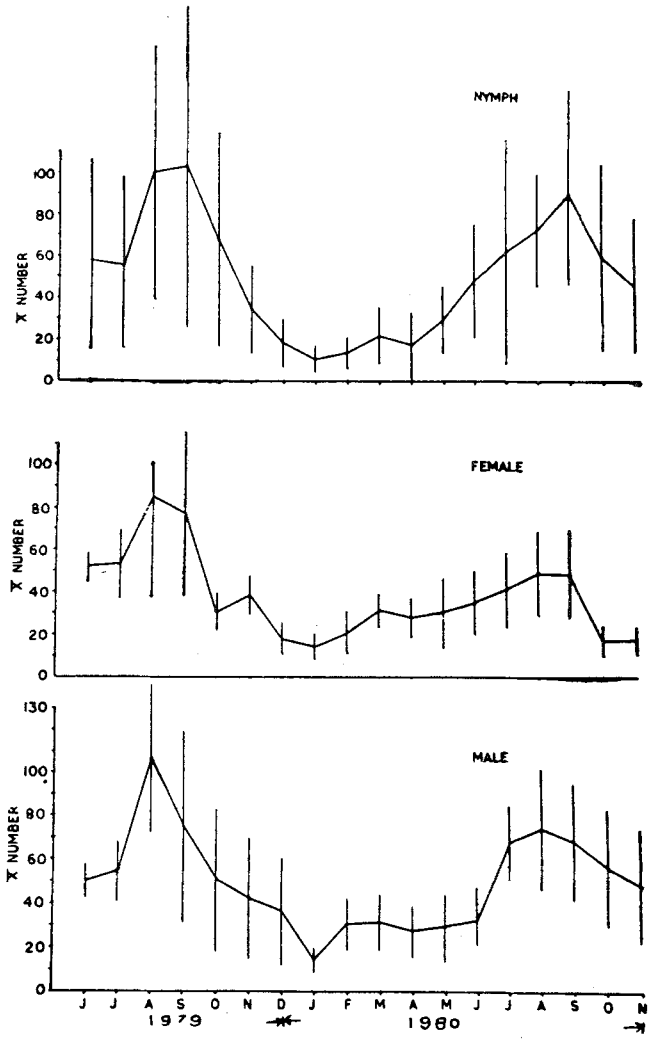

Figure 3. Month wise mean density of male, female and nymph population of *S. monstrosus*.

male and female reached its peak in August, while the nymphs showed its highest number in September in 1979 and 1980 (figure 3).

4.2 *Vertical distribution*

Monthly collections made for seasonal changes in vertical distribution of both adult and nymph populations are shown in figure 4. The highest total density of *Schizodactylus* occurred in the upper depth (0-20 cm) in the first and second row. The adults showed highest concentration in August in the two upper layers and in May maximum population occurred at 40-60 cm depth (figure 5), while the nymphal population showed its maximum concentration in September at 0-20 cm depth and in June at 20-40 cm depth, but the nymphs were absent at 40-60 cm depth (figure 6).

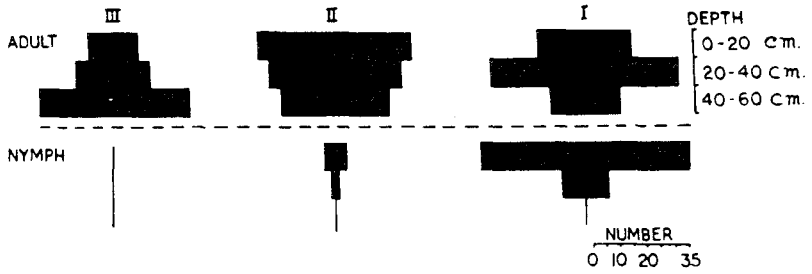

Figure 4. Vertical distribution of total population of *S. monstrosus* in each row.

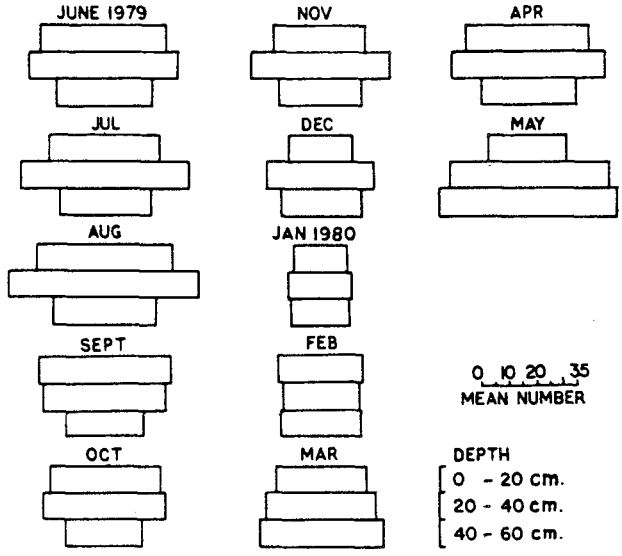

Figure 5. Month wise vertical distribution of adult *S. monstrosus* population.

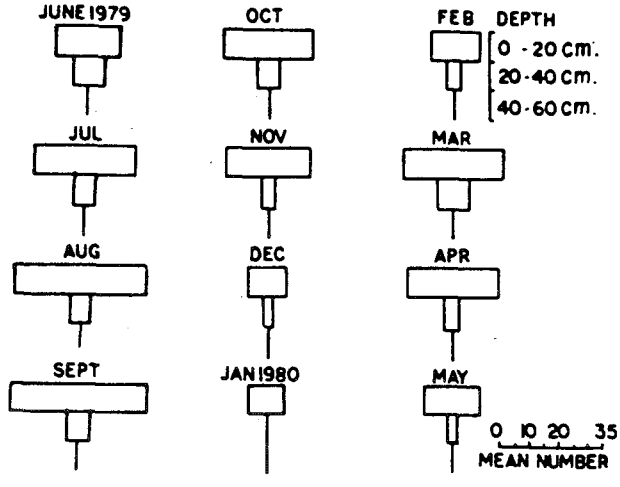

Figure 6. Month wise vertical distribution of *S. monstrosus* nymphal population.

4.3 *Relation between physical factors*

The pH was more or less same in all the three rows throughout the period of observation (figure 7). However, the RH and temperature fluctuated from one row to another and from one month to another. Relative humidity was maximum in August in all the rows and minimum in December in the first row and in May in second and third rows.

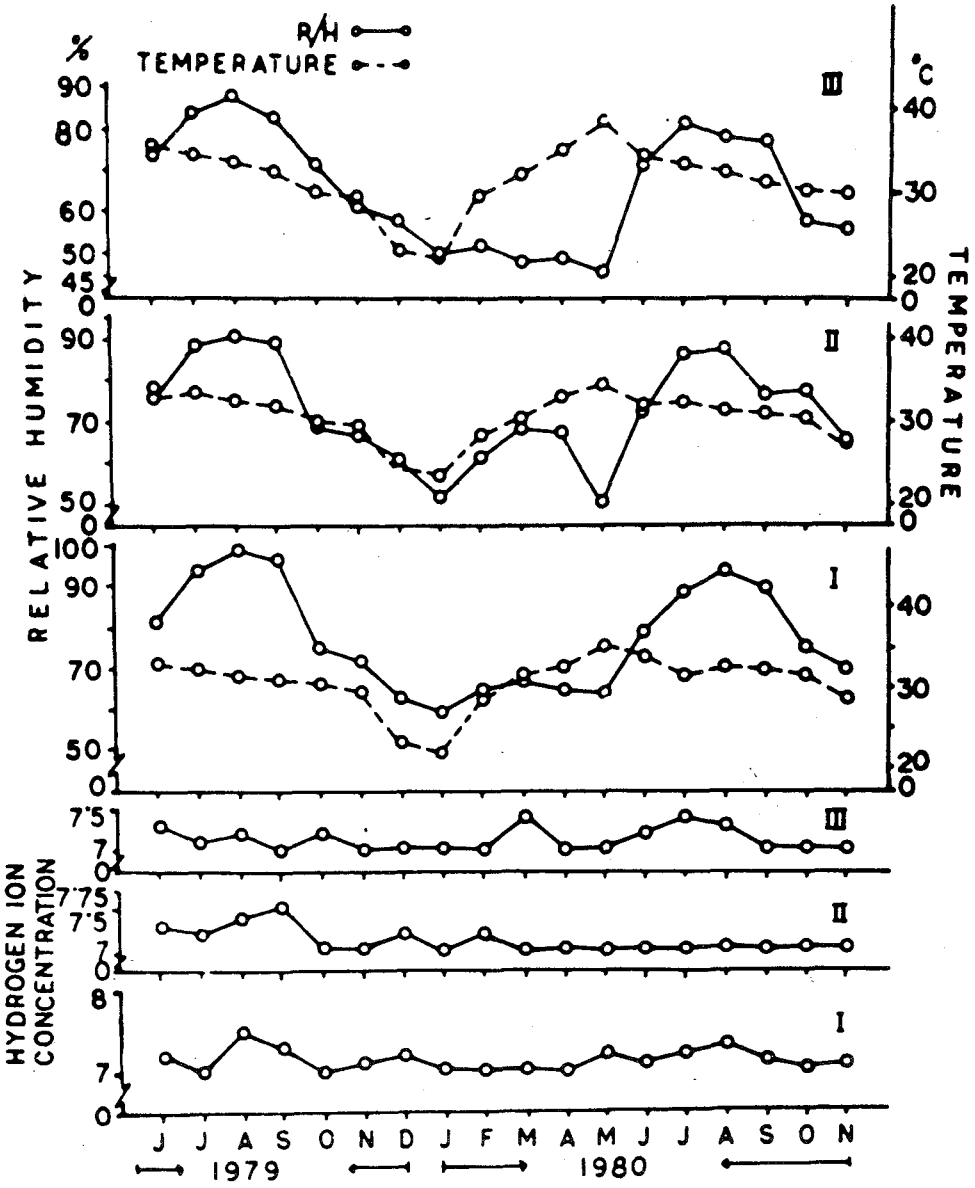

Figure 7. Monthly fluctuations of pH, R H and temperature in rows I, II and III.

4.4 *Statistical analysis*

To ascertain whether physical factors influenced the distribution of *Schizodactylus* and also to show the relationship between the population of one row with the others, the correlation coefficient and regression between the *Schizodactylus* and the physical factors under study were calculated (table 2, figure 8a-d). These results revealed high positive significant correlation (at 1% level) between the number of *Schizodactylus* and the relative humidity content of the sand in all the rows, while the other factors did not show any stable relationship.

Table 2. Relationship between *S. monstrosus* population and different parameters.

	Mean 'r' value	*I row* 'r' value	Regression $y = a+bx$
	I row		
Population	232.33		
pH	7.13	0.74***	7.04 + 0.00039×
Temp	30.89	0.29*	29.50 + 0.0068×
RH	77.13	0.71***	63.19 + 0.06×
	II row		
Population	123.39		
pH	7.10	0.34*	7.03 + .00059×
Temp	30.60	0.45**	28.13 + 0.02×
RH	71.37	0.97**	47.93 + 0.19×
	III row		
Population	33.06		
pH	7.12	0.45**	6.86 + .0079×
Temp	31.64	0.30*	29.99 + 0.05×
RH	66.61	0.77***	50.74 + 0.48×
Population of I and II row	232.33	0.76***	86.37 + 0.30×
Population of I and III row		0.64***	12.15 + 0.09×
Population of II and III row	123.39	0.73***	2.21 + 0.25×

*** significant at 1% level; ** significant at 5% level; * non-significant.

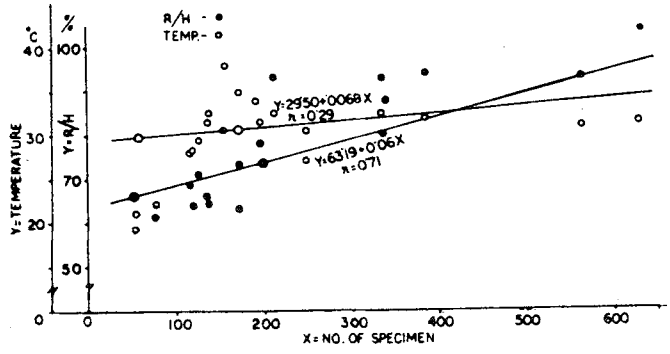

Figure 8. Regression of temperature and relative humidity on *S. monstrosus* population in first row.

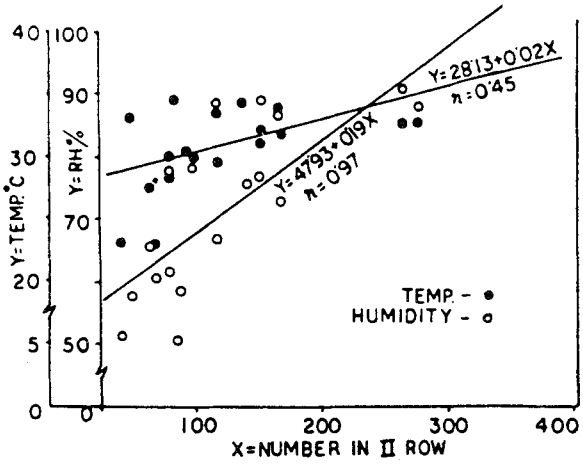

Figure 8a. Regression of temperature and relative humidity on *S. monstrosus* population in second row.

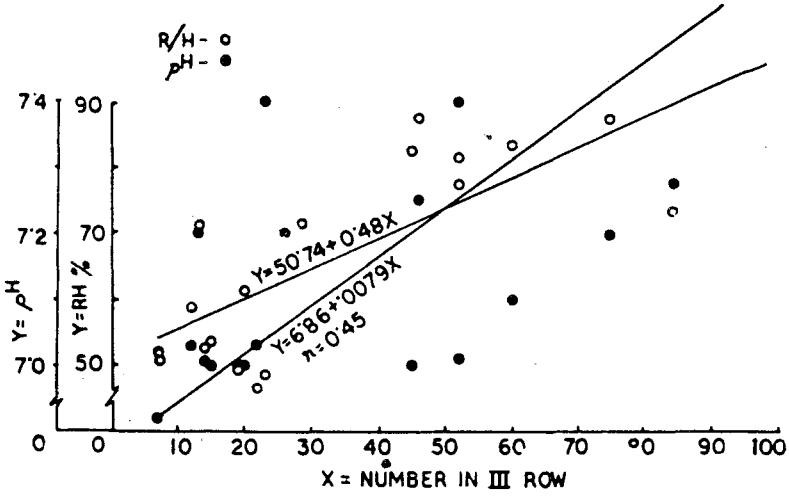

Figure 8b. Regression of pH and relative humidity on *S. monstrosus* population in second row.

4.5 *Biomass of the population*

Biomass is the most widely used measure of the populations (Hale 1966). The mean number of individuals and the biomass of both the sexes and nymphal population in each row per month in 0.1 hectare area are given in table 3 and figure 9. The female population comprised the highest percentage of biomass in all the three rows *viz*

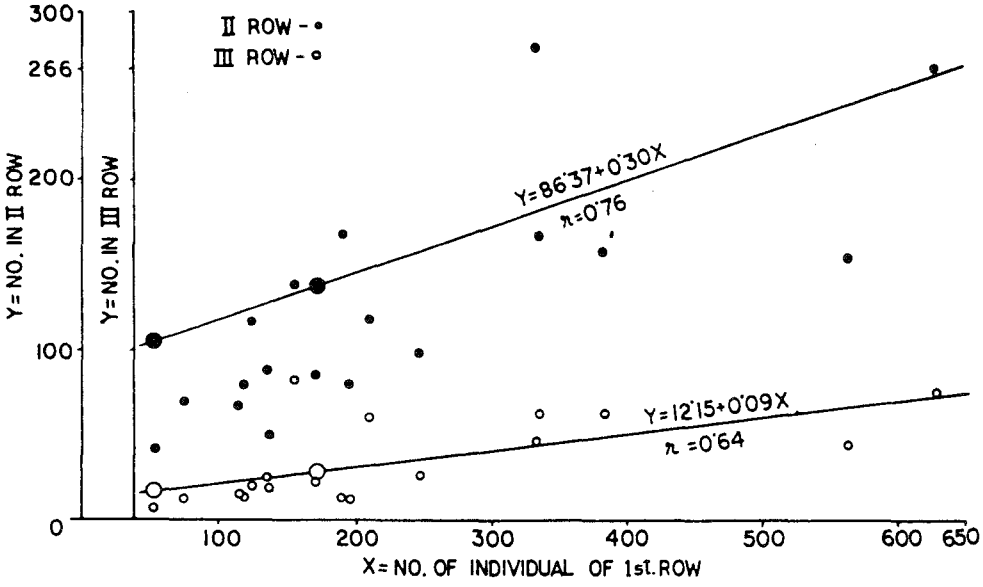

Figure 8c. Regression of second and third row *S. monstrosus* population on first row population.

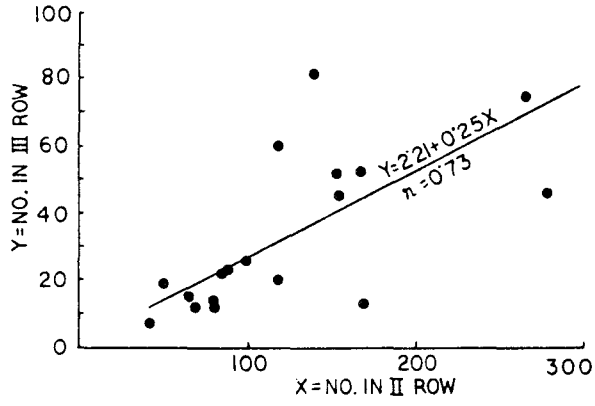

Figure 8d. Regression of third row *S. monstrosus* population on second row population.

27.15%, 19.17% and 5.74% in the 1st, 2nd and 3rd rows respectively. Contrary to this, the nymphal population contributes to the lowest percentage of the total biomass in the sand bed. The monthly fluctuation of biomass in each row was compared (figure 9a). It was seen that the first row yielded the maximum amount in each month, except in November 1979 and June 1980, when the second row showed highest amount. The biomass of male and female (average of three rows) in the studied area was highest in August and lowest in January, but the nymphal population showed maximum biomass during September (figure 10). From figure 2 it is evident that although the density of nymphal population was maximum in the 1st row the biomass added by this population was minimum (figure 10).

Table 3. Number (mean No./0.1 ha) and biomass (g dry wt/0.1 ha) of *S. monstrosus* at sand bed of Damodar riv[illegible].

Months	I row					
	Male		Female		Nymph	
	Mean No.	Mean Biomas	Mean No.	Mean Biomass	Mean No.	Mean Biomass
Jun. '79	20.00	26.26	14 33	27.53	51.00	18.36
Jul.	27.33	35.88	26 00	49.95	50.67	18.24
Aug.	56.67	74.41	80 67	154.97	72.33	26.04
Sep.	53.33	70.02	50.67	97.34	84.00	30.24
Oct.	14.00	18.38	12 67	24.34	56.00	20.16
Nov.	7.00	9.19	10 67	20.50	24.00	8.64
Dec.	5.67	7.44	6 67	12.81	12.67	4.56
Jan.'80	5.00	6.57	5.67	10.99	7.00	2.52
Feb.	17.00	22.32	15.00	28.80	7.67	2.76
Mar.	17.67	23.20	10.67	20.50	15.00	5.40
Apr.	16.00	21.01	14.00	26.39	16.00	5.76
May	19.67	25.83	20.00	38.42	17.33	6.24
Jun.	15.67	20.57	17.67	33.94	30.00	10.80
Jul.	32.33	42.45	25.00	48.00	55.00	19.80
Aug.	48.33	63.46	32.33	62.11	30.67	11.34
Sep.	38.33	50.50	30.33	58.26	59.33	21.36
Oct.	10.67	14.01	7.33	14.08	47.33	17.00
Nov.	7.33	9.62	8.33	16.00	22.67	0.16
Total	412.00	541.12	390.00	749.19	658.87	237.19

Months	II row					
	Male		Female		Nymph	
	Mean No.	Mean Biomass	Mean No.	Mean Biomass	Mean No.	Mean Biomass
Jun. '79	18.33	24.07	21.67	41.63	6.33	2.28
Jul.	15.00	19.70	19.23	37.13	5.00	1.80
Aug.	34.00	44.64	30.67	58.92	24.00	8.64
Sep.	17.33	22.75	17.33	33.29	16.67	6.00
Oct.	9.33	12.25	13.67	26.26	10.00	3.60
Nov.	15.33	20.13	15.00	28.82	9.00	3.24
Dec.	9.33	12.25	5.33	16.00	5.33	1.92
Jan.'80	7.67	10.07	2.67	5.13	3.67	1.32
Feb.	10.00	13.13	11.00	21.13	5.67	2.04
Mar.	10.33	13.56	12.33	20.69	6.67	2.40
Apr.	8.83	10.94	7.33	14.08	1.00	0.36
May	6.67	8.76	10.00	19.21	11.67	4.20
Jun.	19.00	24.35	20.00	38.42	17.33	6.24
Jul.	22.67	29.77	27.33	52.50	5.67	2.04
Aug.	29.33	38.51	24.33	56.34	34.33	12.36
Sep.	10.00	13.13	15.00	28.82	26.00	9.36
Oct.	8.33	10.94	8.00	15.37	10.33	3.72
Nov.	6.00	7.88	7.00	13.45	8.67	3.12
Total	257.00	337.43	285.33	527.19	207.33	74.04

Table 3 (contd.)

Months	III row Male		Female		Nymph	
	Mean No.	Mean Biomass	Mean No.	Mean Biomass	Mean No.	Mean Biomass
Jun. '79	11.67	15.32	15.67	39.10	0	0
Jul.	12.33	16.19	7.67	14.73	0:33	0.12
Aug.	16.00	21.01	6.00	11.53	3.00	1.08
Sep.	4.33	5.69	9.00	17.29	1.67	0.60
Oct.	2.67	3.51	4.33	8.32	1.67	0.60
Nov.	2.00	2.63	3.33	6.40	1.33	0.48
Dec.	3.33	4.37	0.67	1.29	0	0
Jan. '80	1.33	1.75	1.00	1.92	0	0
Feb.	3.33	4.37	1.33	2.55	0	0
Mar.	3.33	4.37	4.33	8.32	0	0
Apr.	3.00	3.94	3.33	6.40	0	0
May	3.33	4.37	4.00	7.68	0	0
Jun.	2.67	3.51	1.67	3.21	0	0
Jul.	13.00	17.07	3.67	7.95	0.67	0.24
Aug.	3.33	4.37	5.67	10.89	6.33	2.28
Sep.	7.67	10.07	6.33	12.16	3.33	1.20
Oct.	1.67	2.19	1.67	3.21	0.67	0.24
Nov.	2.67	3.51	2.33	4.48	0	0
Total	97.67	128.24	82.00	158.43	19.00	6.84

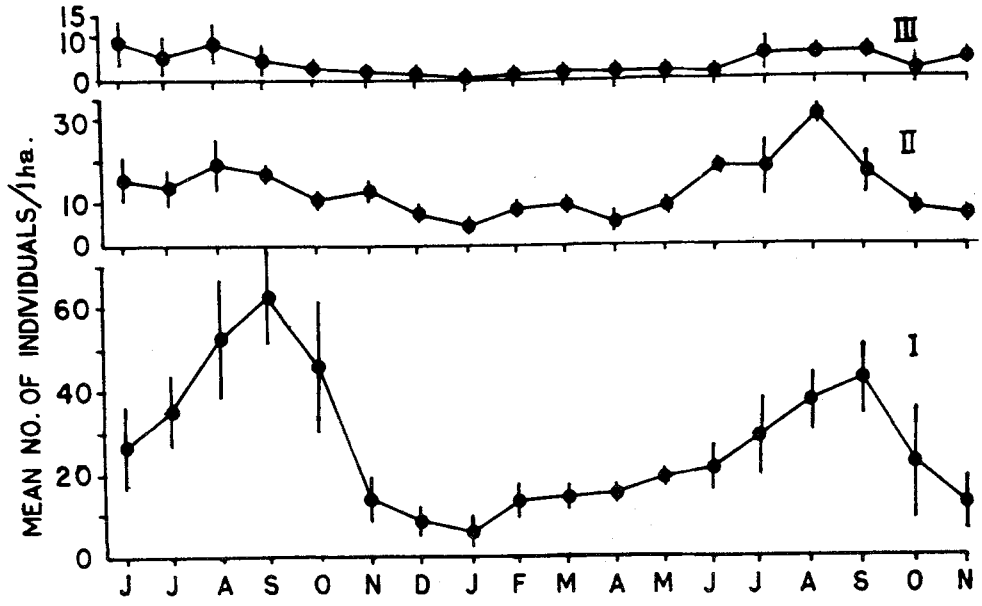

Figure 9. Row wise total population of *S. monstrosus*/month/0.1 ha. (vertical line indicates SE).

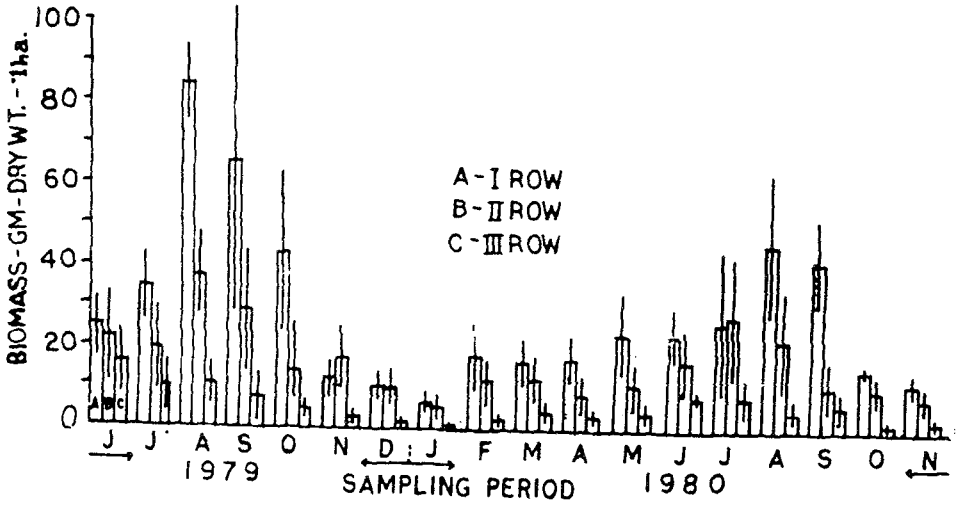

Figure 9a. Monthly changes in mean biomass in each row of *S. monstrosus* (vertical line indicates SE).

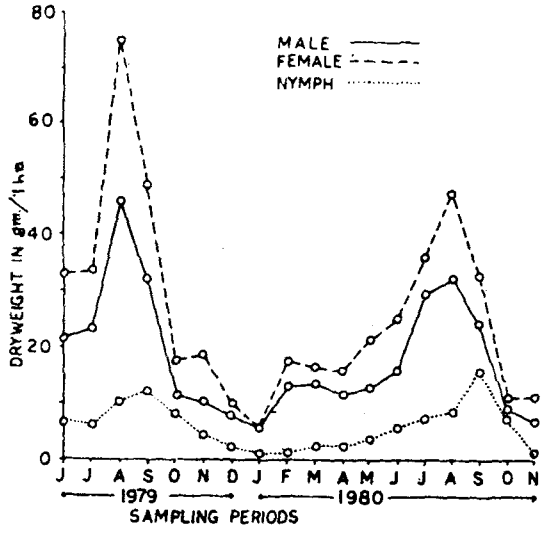

Figure 10. Monthly changes in biomass (g dry wt./0.1 ha.) of male, female and nymph population of *S. monstrosus* (mean of total biomass of 3 rows).

5. Discussion

Although the biology and ecology of different Orthoptera have been extensively studied, majority of the papers deal with Acrididae and Gryllidae, and Schizodactylidae received very little attention. Acrididae attain their maxima at some period between June and September (Khan and Aziz 1973). The present investigation shows that *Schizodactylus* populations attain its highest peak in

August and perhaps due to the cold spell, it was minimum in January. In the field all the nymphal stages are usually found during most of the sampling period, which indicates slow development of this insect from one instar to another and continuous generations. This may be due to the prevalance of major factors like moisture and food throughout the year in the sand bed. Similar observations was also made by Rentz and Weissman (1973) in silk spinning cricket *Cnemotettix* at California. According to Khattar (1972) the entire life cycle of *Schizodactylus* takes more than a year and it passes through nine instars. The highest density of *Schizodactylus* in the upper 0-20 cm depth in the first and second row may be due to the maximum nymphal population within this depth (figure 5). This observation agrees with similar studies on other typical soil inhabiting micro- as well as macro-arthropods (Bellinger 1954; Poole 1961). The nymphal populations were completely absent from 40 to 60 cm depth which may be due to the absence of strong jaws during the nymphal stages as the tunnels are dug solely with the help of jaws (Carpentier 1953; Khattar 1972). Moreover, the nymphal density was higher in the front part of the first row which may be due to the presence of maximum moistened sand. The maximum number of adults in higher depth (40-60 cm) in the third row is due to the presence of less moisture content in the upper layer of this row as compared to other two front rows. As a result the adults go deep inside the sand to get favourable moisture. This confirmed the observation of Khattar (1972) who found a direct correlation between the depth of burrow and the sand conditions. The relative humidity of sand showed a direct correlation with the population density. The first row contained maximum population due to the maximum mean R/H concentration, contrary to this minimum population occurs from the third row, as it contained minimum mean R/H (figure 7). The influence of relative humidity was therefore much pronounced on the population fluctuation of *Schizodactylus*. It might be concluded that 31-32.5°C and 88.5-98.5% relative humidity in sand are the suitable combination for their peak population (figure 8, 8a). The density and biomass data on the burrowing orthopterans are not available. A maximum value of 75 mg/m^2 in the first row was found for female *Schizodactylus* in the present study. However, the grassland inhabiting the orthopterans were studied by several workers. Delvi and Pandian (1979) found 347 gcal/m^2 of *Poecilocerus pictus* near Bangalore field, Wiegert (1965) found 60 mg/m^2 for *Melanoplus* in Michigan according to Vanhook (1970). *Concephalus* had a maximum biomass of 200 mg per/m^2 and *Pteronemobius*, a field cricket, had a maximum biomass of 150 mg/m^2.

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