Diversity and seasonality of ants associated with outdoor and indoor habitats of coastal Odisha

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ABSTRACT
The ant species composition and their seasonality were assessed in two different habitats selected from urban and sub-urban settings of coastal Odisha. A total of 18 species of ants have been documented during April to November, 2014 across habitats and seasons. In terms of species richness the sub-families, Myrmicinae, Formicinae and Ponerinae comprised of 7, 6 and 3 species, respectively. One species each was recorded under the sub-family Dolichoderinae and Pseudomyrmicinae. The species composition was found to be diverse in different seasons and overlapping between habitats. The seasonal occurrence of different ant species in different habitats are discussed.

Key words: Ant species, diversity, composition, seasonality, habitat, coastal Odisha.

Among the insects, ants are diverse, abundant, easily found and can be reliably sampled and monitored (Majer, 1983; Andersen, 1986; Delabie et al. 2006). They are also bio-indicators and efficient invaders of new habitats (Holway et al., 2002). Due to this, ants are increasingly used for biodiversity assessments and comparison of habitats and ecosystems (Andersens and Majer, 2004). Since, the data on the ants in natural and man made habitats are poorly documented (Gadagkar et al. 1993) and the coastal habitats are known to harbor rich biodiversity among the terrestrial ecosystems (Cunha and Nair, 2013), therefore attempts were made in the present investigation to document the ant species composition and their seasonality in outdoor and indoor habitats under the urban and sub-urban settings of coastal Odisha.

MATERIALS AND METHODS
Sampling of ants was done during April – May, July – August and October – November, 2014. Two undisturbed habitats were chosen for sampling, one at the campus of College of Forestry, OUAT, Bhubaneswar (Dist. Khurda), which represented the urban setting (designated as outdoor habitat) and the other being the residential premises in a village Nagapur (Dist. Puri), which represented the suburban setting (designated as indoor habitat). The methods employed for collection of the ant fauna from the first location include all out search (hand collection), bait and pitfall methods, while in the residential premises only the former two methods were adopted. About 25 plastic cups (6 cm in diameter and 7cm in length) half filled with water and few drops of liquid detergent were kept at five different locations @five cups per location within the campus of College of Forestry, where different forest plants were raised and maintained since 15 years. Similarly, plastic tubes with sugar bait (candy) were placed at different locations at both the selected habitats (outdoor & indoor habitats). The ants collected during the above periods were preserved in alcohol (70%) and sorted out to subfamily and genus using the key provided by Bolton (1994). In few cases morpho species were identified by using reliable internet site, such as www.antweb.org. Identification of ants was done using Trinocular zoom stereoscopic microscope (Model: BD42-A). The ant specimens so collected were also sent to ant taxonomist for confirming the species. The identified ant species were listed and the number of ants in each genus / species was documented with respect to habitats as well as periods of observations so as to enumerate the species composition and species structure indices. Various ecological indices like Shannon- wiener’s index, H (Shannon and Wiener, 1963), Simpson’s index of diversity, SID (Simpson, 1949), evenness and Sorensen’s similarity coefficient (QC) were worked out as per the following equations;

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The number of species encountered or species richness, Pi = proportion of the total sample belonging to ith species, lnPi =natural logarithm with base e = 2.718281828........ and ” = sum from species 1 to species S.

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The index values ($H$) can range from 0 to ~4.6. A value near 0 would indicate that every species in the sample is the same, i.e., there is no diversity, while higher value of $H$ would indicate more diverse communities and the numbers of individuals are evenly distributed between all the species.

**Simpson’s Index of diversity (SID)**

The Simpson’s Index ($D$) is a measure to assess the probability that two individuals randomly selected from a sample will belong to the same species or some category other than species. The above index was calculated using the following equation:

$$D = \frac{\sum n(n-1)}{N(N-1)}$$

Where, $n =$ the total number of organisms of a particular species and $N =$ the total number of organisms of all species.

With this index, 0 represents infinite diversity and 1 no diversity. It means the bigger the value of $D$, the lower the diversity. In order to make the measure meaningful, $D$ is often subtracted from 1 to give Simpson’s Index of Diversity ($1 - D$). The value of this index also ranges between 0 and almost 1, the greater the value, the greater the sample diversity. A value approaching zero indicates low biodiversity. For a given richness ($S$), $D$ increases as equitability increases and for a given equitability $D$ increases as richness increases.

**Evenness ($E_H$)**

Using species richness ($S$) and the Shannon-Wiener index ($H$), the evenness was computed using the same log base as with $H$, as per the formula given by Pielou (1975);

$$E_H = \frac{H}{\ln(S)}$$

Where, $H =$ the Shannon species diversity index, $S =$ Number of species encountered or species richness and $\ln =$ natural logarithm with base $e = 2.718281828$.

The equitability assumes a value between 0 and 1 with 1 being complete evenness. Higher values of evenness indicate less variation between species in communities. In other words, there are similar proportions of all species, then evenness is one, but when the abundance are very dissimilar (rare & common species) then the value increases.

**Sorensen’s similarity coefficient**

To measure the similarity between two community samples, coefficient of Sorensen was calculated after Chavhan and Pawar (2011) as per the following equation:

$$QC = \frac{2a}{2a + b + c}$$

Where, $QC =$ Sorensen similarity coefficient, $a =$ number of species in sample A and sample B (joint occurrences), $b =$ number of species in sample B but not in sample A and $c =$ number of species in sample A but not in sample B.

**RESULTS AND DISCUSSION**

Ants collected from outdoor and indoor habitats were mostly represented by five sub-families viz., Myrmicinae, Formicinae, Dolichoderinae, Ponerinae and Pseudomyrmicinae. The density of ants represented by these sub-families proportionately varied with the periods of observations and in descending order of their abundance, the sub-families were recorded as Myrmicinae (51.4%) > Dolichoderinae (25.1%) > Formicinae (16.6%) > Ponerinae (6.9%); Dolichoderinae (37.3%)> Formicinae (31.9%) > Myrmicinae (30.2%) and Myrmicinae (71.5%) > Formicinae (26.7%) > Ponerinae (1.4%) > Pseudomyrmicinae (0.1%), for the corresponding periods, respectively (Fig.1). Under coastal Odisha conditions, irrespective of habitats the Myrmicinae ants mostly predominated numerically during summer (April – May) and post rainy (October – November) season, while the Formicinae ants were found predominantly active during rainy (July – August) and post rainy (October–November) seasons and Dolichoderinae ants confined their activity to summer and rainy seasons (Fig.1). The ants of sub-family, Ponerinae and Pseudomyrmicinae were observed in low numbers either with low or restricted activities in different seasons.

Irrespective of seasons studied, the Myrmicinae ants were found almost in similar proportions (Fig.2) in both...
outdoor (63.4%) and indoor (52.0%) habitats. The population of ants belonging to sub-family Dolichoderinae were relatively high in outdoor habitats (21.6%) than in indoor (10.2%). Similarly, a major proportion of Formicinae ants were mostly sampled from indoor habitats (34.4%) than in outdoor (12.3%).

Ponerinae ants as residential population always prevailed in low proportion in both outdoor (2.7%) and indoor (3.4%) habitats, while negligible proportion of Pseudomyrmicinae ants (0.1%) was noticed only in outdoor habitats. In the west coast of Karnataka, Cunha et al. (2013) observed Myrmicinae (55%) as dominant sub-family followed by Formicinae (32%), Ponerinae (7%), Dolichoderinae and Pseudomyrmicinae. The species richness in proportion to the total species recorded also evidenced predominance of the above sub-families in different seasons under coastal conditions of Odisha (Table 2).

Species richness and composition
A total of 18 species of ants have been documented from the samples collected across habitats and seasons. In terms of species richness the sub-families viz., Myrmicinae, Formicinae and Ponerinae comprised of 7, 6 and 3 species, while one species each was recorded under the sub-family Dolichoderinae and Pseudomyrmicinae. The species richness in proportion to the total species recorded also evidenced predominance of the above sub-families in different seasons under coastal conditions of Odisha (Table 2).

Further, despite the fact that the proportion of species richness in both the habitats studied was almost similar, but the occurrence of ant species varied in these habitats with seasons. In April-May the proportion of ants represented by sub-family Myrmicinae was high (44.4%) in outdoor habitats and the species like Monomorium spp. and Crematogaster spp. occurred in high densities. The species diversity of Formicinae ants was observed to be high (36.4%) in indoor habitats and species like Paratrechina spp. and Camponotus compressus were mostly encountered. Within the residential premises (indoor habitats) at the village Nagapur, ant species like Pachycondyla spp., Diacamma spp. and Leptogeny spp. represented by sub-

Table 1. Species richness, diversity and evenness in ant community of outdoor and indoor habitats of coastal Odisha.

<table>
<thead>
<tr>
<th>Period / habitat</th>
<th>Species richness</th>
<th>Simpson’s index of diversity (SID)</th>
<th>Shannon diversity index (H)</th>
<th>Evenness (E_H)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Periods irrespective of habitat</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>April – May</td>
<td>13</td>
<td>0.84</td>
<td>-2.01</td>
<td>-0.78</td>
</tr>
<tr>
<td>July – August</td>
<td>12</td>
<td>0.78</td>
<td>-1.78</td>
<td>-0.72</td>
</tr>
<tr>
<td>October – November</td>
<td>15</td>
<td>0.71</td>
<td>-1.48</td>
<td>-0.55</td>
</tr>
<tr>
<td><strong>Habitat irrespective of seasons</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outdoor habitat</td>
<td>15</td>
<td>0.76</td>
<td>-1.73</td>
<td>-0.64</td>
</tr>
<tr>
<td>Indoor habitat</td>
<td>15</td>
<td>0.77</td>
<td>-1.82</td>
<td>-0.67</td>
</tr>
</tbody>
</table>
Diversity and seasonality of ants associated with outdoor and indoor habitats of coastal Odisha

Table 2. Species richness in proportion to the total species (%) recorded in different periods and habitats under coastal Odisha.

<table>
<thead>
<tr>
<th>Sub-Family</th>
<th>Proportion of species (%) recorded during periods / habitats</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>April-May</td>
<td>July-August</td>
</tr>
<tr>
<td></td>
<td>OD</td>
<td>ID</td>
</tr>
<tr>
<td>Myrmicinae</td>
<td>44.4</td>
<td>27.3</td>
</tr>
<tr>
<td>Formicinae</td>
<td>22.2</td>
<td>36.4</td>
</tr>
<tr>
<td>Ponerinae</td>
<td>22.2</td>
<td>27.3</td>
</tr>
<tr>
<td>Dolichoderine</td>
<td>11.1</td>
<td>9.1</td>
</tr>
<tr>
<td>Pseudomyrmicinae</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

OD = Outdoor, ID = Indoor

family Ponerinae constituted 27.3 per cent of the total species recorded during summer months. The former species was found to be most predominating, while occurrence of *Leptogeny* spp. was exceptional as this species mostly invades outdoor habitats.

Similarly, during the monsoon months (July – August) ants represented by sub-family Myrmicinae was found to be more diverse in both outdoor (42.8%) and indoor (55.5%) habitats. Among the Myrmicinae ants, *Monomorium* spp. was predominantly seen in both the habitats. On the contrary, the Formicinae ants mostly remained diverse under indoor conditions and species like *Pachycondyla* spp., *C. compressus* and *C. sericeus* being most common. The ant species like *Diacamma* spp. (sub-family: Ponerinae) and *Tapinoma* spp. (sub-family: Dolichoderinae) were noticed as most common in urban garden and each of these constituted about 14.3 per cent of the total species.

The Myrmicinae and Formicinae ant species were more diverse during post monsoon months (October – November) in both outdoor and indoor habitats. However, ant species like *Crema
togaster* spp. (Myrmicinae) and *C. compressus* (Formicinae) were recorded in relatively high densities in outdoor habitats, while species like *M. pharaonis* (Myrmicinae), *Paratrechina* spp. (Formicinae), *C. compressus* (Formicinae) and *Diacamma* spp. (Ponerinae) occurred abundantly in indoor habitats. Ants represented by sub-family Pseudomyrmicinae were only noticed during post monsoon months and exclusively in outdoor habitats. Further, the Sorensen’s Similarity Coefficient showed that the ant community were mostly overlapping, i.e., occurred in similar proportions during April – May (QC= 0.7) and October – November, (QC = 0.8) as compared to the monsoon months (QC = 0.5). The environmental differences between the two sampling periods owing to seasonal climatic conditions are also said to affect the temporal changes in ant assemblages (Barrow and Parr, 2008) and the abiotic factors are more important determinants of ant assemblage structure than competitive interactions (Narendra et al. 2010). Thus, each ant species might respond uniquely to changes in climate (Warren et al. 2011). The data mean over seasons also indicated that Myrmicinae, Formicinae and Ponerine ants were speciose in both the habitats (outdoor and indoor). The composition of ant species is unique to each habitat, and most likely governed by the vegetation, biota around it, soil characteristic and anthropogenic disturbances (Kumar and Mishra, 2008; Ramesh et al. 2010).

The present studies evidenced that various species prevailed differently depending upon the climatic conditions. The population of *Tapinoma melanocephalum* and *Solenopsis geminata* were appreciable in summer months, while *Paratrechina longicornis* and *Monomorium pharaonis* predominated during monsoon and post monsoon months. Bharti (2012) indicated that the Myrmicinae ants form the bulk of Indian ant diversity (45%) with *Pheidole* and *Crema
togaster* having the most species, while the subfamily Formicinae is the second largest ant group (25% of species) with *Camponotus* and *Polyrhachis* constituting the majority of the diversity. The Ponerinae ants like *Diacamma* spp. and *Pachycondyla* spp. were most common in coastal Odisha with the former species being observed invading both the habitats (urban garden & residential premises) during summer and confined to indoor habitats during post-monsoon months. However, *Pachycondyla* spp. invaded both outdoor and indoor habitats during summer and post-monsoon months. The predominance of above two Ponerinae ant species in coastal habitats was in conformity with earlier findings of Patnaik et al. (2014), who reported that of the five species recorded at Bhubaneswar (Odisha), *Pachycondyla sulcata* and *Diacamma rugosm* constituted the major proportion.

The results indicated the prevalence of *Monomorium* spp., *T. melanocephalum*, *Crema
togaster* spp. and *C. compressus* in undisturbed urban gardens and *T. melanocephalum*, *P.
longicornis and M. pharaonis in residential premises need attention. Currently, four ant species, Monomorium pharaonis, M. indicum, P. longicornis and T. melanocephalum have emerged as weedy species in India with few more turning to be notorious as well (Bharti, 2012). Further, it is suggested that these ant species have remarkable adaptability to cope with environmental stress, thus leading to their rapid proliferation, which will be difficult to control with recently launched management practices. However, in order to conserve high species richness in urban areas, Uno et al. (2010) advised to maintain a variety of habitat types.

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REFERENCES


