

NOTES ON THE DIET OF THE MEDITERRANEAN BLACK WIDOW *LATRODECTUS TREDECIMGUTTATUS* (ROSSI, 1790) (ARANEAE: THERIDIIDAE) IN SOUTH WESTERN IBERIAN PENINSULA

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ABSTRACT

Predators play important roles in ecosystems due to their effects on the diversity and abundance of prey communities and, ultimately, on ecosystem functions. To understand the ecology of the predatory behavior of different groups of animals and their impact on prey communities, knowledge of prey composition is essential. The aim of this study was to determine the diet composition of a predatory arthropod, the Mediterranean black widow *Latrodectus tredecimguttatus* (Rossi, 1790), in the Iberian Peninsula. We found that *L. tredecimguttatus* may be considered a stenophagous generalist predator, feeding on nine different arthropod orders (Araneae, Coleoptera, Hemiptera, Hymenoptera, Julida, Mantodea, Orthoptera, Scorpiones and Solifugae). Hymenoptera (mostly ants) were the most common prey (58.9% of prey items) and Coleoptera (mostly Tenebrionidae) was the second most frequent (33.5% of prey items). Besides, we also found evidence of intraguild predation in this species. With this study, we contribute to the knowledge of *L. tredecimguttatus* ecology in the Iberian Peninsula, highlighting its role as a predator of diverse arthropods, including spiders and other predators.

Keywords: ecology; intraguild predation; niche breadth; predation; prey composition.

RESUMEN

Notas sobre la dieta de la viuda negra mediterránea *Latrodectus tredecimguttatus* (Rossi, 1790) (Araneae: Theridiidae) en el suroeste de la península ibérica

Los depredadores juegan un importante papel en la dinámica ecosistémica a raíz de los efectos que producen en la abundancia y diversidad de presas y, en última instancia, en las funciones del ecosistema. Para comprender la ecología del comportamiento depredador de los distintos grupos animales, así como su impacto en las comunidades de presas, es imprescindible conocer la composición de especies presa. El propósito de este estudio ha sido determinar la composición de la dieta de un artrópodo depredador, la viuda negra mediterránea *Latrodectus tredecimguttatus* (Rossi, 1790) en la península ibérica. Encontramos que *L. tredecimguttatus* puede considerarse un depredador generalista estenófago, que se alimenta de nueve órdenes distintos de artrópodos (Araneae, Coleoptera, Hemiptera, Hymenoptera, Julida, Mantodea, Orthoptera, Scorpiones y Solifugae). Los himenópteros (en su mayoría hormigas) fueron las presas más comunes (58.9% del total) y los coleópteros (en su mayoría Tenebrionidae) fueron los segundos más comunes (33.5% del total). Además, hemos encontrado evidencias de depredación intra-gremio en esta especie. Con este trabajo, se contribuye al conocimiento de la ecología de *L. tredecimguttatus* en la península ibérica, destacando su papel como depredador de diversos artrópodos, donde se incluyen arañas y otros depredadores.

Palabras clave: ecología; depredación intra-gremio; amplitud de nicho; depredación; composición de presas.

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Introduction

Spiders (Araneae) constitute a large group of predatory arthropods, as they are located on the top trophic levels of many invertebrate food webs. This group has adapted to many habitats and ecological niches, developing different feeding behaviors depending on the species life-history (Wise, 1993). They are predominantly generalist polyphagous predators capable of feeding on a wide variety of insects and other arthropods (Hayes & Lockley, 1990), thus providing access to different nutrients that are not commonly found in a single prey species (Toft & Wise, 1999). However, a minority of spider species are specialists, such as ant-eating spiders (Cushing, 2012). Furthermore, species from this order use different prey-capture methods, classified broadly in two groups: web-building and non-web-building (hunting) spiders (Uetz, 1991). As for web building spiders, they construct complex webs using thread which is produced from their silk glands, and its web structure ranges from simple to complex two- and three-dimensional designs. The main function of this silken structure is to trap prey (mostly insects) and to transmit vibrations to the resident spider (Vollrath, 2005).

The black widow spider genus *Latrodectus* Walckneer, 1805 is included among the groups of generalists and web-building spiders. It constitutes one of the best-studied spider genera as it entails medical importance due to the potential danger of its venom for large mammals, including humans (Garb *et al.*, 2004). This genus is represented by about 32 recognized species that are distributed worldwide (World Spider Catalog, 2020). Of these 32 species, only *Latrodectus tredecimguttatus* (Rossi, 1790) and *L. lilianae* (Melic, 2000) co-exist in the Iberian Peninsula, and these can be easily differentiated based on opisthosomal coloration. *L. tredecimguttatus* is widely distributed in this territory, with a seasonal activity period from May to November. This species builds simple nests very close to the ground under stones or branches, with bell-shaped three-dimensional webs, where it waits for prey to be trapped (Melic, 2000).

Regarding the diet composition of *Latrodectus* species, a number of studies have been carried out in different countries: Shulov (1940) on *L. tredecimguttatus* in Palestine; Shulov & Weissmann (1959) on *L. pallidus* O. Pickard-Cambridge, 1872, *L. revivensis* Shulov, 1948 and *L. tredecimguttatus* in Israel; Ross (1981), Mackay (1982) and Salomon (2011) on *L. hesperus* Chamberlin et Ivie, 1935 in North America; Nyffeler *et al.* (1988) and Rocha-Dias & Kobler (1999) on *L. mactans* (F.) in USA and Brazil, respectively; Pompozzi *et al.* (2013) on *L. mirabilis* (Holmberg, 1876) in Argentina and Taucare-Ríos & Canals (2015) on *L. geometricus* C. L. Koch, 1841 in Chile. In the Iberian Peninsula, only Hódar & Sánchez-Piñero (2002) investigated *L. lilianae*. All of

these studies have shown that *Latrodectus* diet consists mainly in Coleoptera and Formicidae, with other prey groups being much less common.

In order to understand the ecology and the predatory behavior of the different groups of spiders, knowledge of prey composition is essential. Following the work of researchers cited above about *Latrodectus* diet, the aim of this study was to determine the diet composition of the Mediterranean black widow *L. tredecimguttatus* in South Western Iberian Peninsula during the summer and early autumn period.

Material and methods

The fieldwork was carried out in the Llanos de Olivenza area, near the locality of Olivenza (south-western Spain) from July to October 2019, where a population of *L. tredecimguttatus* was previously recorded (Mora-Rubio & Pérez-Bote, 2018). During this period, most of adult black widows were active, with well-developed webs and they had produced their egg sacs. The climate is typically Continental-Mediterranean, with relatively cold wet winters and dry hot summers. Specifically, the *L. tredecimguttatus* population was located in a holm-oak dehesa of *Quercus ilex* subesp. *ballota* L. (38°41'0.7" N, 7°06'0.1" W, 267 m alt.) with low bovine cattle, and with abundant *Ulex eriocladus* (C. Vicioso) shrubs. All individuals were found in an arid hollow with low herbaceous plants and shrubs, used as a cattle pond (dry during the study period), or surrounding this area.

The study area was sampled weekly in search of black widow webs throughout the study period. During these months, new occupied webs were discovered and recorded. From each web, all prey items that remained in the nest silk were collected, trying to disturb the spiders as little as possible, and they were analyzed and identified in the laboratory using a stereoscopic binocular microscope IBD45B.

The dietary niche breadth of *L. tredecimguttatus* at the study area was calculated using the standardized Levins' index (B_A) as $B_A = [(1/\sum p_i^2) - 1] / (n - 1)$. This index indicates how uniformly resources are used for the studied group, where p_i is the proportion of consumed prey of the prey category i and n is the total number of prey categories available. The range of B_A varies from 0, when the population uses one prey category exclusively, to 1, when the population uses all prey categories in equal proportions (Feinsinger *et al.*, 1981).

Results

A total of 15 webs of adult females *L. tredecimguttatus* were found throughout the study period. Some of the individuals died of natural causes,

and only 3 specimens survived until the end of the fieldwork (late October). 7 out of 15 webs were found in natural cavities (lagomorph excavations, small slopes or little holes as a result of cattle trampling) (Fig. 1) or artificial ones (holes in the ground as a result of a local soil plow); 7 out of 15 were found beneath small *Ulex eriocladius* shrubs; and only 1 out of 15 was found beneath a rock.

We collected a total of 355 prey items from nine different arthropod orders (Araneae, Coleoptera, Hemiptera, Hymenoptera, Julida, Mantodea, Orthoptera, Scorpiones and Solifugae) during the three months of fieldworks, whose abundance data are represented in detail in Table 1 and Figure 2. The dietary niche breadth of *L. tredecimguttatus* (B_A) was 0.146, indicating that a large proportion of its diet is comprised of a few prey orders while others are less represented in the diet.

Of the two major prey orders [Hymenoptera (58.9%) and Coleoptera (33.5%)], most hymenopteran prey items were ants (Formicidae) (97.6%) and the family Tenebrionidae (75.6%) predominated in coleopteran prey items.

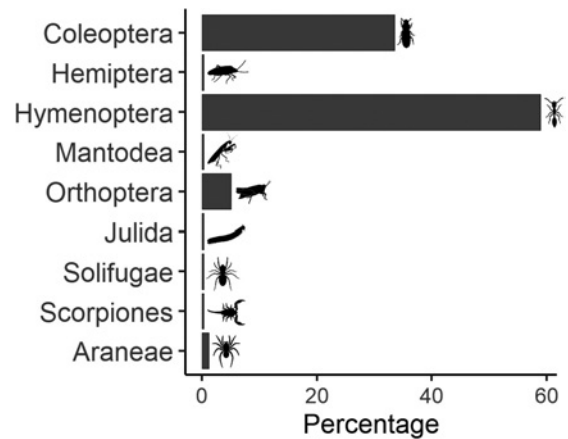


Fig. 2.— Abundance of different prey orders (%) found in *L. tredecimguttatus* webs.

Fig. 2.— Abundancia de los distintos órdenes de presas (%) encontradas en redes de *L. tredecimguttatus*.

Discussion

Our results showed that *L. tredecimguttatus* can be classified as a stenophagous generalist predator

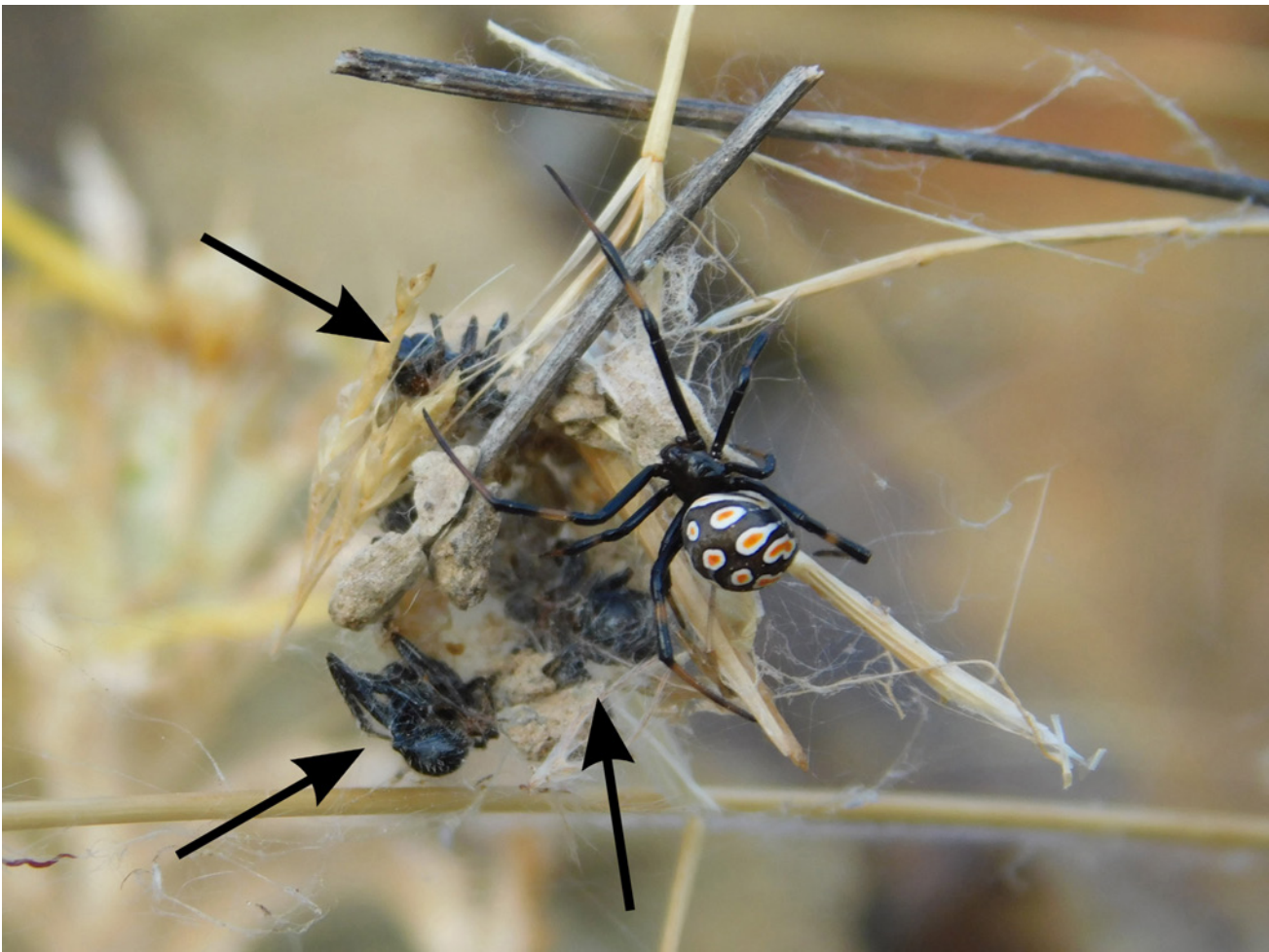


Fig. 1.— Female of *L. tredecimguttatus* in the study area. Arrows point to prey (ants) captured in the web.

Fig. 1.— Hembra de *L. tredecimguttatus* en la zona de estudio. Las flechas señalan las presas (hormigas) capturadas en la tela.

Table 1.— Composition of captured prey by 15 female *L. tredecimguttatus* individuals at a site near Olivenza, southwestern Spain, between July and October 2019.

Tabla 1.— Composición de la presas capturadas por 15 hembras de *L. tredecimguttatus* en una zona cercana a Olivenza, suroeste de España, entre julio y octubre de 2019.

Prey Order	Prey Family	Prey Species	Prey number	%
	Buprestidae	<i>Acmaeoderella</i> sp. Cobos, 1955	1	0.282
	Carabidae	<i>Steropus ebenus</i> (Quensel, 1806)	2	0.563
		<i>Coniocleonus nigrosuturatus</i> (Goeze, 1777)	1	
	Curculionidae	<i>Cycloderes</i> sp. Sahlberg, 1823	13	5.352
		Indet.	5	
	Meloidae	<i>Berberomeloe castuo</i> Sánchez-Vialas, 2019	1	0.282
	Scarabaeidae	Indet.	3	0.845
		<i>Alphasida</i> sp. Escalera, 1905	4	
		<i>Blaps hispanica</i> Laporte, 1840	1	
		<i>Crypticus</i> sp. Latreille, 1817	20	
		<i>Micrositus</i> sp. Mulsant & Rey, 1854	3	
		<i>Misolampus</i> sp. Latreille, 1807	1	
	Tenebrionidae	<i>Pimelia evorensis</i> Reitter, 1916	1	25.35
		<i>Scaurus uncinus</i> (Forster, 1771)	36	
		<i>Sepidium bidentatum</i> Solier, 1843	11	
		<i>Tentyria</i> sp. Latreille, 1802	12	
		Indet.	1	
	Indet.	-	3	0.845
Hemiptera	Lygaeidae	<i>Xanthochilus saturnius</i> (Rossi, 1790)	1	0.282
	Formicidae	<i>Messor barbarus</i> Linnaeus, 1767	96	57.46
		Indet.	108	
		<i>Ronisia</i> sp. Costa, 1858	1	
	Mutillidae	<i>Tropidotilla litoralis</i> (Petagna, 1787)	1	1.127
		Indet.	2	
	Tiphiidae	<i>Meria</i> sp. Illiger, 1807	1	0.282
Mantodea	Indet.	-	1	0.282
		<i>Calliptamus</i> sp. Serville, 1831	5	
	Acrididae	<i>Doclostaurus genei</i> (Ocskay, 1832)	12	5.07
		Indet.	1	
Julida	Indet.	-	1	0.282
Solifugae	Daesiidae	<i>Gluvia dorsalis</i> (Latreille 1817)	1	0.282
Scorpiones	Buthidae	<i>Buthus</i> sp. Leach, 1815	1	0.282
	Sparassidae	<i>Eusparassus dufouri</i> Simon, 1932	1	0.282
Araneae	Salticidae	Indet.	1	0.282
	Indet.	-	2	0.563

($B_A = 0.146$), a trophic category which includes species with generalized adaptations and with a narrow diet breadth in which predominates a certain taxon (Pekár & Toft, 2015). Nonetheless, their diet is polyphagous, given that the spiders preyed upon nine different arthropod orders during the study period (Araneae, Coleoptera, Hemiptera, Hymenoptera, Julida, Mantodea, Orthoptera, Scorpiones and Solifugae). The most abundant order was Hymenoptera (58.9%)

followed by Coleoptera (33.5%). These results are consistent with previous works on *Latrodectus* species whose diet was composed mainly of ants, like *L. pallidus* (Shulov & Weissmann, 1959), *L. mactans* (75% of the total prey items) (Nyffeler *et al.*, 1988) and *L. mirabilis* (>86%) (Pompozzi *et al.*, 2013). Nevertheless, Coleoptera and Isopoda were the most frequent prey orders in the diets of *L. lilianae* and *L. geometricus*, representing 65-82% and 47.64% of the

prey total for these two species-respectively (Hódar & Sánchez-Piñero, 2002; Taucare-Ríos & Canals, 2015). Moreover, Coleoptera was the most common in the diet of *L. hesperus* (61%), followed by Hymenoptera (26%) (Salomon, 2011). In other studies of this species, Shulov (1940) and Shulov & Weissmann (1959) also discovered that Tenebrionidae and Formicidae were the most-abundant prey families consumed, so we conclude that *L. tredecimguttatus* feeds primarily on these two insect groups. Notwithstanding, we would not know if these prey families are selected among others since no prey abundance or availability were sampled in this study.

In addition, the diet composition of black widows may depend on a variety of factors. First, widow spiders do not actively select prey but rather sit and wait for individuals that, when walking through the area, are trapped in the capture web (Hódar & Sánchez-Piñero, 2002). In addition, web location (very close to the ground) makes epigeic prey more likely to be captured. Thus, their diet will depend on the arthropod fauna available surrounding the web. Moreover, the faunal composition varies between regions and habitats (e. g. Rosenzweig, 1995; Hillebrand, 2004), so it is not rare to find differences in prey order composition and abundance between *Latrodectus* species and across habitats. Nevertheless, there is a consistent pattern of ants and Coleoptera as the dominant prey groups in *Latrodectus* diets.

Moreover, other factors such as habitat characteristics and prey ecology must be considered, since seasonal patterns of prey affect their availability in an area (McReynolds & Polis, 1987; Uetz, 1990; Hódar & Sánchez-Piñero, 2002). Most of the previous works of *Latrodectus* diets took place over a longer period or in different months than the current study when focused on species that differ in the activity period from *L. tredecimguttatus*. In contrast to these works, the prey composition of our study was made up of species whose activity period overlaps with late summer, like different families of Arachnida, most Hymenoptera, Orthoptera, or Tenebrionidae beetles. For example, the order Isopoda, whose activity is limited by the humidity of the environment (García, 2015), was detected in great abundance in the *L. lilianae* diet (Hódar & Sánchez-Piñero, 2002) during a year of sampling, while no individuals of that order were found in this study. Extreme and dry weather conditions of Extremadura in 2019 during the four summer-autumn months of sampling or the presence of different Isopoda species with different ecology could explain this absence. In contrast, ants were very abundant in the area throughout the study period, as were Tenebrionidae (Mora-Rubio & Parejo-Pulido, pers. obs.), so they were the most available prey for the spiders in the environment (although not necessarily a preferred prey), and this could explain the low value of B_A .

Additionally, we found that other predators such as mantids, scorpions, solpugids and other spiders are included in the black widow diet. These results support other works that found intraguild predation, often of immature prey stages, in generalist predators (Polis, 1988) and even in *Latrodectus* species (Shulov, 1940; Shulov & Weissmann, 1959; Nyffeler *et al.*, 1988; Hódar & Sánchez-Piñero, 2002; Salomon, 2011; Pompozzi *et al.*, 2013). In this way, potential competitors are eliminated, although there are risks of being killed by the prey.

In conclusion, we found that *L. tredecimguttatus* can be considered a stenophagous generalist predator, whose diet consists mainly of Hymenoptera (mostly ants) and Coleoptera (mostly Tenebrionidae). This study contributes to the knowledge of the ecology of this Mediterranean species in the Iberian Peninsula, highlighting its role as a predator of diverse arthropods, including spiders and other predators.

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