Description of a new trapdoor spider species, *Nemesia amicitia* spec. nov., from southern Spain, and new information on *Nemesia uncinata* (Araneae: Mygalomorphae: Nemesiidae)

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Abstract. A new species of trapdoor spider found in southern Andalusia, Spain, *Nemesia amicitia* **spec. nov.**, is described. This species builds a branched burrow with a characteristic wafer-type trapdoor over a curb around the entrance. In the same geographic area, two populations of *N. uncinata* Bacelar, 1933 have been found. New data about the morphological variability of this species and the structure of its burrow are provided.

Keywords: ecology, Nemesiinae, phenology, taxonomy, trapdoor spiders, western Mediterranean

Zusammenfassung. Beschreibung einer neuen Falltürspinne, *Nemesia amicitia* spec. nov., aus Südspanien und neue Informationen über *Nemesia uncinata* (Araneae: Mygalomorphae: Nemesiidae). Eine neue Falltürspinnenart, *Nemesia amicitia* **spec. nov.**, wird aus Andalusien (Südspanien) beschrieben. Diese Art baut einen verzweigten Bau mit einer charakteristischen waffelartigen Falltür über eine Umrandung um den Eingang herum. Im selben Gebiet wurden zwei Populationen von *N. uncinata* Bacelar, 1933 gefunden. Neue Daten über die morphologische Variabilität dieser Art und die Struktur ihres Baus werden vorgelegt.

Resumen. Descripción de la nueva especie de araña trampera *Nemesia amicitia* spec. nov. del sur de España y nuevos datos de *Nemesia uncinata* (Araneae: Mygalomorphae: Nemesiidae). Se presenta la descripción de una nueva especie de araña trampera, *Nemesia amicitia* **spec. nov.**, encontrada en el sur de Andalucía, España. Esta especie construye una madriguera bifurcada con una trampilla característica de tipo oblea sobre una pared circular alrededor de la entrada. En la misma área geográfica se han encontrado dos poblaciones de *N. uncinata* Bacelar, 1933; se proporcionan datos complementarios sobre su variabilidad morfológica y la estructura de sus madrigueras, comparándolas con las de la nueva especie.

The genus *Nemesia* Audouin, 1826 is one of the most diverse among mygalomorph spiders, including 68 valid species (World Spider Catalog 2022). Most *Nemesia* species occur around the Mediterranean basin. Eight species have been recorded from Andalusia, south of Spain (de Biurrun et al. 2019), including recent additions of *N. dorthesi* (Thorell, 1875) (Zonstein 2019) and the recently described species *N. qarthadasht* Calvo, 2021. Here the description of a new species from Cádiz province, at the southernmost part of Andalusia, is provided and details of its behaviour and habitat are given. In addition, new information on the morphology, ecology and ethology of two populations of *N. uncinata* are given.

Material and methods

All specimens studied were collected by the authors in Cádiz province, Spain. Females and juveniles were collected by hand, looking for their burrows on slopes or near the roots of trees. For collecting males, pitfall traps were placed close to previously detected female burrows. Most pitfall traps were filled with water, salt as a conservative medium and a drop of detergent, other traps were empty to collect living specimens and to take photographs with a Fujifilm Finepix S camera. All collected specimens were preserved in 70% ethanol. Two specimens of both species were deposited in the collection of Museo Nacional de Ciencias Naturales (MNCN) in Madrid; the remaining specimens were placed in the arachnid collection of the Dept. de Zoología of Universidad de Córdoba (UCO), the collection of Sociedad Gaditana de Historia Natural (SGHN) and in the private collection of C. Pertegal (CPC). The localities were plotted on a map of Spain and Cádiz with DIVA-GIS software (Fig. 1 and Tab. 1) (Hijmans et al. 2001). Specimens were examined using a stereomicroscope Euromex SB.1903-P equipped with a Bresser ocular camera to take measurements and a Nikon D3300 camera coupled with an adapter to take photographs. Spermathecae of eight specimens the new species and one *N. uncinata* were extracted with microdissection scissors and cleaned with 10% KOH, meanwhile in the six remaining specimens, their tegument from the epigastric area was removed and spermathecae were cleaned with microdissection scissors and hypodermic needles. The measurements of type specimens and the variability range of morphological parameters in other specimens are given in millimetres.

The morphological study considers characters included in previous literature about the genera *Nemesia* and *Iberesia* (De-

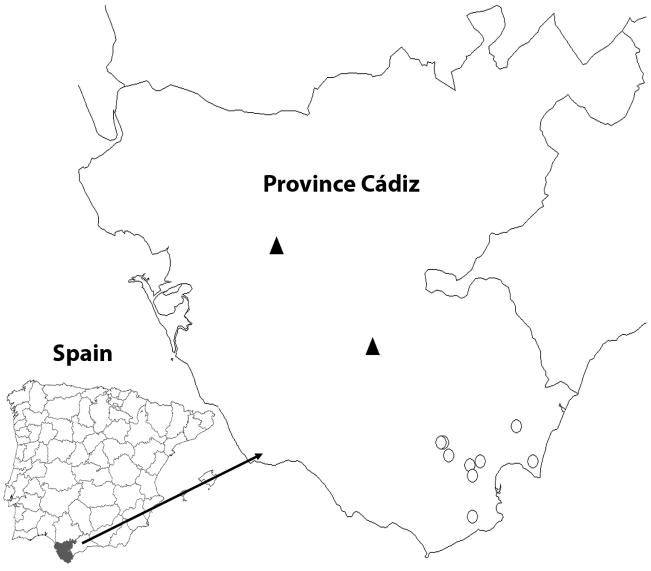

Fig. 1: Map of Iberian Peninsula, map of Cádiz province and localities of *N. amicitia* **spec. nov.** (empty circles) and *N. uncinata* (black triangles)

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Tab. 1. Geographic coordinates and name of the localities where specimens of *Nemesia* were collected for this study

Municipality	Zone	Latitude	Longitude	Altitude (m a.s.l.)
Los Barrios	Depósito de agua	36.18495	-5.48003	69
Los Barrios	Benharás	36.17782	-5.50507	23
Los Barrios	Monte de la Torre	36.15763	-5.49928	61
Los Barrios	Monte de la Torre	36.15940	-5.49754	61
Los Barrios	Montera del Torero I	36.22029	-5.56827	68
Los Barrios	Montera del Torero II	36.22138	-5.57486	118
Los Barrios	Cuevas de Bacinete	36.19631	-5.55666	189
La Línea de la Concepción	El Zabal	36.18491	-5.35439	35
San Roque	Pinar del Rey	36.25126	-5.39384	48
Algeciras	Huerta Grande	36.07957	-5.49961	209
Alcalá de los Gazules	La Cañada de Los Ratones	36.40449	-5.73886	63
Torrecera	Jeréz de la Frontera	36.59692	-5.96851	16

cae et al. 2007, Isaia & Decae 2012, Decae & Huber 2017, Luis de la Iglesia 2019, Calvo 2020). Both qualitative and quantitative characters were taken into account. In addition, the length and width of the embolus, the length of the tibia l spur and the width of the palpal tibia are provided. Studies of the epiandrous fusillae follow Zonstein (1987, 2009). The ratios of the number of epiandrous fusillae/carapace length, length/width of palpal tibia in males and their means and standard deviations were also calculated. The ratio diameter of trapdoor (t) / diameter of entrance (e) of 100 burrows of the new species and the eight available ones of *N. uncinata* was calculated, as well as the mean and standard deviations of this parameter (Fig. 2a).

Spine formulae of palps and legs in the holotype are given as the number of spines on the left and the number of spines on the right for each one of the segments, both numbers separated by a dot. Variations are given with the same formula, but between parentheses.

Abbreviations of body and legs parts: BL: Body, length; Ca: caput, length; Ch: Caput, height; CL: carapace, length; CW: carapace, width; Th: Thorax, height; Cly: Clypeus, length; AER: anterior eye row, length; PER: posterior eye row, length; ALE: anterior lateral eye, length; PLE: posterior lateral eye, length; AME: anterior median eye, length; PME: posterior median eye, length; El: Eye length; POP: pattern of the deep black pigmentation on the ocular process; Ml: maxillae, length; Mw: maxillae, width; Ll: labium, length; Lw: labium, width; Sl: sternum, length; Sw: sternum, width; Bu: bulb, length (Fig. 2b); Em: embolus, length (Fig. 2b); Ew1: embolus width 1 (Fig. 2b); Ew2: embolus width 2 (Fig. 2b); Ew3: embolus width 3 (Fig. 2b); Cy: cymbium, length; Spl: spur length, Ta: tarsus, length; Me: metatarsus, length; Ti: tibia, length (Fig. 2c); Tiw: tibia of the palp, width (Fig. 2c); patella, length; Fe: femur, length; PSP: prolateral spines of patella; RSP: retrolateral spines of patella; MTF4 ratio: relative lengths of metatarsus, tibia and femur of leg IV; PLS: posterior lateral spinnerets; PMS: posterior median spinnerets.

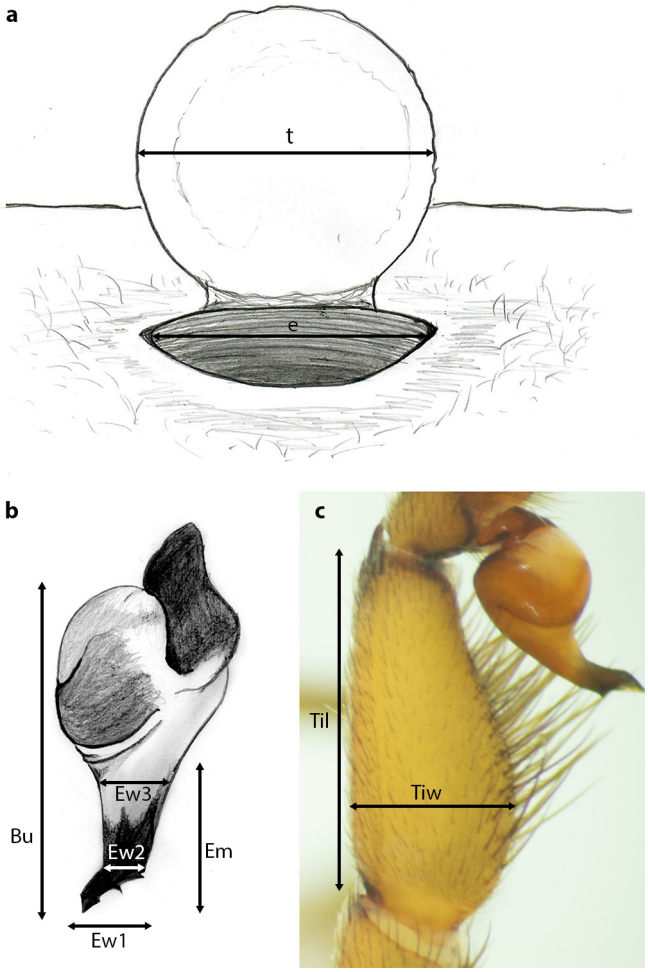

Fig. 2: *Nemesia* spp. **a.** entrance of a burrow of *Nemesia* species; **b.** *N. uncinata*, copulatory bulb; **c.** *N. uncinata*, male palpal tibia. Abbreviations: Bu – length of bulbus; e – diameter of burrow entrance; Em – length of embolus; Ew1, Ew2, Ew3 – width of distal, middle and proximal embolus zone, respectively; t – diameter of trapdoor; Til, Tiw – length and width of male tibia of palp, respectively

Results

Nemesia amicitia **spec. nov.**

Type material. Holotype ♂ (MNCN 20.02/19871): SPAIN, Los Barrios, Benharás (36.17782°N, 5.50507°W, 23 m a.s.l.), 20. Sep. 2020; allotype ♀ (MNCN 20.02/19872): SPAIN, Los Barrios, Monte de la Torre (36.15940°N, 5.49754°W, 61 m a.s.l.), 22. Jun. 2020; paratypes: SPAIN, Los Barrios, Benharás (36.17805°N, 5.50492°W, 23 m a.s.l.), 2 ♀♀, 21. Jun. 2018 (UCO), 1 ♂, 20. Sep. 2020 (UCO); Los Barrios, La Montera del Torero (36.22029°N, 5.56827°W, 68 m a.s.l.), 2 ♀♀, 26. Jun. 2018 (UCO), 1 ♀, 17. Jul. 2018 (UCO); Los Barrios, Monte de la Torre (36.15940°N, 5.49754°W, 61 m a.s.l.), 2 ♀♀, 25. Jul. 2018 (UCO); Algeciras, Huerta Grande (36.07971°N, 5.50022°W, 209 m a.s.l.), 1 ♀, 28. Feb. 2019 (UCO).

Other specimens studied. SPAIN, Los Barrios, Benharás (36.17805°N, 5.50492°W, 23 m a.s.l.), young specimen, 3. May 2018 (UCO), 1 ♂, 27. Sep. 2020 (CPC).

Etymology. The word *amicitia* means friendship in Latin, noun in apposition. This name is chosen to remember all the friends and family of the authors, especially in honour of Alejandra Franco Barberán and Juan Antonio Pecino Rocha.

Diagnosis. Considering the types of sexual organs distinguished by Decae (2012), *N. amicitia* **spec. nov.** can be in-

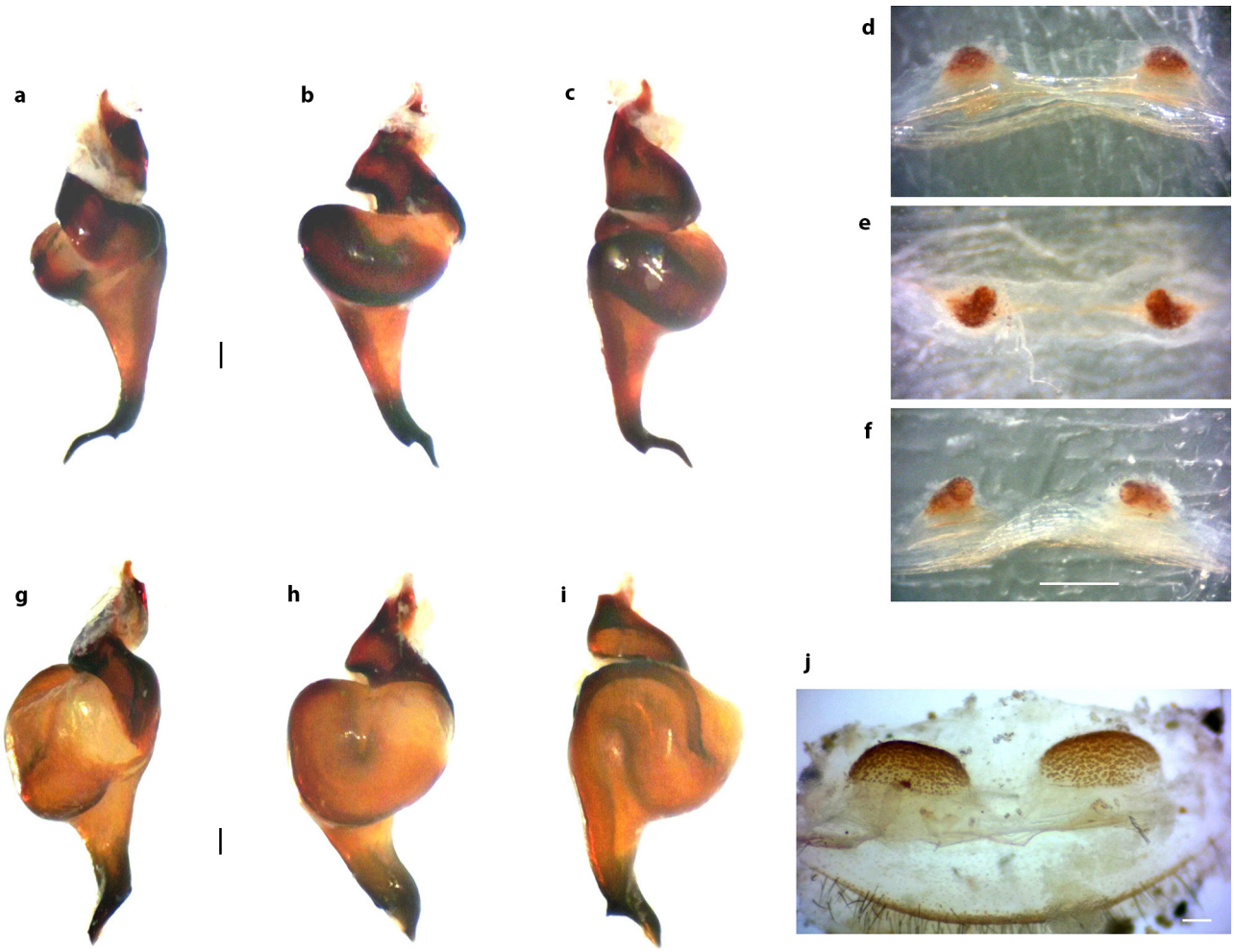

Fig. 3: Comparison of copulatory organs of *Nemesia amicitia* **spec. nov.** and *N. uncinata*. **a.** *N. amicitia* **spec. nov.**, prolateral view of the bulb; **b**. id., dorsal view; **c.** id., retrolateral view; **d.** *N. amicitia* **spec. nov.**, ventral view of the spermathecae; **e.** id., frontal view; **f.** id., dorsal view; **g.** *N. uncinata,* prolateral view of the bulb; **h.** id., dorsal view; **i.** id., retrolateral view; **j.** *N. uncinata,* ventral view of spermathecae. Scale bars: 0.1 mm (a-c, g-j); 0.5 mm (d-f)

cluded in a group of species which combines the B-type of males (characterized by enlarged, compact and ornamented bulbs) with the E-type of females (bag-shaped spermathecae with one or two sections). Males of *N. amicitia* **spec. nov.** have compact and spherical bulbs, with a curved and narrow embolus (Fig. 3). The palpal tibia ratio is 1.89±0.08 and, when alive, males show a compact black pattern on the prosoma. Females present spermathecae that resemble-two funnels, with their tubes slightly curved (Fig. 3). *Nemesia amicitia* **spec. nov.** and *N. uncinata* seem to be closely related considering their morphology, trapdoor type and life cycle, which agrees with the DNA analysis that Miquel Arnedo (Universitat de Barcelona) made in 2019 (unpubl., pers. comm). Females of *N. uncinata* from the Cádiz population and *N. amicitia* **spec. nov.** are similar and can only be separated from the new species by their bag-shaped or hill-shaped spermathecae (Fig. 3). However, in males of *N. uncinata*, the colour pattern (both alive and preserved), the range of the palpal tibia ratio is 2.25±0.04 and, above all, the morphology of the bulbs allows an easy differentiation (Fig. 3). Their burrows present a different structure, highlighting the presence of true branching in the gallery of *N. amicitia* (Fig. 4), suggesting that their behaviour is a phenotypic character that helps to distinguish species or species groups in *Nemesia*. The structure of sexual organs reveals some similarities with other Iberian species, mainly *N. dorthesi* (Thorell, 1875) and *N. athiasi* (Franganillo, 1920). *Nemesia dorthesi* is recorded in Andalusia by Zonstein (2019). According to the photographs provided in Zonstein (2019), the embolus of males is slightly narrowed, with a curve in the middle and present an arrow-shaped tip in the end; females have sac-shaped spermathecae. These characters contrast with the morphology of sexual organs in *N. amicitia* **spec. nov.** The copulatory organs of *N. athiasi* could resemble those of *N. amicitia* **spec. nov.** but, in males, the bulbs are

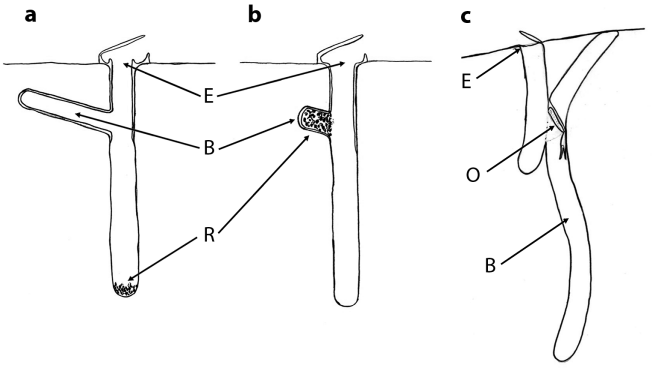

Fig. 4: Comparison of burrows. **a.** *N. amicitia* **spec. nov.**; **b.** *N. uncinata*; **c.** *N. manderstjernae* (Koch, 1871) based on the plate XIX of Moggridge (1874). Abbreviations: E: entrance, B: branch, R: remains of prey, O: operculum

less globous and more elongated, the morphology of the tip is simpler and the ventral denticles are smaller (Decae et al. 2007). In females, each spermatheca is narrow and straight on the distal half with a ring of glandular tissue (Decae et al. 2007). Finally, *N. athiasi* builds a branched burrow with two similar trapdoors. By contrast, the burrow of *N. amicitia* **spec. nov.** has only one trapdoor.

Description. Male (holotype)

Habitus. Black prosoma, crest zone grey and one grey stain on each cheek. Brown-grey opisthosoma, poorly defined dark cardiac mark and multiple dots with three chevrons on the distal area in living specimens (Fig. 5a). Overall dark coloured in alcohol. Carapace with a medal-shaped pattern of black pubescence, long hairs and some bristles on the posterior margin. White pubescence on light zones of prosoma (Fig. 5b).

Prosoma. Clypeus light, flanked by two flecks, with a row of four bristles and a crest of white pubescence. POP black and broken between AME. Caput slightly elevated. Crest zone with a row of five setae, whitish or light grey in living specimens. Fovea shallow. Chelicerae black, with dorsal and retrolateral stripes without white pubescence. Cheliceral rastellum of four–five strong spikes. Fang ridge with smooth keel. Cheliceral furrow teeth with six conical teeth on the promargin and a few small mesobasal denticles arranged in one row. Sternum lighter than other prosomal structures, the first pair of sigillas marginal and poorly visible; the second pair submarginal, the third pair ovoid and somewhat far from the margin. Maxillae along probasal heel with a few long bristles instead of cuspules. Labium dark and similar in colour to coxae; its anterior margin lighter and covered by a row of black setae (Fig. 5c).

Pedipalp and legs I–IV. Cymbium dorsal patch of 19 thin spines in the holotype; 8–13 spines in two other specimens. Bulb proximal spherical, robust, gradually narrowing embolus, distally curved and sharp pointed, with a deep furrow and thin denticle in the ventral zone (Fig. 5e). Tibia of palp 1.89±0.08 times longer than wide, with an apical dorsal patch of 8–13 spines (Figs. 5d–e). Clasper hook curved inwards, placed on inner side of tibia in ventral view. Clasper field convex in its proximal zone, with a few tiny hairs and small cone-shaped cuspules from the middle to the proximal zone metatarsus I straight (Fig. 5f). Femora slightly darker than the other articles. Scopulae on tarsi, metatarsi, tibiae and patellae on legs I and II sparser on proximal articles. On legs III and IV, scopulae only present on tarsi. Trichobothria patterns like in other Nemesiidae (see Decae et al. 2007, Luis de la Iglesia 2019, Luis de la Iglesia et al. 2021). Maculae poorly visible on distal zone of leg femora. MTF4 variable.

Prolateral and retrolateral spination. Leg I, prolateral side Pa: 2(1–4).2; Ti: 2(3).2(3); Met: 1(2–3).1(3) and retrolateral side Pa: 0(1).0(1); Ti: 3(2).3; Met: 2(1).2. Leg II, prolateral side Pa: 2.2; Ti: 3.3; Met: 2(3).2(3–4) and retrolateral side Pa: 0(1).0(1); Ti: 0.0; Met: 2(3).1(2–3). Leg III, prolateral side Pa: 2(3).2; Ti: 3.4; Met: 3(4).5(3–4) and retrolateral side Pa: 1.1; Ti: 3.3; Met = 3.3. Legs IV, prolateral side Pa: 3(2).3(2); Ti: 6(5–7).5(6–7); Met: 5(3–4).5(3–4) and retrolateral side Pa: 1.1; Ti: 3(4).3(4); Met: 3(6).3(6).

Patellar spine formulae, PSP [p: 1.1; I: 2.2; II: 2.2; III: 2.2; IV: 3.3]. RSP [p: 1.1; I: 0.0; II: 0.0; III: 1.1; IV: 1.1]. Variations (n = 2) PSP [p: 1.1; I: 1–4.2; II: 2.2; III: 2–3.2; IV: 2–3.2–3]. RSP [p: 1.1; I: 1.1; II: 1(0).1(0); III: 1.1; IV: 1.1].

Opisthosoma. Epiandrous fusillae: 26 in holotype, 23 in other specimens, distributed as in Fig. 5g. Ratio carapace length/number of epiandrous fusillae 4.61±0.08. Spinneret morphology: PLS: length of proximal segment > length of median + distal segment; with low density of small spigots on its ventral side. PMS cone shaped.

Measurements. Bl: 11.32 (8.83–9.88); dorsal area of prosoma: Ca: 3.26 (3.05–3.07); Ch: 1.56 (1.05–1.27); CL: 5.53 (5.01–5.05); CW: 4.13 (3.6–3.77); Th: 1.50 (0.96–1.17); Cly: 0.14 (0.16–0.19); ocular group: AER: 0.95 (0.76–0.87); PER: 0.95 (0.87–0.90); ALE: 0.25 (0.16–0.24); PLE: 0.22 (0.16–0.17); AME: 0.18 (0.16–0.20); PME: 0.20 (0.14); El: 0.52 (0.43–0.45); ventral area of prosoma: Mal: 1.72 (1.53–1.65); Maw: 0.92 (0.77–0.82); Lal: 0.53 (0.41–0.44); Law: 0.77 (0.74–0.80); Sl: 2.72 (2.34–2.63); Sw: 2.02 (1.39–1.93); Palp: Bulb: 1.03 (0.92–0.96); Em: 0.55 (0.53–0.57); Ew1: 0.15 (0.14); Ew2: 0.08 (0.03–0.07); Ew3: 0.27 (0.18–0.21); Cyl: 0.93 (0.80–0.88); Til: 1.96 (1.82–2.08); Tiw: 1.08 (0.94–1.07); Pal: 1.27 (1.20–1.40); Fel: 2.61 (2.08–2.48); TOTAL: 6.77 (5.90–6.84); Leg I: Spl: 0.88 (0.82–0.84); Tal: 2.21 (2.19–2.20); Mel: 3.14 (2.66–2.87); Til: 2.66 (2.62–3.13); Pal: 2.48 (2.31–2.32); Fel: 4.21 (3.85–4.04); TOTAL: 14.70 (13.85–14.34); Leg II: Tal: 2.13 (1.64–1.87); Mel: 3.28 (2.76–2.80); Til: 2.89 (2.72–2.84); Pal: 2.22 (1.79–1.98); Fel: 4.08 (3.50–3.60); TOTAL: 14.60 (12.64–12.84); Leg III: Tal: 1.67 (2.28–2.30); Mel: 3.65 (3.16–3.51); Til: 2.82 (2.57–2.71); Pal: 1.90 (1.81–1.94); Fel: 3.47 (3.05–3.14); TOTAL: 13.51 (13.09–13.38); Leg IV: Tal: 2.58 (2.30–2.39); Mel: 4.55 (4.01–4.60); Til: 4.92 (4.93–5.03); Pal: 2.93 (2.27–2.34); Fel: 4.14 (3.92–4.11); Total: 19.12 (17.78–18.12).

Female (allotype)

General appearance. Colouration as in male holotype, but prosoma whiter and more grey than brown when alive (Fig. 6a), more reddish-yellow when preserved in alcohol. Dark cardiac mark, five–six chevrons of dots on the posterior area of the opisthosoma and cream colour on its ventral side.

Prosoma. Clypeus lightly pigmented, three marginal bristles and one spot on each side. POP black, with a clear line between AME; some specimens with ALE, PLE and PME in a black fleck and each AME isolated. Caput elevated. Crest zone lightly pigmented, crest-row with seven setae. Fovea shallow and with two rows of three bristles on its anterior margin (Fig. 6b). Chelicerae black, with white stripes on their dorsal and retrolateral sides. Cheliceral rastellum consisting of five–six spikes. Fang ridge smooth. Cheliceral furrow with six promarginal conical teeth and a few small mesobasal denticles. Maxillae dark, similar in colour to coxae and a row of four cone-shaped cuspules on each one. Labium and sternum as in the holotype (Fig. 6c).

Palp and legs I–IV. Ventral ridges of trochanters less evident on legs III. Dense scopulae on tarsi of palps, tarsi and metatarsi of legs I and II; tibiae and patellae less setose. Retrolateral dark line on femora. Femora IV with maculae. MTF4 ratio: tibia > femur > metatarsus.

Prolateral and retrolateral spination. Palp, prolateral side: Pa: 2.2; Ti: 2.2; leg I, prolateral side Pa: 2(0).2(0); Ti: 3(2).2; and prolateral side Met: 0(1).0(1). Leg II, prolateral side Pa: 2.2; Ti: 3(2).3(2); Met: 1.1. Leg III, prolateral side Pa: 2.2(1);

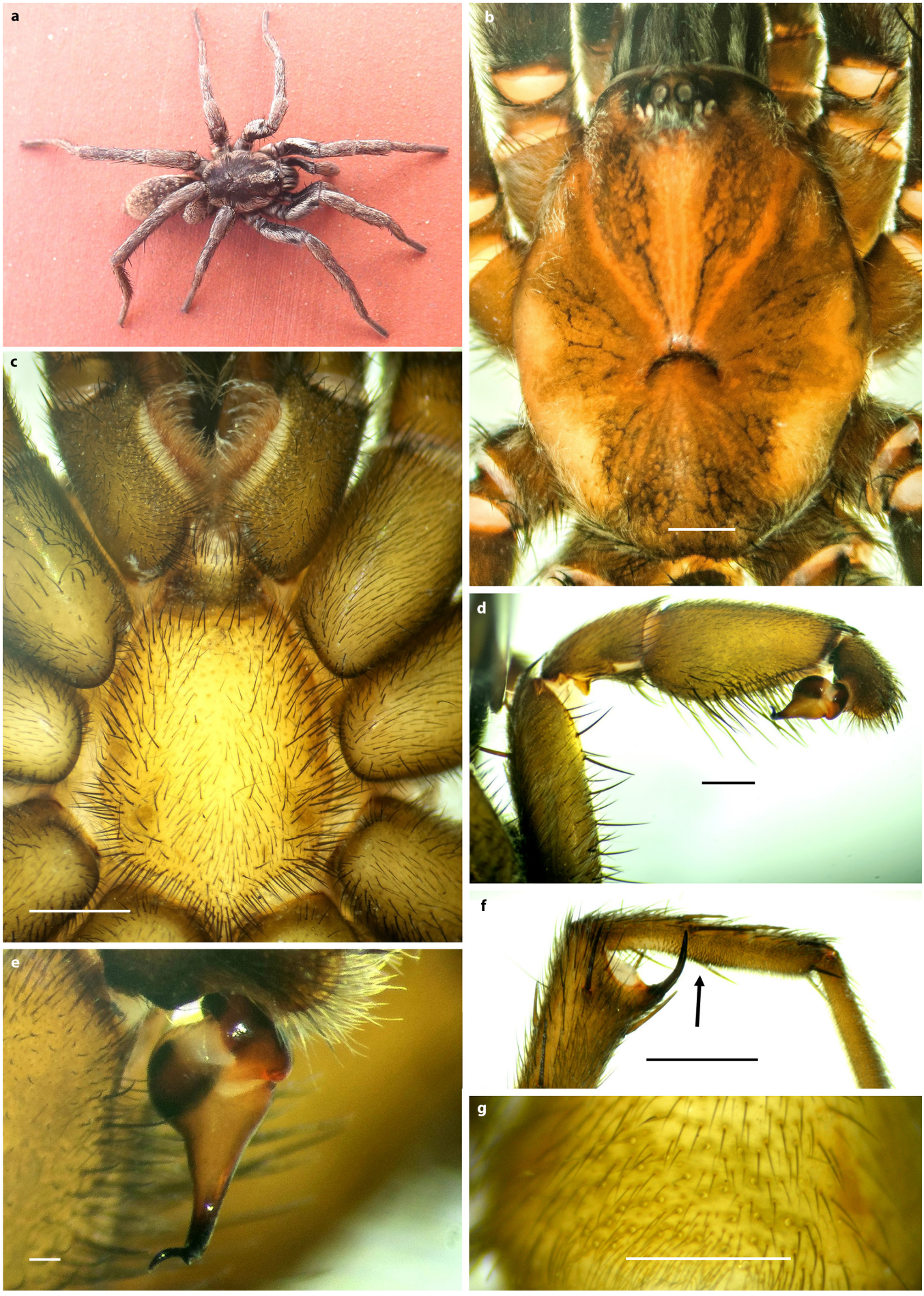

Fig. 5: *Nemesia amicitia* **spec. nov.**, male holotype. **a.** living specimen; **b.** carapace, dorsal view; **c.** maxillae, labium and sternum; **d.** palp; **e.** bulb; **f.** metatarsus I, with the clasper area marked with an arrow; **g.** epigastric area with epiandrous fusillae. Scale bars: 1 mm (b, c, f); 0.5 mm (d, g); 0.1 mm (e)

Fig. 6: *Nemesia amicitia* **spec. nov.**, female paratype. **a.** living specimen; **b.** carapace, dorsal view; **c.** maxillae, labium and sternum; **d.** spermathecae. Scale bars: 1 mm (b, c); 0.1 mm (d)

Ti: 2(1).2(1); Met: 5(3).4(3–4) and retrolateral side Ti: 2.2; Met: 3.3. Legs IV, retrolateral Ti: 2(3).2(3); Met: 3.3. Patellar spine formulae (n = 9) PSP var [p: 2.2; I: 2(0) 2(0); II: 2.2; III: 2.2; IV: 0.0]. RSP var [p: 0.0; I: 0.0; II: 0.0; III: 0.0; IV: 0.0].

Opisthosoma. Spinneret morphology: PLS: somewhat long, one oval insertion in the first segment. PMS: digitiform and small. Spermathecae: funnel-shaped with its tube bent and perpendicular to tegument. Pigmented cells on the narrow zone and on the distal half of the widened zone (Fig. 6d).

Measurements. Bl: 10.93–17.61; dorsal area of prosoma: Ca: 3.14–4.58; Ch: 1.42–1.84; CL: 4.93–7.37; CW: 3.59–-5.48; Th: 1.01–1.14; Cly: 0.14–0.20; ocular group: AER: 0.99–1.35; PER: 0.99–1.35; ALE: 0.15–0.27; PLE: 0.18–0.27; AME: 0.08–0.17; PME: 0.09–0.14; El: 0.45–0.81; ventral area of prosoma: Mal: 1.89–2.88; Maw: 0.99–1.53; Lal: 0.45–0.81; Law: 0.54–1.17; Sl: 2.52–3.68; Sw: 1.98–2.79; Palp: Tal: 1.62–2.25; Til: 1.53–2.34; Pal: 1.26–1.98; Fel: 2.25–3.50; TOTAL: 6.83–9.97; Leg I: Tal: 1.26–1.98; Mel: 1.80–3.23; Til: 2.25–3.50; Pal: 1.98–3.23; Fel: 3.14–4.85; TOTAL: 10.87–15.99; Leg II: Tal: 1.41–2.21; Mel: 1.76–3.14; Til: 2.16–3.37; Pal: 2.11–3.45; Fel: 3.02–4.65; TOTAL: 15.92–16.04; Leg III: Tal: 1.17–2.07; Mel: 2.07–3.06; Til: 1.44–2.16; Pal: 1.44–2.43; Fel: 2.52–3.59; TOTAL: 8.99–13.12; Leg IV: Tal: 1.44–2.07; Mel: 2.97–4.22; Til: 4.22–6.20; Pal: 2.70–3.77; Fel: 3.23–5.48; TOTAL: 14.56–20.94.

Ecology

Preferences for a certain type of soil were not observed, but it seems that this species is associated with sclerophilic vegetation with high levels of humidity, where it is found together with other mygalomorph genera such as *Iberesia* Decae & Cardoso, 2005, *Ummidia* Thorell, 1875, other *Nemesia* species, *Macrothele calpeiana* (Walckenaer, 1805), and *Ischnocolus valentinus* (Dufour, 1820). Trapdoors of *N. amicitia* **spec. nov.** were usually found on slopes and between roots of cork oaks, *Quercus suber* L., wild olive, *Olea europaea* var. *sylvestris* (Mill.) Lehr, palmetto, *Chamaerops humilis* L., or other bushes. *Nemesia amicitia* **spec. nov.** builds a horizontal rigid wafer-type trapdoor which leans on the internal edge of a curb of particles and silk surrounding the entrance. The mean ratio t/e is 2.16±0.37, which means that there is a space between the curb and the real entrance. There is a small sheet of silk at the entrance that the spider closes when disturbed. The burrow has a main gallery that runs vertically downwards. A dead-end branch begins 3 cm from the entrance and is angled upwards, approaching the surface. The first part (about 3 cm) at the beginning of the main gallery and the whole auxiliary gallery are

Fig. 7: *Nemesia amicitia* **spec. nov. a, b.** closed and open trapdoor, respectively; **c.** closed entrance; **d.** hunting specimen waiting for prey; **e.** internal structure of a burrow; **f.** habitat where this species was found for the first time and mature males were collected

covered by silk and are narrower than the rest of the burrow. The carcasses of prey items usually accumulate at the end of the principal gallery, at a depth of about 18–20 cm (Fig. 7).

Adult males were collected in the last half of September, when their reproductive cycle starts. Females build their egg sacs in summer and deposit them close to the deeper end of the principal gallery. At the end of summer, females moult and some days later the spiderlings disperse from their mother's burrow. This happens about a month before adult males begin to emerge from their burrows (personal observation, CP).

Notes on *Nemesia uncinata* Bacelar, 1933

New information on *N. uncinata* (intraspecific variation and previous descriptions) are given based on specimens collected from two populations of *N. uncinata* found in Cádiz province.

Studied material. SPAIN, Alcalá de Los Gazules, La Cañada de los Ratones (36.40449°N, 5.73886°W, 63 m a.s.l.), 2 ♀♀, 20. Apr. 2019 and 23. Nov. 2019 (UCO); Jeréz de la Frontera, Torrecera (36.59692°N, 5.96851°W, 16 m a.s.l.), 1 ♀, 1. Dec. 2019 (SGHN), 1 ♀, 20. Aug. 2020 (CPC), 1 ♀, 6. Sep. 2020 (CPC), 3 ♂♂, 23. Sep. 2020 (MNCN 20.02/19873, UCO and CPC) and 2 ♀♀, 27. Sep. 2020 (MNCN 20.02/19874 and CPC).

Diagnosis. *Nemesia uncinata* differs from the other species by the morphology of their sexual organs. Males bear enlarged and ornamented bulb with a curve in the middle (Fig. 8e) and females have spermathecae that resemble two mounds (Fig. 9d) (Decae et al. 2007).

Male

General habitus. Bacelar (1933) and Decae et al. (2007) provided details based on conserved specimens. According to our observations on live specimens, these spiders are black, grey and brown on the prosoma, and pale yellow and brown on the opisthosoma when they are alive. The general colour turns to brown-yellow and the dark areas of the prosoma become more apparent when preserved in alcohol (Fig. 8a-b). Opisthosoma as described by Bacelar (1933).

Prosoma. The following variations and/or details were not commented on before in other studies. The clypeus is light with two black stains, with a row of five bristles and a crest of white thin hair. POP is black with light stripe between AME in specimens from the present study, while POP is compact and black in the description of Decae et al. (2007). The crest zone is light coloured and has seven to eleven setae. The chelicerae have a rastellum formed by four–five strong spikes and each cheliceral furrow has six flattened teeth on the promargin and a row of small mesobasal denticles. Coxae, labium and maxillae are dark coloured and the sternum is light coloured with small, from oval to elongate and submarginal sigilla (sometimes poorly visible) (Fig. 8c).

Palp and legs I–IV. The cymbium is short and its dorsal patch bears 14–19 thin spines. Palpal tibia is 2.25±0,04 times longer than wide (Fig. 8d), with six–nine dorsal spines, which differs from Portuguese specimens described by Bacelar (1933), that bear a dorsal patch on the tibia of eleven spines and their tibia are almost two times longer than wide. The clasper hook is as in *N. amicitia* **spec. nov.** and the clasper field is convex, with a few tiny hairs and small cuspules (Fig. 8e). Metatarsus I is slightly curved (Fig. 8f). The scopula extends from tarsus to patella on legs I–II, it is thinner on proximal articles. Legs III–IV only with tarsal scopula. One male from the sample collected in Cádiz has maculae on the prolateral side of femora I, II, III, IV and on the retrolateral side of I, II and III; in the other two specimens, maculae are visible on the prolateral side of femora I, II and retrolateral side of III and IV. By contrast, maculae are absent in the Portuguese males. The MTF4 ratio in the population of Cádiz is metatarsus > femur > tibia; meanwhile, in spiders described by Decae et al. (2007), this ratio is tibia > metatarsus, metatarsus = femur.

Prolateral and retrolateral spination. The specimens from Cádiz vary in the number of spines on whole leg I, some differences on retrolateral spines of legs II, and the retrolateral metatarsus of III and IV compared to specimens described by Bacelar (1933). Specimens studied here have spines on: Leg I, prolateral side Pa: 2.2; Ti: 2.2; Met: 3(4).3(4) and retrolateral side Pa: 1.1; Ti: 3.3; Met: (2–3–5).(1–2–4). Leg II, prolateral side Pa: 2.2; Ti: 3(2).3; Met: 3(4).3 and retrolateral side Pa: 1:1; Ti: (0–3–4).0(3); Met: (1–3–4).1(4). Leg III, prolateral side Pa: 2(3).2(3); Ti: 4(3).3; Met: (3–4–6).(3–4–7) and retrolateral side Pa: 1.1; Ti: 3.3; Met: 3.3. Legs IV, prolateral side Pa: 3.3; Ti: 6(7).(4–7–8); Met: (3–4–5).(3–4–5) and retrolateral side Pa: 1.1; Ti: 3(4).3(4); Met: 4(6).(4–5–7). Decae et al. (2007) only commented that spines were present on the patella; in this case, the difference between both populations is that Portuguese specimens present three prolateral spines on the patella IV and lack retrolateral spine on the patella of the palp. Patellar spine formulae of spiders from Cádiz (n = 3): PSP var [p: 1.1; I: 2.2; II: 2.2; III: 2(3).2(3); IV: 0.0]. RSP var [p: 1.1; I: 1.1; II: 1.1; III: 1.1; IV: 1.1].

Opisthosoma. The epiandric area is triangular (Fig. 8g) and has 37 epiandrous fusillae. Ratio carapace length/number of epiandrous fusillae 6.73±0.32.

Measurements. Details of the variability of some metrics in the population of *N. uncinata* from Cádiz are given below. Compared with specimens previously studied by Bacelar (1933) and Decae et al. (2007), Spanish specimens seem to be slightly smaller (body length up to 12.47 mm versus 15 mm in the Portuguese specimens). Nevertheless, the length of the carapace of all populations is in the same size range. Bl: 9.35–12.47; dorsal area of prosoma: Ca: 3.13–3.32; Ch: 1.33–1.49; CL: 5.22–5.70; CW: 3.86–4.06; Th: 1.43–1.04; Cly: 0.13–0.23; ocular group: AER: 0.90–0.92; PER: 0.94–0.99; ALE: 0.23–0.24; PLE: 0.17–0.20; AME: 0.18–0.20; PME: 0.16–0.19; El: 0.46–0.50; ventral area of prosoma: Mal: 1.63–1.69; Maw: 0.87–0.98; Lal: 0.43–0.46; Law: 0.82–0.86; Sl: 2.48–2.77; Sw: 1.88–2.08; Palp: Bulb: 1.06–1.20; Em: 0.53–0.58; Ew1: 0.18–0.30; Ew2: 0.12–0.15; Ew3: 0.23–0.31; Cyl: 0.96–0.99; Til: 2.01–2.12; Tiw: 0.90–0.92; Pal: 1.34–1.40; Fel: 2.59–2.71; TOTAL: 7.00–7.13; Leg I: Spl: 0.73–0.78; Tal: 2.33–2.52; Mel: 3.09–3.13; Til: 3.05–3.17; Pal: 2.40–2.56; Fel: 4.31–4.46; TOTAL: 15.38–15.65; Leg II: Tal: 1.94–2.55; Mel: 3.04–3.37; Til: 3.04–3.22; Pal: 2.23–2.38; Fel: 4.05–4.21; TOTAL: 14.32–15.73; Leg III: Tal: 2.28–2.45; Mel: 3.68–4.00; Til: 2.77–2.90; Pal: 1.85–1.96, Fel: 3.61–3.74; TOTAL: 14.47–14.96; Leg IV: Tal: 2.54–2.60; Mel: 4.52–4.93; Til: 5.19–5.90; Pal: 2.41–2.68; Fel: 4.91–5.10; TOTAL: 19.84–20.94.

Female

General habitus. The description of Decae et al. (2007) seems to fit to the specimens studied here. Females of *N. uncinata* are somewhat similar to *N. amicitia* **spec. nov.** but they

Fig. 8: *Nemesia uncinata,* mature male. **a.** living specimen; **b.** carapace, dorsal view; **c.** maxillae, labium and sternum, with arrows indicating the positions of sigilla; **d.** palp; **e.** bulb; **f.** clasper area marked with an arrow; **g.** epigastric area with epiandrous fusillae. Scale bars: 1 mm (b, c); 0.5 mm (d, f, g); 0.1 mm (e)

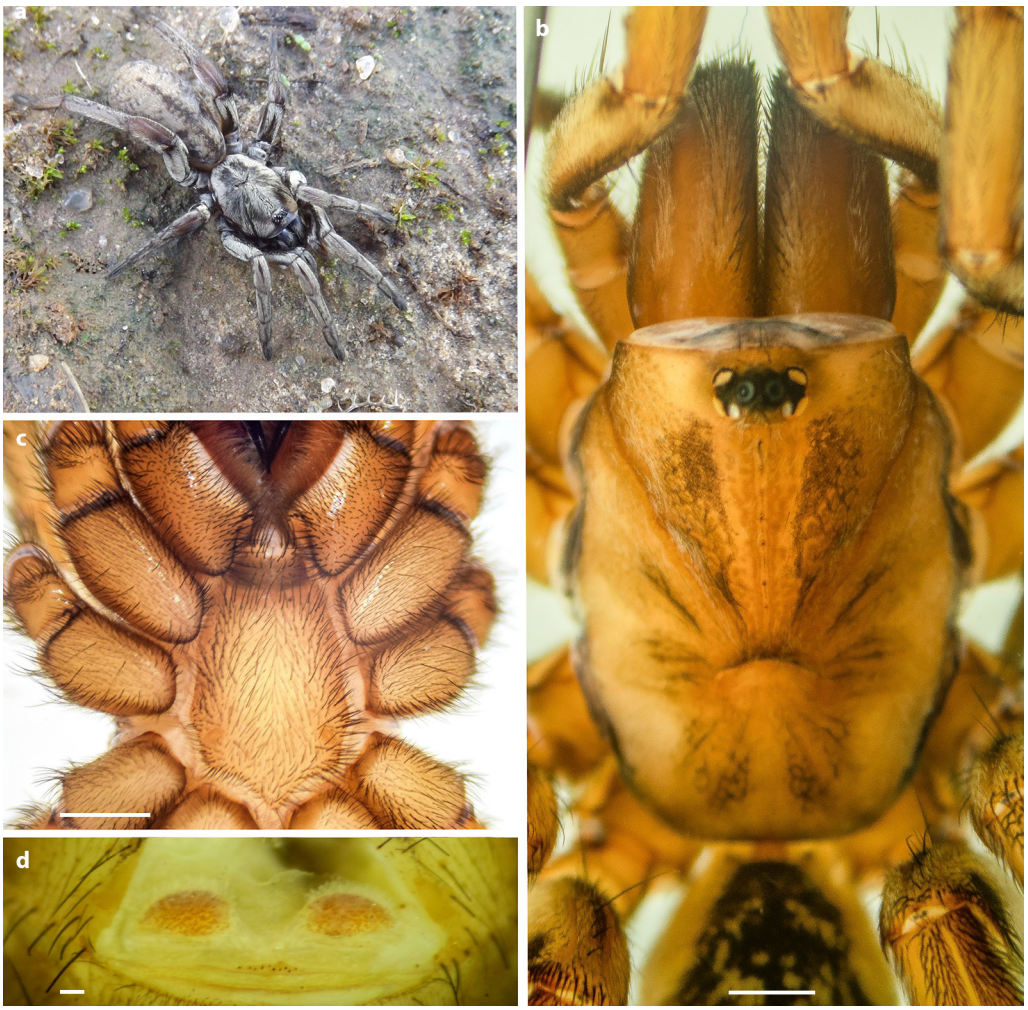

Fig. 9: *Nemesia uncinata,* mature female. **a.** living specimen; **b.** carapace, dorsal view; **c.** maxillae, labium and sternum; **d.** spermathecae. Scale bars: 1 mm (b, c); 0.1 mm (d)

are more yellowish than the new species (Fig. 9a). *Nemesia uncinata* has a dark dorsal mark on its opisthosoma; large specimens have also some dots, but adults with small body size have three–four chevrons.

Prosoma. The rastellum of the chelicerae is formed by five–six strong spikes and presents six furrow teeth (eventually seven). The clypeus is lightly pigmented and with two flecks. POP as described for males from Cádiz, i.e., broken between AME; in specimens described from Portugal the POP is broken between ALE–PLE and ALE–AME. The crest zone is lightly pigmented and has a row of six setae. Maxillae, sternum and coxae are yellowish brown (Fig. 9b-c).

Palp and legs I–IV. Similar to the female of *N. amicitia* **spec. nov.** and those described by Decae et al. (2007). The main difference consists of the absence of maculae on femora of the sample from Portugal, whereas they are always present on the prolateral femora II, III and IV and retrolateral on femora I and II on females from Cádiz. MTF4 ratio: tibia > femur > metatarsus.

Prolateral and retrolateral spination. Palp, prolateral side: Pa: (1–2).(1–2–3); Ti: 2(3).2(4); leg I, prolateral side Pa: 2(1).2; Ti: (2–3).(2–3); Leg II, prolateral side Pa: 2(1).2(1); Ti: 3(2).3(2); Met: (0–1).(0–1); Leg III, prolateral side Pa: 2(1).2; Ti: 2.2; Met: 3(4).3(4) and retrolateral side Pa: 0(2).0(2); Ti: 2.2; Met: 3.3. Leg IV, prolateral side Met: 0(1).0(2) and retrolateral side Ti: 3(2).3(2); Met: 3.3. The distribution of spines on legs segments is similar to that described by Decae et al. (2007), but with some variations in its number. The females from Cádiz have the following patellar spine formulae (n = 7): PSP Var [p: 2(1).(1–2–3); I: 2(1).2; II: 2(1).2(1); III: 2.2; IV: 0.0]. RSP Var [p: 0.0; I: 0.0; II: 0.0; III: 0.0; IV: 0.0].

Opisthosoma. The spermathecae of females from both populations have a similar morphology (Fig. 9d).

Measurements. As with males, females from populations of Cádiz seem to be a bit smaller than those from Portugal. The total body length of Portuguese females is higher (20.5–23.2), as well as the length of the carapace (7.7–8.6) and the total length of the palps and legs (palp = 11.7–12.5; I = 18.0–19.4; II = 17.0–18.4; III = 16.2–17.5; IV = 23.5–26.6). The measurements of the population from Cádiz are: Bl: 9.90–14.10; dorsal area of prosoma: Ca: 2.42–4.35; Ch: 1.23–2.26; CL: 3.79–6.74; CW: 2.69–5.55; Th: 0.64–1.49; Cly: 0.12–0.23; ocular group: AER: 0.24–1.20; PER: 0.21–1.28; ALE: 0.14–0.34; PLE: 0.14–0.33; AME: 0.15–0.99; PME: 0.14–1.01; EI: 0.39–0.64; ventral area of prosoma: Mal: 1.39–2.67; Maw: 0.86–1.42; Lal: 0.45–1.04; Law: 0.57–1.16; Sl: 2.12–3.67; Sw: 1.61–2.71; Palp: Tal: 1.43–2.37; Til: 1.18–2.58; Pal: 0.99–2.12; Fel: 1.51–3.46; TOTAL: 5.11–10.47; Leg I: Tal: 1.09–1.92; Mel: 1.53–2.75; Til: 1.82–3.45; Pal: 1.60–3.11; Fel: 2.35–5.01; TOTAL: 8.39–16.24; Leg II: Tal: 1.06–1.82; Mel: 1.20–2.38; Til: 1.66–3.15; Pal: 1.63–2.70; Fel: 2.44–4.36; TOTAL: 7.99–14.24; Leg III: Tal: 1.03–2.03; Mel: 1.66–2.81; Til: 1.40–2.17; Pal: 1.24–2.36; Fel: 2.07–3.60; TOTAL: 7.40–12.40; Leg IV: Tal: 1.39–2.11; Mel: 2.40–

Fig. 10: *Nemesia uncinata*. **a, b.** closed and open trapdoor, respectively; **c.** internal structure of a burrow. The large arrow indicates the total length of the main gallery

4.13; Til: 3.88–5.93; Pal: 2.08–4.50; Fel: 2.85–4.91; TOTAL: 12.60–20.84.

Ecology

The habitat from "La Cañada de los Ratones" (Alcalá de los Gazules) is a "dehesa" system with cork oak, *Q. suber* L, holm oak, *Q. ilex* L, wild olive-tree, *O. europaea* var. *sylvestris* (Mill.) Lehr, and a grass layer covering the soil. The population from Torrecera (Jerez de la Frontera) occurs in an open "dehesa" with predominance of mastic, *Pistacia lentiscus* L, wild olive-tree, palmetto, *C. humilis* L, and poor or absent grass layer covering the soil. In both habitats, *N. uncinata* builds burrows with some with some details differing compared to those of to those of *N. amicitia* **spec. nov.**: its mean ratio t/e is 1.70±0.26 (i.e. there is less distance between the curb and the real entrance of burrow), its auxiliary branch is shorter (1.5–2.0 cm of length) than the branch that *N. amicitia* **spec. nov.** builds, and the depth of the principal gallery is lower, about 9.0–11.5 cm (Fig. 10). *Nemesia uncinata* uses the auxiliary branch to accumulate prey-remains, meanwhile *N. amicitia* **spec. nov.** accumulates these remains at the end of the principal branch. Males were collected during autumn and spiderlings were seen with their mother in September, suggesting that the reproductive biology and phenology of this species is similar to that of *N. amicitia* **spec. nov.**

Discussion

The species studied in this work belong to the BE group established by Decae (2012). This group includes *N. caementaria* (Latreille, 1799), *N. carminans* (Latreille, 1818), *N. dorthesi*, *N. santeugenia* (Decae, 2005), *N. santeulalia* (Decae, 2005), *N. uncinata* Bacelar, 1933 and *N. valenciae* (Kraus, 1955). Mora (2015) demonstrated with DNA analysis that species of this group belong to different, not related clades: *N. caementaria* and *N. carminans* were included in the same clade and the remaining species (*N. santeulalia*, *N. uncinata*, *N. valenciae* and *N. dorthesi*) in another lineage, with a significant separation between both clades. *Nemesia caementaria* and *N. carminans* are similar considering their morphology, sexual organs and type of trapdoor (Latreille 1799, 1818, Moggridge 1873, 1874), agreeing with the results of DNA analysis carried out by Mora (2015). The remaining species of the BE group share the type of sexual organs and some similarities between known females; the DNA analysis places *N. uncinata* at the base of this second lineage. The information about burrows presented in Decae (2005) and in the present work supports the idea that *N. uncinata* belongs to a different clade than *N. santeulalia* and *N. dorthesi/valenciae*. The trapdoor of the first species consists of a rigid wafer-type trapdoor with a curb before the real entrance; in contrast, *N. santeulalia* builds a thin and flexible trapdoor (Decae 2005: fig. 73). Unfortunately, the burrows of *N. dorthesi* and *N. valenciae* are still unknown. In terms of morphology, their sexual organs are the most outstanding differences. Females of *N. santeugenia* (the conspecific male is unknown) and *N. santeulalia* present potato-shaped receptacles but with different proportions, *N. uncinata* has bag-shape spermathecae and the spermathecae of *N. amicitia* **spec. nov.** resemble curved funnels. Males of *N. santeulalia* have the proximal zone of the embolus with a similar width than the bulb and progressively narrowed to the end with an arrow-shaped tip (Zonstein 2017: figs. 21, 22), while *N. uncinata* has a widened and shorter embolus with ventral denticles on the distal zone. Also, the embolus of *N. amicitia* **spec. nov.** is thinner than in the other two species, with distal ventral denticles. The photographs of the bulbs of *N. valenciae* (Zonstein 2017: figs. 40-41) and *N. dorthesi* (2019, figs. 109, 111-113) are similar to the bulb of *N. santeulalia*, but in *N. valenciae* the bulb is more spherical and somewhat prominent and the middle of the embolus is angulated in *N. santeulalia* and *N. dorthesi*. The bulb of *N. dorthesi* is more flattened and the angle on the middle of the embolus is more acute than *N. santeulalia*.

Some authors, like Latreille (1818), Moggridge (1873, 1874), Decae (2005), Decae et al. (2007) and Decae & Huber (2017), recorded and described many species from Europe and the Mediterranean region and gave some descriptive information of their behaviour. Works like these reveal the high diversity of burrows these spiders build and the wide range of habitats where they can be found. The integration of these characteristics could be specific to species or species groups and of help in species determination (Mora 2015), and in general the type of burrow might also be a valuable character in phylogenetic analyses. For example, it seems possible that species or group of species are associated with a certain type of burrow (Mora 2015).

Regarding the knowledge on the geographical distribution of *Nemesia* species in Cádiz province (southern Spain), the models presented by Decae et al. (2007) show some species originally described from Portugal to be present in Cádiz: *N. uncinata*, *N. athiasi* and *N. fagei* (Frade & Bacelar 1931). However, only the first species has been detected until now in the studied area (personal observation, CP). The populations of *N. amicitia* **spec. nov.** and *N. uncinata* do not overlap in their distribution, but they cohabit with other unpublished species attributable to the *Nemesia* BE and CF group (simple pyriform bulbs and tubular shape spermathecae). In fact, *N. amicitia* **spec. nov.** usually shares its habitat with undetermined species belonging to the group CF, except for the location of "Pinar del Rey", San Roque, where another unpublished species of the BE group with different morphology and type of trapdoor has been found.

Mora (2015) proposed that the Baetic System Mountain range, that includes Cádiz province, represents the centre zone of diversification of *Nemesia* species and probably houses multiple unknown species, so the number of taxa officially recorded in Andalusia is still lower than one might expected. In general, the current knowledge of these spiders is poor due to their hidden lifestyle in a burrow, the ambiguity and imprecision of old descriptions (some of them based only on one sex or a unique specimen), and the loss of type material. These shortcomings induce difficulties in the identification of species included in the genus, false records and, as a result, erroneous distribution limits, as well as further taxonomic problems on higher levels.

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