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Ant and tenebrionid beetle assemblages in arid lands: Their associations with vegetation types in the Patagonian steppe

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ABSTRACT

Arid environments have long been perceived as simple and homogeneous ecosystems, but slight differences in precipitation, topography and soil attributes result in a variety of distinct plant associations. The availability of different vegetation types leads to a non-uniform distribution of resources and abiotic conditions, which may affect the spatial distribution of their associated fauna. Here we describe a study, in the San Jorge Gulf district of Patagonia, where we tested the relationships between ant and tenebrionid diversity and composition and discrete vegetation types in an area where invertebrate fauna is poorly known. We captured 5019 individuals, from 13 to 21 species, of ants and tenebrionids, respectively. We found differences in composition of ants and tenebrionids among the vegetation types, with unique ant composition on peladales and subshrub steppes, and distinct tenebrionid assemblages in all vegetation types. Our results show that ants and darkling beetles responded differently to vegetation type. Because both taxa are key components of arid environment fauna, it is important to consider vegetation heterogeneity when developing management plans to conserve biological diversity and ecological functions in these environments.

1. Introduction

The relationship between environmental heterogeneity, and species composition and diversity has become a central topic in ecology, evolution and biogeography (Stein and Kreft, 2015). Although environmental heterogeneity is a common feature in natural systems, until recently, its importance has been overlooked. In particular, arid lands were often viewed as simple and structurally homogeneous systems until some decades ago, when more detailed ecological studies revealed high levels of temporal and spatial heterogeneity (Polis, 1991). At the landscape scale, vegetation in dry-lands is not continuous in space, mainly due to slight differences in precipitation, topography and soil attributes, resulting in a variety of distinct plant arrangements (Bisigato et al., 2009). The availability of different vegetation types (e.g., shrub steppes, subshrub steppes, grass steppes) is especially important for animals in this kind of environments with high climatic and resource fluctuations, as they provide shelter, food and suitable abiotic conditions (e.g., Heatwole, 1996; Whitford, 2002). The increasing intensity of human activity in arid regions tends to increase bare soil at the expense of vegetation (Bainbridge, 2007), which could indirectly affect animal assemblages. Thus, a better knowledge of the associations between vegetation types and animal species in these regions is crucial for biodiversity conservation (Dufour et al., 2006).

Among the fauna of arid and semiarid environments, ants and beetles are dominant in terms of biomass and abundance (Polis, 1991; Claps et al., 2008). They also stand out as being involved in many ecological processes, such as predation, organic matter consumption, soil nutrient cycling, pollination, seed dispersal, plant anti-herbivore defense, and food for vertebrates (Flores, 1998; Andersen et al., 2004; Sackmann and Farji-Brener, 2006; Rico-Gray and Oliveira, 2007; Lach et al., 2010). Both ants and beetles are taxonomically diverse, occupy a wide range of microsites and also consume varied food resources (Borror et al., 1989; Hölldobler and Wilson, 1990). Since they are key components of arid environments, it is important to know how they are influenced by changes in the spatial heterogeneity of vegetation. This knowledge allows us to predict how human disturbances are likely to influence

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diversity and distribution of ants and beetles, and ultimately their impacts on a range of ecosystem processes.

The Patagonian biogeographic province (Cabrera and Willink, 1980), located in the southern portion of South America, comprises vast xeric areas characterized by marked heterogeneity in climate, soil and vegetation at a range of spatial scales (Oesterheld et al., 1998). In fact, twelve physiognomic floristic units were defined (León et al., 1998) in this phytogeographic province (Cabrera, 1976), comprising shrub, subshrub, and grass steppes, with different plant cover and dominant life forms. Although Patagonian steppe covers a huge area (about 800,000 km^2 or 30% of the surface of Argentina), few studies have dealt with the diversity and composition of ants and beetles (e.g., Sackmann and Flores, 2009; Cheli et al., 2010; Pirk, 2014). Therefore, the knowledge of the ground-dwelling arthropod fauna in some areas of Patagonia is limited (Cuezzo, 1998; Flores, 1998; Claps et al., 2008), let alone their relation with vegetation structure (e.g., Mazia et al., 2006). Both ants and tenebrionids (darkling beetles) are among the predominant components of the terrestrial invertebrate fauna of Patagonia (Sackmann and Flores, 2009; Cheli et al., 2010). Knowledge of the local ant and beetle assemblages associated with vegetation types in Patagonia is valuable to any wildlife inventory of the area. This is useful in order to provide information to establish conservation priorities in response to human activities such as overgrazing and oil extraction, that tend to homogenize the landscape. Thus, the aims of this study are to describe ant and darkling beetle diversity and composition and to determine whether they differ among distinct vegetation types (grass, shrub and subshrub steppes and bare areas) of the Patagonian steppe. Since the availability of distinct plant associations makes a non-uniform distribution of resources and abiotic conditions, and ant and tenebrionid species have a variety of ecological requirements, we expected different vegetation types to harbor distinct ant and tenebrionid assemblages.

2. Methods

2.1. Study area

This study was conducted in the San Jorge Gulf area (South-eastern Patagonia, Argentina), a distinct vegetation district within the Patagonia phytogeographic province (Cabrera, 1976) (Fig. 1). The climate is meso-thermal dry with an average precipitation of 245 mm and a mean annual temperature of 13 °C (Rueter and Bertolami, 2010). Given the Mediterranean precipitation regime and strong westerly winds, the extended water deficit and heat concentration occurs in January (Paruelo et al., 1991). The soils have sandy-clayish characteristics, with little vertical development, and low organic matter and moisture content (Andreis et al., 1975). The dominant vegetation in the area includes typical herbs and shrubs of the Patagonian steppe (e. g. *Retanilla patagonica*, *Colliguaja integerrima*, *Adesmia campestris*, *Anarthrophyllum rigidum*, *Ephedra frustillata*, *Stipa humilis*, *Poa ligularis*, *Poa ligularis*, *Stipa patagonica*, *Festuca pallescens*, *Festuca argentina*; Cabrera, 1976; Paruelo et al., 1991). However, there are five well-defined plant communities: shrub steppes, subshrub steppes, grass steppes, bare areas or “peladales”, and wetland meadows or “mallines” (Fig. 1). Although wetland meadows are floristically important, they were excluded

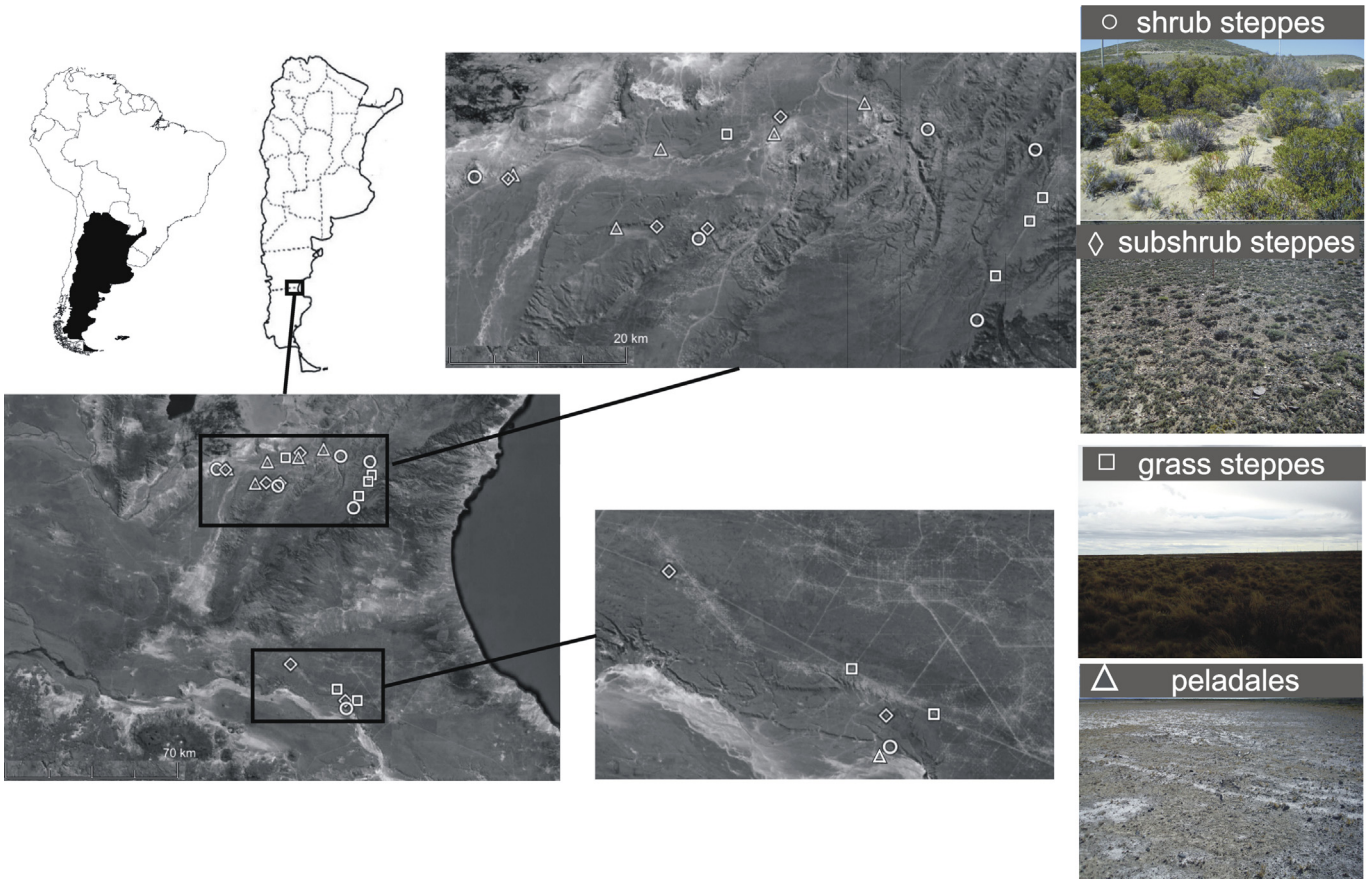

Fig. 1. Map of the sampling area in the San Jorge Gulf, South-eastern Patagonia, Argentina, showing the sampling units among the four vegetation types: shrub steppes (○), subshrub steppes (◊), grass steppes (□), and *peladales* (△). Upper inset shows Valle Hermoso area while lower inset is Koluel Kaike.