

## STUDIES ON POPULATION DENSITY AND DIVERSITY OF TERMITES OF DISTRICT BAHAWALNAGAR

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**Abstract:** Six species of termites (*Coptotermes heimi*, *Microtermes mycophagus*, *Microtermes obesi*, *Odontotermes guptai*, *Odontotermes obesus* and *Amitermes* sp.), foraging in soil, were recorded by 250 soil cores of 30x30 cm area taken from district Bahawalnagar. Maximum population density of termites was recorded in January (124.44/m<sup>2</sup>) and minimum in March (30.27/m<sup>2</sup>). There was positive but non-significant ( $P>0.05$ ) correlation between population density and atmospheric temperature and relative humidity. Termite diversity on Simpson scale was 62% and according to Shannon Weiner function 65%. Termites foraging on trees were the same that were recorded foraging in the soil. Termite diversity worked out on the basis of termites foraging in soil and on trees is also discussed.

**Keywords:** Termites, Population density, Foraging, Shannon Weiner function, Simpson scale.

### INTRODUCTION

Termites have an important economic role in economic entomology, with the cost of damage to the buildings, especially in developed countries in America and Asia, amounting to many millions of pounds. Damage to houses by termites can, in some countries, exceed that caused by natural disasters and fires in a single year. In developing countries they have even more impact, destroying local huts and crops of poor subsistence farmers. Villages in India and Egypt have been destroyed by termites and the inhabitants forced to move to other areas. In Asia, ancient temples have also been attacked [Pearce 1997].

District Bahawalnagar lies from 28°-51' to 30°-22' north latitudes and from 72°-17' to 73°-58' east longitudes. Its climate is extremely hot and dry in summer and cold and dry in winter. The summer season starts in April and continues up to October. The hottest months are May, June and July, whereas the coldest months are December, January and February. Fifty species of termites have been recorded from different ecological zones of Pakistan [Akhtar 1974], but there is paucity of information regarding their abundance and foraging activity in different climatic regions of Pakistan. Based on this consideration, termite population density and termite diversity in district Bahawalnagar, a desert area, was studied for comparison with other ecological zones of Pakistan.

## MATERIALS AND METHODS

### POPULATION DENSITY

Population density of termites was based on soil cores only; whereas diversity was based on foraging population of termites in soil and on the trees present in the area.

For the estimation of population density, soil cores (30 cm x 30 cm) were taken from three localities, namely, Harun Abad, Fort Abbas and Chishtian. The soil from each core was thoroughly examined and termites were preserved in 80% alcohol for further studies in the laboratory. Population density for each species was worked out by dividing the number of termites with the number of cores after Llyod [1967] and the resulting figure was then divided by area of the core.

### TERMITES ATTACKING TREES

For taking samples of termites attacking trees, a plot of 100 x 100 m was selected each at Haroonabad, Fort Abbas and Chishtian. Nearly 50-120 plants were examined at different localities to record the number of trees harbouring termite colonies. Collection was also made from infested trees.

### ENVIRONMENTAL FACTORS

Atmospheric temperature and relative humidity were recorded on each observation to see its impact on foraging population.

### TERMITE DIVERSITY

Termite diversity on Simpson and Shannon index was worked out according to Simpson [1949] and Shannon-Weiner function [Odum 1975].

## RESULTS

### POPULATION DENSITY OF TERMITES IN SOIL

Population density of termites is based on 250 soil cores taken from different localities of Bahawalnagar during October, 1998 to March, 1999. Six species viz; *Coptotermes heimi*, *Microtermes obesi*, *Microtermes mycophagus*, *Odontotermes guptai*, *Odontotermes obesus* and *Amitermes* sp., were recorded foraging in the soil. Population density varied from 30.27/m<sup>2</sup> in March to 124.44/m<sup>2</sup> in January 1999. There was positive but non-significant correlation between atmospheric temperature and population density (0.4636; P>0.05) and relative humidity versus population density (0.1155; P>0.05) (Table 1).

### TERMITES FORAGING ON TREES

Termite's species foraging on trees were the same as were recorded in the soil: The trees in the sampling area belonged to *Acacia modesta* and *Dalbergia sissoo*. Termites were mostly collected from *Acacia modesta*, which represented almost 98% of the total trees. Table 2 indicated termite

**Table 1:** Temperature, humidity, number of termites and population density of termites recovered by soil cores (core size, 30 cm x 30 cm) during the sampling session.

| Date and Locality                                                  | Temp (°C) | Humidity (%) | Total cores dug | Positive cores | No. of Total Termites | Termite Species                                                  | No.             | Population Density/m <sup>2</sup>        |
|--------------------------------------------------------------------|-----------|--------------|-----------------|----------------|-----------------------|------------------------------------------------------------------|-----------------|------------------------------------------|
| Oct. 13, 14, 15, 1998<br>Harunabad                                 | 31.32     | 77.15        | 60              | 6              | 401                   | <i>C. heimi</i>                                                  | 401             | 74.25                                    |
| Nov. 23, 24, 25, 1998<br>Fort Abbas                                | 22.47     | 71.45        | 60              | 7              | 214                   | <i>O. obesus</i><br><i>M. obesi</i><br><i>M. mycophagus</i>      | 89<br>13<br>112 | 16.48<br>2.407<br>20.74<br>Total: 39.629 |
| Dec. 20, 21, 22, 1998<br>Chishtian                                 | 12.54     | 55.75        | 30              | 6              | 308                   | <i>M. mycophagus</i><br><i>O. guptai</i><br><i>Amitermes</i> sp. | 222<br>56<br>30 | 82.22<br>20.74<br>11.11<br>Total: 114.07 |
| Jan. 15, 16, 17, 1999<br>Chishtian                                 | 15.56     | 64.25        | 30              | 6              | 336                   | <i>M. mycophagus</i>                                             | 336             | 124.44                                   |
| Feb. 17, 18, 19, 1999<br>Harunabad                                 | 22.41     | 68.24        | 30              | 7              | 146                   | <i>C. heimi</i><br><i>M. obesi</i><br><i>M. mycophagus</i>       | 85<br>21<br>40  | 31.48<br>7.77<br>14.81<br>Total: 54.44   |
| March 20, 21, 22, 1999<br>Fort Abbas                               | 26.61     | 59.54        | 40              | 5              | 109                   | <i>C. heimi</i>                                                  | 109             | 30.27                                    |
| Coefficient of correlation (r)                                     |           |              |                 |                |                       |                                                                  |                 |                                          |
| Atmospheric temperature versus population density = 0.4636; P>0.05 |           |              |                 |                |                       |                                                                  |                 |                                          |
| Relative humidity versus population density = 0.1155; P>0.05.      |           |              |                 |                |                       |                                                                  |                 |                                          |

**Table 2:** Temperature, humidity and number of termites collected from trees.

| Date and Locality                    | Temp. (°C) | Humidity (%) | Total Plants examined | Positive Plants | No. of Total Termites | Termite Species on Trees                                                                           | No.                         |
|--------------------------------------|------------|--------------|-----------------------|-----------------|-----------------------|----------------------------------------------------------------------------------------------------|-----------------------------|
| Oct. 13, 14, 15, 1998<br>Harunabad   | 31.32      | 77.15        | 120                   | 51              | 379                   | <i>C. heimi</i><br><i>M. mycophagus</i>                                                            | 69<br>310                   |
| Nov. 23, 24, 25, 1998<br>Fort Abbas  | 22.47      | 71.45        | 120                   | 60              | 323                   | <i>O. obesus</i><br><i>M. obesi</i><br><i>M. mycophagus</i>                                        | 61<br>156<br>106            |
| Dec. 20, 21, 22, 1998<br>Chishtian   | 12.54      | 55.75        | 50                    | 15              | 300                   | <i>O. obesus</i><br><i>M. mycophagus</i><br><i>C. heimi</i><br><i>M. obesi</i><br><i>O. guptai</i> | 17<br>126<br>63<br>51<br>43 |
| Jan. 15, 16, 17, 1999<br>Chishtian   | 15.56      | 64.25        | 62                    | 17              | 795                   | <i>M. mycophagus</i><br><i>O. guptai</i>                                                           | 738<br>57                   |
| Feb. 17, 18, 19, 1999<br>Harunabad   | 22.41      | 68.24        | 50                    | 12              | 213                   | <i>M. obesi</i><br><i>M. mycophagus</i><br><i>C. heimi</i><br><i>A. bellai</i>                     | 57<br>65<br>52<br>39        |
| March 20, 21, 22, 1999<br>Fort Abbas | 26.61      | 59.54        | 100                   | 28              | 234                   | <i>C. heimi</i><br><i>M. obesi</i><br><i>M. mycophagus</i>                                         | 74<br>33<br>127             |

species and their number collected from trees in different months. Maximum number (795) of termites (*M. mycophagus* 738, *M. guptai*, 57) was collected in January 1999, but maximum number of foraging termite

species (N=5; *C. heimi*, *O. guptai*, *O. obesus*, *M. mycophagus* and *M. obesi*) were recorded in December 1998.

### DIVERSITY

Diversity of termites based on the basis of number of termites collected from 250 soil cores of different localities of district Bahawalnagar is shown in Table 3.

**Table 3:** Diversity index of number of individuals of six species of termites recovered from 250 soil cores.

| Name of species               | No. of termites | $P_i$     | Simpson's index $P_i^2 \times S$ | Shannon's index $P_i (\log P_i) \times S$ |
|-------------------------------|-----------------|-----------|----------------------------------|-------------------------------------------|
| <i>Coptotermes heimi</i>      | 595             | 0.39299   | 0.15444                          | 0.36704                                   |
| <i>Microtermes mycophagus</i> | 710             | 0.46895   | 0.21991                          | 0.35511                                   |
| <i>Odontotermes obesus</i>    | 89              | 0.058784  | 0.003455                         | 0.166587                                  |
| <i>Odontotermes guptai</i>    | 56              | 0.036988  | 0.001368                         | 0.12195                                   |
| <i>Microtermes obesi</i>      | 34              | 0.022457  | 0.0005043                        | 0.085250                                  |
| <i>Amitermes sp.</i>          | 30              | 0.0198150 | 0.000392634                      | 0.07770                                   |
|                               | 1514            | 0.999984  | D = 0.3800<br>1-D = 0.62         | H=1.1736                                  |

$$E=H/\log S = 1.1736/1.7917 = 0.65502$$

**Table 4:** Abundance of termites in District Bahawalnagar and atmospheric conditions (Termites from soil and trees are combined).

| Month          | Atmospheric conditions<br>Temperature (°C) |      | Humidity (%) | Total No. of termites | Total No. of species | Name of species      | No. of each species |
|----------------|--------------------------------------------|------|--------------|-----------------------|----------------------|----------------------|---------------------|
|                | Max.                                       | Min. |              |                       |                      |                      |                     |
| October, 1998  | 31.32                                      | 19.1 | 77.15        | 780                   | 2                    | <i>C. heimi</i>      | 470                 |
| November, 1998 | 22.47                                      | 12.7 | 71.45        | 537                   | 3                    | <i>M. mycophagus</i> | 310                 |
|                |                                            |      |              |                       |                      | <i>O. obesus</i>     | 150                 |
|                |                                            |      |              |                       |                      | <i>M. obesi</i>      | 169                 |
|                |                                            |      |              |                       |                      | <i>M. mycophagus</i> | 218                 |
| December, 1998 | 12.54                                      | 6.11 | 55.75        | 608                   | 6                    | <i>O. obesus</i>     | 17                  |
|                |                                            |      |              |                       |                      | <i>M. obesi</i>      | 51                  |
|                |                                            |      |              |                       |                      | <i>C. heimi</i>      | 63                  |
|                |                                            |      |              |                       |                      | <i>M. mycophagus</i> | 348                 |
|                |                                            |      |              |                       |                      | <i>O. guptai</i>     | 99                  |
|                |                                            |      |              |                       |                      | <i>Amitermes sp.</i> | 30                  |
|                |                                            |      |              |                       |                      | <i>M. mycophagus</i> | 1074                |
| January, 1999  | 15.56                                      | 5.2  | 64.25        | 1131                  | 2                    | <i>O. guptai</i>     | 57                  |
| February, 1999 | 22.41                                      | 10.4 | 68.24        | 359                   | 4                    | <i>C. heimi</i>      | 137                 |
|                |                                            |      |              |                       |                      | <i>M. obesi</i>      | 78                  |
|                |                                            |      |              |                       |                      | <i>M. mycophagus</i> | 105                 |
|                |                                            |      |              |                       |                      | <i>A. belli</i>      | 39                  |
| March, 1999    | 26.61                                      | 14.5 | 59.54        | 343                   | 3                    | <i>C. heimi</i>      | 217                 |
|                |                                            |      |              |                       |                      | <i>M. obesi</i>      | 33                  |
|                |                                            |      |              |                       |                      | <i>M. mycophagus</i> | 93                  |

Coefficient of correlation (r)

Atmospheric temperature versus population density = 0.4636;  $P > 0.05$

Relative humidity versus population density = 0.1155;  $P > 0.05$ .

Using Simpson's [1949] equation of C (index of dominance), a value of 0.3800 emerged for this community of termites in district Bahawalnagar. *Microtermes mycophagus*, with a value of 0.2199, was more dominant than other species. In general, termite diversity on the Simpson Scale

was 62% and on the Shannon Scale 65% (Table 3). The data regarding number of termites collected from soil cores and trees were also combined to work out diversity on monthly basis (Tables 4, 5). It made possible to compare evenness or apportionment of the individuals amongst species foraging during the collection session. Maximum diversity on Simpson Scale was recorded 70% in February and the minimum 47% in October.. Shannon Weiner function revealed the highest value of diversity for December ( $H=1.3058$ ). As regards apportionment of individuals amongst species, maximum value of Equitability (E) was recorded in November (0.9884) and the minimum in January (0.14640).

**Table 5:** Monthly variation in diversity indices for termites foraging in soil and on trees during collection session.

| Month & Name of the species | %age    | $P_i$    | $P_i^2 \times S$ | $P_i (\log_e P_i) \times S$ | Equitability |
|-----------------------------|---------|----------|------------------|-----------------------------|--------------|
| <b>1 October</b>            |         |          |                  |                             |              |
| <i>Coptotermes heimi</i>    | 60.256  | 0.60256  | 0.3630           | 0.3052                      | 0.9694       |
| <i>Microtermes</i>          | 39.743  | 0.39743  | 0.1579           | 0.36672                     |              |
| <i>mycophagus</i>           |         |          | D = 0.5209       | H = 0.6719                  |              |
|                             |         |          | 1-D = 0.4791     |                             |              |
| <b>2 November</b>           |         |          |                  |                             |              |
| <i>Odontotermes obesus</i>  | 27.9329 | 0.279329 | 0.07802          | 0.35623                     | 0.9884       |
| <i>Microtermes obesi</i>    | 31.471  | 0.31471  | 0.09903          | 0.36383                     |              |
| <i>Microtermes</i>          | 40.595  | 0.4059   | 0.1647           | 0.3659                      |              |
| <i>mycophagus</i>           |         |          | D = 0.34175      | H = 1.0859                  |              |
|                             |         |          | 1-D = 0.6582     |                             |              |
| <b>3 December</b>           |         |          |                  |                             |              |
| <i>Odontotermes obesus</i>  | 2.7960  | 0.027960 | 0.0007817        | 0.10000                     | 0.7288       |
| <i>Microtermes obesi</i>    | 8.3881  | 0.083881 | 0.00703          | 0.20788                     |              |
| <i>Coptotermes heimi</i>    | 10.3618 | 0.103618 | 0.010736         | 0.2348                      |              |
| <i>Microtermes</i>          | 57.2368 | 0.57236  | 0.32752          | 0.31939                     |              |
| <i>mycophagus</i>           | 16.2828 | 0.162828 | 0.02651          | 0.2955                      |              |
| <i>Odontotermes guptai</i>  | 4.9342  | 0.04934  | = 0.002434       | 0.14846                     |              |
| <i>Amitermes</i> sp.        |         |          | D = 0.3750117    | H = 1.3058                  |              |
|                             |         |          | 1-D = 0.62499    |                             |              |
| <b>4 January</b>            |         |          |                  |                             |              |
| <i>Microtermes</i>          | 94.9602 | 0.949602 | = 0.90174        | 0.04910                     | 0.14640      |
| <i>mycophagus</i>           | 5.0397  | 0.050397 | = 0.002539       | 0.15057                     |              |
| <i>Odontotermes guptai</i>  |         |          | D = 0.904279     | H = 0.19967                 |              |
|                             |         |          | 1-D = 0.0957     |                             |              |
| <b>5 February</b>           |         |          |                  |                             |              |
| <i>Coptotermes heimi</i>    | 38.1615 | 0.38161  | 0.14562          | 0.36760                     | 0.9377       |
| <i>Microtermes obesi</i>    | 59      | 0.217270 | 0.04717          | 0.33168                     |              |
| <i>Microtermes</i>          | 21.7270 | 0.29249  | 0.08555          | 0.35955                     |              |
| <i>mycophagus</i>           | 29.2479 | 0.108635 | 0.011801         | 0.241143                    |              |
| <i>Amitermes belli</i>      | 10.8635 |          | D=0.290141       | H = 1.29997                 |              |
|                             |         |          | 1-D = 0.7098     |                             |              |
| <b>6 March</b>              |         |          |                  |                             |              |
| <i>Coptotermes heimi</i>    | 63.2653 | 0.63265  | 0.40024          | 0.28962                     | 0.79075      |
| <i>Microtermes obesi</i>    | 9.62099 | 0.096209 | 0.00925617       | 0.22524                     |              |
| <i>Microtermes</i>          | 27.1137 | 0.271137 | 0.073515         | 0.35386                     |              |
| <i>mycophagus</i>           |         |          | D = 0.48301117   | H = 0.86872                 |              |
|                             |         |          | 1-D = 0.516988   |                             |              |

## DISCUSSION

Termites play an important role in the ecosystem and some species certainly improve the fertility of soil [Pearce 1997]. At the same time,

some species cause extensive damage to woodworks in buildings and agricultural crops in Pakistan and many other countries of the world (Sen-Sarma *et al.* 1975, Akhtar 1983, Akhtar and Shahid 1988, 1990].

Termite fauna in Pakistan is fairly well known and 50 species of termites have been recorded so far [Akhtar 1974]. Detailed studies about the abundance of different species of termites in different habitats have not been carried out. Akhtar and Shahid [1989] recorded four species of termites, *M. mycophagus*, *M. obesi*, *M. unicolor* and *E. paradoxalis*, in cotton fields in Multan. They reported that high population density of termites ( $148.2 \text{ m}^{-2}$ ) was recorded in October in cotton fields.

Akhtar and Sarwar [1997] reported four species of termites, i.e. *M. mycophagus*, *M. obesi*, *O. guptai* and *E. paradoxalis*, foraging in wheat crop, from Bahawalpur division. They reported that population density of termites during wheat-growing season varied from 113.25 to  $3437.0 \text{ m}^{-2}$ . Present studies involving soil cores from district Bahawal Nagar revealed that population density varied from 2.407 to  $124.44 \text{ m}^{-2}$ .

Species diversity tends to be low in physically controlled ecosystems and high in biologically controlled ecosystems [Owen 1971]. A convenient way to express and compare diversity is to calculate diversity indices based on the ratio of parts to the whole, or  $n_i/N$  where  $n_i$  is the number or other importance value (biomass, productivity, etc.) of each component (species, for example) and  $N$  is total of importance value [Odum 1975]. For data of Crossley and Bohnsack [1960] about the number of individuals of oribatid mites recovered from 21 samples of pine litter, Simpson and Shannon indices were 0.8142 and 0.682, respectively.

Data on diversity indices regarding abundance of termites for the 1st time was given by Akhtar and Sarwar in 1993, that termite diversity in wheat fields was 56% on Simpson scale and 67% on Shannon scale. Present studies about diversity of termites recovered by soil cores, revealed 62% diversity on Simpson scale and 65% on Shannon scale.

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