CHAPTER - 2

MATERIALS AND METHODOLOGY

2.1 STUDY SITE:

The study site was a part of Guru Ghasidas University campus, located 5 km. away from the Bilaspur town on Bilaspur-Ratanpur bus route. It lies between 21°37' to 23°7' N latitude and 81°12' to 83°40' E longitude. The university was started on 16th June 1983 in a peaceful area which affords a campus spread over one thousand acres of land (Tiwari, 1987-90). The area, at its belly, has eight ponds, some pithole-eroded areas with nullahs, ravines and plateaus, contributing to its topography. Before 1988, the area was a grazing land having scattered growth of *Acacia* and *Butea* trees. To save the land from erosion primarily *Acacia* plants were planted in and around the pitholes, nullahs and ravines.

It was during the periods between 1990-92, about 8 lakhs seedlings of various plant species were planted with a view to convert the campus green and attractive. In fact, parallel to the development of the academic infrastructure, full attention was given to modify the barren campus into a green belt. A central nursery was established within the campus to develop seedlings of various species, primarily for its use within the campus and later as a resource centre of seedling supply to various social organisations, institutions and educational institutions, on demand.
On the northern belt of the campus, nearly forty acres of planted area was fenced to protect land from any interference by cattle and common man. This part, hence, shortly evolved into a nice grass cover with dense trees. The present study was mainly confined to this fenced area.

2.2 THE GRASSHOPPERS:

The area was surveyed throughout the year so as to have a record of the grasshopper fauna inhabiting within the fenced area. A total of twenty-three species were collected and identified, whose detailed account of distribution is described in the next chapter. Complete ecology of only two grasshopper genera, namely *Catantops pinguis innotabilis* Walk. and *Spastosternum prasiniferum prasiniferum* Walker was studied in detail in the present work.

2.3 POPULATION STUDY

The natural population of two different grasshopper types were opted for population study. For this purpose, the entire fenced area was divided lengthwise in three blocks - A, B and C. Each block was approximately of equal area and identical size. Block A was the outer one aside the administrative section of university building; Block B was the middle part and Block C formed the inner block, bounded externally by barren land of the university. Censusing of the population was undertaken for one complete year during the period from June 1996 to June 1997. During the census period, random sampling of the test insects was carried out twice each month, i.e. once on or around the 15th and other on or around the end of the
LOCATION OF STUDY SITE
IN
GURU GHASIDAS UNIVERSITY CAMPUS, BILASPUR (C.G.)

LOCATIONS
1. Entrance of the Campus
3. University Nursery
4. Administrative Block
5. Road
6. Study site
7. Library bldg.
8. Univ. Teaching Deptts.
11. & 12. Staff Quarters
month. Catch-count method (Gause, 1930, Isely, 1937, Andrewartha, 1970, Dwivedi, 1984) was preferred for these orthopteroid species. Direct sight counting of the grasshoppers was done in a single square meter. A standard net covered frame of this size was used for the purpose of catch-counts. The counts in each block (A, B and C) were made thrice on the study days, i.e. morning (between 7.30 to 8.30 am, noon (between 12.30 to 1.30 pm) and evening (between 4.30 to 6.30 pm). The results so obtained were summed-up for per square meter value. Every care was taken to get population values to the nearest accuracy.

2.4 SECONDARY PRODUCTIVITY:

The insect ecology censusing the animal populations of an ecosystem is not of much credit until the secondary productivity of the population is also taken into account. In the present study the grasshoppers captured during their census were not released but were being collected in small sized portable insect cages of the size 7" x 4½" x 3½". Five such cages were used on each date of census. The side wall and sliding cover of these cages were made of wire-meshing, fitted on wooden frames, so as to provide maximum aeration to the captured insects during their transportation from the field to the laboratory. The collection of the individuals for biomass study included hoppers and adults found in all the three blocks - A, B and C, during the day long (morning, noon and evening) censusing. In this way, the biomass values were also determined fortnightly along with population study.

The individuals collected from the field, were taken to the laboratory. Subsequently, they were killed and dried in oven at 105° C
(Ananthakrishnan, 1970). The dry body weight of the insects were taken after 24 hours of drying.

The values of the dry body weights, as obtained during the period of study, enabled us to infer the increase in the secondary production of the insects at population level.

2.5 METABOLIC RATE:

The metabolism of the grasshoppers has been expressed in terms of the volume of oxygen consumed per unit of live weight (Prossor and Brown, 1965) per unit of time.

For the insects in the present work, this unit is c.m³(c.c.)/gm. of live body weight per hour. Metabolic rate values of both, the growing hoppers of each stage as well as adult grasshoppers, were determined. The insects for the metabolic rate determination were seperately collected from their natural habitat as and when desired. The measurement of oxygen consumption was done at an interval of nearly fifteen days. The respirometers used were self-designed (Fig. 2.1). The results obtained by the use of these respirometers were found as accurate as by that of Warburg's respirometer. Three respirometers were run simultaneously in the day as well as night. To set the apparatus, first the potassium hydroxide pellets were placed in the central cuplet of the bottom of the flask which was then covered with a perforated and moist filter paper. In the beginning the number of early instar hoppers, placed in the flask, varied between 15 to 20 depending on their size. After 3rd instar, due to grown up size of hoppers, only ten individuals were placed inside the flask, whereas, only five adult individuals were placed in later experiments because of the same obvious reasons. The
Fig. No. 2.1. RESPIROMETER
Experimental insects were pre-starved for half an hour before experimentation. They were left inside experimental flask for another half hour before setting the experiments to enable them to regain their normal relaxed state of equilibrium. The readings in day time experiments, were recorded at an interval of fifteen minutes over a period of an hour to observe the regularity of oxygen uptake during the experiments. However, in the experiments carried during night hours, only the start and end readings of the experiment were recorded. This was done intentionally because the night experiment were conducted in the total darkness, hence, putting on of the light at fifteen minutes intervals to record the reading would necessarily have caused a disturbance by its sudden glow to the insects, thus affecting their metabolism. The final readings, both in the day and night, were always recorded after bringing the water level of the two tubes (graduated and levelling) to parallel on completion of experiment. The insects were taken out of the experimental flask. They were, then, weighed so as to get their live body weights.

2.6 ESTIMATION OF CALORIFIC VALUE:

Calorific values of the dried grasshoppers were estimated at the end of sampling period. Samples of different stages of insects were powdered in hand mortar and pestle. Pellets of the powdered material were then prepared for each sample in a hand-run pellet-making machine. These were, then, dried for two hours at 105°C and thereafter these were transferred in a dessicator. After cooling down, individual pellets were weighed accurately upto the fourth decimal place. Pellets of each stage were then fired in Bomb-Calorimeter. Standard procedure and precautions for determination of calorific values,
as fully discussed in the accompanying manual of the Bomb-calorimeter was followed. Two pellets were ignited for each sample. Due corrections were made for fusewire and for the acids ($H_2SO_4$ and $HNO_3$) formed during combustion. The caloric value was calculated according to the following formula of Leith (1968):

\[
C_v = \frac{W \Delta t - \sum c}{G}
\]

Where,
- $C_v$ = Calorific value
- $W$ = Weight of water
- $\Delta t$ = Corrected temperature difference reading of Beckmen thermometer (°C)
- $\sum c$ = Temperature correction value for cotton thread, ignition wire, and sulphur, nitrogen corrections.
- $G$ = Sample's dry weight

Calorific values have been expressed on per gram dry weight basis.

2.7 STATISTICAL ANALYSIS :

I. Population study :

Following formulae were used to analyse the population structure.
(a) **Mean Density** :

Mean density of both the grasshopper populations were calculated for each species as under:

\[ \bar{x} = \frac{\sum x}{n} = \frac{x_1 + x_2 + x_3 + \ldots + x_n}{n'} \]

where,

- \( \bar{x} \) = mean density/m²
- \( \sum x \) = sum of \( x_1 + x_2 + x_3 + \ldots + x_n \)
- \( x_1, x_2, x_3, x_n \) = number of grasshoppers caught in quadrats 1, 2, 3, \ldots n on each day of sampling.
- \( n \) = Total number of quadrats sampled on each day.

(b) **Relative Density** :

The relative density was calculated as follows:

\[ \text{R.D. (\%)} = \frac{x_1}{x} \times 100 \]

where,

- \( x_1 (x_2, x_3, \ldots) \) = number of individuals of one species
- \( x \) = total no. of individuals of all species.
(c) **Relative Frequency**:
Relative frequency of the test insects was, likewise, calculated by the following formula -

\[
R.F. (\%) = \frac{\text{Number of occurrences of one species}}{\text{Number of occurrences of all species}} \times 100
\]

(d) **Percentage Frequency**:
Percentage frequency was calculated by dividing the total number of quadrats in which a species occurred with the total number of quadrats sampled, and, converting the figure to percentage value -

\[
P.F. (\%) = \frac{n_1}{n} \times 100
\]

where,

\[n_1 (n_2, n_3 \ldots) = \text{No. of quadrats in which the species occurred.}\]

\[n = \text{Total no. of quadrats sampled.}\]

(e) **Partial Correlation**:
Following formula of Karl Pearson was used to work out the simple correlation between -

(i) Mean density of grasshoppers and temperature

(ii) Mean density of grasshoppers and relative humidity

(iii) Mean density and biomass.

(iv) Biomass and energy
\[
r = \frac{\sum dx \cdot \sum dy - (\frac{\sum dx \cdot \sum dy}{n})}{\sqrt{\left\{ \frac{\sum dx^2 - (\frac{\sum dx^2}{n})}{n} \right\} \left\{ \frac{\sum dy^2 - (\frac{\sum dy^2}{n})}{n} \right\}}}
\]

where,
\[
\begin{align*}
r & = \text{coefficient of correlation (Partial)} \\
\sum dx & = \text{sum of deviations of variations (s) from assumed mean (A)} \\
\sum dy & = \text{sum of deviations of variations (y) from assumed mean (B)} \\
n & = \text{total number of items.}
\end{align*}
\]

Calculated values of 'r' were matched with the critical values of \(n-2\) degree of freedom and 5 percent probability in each case.

### III. ECOLOGICAL EFFICIENCY:

Ecological efficiency was calculated according to the methods of Singh et. al (1975) as follows:

\[
\text{Tissue growth efficiency} = \frac{\text{Tissue growth}}{\text{Assimilation}} \times 100
\]