

Nagaland University Research Communication

Edited by

R. C. Gupta



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BOOKS

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Relative Abundance of Soil Dwelling Arthropods in Rice Ecosystem of Nagaland

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This chapter studies the soil surface dwelling arthropods of wetland rice ecosystem recorded at three selected locations of Nagaland between 2002–04. The locations are a lowland at Dimapur (260m MSL), foothill at Medziphema (310m MSL) and upland near Kohima (1070m MSL). Rice ecosystems consists of 4 classes with 11 orders and 21 families 4 classes with 9 orders and 17 families and 2 classes with 11 orders and 21 families respectively. The order *Collembola* was the most dominant group followed by *Hymenoptera* (*Formicidae*). At all the three selected locations *Podura aquatica* (*Collembola: Poduridae*) was recorded to be the most abundant. Besides, natural enemies, such as *Cicindella* sp. (*Cicindellidae*), *Coccinella septempunctata* (*Coccinellidae*), *Hyparpalus lividus* (*Carabidae*), *Pharopsophus occipitalis* (*Carabidae*), *Claenius hamifer* (*Carabidae*), *Lycosa* sp. (*Lycosidae*), *Pardosa* sp. (*Lycosidae*) and *Atrax* sp. (*Dipluridae*) were recorded, which needs to be attended.

Introduction

Nagaland, located in the north eastern region of India, covers an area of 16,579 sq. km. The climate ranges from sub-tropical to sub-temperate and temperate with an altitude which varies from 200m to 3840m above mean sea level.

Rice is the main crop of the state. Having all types of agro-climatic conditions with different topographic locations, three types such as *jhum* or shifting cultivation, wetland and terrace farming are practiced. So far, the state produces only 0.206 million tons of rice from an area of 0.146 ha with average productivity of 1.41 ton/ha indicating that the current rate of rice production is about 26.2 per cent less than the national average. One of the major reasons for the low production of rice is the pest problem associated with the crops.

Phylum arthropoda includes the largest number of pests of crops and animals. The presence of arthropod fauna is destructive on crops, animals, stored commodities and as a vector of diseases while some of them benefit humans in the form of parasitoids, predators, pollinators, producers of honey, silk and lac.

* A part of PhD thesis.

Diverse groups of arthropods are associated as pests but are beneficial with rice-ecosystem. For an efficient and sound pest management, identification of key pests and their natural enemies is most important. Considering the importance of arthropod fauna particularly in rice ecosystem as pests and at the same time their role as natural enemies to those pests, the present investigation was carried out to study their relative abundance at three locations of rice ecosystems of Nagaland during 2002–04.

Materials and methods

The experiment was conducted during 2002–04 under wetland rice farming system at three selected locations of Nagaland viz. lowland at Dimapur (260m MSL), foothill at Medziphema (310m MSL) and upland near Kohima (1070m MSL). Pitfall traps were employed to capture the soil surface arthropods. These traps were wide-mouthed transparent bottles having a length of 13 cm and a diameter of 5 cm. 15 such traps were kept randomly in three different fields buried below the soil with the mouth rim remaining at level of the soil surface. A cover was provided at a height of about 2 cm over the mouth of the traps to avoid rain and other unwanted particles. Five per cent formaldehyde solution was used in the container (trap bottle) to avoid decomposition of trapped specimens.

Observations on different arthropod fauna was recorded at fortnightly intervals from each trap by counting all individuals which were identified at least up to family level in the laboratory of Department of Entomology, SASRD, NU. On the basis of population density of different soil surface dwelling arthropods, their mean relative abundance was calculated with the formula suggested by Singh and Rai (2000).

$$R = \frac{a}{n} \times 100$$

Where

R = Relative abundance (%)

a = Number of individuals present on date of sampling

n = Total population of all species.

Results and discussion

The data on the mean relative abundance of soil surface arthropod fauna recorded during 2002–04 under wetland rice farming systems at three selected locations of different altitudes of Nagaland, viz. lowland, foothill and upland are presented in Tables 1, 2 and 3, respectively.

Table 1. *Mean relative abundance (%) of different soil surface dwelling arthropods in wetland rice ecosystem (Dimapur) during 2002–04

| | A. Insecta | Sampling Dates | | | | | | | | | | | |
|----|--|----------------|------|------|------|------|------|------|------|------|------|------|------|
| | | Sept | | Oct | | Nov | | Dec | | Jan | | Feb | |
| | | I | II | I | II | I | II | I | II | I | II | I | II |
| 1 | <i>Hyparpalus lividus</i> Coleoptera: Carabidae | 0.17 | 0.13 | 0.11 | 0.26 | 0.45 | 0.17 | 0.13 | 0.09 | 0.11 | 0.15 | 0.17 | 0.13 |
| 2 | Coleoptera: Scarabaeidae | 0.19 | 0.07 | 0.12 | 0.02 | 0.01 | 0 | 0.06 | 0.12 | 0.03 | 0.09 | 0.08 | 0.08 |
| 3 | <i>Coccinella septempunctata</i> Coleoptera: Coccinellidae | 0 | 0.01 | 0.02 | 0.01 | 0 | 0 | 0 | 0 | 0.01 | 0.01 | 0.01 | 0 |
| 4 | <i>Cicindela</i> sp, Coleoptera: Cicindellidae | 0.02 | 0.06 | 0.01 | 0.02 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | <i>Hydrophiles</i> sp, Coleoptera: Hydrophilidae | 0 | 0.01 | 0.03 | 0.04 | 0.02 | 0.02 | 0.04 | 0.05 | 0.04 | 0.01 | 0 | 0 |
| 6 | Hemiptera: Reduviidae | 0.03 | 0.03 | 0.09 | 0.03 | 0.01 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | Hymenoptera : Formicidae | 0.40 | 0.89 | 0.83 | 0.79 | 0.45 | 0.84 | 0.76 | 0.88 | 0.61 | 0.50 | 0.38 | 0.67 |
| 8 | <i>Ropalidia</i> sp, Hymenoptera : Vespidae | 0.13 | 0.04 | 0 | 0 | 0.02 | 0 | 0 | 0 | 0 | 0.01 | 0 | 0 |
| 9 | Orthoptera: Gryllidae | 0.14 | 0.25 | 0.37 | 0.19 | 0.40 | 0.60 | 0.53 | 0.36 | 0.28 | 0.32 | 0.36 | 0.35 |
| 10 | Orthoptera: Acrididae | 0 | 0 | 0 | 0 | 0 | 0.01 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | <i>Conocephalus longipennis</i> Orthoptera: Tettigonidae | 0.07 | 0.01 | 0 | 0 | 0 | 0.01 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | <i>Grylotalpa</i> sp, Orthoptera: Grylotalpidae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.02 | 0.01 | 0.01 | 0 |
| 13 | Dermaptera | 0.05 | 0.06 | 0.01 | 0 | 0.07 | 0 | 0 | 0.01 | 0 | 0 | 0.01 | 0.07 |
| 14 | <i>Macrotermes</i> sp, Isoptera: Termitidae | 0.10 | 0.01 | 0 | 0 | 0 | 0 | 0 | 0 | 0.07 | 0.07 | 0.09 | 0.07 |
| 15 | Dictyoptera: Blattidae | 0.07 | 0.02 | 0 | 0 | 0.08 | 0 | 0 | 0.01 | 0.01 | 0.02 | 0 | 0.07 |
| 16 | Lepidoptera (Larvae) | 0 | 0 | 0 | 0 | 0.02 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | <i>Podura aquatica</i> Collembola: Poduridae | 1.40 | 0.49 | 0.01 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | <i>Entomobrya</i> sp: Collembola: Entomobryidae | 0.21 | 0.07 | 0.09 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | <i>Isotoma</i> sp, Collembola: Isotomidae | 0.07 | 0.06 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | B. Diplopoda | 0.10 | 0.08 | 0.02 | 0 | 0.01 | 0.06 | 0.01 | 0.03 | 0.02 | 0.02 | 0.07 | 0.01 |
| 21 | C. Chilopoda | 0.04 | 0 | 0 | 0.01 | 0.01 | 0 | 0 | 0 | 0 | 0 | 0.01 | 0.01 |
| 22 | D. Arachnida | | | | | | | | | | | | |
| 23 | Acarina: Cryptostigmata | 0.06 | 0.04 | 0.02 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 24 | Acarina: Mesostigmata | 0.03 | 0.06 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 25 | Acarina: Prostigmata | 0.02 | 0.02 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 26 | <i>Lycosa</i> sp, Araneida: Lycosidae | 0.45 | 0.30 | 0.36 | 0.28 | 0.31 | 0.18 | 0.35 | 0.24 | 0.23 | 0.23 | 0.18 | 0.16 |
| 27 | <i>Pardosa</i> sp, Araneida: Lycosidae | 0.07 | 0.06 | 0 | 0.07 | 0.02 | 0.06 | 0.09 | 0.06 | 0.11 | 0.02 | 0.07 | 0.04 |

[Table 1. Contd.]

| A. Insecta | | Sampling Dates | | | | | | | | | | | | Total (%) |
|------------|--|----------------|------|-------|------|------|------|------|------|------|------|------|------|-----------|
| | | March | | April | | May | | June | | July | | Aug | | |
| | | I | II | I | II | I | II | I | II | I | II | I | II | |
| 1 | <i>Hyparpalus lividus</i> Coleoptera: Carabidae | 0.09 | 0.12 | 0.09 | 0.16 | 0.20 | 0.25 | 0.30 | 0.33 | 0.58 | 0.15 | 0.55 | 0.18 | 5.07 |
| 2 | Coleoptera: Scarabaeidae | 0.12 | 0.27 | 0.64 | 0.72 | 0.62 | 0.18 | 0.24 | 0.17 | 0.04 | 0 | 0.09 | 0.13 | 4.09 |
| 3 | <i>Coccinella septempunctata</i> Coleoptera: Coccinellidae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.01 | 0 | 0.01 | 0.09 |
| 4 | <i>Cicindela</i> sp, Coleoptera: Cicindellidae | 0.01 | 0.05 | 0.09 | 0.03 | 0.02 | 0.24 | 0.32 | 0.28 | 0.05 | 0.18 | 0.01 | 0.20 | 1.59 |
| 5 | <i>Hydrophilus</i> sp, Coleoptera: Hydrophilidae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.02 | 0.04 | 0.32 |
| 6 | Hemiptera: Reduviidae | 0 | 0 | 0 | 0 | 0 | 0 | 0.01 | 0.08 | 0.03 | 0.04 | 0.01 | 0 | 0.36 |
| 7 | Hymenoptera : Formicidae | 1.03 | 1.64 | 1.56 | 1.96 | 1.87 | 1.99 | 3.00 | 1.59 | 1.70 | 1.50 | 1.43 | 1.66 | 28.93 |
| 8 | <i>Ropalidia</i> sp, Hymenoptera : Vespidae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.02 | 0.05 | 0.27 |
| 9 | Orthoptera: Gryllidae | 0.28 | 0.45 | 0.60 | 0.81 | 0.59 | 0.62 | 1.23 | 0.60 | 0.42 | 0.35 | 0.43 | 0.64 | 11.17 |
| 10 | Orthoptera: Acrididae | 0 | 0 | 0 | 0.02 | 0.02 | 0 | 0 | 0.02 | 0 | 0 | 0.01 | 0.02 | 0.10 |
| 11 | <i>Conocephalus longipennis</i> Orthoptera: Tettigonidae | 0 | 0 | 0 | 0 | 0 | 0 | 0.01 | 0.01 | 0.01 | 0 | 0 | 0 | 0.12 |
| 12 | <i>Grylotalpa</i> sp, Orthoptera: Grylotalpidae | 0.01 | 0.03 | 0 | 0 | 0.01 | 0.01 | 0 | 0 | 0 | 0 | 0 | 0 | 0.10 |
| 13 | Dermaptera | 0 | 0.05 | 0.08 | 0.03 | 0.02 | 0.01 | 0.01 | 0 | 0.02 | 0.02 | 0.03 | 0.02 | 0.57 |
| 14 | <i>Macrotermes</i> sp, Isoptera: Termitidae | 0.09 | 0.04 | 0.07 | 0.06 | 0.06 | 0.03 | 0.02 | 0.02 | 0.02 | 0.04 | 0.01 | 0.03 | 0.90 |
| 15 | Dictyoptera: Blattidae | 0 | 0.03 | 0.01 | 0.01 | 0.02 | 0.01 | 0.03 | 0 | 0 | 0.04 | 0.01 | 0.04 | 0.48 |
| 16 | Lepidoptera (Larvae) | 0 | 0 | 0 | 0.03 | 0.03 | 0.02 | 0.03 | 0.02 | 0 | 0.01 | 0 | 0 | 0.16 |
| 17 | <i>Podura aquatica</i> Collembola: Poduridae | 0 | 0.96 | 5.81 | 6.08 | 7.22 | 1.22 | 1.97 | 1.10 | 1.52 | 1.18 | 1.06 | 1.37 | 31.39 |
| 18 | <i>Entomobrya</i> sp: Collembola: Entomobryidae | 0 | 0 | 0.18 | 0.19 | 0.20 | 0.23 | 0.01 | 0.10 | 0.09 | 0.08 | 0.06 | 0 | 1.51 |
| 19 | <i>Isotoma</i> sp, Collembola: Isotomidae | 0 | 0 | 0 | 0.04 | 0.01 | 0.03 | 0.05 | 0.01 | 0.13 | 0.08 | 0 | 0.01 | 0.49 |
| 20 | B. Diplopoda | 0.04 | 0.08 | 0.03 | 0.08 | 0.04 | 0.02 | 0.02 | 0.03 | 0.07 | 0.01 | 0.02 | 0.01 | 0.88 |
| 21 | C. Chilopoda | 0 | 0.01 | 0 | 0 | 0 | 0.02 | 0.04 | 0.01 | 0.03 | 0.11 | 0.01 | 0 | 0.31 |
| | D. Arachnida | | | | | | | | | | | | | |
| 22 | Acarina: Cryptostigmata | 0 | 0 | 0 | 0 | 0 | 0.08 | 0.09 | 0.12 | 0.20 | 0.10 | 0.12 | 0.12 | 0.95 |
| 23 | Acarina: Mesostigmata | 0 | 0 | 0.02 | 0.04 | 0.06 | 0.06 | 0.13 | 0.12 | 0.09 | 0.11 | 0.14 | 0.14 | 1.00 |
| 24 | Acarina: Prostigmata | 0 | 0 | 0 | 0.04 | 0.02 | 0.06 | 0.10 | 0.08 | 0.04 | 0.02 | 0.07 | 0.04 | 0.51 |
| 25 | <i>Lycosa</i> sp, Araneida: Lycosidae | 0.24 | 0.21 | 0.61 | 0.41 | 0.29 | 0.41 | 0.48 | 0.27 | 0.29 | 0.19 | 0.42 | 0.40 | 7.49 |
| 26 | <i>Pardosa</i> sp, Araneida: Lycosidae | 0.06 | 0.02 | 0.04 | 0.06 | 0.06 | 0.06 | 0.04 | 0.04 | 0 | 0 | 0.03 | 0.07 | 1.15 |
| | | | | | | | | | | | | | | 100 |

* Mean value of 15 pitfall traps

Table 2. *Mean relative abundance (%) of different soil surface dwelling arthropods in wetland rice ecosystem (Medziphema) during 2002–04

| | A. Insecta | Sampling Dates | | | | | | | | | | | |
|----|--|----------------|------|------|------|------|------|------|------|------|------|------|------|
| | | Sept | | Oct | | Nov | | Dec | | Jan | | Feb | |
| | | I | II | I | II | I | II | I | II | I | II | I | II |
| 1 | <i>Hyarpalus lividus</i> , Coleoptera: Carabidae | 0.21 | 0.20 | 0.08 | 0.10 | 0.11 | 0.11 | 0.04 | 0.05 | 0.05 | 0.03 | 0.06 | 0.05 |
| 2 | Coleoptera: Scarabaeidae | 0.08 | 0 | 0.02 | 0.08 | 0.10 | 0.06 | 0 | 0.04 | 0 | 0 | 0 | 0.12 |
| 3 | <i>Cicindella</i> sp, Coleptera:Cicindellidae | 0.02 | 0 | 0.01 | 0 | 0 | 0 | 0 | 0.24 | 0 | 0 | 0 | 0 |
| 4 | Hymenoptera: Formicidae | 1.44 | 0.76 | 1.81 | 0.78 | 0.66 | 0.30 | 0.44 | 0.20 | 0.46 | 0.50 | 0.74 | 1.04 |
| 5 | <i>Ropalidia</i> sp, Hymenoptera: Vespidae | 0 | 0 | 0.01 | 0 | 0 | 0 | 0 | 0.06 | 0 | 0 | 0 | 0 |
| 6 | Orthoptera: Gryllidae | 0.32 | 0.22 | 0.30 | 0.24 | 0.32 | 0.32 | 0.16 | 0.18 | 0.66 | 0.26 | 0.22 | 0.40 |
| 7 | Orthoptera: Acrididae | 0 | 0.08 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | Dictyoptera: Blattidae | 0 | 0.01 | 0.01 | 0 | 0.06 | 0 | 0 | 0 | 0 | 0 | 0 | 0.02 |
| 9 | Dermaptera | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.06 | 0 | 0 | 0 | 0 |
| 10 | <i>Macrotermes</i> sp, Isoptera: Termitidae | 0 | 0 | 0 | 0 | 0.02 | 0 | 0.14 | 0.02 | 0.02 | 0 | 0 | 0 |
| 11 | <i>Podura aquatica</i> : Collembola: Poduridae | 0.68 | 0.30 | 0.20 | 0.28 | 0.14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | <i>Entomobrya</i> sp: Collembola: Entomobryidae | 0.02 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | <i>Isotoma</i> sp, Collembola: Isotomidae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | B. Diplopoda | 0.06 | 0 | 0.01 | 0.01 | 0 | 0 | 0 | 0 | 0 | 0.14 | 0 | 0.02 |
| 15 | C. Chilopoda D. Arachnida | 0.02 | 0 | 0.02 | 0 | 0 | 0 | 0.02 | 0 | 0 | 0 | 0 | 0 |
| 16 | Acarina:Cryptostigmata | 0.10 | 0.02 | 0.04 | 0.01 | 0 | 0 | 0 | 0.04 | 0 | 0 | 0 | 0 |
| 17 | Acarina: Mesostigmata | 0.10 | 0.06 | 0 | 0.04 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | Acarina:Prostigmata | 0.04 | 0.02 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | <i>Lycosa</i> sp, Araneida: Lycosidae | 0.22 | 0.20 | 0.26 | 0.18 | 0.22 | 0.16 | 0.14 | 0.14 | 0.12 | 0.16 | 0.22 | 0.26 |
| 20 | <i>Pardosa</i> sp, Araneida: Lycosidae | 0.01 | 0 | 0.04 | 0 | 0 | 0.02 | 0.02 | 0.04 | 0.04 | 0.04 | 0.02 | 0.05 |
| 21 | <i>Atrax</i> sp, Araneida: Dipluridae | 0 | 0 | 0.02 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

[Table 2. Contd.

| A. Insecta | | Sampling Dates | | | | | | | | | | | | Total (%) |
|------------|--|----------------|------|-------|------|-------|------|------|------|------|------|------|------|--------------|
| | | March | | April | | May | | June | | July | | Aug | | |
| | | I | II | I | II | I | II | I | II | I | II | I | II | |
| 1 | <i>Hyparpalus lividus</i> , Coleoptera: Carabidae | 0.10 | 0.06 | 0.07 | 0.08 | 0.13 | 0.05 | 0.03 | 0.08 | 0.11 | 0.26 | 0.36 | 0.21 | 2.63 |
| 2 | Coleoptera: Scarabaeidae | 0.32 | 0.24 | 0.24 | 0.26 | 0.32 | 0.10 | 0.28 | 0.50 | 0.50 | 0.54 | 0.40 | 0.18 | 4.38 |
| 3 | <i>Cicindella</i> sp, Coleoptera:Cicindellidae | 0 | 0 | 0 | 0 | 0.03 | 0 | 0.04 | 0 | 0 | 0.06 | 0.06 | 0.06 | 0.52 |
| 4 | Hymenoptera: Formicidae | 1.52 | 1.60 | 1.76 | 2.33 | 1.16 | 1.22 | 1.56 | 1.26 | 1.70 | 1.42 | 1.72 | 2.14 | 28.52 |
| 5 | <i>Ropalidia</i> sp, Hymenoptera: Vespidae | 0 | 0 | 0.06 | 0 | 0 | 0 | 0.01 | 0 | 0.06 | 0 | 0 | 0 | 0.20 |
| 6 | Orthoptera: Gryllidae | 0.42 | 0.50 | 0.52 | 0.44 | 0.30 | 0.26 | 0.40 | 0.46 | 0.46 | 0.40 | 0.42 | 0.40 | 8.58 |
| 7 | Orthoptera: Acrididae | 0 | 0 | 0 | 0 | 0 | 0.06 | 0 | 0.03 | 0.06 | 0 | 0.01 | 0.02 | 0.26 |
| 8 | Dictyoptera: Blattidae | 0.10 | 0 | 0.04 | 0.06 | 0.04 | 0 | 0.06 | 0.08 | 0.06 | 0.04 | 0.04 | 0.06 | 0.68 |
| 9 | Dermaptera | 0 | 0 | 0 | 0.04 | 0 | 0 | 0.02 | 0.04 | 0.03 | 0.04 | 0.01 | 0 | 0.24 |
| 10 | <i>Macrotermes</i> sp, Isoptera: Termitidae | 0 | 0.06 | 0.01 | 0.08 | 0.04 | 0.03 | 0 | 0.04 | 0.10 | 0 | 0 | 0 | 0.56 |
| 11 | <i>Podura aquatica</i> : Collembola: Poduridae | 1.60 | 2.56 | 4.38 | 6.41 | 10.04 | 2.60 | 3.72 | 2.80 | 2.72 | 1.40 | 0.76 | 0.86 | 41.45 |
| 12 | <i>Entomobrya</i> sp: Collembola: Entomobryidae | 0 | 0.02 | 0.04 | 0.04 | 0.08 | 0.10 | 0.10 | 0.10 | 0.10 | 0.06 | 0.08 | 0.04 | 0.78 |
| 13 | <i>Isotoma</i> sp, Collembola: Isotomidae | 0 | 0 | 0.04 | 0.02 | 0.04 | 0.04 | 0.02 | 0.06 | 0.06 | 0.06 | 0.06 | 0 | 0.40 |
| 14 | B. Diplopoda | 0 | 0.06 | 0.02 | 0.02 | 0.01 | 0.02 | 0.10 | 0.06 | 0.08 | 0 | 0.04 | 0.01 | 0.66 |
| 15 | C. Chilopoda D. Arachnida | 0 | 0 | 0 | 0 | 0 | 0.02 | 0.04 | 0.06 | 0.02 | 0.01 | 0.01 | 0.04 | 0.26 |
| 16 | Acarina:Cryptostigmata | 0 | 0 | 0.03 | 0 | 0.04 | 0.08 | 0.08 | 0.14 | 0.18 | 0.20 | 0.12 | 0.20 | 1.28 |
| 17 | Acarina: Mesostigmata | 0 | 0.02 | 0.06 | 0.02 | 0.10 | 0.08 | 0.10 | 0.12 | 0.10 | 0.08 | 0.08 | 0.12 | 1.08 |
| 18 | Acarina:Prostigmata | 0.02 | 0.02 | 0 | 0.04 | 0.06 | 0.04 | 0.06 | 0.06 | 0.08 | 0.10 | 0.08 | 0.08 | 0.70 |
| 19 | <i>Lycosa</i> sp, Araneida: Lycosidae | 0.30 | 0.24 | 0.32 | 0.34 | 0.26 | 0.22 | 0.46 | 0.34 | 0.32 | 0.38 | 0.34 | 0.28 | 6.08 |
| 20 | <i>Pardosa</i> sp, Araneida: Lycosidae | 0.02 | 0 | 0.02 | 0.06 | 0.14 | 0.04 | 0.06 | 0 | 0 | 0.04 | 0.02 | 0 | 0.68 |
| 21 | <i>Atrax</i> sp,Araneida: Dipluridae | 0 | 0 | 0 | 0 | 0 | 0.02 | 0 | 0 | 0 | 0 | 0 | 0.02 | 0.06 |
| | | | | | | | | | | | | | | 100 |

* Mean value of 15 pitfall traps.

Table 3. *Mean relative abundance (%) of different soil surface dwelling arthropods in wetland rice ecosystem (Kohima) during 2002–04

| A. Insecta | Sampling Dates | | | | | | | | | | | | |
|--------------|---|------|------|------|------|------|------|------|------|------|------|------|------|
| | Sept | | Oct | | Nov | | Dec | | Jan | | Feb | | |
| | I | II | I | II | I | II | I | II | I | II | I | II | |
| 1 | <i>Pheropsophus occipitalis</i> , Coleoptera: Carabidae | 0.10 | 0.12 | 0.10 | 0.06 | 0.10 | 0.05 | 0.05 | 0 | 0 | 0 | 0 | 0.01 |
| 2 | <i>Claenius hamifer</i> , Coleoptera: Carabidae | 0.06 | 0.08 | 0.05 | 0.09 | 0.09 | 0.05 | 0.05 | 0.02 | 0 | 0 | 0 | 0 |
| 3 | <i>Hyparpalus lividus</i> , Coleoptera: Carabidae | 0.09 | 0.12 | 0.09 | 0.09 | 0.10 | 0 | 0.06 | 0 | 0 | 0.06 | 0.06 | 0.04 |
| 4 | <i>Epicauta mannerheimi</i> , Coleoptera: Meloidae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | <i>Onthophagus vaulogeri</i> , Coleoptera: Scarabaeidae | 0.02 | 0 | 0.03 | 0.01 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | <i>Cicindella</i> sp, Coleoptera: Cicindellidae | 0.02 | 0.01 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | Orthoptera: Gryllidae | 0.50 | 0.37 | 0.09 | 0.44 | 0.20 | 0.15 | 0.04 | 0.19 | 0.04 | 0.04 | 0.02 | 0.02 |
| 8 | <i>Gryllotalpa</i> sp, Orthoptera: Gryllotalpidae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | Orthoptera: Acrididae | 0.01 | 0 | 0.01 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | <i>Musca domestica</i> , Diptera: Muscidae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.02 |
| 11 | Lepidoptera (Larvae) | 0.01 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | Hymenoptera: Formicidae | 5.15 | 5.78 | 2.21 | 2.83 | 1.65 | 1.24 | 0.84 | 0.59 | 0.32 | 0.28 | 0.09 | 0.25 |
| 13 | <i>Nepa</i> sp, Hemiptera: Nepidae | 0.01 | 0.02 | 0.05 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | Hemiptera: Pentatomidae | 0.01 | 0.01 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | <i>Forcipula</i> sp, Demaptera: Labiduridae | 0.02 | 0.03 | 0.01 | 0 | 0.01 | 0.01 | 0.02 | 0 | 0.05 | 0.01 | 0 | 0.01 |
| 16 | <i>Carcinophora</i> spp, Dermaptera: Carcinophoridae | 0.02 | 0.02 | 0.03 | 0.03 | 0.01 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | Dictyoptera: Blattidae | 0.08 | 0.02 | 0.05 | 0.05 | 0.08 | 0.02 | 0.02 | 0.04 | 0.03 | 0.02 | 0.02 | 0.05 |
| 18 | <i>Macrotermes</i> spp, Isoptera; Termitidae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | <i>Podura aquatica</i> , Collembola: Poduridae | 0.07 | 0.49 | 0.46 | 0.50 | 0.32 | 0.25 | 0.14 | 0.13 | 0.12 | 0.10 | 0.08 | 0.17 |
| 20 | <i>Entomobrya</i> sp, Collembola: Entomobryidae | 0.10 | 0.10 | 0.04 | 0.01 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21 | <i>Opilones</i> op, Collembola: Leiobunidae | 0.04 | 0.03 | 0.02 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| B. Arachinda | | | | | | | | | | | | | |
| 22 | Acarina: Mesostigmata | 0.09 | 0.04 | 0.06 | 0.01 | 0.01 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23 | Acarina: Trombidiiidae | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 24 | <i>Lycosa</i> sp, Araneida: Lycosidae | 0.45 | 0.28 | 0.21 | 0.13 | 0.08 | 0.08 | 0.05 | 0.07 | 0.01 | 0.05 | 0.03 | 0.04 |

[Table 3. Contd.]

| A. Insecta | Sampling Dates | | | | | | | | | | | | | |
|--------------|--|------|-------|------|------|------|------|------|------|------|------|------|-------|--|
| | March | | April | | May | | June | | July | | Aug | | Total | |
| | I | II | I | II | I | II | I | II | I | II | I | II | (%) | |
| 1 | <i>Pheropsophus occipitalis</i> , Coleoptera: Carabidae | | | | | | | | | | | | | |
| | 0.02 | 0.07 | 0.08 | 0.09 | 0.07 | 0.08 | 0.10 | 0.12 | 0.09 | 0.19 | 0.16 | 0.16 | 1.82 | |
| 2 | <i>Claenius hamifer</i> , Coleoptera: Carabidae | | | | | | | | | | | | | |
| | 0 | 0.02 | 0.03 | 0.04 | 0.05 | 0.08 | 0.02 | 0.07 | 0.07 | 0.09 | 0.06 | 0.19 | 1.21 | |
| 3 | <i>Hyparpalus lividus</i> , Coleoptera: Carabidae | | | | | | | | | | | | | |
| | 0.08 | 0.10 | 0.03 | 0.08 | 0.16 | 0.11 | 0.23 | 0.29 | 0.32 | 0.11 | 0.11 | 0.10 | 2.43 | |
| 4 | <i>Epicauta mannerheimi</i> , Coleoptera: Meloidae | | | | | | | | | | | | | |
| | 0 | 0 | 0.02 | 0.04 | 0.01 | 0.04 | 0.02 | 0.02 | 0.02 | 0 | 0 | 0 | 0.17 | |
| 5 | <i>Onthophagus vauloegeri</i> , Coleoptera: Scarabaeidae | | | | | | | | | | | | | |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.01 | 0 | 0.15 | 0 | 0.02 | 0.24 | |
| 6 | <i>Cicindella</i> sp, Coleoptera: Cicindellidae | | | | | | | | | | | | | |
| | 0 | 0 | 0 | 0.01 | 0 | 0 | 0.03 | 0 | 0.01 | 0.05 | 0.03 | 0.05 | 0.21 | |
| 7 | Orthoptera: Gryllidae | | | | | | | | | | | | | |
| | 0.08 | 0.08 | 0.20 | 0.07 | 0.39 | 0.34 | 0.26 | 0.34 | 0.21 | 0.23 | 0.32 | 0.19 | 4.81 | |
| 8 | <i>Gryllotalpa</i> sp, Orthoptera: Gryllotalpidae | | | | | | | | | | | | | |
| | 0 | 0 | 0.01 | 0.01 | 0.02 | 0 | 0.17 | 0.03 | 0 | 0.01 | 0 | 0 | 0.25 | |
| 9 | Orthoptera: Acrididae | | | | | | | | | | | | | |
| | 0 | 0 | 0.01 | 0.01 | 0.02 | 0 | 0 | 0.03 | 0.02 | 0 | 0.02 | 0.02 | 0.15 | |
| 10 | <i>Musca domestica</i> , Diptera: Muscidae | | | | | | | | | | | | | |
| | 0.02 | 0.03 | 0.06 | 0.08 | 0.04 | 0.09 | 0.02 | 0.02 | 0.01 | 0 | 0 | 0 | 0.39 | |
| 11 | Lepidoptera (Larvae) | | | | | | | | | | | | | |
| | 0.04 | 0.09 | 0.13 | 0.22 | 0.20 | 0.04 | 0.04 | 0.05 | 0.02 | 0 | 0 | 0 | 0.84 | |
| 12 | Hymenoptera: Formicidae | | | | | | | | | | | | | |
| | 0.44 | 0.96 | 0.54 | 1.03 | 0.70 | 1.81 | 1.65 | 1.78 | 1.81 | 2.01 | 1.76 | 3.02 | 38.74 | |
| 13 | <i>Nepa</i> sp, Hemiptera: Nepidae | | | | | | | | | | | | | |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0.02 | 0.06 | 0 | 0.06 | 0.01 | 0.07 | 0.30 | |
| 14 | Hemiptera: Pentatomidae | | | | | | | | | | | | | |
| | 0 | 0.01 | 0.01 | 0.02 | 0.01 | 0 | 0.01 | 0 | 0.01 | 0 | 0 | 0.01 | 0.10 | |
| 15 | <i>Forcipula</i> sp, Dermaptera: Labiduridae | | | | | | | | | | | | | |
| | 0.01 | 0.02 | 0.02 | 0.01 | 0.01 | 0 | 0.01 | 0.01 | 0 | 0 | 0 | 0.02 | 0.28 | |
| 16 | <i>Carcinophora</i> spp, Dermaptera: Carcinophoridae | | | | | | | | | | | | | |
| | 0.02 | 0 | 0.02 | 0.04 | 0.01 | 0.05 | 0 | 0.03 | 0.01 | 0.04 | 0.02 | 0 | 0.35 | |
| 17 | Diptera: Blattidae | | | | | | | | | | | | | |
| | 0.02 | 0.08 | 0.01 | 0 | 0.01 | 0.03 | 0.01 | 0.03 | 0.03 | 0.07 | 0.07 | 0.08 | 0.92 | |
| 18 | <i>Macrotermes</i> spp, Isoptera; Termitidae | | | | | | | | | | | | | |
| | 0.10 | 0.09 | 0.03 | 0.08 | 0 | 0 | 0 | 0 | 0.01 | 0 | 0 | 0.15 | 0.46 | |
| 19 | <i>Podura aquatica</i> , Collembola: Poduridae | | | | | | | | | | | | | |
| | 0.32 | 1.41 | 1.83 | 1.78 | 6.02 | 8.46 | 3.85 | 4.02 | 5.36 | 1.75 | 1.19 | 0.88 | 39.70 | |
| 20 | <i>Entomobrya</i> sp, Collembola: Entomobryidae | | | | | | | | | | | | | |
| | 0 | 0 | 0.08 | 0.06 | 0.08 | 0.05 | 0.10 | 0.11 | 0.10 | 0.07 | 0.08 | 0.03 | 1.01 | |
| 21 | <i>Opilones</i> sp, Collembola: Leiobunidae | | | | | | | | | | | | | |
| | 0 | 0.03 | 0.03 | 0 | 0.04 | 0.03 | 0.08 | 0.02 | 0.04 | 0.02 | 0.05 | 0.04 | 0.47 | |
| B. Arachnida | | | | | | | | | | | | | | |
| 22 | Acarina: Mesostigmata | | | | | | | | | | | | | |
| | 0.01 | 0.10 | 0.04 | 0.12 | 0.05 | 0.14 | 0.11 | 0.15 | 0.14 | 0.07 | 0.10 | 0.05 | 1.29 | |
| 23 | Acarina: Trombididae | | | | | | | | | | | | | |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0.02 | 0 | 0 | 0 | 0 | 0.02 | 0.04 | |
| 24 | <i>Lycosa</i> sp, Araneida: Lycosidae | | | | | | | | | | | | | |
| | 0.03 | 0.04 | 0.32 | 0.26 | 0.31 | 0.30 | 0.10 | 0.19 | 0.19 | 0.08 | 0.26 | 0.26 | 3.82 | |

* Mean value of 15 pitfall traps

Lowland rice ecosystem

An overall observation on the composition of soil surface dwelling arthropod fauna in lowland rice ecosystem consists of four classes, 11 orders and 21 families. Order Coleoptera was represented by four known species under five families. *Hyparpalus lividus*, Carabidae was found with a maximum mean relative abundance of 5.07 per cent followed by family Scarabaeidae (4.09 per cent); *Cicindella* sp, Cicindellidae (1.59 per cent) and *Coccinella septempunctata*, Coccinellidae (0.09 per cent). Hemiptera was represented by only two families, viz. Hydrophilidae and Reduviidae which accounts for a relative abundance of 0.32 per cent and 0.36 per cent, respectively. Order Hymenoptera comprised of Formicidae and Vespidae (*Ropalidia* sp), the former being most dominant with a relative abundance of 28.93 per cent. Under Orthoptera, four families, viz. Gryllidae, Acrididae, Tettigonidae and Gryllotalpidae were recorded where Gryllidae was caught abundantly throughout the year with a mean relative abundance of 11.17 per cent. Earwig was recorded with an abundance of 0.57 per cent. Adult termite (Termitidae) were also found throughout the period but recorded nil from October to December. The family Blattidae (Dictyoptera) and Lepidopteran larvae were also observed with negligible number during the period of investigation. Order of Collembola was represented by three families, viz. Poduridae, Entomobryidae and Isotomidae where Poduridae accounts a maximum abundance of 31.39 per cent of all the arthropods. During the study period the presence of Collembola was recorded nil during November–February. Diplopoda was recorded throughout the period with an abundance of 0.88 per cent whereas Chilopoda accounts an abundance of 0.31 per cent.

The class Arachnida constitutes mites and spiders. Mites were completely nil during October–March but the presence of spiders were recorded in good number throughout the year. Spiders comprise of two species, viz. *Lycosa* sp and *Pardosa* sp under family Lycosidae with a relative abundance of 7.49 per cent and 1.15 per cent, respectively.

Foothill rice ecosystem

Similar trends of arthropod fauna were recorded from foothill rice ecosystem (Table 2) consisting of 4 classes, 9 orders and 17 families. Under class Insecta, the most dominant order recorded was Collembola followed by Hymenoptera, Orthoptera, Coleoptera, Dictyoptera, Isoptera and Dermaptera. The species *Podura aquatica* (Collembola: Poduridae) was recorded to be present with a maximum relative abundance of 41.45 per cent followed by Formicidae (Hymenoptera) with 28.52 per cent mean abundance and Gryllidae (Orthoptera) with 8.58 per cent mean abundance.

Class Diplopoda and Chilopoda were also recorded in negligible number with a mean relative abundance of 0.66 per cent and 0.26 per cent, respectively.

The arthropod fauna under class Arachnida were represented by mites (Acarina) and spiders, (Araneida). Three sub-order of Acarina viz. Cryptostigmata, Mesostigmata and Prostigmata with a mean relative abundance of 1.28 per cent, 1.08 per cent and 0.70 per cent respectively, were recorded. The spider fauna were represented by 3 species viz. *Lycosa* sp, *Pardosa* sp, and *Atrax* sp with a mean relative abundance of 6.08 per cent, 0.68 per cent and 0.06 per cent, respectively.

Upland rice ecosystem

The soil surface dwelling Arthropods collected from upland rice ecosystem composed of 11 orders and 21 families under 2 classes. Under class Insecta, the most dominant order recorded was Collembola (41.18 per cent) followed by Hymenoptera (38.74 per cent), Coleoptera (6.08 per cent), Orthoptera (5.21 per cent), Dictyoptera (0.92 per cent), Lepidoptera (0.84 per cent), Dermaptera (0.63 per cent), Isoptera (0.46 per cent), Hemiptera (0.40 per cent) and Diptera (0.39 per cent).

The order Coleoptera was represented by six species, viz. *Pharopsophus occipitalis*, *Claenius hamifer*, *Hyparpalus lividus* (Carabidae); *Epicauta mannerheimi* (Meloidae); *Onthophagus vaulogeri* (Scarabaeidae) and *Cicindella* sp. (Cicindellidae) from which *Hyparpalus lividus* was the most dominant (2.43 per cent) and *E. mannerheimi* was least dominant (0.17 per cent).

Order Orthoptera composed of three families (Gryllidae, Gryllotalpidae and Acrididae) while Diptera was represented by only one family, i.e., Muscidae (*Musca domestica*). The family Gryllidae was recorded throughout the year with a mean relative abundance of 4.81 per cent. Hymenopterans under family Formicidae were collected in good numbers throughout the year of study with a mean of 38.74 per cent abundance while the order Hemiptera was represented by family Nepidae and Pentatomidae with less number. Two species of Earwig, *Forcipula* sp (Labiduvidae) and *Carcinophora* sp (Carcinophoridae) were also recorded in less number with a mean of 0.28 per cent and 0.35 per cent abundance, respectively. Order Collembola was represented by three species viz. *Podura aquatica* (Poduridae) *Entomobrya* sp. (Entomobryidae) and *Opilonas* sp. (Leibunidae) where *P aquatica* was the most dominant species (39.70 per cent).

Under class Arachnida, mites (Acarina) and spider (Araneida) were also recorded during the investigations; sub-order Mesostigmata and family Trombididae accounts 1.29 per cent and 0.04 per cent mean abundance, respectively. The spider *Lycosa* sp (Lycosidae) was recorded throughout the year with a mean abundance of 3.82 per cent.

The present findings on arthropod fauna in the three different rice ecosystems corroborate the findings of Reddy and Alemla (1995), Nashriyah *et al.* (1998), Khan and Mishra (2003) and Singh and Singh (2005).

This study strongly suggests the presence of diverse range of arthropods in the rice ecosystems of Nagaland which may be of great value both as pests and as natural enemies. Therefore, greater emphasis is required for proper identification of major and minor pests and on the naturally occurring bio-agents, so that a sustainable pest management can be brought out by conserving and augmenting the available bio-agents under natural condition and their role in regulating the pest population.

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