STUDIES ON SEASONAL VARIATIONS IN THE DIVERSITY PATTERN OF SOIL ARTHROPODS IN RUBBER PLANTATIONS - CENTRAL TRAVANCORE AREA

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Abstract- The diversity of soil arthropod fauna inhabiting in rubber plantations at Central Travancore area of South Kerala regions were studied. The soil arthropods were collected during the year 2014. Soil samples were periodically and regularly collected from 10 different sites of rubber plantation. At each station, soil samples were collected between the hours of 8 am to 10 am. 17 orders of soil arthropod were collected and extracted using Berlesse tullgren funnel. Arthropods were collected, using 70% alcohol. The obtained soil arthropods belonging to order Isopoda, Diplopoda, Pauropoda, Chilopoda, Symphyla, Araneida, Acari, Chelonethi, Collembola, Protura, Diplura, Hymenoptera, Isoptera, Psocoptera, Diptera, Coleoptera, Dermaptera and Psocoptera. Seasonal variations of soil arthropod fauna in rubber plantations were studied. Data collected from the rubber plantation sites were subjected to appropriate statistical analysis. Shannon Weiner Diversity, Simpson’s dominant index, Berger parker dominance, Hill’s abundance, Mergaleff richness and McIntosh territorial indices were calculated. The order Collembola, Acari, Hymenoptera, Diplopoda, Isopoda were the dominant and abundant groups in all rubber plantation study sites. Diversity of soil arthropod population in each season was similar among all of the study sites. In all the sites, maximum diversity, richness, dominance, abundance and evenness were noted in monsoon and post monsoon seasons, while the minimum was during the summer season. Seasonality exerted a strong effect on the abundance and diversity of rubber plantation arthropods.

Index Terms- Soil arthropods, Diversity, Berlesse tullgren funnel, Rubber plantation, Isopoda, Collembola

I INTRODUCTION
Biodiversity is the key factor of the structure and function of ecosystems (Lee, 1991 and Wall et al., 2005). Soil is an extremely dynamic, complex and highly heterogeneous system that allows the development of large number of ecological habitats, home of an array of live organisms and performs important functions for the ecosystem (Gardi and Jeffery, 2009). Soil creates a favorable habitat for micro organisms and it is inhabited by a wide range of them namely, algae, fungi, bacteria, arthropods and protozoa (Koehler 1992). Soil organisms range from microscopic forms to the macroscopic forms (Franke, 2003). Arthropods are the most diverse group of animals on earth and functional component of the major soil food web, such as soil accumulation of organic matter, soil structure and nutrient cycling also encouraging plant root development (Basset et al., 2003; Gardi and Jeffery 2009).

II METHODOLOGY
a) Study area:
The study was conducted in ten rubber plantation sites at Central Travancore area of South Kerala state during the year of 2014.

b) Sampling sites:
Ten study sites were selected in random from the study area for soil and soil arthropod sampling.

c) Collection, extraction, sorting and preservation:
Soil samples were collected from 10 rubber plantation sites. Soil samples of 5×5 cm² area, from a depth of 5 cm randomly collected with soil auger. Soil samples were collected in all seasons this was carried out between the hours of 8.00 am to 10.00 am in the morning. Soil samples were placed in a labelled polythene covers and taken to the laboratory.

Collected soil samples placed into a 15×25 cm tray and hand sorted to collect large soil microarthropods. Remaining soil samples were transferred to the Berlese Tullgren funnel for soil arthropods extraction. Berlese Tullgren Funnel extractor is the best extraction method for extracting soil arthropods (Hopkins, 1970; Frith and Frith, 1990; Iloba and Ekrakene, 2008). The soil micro arthropods were extracted overnight into a picric acid.

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Hill’s abundance, showed values between 60.01-64.23. Margaleff richness index showed value 7.1 representing moderate diversity of soil arthropods in all sites. McIntosh eveness index was used for describing the distribution of soil organisms and showed a value of 1.31. Among the orders of soil organisms, majority of orders showed random and regular aggregation.

### Table 1.2: Biodiversity indices of soil arthropods during monsoon season.

<table>
<thead>
<tr>
<th>Index</th>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
<th>Site 4</th>
<th>Site 5</th>
<th>Site 6</th>
<th>Site 7</th>
<th>Site 8</th>
<th>Site 9</th>
<th>Site 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shannon H’ Log Base 10.</td>
<td>1.105</td>
<td>1.093</td>
<td>1.112</td>
<td>1.109</td>
<td>1.119</td>
<td>1.103</td>
<td>1.101</td>
<td>1.117</td>
<td>1.093</td>
<td>1.088</td>
</tr>
<tr>
<td>Berger-Parker Dominance</td>
<td>0.167</td>
<td>0.168</td>
<td>0.156</td>
<td>0.163</td>
<td>0.153</td>
<td>0.148</td>
<td>0.149</td>
<td>0.15</td>
<td>0.167</td>
<td>0.179</td>
</tr>
<tr>
<td>Simpsons Diversity</td>
<td>0.09</td>
<td>0.093</td>
<td>0.087</td>
<td>0.088</td>
<td>0.086</td>
<td>0.09</td>
<td>0.089</td>
<td>0.085</td>
<td>0.093</td>
<td>0.095</td>
</tr>
<tr>
<td>Hill’s Number H0</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>Hill’s Number H1</td>
<td>56.736</td>
<td>54.528</td>
<td>58.099</td>
<td>57.391</td>
<td>59.332</td>
<td>56.321</td>
<td>56.002</td>
<td>59.047</td>
<td>54.513</td>
<td>53.628</td>
</tr>
<tr>
<td>Mackintosh Distance (U)</td>
<td>0.312</td>
<td>0.446</td>
<td>0.541</td>
<td>0.623</td>
<td>0.694</td>
<td>0.761</td>
<td>0.823</td>
<td>0.877</td>
<td>0.933</td>
<td>0.986</td>
</tr>
<tr>
<td>Mackintosh Eveness (E)</td>
<td>1.317</td>
<td>1.315</td>
<td>1.314</td>
<td>1.314</td>
<td>1.313</td>
<td>1.312</td>
<td>1.311</td>
<td>1.311</td>
<td>1.309</td>
<td>1.309</td>
</tr>
</tbody>
</table>

## iii. Post monsoon season (September–November)

17 orders of soil arthropods were collected during the post monsoon season. Order wise K dominance values showed in table 1.3. Psocoptera and Diptera orders showed maximum K dominance value (100) in some sites; represents less dominance in ecosystem. Table1.3a showed the biodiversity indices of soil arthropods. Shannon-Weiner diversity index, showed minimum 1.114 and maximum 1.134, indicating moderate diversity of soil organisms in all rubber plantation sites. Berger-Parker Dominance (d) showed value between 0.148-0.165, there was no over dominance showed among the arthropod orders. Simpson’s dominant index, exhibited a value between 0.083-0.09, indicating Dominance (d) got value between 0.148-0.168, so there was no over dominance among the arthropod orders. Simpson dominant index showed that there was no chance of over dominance within the orders. Hill’s abundance value between 53.628-59.332, indicated moderate soil arthropod abundance. Margaleff richness index showed the value range from 7.643 to 7.793 representing average arthropod richness. McIntosh evenness was used to analyse the distribution and got index value 1.31 (Table1.2a). Most of the soil arthropods orders from rubber plantation sites showed random aggregation.

### ii. Monsoon season: (June-August)

During monsoon season, the data showed that orders Diptera and Dermoptera show maximum K dominance value (100) and minimum for the order Isopoda, Collembola, Hymenoptera and Acari(Table 1.2). In biodiversity analysis, Shannon-Weiner index ranged between 1.088-1.119, indicated the soil arthropods in the rubber plantation have moderate diversity. Berger-Parker.
moderate diversity of soil organisms in all rubber plantation sites. Berger-Parker Dominance (d) showed value between 0.148-0.165, there was no over dominance showed among the arthropod orders. Simpson's dominant index, exhibited a value between 0.083-0.09, indicating more dominance of soil arthropods. Hill's abundance, showed a value between 58.383-62.319. Margaleff richness ranged between 7.007 and 7.079 representing moderate diversity of soil arthropods in rubber plantations. McIntosh eveness index was used for observing the distribution of soil organisms and the value ranged between 0.083-0.09, indicating more dominance of soil arthropod orders. Simpson's dominant index, exhibited a value between 0.165, there was no over dominance showed among the arthropod orders. Simpson dominant index showed that there was no chance of over dominance within the orders. Hill's abundance index showed a maximum value of 56.025 at site 7 and minimum value of 55.914 at site 6, indicates moderate soil arthropod diversity in all study sites. Margaleff richness index showed value between 7.511-7.593, represents moderate soil arthropod richness. McIntosh evenness was used to indicate the distribution of soil arthropods over dominance showed among the arthropod orders.

iv. **Summer season (December-February)**

In summer season, the K dominance data showed that the orders Chilopoda and Diplura showed maximum K dominance value (100), hence lower dominance (Table 1.4). Biodiversity indices showed that Shannon-Weiner index with a maximum value of 1.106 at site 8, this indicated that the soil arthropods in the rubber plantation with moderate diversity. Berger-Parker Dominance (d) showed value between 0.16-0.183, there was no
Table 1.4a: Biodiversity indices of soil arthropods during summer

<table>
<thead>
<tr>
<th>Index</th>
<th>Order</th>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
<th>Site 4</th>
<th>Site 5</th>
<th>Site 6</th>
<th>Site 7</th>
<th>Site 8</th>
<th>Site 9</th>
<th>Site 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shannon H' Log Base 10.</td>
<td>Psocoptera</td>
<td>66.67</td>
<td>58.73</td>
<td>18.25</td>
<td>93.65</td>
<td>97.62</td>
<td>99.21</td>
<td>79.37</td>
<td>54.049</td>
<td>59.08</td>
<td>45.10</td>
</tr>
<tr>
<td>Hill's Number H0</td>
<td>Psocoptera</td>
<td>0.388</td>
<td>0.528</td>
<td>0.805</td>
<td>0.595</td>
<td>0.829</td>
<td>0.875</td>
<td>0.831</td>
<td>0.886</td>
<td>0.94</td>
<td>1.31</td>
</tr>
</tbody>
</table>

During present study, a total of seventeen orders of soil arthropods were extracted from ten sites of rubber plantation during the year 2014. Among the soil micro arthropods extracted from ten rubber plantation sites, Collembola, Diplopoda, Hymenoptera, Isopoda, Acari were found to be the most abundant arthropod orders in all study sites. The highest population of soil arthropods was found in post monsoon and monsoon seasons, lowest in summer season. Similar observation made by Bhattacharya and Raychoudhuri (1979), Bhattacharya...
et al., (1980). Lowest abundance of soil arthropods during summer season due to high temperature and low moisture content in the soil.

Biodiversity Indices were used to study the diversity, richness, evenness of soil arthropods. Diversity of soil arthropods was high in post monsoon and monsoon season as compared to the dry season. Soil temperature influences the distribution of soil animals, as temperature increases soil micro arthropod population decreases, because the temperature directly affects the rate of physiological reactions and indirectly effect on the soil biological activities then the soil animals migrate into the deeper layer of soil profile (Swift et al., 1979) Shannon Weiner diversity index and evenness index were also recorded higher value in wet season as compared to dry season from all the study sites. Shannon Weiner diversity index and evenness index all are high during wet season may be due to the higher decomposition and nutrient release. Good habitat condition, higher the diversity index and the worse habitat condition lower the diversity index of soil arthropods. The diversity of soil animal groups in surface soil is abundant and decreases with the increasing depth of soil profiles.

From this study order Collembola, Diplopoda were more in number during wet season. Collembola more in number in monsoon periods due to high moisture content in the soil. Order Collembola considered as biological regulators, they help to increase soil respiration and also accelerate nitrogen mineralization (Kaneda and Kaneko, 2008). Collembolans are among the abundant soil arthropods and play an important role in decomposing grasses (Brown and Gange, 1989). Higher abundance of collembolans than acarines, also recorded by (Chattopadhyay and Hazra 2000) at Kolkata. Myriapods number was low during summer season.

Seasons had direct influence on the diversity, richness, abundance and evenness of soil arthropods in rubber plantation. Climatic seasons tend to translate into seasonal activity patterns in living organisms including arthropods which became active only at certain times of the year (Wolda, 1988). Soil temperature and moisture influence micro arthropod reproduction and development rates (Van Straalen, 1994).

Soil arthropods were not evenly distributed. Application of pesticides during agricultural activities, has strong influence on the diversity and abundance of soil fauna (Adan et al., 1991; Arroyo and Iturrondebeltia, 2006). The rubber plantation sites had moderate soil arthropod diversity, the rubber plantations had high organic matter contents. When the organic matter increases the soil arthropod population also increases. During various seasons the soil arthropods showed variations in their diversity, richness and evenness. Richness and evenness of arthropods were more in post monsoon and monsoon seasons, least in summer season.

CONCLUSION

Seventeen Orders of soil arthropods like Isopoda, Diplopoda, Pauropoda, Chilopoda, Symphyla, Araneida, Acari, Chelonethi, Collembola, Protura, Diplura, Hymenoptera, Isoptera, Psocoptera, Diptera, Coleoptera, Dermaptera, Pscoptera were obtained during the study period. The order Collembola, Acari, Hymenoptera, Diplopoda, Isopoda were the dominant and abundant groups in all rubber plantation study sites. Seasons had direct influence on the diversity, richness, abundance, evenness of soil arthropods. During the study period post monsoon and monsoon seasons had maximum richness, diversity, abundance and evenness but showed minimum in summer season. From this study found that the rubber plantation sites had moderate soil arthropod diversity.

REFERENCES

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