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ARTÍCULO DE INVESTIGACIÓN

Antlions (Myrmeleontidae) of Doñana National Park (Spain)

Hormigas león (Myrmeleontidae) del Parque Nacional de Doñana (España)

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ABSTRACT

This study represents the first list of antlions (Myrmeleontidae) in Doñana National Park, conducted across 58 sampling locations during two field seasons (April-June 2023 and March-July 2024). A total of 12 species from 9 genera were identified, with 406 larval-stage specimens collected, of which 295 successfully emerged as adults (201 females and 94 males). The altitudes of collection locations ranged from 2 to 38 m a.b.l., reflecting the diverse landscapes of the Park. These findings enhance knowledge of the Neuroptera biodiversity in the region. Notably, this research documents the first records of *Distoleon tetragrammicus* and *Neuroleon ocreatus* in Huelva province, expanding their known distribution ranges. Our results highlight shrublands and grasslands as key habitats for antlion colonization. These biotopes provide optimal conditions for larval development due to fine soil textures and high prey availability. While most species occupied distinct ecological niches, *Myrmeleon hyalinus*, *M. almohadarum*, and *M. gerlindae* were observed coexisting in different biotopes, with spatial segregation driven by ecological requirements and competition. This study establishes a foundational species inventory for Doñana National Park and underscores the importance of continued monitoring to assess ecological dynamics and species interactions. Future research should focus on resource competition, habitat preferences, and the impacts of environmental changes to further understand Myrmeleontidae adaptation and biodiversity within this protected area.

Keywords: diversity, grasslands, habitat, larval development, Mediterranean, Myrmeleontidae, shrublands.

RESUMEN

Este estudio representa la primera lista exhaustiva de las hormigas león (Myrmeleontidae) del Parque Nacional de Doñana, realizado en 58 puntos de muestreo durante dos temporadas de campo (abril-junio de 2023 y marzo-julio de 2024). Se identificaron un total de 12 especies de 9 géneros, con 406 especímenes en fase larval capturan, de los cuales 295 emergieron como adultos (201 hembras y 94 machos). Las altitudes de los puntos de recolección variaron entre 2 y 38 m s.n.m., reflejando los diversos paisajes del Parque. Estos hallazgos mejoran el conocimiento sobre la biodiversidad de Neuroptera en la región. Es destacable el primer registro de las especies *Distoleon tetragrammicus* y *Neuroleon ocreatus* en la provincia de Huelva, ampliando sus rangos de distribución conocidos. Los resultados destacan que los matorrales y los pastizales son hábitats clave para la colonización de hormigas león. Estos biotopos proporcionan condiciones óptimas para el desarrollo larval debido a la textura fina del suelo y la alta disponibilidad de presas. Aunque la mayoría de las especies ocuparon nichos ecológicos distintos, se observó la coexistencia de *Myrmeleon hyalinus*, *M. almohadarum* y *M. gerlindae* en diferentes biotopos, con una segregación espacial impulsada por requerimientos ecológicos y competencia. Este estudio establece un inventario de especies de Myrmeleontidae para el Parque Nacional de Doñana y subraya la importancia de un monitoreo continuo para evaluar las dinámicas ecológicas y las interacciones entre especies. Las investigaciones futuras deberían centrarse en la competencia por los recursos, las preferencias de hábitat y los impactos de los cambios ambientales para comprender mejor la adaptación de *Myrmeleontidae* y la biodiversidad dentro de esta área protegida.

Palabras clave: diversidad, pastizales, habitat, desarrollo larval, Mediterráneo, Myrmeleontidae, matorrales.

INTRODUCTION

Antlions (Myrmeleontidae) belong to the infra-order Neuropterida and constitute the most diverse family within Neuroptera. Over 2000 species of this family have been described worldwide (ASPÖCK *et al*., 2001; ACEVEDO *et al*., 2013). Antlions are distributed across all continents, except Antarctica, with primary distribution centers in Asia and Africa. Additionally, they are found to a lesser extent in Australia and the Americas. In Europe, the Mediterranean region is the center of antlion distribution and exhibits the highest species diversity (ASPÖCK *et al*., 1980; MONSERRAT, 2022).

The family Myrmeleontidae has a rich biodiversity in the Mediterranean region, with several genera and species recorded from the Iberian Peninsula and nearby regions. According to Monserrat (2022), 27 species belonging to 15 genera of antlions are known from the Iberian Peninsula, with a high degree of specialization to specific habitats, particularly in dry and sandy environments. More generally, the Mediterranean basin, with its varied climatic conditions, supports a wide range of antlion species, including those that thrive in coastal sand dunes, shrublands, and grasslands. Many of these species are adapted to arid and semi-arid environments, where they utilize sand to construct conical pit traps that are effective for ambush predation. These habitats, characterized by open sandy soils, provide the ideal conditions for antlions (MONSERRAT & ACEVEDO, 2011; MONSERRAT, 2022).

The life cycle of antlions comprises four stages: egg, larva, pupa, and imago. The majority of adult antlions lead an active nocturnal or crepuscular lifestyle, resting on vegetation during the daylight hours, though some species exhibit a more pronounced diurnal rhythm. Most adult antlions are predators; in some species, their diet includes plant pollen, and there are also non-feeding (afagous) species (ASPÖCK *et al*., 1980; STELZL & GEPP, 1990; MIRMOAYEDI, 2008). All antlion larvae are predators, primarily preying on ants and, to a lesser extent, other arthropods. They are well-known for their distinctive behavior, employing ambush hunting and constructing pitfall traps (MILLER & STANGE, 1985; STANGE, 2004; BADANO & PANTALEONI, 2014). The larvae of many antlion species construct conical pits in sand or fine soil. Typically, the larva settles at the bottom, burying itself in the soil, with only the jaws protruding above the surface, typically in a widely open position on both sides of the tip of the cone trap. The larvae go through three stages before burrowing into the ground and pupating. They are most commonly found in dry and sandy habitats, where larvae can easily dig their pits.

The Doñana Protected Area, including the National Park, is situated in the Mediterranean region, recognized as one of 34 global biodiversity hotspots (TABERLET *et al*., 1998; MYERS *et al*., 2000; DELIBES-MATEOS *et al*., 2008; ZACHOS & HABEL, 2011) (Fig. 1). Despite its ecological importance, only a limited number of publications provide valuable data on Myrmeleontidae species from the surrounding areas and the vicinity of the park (MONSERRAT & ACEVEDO, 2011, 2013; BARREDA *et al*., 2015; RAMOS, 2017; MONSERRAT, 2022).

however, comprehensive investigations focused on antlions within the park itself have not been conducted until now.

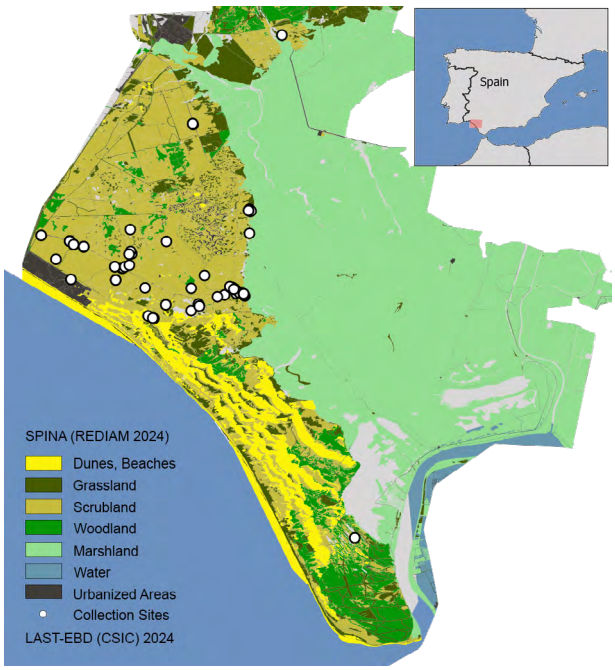

Fig. 1. Map of habitat distribution and sampling locations for antlion larvae and imagoes in Doñana National Park, 2023-2024 (Figure by LAST-EBD/CSIC 2024 ©, with permission).
Fig. 1. Mapa de la distribución de hábitats y los puntos de muestreo de larvas y adultos de hormigas león en el Parque Nacional de Doñana, 2023-2024 (Figura de LAST EBD/CSIC 2024 ©, con permiso).

Our primary objective was to study the species composition of antlions in Doñana National Park. Specifically, we aimed to identify which species are present in the most representative habitats in the Park and to explore the coexistence of antlion species that construct conical sand traps across different environments. By addressing these objectives, we sought to contribute to a deeper understanding of the ecological dynamics of antlion populations in this protected area, particularly in terms of their species composition, habitat preferences, and patterns of coexistence.

To achieve this, we employed an integrated approach, combining field and laboratory methodologies. Our methodology included deploying Malaise traps over two consecutive seasons, from April to August in 2023 and 2024. Additionally, we periodically used a butterfly net to collect imagoes and manually gathered larvae from their characteristic conical traps in the field. The collected larvae were reared to the adult stage in laboratory conditions to confirm species identification. These methods allowed us to systematically document the antlion fauna and, for the first time, compile a detailed species list for Doñana National Park.

MATERIALS AND METHODS

Study area

Doñana National Park, located in southwestern Spain (Fig. 1), is one of the largest nature reserves in Europe. The ecological importance of this region led to its initial protection in 1963, with its establishment as a national park in 1969. In 1994, it was designated a UNESCO World Heritage Site due to its unique environmental value (PÉREZ-RAMOS *et al*., 2017). The region is characterized by a Mediterranean climate, with variable rainy seasons in autumn, winter, and spring, and hot and dry summers. These seasonal changes play a key role in shaping the park's diverse ecosystems. Doñana National Park is characterized by a rich array of terrestrial and aquatic ecosystems, ranging from pine and cork forests to shrublands, grasslands, dunes, and marshes with varying levels of salinity (PÉREZ-RAMOS *et al*., 2017).

Key zones of the Park

Doñana National Park encompasses a variety of ecosystems that can be categorized into several key zones. Along the coastline lies a sandy beach area and an active dune system, which forms part of the largest mobile dune formation in Europe. Further inland, stabilized dunes host diverse shrublands. Beyond this lies the Vera, a transitional zone between dunes and marshes, characterized by unique soil types and vegetation that are crucial for maintaining biodiversity. The Vera creates a contour-like belt throughout the park, varying in width from a few meters to several kilometers. Finally, extensive marshlands, covering approximately 34,000 hectares, represent one of the largest wetland habitats in Europe and serve as critical stopover sites for migratory birds travelling between Africa and Europe (DOMINGO *et al*., 2020; RODRÍGUEZ-VIDAL *et al*., 2014; DÍAZ-PANIAGUA *et al*., 2015; SERRANO *et al*., 2006; LIONELLO *et al*., 2006; FERNÁNDEZ *et al*., 2010).

Habitats within these zones

Within these primary zones, more specific habitats can be identified, such as beaches and dunes, grasslands, shrublands, forests, and areas influenced by urbanization (Fig. 1). All zones, except the marshes, provide unique conditions that support antlions at both larval and adult stages. The sandy, easily excavated soils of dunes and beaches allow antlions to construct their characteristic pit traps for hunting. Grasslands provide open landscapes rich in food resources for ants, which serve as the primary prey for antlions. Shrublands and forests feature diverse vegetation, creating a wide range of microclimatic niches that ensure stable population dynamics. Habitats such as roadsides and zones near human settlements offer unexpected yet favourable conditions for certain antlion species, mainly due to the high abundance of ants (TSHIGUVHO *et al*., 1999; AMATTA *et al*., 2023).

Sample collection

Larvae

Our habitat selection within Doñana National Park was guided by the specific ecological requirements of antlions, focusing on areas with sandy or loose soils, which are known to support their presence and facilitate the construction of pit traps (Fig. 2) (Supporting Material S1).

During the 2023 and 2024 field seasons, we systematically collected antlion larvae and adults from 58 locations across the Park. After collection, the larvae were transported to the Doñana Biological Station in Seville (Spain), where they were reared under controlled conditions in climate chambers. The rearing conditions were maintained at 25±1 °C, with a 16L:8D photoperiod and 65±5% relative humidity. Larvae were fed daily with *Messor barbarus* ants or *Tenebrio molitor* larvae, and their development was monitored until the appearance of imagoes.

Upon appearance, the adult antlions were immediately preserved in 96% ethanol in labeled vials for future analysis. These specimens are stored at the Doñana Biological Station (EBD-CSIC), ensuring their long-term preservation for taxonomic and ecological studies.

Imagoes

Malaise traps were deployed from April to August in both 2023 and 2024. We deployed the Malaise traps in four representative habitats within the Park to ensure a representative sample of diversity of Myrmeleontidae. In 2023, two Malaise traps were deployed: one in a shrubland zone and the other at the boundary of grasslands (37°00’20.9”N, 6°30’22.6”W) and shrublands near the urbanized area (36°59’20.6”N, 6°26’29.6”W). In 2024, three Malaise traps were set: one in a pine forest near the dunes (36°58’40.6”N, 6°29’37.0”W), another in the shade of a cork oak (*Quercus suber* L.) at the edge of a dry lagoon and shrublands (37°01’30.7”N, 6°30’19.0”W), and a third in shrublands with sporadic trees *Pinus pinea* L. (37°00’48.6”N, 6°30’19.0”W).

During the field seasons of 2023 and 2024, imagoes antlions were captured using an insect net across various habitats in Doñana National Park (Fig. 1). The sampling was aimed at covering a representative range of habitats, including shrublands, grasslands, forests, and dunes. A butterfly net with a 32 cm diameter hoop and a 90 cm deep mesh bag with a telescopic handle was used. The net was reinforced with sturdy cloth, allowing for sampling not only from herbaceous plants but also from trees and shrubs.

Sampling was conducted using both random and targeted approaches. For random sampling, we randomly stopped along roads in specific habitats to conduct sampling, performing 2-3 runs with 50 sweeps of the net each. We also conducted sampling during 2-3 km walking transects, using the net every 200 meters along the transect to perform 50 sweeps at each sampling point. Targeted sampling focused on pre-mapped areas deemed ecologically suitable for antlions presence. At these sites, we conducted both one-time sampling and regular monitoring at several points 1-2 times per month. The altitudes of collection locations ranged from 2 to 38 m a.s.l., reflecting the diverse landscapes of the park. Additionally, we performed sampling at different times of the day, from 10 AM to 8 PM, to capture the full spectrum of adult activity. This adaptive approach increased the representativeness of the dataset by covering a wide range of habitats with different ecological conditions. All captured specimens were preserved in 96% ethanol and stored at the Doñana Biological Station (EBD-CSIC).

Identification

For larval identification, we used the keys provided by BADANO & PANTALEONI (2014) in their work “The Larvae of European Myrmeleontidae (Neuroptera).” To confirm the identification of *Myrmeleon almohadarum*, we referred to the study by BADANO *et al*. (2016), which offers detailed descriptions of both larvae and imagoes. For the identification of most imagoes, we utilized the comprehensive taxonomic descriptions found in the works of ASPÖCK *et al*. (1980) and MONSERRAT (2022), which cover European and Mediterranean antlion species.

Fig. 2. Typical habitats where antlions were collected in Doñana National Park: a-d: Roadside habitats with sandy soil, sparse vegetation, and low shrubs, typical of open and dry roadside environments; e-h: Dune habitats with sandy soil and scattered low shrubs, adapted to arid and exposed conditions; i-l: Semi-natural areas near human habitation with scattered trees and open ground, providing shaded and moderately vegetated environments; m-p: Grassland areas with a mix of low grasses, shrubs, and occasional trees, offering open, sun-exposed habitats; q-t: Shrubland with scattered trees and low shrubs, creating a semi-wooded and structurally diverse environment; u-x: Dense shrubland with sandy soil and compact low shrubs.

Fig. 2. Hábitats típicos donde se recolectaron hormigas león en el Parque Nacional de Doñana: a-d: Hábitats de bordes de caminos con suelo arenoso, vegetación escasa y arbustos bajos, típicos de entornos abiertos y secos; e-h: Hábitats de dunas con suelo arenoso y arbustos bajos dispersos, adaptados a condiciones áridas y expuestas; i-l: Áreas semi-naturales cerca de asentamientos humanos con árboles dispersos y suelo abierto, que proporcionan entornos sombreados y moderadamente vegetados; m-p: Áreas de pastizales con una mezcla de hierbas bajas, arbustos y árboles ocasionales, ofreciendo hábitats abiertos y expuestos al sol; q-t: Matorral con árboles dispersos y arbustos bajos, creando un entorno semi-boscoso y estructuralmente diverso; u-x: Matorral denso con suelo arenoso y arbustos bajos compactos.

Fig. 3. Malaise trap set up in a pine forest near the dunes of Doñana National Park during the 2023-2024 field seasons.
Fig. 3. Trampa Malaise instalada en un bosque de pinos cerca de las dunas del Parque Nacional de Doñana durante las temporadas de campo 2023-2024.

RESULTS

A total of 58 locations (Fig. 1) across Doñana National Park were surveyed for antlions (Myrmeleontidae) during two collection periods: from April 25, 2023, to June 22, 2023, and from March 28, 2024, to July 27, 2024. Larval-stage collections yielded 406 specimens, of which 295 successfully emerged as adults in the laboratory, including 201 females and 94 males. Additionally, 28 imago-stage individuals were directly captured in the field using butterfly nets and Malaise traps, comprising 15 males and 13 females. The total number of adult individuals, therefore, was 323. The altitudes of the locations ranged from 2 to 38 m a.s.l. Following the identification and processing of the collected material, a total of 12 species representing 9 genera of antlions were documented.

During the study, we recorded four species that construct conical pit traps, along with *Synclisis baetica*, which was observed both with and without traps, suggesting flexibility in its hunting strategies.

Co-occurrence patterns of species across habitats were observed. For example, *Myrmeleon hyalinus* and *Myrmeleon almohadarum* were frequently found along dirt road edges but displayed spatial segregation. *Myrmeleon hyalinus* preferred areas near vegetation, constructing traps at plant bases, while *M. almohadarum* inhabited open sandy patches closer to the road. In one location, *M. hyalinus, M. almohadarum,* and *Myrmeleon gerlindae* were found coexisting. *Myrmecaelurus trigrammus* was never observed near other species, indicating a preference for habitats with low species co-occurrence.

Our research findings indicate that shrub-dominated biotopes are the most attractive for antlion

colonization. We recorded ten species within this biotope (Fig. 4). Open grassland biotopes are also favourable for settlement, with six species collected in these areas. Other suitable biotopes exhibited relatively low species diversity; specifically, three species were observed in dune and urbanized areas, while only two species were found in coniferous forests.

In the following section, we provide detailed information for each Myrmeleontidae species recorded in Doñana National Park. Each entry includes data on the species' broader distribution, the specific habitat characteristics at the collection locations, geographical coordinates, and relevant details of the collected specimens.

MYRMEMELONTIDAE Latreille, 1802

Acanthaclisinae Navás, 1912

Acanthaclisini Navás, 1912

Acanthaclisis occitanica (Villers, 1789) (Fig. 5)

A Holomediterranean species, distributed in the Western Palearctic, including the Caucasus, Armenia, Iran, Afghanistan, Pakistan, India, and Kazakhstan. It is also known from the Iberian Peninsula and Mallorca in Mediterranean-influenced regions (MONSERRAT & ACEVEDO, 2013; BADANO & PANTALEONI, 2014; MONSERRAT, 2022).

In Andalusia, records of this species have been reported from the provinces of Almería (MONSE-

Fig. 4. Habitat preferences of antlion species recorded in Doñana National Park during the 2023-2024 field seasons, based on collection data from March to August.
Fig. 4. Preferencias de hábitat de las especies de hormigas león registradas en el Parque Nacional de Doñana durante las temporadas de campo 2023-2024, basadas en datos de recolección de marzo a agosto.

Fig. 5. Larvae of two antlion species collected in Doñana National Park: a) *Synclisis baetica*; b) *Acanthaclisis occitanica*.
Fig. 5. Larvas de dos especies de hormigas león recolectadas en el Parque Nacional de Doñana: a) *Synclisis baetica*; b) *Acanthaclisis occitanica*.

RRAT & ACEVEDO, 2011; BADANO & PANTALEONI, 2014), Huelva (RAMOS, 2017), Seville (BARREDA *et al*., 2013a, 2015; RAMOS, 2017), Cádiz (RAMOS, 2017), Málaga (RAMOS, 2017) and Jaén (RAMOS, 2017).

New examined material: 27.07.2024, 1 2nd instar larva (7 m a.s.l., 36°58'59.2"N 6°28'04.5"W). We found one second instar larva in sandy soil; the surrounding vegetation included shrubs *Halimium halimifolium* (L.) Willk. and *Juniperus macrocarpa* Sibth. & Sm., along with herbaceous plants, primarily from the Poaceae family, and scattered bushes of *Lavandula pedunculata* (Mill.) Cav.

Synclisis baetica (Rambur, 1842) (Fig. 5)

A Holomediterranean species, distributed from Macaronesia and Senegal to Anatolia and Iran. It is known across the entire Iberian Peninsula and Mallorca, particularly in coastal regions. The species has been recorded throughout the Iberian Peninsula, especially in the coastal areas of both the Atlantic Ocean and the Mediterranean Sea, as well as on the Balearic Islands (MONSERRAT & ACEVEDO, 2013; BARREDA *et al*., 2015; MONSERRAT, 2022).

In Andalusia, records of this species come from the provinces of Almería (MONSERRAT & ACEVEDO, 2011, 2013; RAMOS, 2017; MONSERRAT, 2022) Huelva (RAMOS, 2017), Málaga (RAMOS, 2017) and Seville (BARREDA *et al*., 2013a; RAMOS, 2017).

New examined material: Three larvae at different instar stages were found at three separate locations: 1 3rd instar larva → 1♀ on 28.03.2024 (20 m a.s.l., 36°58'36.3"N, 6°29'36.0"W); 1 1st instar larva on 10.06.2024 (13 m a.s.l., 36°59'35.5"N, 6°28'19.7"W); 1 2nd instar larva on 11.07.2024 (11 m a.s.l., 36°59'36.3"N, 6°29'51.3"W).

We collected the first larva, in the third instar stage, from dune sand within a conical pit trap with a diameter of 7.34 mm, located at the base of *Corema album* (L.) D. Don in a shaded area. Under laboratory conditions, the adult emerged on August 17. We collected the second larva, in the first instar stage, from sand on a wide dirt road, 70 cm from the roadside and 10 m from shrubs and continuous herb cover. Nearby vegetation included scattered plants of *Malcolmia littorea* (L.) W.T. Aiton and species from the Poaceae family. Although no pit trap was present, a small depression was visible in the sand. We found the third larva accidentally in the sand without any visible conical pit trap or markings. Nearby vegetation included scattered herbaceous plants and *Halimium halimifolium* shurbs.

Myrmecaelurinae Esben-Petersen, 1919

Myrmecaelurini Esben-Petersen, 1919

Myrmecaelurus trigrammus (Pallas, 1771) (Fig.7a)

A Holomediterranean species, distributed across the Caucasus, Armenia, Iran, Kyrgyzstan, Tajikistan, Afghanistan, and Kazakhstan. It is known from the Iberian Peninsula and the Balearic Islands (Mallorca, Formentera) in Mediterranean-influenced regions (MONSERRAT & ACEVEDO, 2011, 2013; BARREDA *et al*., 2015; MONSERRAT, 2022).

In Andalusia, this species has been recorded in the provinces of Almería (MONSERRAT & ACEVEDO, 2011, 2013; RAMOS, 2017), Cádiz (MONSERRAT & ACEVEDO, 2011; RAMOS, 2017), Córdoba (MONSERRAT & ACEVEDO, 2011; RAMOS, 2017), Granada (MONSERRAT & ACEVEDO, 2013; BARREDA *et al*., 2015; RAMOS, 2017), Jaén (MONSERRAT & ACEVEDO, 2011; RAMOS, 2017), Huelva (Doñana, La Rocina, Matalascañas) (MONSERRAT & ACEVEDO, 2011; RAMOS, 2017), Málaga (MONSERRAT & ACEVEDO, 2011; RAMOS, 2017) and Seville (BARREDA *et al*., 2015; RAMOS, 2017).

New examined material: 09.05.2024, 3rd instar → 2♀ (7 m a.s.l., 36°59’20.1N, 6°26’33.2”W), 3rd instar → 1♀ (8 m a.s.l., 36°58’59.9”N, 6°28’3.5”W), 3rd instar → 1♀ (4 m a.s.l., 37°2’9.1”N, 6°26’20.8”W); 14.05.2024, 3rd instar → 1♀ (7 m a.s.l., 36°59’36.3”N, 6°29’51.3”W); 31.05.2024, 3rd instar → 1♀ (8 m a.s.l., 36°58’59.9”N, 6°28’3.5”W); 26.06.2024, 1♀ 1♂ (2 m a.s.l., 37°02’08.4”N, 6°26’22.3”W); 01.07.2024, 1♂ (9 m a.s.l., 36°59’37.3”N, 6°27’2.6”W), 1♂ (8 m a.s.l., 36°59’36.3”N, 6°29’51.3”W), 1♂ (9 m a.s.l., 36°59’35.7”N, 6°26’55.4”W), 2♂ (5 m a.s.l., 36°59’32.3”N, 6°26’51.4”W); 11.07.2024, 1♀ 1♂ (2 m a.s.l., 37°02’12.8”N, 6°26’24.1”W).

Adults of this species prefer open, sunlit environments, particularly grassy meadows (MONSERRAT & ACEVEDO, 2013). In Doñana National Park, although relatively common, this species tends to localize in specific areas with favorable conditions. It thrives in open habitats with dense grassy vegetation, primarily composed of species from the Poaceae family. The larvae construct cone-shaped pit traps at the base of plants, which is typical of their behaviour. The adult flight period begins in early June and extends through the first week of August, with peak activity observed between mid-June and late July in 2024.

Myrmeleontinae Latreille, 1802

Myrmeleontini Latreille, 1802

Myrmeleon hyalinus Olivier, 1811

Holomediterranean species. This species is widely distributed from Macaronesia and North Africa (Morocco, Algeria, Libya, Egypt, Ethiopia, Gambia, Mauritania, Senegal, Sudan) to Syria, Saudi Arabia, Oman, Yemen, Iran, Iraq, Uzbekistan, India, and Afghanistan. It is well-known across the Iberian Peninsula and the Balearic Islands (Mallorca, Menorca, Formentera, Ibiza), primarily in coastal areas influenced by the Mediterranean Sea (MONSERRAT & ACEVEDO, 2013; MONSERRAT, 2022).

In Andalusia, records of this species come from the provinces of Almería (MONSERRAT & ACEVEDO, 2011, 2013; RAMOS, 2017), Cádiz (MONSERRAT & ACEVEDO, 2011, 2013; RAMOS, 2017), Granada (MONSERRAT & ACEVEDO, 2013; RAMOS, 2017), Huelva (Matalascañas, Punta Umbría, Doñana, La Rocina) (MONSERRAT & ACEVEDO, 2011, 2013; RAMOS, 2017) and Jaén (MONSERRAT & ACEVEDO, 2011).

New examined material: 17.05.2023, 3rd instar → 3♂ (3 m a.s.l., 36°59’24.5”N, 6°26’35.5”W), 3rd instar → 7♀ 2♂ (22 m a.s.l., 36°59’51.9”N, 6°30’49.7”W); 15.06.2023, 3rd instar → 1♀ (22 m a.s.l., 37°01’08.6”N, 6°29’09.0”W); 02.04.2024, 3rd instar → 1♀ (38 m a.s.l., 37°01’20.7”N, 6°33’17.7”W), 3rd instar → 1♀ (31 m a.s.l., 37°01’20.7”N, 6°33’17.7”W); 08.04.2024, 3rd instar → 1♀ (34 m a.s.l., 37°0’58.3”N, 6°31’53.1”W); 11.04.2024, 3rd instar → 1♀ (22 m a.s.l., 37°00’15.6”N, 6°30’35.3”W); 15.04.2024, 3rd instar → 1♀ (24 m a.s.l., 37°0’48.9”N, 6°30’20.0”W); 09.05.2024, 3rd instar → 1♂ (5 m a.s.l., 37°2’10.1”N, 6°26’25.9”W), 3rd instar → 1♀ (35 m a.s.l., 37°0’57.5”N, 6°31’53.4”W), 3rd instar → 1♂ (6 m a.s.l., 36°59’39.1”N, 6°27’3.0”W), 3rd instar → 1♀ (31 m a.s.l., 36°59’36.3”N, 6°29’51.3”W), 3rd instar → 1♀ (37 m a.s.l., 37°01’32.3”N, 6°30’20.7”W), 14.05.2024 3rd instar → 1♂ (29 m a.s.l., 37°0’15.3”N, 6°30’37.5”W), 3rd instar → 1♀ (31 m a.s.l., 37°0’18.3”N, 6°30’51.4”W), 3rd instar → 1♂ (12 m a.s.l.,

36°58’36.0”N, 6°29’33.1”W), 3rd instar → 1♂ (10 m a.s.l., 36°59’2.7”N, 6°29’10.2”W), 3rd instar → 2♂ (37 m a.s.l., 37°1’9.1”N, 6°32’21.0”W), 3rd instar → 1♀ (31 m a.s.l., 37°0’18.3”N, 6°30’51.4”W), 3rd instar → 1♂ (10 m a.s.l., 36°59’2.7”N, 6°29’10.2”W), 3rd instar → 1♀ (35 m a.s.l., 36°59’36.3”N, 6°29’51.3”W), 3rd instar → 1♀ (37 m a.s.l., 37°1’9.1”N, 6°32’21.0”W), 3rd instar → 1♂ (34 m a.s.l., 37°1’2.4”N, 6°32’13.3”W), 3rd instar → 1♀ (37 m a.s.l., 37°1’9.1”N, 6°32’21.0”W), 3rd instar → 1♀ (37 m a.s.l., 37°1’9.1”N, 6°32’21.0”W), 3rd instar → 1♀ (35 m a.s.l., 37°1’2.4”N, 6°32’13.3W), 3rd instar → 2♀ (31 m a.s.l., 37°0’18.3”N, 6°30’51.4”W), 3rd instar → 1♀ (7 m a.s.l., 36°59’36.3”N, 6°29’51.3”W), 3rd instar → 1♀ (29 m a.s.l., 37°0’43.4”N, 6°30’23.0”W), 3rd instar → 1♀ (37 m a.s.l., 37°1’9.6”N, 6°32’20.8”W), 3rd instar → 1♀ (12 m a.s.l., 37°58’35.2”N, 6°29’33.8”W), 3rd instar → 2♀ (34 m a.s.l., 37°1’2.4”N 6°32’13.3”W), 3rd instar → 1♂ (37 m a.s.l., 37°1’9.1”N, 6°32’21.0”W), 3rd instar → 1♀ (31 m a.s.l., 37°0’18.3”N, 6°30’31.4”W), 3rd instar → 2♀ (12 m a.s.l., 36°58’35.2”N, 6°29’33.8”W), 3rd instar → 1♂ (34 m a.s.l., 37°1’2.4”N, 6°32’13.3”W), 01.07.2024 3rd instar → 1♀ 1♂ (9 m a.s.l., 36°59’37.3”N, 6°27’2.6”W), 26.03.2024 larvae 58, 1-3 instars → 50♂ 43♀ (7 m a.s.l., 36°58’36.1”N, 6°29’36.5”W).

Myrmeleon hyalinus is one of the most characteristic species of Doñana National Park, frequently encountered across various habitats. The larvae construct cone-shaped pit traps in sandy soil and begin their activity in late February or early March, depending on weather conditions. Over the course of the year, two generations were observed. The first generation consists of overwintering larvae that emerge in early spring, with adults appearing from May to early June. The second generation of larvae starts to appear in early August.

Although larvae were found in a variety of habitats, they were most frequently encountered in specific environments, such as sandy dunes with sparse shrubs like *Corema album* and *Juniperus macrocarpa*. Larvae are also commonly found in partially shaded sandy areas along dirt roads or in grassy habitats dominated by species from the Poaceae family. In addition, larvae have been observed near human dwellings, indicating their adaptability to different environments.

Myrmeleon gerlindae Hölzel, 1974 (Fig. 7b)

This Western Mediterranean species is known from the Iberian Peninsula, southern France, northern and western Italy, Sardinia, and Morocco, primarily in areas influenced by the Mediterranean climate. (MONSERRAT & ACEVEDO, 2013; MONSERRAT, 2022).

In Andalusia, records of this species come from the provinces of Granada (MONSERRAT & ACEVEDO, 2013; RAMOS, 2017), Huelva (MONSERRAT & ACEVEDO, 2013; RAMOS, 2017), Jaén (MONSERRAT & ACEVEDO, 2013; RAMOS, 2017), and Málaga (RAMOS, 2017).

New examined material: 17.05.2023, 3rd instar → 1♂ (24 m a.s.l., 36°59’51.9”N, 6°30’49.7”W); 08.04.2024, 3rd instar → 1♀ (22 m a.s.l., 36°59’58.3”N, 6°31’53.1”W), 3rd instar → 1♂ (35 m a.s.l., 36°0’58.3”N, 6°31’53.1”W); 14.05.2024, 3rd instar → 1♂ (8 m a.s.l., 36°59’14.1”N, 6°27’50.8”W); 01.07.2024, 1♂ (6 m a.s.l., 36°59’21.1”N, 6°27’20.4”W), 1♀ (9 m a.s.l., 36°59’18.5”N, 6°27’27.6”W).

Adults of *Myrmeleon gerlindae* inhabit forested, open, and sunny areas, sometimes in coastal or mountainous regions. The larvae prefer sandy forested environments with abundant plant debris, where they construct their typical pit traps (MONSERRAT & ACEVEDO, 2013; MONSERRAT, 2022). We collected one larva from a conical pit trap in sand along the edge of a dirt road and reared it under laboratory conditions. Other specimens were adults that we captured using an entomological net in their typical shrub-grass habitats with low vegetation density.

Myrmeleon almohadarum Badano, Acevedo, Pantaleoni & Monserrat, 2016 (Fig. 6)

This species was described in 2016 from specimens collected in Spain and North Africa, particularly Tunisia. It is known from the southern Iberian Peninsula, the Balearic Islands (Ibiza), and with new records from Seville and Tarragona (RAMOS, 2017; MONSERRAT, 2022).

In North Africa, it has been recorded in Tunisia, and it is likely distributed across the northwestern Mediterranean coast of Africa, excluding desert regions (RAMOS, 2017; MONSERRAT, 2022).

In Andalusia, records of this species come from the provinces of Cádiz (BADANO *et al*., 2016, RAMOS, 2017), Almería (BADANO *et al*., 2016,

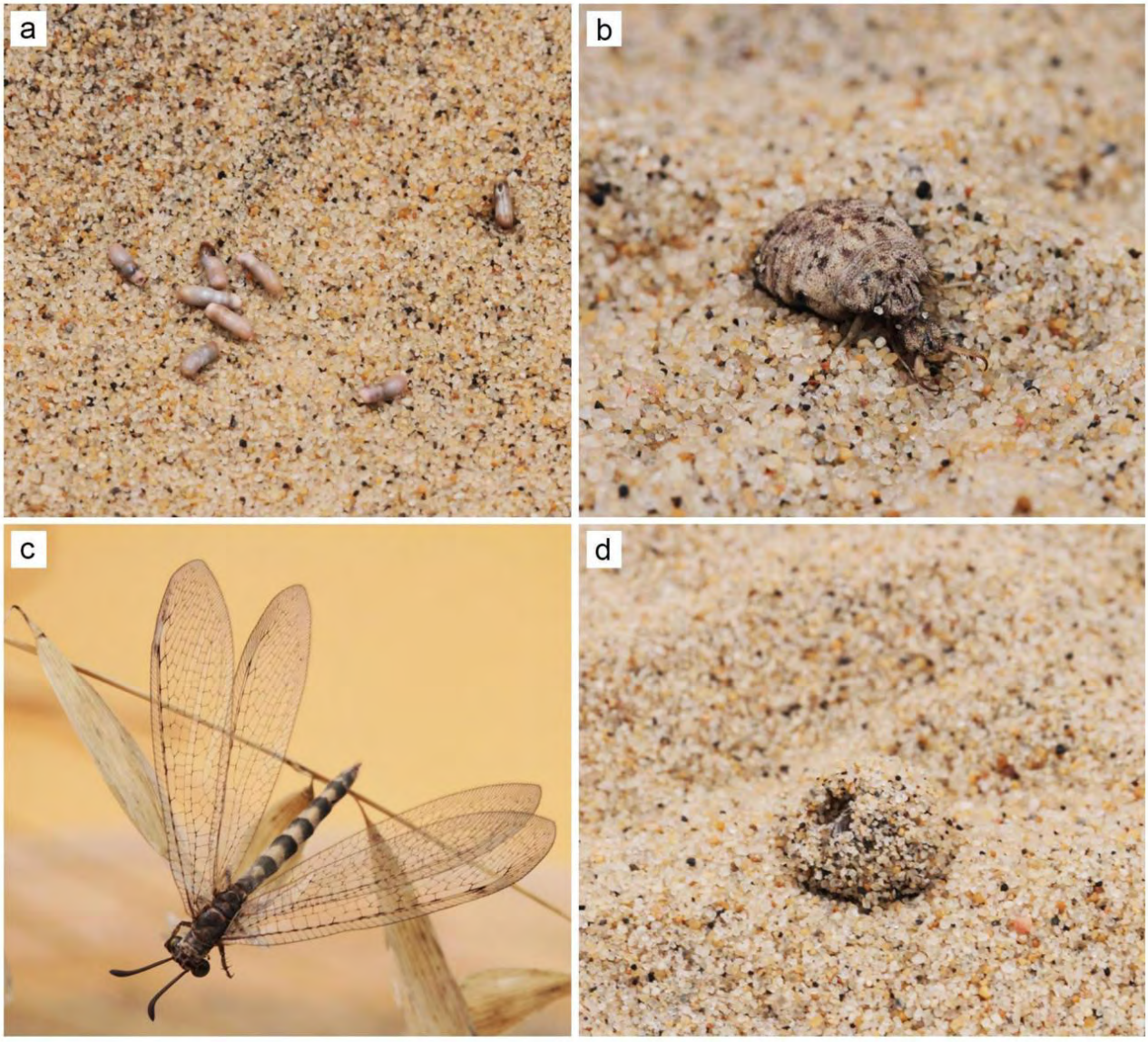

Fig. 6. Life cycle stages of *Myrmeleon almohadarum*: a) eggs, b) 3rd instar larva, c) adult, d) cocoon.
Fig. 6. Etapas del ciclo de vida de *Myrmeleon almohadarum*: a) huevos, b) larva de tercer estadio, c) adulto, d) capullo.

RAMOS, 2017), Huelva (Punta Umbría) (BADANO *et al*., 2016, RAMOS, 2017), Jaén (BADANO *et al*., 2016, RAMOS, 2017), Málaga (BADANO *et al*., 2016, RAMOS, 2017) and Seville (RAMOS, 2017; MONSERRAT, 2022).

New examined material: 17.05.2023, 3rd instar → 11♀ 2♂ (3 m a.s.l., 36°59'24.5"N, 6°26'35.5"W), 3rd instar → 2♀ 2♂ (21 m a.s.l., 36°59'51.9"N, 6°30'49.7"W); 09.05.2024, 3rd instar → 3♀ 2♂ (3 m a.s.l., 36°59'22.5"N, 6°26'35.4"W), 10.05.2024, 3rd instar → 2♀ 1♂ (3 m a.s.l., 36°59'26.0"N, 6°26'43.2"W), 3rd instar → 1♂ (23 m a.s.l., 36°58'35.9"N, 6°29'43.4"W), 29.05.2024, 3rd instar → 2♀ (21 m a.s.l., 37°00'44.3"N, 6°30'14.7"W); 26.03.2024, larvae 7, 1-3 instars → 7♂ 11♀ (3 m a.s.l., 36°58'36.1"N, 6°29'36.5"W); 01.06.2024, larvae 15, 1-3 instars → 2♂ 87♀ (11 m a.s.l., 36°59'23.5"N, 6°26'35.2"W).

In Tunisia, *M. almohadarum* larvae, which construct pit traps, have been found in old coastal sandy dunes with woody vegetation, including pine plantations. In Spain, in addition to coastal dunes, the species has also been recorded along riverbanks and dry streambeds (MONSERRAT, 2022).

This species constructs cone-shaped pit traps in sandy dunes and along dirt roads near residential areas, similar to *Myrmeleon hyalinus*. Larval populations can number several hundred individuals in a single area. However, unlike *Myrmeleon hyalinus* and *Myrmecaelurus trigrammus*, we have not observed mass adult flights, nor have we captured adults in Malaise traps or with entomological nets. The cone-shaped pit traps of *M. almohadarum* are frequently found in the shade of shrubs and herbaceous plants, though about 5% of the traps are located in fully exposed sandy areas without shade. Laboratory studies indicate that this species is well-adapted to survive in high-temperature environments.

Nemoleon notatus (Rambur, 1842)

This is a Circum-Saharan species, known from the Iberian Peninsula and Mallorca, with reports from Spain, Italy (Sardinia), Morocco, Algeria, Ethiopia, Chad, Uganda, Angola, and Madagascar (MONSERRAT & ACEVEDO, 2013; MONSERRAT, 2022).

In Andalusia, this species has been recorded in the provinces of Almería (MONSERRAT & ACEVEDO, 2013; RAMOS, 2017), Granada (MONSERRAT & ACEVEDO, 2013; RAMOS, 2017), Huelva (Matalascañas) (BARREDA *et al*., 2015; RAMOS, 2017) and Jaén (RAMOS, 2017).

New examined material: 15.06.2023, 1♀ (29 m a.s.l., 37°00’22.5”N, 6°30’20.0”W).

Nemoleon notatus is a little-known species, typically reported in the literature as being associated with open, arid environments such as savannas. In Europe, it has primarily been recorded in dry coastal areas, where adults are found in very hot, sub-desert, open, xeric, rocky, and sunny habitats (MONSERRAT, 2022).

In our study, we captured one specimen using an entomological net in an open area with dense grass cover, predominantly Poaceae, interspersed with scattered shrubs, characteristic of a typical xeric landscape.

Creoleon aegyptiacus (Rambur, 1842) (Fig. 7c)

This expansive Holomediterranean species is known from Egypt, Algeria, Tunisia, Morocco, Spain, Italy (Sicily and adjacent islands), Israel, Iraq, Iran, and Afghanistan. In the Iberian Peninsula, it has been recorded from both continental and Mediterranean regions, including the Balearic Islands (Mallorca, Menorca, Ibiza) (MONSERRAT & ACEVEDO, 2013; BARREDA *et al*., 2015; MONSERRAT, 2022).

In Andalusia, this species has been recorded in the provinces of Almería (MONSERRAT & ACEVEDO, 2011, 2013; RAMOS, 2017), Cádiz (MONSERRAT & ACEVEDO, 2013; RAMOS, 2017), Granada (MONSERRAT & ACEVEDO, 2013; RAMOS, 2017), Huelva (Matalascañas), (MONSERRAT, 1986; MONSERRAT & ACEVEDO, 2013; BARREDA *et al*., 2015; RAMOS, 2017), Málaga (MONSERRAT & ACEVEDO, 2011; RAMOS, 2017), Jaén (MONSERRAT & ACEVEDO, 2011; RAMOS, 2017), and Seville (RAMOS, 2017).

New examined material: 01.07.2024, 1♂ (10 m a.s.l., 36°59’17.5”N, 6°27’19.6”W), 1♀ (10 m a.s.l., 36°59’04.1”N, 6°28’05.4”W), 3rd instar → 1♀ (8 m a.s.l., 36°58’50.9”N, 6°28’19.8”W).

Literature sources indicate that the adults of *Creoleon aegyptiacus* inhabit hot, dry, arid, open, and sunny environments, often in dried-out meadows.

We collected three adults using a butterfly net, sweeping insects off various shrubs and herbaceous plants, such as *Halimium halimifolium*, *Salvia rosmarinus* Spenn., *Lavandula pedunculata*, *Linaria viscosa* (L.) Dum. Cours, *Thymus mastichina* (L.) L., and *Armeria gaditana* Boiss.

The habitats where we collected *Creoleon aegyptiacus* were similar — dry, sandy areas with scattered vegetation consisting of shrubs and herbaceous plants.

Creoleon lugdunensis (Villers, 1789)

This Western Mediterranean species is known from Croatia, Switzerland, Italy, Malta, France, Spain, Portugal, Morocco, and Tunisia. It is found in Mediterranean-influenced areas of the Iberian Peninsula and the Balearic Islands (MONSERRAT & ACEVEDO, 2013; MONSERRAT, 2022).

In Andalusia, this species has been recorded in the provinces of Almería (MONSERRAT &

ACEVEDO, 2011, 2013; RAMOS, 2017), Cádiz (BARREDA 2013b; MONSERRAT & ACEVEDO, 2013; BARREDA *et al*., 2015; RAMOS, 2017), Córdoba (BARREDA 2013b; BARREDA *et al*., 2015; RAMOS, 2017), Granada (BARREDA *et al*., 2015; RAMOS, 2017), Málaga (BARREDA *et al*., 2015; RAMOS, 2017), Jaén (MONSERRAT & ACEVEDO, 2011, 2013; RAMOS, 2017), Huelva (El Rocío, Niebla) (MONSERRAT & ACEVEDO, 2013; RAMOS, 2017) and Seville (BARREDA 2013b; BARREDA *et al*., 2015; RAMOS, 2017).

New examined material: 25.04.2023, 3rd instar → 3♂ 2♀ (10 m a.s.l., 37°05'01.1"N, 6°28'15.8"W), 1♀ (5 m a.s.l., 37°07'59.3"N, 6°25'19.5"W), 04.05.2023, 1♂ (5 m a.s.l., 36°51'18.9"N, 6°22'54.8"W); 01.06.2023, 1♀ (3 m a.s.l., 36°59'24.8"N, 6°26'50.2"W); 06.05.2024, 3rd instar → 1♂ (6 m a.s.l., 37°01'24.7"N, 6°26'24.0"W); 26.06.2024, 1♀ (2 m a.s.l., 37°02'08.4"N, 6°26'22.3"W); 01.07.2024, 1♂ (9 m a.s.l., 36°59'37.3"N, 6°27'2.6"W); 01.07.2024, 1♀ 1♂ (5 m a.s.l., 36°59'32.3"N, 6°26'51.4"W).

According to the literature, adults of *Creoleon lugdunensis* are frequently found in dry, open, sunny environments without woody vegetation, such as steppes, dried-out meadows, forest clearings, as well as in thermal and arid coastal areas (MONSERRAT & ACEVEDO, 2013; MONSERRAT, 2022).

In our study, we collected adults of this species using two methods: Malaise traps and a butterfly net. The Malaise trap was set among shrubs like *Juniperus macrocarpa*, *Halimium halimifolium*, juvenile trees *Pinus pinea* L. and other species. Using the butterfly net, we collected specimens from dry vegetation in a dried-up lagoon near dunes with dense cover of dry plants from the genus *Juncus*. Additionally, we found this species in habitats characterized by sandy soil with shrubs and herbaceous plants, such as *Halimium halimifolium*, *H. calycinum* (L.) K. Koch, *Salvia rosmarinus* Spenn., *Lavandula pedunculata*, *Linaria viscosa* (L.) Dum. Cours, *Thymus mastichina* (L.) L., *Armeria gaditana* Boiss., and other species.

Distoleon tetragrammicus (Fabricius, 1798) (Fig.7d)

This Holomediterranean species extends into Central and Northern Europe, the Caucasus, Armenia, Georgia, Syria, Azerbaijan, Kazakhstan, Iraq, and Iran (possibly Korea). It is widespread across the Iberian Peninsula (MONSERRAT & ACEVEDO, 2013; MONSERRAT, 2022).

In Andalusia, this species has been recorded in the provinces of Cádiz (MONSERRAT & ACEVEDO, 2013), Granada (MONSERRAT & ACEVEDO, 2013; RAMOS, 2017), Jaén (MONSERRAT & ACEVEDO, 2011; RAMOS, 2017), Seville (BARREDA 2013b; RAMOS, 2017), Málaga (RAMOS, 2017) and Córdoba (RAMOS, 2017).

New examined material: 01.07.2024, 1♂ (4 m a.s.l., 36°59'33.7"N 6°26'55.0"W).

According to the literature, adults of *Distoleon tetragrammicus* are found in forested and humid environments. The larvae, being highly adaptable, can colonize microhabitats with dry, fine-grained substrates, especially in Mediterranean forests rich in humus. In Southern Europe, the species inhabits various biotopes, from coastal dunes to mountain forests, preferring sheltered areas at the base of trees, shrubs, or rocky ledges, and can also be found in artificial structures like stone walls (MONSERRAT & ACEVEDO, 2013; MONSERRAT, 2022).

In our study, we collected only one specimen of this species from *Juniperus macrocarpa* using a butterfly net. The habitat where we caught this specimen featured dense shrub cover, mainly *J. macrocarpa*, bordering a large open area with a dense cover of grasses. It is also noteworthy that a residential area was located about 300 meters from the collection site.

Neuroleontini Navás, 1912

Neuroleon ocreatus (Navás, 1904)

This Atlantic-Mediterranean species is known from Spain, France, Italy, and Portugal. It has been recorded on the Iberian Peninsula, Mallorca, and Ibiza, primarily in areas under Mediterranean influence (MONSERRAT & ACEVEDO, 2013; MONSERRAT, 2022).

In Andalusia, this species has been recorded in the provinces of Almería (MONSERRAT & ACEVEDO, 2013), Málaga (MONSERRAT &

Fig. 7. Imagines of antlion species found in Doñana National Park: a) *Myrmecaelurus trigrammus*; b) *Myrmeleon gerlindae*; c) *Distoleon tetragrammicus*; d) *Creoleon aegyptiacus*.
Fig. 7. Imagoes de especies de hormigas león encontradas en el Parque Nacional de Doñana: a) *Myrmecaelurus trigrammus*; b) *Myrmeleon gerlindae*; c) *Distoleon tetragrammicus*; d) *Creoleon aegyptiacus*.

ACEVEDO, 2013), Cádiz (RAMOS, 2017) and Jaén (RAMOS, 2017).

New examined material: 22.06.2023, 1♀ (8 m a.s.l., 36°58'40.5"N 6°29'45.2"W).

According to the literature, adults of *Neuroleon ocreatus* inhabit open, sunny areas, often near dry riverbeds (MONSERRAT & ACEVEDO, 2013; MONSERRAT, 2022). In our study, we collected one specimen of this species from *Halimium halimifolium* using a butterfly net. The habitat where we found this specimen is a site near a dried lagoon, bordered on one side by a forest strip of *Pinus pinea* and on the other by tall sand dunes.

Macronemurini Esben-Petersen, 1919

Macronemurus appendiculatus (Latreille, 1807)

This Holomediterranean species is distributed across the Iberian Peninsula and the Balearic Islands, primarily in areas influenced by the Mediterranean climate. It is found in continental, Atlantic, and Mediterranean zones, with confirmed records from Mallorca, Menorca, Ibiza, and Formentera (MONSERRAT & ACEVEDO, 2013; MONSERRAT, 2022).

In Andalusia, this species has been recorded in the provinces of Almería (MONSERRAT & ACEVEDO, 2013), Cádiz (MONSERRAT & ACEVEDO, 2013; BARREDA *et al*., 2015; RAMOS, 2017), Córdoba, (MONSERRAT & ACEVEDO, 2013; BARREDA *et al*., 2015; RAMOS, 2017), Málaga (MONSERRAT & ACEVEDO, 2013; RAMOS, 2017), Huelva (Matalascañas, Marismas del Odiel, Isla de Saltes) (MONSERRAT & ACEVEDO, 2013; BARREDA *et al*., 2015; RAMOS, 2017), Seville (BARREDA *et al*., 2013a; BARREDA *et al*., 2015; RAMOS, 2017), Jaén (RAMOS, 2017) and Granada (BARREDA *et al*., 2015; RAMOS, 2017).

New examined material: 01.07.2024, 1♀ 1♂ (5 m a.s.l., 36°59'37.5"N 6°26'59.1"W).

According to the literature, adults of *Macronemurus appendiculatus* inhabit open, sunny areas, particularly grassy spaces with little to no woody vegetation. They are often found in steppe regions, rocky areas, and on dried-out or abandoned cereal fields (MONSERRAT & ACEVEDO, 2013; MONSERRAT, 2022).

In our study, *Macronemurus appendiculatus* was collected from dense grassy vegetation using a butterfly net. The habitat was an open area dominated by various grass species, particularly Poaceae, and bordered by shrubland, providing a suitable environment for this species.

DISCUSSION AND CONCLUSIONS

This study provides the first comprehensive investigation of Myrmeleontidae in Doñana National Park, conducted across 58 sampling locations during two consecutive years (April-June 2023 and March-July 2024). A total of 12 species from 9 genera were identified, significantly enhancing knowledge of the region's biodiversity. Among the 406 larval specimens collected, 295 successfully emerged as imagoes (201 females and 94 males), along with 28 imagoes captured directly in the field. These findings significantly enhance knowledge of the region's biodiversity. Notably, this study also reports the first records of *Distoleon tetragrammicus* and *Neuroleon ocreatus* in the province of Huelva, expanding their known distribution.

Previous research predominantly documented the coexistence of only two antlion species within the same habitat (DEVETAK, 2000; GRIFFITHS, 1991; KLOKOČOVNIK *et al*., 2020; MILER *et al*., 2017), with few reports indicating three. Among the most thoroughly studied cases are *Myrmeleon hyalinus* and *Cueta lineosa*, two species often found in shared habitats across the Eastern Mediterranean, where they avoid spatial overlap through territorial segregation (BARKAE *et al*., 2012; OVADIA *et al*., 2020; ROTKOPF *et al*., 2013; SCHARF *et al*., 2008). Our findings confirmed the coexistence of three antlion species (*Myrmeleon almohadarum*, *M. hyalinus*, and *M. gerlindae*) within a single habitat in Doñana. *Myrmeleon almohadarum* was more frequently recorded in sites with higher human impact, such as urbanized areas and roadsides, whereas *M. hyalinus* was mainly found in sandy dunes and grasslands with specific microclimatic conditions.

The presence of *M. almohadarum* populations near residential areas suggests a high tolerance for

human-induced changes (Fig. 4). Future research investigating resource competition, including prey availability and optimal trap-building conditions, would further clarify the adaptive strategies of these species.

Our data indicate that shrub-dominated biotopes and grasslands within Doñana National Park provide favorable conditions for the presence of antlions. These habitats offer critical resources such as shelter and abundant prey, facilitating optimal conditions for larval development due to fine soil textures and high prey availability. Shrub- and grassland-dominated environments provide natural shelter, helping to mitigate the effects of extreme temperatures and heavy rainfall. Key factors for the successful reproduction of Myrmeleontidae populations include climatic conditions (e.g., temperature, humidity, light levels, soil type), availability of food resources, protection from predators, and manageable levels of inter- and intraspecific competition (ASPÖCK *et al*., 1980; MORRISON, 2004; SCHARF *et al*., 2011). Additionally, these biotopes provide abundant food resources, attracting ants and caterpillars — primary prey for antlions — through diverse food sources such as small insects, nectar, carrion, and fruits. This rich food supply makes these habitats particularly favorable for ants (TSHIGUVHO *et al*., 1999; AMATTA *et al*., 2023), the primary food source for antlion larvae.

Moreover, shrub and grassland biotopes offer various microhabitats for constructing pitfall traps. Antlions can establish traps under shrubs, around roots, or within decaying vegetation. In these biotopes, we observed that the edges of unpaved roads are particularly attractive habitats for Myrmeleontidae. The fine soil texture facilitates trap construction and increases food accessibility, supporting antlion development (ITZHAK, 2008). Reduced vegetation and altered substrates along road edges promote higher ant abundance, further enriched by additional food sources such as herbivore droppings (AMATTA *et al*., 2023). Ant nests are denser along road edges than in natural areas (ITZHAK, 2008), attracting antlion species that benefit from high prey densities. Since 1956, the density of roads within Doñana National Park has doubled, with unpaved roads now covering approximately 4% of the protected area (ROMÁN *et al*., 2010).

In conclusion, our findings indicate that shrub and grassland biotopes, especially those along unpaved road edges, offer ideal conditions for antlion settlement in Doñana National Park. This habitat preference underscores the importance of food availability, microhabitat diversity, and favorable microclimatic conditions essential for sustaining robust Myrmeleontidae populations.

Overall, this study establishes a baseline species list for Doñana National Park. Future research should focus on resource competition, habitat preferences, and the impacts of environmental changes to further understand Myrmeleontidae adaptation and biodiversity within this protected area.

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