Title page

What's On The Menu Today? First Report of Nectarivory for *Rhynocorus cuspidatus* (Hemiptera: Reduviidae)

Running head title

First Report of Nectarivory for *Rhynocorus cuspidatus*

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None conflicts to our knowledge, no special approval required

Contribution of authors

Maria Pizarro-Borrull drafted the initial manuscript. Mario Alamo collected the field data and provided critical insights into the ecological interpretation of the observations. Both authors collaboratively revised and refined the manuscript, contributing to the development of the final version.

ABSTRACT

This study reports the first observation of nectarivory in the predator reduviid *Rhynocoris cuspidatus* (Ribaut, 1921) in Spain. One individual of *R. cuspidatus* was observed sucking nectar from a *Jacobeae vulgaris* Gaertn flower inflorescence in a grassland meadow in Berrecil de la Sierra (Spain). Our observation suggested that *R. cuspidatus* can use floral resources to obtain sugar or moisture during extreme climate conditions, such as the Mediterranean summer.

Keywords. Mediterranean ecosystems, Zoophytophagy, Assassin bug, Trophic interactions, Floral resources scarcity

INTRODUCTION

The use of auxiliary trophic resources can be crucial for survival in climates such as the Mediterranean, where summers are characterized by a marked scarcity of trophic and water resource (García-Ruíz et al. 2011; Lionello et al. 2006; Seager et al. 2019). Under such extreme conditions, heteropterans are compelled to explore alternative food sources, demonstrating remarkable trophic plasticity. For instance, some species have been observed shifting their trophic roles, with herbivores feeding on carrion (Alamo & Cepeda 2024) or carnivores consuming plant-based resources, such as through phytophagy or nectarivory. These unconventional strategies have been shown to confer significant benefits, including increased survival, higher fecundity rates, and shorter development times (Coll 1998; Naranjo & Gibson, 1996; Ruberson et al. 1986).

One such adaptive strategy observed in predatory insects is zoophytophagy, where carnivores exploit plant-based resources under extreme conditions (Torres & Boyd 2009). These interactions can involve feeding on plant tissues (phytophagy) or consuming nectar from flowers (nectarivory). Reports of phytophagy include *Podisus maculiventris* nymphs (Pentatomidae) (Ruberson et al. 1986), *Geocoris punctipes* and *G. pallens* (Geocoridae) (York, 1944), and *Nesidiocoris tenuis* (Miridae) (Sanchez 2008). Nectarivory has also been observed in *Heniartes erythromeus* and *Zelus armillatus* (Reduviidae) (Gil-Santana & Keller 2022).

Reduviidae (Hemiptera: Heteroptera), also known as assassin bugs, is one of the most diverse groups of Heteroptera, with approximately 6,800 described species distributed worldwide (Hwang & Weirauch 2012), being the largest family of predaceous

terrestrial Heteroptera (Costa et al. 2022). Reduviids are obligate zoophages with remarkable predatory behaviour (Guillermo-Ferreira et al. 2012; Torres & Boyd 2009). Most reduviids exhibit a generalist diet, but some specialize in certain taxonomic groups (Evangelin et al. 2014). Nonetheless, cases of phytophagy and nectarivory have been observed, particularly among species in the Harpactorini tribe of the Harpactorinae subfamily (Gil-Santana & Keller 2022). *Atrachelus cinereus* (Fabricius, 1798) has been recorded feeding on pollen and plant seeds (Stoner et al. 1975), *Atopozelus opsimus* (Elkins, 1954) on extrafloral nectaries (Guillermo-Ferreira et al. 2012), and *Zelus versicolor* (Herrich-Schaeffer, 1848) sucking nectar from *Oxypetalum balansae* (Gil-Santana & Keller 2022), among others.

The genus *Rhynocoris* (Reduviidae: Harpactorinae) comprises *circa* 150 species worldwide (Putshkov & Moulet 2009), four of which are present in the Iberian Peninsula: *Rhynocoris annulatus* (Linnaeus, 1758), *R. cuspidatus* Ribaut, 1921, *R. erythropus* (Linnaeus, 1767), and *R. iracundus* (Poda, 1761) (Goula et al. 2020; Vivas & López Gallego 2013). However, only one record of phytophagy (nectarivory) has been documented for this genus: *R. erythrophus* feeding on *Verbascum* sp. flowers in southern Spain (Baena 2011).

This study presents the first observation of nectarivory in *R. cuspidatus* (Ribaut, 1921) feeding on capitulos of *Jacobaea vulgaris* Gaertn during the Mediterranean summer in the Iberian Peninsula, highlighting a zoophytophagous strategy in this carnivorous species.

MATERIAL AND METHODS

The study was conducted in the vicinity of Arroyo de la Angostura (Becerril de la Sierra, Madrid, Spain; 40.725917N, 3.9925W) (Fig. 1). Plant diversity was assessed during the last week of June 2023 using a 20 × 5 m transect, as part of a broader study on flower-butterfly trophic networks being carried out in the area of the interaction. The study site is characterized as open scrubland, dominated primarily by *Juniperus oxycedrus* and *Cistus ladanifer*, with less abundant representation of *Thymus vulgaris* and *Lavandula pedunculata*. The arboreal stratum is sparsely populated by holm oaks (*Quercus ilex*). By late June, the area exhibited a high diversity of floral resources, including both shrubs (*Rosa canina*, *Rubus ulmifolius*) and herbaceous species such as *Daphne gnidium*, *Leontodon saxatilis*, *Senecio squalidus*, *Anthemis arvensis*, *Crepis*

capillaris, *Lavandula stoechas*, *Verbascum pulverulentum*, *Hirschfeldia incana*, and *Convolvulus arvensis*, among others. Plant species were identified using morphological keys (Flora Iberica) and geographic and visual identification systems (Pl@ntNet).

The streambed is not an active stream but rather an area with highly waterlogged soil. Human activities, primarily cattle grazing, are common in the study area.

The reduviid was identified through photographs taken in the field, following the taxonomic keys of Putshkov & Moulet (2009).

RESULTS

The observation occurred at 10:43 a.m. on 19 July 2023, during a heat wave. Weather conditions were predominantly sunny, with 20–30% cloud cover, and a recorded temperature of 29.2°C (AEMET, 2025). An individual of *R. cuspidatus* was observed feeding on an open capitulum of *Jacobaea vulgaris*. A significant amount of pollen was visible on the rostrum, indicating active feeding behavior (Fig. 2). Shortly after the photograph was taken, the individual ceased feeding and flew away.

Other *J. vulgaris* plants in the study area were found hosting *Tyria jacobaeae* caterpillars (Linnaeus, 1758) (Fig. 3). However, it is noteworthy that the *J. vulgaris* plant on which *R. cuspidatus* was observed did not host any *T. jacobaeae* caterpillars. Most flowering plants recorded during June had either lost their flowers by the time of the observation, highlighting the scarcity of viable floral resources in the area during the peak of summer.

DISCUSION

Phytophagy and nectarivory behaviors have been reported in several reduviids, but there is limited information regarding the ecological context and motivations behind plant feeding in these generalist predators. Multiple hypotheses have been proposed, including the use of plants as additional sources of water or sugar (Baena 2011; Bérenger & Pluot-Sigwalt 1997; Stoner et al. 1975), as an alternative resource during prey scarcity (Sanchez 2008), or as a safer feeding strategy compared to hunting (Guillermo-Ferreira et al. 2012).

Although *R. cuspidatus* is primarily an insect predator, preying on species such as honey bees, its nectarivory behavior can be explained through several hypotheses. One possibility is that plant feeding provides an alternative source of water during arid conditions, as suggested for *R. erythropus* in Jaén, Spain (Baena 2011). However, despite the heat wave affecting the Iberian Peninsula, the study site maintained relatively moist conditions, likely due to water infiltration from Arroyo de la Angostura, which sustained a humid microenvironment. Given these conditions, it seems unlikely that the observed individual was feeding on *J. vulgaris* solely to obtain water. Instead, feeding for sugar acquisition should be considered, as similar behaviors have been documented in other reduviids (Bérenger & Pluot-Sigwalt 1997).

The observed individual of *R. cuspidatus* was feeding on the capitulum of the toxic plant *J. vulgaris*, which contains pyrrolizidine alkaloids (PAs). These compounds are known to deter or intoxicate generalist herbivores (Harper & Wood 1957; Hartmann & Ober 2000; Kalač & Kaltner 2021). Despite its toxicity, some pollinators, such as Lepidoptera and Coleoptera, tolerate PAs and even utilize them as defense compounds against predators (Hartmann & Ober 2000; Nishida 2002). If *R. cuspidatus* was indeed using *J. vulgaris* as a food resource, it would likely require a tolerance mechanism for PAs. However, the position of *R. cuspidatus* on the plant suggests that it may have been primarily using the capitulum as a hunting perch, with nectar feeding as a secondary behavior.

Many species of *Rhynocoris* (e.g., *R. iracundus*, *R. erythropus*), including *R. cuspidatus* (Baena 2011), have been observed using plant inflorescences as hunting spots, primarily preying on pollinators (Baena 2011; Gil-Santana & Alves 2011; Miller 1953; Putshkov & Moulet 2009). During this observation, other *J. vulgaris* plants in the study area hosted *T. jacobaeae* caterpillars, while the plant where *R. cuspidatus* was observed did not. This suggests that *R. cuspidatus* could potentially use *J. vulgaris* as a hunting platform to prey on *T. jacobaeae* caterpillars, which are the primary herbivores of this plant (Joshi & Vrieling 2005). If this were the case, *R. cuspidatus* would require a mechanism to tolerate PAs, as *T. jacobaeae* caterpillars sequester these toxic compounds from *J. vulgaris* (Aplin et al. 1968). However, no records of *R. cuspidatus* preying on these caterpillars currently exist.

By late July, flowering plants become scarce due to the summer drought and intensive grazing in the area. Under these conditions, non-palatable plants such as *J. vulgaris* and other Asteraceae were among the few floral resources available, limiting

access for animals. In this context, *R. cuspidatus* likely used *J. vulgaris* both as a secondary food resource for sugar and as a hunting platform, waiting for potential prey such as butterflies and beetles feeding on the plant's flowers.

This is the first report of *R. cuspidatus*, a predatory reduviid, feeding on nectar from *J. vulgaris* in Spain. The evidence suggests that the reduviid utilized the plant as an alternative resource to obtain sugar and moisture during the Mediterranean summer, while simultaneously using the capitulum as a hunting perch.

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276

277 **FIGURES**

278

279 **Fig 1.** Habitat surrounding the recorded trophic interaction at Arroyo de la Angostura,
280 19th July 2023. © M-A

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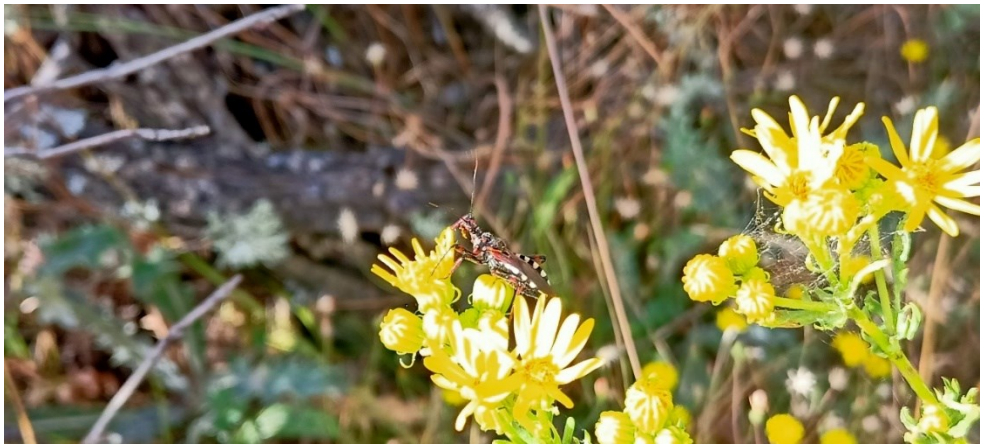

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283 **Fig 2.** Observation of *Rhynocoris cuspidatus* with its rostrum covered in pollen after
284 inserting it into the inflorescence of a capitulum of *Jacobaea vulgaris*. © M-A

Fig 3. *Jacobaea vulgaris* plant hosting *Tyria jacobaeae* caterpillars in the vicinity of Arroyo de la Angostura, 19th July 2023. © M-A