A hierarchical analysis of species richness and diversity of ants in Iran

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Introduction

Geographic patterns of biodiversity across multiple spatial scales play an essential role for many contemporary theories in ecology and have received much attention during the last decade. Hierarchical partitioning of diversity into its components is a promising application that can disclose patterns of diversity turnovers across scales. The most critical outcome from the application of diversity partitioning is the recognition of the spatial scale that most strongly affects the diversity of species. In our study on ants of Iran, we employed spatially multi-stage sampling that varies from a fine to a regional scale and we asked:

1- How ant diversity increases across scale?
2- At which scale the highest amount of beta diversity are found?
3- Is there any difference between steppe and desert habitats in ant diversity ?
4- Do commonness or rarity increase or decrease across scales?

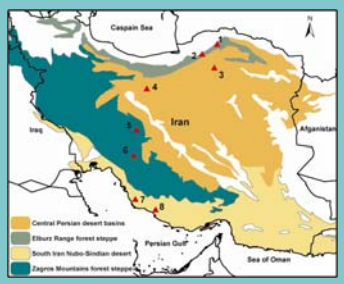

Fig. 1 Map of ecoregions of Iran, documenting four main ecoregions that were sampled along our transect.

Fig. 2 Zagros Mountains forest steppe ecoregion in the west of Iran (plot Nr. 6 in the map).

Methods

The field work in Iran was carried out from May until August 2007. We conducted our sampling along a transect (ca 1300 km) from the north to the south of Iran. We collected ants across four main ecoregions (Fig. 1, 2 & 4). Totally we sampled ants from 8 sample sites (two samples sites for every ecoregion). We used pitfall traps for all the sites. We used a total of 60 pitfall traps, that were placed in two 300 m-transects. Traps were collected after 3 days. We considered each transect as a “fine scale” at the lowest level of our hierarchical design, the two transects of one site as the “local scale”, the two local scales of one ecoregion as the “ecoregion scale”. At the higher level, the two steppe ecoregions were pooled as the “steppe habitats” and two desert and semi-desert ecoregions were pooled as the “desert habitats”.

Results

Along the transect we collected a total of 69 species corresponding to 1844 species occurrences by pitfall traps. Among them several species were recorded for the first time from Iran (Fig. 7 & Fig. 8).
Our results showed that species richness and diversity measures of ants increased, but evenness decreased across scales (Fig. 3).
Commonness decreased and rarity of species increased from fine to broad scales (Fig. 5). No significant difference was found in species richness and Shannon diversity between steppe and desert regions at different scales, except for Shannon diversity at the highest scale. The highest turnover for total region occurred among habitats and for both steppe and desert habitats occurred among ecoregions (Fig. 6)

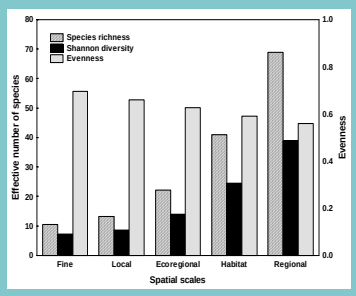

Fig. 3 Mean of species richness, Shannon diversity and evenness of ants on five spatial scales.

Fig. 4 Central Persian deserts basins ecoregion (plot Nr. 4 in the map).

Camponotus was the main genus in steppe region. In contrast *Messor*, *Monomorium* and *Cataglyphis* were more common in desert regions. Looking over the complete transect *Monomorium kusenzovi* was the commonest species which occurred in 39% of all pitfalls and in all Central deserts pitfall traps. The second most species *Cataglyphis niger* and *Tetramorium striaventre* both occurred in 23% of all pitfalls.

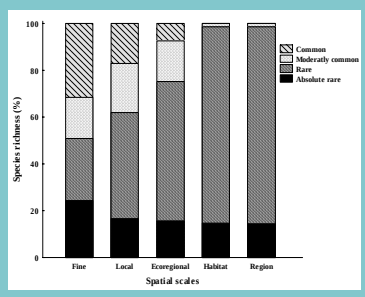

Fig. 5 Percentage of total ant species richness explained by absolute rare(unique or duplicates), rare (occurred in at most 25% of the pitfalls), moderately common (occurred in 50% of the pitfalls) and common species (occurred in more than 50% of the pitfall traps) on five spatial scales.

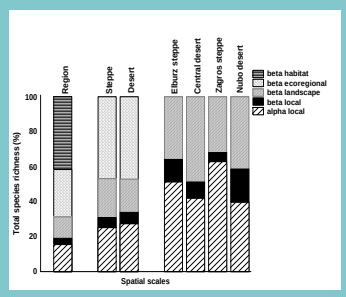

Fig. 6 Hierarchical partitioning of species richness for the whole region, two habitats and four ecoregions. The highest beta diversity occurred at the highest level, among habitats for the whole region and among ecoregions for both habitats and among locals for all ecoregions.

Fig. 7 *Messor turcmenochorassanicus* Arnoldi, 1977, new recorded ant from Iran from Zagros forest steppe.

Fig. 8 *Cataglyphis kurdistanicus* Pisarski, 1965, new recorded ant from Iran from Zagros forest steppe.

Discussion

Abiotic factors that operate at broad scales, such as climate history and climate heterogeneity, habitat heterogeneity and paleogeographical history, have the strongest influence on ant diversity in arid and semi-arid areas of Iran. Additionally, they control for the large turnover of ant composition among ecoregions and vast steppe and desert habitats.

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