

Original Research Article

Preliminary survey and ecological studies on diversity of ants fauna in Asir region, Kingdom of Saudi Arabia

ABSTRACT

New records twelve species of ants fauna in Asir region, they are *Camponotus aegyptiacus*, *Camponotus sericeus*, *Camponotus xerxes*, *Cataglyphis bicolor bicolor*, *Cataglyphis fortis*, *Cataglyphis niger*, *Lepisiota opaciventris*, *Paratrechina longicornis*, *Crematogaster aegyptiaca*, *Crematogaster senegalensis*, *Monomorium carbonarium*, and *Monomorium salomonis*. Genera like *Cataglyphis*, *Camponotus*, *Crematogaster* and *Messor* gradually dominate the ant fauna and are represented by maximum number of endemic species with Myrmicinae most species subfamily followed by Formicinae. Maximum Relative abundance and distribution of ant species in Asir province observed in subfamily Formicinae (*Cataglyphis bicolor*) and subfamily Myrmicinae (*Messor ebeninus*).

Keywords: *Ants, Formicidae, survey, diversity, Asir region, Kingdom of Saudi Arabia.*

1. INTRODUCTION

Ants belong to the family Formicidae of the order Hymenoptera, with approximately 12,000 described species worldwide, of an expected total of 20,000 species (Hölldobler and Wilson, 1990). Ants are much more diverse than the other social insects such as termites, bees and wasps (Wilson, 1990; Bolton, 1995). Ants play an important role in maintaining the natural balance of ecosystem and they can be used as an indicator of environmental changes (Maryati, 1997; Peck et al., 1998; Toda and Kitching, 1999). Ants play many important ecological roles, having direct interactions with the soil, plants and animals at all trophic levels. Many of these roles are related to paedogenesis, nutrient cycling (Hutson, 1989), seed predation (Andersen, 1990; Majer, 1990) and seed dispersal (Majer, 1990). Ants are considered to be an ideal candidate for use as an indicator group for a number of reasons: they are abundant and ubiquitous in areas of disturbance (Andersen, 1990), they exhibit strong interactions with all trophic levels (Briese, 1982), and most ants have stationary nests and restricted foraging ranges which reduce competition between ant species (Alonso, 2000). They are highly sensitive to environmental conditions and disturbance and they respond rapidly to environmental change (Vanderwoude et al., 1997a; Andersen 1990). Furthermore, sampling is relatively easy, without requiring enormous expertise and experience.

Assessments of biodiversity and its conservation have become important issues given the current rates of habitat destruction (Magurran 2004; Alonso 2010). However, complete surveys of all taxonomic groups in a given area are impractical or even impossible. Thus, it is useful to focus resources on taxa that are ecologically important, diverse, abundant, easy to sample/monitor, taxonomically stable, and indicators of other taxonomic diversity because this allows for a more rapid assessment of diversity (Ellison 2012). Even if diversity of a focal taxon does not always correlate with diversity of other taxa (Olivier et al., 1998), surveys of single taxa provide knowledge of that group and increase our understanding of local biodiversity (Alonso 2000; Ellison 2012).

Understanding the natural history of a focal taxon is important in relation to elaborating biodiversity and using the information for conservation purposes (Alonso 2010). In particular, determining the effects of regional and local environments on abundance and distribution of focal taxa is important (Magurran 2004; Alonso 2010).

Ants (Hymenoptera: Formicidae) are an excellent taxon for biodiversity studies because they are conspicuous and important faunistic elements in most ecosystems. For example, ants contribute as much to soil turnover as terrestrial annelids (Hölldobler and Wilson 1990). In areas with no termites, such as northern temperate regions, ants are also major contributors to the breakdown of wood (Hasen and Klotz 2005). Ants are also excellent focal taxa for study and monitoring since they are found abundantly in most terrestrial ecosystems (Majer 1983; Hölldobler and Wilson 1990). The majority of ground dwelling ants live in perennial, sessile colonies with workers having limited foraging ranges (Hölldobler and Wilson

1990), allowing for reliable sampling and monitoring that is well-linked to characteristics of the local habitat (Alonso 2010). Ants have been used as indicator taxa, most notably in Australia, where their diversity of ants is positively related to biodiversity in arid environments. They have also been used to monitor the effect of disturbances, such as mining, on biodiversity (Andersen *et al.*, 1996; Andersen *et al.*, 2007). Economically, ants are also important, having both positive and negative influences.

2. MATERIAL AND METHODS

The study area (Asir region)

South western region Fig.1. is located between latitude 17°30'- 21°-00' N and Longitude 41°30'- 44°-30' E. It is entirely different from the rest of the kingdom. The series of Al-Sarawat mountains, with its highest peak (Al-Sawdah mountain, 3000-3100 m), near Abha (2093.96 m) the capital of Asir province, divide the area into two distinct ecological regions. They are the high plateau the slopes gently eastward from the escarpment to form the highlands of Asir, and to west the highly dissected mountains terrain to Tehamah Asir that merges westward into narrow, sandy Red Sea coastal plain, make it the hottest part of the region. The Asir highland receives a variable seasonal rainfall which higher than the rest of the kingdom, i.e. 300-500 mm/year as compared with 50-100 mm/year elsewhere.

Field techniques

Two field techniques were used to collect and study ants mainly Pitfall trapping and direct sampling (Hand picking). In all the pervious techniques, ants were collected in the field and then put into vials filled with 70% ethanol and tight-fitting caps to retard the evaporation of alcohol. For every sample, receptacle (vial) was clearly labeled with a code number written on a thick paper using a good quality pencil and then placed inside the vials. The previous code number refers to the location, date, habitat....etc. These samples collected every two weeks for one year (Nov.2013- Oct. 2014).

Sorting ant specimen

The first step in ant specimen preparations was the sorting of the material collected from the field. After field work, ant specimens were usually contained in vials and jars were mixed with soil, other organisms and miscellaneous matter. It was important to remove the ant from this other materials as soon as possible in order to prevent damage to specimens by abrasive particles and to avoid the formation of coating of clay and mineral salts on specimens. Salt-water extraction technique described by (Agosti *et al.*, 2000) was used in order to separate ant specimens from the other materials because of its simplicity and low cost.

Identification ants to species

Examination and identification of ants to species rank was carried out by the use of a stereoscopic binocular microscope. Identification of ants to the species rank was obtained by the use of different taxonomic keys (Collingwood, 1985; Agosti, 1990; Bolton, 1995; Collingwood & Agosti, 1996; Cagniant, 2009).

Specimens storage

Since a sample of ants was mounted, the remaining specimens were kept into alcohol vials. The alcohol used for storage was ethanol at a concentration of 70%. This alcohol collection was checked three times a year and empty vials were provided with additional alcohol. The risk of desiccation of vials was avoided by sorting the vials in a large jar that also filled with ethanol. For dry specimens, they were sorted in drawers that are airtight. Damage was reduced by adding naphthalene to drawers to protect collection against insect attack.

Diversity data analysis

Data was analysed by Incidence-based coverage estimator (ICE). Species richness and Alpha diversity was estimated by using Shannon wiener, and Simpson's D diversity indices. The program EstimateS (Colwell, 2009) was used to calculate these standard estimators.

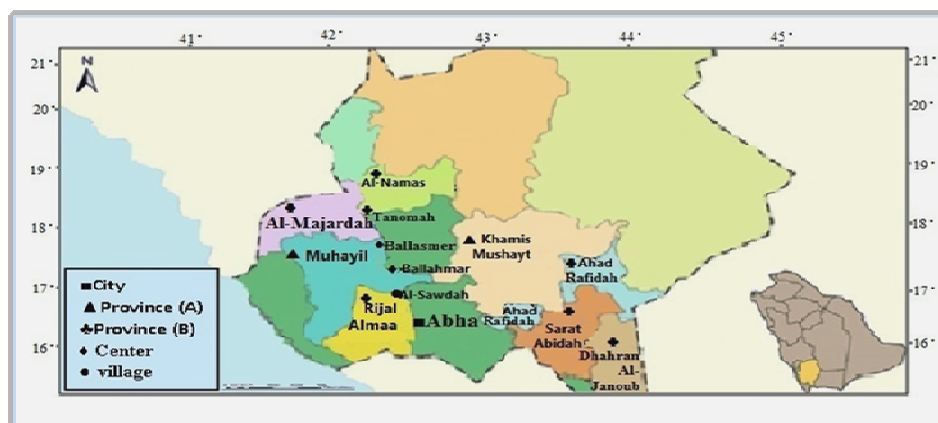


Fig.1. Asir map showing the surveyed localities.

3. RESULTS AND DISCUSSION

Results of ant diversity studies

Table.1. Data of the surveyed in Asir province along with number of specimens at each site.

	Area (Area more than 2000 m elevation)	Coordinates of latitude and longitude		Above sea level (altitude) asl	Total no. specimen collected	No. species
		N	E			
1	Abha (AB)**	18°14'460"	42°31'767"	2093.96 m	176	7
2	Al-Sawdah (AS)**	18°27'173"	42°38'400"	3000 - 3100 m	50	2
3	Sarat Abidah (SA)**	18°00'852"	43°09'00"	2380 m	56	2
4	Ahad Rafidah (AR)**	18°21'216"	42°84'378"	2000 m	28	2
5	Dhahran Al-Janoub (DJ)**	17°39'56.1	43°31'00.1	2100-2570 m	40	4
6	Ballahmar (BA)**	18°54'947"	42°40'899"	2250 m	150	9
7	Ballasmar (BS)**	18°79'296"	42°25'570"	2250 m	20	2
8	Tanomah (TA)**	18°89'215"	42°22'767"	2148 m	34	3
9	Al-Namas (AN)**	19°07'12"	42°07'48"	2600 m	73	4
(Area below 2000 m elevation)						
10	Muhayil (MU)*	18°34'760"	42°02'151"	456 m	115	5
11	Al-Majardah (AM)*	19°12'844"	41°92'460"	2000 m	33	4
12	Khamis Mushayt (KM)*	18°29'153"	42°73'874"	1850 - 2000 m	132	6
13	Rijal Almaa (RA)*	18°14'608"	42°16'500"	1000- 1500 m	113	5

*=Study area below 2000 m elevation; **= Study area more than 2000 m elevation.

Fig. 2. Showing corelation of temp, humidity, wind speed & precipitation with species abundance in 2013-2014.

	<i>Paratrechina(Nylanderia) longicornis</i> (Latreille)			+	+								
subfamily: Myrmicinae	<i>Crematogaster aegyptiacus</i> Mayr	+									+	+	
	<i>Crematogaster senegalensis</i> Roger			++	++	+							
	<i>Monomorium carbonarium</i> (Smith)	+							+		+		
	<i>Monomorium</i> sp.				+	+	+				+		
	<i>Monomorium salomonis</i>										+		
	<i>Messor ebeninus</i> Santschi	++	+				++			+	++	+	+
	<i>Pheidole megacephala</i>			++			+			+	+		
	<i>Tetramorium sericeiventris</i> Emery										+		+
	<i>Tetramorium depressicepes</i>										+		

(+) low density, (++) moderate density and (+++) high density

Table. 3. Showing alpha diversity of ants in both elevational gradients

SAMPLE	ALPHA SD (ANALYTICAL)	SHANNON MEAN	SIMPSON MEAN
DIRECT SAMPLING	0.79	2.47	9.30
PITFALL TRAP	0.43	2.56	12.14

Diversity of Ants along elevational gradient

A total of 1,020 ants belonging to 19 species of 9 genera were collected. *Lepisiota*, *Paratrechina*, *Messor* and *Pheidole* genera are represented by single species each, while *Camponotus*, *Cataglyphis*, *Monomorium*, *Crematogaster* and *Tetramorium* represented by 4, 4, 3, 2 and 2 respectively (Table.2 & Fig. 3). In all 9 genera are recorded among them Subfamily Formicinae contains 4 genera while Myrmicinae has 5 genera. More than half of the species belong to subfamily Myrmicinae (51%), and the rest by (49%) belongs to Formicinae. Relative abundance was recorded maximum for *Messor ebeninus* Santschi, *Cataglyphis bicolor bicolor* and *Crematogaster senegalensis* Roger (17.65%; 13.93% and 11.67%) respectively while *Lepisiota opaciventris* has the minimum 0.49%. Hand collection yielded maximum number of specimens (68.23%) followed by Pitfall Trap (31.77%) (Fig. 3).

At <2000 mtrs (Table.1 & Fig. 2) the average temperature was 25°C, relative humidity 51%, wind speed was 7km/h and precipitation 35mm. The total catch in terms of number of specimens was 393. Total specimen were 33.59% (132) with maximum 6 different type of species were recorded at the site of KM. Genus *Crematogaster* was the most abundant with *Crematogaster senegalensis* represents 119 (30.28%) specimens of the total catch and majority of the specimens were collected by hand picking method followed by pitfall. Subfamily Formicinae represents mainly of the genus *Camponotus* forming the bulk with 19.85% with *Camponotus sericeus* has maximum catch of 78 specimens, again hand picking method was found to be most effective followed by pitfall (Table.2 & Fig. 3).

At >2000 mtrs (Table.1 & Fig. 2) the average temperature was 15.5°C, relative humidity 45 %, wind speed was 10 km/h and precipitation 30mm. The total catch in terms of number of specimens was 627. In terms of abundance 176 (28.07%) specimen with 7 different types of species were recorded at the site of AB while maximum diversity with 9 different species were observed at the site of BA. Genus *Messor* was the most abundant genera with *Messor ebeninus* Santschi represents 22.17% of the total catch and majority of the specimens were collected by hand picking method followed by pitfall. Subfamily Formicinae represents 51.35%, with genus *Cataglyphis* forming the bulk with 32.69%, *Cataglyphis bicolor bicolor* has the maximum catch of 103 (16.43%) specimens. Again hand picking method was found to be most effective followed by pitfall (Table.2 & Fig. 3).

Discussion

Ants diversity along elevational gradient

There are several studies have examined the effects of elevation on ant diversity. In general these studies have revealed two patterns; a steady decline in ant diversity from low to high elevations (Brühl *et al.*, 1998; Janzen 1976), or a pattern of mid-elevation peak in species richness (Fisher & Robertson 2002; Sabu *et al.*, 2008; Samson *et al.*, 1997). One common element to these studies is that they have tended to quantify biodiversity using species diversity metrics that are based on morphospecies designations or morphologically determined taxonomic units (Gotelli & Colwell 2001).

In the present work, also used morphology as a direct measure of the levels of ant functional diversity present at varying elevations gradient. For this categorize our study area in two section one is <2000 m and another is >2000 m with 13 collecting sites. Also try to explain ant species to a set of guilds using both ecological information as well as a group of functionally significant morphological traits. In general, found that functional diversity peaked at mid-elevation (although non-significantly). The results of these guild proportionality analysis show that at low and high elevations, ant communities contain uneven numbers of species from each guild and contain less of the overall variation in ant functional morphology suggesting that environmental factors like temperature; humidity etc. may have controlled these communities. As have mentioned earlier that found a mid-elevational peak of species density that differs in both size and shape depending on the season and year. Abha (AB) and Ballahmar (BA) sites were dominant in terms of number of species (Table. 1). These results are in accordance with studies found mid-elevational peaks of ant species density (e.g. Fisher, 1999; Sanders, 2002; Bharti *et al.*, 2013). This peak was found to change in scale and position depending on the season (Fig. 2 & 3). Larger community structure, abundance and variation was found in these sites, which may be because of suitable ecological factors like temperature, and humidity and these areas are known to have maximum rainfalls in kingdom (Fig. 2). Fewer species were observed in the dry season than in the wet season (Fig. 2). In our dataset, the seasonal change in the elevation–species density relationship is due to greater seasonal fluctuation at low elevations. These patterns of species density appear to be entirely explained by the effects of mean temperature and available area. In general, a weak linear decline in abundance across elevation was seen in the wet season (Fig. 2&3).

Species richness by different indices have been depicted in (Fig. 3) and species abundance and effectiveness of sampling methods by Sobs (species observed) while Alpha diversity indices have been depicted in (Table. 3). The data generated reflects that with decrease in temperature and humidity, composition of species changes; as in case of Myrmicinae the generalist species are replaced by more high altitude specialists like *Messor ebeninus* Santschi, *Crematogaster senegalensis* Roger, and *Cataglyphis bicolor bicolor* (Formicinae). In case of Formicinae the interpretation resembles Myrmicinae as cold specialist *Camponotus sericeus* increases in abundance. But interestingly, the overall abundance increases from 1800 mtrs to 2500 mtrs with number of species almost same at both the elevations. At this point of time, it is difficult to conclude that with more increase in altitude, the number of species and abundance would increase, but it has been observed that with increase in altitude in Asir.

Ants taxonomy with distribution

The results of the present study record the presence of nineteen species they are (*Camponotus aegyptiacus*, *Camponotus sericeus*, *Camponotus xerxes*, *Camponotus flavomarginatus*, *Cataglyphis albicans*, *Cataglyphis bicolor bicolor*, *Cataglyphis fortis*, *Cataglyphis niger*, *Lepisiota opaciventris*, *Paratrechina longicornis*, *Crematogaster aegyptiaca*, *Crematogaster senegalensis*, *Messor ebeninus*, *Monomorium carbonarium*, *Monomorium sp.*, *Monomorium salomonis*, *Pheidole megacephala*, *Tetramorium sericeiventre* and *Tetramorium depressicepes*) from two subfamilies they are Formicinae and Myrmecinae.

Twelve species were new record in Asir region, they are (*Camponotus aegyptiacus*, *Camponotus sericeus*, *Camponotus xerxes*, *Cataglyphis bicolor bicolor*, *Cataglyphis fortis*, *Cataglyphis niger*, *Lepisiota opaciventris*, *Paratrechina longicornis*, *Crematogaster aegyptiaca*, *Crematogaster senegalensis*, *Monomorium carbonarium* and *Monomorium salomonis*).

Five species were previously recorded and also found in new places, they are (*Camponotus flavomarginatus*, *Messor ebeninus*, *Pheidole megacephala*, *Tetramorium sericeiventre* and *Tetramorium depressicepes*) and two species were previously recorded in Asir region, they are (*Cataglyphis albicans* and *Monomorium sp.*).

4. CONCLUSION

Diversity of Asir region ants in relation to elevation gradient reveals that the functional diversity peaked at mid-elevation in Asir region, The data generated reflects that the composition of species changes with accordance of environmental factors like temperature, humidity etc.; More ant individuals and species are found in the wetter parts of the elevation gradient rather than hot and dry areas. These results suggest a strong environmental, control on ant diversity patterns in Asir region of KSA. Genera like *Cataglyphis*, *Camponotus*, *Crematogaster* and *Messor* gradually dominate the ant fauna and are represented by maximum number of endemic species, with Myrmicinae most species subfamily followed by Formicinae. Maximum relative abundance and distribution of ant species in Asir province observed in subfamily Formicinae (*Cataglyphis bicolor*) and subfamily Myrmicinae (*Messor ebeninus*).

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