Feeding habits of the brown widow spider *Latrodectus geometricus* (Araneae: Theridiidae) in northern Chile

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Abstract: The brown widow *Latrodectus geometricus* is a cosmopolitan spider commonly found in buildings, gardens and lamp posts in northern Chile. Here we studied its diet composition and potential prey present in the same micro-habitat. We identified 63 prey items collected from its webs during the study, representing nine arthropod orders. The diet was variable but the spiders preyed mainly on beetles and woodlice, which represented more than 49.21 % of the total. Our results show that in Chile this spider has a polyphagous diet, and point to a positive and significant preference for Elateridae (Coleoptera), Curculionidae (Coleoptera) and Kalotermitidae (Isoptera) over other arthropods. We have also detected intra-guild predation with Chilean recluse spiders.
Key words: Araneae, Theridiidae, spiders, diet composition, intra-guild predation, niche breadth, northern Chile, South America.

Hábitos alimentarios de la viuda marrón *Latrodectus geometricus* (Araneae: Theridiidae) en el norte de Chile
Resumen: La viuda marrón *Latrodectus geometricus* es una araña cosmopolita común en viviendas, jardines y postes de luz en el norte de Chile. En este trabajo estudiamos la composición de su dieta y las potenciales presas presentes en el mismo micro-hábitat. Encontramos 63 ítems presas colectadas en sus telas durante el estudio, representando nueve órdenes de artrópodos. La dieta fue variable, pero las arañas depredaron principalmente escarabajos e isópodos, que representaron más del 49.21% del total. Reportamos una dieta polífaga de esta araña en Chile y encontramos una selección positiva y significativa por Elateridae (Coleoptera), Curculionidae (Coleoptera) y Kalotermitidae (Isoptera) con respecto a los otros artrópodos. También reportamos depredación intra-gremio con las arañas reclusas chilenas.
Palabras clave: Araneae, Theridiidae, arañas, composición de dieta, depredación intra-gremio, amplitud de nicho, norte de Chile, Sudamérica.

Introduction

Knowledge of prey items and rates of predation is relevant to evaluate the effect of predators on prey populations and mainly in estimating the potential effectiveness of a predator as an agent of biological control (Hayes & Lockley, 1990). Diet studies are a critical first step to understand the complex relationships in a food web (Cohen *et al*., 1993). Nevertheless, this role might be much more important when intraguild predation is involved, since the direct effects produced by predatory arthropods on herbivore-detritivore populations may combine with that of other predators (Hodar & Sanchez-Piñero, 2002).

Usually, terrestrial food webs have a high diversity of generalist predators, among which spiders are very common (Polis & Strong, 1996). Spiders are relevant terrestrial predators and also located on the top of many invertebrate food webs. They are abundant and showing diverse feeding habits (Wise, 1993). Most of the spiders are polyphagous predators and are capable to feed on many insects including major urban pests (Nyffeler & Benz, 1988). The spiders have a suite of adaptations that enable them to wait out periods of low prey abundance rather than dispersing like some other groups of arthropod predators (Greenstone & Bennett, 1980). It has therefore been assumed that spiders play a major role in suppressing insect pest populations (Young & Edwards, 1990). In this sense, the diet and prey selectivity are very important for the ecology of spiders and has been well studied in Europe both in the field as in laboratory (Nyfeller, 1982; Nyffeler & Benz, 1988; Nyfeller, 1999); however, despite its importance in South America the information is more limited, focusing mainly on agroecosystem spiders in Argentina (Cheli *et al.,* 2006; González *et al.,* 2009; Pompozzi *et al.,* 2013).

Latrodectus spiders are generalist predators known to feed on insects, crustaceans, other arachnids, and on small vertebrates including lizards, geckos, and mice (Forster, 1995; Hódar & Sánchez-Piñero, 2002), and this broad diet may in part explain the presence of a vertebrate specific toxin in their venom. Several *Latrodectus* species are synanthropic, often found in urban areas around houses, garden sheds, and barns (Muller 1993; Garb *et al*., 2004), as well as in agricultural areas (Costello & Daane, 1998; Muller, 1993). There are several studies of diet involving *Latrodectus* species in different countries around the world (Exline & Hatch, 1934; Shulov, 1940; Ross, 1981; Mackay, 1982; Nyffeler *et al*., 1988; Rocha Dias & Kobler, 1999; Hódar & Sánchez-Piñero, 2002; Bertani *et al.,* 2008; Johnson *et al.,* 2011; Salomon 2011; Pompozzi *et al.*, 2013); however few of these studies has been done in urban areas. In Chile, studies on diet composition and prey selection are scarce; highlighting only that from *L. thoracicus* (Nicolet, 1849) in Magallanes (southern Chile) based only on field observations (Jackson, 2013).

The brown widow, *Latrodectus geometricus* C. L. Koch, 1841, is a synantrophic spider that has an affinity for human structures and residential buildings (Bayram *et al*., 2008; Vetter *et al.,* 2012; Taucare-Rios *et al.,* 2013; Simo *et al.,* 2013) where it constructs a web of irregular shape. This spider is probably native from Africa, but has expanded its range around the world mainly in the last century as a consequence of globalization (Garb *et al.,* 2004), to becoming in a cosmopolitan spider (World Spider Catalog, 2015). This species has been reported in many countries in South America, but has been recently reported in northern Chile (Taucare-Rios, 2011; Taucare-Rios *et al*., 2013) where is common in the houses; however, nothing is known about their feeding ecology in the country.

Therefore, the main goal of this study was to determine the diet of the brown widow spider in a synanthropic environment in northern Chile. In this study, we documented the range of prey captured in *L. geometricus* webs and recorded the potential prey present in the same microhabitat.

Table I. Number of prey items collected in *L. geometricus* webs and the prey availability (PA) collected in the same microhabitat. Prey selection: S= Savage index. * P<0.05. Values above 1 indicate positive selection, below 1 indicate avoidance.

Prey taxon	Prey abundance	PA	S
Coleoptera			
Elateridae	4	2	3.75*
Curculionidae	4	1	7.49*
Tenebrionidae	6	8	1.40
Diptera			
Sarcophagidae	6	10	1.12
Culicidae	2	2	1.00
Blattodea			
Blattellidae	2	4	0.94
Isopoda			
Porcellionidae	17	30	1.06
Araneae			
Sicariidae	4	8	0.94
Theridiidae	0	5	0.00*
Isoptera			
Kalotermitidae	4	1	7.49*
Dermaptera			
Forficulidae	2	12	0.31*
Hymenoptera			
Formicidae	7	15	0.87
Vespidae	3	6	0.94
Apidae	1	4	0.47
Orthoptera			
Gryllidae	1	10	0.19*
Total	63	117	

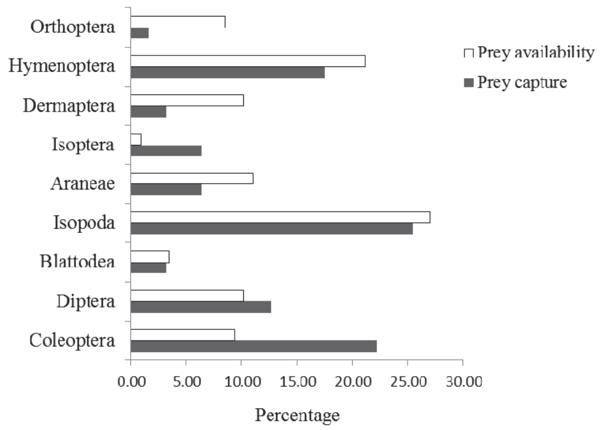

Figure 1. Different prey types found in the diet of the spider *Latrodectus geometricus*. For each taxon: upper row (white), potential prey availability; lower row (black), prey captured.

Material and Methods

Study area

The study was conducted in Iquique city in northern Chile (20°13'20.11"S; 70° 8'46.52"W) in an urban area (1000 m^2) of desert climate with an annual average temperature of 22.6 °C (Relative humidity: 65%). The field work comprised seven sampling dates during summer of 2015 (January-February), where the first author made weekly visits in buildings of the city. We chose this period, as the period of greatest activity of these spiders in Chile.

Field observation

When a web was found, we collected all prey items that had been captured by the spiders. This was achieved by picking the preys off the webs with specialized forceps. We use chlorine bleach for dissolve the spider silk and subsequently identify the prey caught in the webs (Vetter *et al*., 1996). Specimens were preserved in 70% ethyl alcohol. All prey items were identified at the order/family level. Prey remains are kept in the spider's web, which facilitates the assessment of diet composition. The diet of the brown widow spider was compared with the prey availability (PA) to determine whether spiders prefer particular prey. We did not distinguish webs of adults and juveniles, nor if the spider present in the web was the same in successive samples following the procedure of Fisher *et al.* (2006). We considered as potential prey the arthropod present in the same microhabitat as *L. geometricus*; these animals were collected through visual search and with the use of forceps and fixed in 70% alcohol.

Diet analysis

We quantified the degree of variation of prey composition using Levins' standardized index of diet breadth, BA= $((1/\Sigma pi^2) - 1)/(n - 1)$, where pi is the proportion of prey items from prey type i, and n is the total number of prey types (Hurlbert, 1978). This index ranges from 0 to 1, with values close to 0 indicating that a predator consumes few prey types in high proportions (specialist predators) and higher values indicating generalist diets (Krebs, 1989). Selectivity was quantified using the Wi Savage's index, and significance of selection evaluated by X^2 test (Manly *et al*., 1993).

Results

We found nine arthropod orders both in the webs as in the micro-habitat (Table I). In total we collected and identified 63 preys of *L. geometricus* and 117 potential preys. The prey composition was variable but the spiders prey mostly Coleoptera (22.22%) and Isopoda (25.42%) followed by Hymenoptera (17.46%) and Diptera (12.70%); on the other hand, in the micro-habitat there are a high availability of Isopoda (26.96%) and Hymenoptera (21.19%) as potential prey (Figure 1). The most common preys in the webs were beetles and woodlice reaching 49.21 % of the total preys. Predatory arthropods (Araneae) as *Loxosceles laeta* (Sicariidae) and *Steatoda grossa* (Theridiidae) were present in the same micro-habitat as potential prey, but only *L. laeta* was present in the webs of the brown widow. The diet breadth of *L. geometricus* at the study site was 0.54 (standardized Levin's index, BA). We found a significant positive selection to Elateridae (S= 3.75), Curculionidae (S=7.49) and Kalotermitidae (S = 7.49) (X^2 = 63.89, gl = 14, p<<0.05). In contrast, Orthoptera (Gryllidae), Araneae (Theridiidae) and Dermaptera (Formiculidae) was consistently rejected, while for the other preys was not selection (Table I).

Discussion

This study presents detailed data of the diet composition of *L. geometricus* in Chile. We found that the brown widow is a polyphagous spider that consume a wide range of arthropods, but is not generalist (BA= 0.54). This spider obtain their primarily sources of prey from two orders: Coleoptera and Isopoda, where the prey are almost exclusively ground-dwelling arthropod, preferentially with nocturnal activity (coinciding with the spider activity). Althouhg its condition as polyphagous species our results show that this spider selects insects of Elateridae (Coleoptera), Curculionidae (Coleoptera) and Kalotermitidae (Isoptera) families. Particular prey taxa are often disproportionate represented in the diets of many polyphagous spider species (Nyffeler, 1999), as was found in this study. Other *Latrodectus* species have also a polyphagous diet, and has been reported that the prevalent prey type is Coleoptera (Exline & Hatch, 1934; Shulov, 1940; Hódar & Sánchez-Piñero, 2002; Rossi & Godoy, 2005; Salomon, 2011; Jackson, 2013), in this sense; our data are consistent with the literature. Another interesting aspect is the large presence of woodlice in the diet what could be a dietary supplement for these spiders. Similar results have been found in *Latrodectus lilianae* Melic, 2000 (Hódar & Sánchez-Piñero, 2002) where these arthropods are quite numerous in their webs. The abundance of these arthropods in the habitat could facilitate predation, although not necessarily constitute a preferred prey. For example, other synantrophic spiders of the same genus as *Latrodectus mactans* (Fabricius, 1775) and *Latrodectus hesperus* often consume isopods, but Coleoptera remain mostly preferred prey (Exline & Hatch, 1934; Salomon, 2011). In this context, it is know that the polyphagy provides access to a variety of nutrients that usually are not obtained through a single prey source, which could enhance growth rates and juvenile survival (Toft & Wise, 1999). Furthermore, these results differ from those found in *Latrodectus mirabilis*, a specialist predator, that consume mainly ants (Formicidae, Hymenoptera), who represented more than 86% of the total, exhibiting narrow diet breadth (Pompozzi *et al.,* 2013).

We found intra-guild predation, but the spiders represent a low percentage in the diet of the brown widow spider, similar to that found in other species of the genus (Nyffeler *et al.,* 1988; Hódar & Sánchez-Piñero, 2002; Salomon, 2011; Pompozzi *et al.,* 2013). Some juveniles of Chilean recluse spiders (*Loxosceles laeta*) were found in the webs. The intraguild predation often occurs in age/size structured populations of generalist predators (Polis, 1988): "*it is common that a species may eat a competitor that is at a younger stage of development*". However, the advantage of eating potential competitors implies some risks, because the widow spiders may itself be killed by the prey (Hódar & Sánchez-Piñero, 2002), what might happen often.

In conclusion, we can say that the brown widow spider is a polyphagous predator; however this spider prefers mainly Coleoptera. Occasionally could eat other insects (*e.g*., ants, bees and flies) and substantially abundant crustaceous as woodlice. Although the evidence presented is limited to a small number of samples, they represent the first prey identified that consumes *L. geometricus* in Chile, allowing preliminarily define the assembly of species caught. The results of this study invite further research related to the feeding ecology of this species, especially in the possible variation in the diet composition in different stages of development and how these might vary seasonally in the northern Chile.

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