

Trapdoor spiders of the genus *Nemesia* Audouin, 1826 on Majorca and Ibiza: taxonomy, distribution and behaviour (Araneae, Mygalomorphae, Nemesiidae)

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Summary

Seven species of the trapdoor spider genus *Nemesia* (family Nemesiidae) have recently been found in the Balearics, five on Majorca and two on Ibiza. Only one of these species, *N. brauni* (L. Koch, 1882), had previously been named and described. Another, *N. bristowei* sp. n., had been reported from Majorca by Bristowe (1941, 1952), but it was never formally described. The remaining five species are new. Here, supplementary notes and new figures are given for *N. brauni*, and six new species are described and figured for the first time. Additional information on the natural history, behaviour and distribution of all seven species is provided. The six new species are: *N. bristowei* sp. n., *N. seldeni* sp. n., *N. randa* sp. n. and *N. santeugenia* sp. n., all from Majorca; *N. ibiza* sp. n. and *N. santeulalia* sp. n., from Ibiza. All are regarded as endemic to the Balearics.

The information on the individual species is preceded by a review of the morphology of *Nemesia* at the generic level in order to discuss diagnostic characters for distinguishing species.

Introduction

Among the Mygalomorphae, the genus *Nemesia* is comparatively rich in species. A survey of Platnick's (2003) catalogue shows that *Nemesia* currently ranks fifth in a list of 303 mygalomorph genera (Table 1). Large genera usually have large areas of distribution. The largest genus, *Idiops*, occurs in Africa, Asia and South America, and the second largest genus, *Aphonopelma*, although concentrated in North America, also has South American representatives. According to Platnick's list, *Nemesia* also has an almost cosmopolitan distribution. The reality of this wide occurrence, however, is biogeographically difficult to explain, because of a curious discontinuous distribution, with single species recorded from China, Afghanistan, Mozambique and Cuba and approximately fifty species reported from one relatively small geographical zone. In fact the distribution of *Nemesia* is concentrated around the western and central Mediterranean, bordered by Alpine mountain ranges in the north, the Sahara desert in the south and the Atlantic Ocean in the west (Fig. 1). In North Africa the genus is reported from as far east as Egypt, and in southern Europe as far east as Greece. *Nemesia* is not known from Anatolia or Cyprus in the eastern Mediterranean, where it seems to be replaced by the related genus *Brachythele* Ausserer, 1871.

The high species diversity of *Nemesia* in the restricted geographical zone around the western and central Mediterranean might tentatively be explained by the

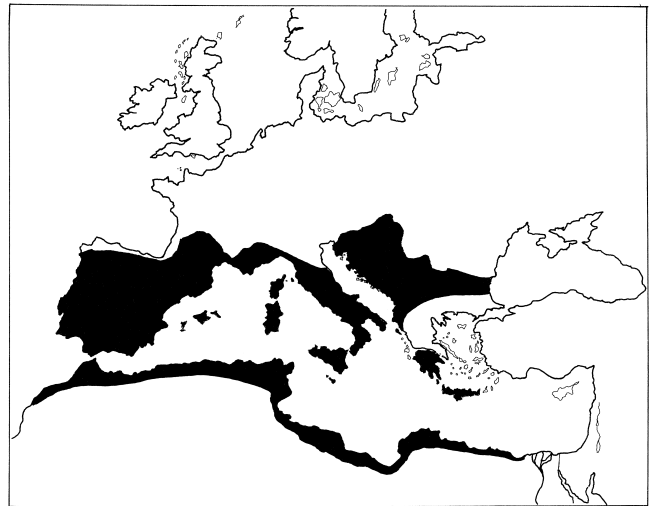


Fig. 1: Known distribution range of the genus *Nemesia* in southern Europe and northern Africa.

combined effects of poor powers of dispersal and strong allopatric speciation in an area that has been fragmented for millions of years by tectonic activity and/or that has seen numerous relict populations formed in an area that, in the not too distant past, has been affected by Pleistocene glaciations. The reality of such speculation, however, remains to be investigated, but it could possibly explain why so many, if not all, *Nemesia* species seem to be local endemics.

The questions of whether these species really are local endemics, and whether *Nemesia* contains as many species as the catalogues suggest (Roewer (1942): 40 species, 6 subspecies; Bonnet (1958): 37 species, 4 subspecies; Platnick (2003): 49 species, 4 subspecies) are of present concern. Currently there are good arguments to believe that the lists of species are over-estimations of the real numbers, because species reported from Asia, southern Africa and the Caribbean probably belong to different genera and revisions of Mediterranean species will surely reveal synonymies. On the other hand the list of *Nemesia* species may yet increase considerably in length because particularly the North African, Balkan, Greek, Spanish and Italian faunas are still very incompletely known and, as this study shows, numerous new species can still be discovered.

Material and methods

In order to find the most useful morphological characters for diagnosis at the species level, a survey of about forty *Nemesia* species (described and undescribed) present in the author's collection and in the collection of

Genus name	No. species	No. subspecies
<i>Idiops</i>	90	1
<i>Aphonopelma</i>	90	0
<i>Misgolas</i>	61	0
<i>Avicularia</i>	54	2
<i>Nemesia</i>	49	4

Table 1: Ranking of most diverse mygalomorph genera according to Platnick (2003).

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the MNHN in Paris was conducted. This survey resulted in the present review of the genus and in special attention being paid to character variation in the morphology of leg IV, spinnerets, fangs, eye-formation and sexual organs of the different species discussed.

The specimens reported on are housed, or will be deposited, in the following collections: British Museum of Natural History (BMNH), London (type material of *N. brauni*); Museum National d'Histoire Naturelle (MNHN), Paris (numbers starting with AR14 . . .); Natural History Museum (NMR), Rotterdam (numbers starting with 9972.40 . . .). The collection numbers are given with the references to the material studied under the heading of each species discussed.

All spiders described here (with the exception of the male of *N. brauni*) were collected from their natural burrows. Field data and burrow characteristics were noted *in situ* and parts of the burrows (burrow entrance tubes with trapdoors intact and some burrow bottoms) or whole burrows were collected for study in the laboratory. The samples so taken contained only adult female and juvenile spiders. Some juvenile spiders from Majorca (often in their natural burrows) were reared in captivity in an attempt to produce adult males (successful in only one species, *N. bristowei*). Other Majorcan spiders, both adult and juvenile, were kept alive to study their behaviour. The spiders from Ibiza were not studied alive. Spiders used for taxonomic research were killed in the deep-freeze compartment of a refrigerator at -21°C and preserved in 70% ethanol. These spiders were studied and drawn with the aid of a CETI-MEDO 2 stereomicroscope equipped with an ocular micrometer, a drawing mirror and a cold light source. All specimens were studied fully submerged in 70% ethanol, and fixed in position by supporting them with insect-pins stuck in the polystyrene bottom of a small dish. Measurements of body parts were taken by positioning that part horizontally with respect to the microscope's objective and having both points of measurement simultaneously in sharp focus (Figs. 2–5).

Three descriptive formulae are used:

1. Leg IV; summarising the relative lengths of the metatarsus, tibia and femur (e.g. $T4 > F4 = M4$, means that tibia IV is longer than both femur IV and metatarsus IV which are of equal length). The leg segments were measured along the prolateral side of the right leg (see Fig. 5).
2. PSP; summarising the prolateral spine pattern on all patellae of a single specimen such as a holotype: e.g. $p=0-0$, $I=1-1$, $II=1-1$, $III=3-3$, $IV=1=0$, means that there are no prolateral spines on the palp patellae, one prolateral spine on patellae I and II (one left and one right), three spines left and right on patellae III and one spine left and none right on patellae IV.
3. PSPvar; is used to describe the variation in the patellar prolateral spine pattern in a sample of several spiders (e.g. paratypes): $p=1(0-2)$, $I=1$, $II=1(2)$, $III=1(0-2)$, $IV=0$, means that usually there is one prolateral spine on the palp patella, but occasionally none or two spines, that on patella I, invariably a

BL	body length ¹
CL	carapace length ²
CW	carapace width ²
Ca	caput length ²
Ch	caput height ²
Th	thorax height ²
AR	anterior eye-row width ³
PR	posterior eye-row width ³
EI	eye-formation length ³
Clyp	clypeus height ³
ALE	diam. anterior lateral eye ³
PLE	diam. posterior lateral eye ³
POP	periocular pigmentation
M4	metatarsus IV length ²
T4	tibia IV length ²
F4	femur IV length ²
PSP	number of prolateral spines on patellae
PMS	posterior median spinnerets
PLS	posterior lateral spinnerets

Table 2: Abbreviations and methods of measurement of diagnostic characters (see also Figs. 2–8). ¹Measured in mm with callipers; ²measured in mm with ocular micrometer at $10\times$ magnification; ³measured with ocular micrometer at $40\times$ magnification.

single prolateral spine was observed, that patella II usually has one prolateral spine, but occasionally two, etc.

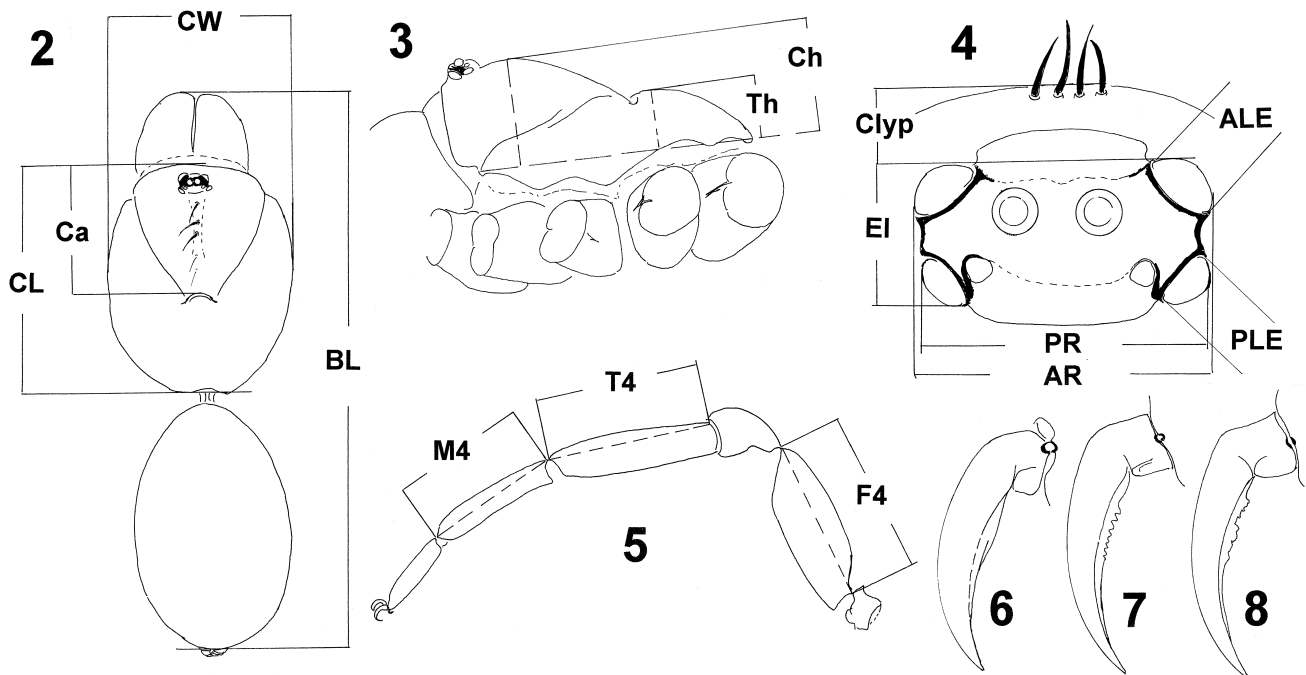
Abbreviations and methods of measurement and description are summarised in Tables 2–3 and in Figs. 2–8. Measurements of body parts are in mm, and measurements of burrow parts are in cm.

Genus *Nemesia* Audouin, 1826

Nemesia is a genus of small to large Mediterranean trapdoor spiders (body length of adults 9–31 mm). The generally dull brownish colour, relatively long legs and distinctly recurved fovea distinguish *Nemesia* species in the field readily from sympatric ctenizids that usually have a procurved fovea, a mostly dark blackish colour, and are more compactly built. Morphologically *Nemesia* species are not easily distinguished from each other. Particularly the females of different species can be very similar in appearance, and males also vary little in their anatomy. This inconspicuous anatomical variation has undoubtedly contributed to the taxonomy of *Nemesia* having been confused virtually from the start (Thorell, 1870; Pickard-Cambridge in Moggridge, 1874: 270–274). Another factor adding to the confusion probably resulted from the different and personal styles of descriptions that authors have used (e.g. Ausserer, 1871, 1875; Thorell, 1875; Simon, 1914; Franganillo, 1920; Frade & Bacelar, 1931; Bacelar, 1933). Modern

CL/CW	carapace length/carapace width
CL/Ca	carapace length/caput length
Ch/Th	caput height/thorax height
l/w	length/width
AR/PR	width anterior eye-row/width posterior eye-row
AR/EI	width anterior eye-row/length eye-formation
ALE/PLE	diam. anterior lateral eye/diam. posterior lateral eye

Table 3: Diagnostic ratios used (see also Figs. 2–5).



Figs. 2–8: Measurements and abbreviations. **2** Body, dorsal: BL=body length, CL=carapace length, CW=carapace width, Ca=caput length; **3** Carapace, lateral: Ch=caput height, Th=thorax height; **4** Eye-formation: AR=width anterior row, PR=width posterior row, EI=eye-formation length, ALE=diameter anterior lateral eye, PLE=diameter posterior lateral eye, Clyp=clypeus height; **5** Leg IV, prolateral: F4=femur IV length, T4=tibia IV length, M4=metatarsus IV length; **6** Fang with smooth keel; **7** Fang with serrated keel; **8** Fang with irregular keel.

descriptions of spider taxa usually follow a more or less standard format that discusses the various body parts in a given order (carapace, eye group, chelicerae, etc.) defining both qualitative (e.g. colour, shape, pattern) and quantitative (e.g. counts, measurements, ratios) characters. This *modern method* produces improved prospects of finding character states of diagnostic value at all taxonomic levels. The morphological *character description* of the genus *Nemesia* below focuses on finding such characters of diagnostic value at the species level.

Species level diagnostic characters within Nemesia (Tables 2–3, Figs. 2–8):

Size: Larger and smaller bodied *Nemesia* species exist (in the field sometimes in close proximity). Three different size-classes of *Nemesia* species are recognised here:

- (a) Small sized species: adult BL ♂ 9–10, ♀ 11–17.
- (b) Medium sized species: adult BL ♂ 13–14, ♀ 15–23.
- (c) Large sized species: adult BL ♂ 17–18, ♀ 20–31.

Colour: All *Nemesia* species are brownish in general appearance, but pigmentation of the carapace, basal segment of the chelicerae, legs, palps, abdomen and spinnerets may show species specific patterns. Particularly colour differences between leg segments and the degree of colour contrast between the chelicerae and carapace may be of diagnostic value.

Carapace: The shape of the carapace and the degree of elevation of the head region (caput) above the fovea may vary between species and is here reflected in the ratios CL/CW, CL/Ca and Ch/Th (Table 3; Figs. 2–3).

Pubescence: In some *Nemesia* species the carapace, chelicerae, femora and other leg-segments are clothed

with a dense cover of fine pubescent hairs, in other species these body parts may be devoid of pubescence. *Nemesia* males may differ in the possession of “fringe setae”, curved bristles on the edge of the carapace directed outwards. These fringe setae may be found along the full length of both lateral sides of the carapace, only locally, or they may be absent.

Eye-formation: Variation in the shape of the eye-formation is reflected in the ratios AR/PR and AR/EI (Table 3; Fig. 4). Variation in the position of the eye-formation relative to the anterior edge of the carapace is expressed as Clyp (Table 2; Fig. 4), a measure of the clypeus in mm.

Fovea: The shape of the fovea may vary from species to species and is here described as curved, angular, with or without a central longitudinal groove, etc., with relevant illustrations in the dorsal habitus drawings of the different species.

Fang: The inner surface of the fang carries a sharp longitudinal keel that may be either smooth, irregularly notched or neatly serrated (Figs. 6–8).

Cuspules: Usually, but not always, present. When present they may form short single rows, two more or less parallel rows, or irregular groups on the proximal margin of the maxillae.

Sigilla: Three pairs of round or oval sigilla may, or may not, be visible on the sternum; the anterior and median pairs usually touch the sternum’s margin opposite coxae I & II; the position and shape of the posterior pair may be of diagnostic value.

Scopulae: Always present in females on the palp tarsi and tarsi and metatarsi I & II, but they may or may not extend onto the tibiae. In some species the typical scopula-hairs are replaced by dense pubescence on the

anterior tibiae, thus forming a distinct pseudoscopula (Decae, 1995).

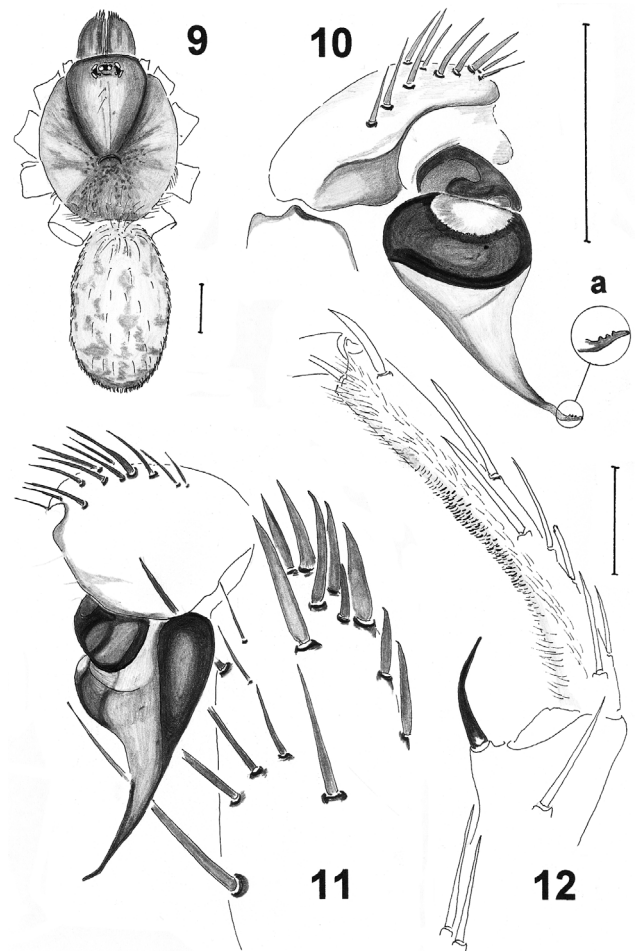
Spines: Descriptions of spine patterns are a major source of confusion in *Nemesia* taxonomy. Owing to their conspicuous presence, spines and spine patterns were used extensively as discriminative characters at the species level in early literature. Usually these patterns were reported in the form of descriptions where figures would have been less ambiguous. In more recent literature (Blasco, 1986a; Cardoso, 2000) spine patterns in *Nemesia* have been regarded as taxonomically virtually useless, owing to their extreme variability down to the individual level where different spine patterns are frequently found on the left and right sides of a single spider. However, on certain faces of some leg and palp segments, spine patterns may contain useful taxonomic information. Here the prolateral spine formulae for all patellae are given (PSP, PSPvar), and those on patella III and tibia III are figured (Figs. 17, 30, 37, 44, 51, 58, 65).

Leg IV: The relative lengths, measured along the prolateral margin of the metatarsus, tibia and femur, are of diagnostic value at the species level and are given in the ratios M4:T4:F4 (Fig. 5).

Metatarsal combs: The metatarsal preening combs on legs III and IV that were reported to be of diagnostic value in *Nemesia* by Raven (1985: 96) are unambiguously found only distally on metatarsus IV in three Balearic species (*N. ibiza*, *N. randa* and *N. bristowei*).

Spinnerets (Table 2): The spinneret morphology of *Nemesia* shows important, but so far underrated, taxonomic characters for species level taxonomy. The PMS may be absent as in *N. brauni* (Fig. 18), reduced, having none or few apical spigots as in *N. bristowei* (Fig. 31), or fully functional, having spigots distributed over the distal and ventral surface as in *N. seldeni* (Fig. 52). The PLS also show variation, particularly in the spigot development on the ventral surface of the basal segment. Spigots may be absent, restricted to the distal half of the segment (most species), or distributed widely over the ventral surface of the segment as in *N. seldeni* (Fig. 52). Finally, the apical spigots on the distal segment of the PLS may also show important differences between species. All species have a dense field of spigots at the apex of the PLS that are roughly arranged in circular concentric rings of smaller spigots on the periphery around larger spigots more centrally, with a few distinct "macro-spigots" in the centre. The number of macro-spigots can be of diagnostic value.

Spermathecae: The receptacles of the spermathecae provide a key character for species identification in female *Nemesia* (see also Blasco, 1986a). In general three broad types of shape can be distinguished: unipartite with no distinct divisions between parts as in *N. santeugenia* (Fig. 46), bipartite with distinct proximal and distal parts as in *N. brauni* (Fig. 19), and tripartite with a median part clearly separating the proximal and distal parts as in *N. ibiza* (Fig. 67). Furthermore, the shape of the receptacles may differ from species to species: the parts of the receptacles may lie in line (straight) as in *N. bristowei* (Fig. 32), the median part



Figs. 9–12: *Nemesia brauni* L. Koch, male. **9** Body, dorsal; **10** Distal end of right palp, retrolateral; **11** Ditto, prolateral; **12** Leg I clasper, prolateral. Scale lines=2 mm (9), 1 mm (10–12).

may be bent, or doubly bent (not seen in any of the Balearic species but shown by Blasco (1986a) for *N. simoni* O.P.-Cambridge, 1874 (fig. 1b) and *N. manderstjernae* Ausserer, 1871 (fig. 1g)), or the receptacles may be twisted in the median part as seen in *N. seldeni* (Fig. 53). Finally, a third useful diagnostic character may be found in the density and degree of coverage of the receptacles with glandular tissue. The whole receptacle may be densely covered as in *N. santeugenia* (Fig. 46), coverage may be thin as in *N. ibiza* (Fig. 67), or it may be locally dense and locally thin as in *N. seldeni* (Fig. 53) where the glandular tissue is concentrated proximally on both receptacles.

Clasper: The structure of the clasper on the tibia and metatarsus I of *Nemesia* males may vary somewhat from species to species. Particularly the ventral "clasper-field" of short stiff hairs and cuspules on the metatarsus (Figs. 12, 25) can be of diagnostic value.

Bulb: The palpal bulb of *Nemesia* males shows little variation in the proximal parts; the shape of the embolus and its ornamentation (or lack of it) with denticles, combs or ridges on its tip, however, is of important diagnostic value at the species level.

Other characters: *Nemesia* species are remarkably similar in most other features of their morphology, and the clearest diagnostic characters are typically found in

burrow-structure, trapdoor construction and in other aspects of behaviour and distribution (Moggridge, 1873, 1874). Available information on these characters is given following the morphological species descriptions.

***Nemesia brauni* L. Koch, 1882** (Figs. 9–19, 68, 75, 79, 85)

Nemesia braunii L. Koch, 1882: 642, pl. 20, fig. 21 (D♂♀).

Nemesia brauni: Simon, 1892: 113; Reimoser, 1919: 6; Frade & Bacelar, 1931: 226, figs. 7–8 (♂).

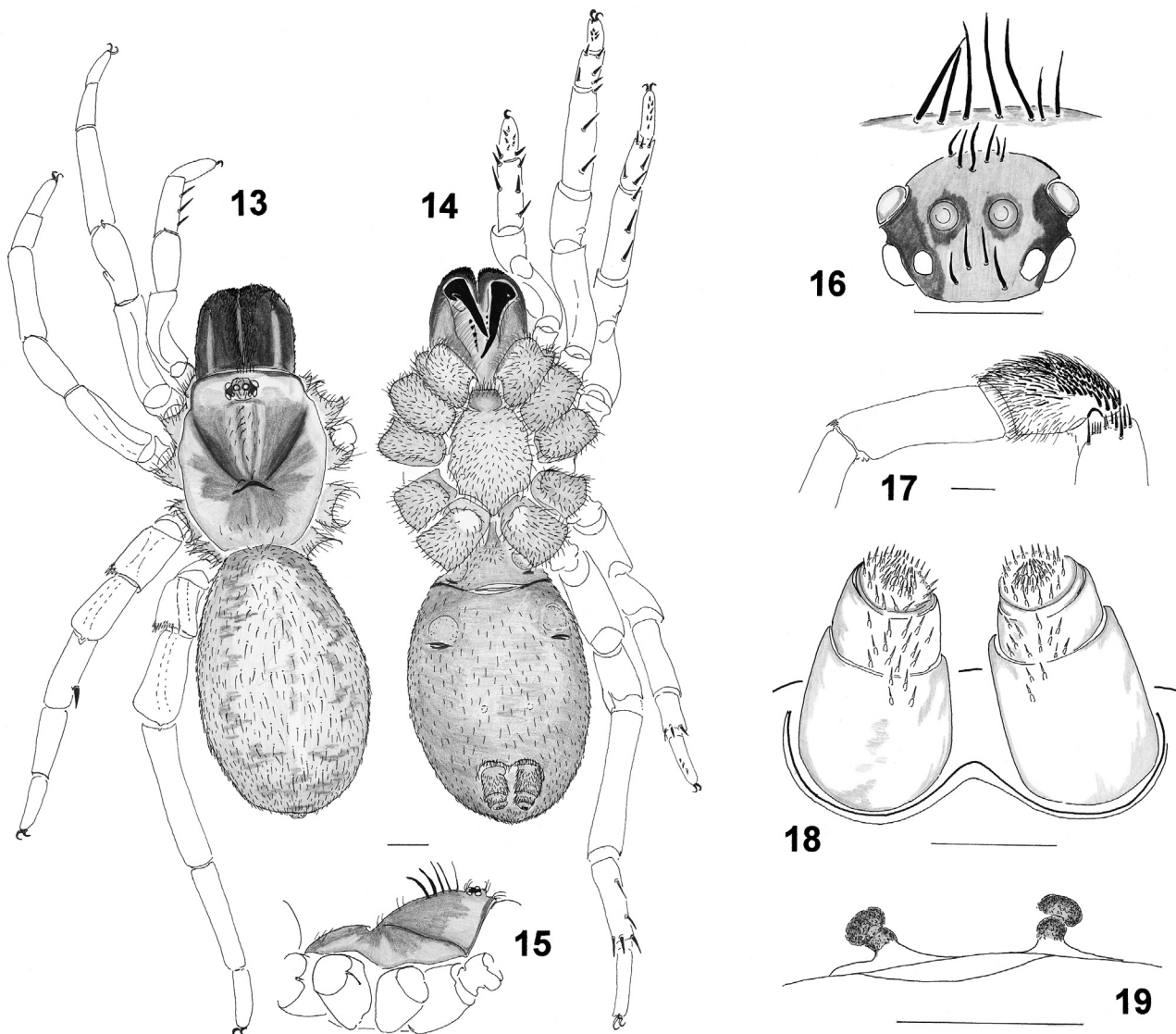
Type: Material in the BMNH examined by P. Hillyard (pers. comm.).

Other material examined: MAJORCA: 1♂ in E. Simon's collection at the MNHN (labelled *N. brauni* L.K. Palma AR4491). 8♀ leg. A. E. Decae: 1♀, Porto Sóller, 39.783°N, 2.663°E, 13 September 1997 (AR14191); 1♀, Arta, 39.725°N, 3.325°E, 16 September 1997 (9972.4004); 1♀, Santa Maria, 39.691°N, 2.713°E, 10 April 1997 (AR14193); 1♀, Santa Eugenia, 39.640°N, 2.830°E, 29 March 2000 (9972.4002); 2♀, roadside between Inca and Puebla, 39.766°N, 2.992°E,

13 October 2000 (9972.4003; AR14192); 1♀, roadside near Campos, 39.415°N, 2.998°E, 16 April 2002 (9972.4005); 1♀, Massis de Randa, 39.534°N, 2.925°E, 18 April 2003 (AR14190).

Diagnosis: *Nemesia brauni* differs from all other described *Nemesia* species by the absence of PMS and the presence of a row of three tiny denticles just proximal to the embolus tip (Fig. 10). The absence of PMS in *N. brauni* has been confirmed by a study of the type material, BMNH collection, by P. Hillyard (pers. comm.).

Notes: Machado (1944) reported the absence of PMS for *N. hispanica* L. Koch, 1871, but a check of the type material of this species in the BMNH by P. Hillyard (pers. comm.) revealed that the PMS, although reduced, are present in *N. hispanica*. At least two other *Nemesia* species lacking PMS are known from the Iberian Peninsula, but these have not yet been formally described. These two species differ from *N. brauni*, and from each other, in the morphology of their sexual organs and it might be argued that the absence of



Figs. 13–19: *Nemesia brauni* L. Koch, female. **13** Habitus, dorsal; **14** Habitus, ventral; **15** Carapace, lateral; **16** Eye-formation, dorsal; **17** Patella and tibia III, prolateral; **18** Spinnerets, ventral (note absence of PMS); **19** Spermathecae, dorsal. Scale lines=2 mm (13–15), 1 mm (16–18).

PMS is sufficient to group them with *N. brauni* in a separate genus. Further study of probable phylogenetic relationships between these species is necessary, however, before revision of the genus *Nemesia* can usefully be attempted.

Description: L. Koch (1882) described both sexes and figured the male palp. Koch's descriptions are elaborate and accurate, but lack detailed information on the morphology of the embolus, clasper, fang structure, spermathecae and spinnerets that is of diagnostic importance. Supplementary information on these aspects is provided here, as well as measurements of some body parts and figures that are considered to be of diagnostic value.

Male ($n=1$): BL=15.6, CL=6.6, CW=5.4. Leg IV: M4>T4>F4. PSP: p=1-1; I=2-2; II=1-2; III=2-2; IV=1-1. Body dorsally as in Fig. 9. Carapace longer than wide, CL/CW=1.2. Similar to female in distinct morphological characters such as large size, absence of PMS, relatively wide clypeus (Clyp=0.39), shape of eye-formation (AR/PR=0.96; AR/EI=2.00), and presence of lighter longitudinal zones on basal segment of chelicerae clothed with silvery white pubescence. The male studied differs from the females in having a low caput, an irregular serrated fang ridge (Fig. 8), and presence of dorsal spines on metatarsi and tibiae I and II. It differs also in relative lengths of segments in leg IV and prolateral spine pattern on patellae. Embolus (Figs. 10–11) neither shortened nor elongated; tip sigmoid, curved, and furnished with three tiny denticles (Fig. 10a), evident when embolus examined under high magnification in retrolateral view. Clasper as in Fig. 12.

Female ($n=8$): BL=20–26, CL=7.3–9.2, CW=6.2–7.9. Leg IV: T4>F4>M4. PSPvar: p=0; I=0; II=0; III=0; IV=0. Dorsal aspect (Fig. 13). Carapace slightly longer than wide, CL/CW=1.1–1.2, caput strongly elevated (Fig. 15), Ch/Th=2.2–2.7. Clypeus wide, Clyp=0.43–0.65. Eye-formation (Fig. 16): posterior row slightly longer than anterior row, AR/PR=1.01–1.08, more than twice as wide as long, AR/EI=2.08–2.39, grouped on and around a sloping rather than steep ocular tubercle; anterior laterals larger than posterior laterals, ALE/PLE=1.05–1.31. POP broken between median eyes and between median and lateral eyes, PME clearly smallest. Fang ridge smooth (Fig. 6). Leg III: one very strong retrolateral spine on tibia III; no prolateral spines on tibia III and patella III (Fig. 17). Ventral aspect (Fig. 14). Spinnerets (Fig. 18): PMS absent, PLS with spigots on ventral surface of basal segment restricted to distal half. Spermathecae (Fig. 19): bipartite, short “mushroom” shape, evenly covered with dense glandular tissue.

Burrow (Fig. 68): *Nemesia brauni* digs a burrow that is closed at the entrance by a thick, plug-like trapdoor (typical cork-door, as illustrated in Moggridge (1873: pl. 8) and here in Fig. 79). The depth of the burrow seems to vary with soil conditions and underground obstacles such as stones and roots. Some adult spiders were found in shallow burrows, 10–13 cm deep, in stony and very compact soils, but generally burrows of *N. brauni* are between 17–25 cm deep. The burrow shaft is a

simple, unbranched tube with a diameter of 1.2–2.0 cm in adult females. The burrow-walls are compacted and apparently impregnated with a liquid excretion from the oral opening (observed in captive spiders) to form a hard plaster wall. This hard plaster can be used to construct burrow tubes in hollow spaces underground. That the spiders can construct their nests in this way is shown when they build hard clay cells from loose soil material packed with the spiders in containers for transport. Silk is used only sparsely in burrow construction by *N. brauni*. Only the uppermost parts of the burrow-wall are covered with a thin sheet of silk that extends upwards to form a narrow, ribbon-like “hinge” that connects the burrow lining with the much thicker silken cover of the under surface and bevelled edges of the trapdoor.

Behaviour: The adult *N. brauni* female is an aggressive spider that will vigorously strike at any object (or organism) entering the burrow. During daylight hours, however, the spiders usually react to disturbances by running up the burrow and pulling the trapdoor firmly closed by anchoring the claws of the first two pairs of legs in the silken sheet that covers the underside of the trapdoor.

Around dusk *N. brauni* spiders come to the entrance of their burrow to lie in wait for passing prey. At first they just open their trapdoors by a small crack like most other trapdoor spiders, but with the growing darkness they come out more and more, until finally the trapdoor is wide open and the spiders sit fully exposed in the burrow entrance (Fig. 75). From this position the spider strikes at, and may even pursue, prey within a range of up to at least 10 cm around the burrow entrance. After a prey is captured away from the burrow, the spider will pause for a few seconds before picking up the prey with the fangs and supporting it with the palps. Apparently it has a “memory” for the location of the burrow, because usually it will turn around to carry the captured prey straight back to the burrow. If the trapdoor has remained open during the spider's actions it descends, head first, into the burrow tube and then turns around and closes the door with its front legs. Often, however, the vigorous action of the spider rushing from the burrow in pursuit of prey causes the door to fall back, closing the burrow entrance behind the hunting spider. On its return to the closed burrow the spider sometimes has some difficulty in opening the trapdoor from the outside. If the spider does not succeed in opening the door with its front legs it will turn around to lift the door with the claws of the fourth leg before reversing back into its burrow. This action shows that the behaviour of a trapdoor spider is not necessarily as stereotyped as sometimes supposed.

When it captures a large prey, the spider will remain in the closed burrow for many hours, presumably feeding. When the capture is a small prey the spider may be seen in the ambush position again ready to capture a second prey while still eating the first.

Distribution (Fig. 85): *Nemesia brauni* appears to be the most common trapdoor spider on Majorca. It has a wide distribution on the island, but it appears to be rare

in the far southeast of the island, where it seems to be largely replaced by *N. randa* (Fig. 84). Koch (1882) reported *N. brauni* also from Minorca. Its presence there has not been checked in the course of this study.

Nemesia brauni may be found in various habitats and situations and occurs locally in close association with all other Majorcan *Nemesia* species. It tends to be present in more exposed locations and occurs more frequently in horizontal surfaces than other *Nemesia* species on Majorca, although numerous burrows of *N. brauni* were also found in steep and vertical surfaces, both on natural slopes and in clay fillings between rocks of man-made stone walls. The species was found inland up to an altitude of over 800 m, but also at sea level no more than 2 m from the flood line.

***Nemesia bristowei* sp. n.** (Figs. 20–32, 69, 76, 80, 84)

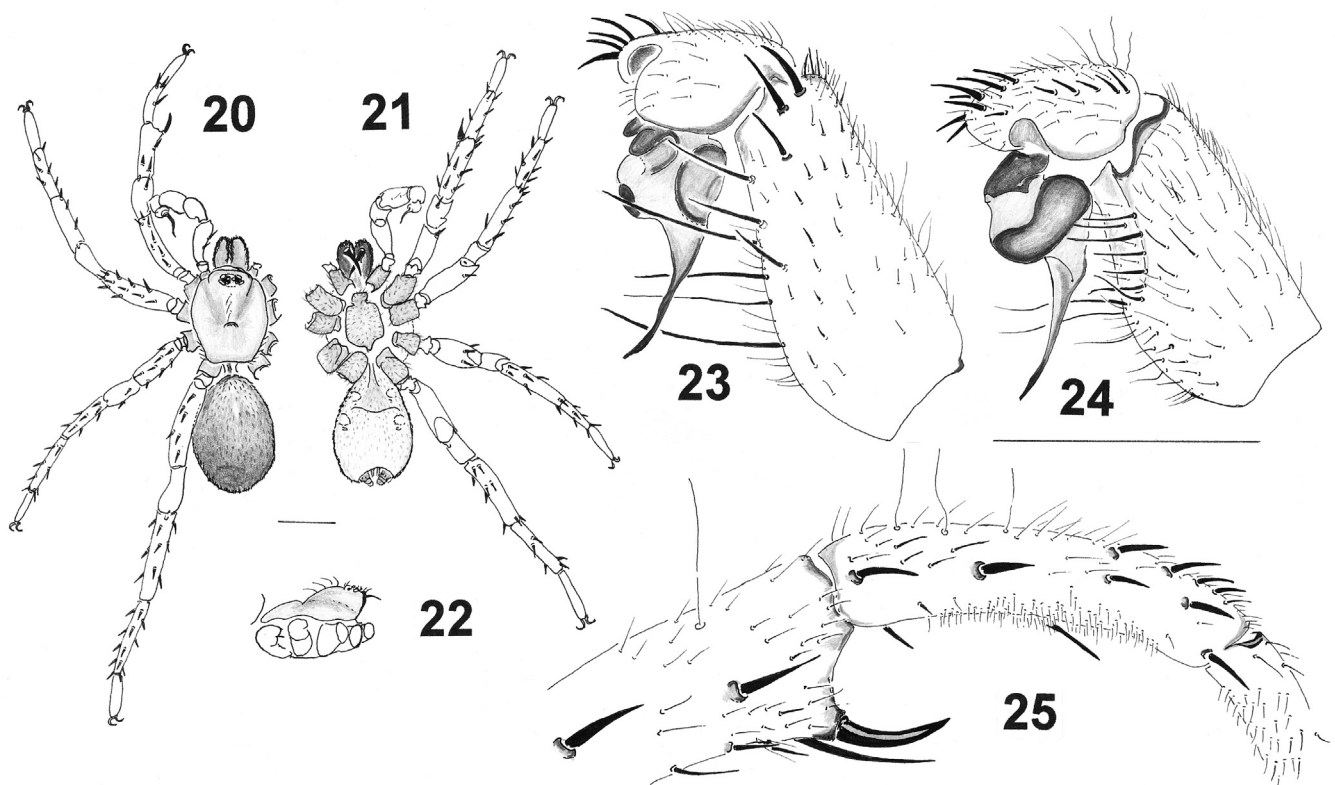
Types: Holotype ♂ (AR14208), 17 September 1997, Majorca, Porto Sóller, 39.793°N, 2.673°E, burrow in steep clay-bank along a road between farmland. Paratypes: MAJORCA: 1♂ (9972.4010), same data; 1♂ (9972.4009), same locality, 11 September 1997; 3♀ (AR14205; 9972.4007; 9972.4006), same locality, 11, 17, 20 September 1997 respectively; 3♀ (9972.4008; AR14206–7), 2 April 1996, Esporles/LaGranja, 39.656°N, 2.576°E, burrows in steep roadside bank between pine forest and farm fields. All leg. A. E. Decae. Males were collected as juveniles and reared in captivity.

Etymology: The species is named in honour of W. S. Bristowe who discovered the species first on Majorca

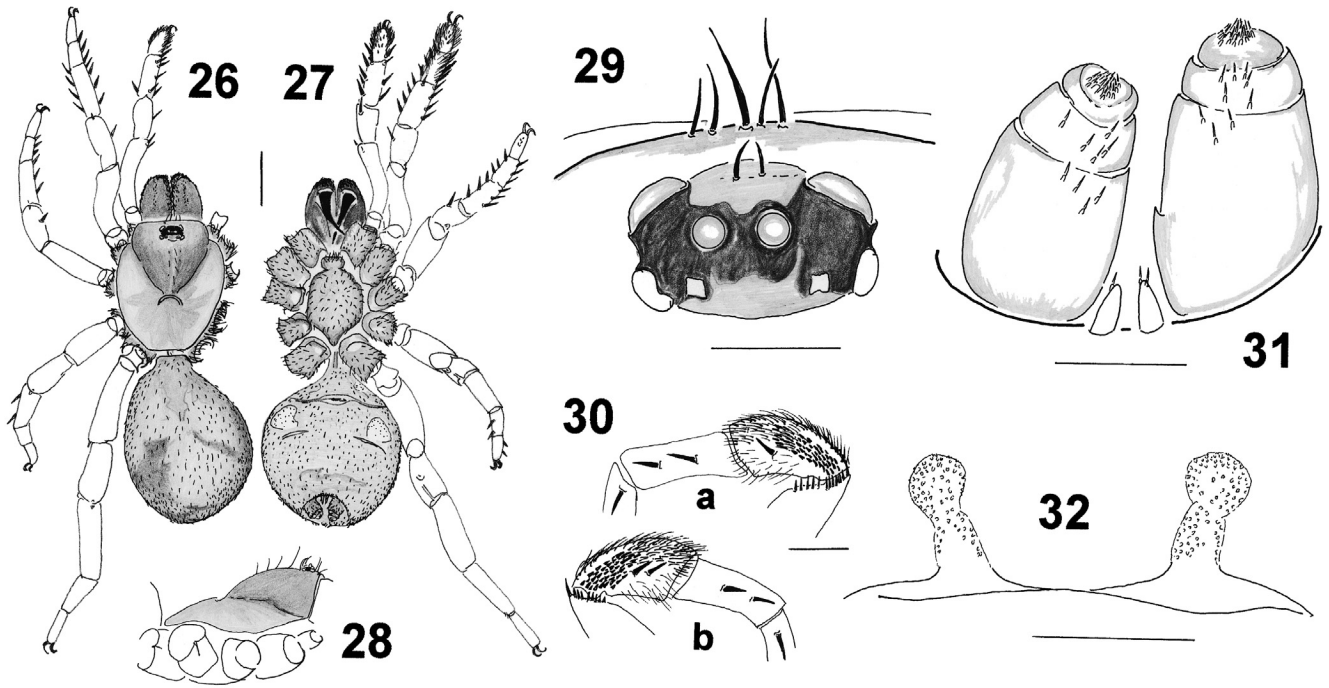
near Genova, 39.56°N, 2.60°E, in January 1930 and published about it in 1941 and 1952.

Diagnosis: *Nemesia bristowei* seems to be closely related to *N. randa*, with which it shares the characteristic forwardly directed ALE (Figs. 29, 36) that seem to be unique to these two Majorcan endemics. It differs from *N. randa*, however, in its smaller adult size, the glabrous carapace and the presence of prolatateral spines on patella III. It differs from all other *Nemesia* species by the construction of a remarkable, cog-wheel shaped trapdoor and the regular moulded counter shapes in the burrow margin that neatly receive the teeth of the cog-wheel when the door is closed (see Bristowe, 1941: 257, fig. 26 and the photographs presented in Figs. 76, 80).

Description: **Male** (holotype): BL=10.3, CL=3.9, CW=3.3. Leg IV: F4=M4>T4. PSP: p=1-1; I=2-2; II=2-1; III=2-2; IV=0-0. Dorsal aspect (Fig. 20). Carapace slightly longer than wide, CL/CW=1.2, glabrous, light yellowish brown, caput elevated (Fig. 22) and darker in colour than thorax, Ch/Th=1.4, few setae on crest of caput and on clypeus, fringe setae restricted to posterior margins of carapace. Clypeus narrow, Clyp=0.10. Eye-group less than twice as wide as long, AR/EI=1.88, PR slightly longer than AR, AR/PR=0.96, ALE much larger than PLE, ALE/PLE=1.43, and characteristically forwardly orientated. Ocular tubercle steep in front, sloping behind. Fovea deep, smoothly recurved. Chelicerae brown, darker than, and contrasting with carapace, stiff spiny setae in longitudinal group on dorsal crest and finer setae in narrow lateral line,



Figs. 20–25: *Nemesia bristowei* sp. n., male. **20** Habitus, dorsal; **21** Habitus, ventral; **22** Carapace, lateral; **23** Distal end of right palp, prolatateral; **24** Distal end of left palp, retrolateral; **25** Left leg I clasper, prolatateral. Scale lines=2 mm (20–22), 1 mm (23–25).



Figs. 26–32: *Nemesia bristowei* sp. n., female. **26** Habitus, dorsal; **27** Habitus, ventral; **28** Carapace, lateral; **29** Eye-formation, dorsal; **30** Patella and tibia III, prolateral (note variation in spine pattern, right (a) and left (b)); **31** Spinnerets, ventral (note vestigial PMS); **32** Spermathecae, dorsal. Scale lines=2 mm (26–28), 1 mm (30), 0.5 mm (29, 31–32).

pubescence absent. Promargin of cheliceral furrow with six teeth, all somewhat spaced apart, second and fifth teeth largest. Rastellum with two strong teeth apically, standing out in field of smaller rastellar teeth. Fangs with neatly serrated keel (Fig. 7) along promargin. Ventral aspect (Fig. 21). Maxillae slightly darker than sternum and ventral surface of coxae, longer than wide ($l/w=1.8$), with few cuspsules near prolateral proximal margin. Sternum light yellow, slightly longer than wide ($l/w=1.3$), evenly covered with black setae. Anterior and median pairs of sigilla round, touching sternum margin, posterior pair placed slightly away from margin. Labium greyish, dome shaped, wider than long, evenly covered with fine setae, proximal setae strongest. Labial furrow wide and glabrous. Legs lighter yellow than carapace, with numerous spiky spines on metatarsi, tibiae, and femora; all metatarsi and tibiae with dorsal, ventral pro- and retrolateral spines, prolateral spines on patellae I and II, pro- and retrolateral spines on patella III, no spines on patella IV, numerous short dorsal and dorso-lateral spines on all femora, spine patterns differ on left and right legs. Dense pubescence on all femora. Palps (Figs. 23–24): colour and pubescence as legs, dorsal apical spine-group on tibia with two spines left and three right, cymbial spines restricted to distal half of segment. Abdomen light greyish brown with vague dorsal pattern of darker blotches, fully covered with fine hairs. Spinnerets (as in female, Fig. 31) creamy yellow. PMS small, spiky, with one apical spigot. PLS basal segment without spigots, as long as median and distal segments together. Apical spigots grouped around one large central spigot. Bulb (Figs. 23–24): embolus long, slender and slightly bent. Tibial spur (Fig. 25) inwardly curved.

Ventral clasper field on metatarsus I with short sharp spikes not closely grouped.

Variation ($n=3$): Males vary considerably in size, $BL=9-10.5$, $CL=3.2-3.9$, $CW=2.8-3.3$. Shape of carapace rather constant, $CL/CW=1.2$. $ALE/PLE=1.36-1.55$, $AR/PR=0.94-0.96$. Fovea varies from smoothly recurved to almost straight. Slight variation was found in relative lengths of femur IV and metatarsus IV, $F4/M4=1.00-1.02$. Most conspicuous variation in spine patterns, which differ considerably on left and right appendages of all individuals and between all spiders studied. PSPvar: $p=1(0)$; $I=2(1)$; $II=2(1)$; $III=2(1)$; $IV=0(1)$. Number of macro-spigots on distal segment of PLS may vary from 1–3.

Female ($n=6$): $BL=12-17$, $CL=4.8-5.7$, $CW=3.8-4.6$. Leg IV: $F4>T4>M4$. PSPvar: $p=1(0-2)$; $I=1$; $II=1(2)$; $III=1(0-2)$; $IV=0$. Dorsal aspect (Fig. 26). Larger and more compactly built than males. Carapace colour pattern as in male, $CL/CW=1.2$. Caput (Fig. 28) elevated, $Ch/Th=1.7-1.9$. Clypeus variable in width, $Clyp=0.12-0.24$. Ocular tubercle as in male. Eye-formation (Fig. 29), $AR/PR=0.92-1.00$, POP unbroken, ALE directed forwards and larger than PLE, $ALE/PLE=1.25-1.62$. Fovea recurved, sometimes somewhat extended laterally. Chelicerae strong, colour and setae as in male. Rastellum more strongly developed than in male. Fang keel serrated (Fig. 7) or rarely smooth (in one specimen). Ventral aspect (Fig. 27). Maxillae with small anterior apical process, cuspsules well developed, in irregular rows. Sternum ($l/w=1.4-1.6$), posterior sigilla oval, about their largest diameter from sternum edge, anterior and median sigilla hardly visible. Labium with anterior edge slightly convex. Legs with very strong

spines on anterior metatarsi and tibiae, scopula restricted to tarsi and metatarsi (no pseudoscopula on tibiae). One or two prolateral spines on patella III (Fig. 30a, b), rarely none. Retrolateral apical comb on metatarsus IV not evident in all specimens. Palp with numerous strong spines and spine pairs on both lateral sides of tibia; scopula restricted to tarsus. Abdomen light greyish brown with vague, irregular dorsal pattern of darker patches. Spinnerets (Fig. 31) creamy yellow, PMS vestigial with only one or two fine apical spigots, conical, PLS apical field spigots grouped around 1–3 macro-spigots. Spermathecae (Fig. 32) bipartite, slender “mushroom” shape (proximal part of receptacle tubular, distal part globular), evenly covered with thin glandular tissue.

Burrow (Fig. 69): The burrow of *N. bristowei* is immediately recognisable by the peculiar, intricate shape of the trapdoor and burrow rim (Fig. 80). Bristowe (1941: 257) first found and illustrated this “cogwheel-door”. Bristowe (1952) reported that he had not been able to describe the species, because his collection was destroyed during World War II. It took nearly half a century before Selden (1997) rediscovered this remarkable trapdoor spider in 1989. The tube of the burrow has no special features, but is a narrow cylindrical hole (diameter 0.6–0.9 cm) about 8–15 cm deep, that often widens somewhat near the bottom. The largest diameter of the trapdoor is about 1.15. The walls and bottom of the tube are lined with a dense sheet of silk. In this respect it is similar to the burrow of *N. randa* (Fig. 70), but different from that of *N. brauni* (Fig. 68), in which only the upper parts of the burrow are lined with silk.

Behaviour: Adult *N. bristowei* females are small, rather shy spiders that have a much more defensive attitude than *N. brauni*. The peculiar trapdoor, the construction of which was described by Bristowe (1941: 257), seems to function to improve the closing of the burrow. The “teeth” on the edge of the door fit closely between the notches on the burrow rim (Fig. 80), providing what seems to be a “locking” system. This system of closure appears to function in keeping the door shut on the vertical or even slightly overhanging surfaces in which these spiders frequently build their burrows. When disturbed, *N. bristowei*, as all trapdoor spiders so far observed, runs up to the trapdoor to pull it shut. The spider reacts to excavation of the burrow by retreating to the bottom of the burrow, where it sits still with its legs drawn close to the body (Fig. 69). Only when taken from the burrow will it try to escape by suddenly dashing away with surprising speed. In captivity the spiders will, given the opportunity, readily construct a new burrow both in sloping and horizontal soils. Shortly after a spider has constructed a new trapdoor it may be found hunting by lying in ambush behind an only slightly cracked open door (Fig. 76). The tips of tarsi I and II rest against the inside of the notches on the burrow rim, but no part of the spider extends from under the trapdoor. The spider will react aggressively to small prey passing the burrow within a distance of less than 1 cm. Small isopods, with body lengths up to about half the body length of the spider, are readily captured,

in the usual trapdoor spider fashion, by a quick and aimed dash forwards. Small beetles, flies and ants will also be captured and eaten by the spiders in the laboratory. The natural prey of *N. bristowei* is difficult to establish because this species, as all other Majorcan *Nemesia* species, removes indigestible remains of eaten prey from the burrow by “throwing” them out of the burrow entrance. In the laboratory these remains, compressed into compact little balls, are invariably found in the container in which the spider is kept, some hours after prey is captured. That the spiders are inclined to keep their burrows clean is also evident from the traces of defecation usually found on the cover of the container some centimetres above the trapdoor. Apparently these spiders eject faeces with some force from the burrow opening.

Annual cycle: The males of *N. bristowei* described here were collected as juveniles in September 1997. They left their burrows as adults (in captivity) one year later in September 1998. Because this period of the year coincides with the peak in male wandering of *Nemesia* in the field (121 records between 1 September and 30 November in pitfall trap catches of males in Portugal, Spain, France and Italy) it is supposed here that males of *N. bristowei* wander predominantly in autumn. They would do so after a period of aestivation in summer when the burrows of most Mediterranean trapdoor spiders are found to be “locked” with silk spun around the inner edges of the trapdoor to seal it to the burrow rim and/or by a thick clay plug positioned directly under the trapdoor. The last feature has not been observed in *N. bristowei*. In spring most females show development of eggs in the ventral part of their abdomen. Egg-sacs and spiderlings may be found in the burrows of females between May and September. It seems that *N. bristowei* does not practise extended brood care as do some *Nemesia* species in southern France.

Distribution (Fig. 84): The distribution of *N. bristowei* seems to be restricted to the western half of Majorca, where the species is very common in the mountain range of the Serra de Tramuntana. It seems to be rare anywhere east of the line Palma–Pollença. Within its area of distribution *N. bristowei* seems to be a specialist of steep surfaces. Although burrows are also found on gradually sloping banks, the densest aggregations of burrows are found on nearly vertical or even overhanging surfaces, often of eroding clay banks. The spiders may also be found within human settlements in garden walls, parks and even in the walls of houses.

***Nemesia randa* sp. n.** (Figs. 33–39, 70, 78, 82, 84)

Types: Holotype ♀ (AR14198), 2 April 2002, Majorca, Castelix de la Pau, 39.550°N, 2.898°E, burrow in steep bank of white clay within patch of pine forest. Paratypes: MAJORCA: 3♀ (AR14199; AR14200; 9972.4011), 1 April 1998, between Randa and Monturi, 39.539°N, 2.974°E, burrows in steep clay-bank along road between mixed forest and cultivated fields; 1♀ (AR14201), Randa, 39.531°N, 2.904°E, 8 April 1995, burrow in

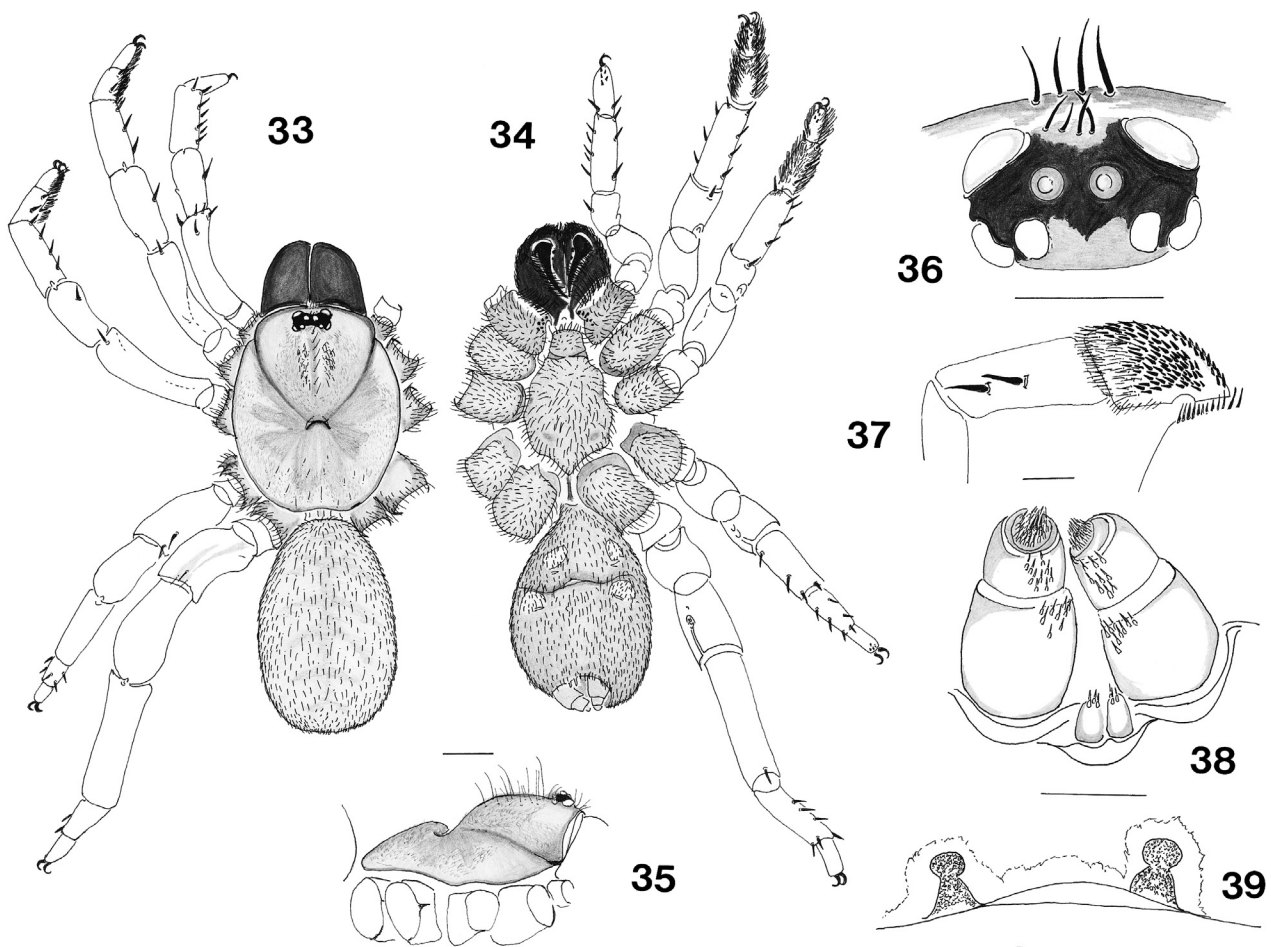
steep clay bank in garigue; 2♀ (9972.4012; 9972.4013), between Lluçmajor and Porreres, 39.503°N, 2.972°E, 5 April 1995 and 18 April 2002, burrows in steep roadside bank in mixed forest. All leg. A. E. Decae.

Etymology: The specific name is a noun in apposition taken from the geographical area, the Massis de Randa, where it was first discovered.

Diagnosis: *Nemesia randa* differs from all other known *Nemesia* species, with the exception of *N. bristowei*, in the relatively large size and forward orientation of the ALE and the narrow clypeus (Fig. 36). It differs from *N. bristowei* by the larger size of adult female spiders and other characters mentioned in the diagnosis of *N. bristowei*. The male is unknown.

Description: *Female* (holotype): BL=20.6, CL=7.6, CW=6.0. Leg IV: T4>F4>M4. PSP: p=2-2; I=1-1; II=1-1; III=0-0; IV=0-0. Dorsal aspect (Fig. 33). Carapace longer than wide, CL/CW=1.3, different shades of brown and yellow in suffused, indistinct pattern of darker central zones and lighter lateral zones, cervical grooves distinctly dark brown, setae in three longitudinal, somewhat irregular parallel rows, with strongest setae in central row and in small groups on ocular tubercle and along anterior edge of clypeus. Carapace indistinctly, but fully, covered with fine whitish pubescent hairs. Caput elevated, Ch/Th=2.0. Clypeus narrow, Clyp=0.12. Eye-group (Fig. 36) on steep ocular

tubercle, less than twice as wide as long, AR/EI=1.69, anterior row slightly longer than posterior row, AR/PR=1.04, ALE orientated forward and much larger than other eyes, ALE/PLE=1.57. POP unbroken. Fovea not smoothly recurved, but somewhat angular, dropping away from base of caput. Chelicerae dark chocolate brown, contrasting with yellowish carapace, broad glabrous zones between dorsal setae-field and lateral zones with fine hairs. Dorsal setae merging distally with field of stronger spines surrounding rastellum teeth. Cuticle of cheliceral furrow distinctly lighter in colour, pro-margin of furrow with seven strong teeth, second and third (counting from fang base) largest, two proximals (6th and 7th) somewhat separated. Rastellum on small process distal and prolateral of fang base. Fangs rather short and blunt, with serrated keel (Fig. 7). Legs yellowish brown, slightly lighter than carapace; ventral and lateral surfaces of femora III and IV, ventral surfaces of patella I and tibiae I and II conspicuously lighter creamy white, all femora with dark central longitudinal zone dorsally. Scopulae strongly developed on tarsi and metatarsi I and II, extending slightly onto distal ends of tibiae I and II. Strong prolateral ventral spines in longitudinal rows on metatarsi and tibiae I and II, also more dorsally on metatarsus III, tibia III with two short prolateral spines (Fig. 37), spines on metatarsus and tibia IV thinner and fewer than on those segments of other legs.



Figs. 33–39: *Nemesia randa* sp. n., female. **33** Habitus, dorsal; **34** Habitus, ventral; **35** Carapace, lateral; **36** Eye-formation, dorsal; **37** Patella and tibia III, prolateral; **38** Spinnerets, ventral; **39** Spermathecae, dorsal. Scale lines=2 mm (33–35), 1 mm (36–38), 0.5 mm (39).

Slender spiny setae in longitudinal rows and distal groups dorsally on all femora. Metatarsus IV with retrolateral apical comb. Palp similar colour to anterior legs, scopula on tarsus not extending onto tibia, one pro- and one retrolateral proximal spine on tarsus (left prolateral spine absent), fine ventral spines in tarsal scopula, rows of strong pro- and retrolateral spines on tibia, two prolateral spines on patella, a larger spine more ventrally and a smaller spine more dorsally placed, femur as legs. Ventral aspect (Fig. 34). Maxillae longer than wide ($l/w=1.8$), extending into indistinct prolateral distal process, slightly darker than coxae and sternum, except for creamy white anterior zone of maxillary scopula. Ventrally evenly covered with setae; well developed row of cuspules along proximal margin. Sternum longer than wide ($l/w=1.2$), widest between coxae II and III, yellow, evenly covered with fine setae of varying size, strongest setae along edges, three pairs of sigilla, anterior and median pairs touching margin, posterior pair more centrally placed (twice their diameter from sternum edge). Labium slightly darker than sternum, dome shaped, wider than long, evenly covered with setae. Labial furrow wide, glabrous, distinctly bicoloured (yellowish along sternum, more greyish along labium). Abdomen greyish, evenly covered with fine setae, faint dorsal pattern of darker lines and chevrons. Spinnerets (Fig. 38) similar colour to ventral abdomen; PMS reduced, spiky, with two apical spigots, PLS short, basal segment longer than median and distal segment together, ventral spigots only on distal half of basal segment, apical spigots grouped around three macro-spigots. Spermathecae (Fig. 39) bipartite, proximal part conical, distal part globular, both parts evenly covered with not very dense glandular tissue.

Variation ($n=7$): Females are medium to large trapdoor spiders, BL=18–24, CL=6.8–8.4. Carapace, CL/CW=1.2–1.3, CL/Ca=1.7. Caput Ch/Th=1.7–2.2. Clyp=0.07–0.20. ALE/PLE=1.26–1.55. AR/PR=1.03–1.08. Fang ridge may be either neatly serrated (Fig. 7) or more irregular (Fig. 8). PSPvar: p=1(2), I=1, II=1, III=0(1), IV=0. Leg IV: F4>T4≥M4. PMS reduced, 2–3 apical spigots. PLS apical spigots grouped around 2–3 macro-spigots.

Male: Unknown.

Burrow (Fig. 70): The first impression of the burrow of *N. randa* in the field is that of a classical cork-burrow as first described in detail by Moggridge (1873) for *N. carminans* (Latreille, 1818) in southern France, and as reported here for *N. brauni* from Majorca and *N. ibiza* from Ibiza. On closer inspection, however, there are some interesting differences. The silken lining of the burrow tube is not restricted to the upper parts of the burrow, as it is in all three species mentioned above, but it extends all the way down the walls of the tube and also covers the bottom of the burrow (Fig. 70, dashed line). The trapdoor of *N. randa* also differs from that of the classical “cork-type” in that it not only fits snugly into the entrance opening of the burrow, but it also extends over the edges of the burrow opening, resting on some irregular extensions (tags) constructed on the upper side of the door (Fig. 82). In this respect the trapdoor of

N. randa is somewhat like the “cog-wheel” door of *N. bristowei*, although not nearly so regularly sculptured. Another similarity between the trapdoors of *N. randa* and *N. bristowei*, in which both differ from a typical cork-door, is the width of the hinge. In a typical cork-door, as built by the three above-mentioned species, the hinge is a narrow, ribbon-like silken strap that allows the door, when open, to rotate slightly. The trapdoors of both *N. randa* and *N. bristowei*, however, have a much broader silken hinge that limits the door to simple straightforward opening and closing movements. Like the burrow of all other species mentioned in this paragraph, the burrow of *N. randa* is a simple tube without side excavations.

Behaviour: In the field the burrows of *N. randa* may be found on rather horizontal and gradually sloping soil surfaces but, like *N. bristowei*, it is most frequently found on very steep or vertical clay walls. Particularly where *N. randa* is found syntopically with *N. brauni* there seems to be some habitat partitioning in which *N. brauni* predominantly occupies the more horizontal ground and *N. randa* the steeper surfaces. A curious observation, that so far has no clear explanation, is that whereas most trapdoor spider species orient their trapdoors in the same position with respect to the slope of the terrain, *N. randa* orients its door differently. In most trapdoor spiders the hinge connects the trapdoor to the highest (most uphill) point of the burrow entrance and the door opens widely facing downhill, but in *N. randa* the trapdoor almost invariably opens sideways with respect to the slope, or even uphill (also observed though less frequently in *N. bristowei*).

In temperament *N. randa* is a rather unaggressive spider that will bite only as a last defence after capture. It is also “shy” in its hunting posture, which is essentially similar to that described for *N. bristowei* (Fig. 78). The prey capture range of *N. randa*, owing to the spider’s larger size, extends to a somewhat greater distance of about 2 cm from the burrow rim. Prey handling and the ejection of prey-remains and faeces from the burrow are as described for *N. bristowei*.

In captivity *N. randa* was found to be more reluctant to construct a new burrow than the other Majorcan *Nemesia* species. Some spiders wandered around their clay-filled containers for weeks before they finally started digging, and some never dug. When the spiders finally constructed a burrow, it was indistinguishable from a natural burrow, and usually the spiders were found hunting normally the night after the construction work was finished. In captivity *N. randa* would take a wide range of arthropod prey, but none larger than about half the size of the spider. As *N. bristowei*, and in contrast to *N. brauni* and *N. seldeni*, *N. randa* was never seen to leave the burrow in pursuit of prey.

Distribution (Fig. 84): *Nemesia randa* was found to have a restricted distribution on Majorca, where it is common around the central massif of the Massis de Randa and in the south-eastern parts of the island. It inhabits similar habitats to *N. brauni*, with which species it is sometimes found in close association.

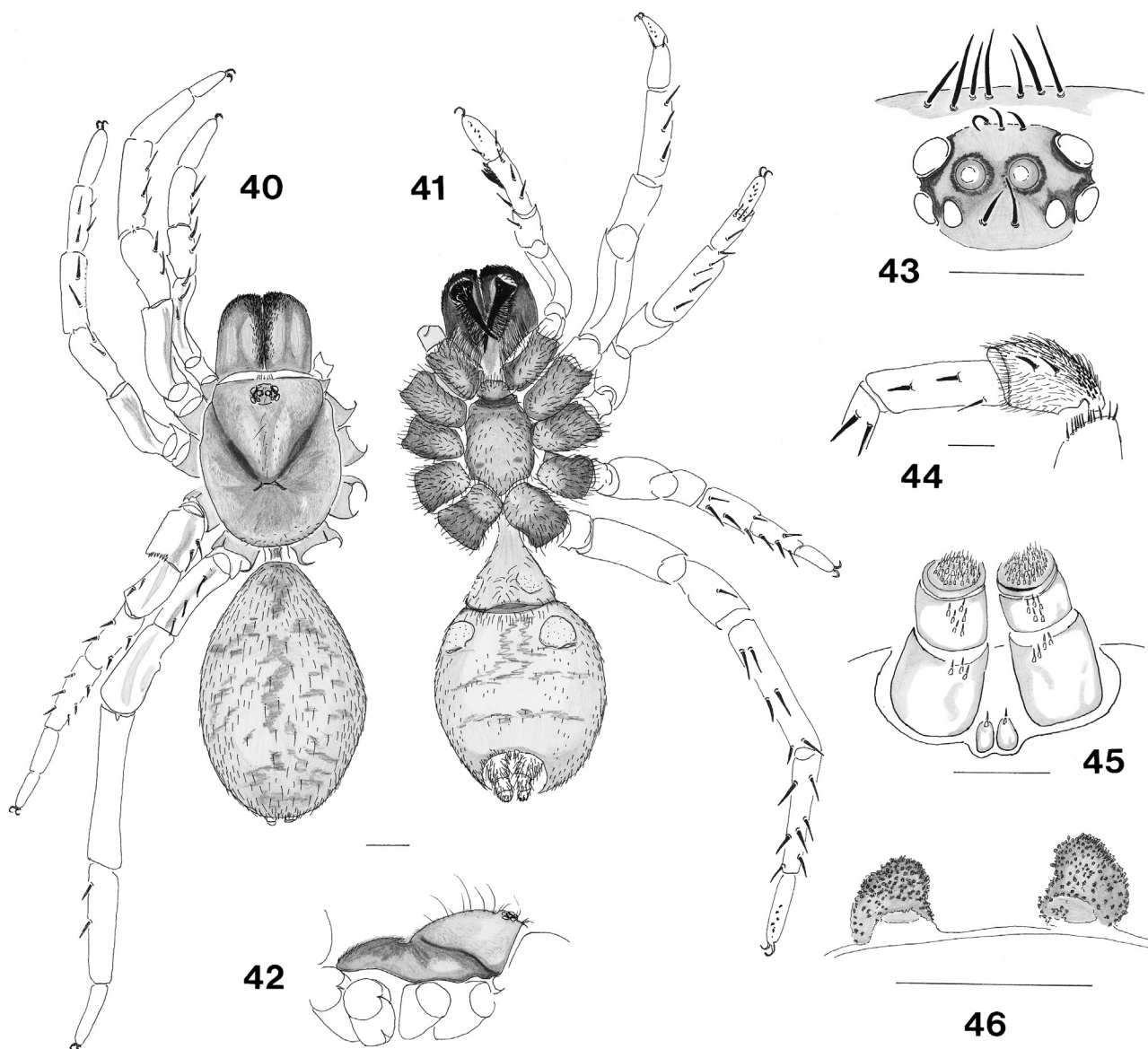
Nemesia santeugenia sp. n. (Figs. 40–46, 71, 86)

Types: Holotype ♀ (AR14197), 11 April 1997, Majorca, Santa Eugenia, 39.611°N, 2.876°E, burrow in horizontal ground on edge of pine growth. Paratype: 1♀ (9972.4014), Majorca, Bon Ani, 39.590°N, 3.082°E, 16 October 2000, burrow in sloping ground on hillside pine forest. Both leg. A. E. Decae.

Etymology: The specific name is a noun in apposition taken from the village Santa Eugenia, in the vicinity of which it was first found on Majorca.

Diagnosis: *Nemesia santeugenia* is a medium to large sized *Nemesia* species from Majorca that shares a characteristic type of spermatheca with *N. santeulalia* sp. n. from Ibiza (cf. Figs. 46 and 60). The spermathecae are compact (without a clear division between proximal and distal parts), short, more or less “potato-shaped” and densely covered with glandular tissue over their total surface. In their external morphology *N. santeugenia* and *N. santeulalia* are also very similar,

although some differences were observed in the relative sizes of ALE and PLE (ALE/PLE=1.2–1.4 ($n=2$) for *N. santeugenia* and ALE/PLE=0.9–1.2 ($n=6$) for *N. santeulalia*), the broken POP in the first species that is not seen in the second, and the difference in reduction of the PMS (cf. Figs. 45 and 59). The limited material of *N. santeugenia* available for study and the absence of males of both species, however, make the morphological distinction between these species problematic. The main argument to regard *N. santeugenia* distinct from *N. santeulalia* rests on conspicuous differences in their behaviour and burrow construction as observed in the field. While *N. santeugenia* was aggressive and ready to escape as a reaction to disturbance, *N. santeulalia* remained passive and tried to hide in a dead-ended side tube of the main burrow (Fig. 73). In *N. santeugenia* the side tube reaches the surface (probably closed off only by a thin silk sheet, Fig. 71), while in *N. santeulalia* it does not reach the surface. Another remarkable difference in behaviour is that *N. santeulalia* retains



Figs. 40–46: *Nemesia santeugenia* sp. n., female. 40 Habitus, dorsal; 41 Habitus, ventral; 42 Carapace, lateral; 43 Eye-formation, dorsal; 44 Patella and tibia III, prolateral; 45 Spinnerets, ventral; 46 Spermathecae, dorsal. Scale lines=2 mm (40–42), 1 mm (43–46).

indigestible remains of prey packed in the bottom and lower walls of the burrow (Fig. 73), but such storage of debris was not found in the burrows of *N. santeugenia* (Fig. 71). The male is unknown.

Note: Blasco (1986a: 347, fig. 2F) shows comparable spermathecae for *N. ariasi* Simon, 1914 that were reproduced “après Buchli”. A check of an unpublished manuscript by Buchli (1968: 79, fig. 44E) that shows these spermathecae suggests that Blasco was mistaken, because Buchli attributes this type of spermatheca not to *N. ariasi*, but to *N. hispanica*. Buchli must have been confused about the identity of *N. hispanica* because, in the same manuscript, he shows *N. hispanica* (p. 79, fig. 43C) as having no PMS. A check of the type material of *N. hispanica* in the BMNH by P. Hillyard (pers. comm.) has shown that this species has PMS. In the course of the present study (of around forty different species), no other species except *N. santeugenia* and *N. santeulalia* have been observed to have the described type of spermatheca; the spermathecae of *N. ariasi* have not been studied because the female of this species is unknown (Roewer, 1942).

Description: Female (holotype): BL=23.5, CL=8.2, CW=6.3. Leg IV: T4>F4≥M4. PSP: p=3-3; I=2-2; II=2-2; III=2-2; IV=1-0. Dorsal aspect (Fig. 40). Carapace longer than wide, CL/CW=1.3, brown, caput elevated (Ch/Th=8.8) and slightly lighter brown than thorax, no clear pattern, stronger setae in line on caput crest, fine setae on anterior clypeus edge, dense white pubescence on most of carapace. Clypeus wide, Clyp=0.27. Eye-group (Fig. 43) on and around sloping, not steep, ocular process, rectangular, AR/PR=0.99, twice as wide as long, AR/EI=2.00, POP faint and broken-up, ALE largest, ALE/PLE=1.41. Fovea recurved at base of caput, curving out laterally. Chelicerae strong, bicoloured brown (dorsally lighter than laterally), fine black setae along dorsal crest, merging distally with rastellum, fine whitish pubescence in longitudinal zones on lateral faces. Cheliceral furrow promargin with five teeth, distal tooth strongest. Rastellum consists of five strong spines apical to fang base. Fangs very strong with smooth prolateral keel (Fig. 6). Legs yellowish brown, lighter yellow laterally and ventrally on femur IV and on proximal parts of coxae II–IV; scopulae over full length of tarsi and metatarsi, and on tibiae I & II extending as thin pseudoscopula on patellae I & II; spines in rows on lateral or ventral sides of all metatarsi, tibiae and patellae, spiny setae dorsally on femora; prolateral spines on patella and tibia III (Fig. 44). Palp: colour as legs, scopula on tarsus and ventrally and laterally on distal half of tibia, three prolateral spines (2 in line and 1 more ventrally) on patella. Ventral aspect (Fig. 41). Maxillae almost twice as long as wide, l/w=1.96, with small antero-apical process, cuspules in irregular rows along prolateral proximal edge. Sternum centrally lighter brown than along edges, similar shading as ventrally on coxae, evenly covered with setae of varying size, anterior and median sigilla round and marginal, posterior sigilla oval and sub-marginal (about their largest diameter from sternum edge). Labium more greyish than sternum, dome-shaped, wider than long,

evenly covered with fine setae proximally and stronger setae distally. Labial furrow wide, glabrous, colour as sternum edge. Abdomen brownish grey with complex dorso-lateral pattern of brownish patches and chevrons. Spinnerets (Fig. 45) same colour as ventral abdomen, PMS reduced, spiky, with few apical spigots, PLS basal segment with few fine spigots near ventro-distal edge, apical spigots evenly distributed around four macro-spigots. Spermathecae (Fig. 46) unipartite, compact, almost as broad as long, “potato-shaped”, with dense cover of glandular tissue.

Variation (n=2): BL=15–23.5, CL=5.9–8.2. Carapace, CL/CW=1.3–1.5, CL/Ca=1.6. Caput Ch/Th=1.9–2.2. Clyp=0.19–0.27. Eye-formation: AR/PR=0.99–1.02, AR/EI=2.00–2.06, ALE/PLE=1.21–1.41.

Male: Unknown.

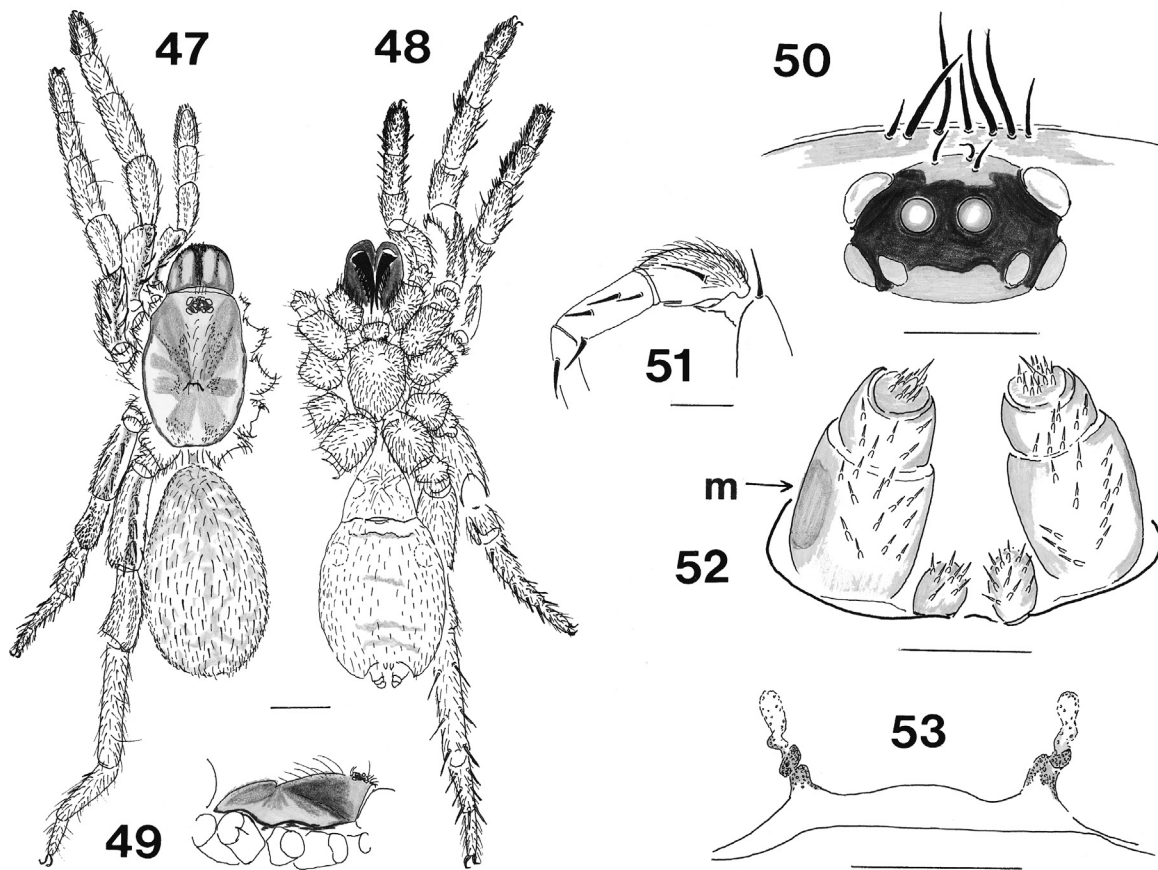
Burrow (Fig. 71): *Nemesia santeugenia* inhabits a typical “branched wafer-door burrow”. The burrows were found in relatively soft sandy soils on gently sloping surfaces covered with debris of conifer needles, fallen leaves, bits of grasses and moss. The thin, flexible trapdoor (wafer door; Moggridge, 1873, 1874) is camouflaged by spun-in debris from the surrounding surface and loosely closes the burrow entrance by falling over the entrance opening. The burrow runs almost vertically into the ground and may reach a depth of 30 cm. Four to five centimetres behind the trapdoor a side tube branches off from the main burrow. This side tube reaches the soil surface a few centimetres from the trapdoor, where its surface opening is covered with a thin sheet of silk that is well camouflaged among the plant debris. On the lower side of the burrow entrance some “linear litter”, as described by Main (1957), is spun into the burrow rim.

Behaviour: The only spider of this species kept in captivity never settled down properly. After days of hiding inactively in a shallow depression made in the clay bottom of its container, it started digging down to produce a burrow. The burrow was never completed, however, and no trapdoor was built. Nevertheless, in the six months that the spider was kept in this way it captured four isopods that wandered near the open burrow. It ate these prey and removed the compacted chitin remains by working them out of the burrow entrance.

Distribution (Fig. 86): *Nemesia santeugenia* seems to be remarkably rare. Among 120 *Nemesia* spiders collected on Majorca, only 2 specimens appeared to be *N. santeugenia*. These two specimens came from locations about 25 km apart in the central regions of the island.

Nemesia seldeni sp. n. (Figs. 47–53, 72, 77, 81, 83)

Types: Holotype ♀ (AR14202), 4 April 1996, Majorca, Randa, 39.503°N, 2.972°E, burrow in sloping clay-bank along forested roadside. Paratypes: MAJORCA: 2♀ (AR14203; 9972.4015), 8 April 1995, Randa, 39.503°N, 2.972°E, same habitat; 1♀ (AR14204), 9 April 1995, Randa, 39.503°N, 2.972°E, same habitat; 1♀ (9972.4017), 4 April 1996, Lluçmajor, 39.500°N, 2.937°E, same habitat; 1♀ (9972.4016), 13 October 2000,



Figs. 47–53: *Nemesia seldeni* sp. n., female. **47** Habitus, dorsal; **48** Habitus, ventral; **49** Carapace, lateral; **50** Eye-formation, dorsal; **51** Patella and tibia III, prolateral; **52** Spinnerets, ventral; **53** Spermathecae, dorsal (m=macula). Scale lines=2 mm (47–49), 1 mm (51), 0.5 mm (50, 52–53).

Inca-Puebla, 39.767°N, 2.986°E, horizontal ground, edge of cultivated field. All leg. A. E. Decae.

Etymology: The species is named after Dr P. A. Selden who rediscovered Bristowe's *N. bristowei* in 1989 on Majorca near Estellencs (39.655°N, 2.480°E), and provided the author with the first specimens for study.

Diagnosis: Females of *N. seldeni* are morphologically very similar to those of *N. maculatipes* Doleschall, in Ausserer, 1871 and *N. sanzoi* Fage, 1917. They differ from both those species by the relatively elongated carapace, $CL/CW \geq 1.4$ ($n=6$) in *N. seldeni*, $CL/CW=1.3$ ($n=5$) in the other two species, the lower caput ($Ch/Th=1.2$ vs. $1.5-1.7$), the prolateral scopula on tibiae I and II restricted to the distal half of the segment (vs. extending over the full length of the tibiae), and the prolateral spine pattern on patella III (usually 2 spines, rarely 3, in *N. seldeni*, vs. usually 3 spines, rarely 2, in *N. maculatipes* and *N. sanzoi*). The male is unknown.

Description: *Female* (holotype): BL=15.4, CL=5.5, CW=3.7. Leg IV: T4>F4>M4. PSP: p=0-0; I=1-1; II=2-2; III=2-2; IV=0-0. Dorsal aspect (Fig. 47). Carapace distinctly longer than wide, $CL/CW=1.5$, with distinct narrow dark purplish lateral edges, and clear pattern of darker brown zones radiating from fovea over lighter, yellowish background. Brown zones cover lateral slopes of caput and follow cervical grooves and all shallow radial furrows. Clypeus narrow, $Clyp=0.17$, light yellowish brown, as is cuticle at sides of eye-group

and on central caput. Caput (Fig. 49) slightly elevated, $Ch/Th=1.2$. Fine setae in one longitudinal row on central caput and in irregular group on clypeus and ocular tubercle. Fine hairs in irregular patches predominantly on darker coloured zones and along carapace edge. Eyes (Fig. 50) compactly grouped on and around steep ocular tubercle, eye-formation less than twice as wide as long, $AR/EI=1.83$, AR slightly shorter than PR, $AR/PR=0.98$, ALE larger than PLE, $ALE/PLE=1.21$, PLE pearly, other eyes greyish. POP unbroken. Fovea narrow, deep, recurved, with small central longitudinal groove. Chelicerae dorsally appearing somewhat darker than carapace, distinctly bicoloured with lighter and darker brown zones, lighter zones covered with fine hairs and stronger setae that merge distally with rastellum. Cheliceral furrow with six promarginal teeth, increasing in size from proximal to distal. Rastellum of five strong teeth. Fangs with smooth promarginal keel (Fig. 6). Legs yellow with darker longitudinal zones dorsally on femora and inconspicuous maculae on outer surfaces; dense scopulae on tarsi and metatarsi I and II extending onto prolateral distal half of tibiae I and II. Fine pro- and retrolateral spines in ventral rows on metatarsi and tibiae I and II and more laterally and dorsally on III and IV, lateral spines on patellae I–III (see PSP), prolateral spines on tibia and patella III (Fig. 51), dorsal spines on all femora. Palp: colour as legs, scopula on tarsus and tibia, one pro- and one retrolateral proximal spine on

tarsus; double row of short ventral spines dividing tarsal scopula, no patellar spines, group of long dorsal spiny setae distally on femur. Ventral aspect (Fig. 48). Maxillae almost twice as long as wide, extending into small anterior distal process, yellow, except for creamy white anterior zone of maxillary scopula, evenly covered with setae, only one cuspule in proximal prolateral corner. Sternum longer than wide ($l/w=1.44$), yellow, evenly covered with fine setae, three pairs of oval sigilla. Labium twice as wide as long, darker than sternum, evenly covered with setae, labial furrow wide and glabrous. Abdomen ovoid, densely covered with fine greyish-white hairs, pale grey cuticle with yellowish sheen ventrally and irregular dorsal pattern of dark greyish brown blotches around similarly coloured central longitudinal zone, fine setae dorsally. Spinnerets similar in colour to ventral abdomen, PMS well developed with fine spigots ventrally and distally, PLS short, lateral macula (Fig. 52), basal segment longer than median and distal segments together, spigots evenly spread over ventral surface of basal and median segments and apically grouped around one macro-spigot. Spermathecae (Fig. 53) tripartite, proximal part short with dense glandular tissue, middle part twisted with dense glandular tissue proximally and thin glandular tissue distally, distal part digitiform with thin glandular tissue.

Variation ($n=6$): Adult females small *Nemesia* species, BL=13.7–16.3, CL=4.2–5.8. Carapace, CL/CW=1.4–1.5, CL/Ca=1.5–1.7. Clyp=0.14–0.19. Eye-formation: AR/PR=0.96–1.02, AR/EI=1.86–2.04, ALE/PLE=1.07–1.25. Chelicerae in some specimens not contrasting with colour of carapace. Maxillary antero-apical process relatively well developed in some specimens, less so in others, one or more cuspules (in irregular rows) may be present. PSPvar: p=0(2); I=1(2); II=2; III=2(1); IV=0. Maculae on leg segments and basal segment of PLS more or less distinct.

Male: Unknown.

Burrow (Fig. 72): The structure of the burrow of *N. seldeni* is roughly similar to that of *N. santeugenia*. Both have a thin flexible wafer-door (Moggridge, 1873, 1874), which closes off the main burrow tube at the soil surface, both have a side tube that branches off from the main burrow a few centimetres behind the trapdoor and that opens onto the soil surface, both have only the upper half of the burrow (including the inside of the side tube) lined with silk, and both have linear plant material spun into the burrow rim (Fig. 81). Two differences between the burrows of *N. seldeni* and *N. santeugenia* have been noticed: first, the diameter and depth are smaller in *N. seldeni* (probably because *N. seldeni* is a smaller spider), and secondly, *N. seldeni* constructs a second, smaller trapdoor that closes off the side tube (Fig. 72, d). A second trapdoor has not been observed in *N. santeugenia*.

Behaviour: *Nemesia seldeni* spiders, captured in the field, readily constructed new burrows in the laboratory. Usually the spiders could be induced to dig their burrow in a desired position, by providing them with an artificial impression about 1 cm deep in the clay soil in the centre

of the container. The main burrow tube with trapdoor was built first, and the side tube, including a smaller trapdoor, appeared later. In the field the larger, first trapdoor, usually faces down the slope, while the second smaller trapdoor usually opens uphill (Fig. 72). Observations on captive spiders showed that the spiders invariably take up their ambush positions at dusk under the larger, first trapdoor. The second trapdoor was found to serve probably several functions. It may be used for escape when the spider is threatened inside its burrow, as has been seen in several other *Nemesia* species that build similar burrows, although this escape function was not definitely established in the course of this study on *N. seldeni*. When capturing *N. seldeni* in their natural burrows these spiders were inclined to retreat to the bottom of their burrow and, when the top half of the burrow was removed, the spiders would dash out from the remnants of the main burrow in an effort to escape collection. The smaller, second trapdoor definitely serves purposes other than solely as a possible escape route. One function is an enlargement of the hunting area by serving as an “early-warning” system. In captivity *N. seldeni*, while waiting in ambush at the larger trapdoor, was seen to react to small isopods crawling over the smaller trapdoor by swiftly retreating from its ambush position and launching an immediate attack from the second trapdoor. Generally, however, prey was captured from the larger trapdoor within a range of up to several centimetres away from the burrow entrance. Like *N. brauni*, *N. seldeni* was found to leave the burrow completely in pursuit of prey that may be captured at distances of several centimetres away from the burrow. The second trapdoor also functions in waste disposal. Indigestible chitin remains of prey and exuviae are pushed out of this smaller door. *Nemesia seldeni* seems less strictly nocturnal in its hunting activity than most other *Nemesia* species and was sometimes found, both in the field and in captivity, to lie in ambush during daylight hours.

Distribution (Fig. 83): *Nemesia seldeni* has a wide distribution in the western and central parts of Majorca, where it prefers moist and shady positions. It is particularly common in humus-rich soils under vegetation and in creek banks. In preferring these moist and shady habitats it is often separated from other *Nemesia* species that seem to prefer more exposed and often less stable soils, although *N. seldeni* has also been found in close proximity (<1 m) to all other *Nemesia* species found on Majorca.

Nemesia santeulalia sp. n. (Figs. 54–60, 73, 86)

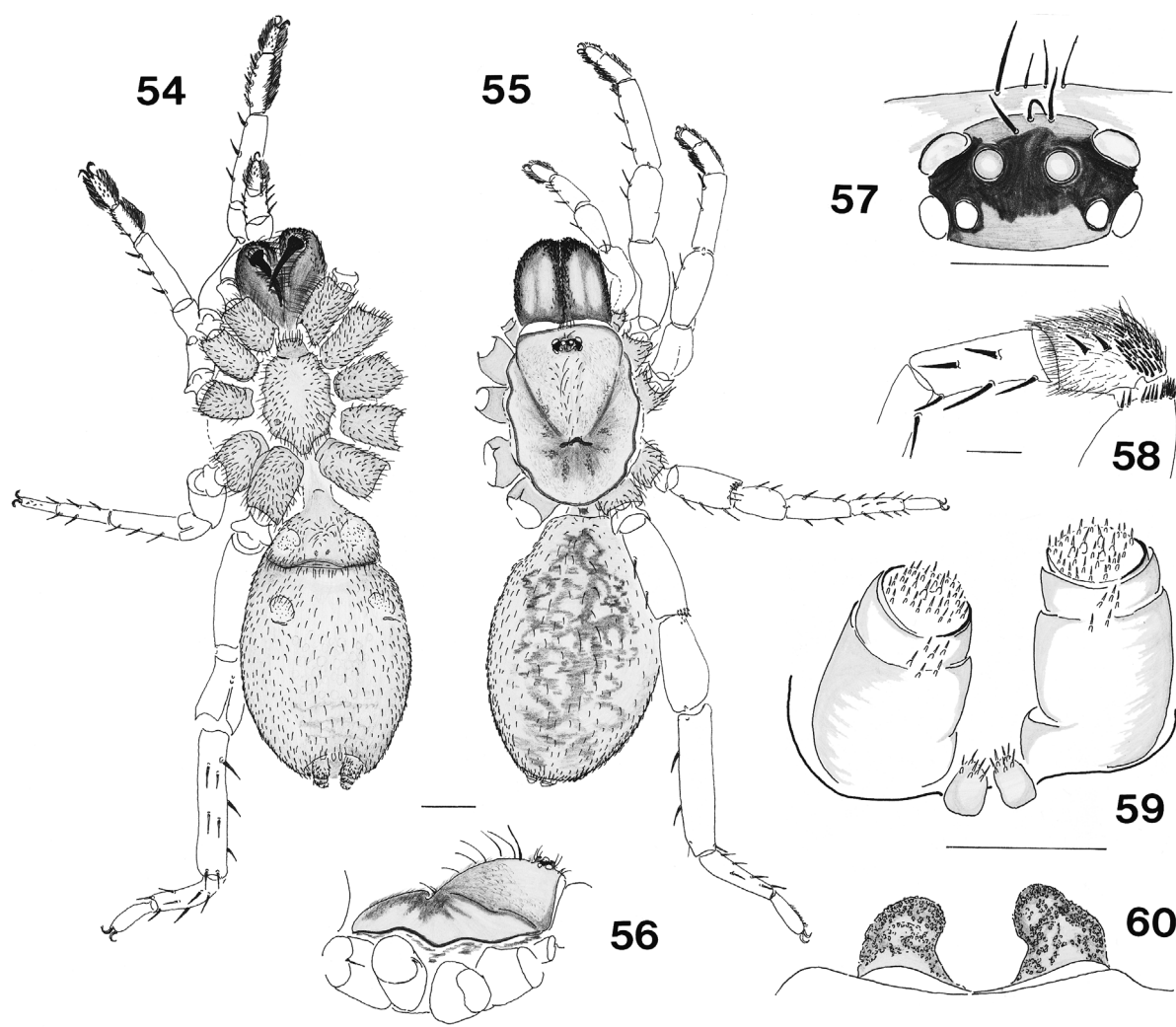
Types: Holotype ♀ (AR14194), 8 May 1986, Ibiza, Santa Eulalia del Rio, 38.987°N, 1.530°E, burrow in clay-bank along road between pine forest and village edge. Paratypes: IBIZA: 4♀ (AR14195; AR14196; 9972.4022; 9972.4023), 9–10 May 1986, Figueritas, 38.911°N, 1.416°E, horizontal and slightly sloping ground in wasteland on building site; 1♀ (9972.4021), 4 May 1986, San Antonio, 38.977°N, 1.316°E, in sandy slope on village edge. All leg. A. E. Decae.

Etymology: The specific name is a noun in apposition taken from the village Santa Eulalia del Rio, the type locality, on Ibiza.

Diagnosis: Differs from all other known *Nemesia* species, except *N. santeugenia* sp. n., in the morphology of the spermathecae (Fig. 60). For observed differences in the morphology, burrow structure and behaviour between *N. santeulalia* and *N. santeugenia*, see diagnosis of the latter species. The male is unknown.

Description: *Female* (holotype): BL=22.7, CL=7.7, CW=5.7. Leg IV: T4>F4>M4. PSP: p=3-3; I=2-2; II=2-1; III=2-?; IV=0-0. Dorsal aspect (Fig. 55). Carapace longer than wide, CL/CW=1.4, central dark brown zones with irregular fine black line patterns radiating from fovea over yellowish brown background, posterior and lateral edges marked with narrow purplish black line, darker zones covered with black and silvery white pubescence. Caput strongly elevated, Ch/Th=1.9, fine setae on caput crest, ocular tubercle and posterior end of thorax. Clypeus wide, Clyp=0.27. Eye-group (Fig. 57) rectangular, AR/PR=0.99, slightly more than twice as wide as long, AR/EI=2.03, ALE as large as PLE, ALE/PLE=1.00, posterior eyes pearly, anterior eyes greyish. POP dense and unbroken. Fovea smoothly recurved, centrally narrow; laterally distinctly widened.

Chelicerae dark brown, contrasting with carapace, darker brown in areas with setae or hair cover, lighter in glabrous areas, narrow band of silvery white pubescence laterally, cheliceral furrow with six promarginal teeth, distal five equally strong, most proximal tooth smaller and placed somewhat apart. Fangs strong, blunt with smooth keel (Fig. 6). Legs yellowish brown, similar colour to sternum, with darker longitudinal zone dorsally on femora and dark pigmented maculae distally on all outer surfaces of femora. Spines on metatarsi, tibiae and femora thin. Scopulae on tarsi and metatarsi I and II extending over full length of tibiae onto patellae. Prolateral spines on tibia and patella III (Fig. 58). Palp: colour as legs, but without lateral maculae on femora, tarsal scopula extending halfway along tibia, three prolateral spines on patella (2 in line and 1 more ventrally). Ventral aspect (Fig. 54). Maxillae dark brown, with creamy white anterior scopula zone, longer than wide (l/w=1.7), well developed row of cuspules along proximal margin. Sternum warm yellowish brown, darker around edges, evenly covered with setae, three pairs of well-developed sigilla, posteriors oval and placed slightly away from margin. Labium almost as long as wide, dome-shaped, strongly elevated, separated from sternum by narrow dark brown furrow. Abdomen evenly covered



Figs. 54–60: *Nemesia santeulalia* sp. n., female. **54** Habitus, ventral; **55** Habitus, dorsal; **56** Carapace, lateral; **57** Eye-formation, dorsal; **58** Patella and tibia III, prolateral; **59** Spinnerets, ventral; **60** Spermathecae, dorsal. Scale lines=2 mm (54–56), 1 mm (57–60).

with fine hairs, dorsally with dense irregular pattern of dark lines and patches on light background, ventrally light grey with yellow book lung covers. Spinnerets (Fig. 59): PMS lighter than PLS, PMS small with several apical spigots, PLS proximal segment longer than median and distal segments together, spigots on apical spigot field in concentric circles around four macrospigots. Spermathecae (Fig. 60) unipartite, compact, almost as broad as long, “potato-shape”, with dense cover of glandular tissue.

Variation ($n=6$): Adult females, medium to large spiders, BL=18–23, CL=6.7–7.7. Carapace, CL/CW=1.3–1.4, CL/Ca=1.5–1.6, Ch/Th=1.9–2.0. Eye-formation: AR/PR=0.95–0.99, AR/EI=1.97–2.06, ALE/PLE=0.9–1.2. PSPvar: $p=2(3)$; $I=2(1)$; $II=2(0-1)$; $III=2(1)$; $IV=0$.

Male: Unknown.

Burrow (Fig. 73): Adult *N. santeulalia* females dig a 15–20 cm deep burrow, closed at the entrance by a thin flexible trapdoor (wafer-door). The maximum diameter of the trapdoor measured in the field was 1.5 cm, and the largest entrance diameter of the burrow measured was 1.4 cm. Two to three centimetres behind the trapdoor a side tube branches off from the main burrow. The side tube slopes upwards to end in a cul-de-sac (ten out of ten observations) just below the soil surface. The whole inside of the burrow, including the side tube and the underside of the trapdoor, is lined with one continuous, densely woven sheet of silk. Near the bottom of the main tube the silk is thinner than in the higher parts of the burrow. Indigestible remains of prey are packed into the burrow bottom or into the lower wall of the main tube. In building a dead-ended side tube, the full lining of the burrow with silk and the storage of chitinous remains in the walls and bottom of the burrow, *N. santeulalia* of Ibiza differs markedly from *N. santeugenia* from Majorca, from which species it is morphologically difficult to distinguish.

Behaviour: Females of *N. santeulalia* seem to spend the day rather passively. Insects placed on the trapdoor in daylight hours, or lightly teasing the burrow entrance with a blade of grass, failed to trigger any observable reaction from the spider. Stronger teasing, however, resulted in the spider coming to the burrow entrance to pull the door firmly closed. After dark the spider reacts differently to both stimuli. An insect placed on or near the trapdoor, or teasing of the burrow rim with a grass blade, elicit an instant aggressive response as the spider darts forwards with great accuracy in the direction of the stimulus.

Nemesia santeulalia hunts from behind an almost closed trapdoor. Most wafer-door building species extend the distal parts of the first, second and third pairs of legs from under the door when lying in wait for prey (see *N. seldeni*, Fig. 77), but no parts were observed to be extended in *N. santeulalia*. On disturbance of the burrow (by the spider collector), *N. santeulalia* will initially hold on to the trapdoor to keep it closed. When the trapdoor is forced open the spider will retreat to the bottom of the burrow and wait there head-up. When further disturbed, it will finally run up the burrow again to hide in the

side tube. The spiders were not aggressive and were hardly ever observed to bite. Analysis of the indigestible remains of prey found in the burrow bottoms and walls revealed head-capsules, legs and mandibles of ants, legs and elytra of beetles and possibly remains of woodlice. Probably such ground-dwelling arthropods constitute the main prey of *N. santeulalia*, although other types of prey cannot be ruled out on the grounds of this observation alone*.

Distribution (Fig. 86): *Nemesia santeulalia* was found to be common in quite widely separated places on Ibiza. It has not so far been found on the nearby island of Formentera.

Nemesia ibiza sp. n. (Figs. 61–67, 74, 85)

Types: Holotype ♀ (AR14067), 3 May 1986, Ibiza, San Juan, 39.081°N, 1.510°E, burrow in clay-fillings between limestone rocks. Paratypes: IBIZA: 1♀ (AR14065), 3 May 1986, same data as holotype; 2♀ (AR14066; 9972.4018), 10 May 1986, Figueritas, 38.911°N, 1.416°E, horizontal and slightly sloping ground in wasteland on building site; 2♀ (9972.4019, 9972.4020), 8 May 1986, Santa Eulalia del Rio, 38.987°N, 1.530°E, in clay-bank along road between pine forest and village edge. All leg. A. E. Decae. All locations mentioned here are on Ibiza, but the species was also found near Punta de la Anguila on the nearby island of Formentera.

Etymology: The specific name is a noun in apposition taken from the type locality, the island of Ibiza, where it was found to be common and widely distributed.

Diagnosis: Females of *N. ibiza* can be distinguished from all other known *Nemesia* species by the “hour-glass” shape of the spermathecae (Fig. 67), particularly the proximal narrowing of the receptacula seems to be characteristic. The male is unknown.

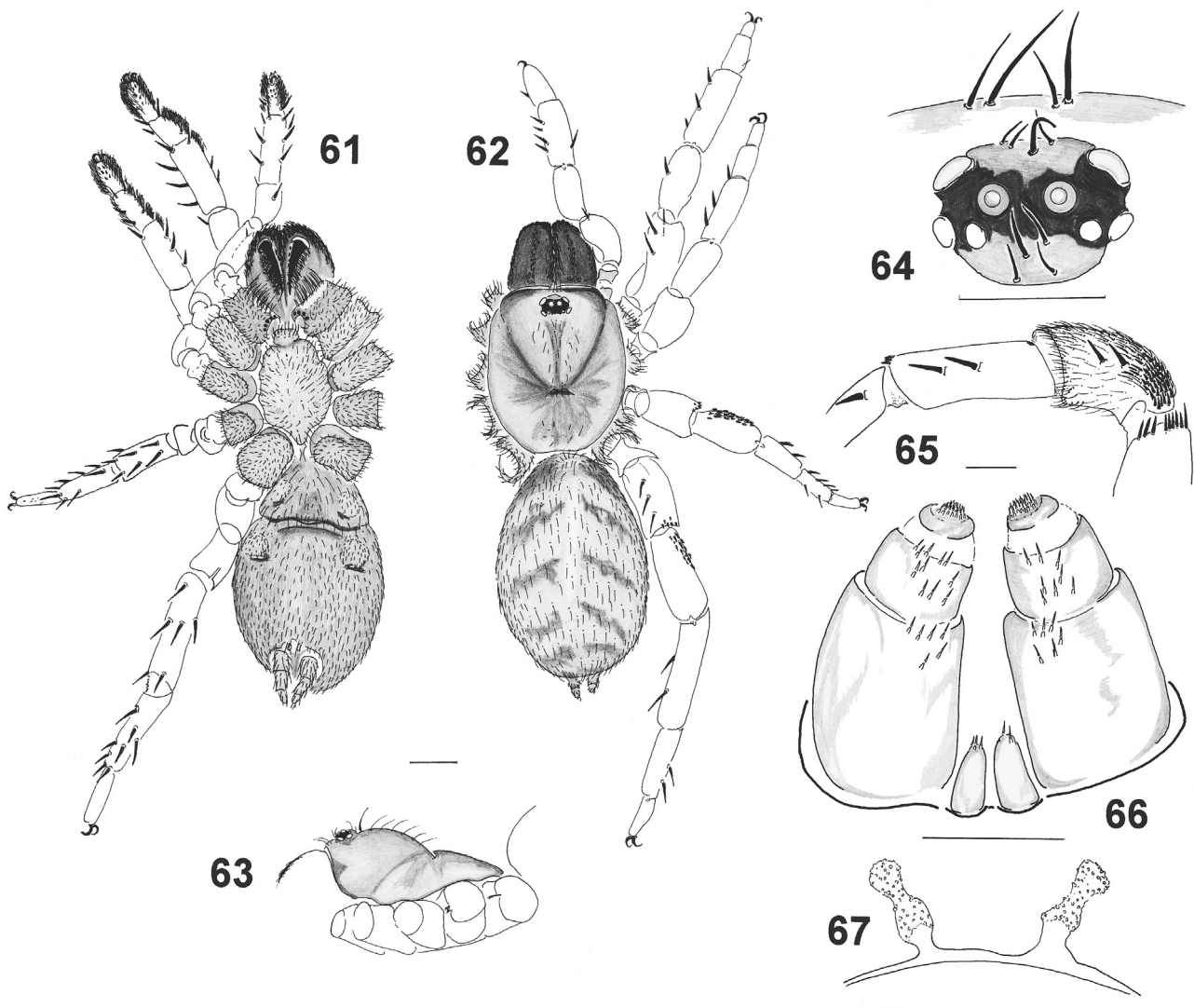
Note: *Nemesia ibiza* seems to be closely related to *N. hispanica*, because some differences observed in the morphology of the two species (eye-formation, spine pattern, morphology of legs III and IV) may fall within the range of geographical variation of *N. hispanica*. However, on the grounds of the observed differences, the limited material of *N. hispanica*, and the absence of males of both species, *N. ibiza* is here regarded as a distinct species.

Description: Female (holotype): BL=20.4, CL=7.4, CW=6.7. Leg IV: F4>T4>M4. PSP: $p=2-2$; $I=1-1$; $II=1-1$; $III=2-2$; $IV=0-0$. Dorsal aspect (Fig. 62). Carapace slightly longer than wide, CL/CW=1.1, yellowish brown with “leaf pattern” of darker zones radiating from fovea and along cervical grooves and radial furrows, setae along anterior edge of clypeus and on ocular tubercle. Caput elevated, Ch/Th=1.9, groups of fine

*Ants, beetles and woodlice were all observed to be captured and eaten by other *Nemesia* species in captivity. Other types of prey such as earthworms, maggots, flies and earwigs, were captured and eaten, and even food items that cannot possibly be part of their natural diet, such as pieces of prawn and tiny meatballs, placed on the burrow rim were accepted as food. These observations indicate that *Nemesia* are food generalists.

setae on each side of central longitudinal row of stronger bristles on crest of caput, pubescence absent, but widely dispersed fine hairs present. Clypeus yellowish, relatively wide, $Clyp=0.36$. Eye-group (Fig. 64) almost rectangular, $AR/PR=0.96$, less than twice as wide as long, $AR/EI=1.87$, ALE largest, $ALE/PLE=1.17$, anterior eyes greyish, posterior eyes pearly. POP broken between AME and lateral eyes. Fovea not smoothly recurved, but somewhat angular. Chelicerae warm reddish brown, darker than and contrasting with overall colour of carapace, with narrow dark brown glabrous zone dorso-laterally, cheliceral furrow with seven promarginal teeth, distal tooth largest. Rastellum on small process. Fangs short, blunt, with irregularly serrated keel (Fig. 8). Legs mostly uniform yellowish brown, femora III and IV laterally and ventrally lighter whitish yellow, scopulae on tarsi and metatarsi I and II not extending onto tibia I, numerous spines dorsally and dorso-laterally on femora, ventrally and ventro-laterally on tibiae and metatarsi I–III, two dorsal spines on metatarsus III, prolateral spines on tibia and patella III (Fig. 65), tibia IV with three long slender prolateral spines along

ventro-lateral edge, metatarsus IV with retrolateral apical comb. Palp: coloured as anterior legs, scopula extending onto tibia, two parallel rows of strong prolateral spines and three parallel rows of strong retrolateral spines on tibia. Ventral aspect (Fig. 61). Maxillae yellowish brown, almost twice as long as wide ($l/w=1.9$), evenly covered with curved setae, well defined double rows of cuspules along proximal edge, anterior scopula zone white. Sternum yellow, slightly longer than wide ($l/w=1.1$), evenly covered with setae, three pairs of oval sigilla, anterior and median pairs touching edge, posterior pair their longest diameter from sternum edge. Labium wider than long, almost rectangular, dome-shaped, strongly elevated, separated from sternum by wide glabrous furrow. Abdomen grey dorsally with dark lateral chevrons, ventrally lighter and more uniformly grey, whole abdominal surface evenly covered with fine hairs. Spinnerets (Fig. 66) yellow, contrasting with grey of ventral abdomen, PMS reduced with few apical spigots, basal segment of PLS as long as median and distal segments together, spigots in apical field tightly grouped, with smaller spigots in circles around three



Figs. 61–67: *Nemesia ibiza* sp. n., female. **61** Habitus, ventral; **62** Habitus, dorsal; **63** Carapace, lateral; **64** Eye-formation, dorsal; **65** Patella and tibia III, prolateral; **66** Spinnerets, ventral; **67** Spermathecae, dorsal. Scale lines=2 mm (61–63), 1 mm (64–67).

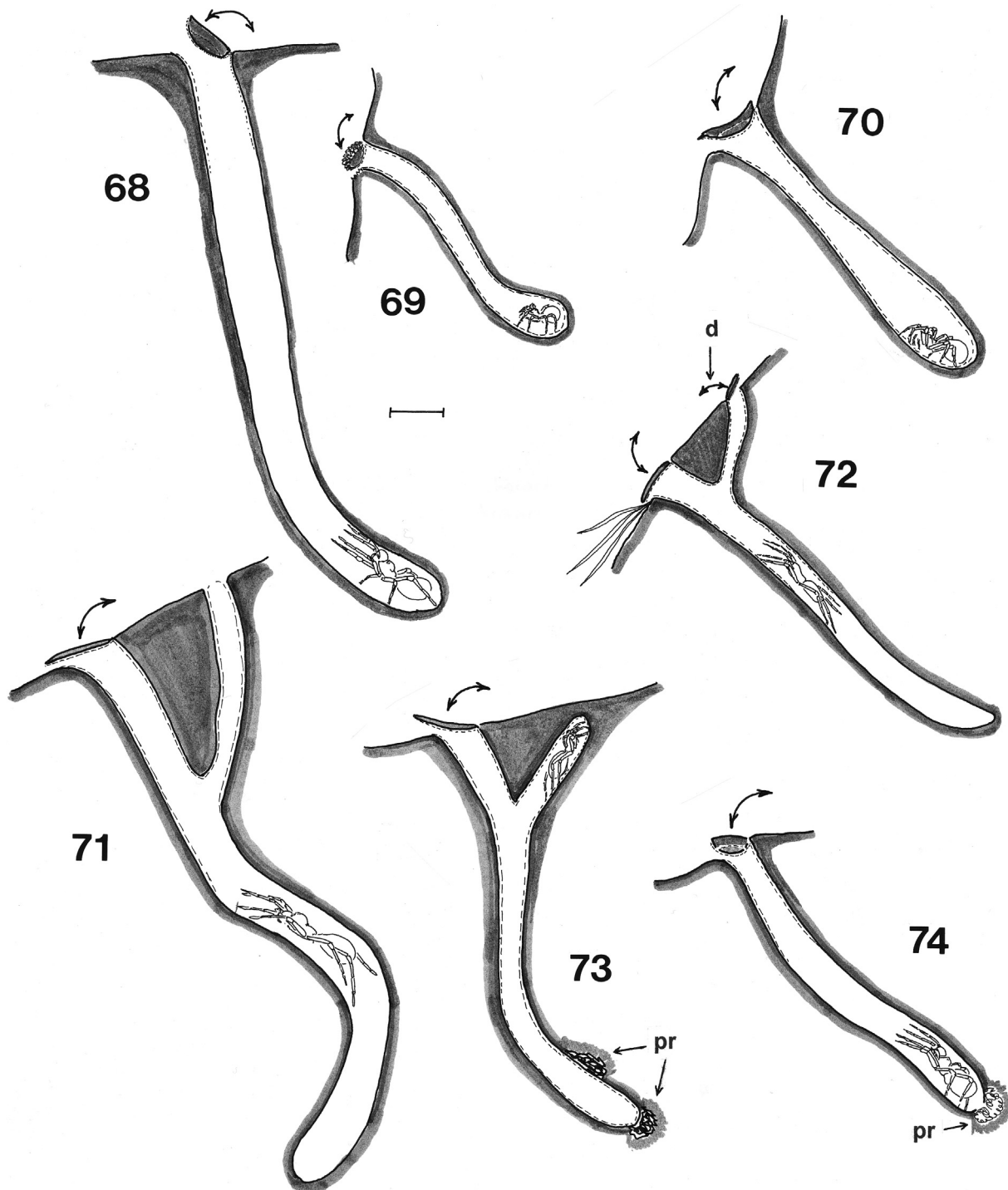
central macro-spigots. Spermathecae (Fig. 67) tripartite, "hourglass-shape", evenly covered with very thin glandular tissue.

Variation ($n=6$): Females medium sized spiders, BL=19–21, CL=6.5–8.0. Carapace, CL/CW=1.1–1.2, CL/Ca=1.6, Ch/Th=1.9–2.5. Clyp=0.31–0.36. Eye-formation: AR/PR=0.96–1.00, AR/EI=1.87–2.14, ALE/PLE=1.18–1.38. POP entirely or indistinctly broken between AME. PSPvar: p=1(2-3); I=1(2); II=1(2);

III=2(0-1); IV=0. Leg IV: F4>T4≥M4. Spinnerets: PMS with two or three fine spigots on apex. Fang-keel: serrated (rarely smooth). Abdominal pattern more or less distinct.

Male: Unknown.

Burrow (Fig. 74): *Nemesia ibiza* builds a typical cork-burrow, with a thick trapdoor that fits within the entrance of the burrow-tube. The depth of the burrow is usually around 12 cm, but may vary between 7–16 cm.



Figs. 68–74: Longitudinal sections of *Nemesia* burrows showing different tube shapes and types of trapdoors, extent of silk burrow linings (dashed lines), presence or absence of prey remains in pockets associated with the burrows (pr), presence of a second trapdoor (d), and positions in which the spiders were usually encountered during collection. **68** *N. brauni* (aggressive, ready to attack at burrow bottom); **69** *N. bristowei* (defensive posture, inactive at burrow bottom); **70** *N. randa* (defensive posture, inactive at burrow bottom); **71** *N. santeugenia* (halfway up burrow ready to escape); **72** *N. seldeni* (halfway up burrow ready to escape); **73** *N. santeulalia* (hiding in side branch); **74** *N. ibiza* (aggressive, ready to attack at burrow bottom). Arrows indicate opening direction of trapdoors. Scale line=1 cm.



Figs. 75–78: Ambush positions of Majorcan *Nemesia* species. 75 *N. brauni*; 76 *N. bristowei*; 77 *N. seldeni*; 78 *N. randa*.

The maximum diameter of the trapdoor measured in the field was 1.8 cm, and the diameter of the burrow entrance was 1.75 cm. There are no internal side-diggings, but the burrow may bend in various ways, probably around underground obstacles. Most of the burrows are dug in steep or vertical clay-fillings between natural rock-layers or in constructed stone walls. The silk lining of the burrow is thickest near the burrow-entrance and vanishes completely a few centimetres down the shaft. Indigestible chitin-chips and remains of prey are stored in a compacted package pushed into the lower burrow-wall, or in the burrow-bottom. Identified prey-remains were similar to those found for *N. santeulalia*.

Behaviour: Some spiders were found to be active during daylight hours, lying in wait for prey behind a cracked-open trapdoor. Generally, however, *N. ibiza* only becomes active at dusk, when the spiders come to the entrance of the burrow to lie in wait for prey passing near to the burrow, as do virtually all other trapdoor spiders. *Nemesia ibiza* seems to defend its burrow somewhat more actively by pulling the door closed when it is disturbed than is the case in *N. santeulalia*. Although both species show this behaviour as a reaction to attempts to open the trapdoor from the outside, this “door-holding” was rarely observed in the latter species and virtually always in *N. ibiza*.

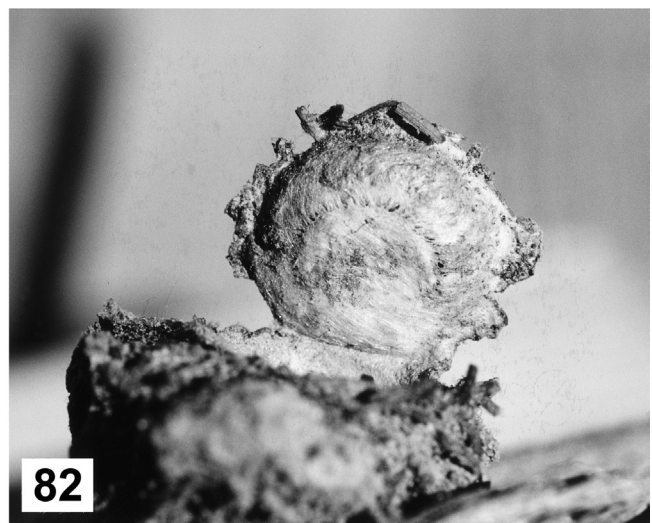
Distribution (Fig. 85): *Nemesia ibiza* was widely and commonly found on Ibiza. It appeared to be rarer on Formentera where it was found only in association with clay-fillings in stone walls.

Discussion

Excluding the four species (see introduction) from China, Mozambique, Afghanistan and Cuba listed in Platnick (2003), which on biogeographical grounds are unlikely to be members of the genus, *Nemesia* is distributed in a rather restricted geographical area in southern Europe and in Africa north of the Sahara (Fig. 1). In this relatively small distribution zone, about fifty different species are currently recognised. Many, if not all, of these species appear to be local endemics. Several observations may support this view of *Nemesia* being a regionally distributed genus composed of numerous locally endemic species both on islands and in continental regions.

Island endemics: Of the 49 “Mediterranean” species and subspecies listed in Platnick (2003) twelve species (24%) are known exclusively from islands, and only two, both arguable, species (4%) are recorded from both mainland and island locations*. Widespread island

*There is some doubt about the correctness of distribution data for the two species reported from both mainland and island locations, first, because the reported distributions are not easily explained and show unlikely disjunctions, and secondly, because these two species, *N. cellicola* (Audouin, 1826) and *N. maculatipes* Ausserer, 1871, are species that (for different reasons) are easily misidentified. *N. cellicola* is the type species of the genus, and in early collections, before information on the diversity of *Nemesia* was available, was reported mistakenly from various widely separated locations. *Nemesia maculatipes* seems to carry its diagnostic character in its name (the maculae on legs and PLS), but it is now clear that the maculate pattern is present in different, only distantly related, *Nemesia* species and that such species are easily confused.



Figs. 79–82: Trapdoors of Majorcan *Nemesia* species. **79** *N. brauni*; **80** *N. bristowei*; **81** *N. seldeni*; **82** *N. randa*.

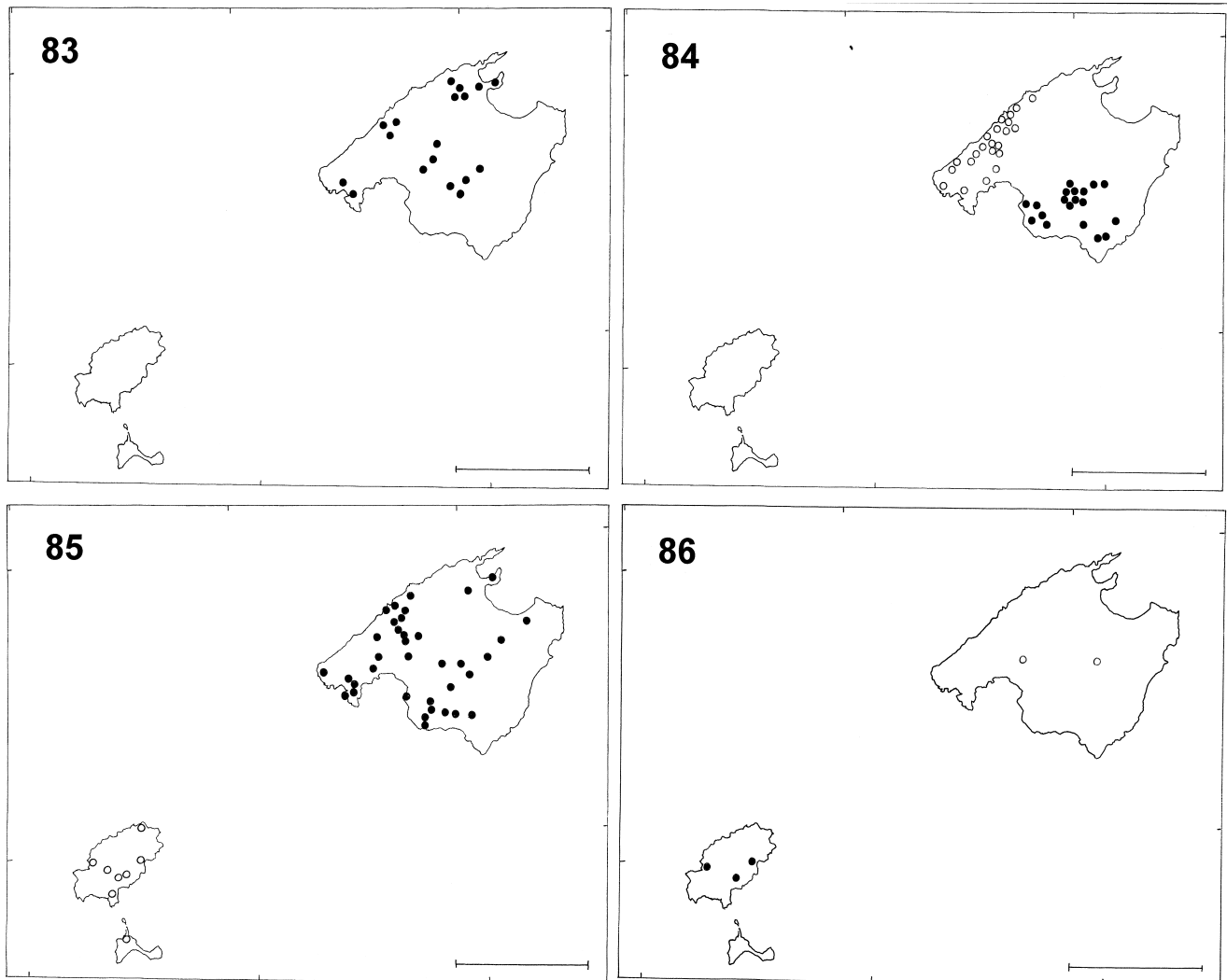
endemism is also supported by records, partly as yet unpublished, of endemic *Nemesia* species from Crete, Corfu, Malta, Sicily, Sardinia, Corsica, Elba, Montecristo, Ile d'Alboran, Majorca and Ibiza.

Mainland endemics: Local endemism is also found in continental areas. In southern France, where *Nemesia* was first studied in some detail, Moggridge (1873, 1874) discovered that the *Nemesia* faunas east and west of the river Rhone differed markedly in their species composition. East of the Rhone he found *N. carminans*, *N. congener* O.P.-Cambridge, 1874, *N. eleanora* O.P.-Cambridge, 1873 and *N. manderstjernae**, while west of the Rhone he found *N. caementaria* (Latreille, 1799), *N. dubia* O.P.-Cambridge, 1874 and *N. simoni*. Simon (1914) added *N. raripila* from the Pyrénées to the *Nemesia* fauna of south-west France. In a current study of the *Nemesia* fauna of Portugal (Decae & Cardoso, in prep.) endemism again seems to be a remarkable feature, because none of the six species collected from various sites throughout Portugal has so far been found in Spain. Since some of the Portuguese collections were made close to the Spanish border, it is unlikely that all

these species are absent from Spain, but their presence there still has to be established. This study of the Portuguese *Nemesia* fauna also shows that the presence of species that had previously been reported from Portugal, but that have their type localities in distant lands (*N. dubia* from Montpellier, *N. meridionalis* Costa, 1835 from Naples), could not be reconfirmed, which suggests that the distribution of these species is more restricted than previously supposed. The information presented here on the species of Majorca and Ibiza also underlines the view that local endemism is strong in *Nemesia*, because the *Nemesia* fauna of Majorca appears to differ from that of nearby Ibiza, and because it shows that even on an island the size of Majorca, species distributions can be geographically separate (see Fig. 84 for the distributions of *N. bristowei* and *N. randa*).

Whether *Nemesia* really is a regional genus composed of numerous locally endemic species, however, requires further investigation. Too little is currently known about the identity of individual species in large parts of the distribution range (Spain, Italy, Balkans, Greece, North Africa) and virtually nothing is known about possible interspecific, let alone phylogenetic, relationships between species. Early suggestions of such

*The distinction between the last three species is currently unclear.



Figs. 83–86: Distribution maps of *Nemesia* species on Majorca, Ibiza and Formentera. **83** *N. seldeni*; **84** *N. bristowei* (open circles), *N. randa* (black dots); **85** *N. ibiza* (open circles); *N. brauni* (black dots); **86** *N. santeugenia* (open circles), *N. santeulalia* (black dots). Scale lines=50 km.

relationships (Simon, 1914; Frade & Bacelar, 1931) were unavoidably speculative owing to the very limited amount of information then available.

New collections and the discovery of better diagnostic characters (particularly spermatheca and spinneret morphology) have provided the opportunity for the following fresh speculations on possible interspecific relationships within *Nemesia*.

Based on the morphology of the spermathecae, a broad division between eastern and western *Nemesia* species may exist. The eastern species characteristically have narrow, elongated spermathecae that are medially “twisted”, as illustrated here for *N. seldeni* (Fig. 53). Western species have more simple and much broader spermathecae as shown here in Figs. 19, 32, 39, 46, 60 and 67. In the central areas of the distribution range, species with these two different types of spermathecae overlap. *Nemesia carminans*, which occurs in an area between the river Rhone in south-central France and the city of Genoa in northern Italy, is currently the species with “western-type” spermathecae that extend its distribution range furthest to the east. *Nemesia dubia*, with a distribution range between Montpellier (southern France) and eastern Spain (Blasco, 1986b), is currently

the most westward extending species with “eastern-type” spermathecae*. It is currently unknown if a similar phenomenon occurs on the north African side of the Mediterranean, but on Mediterranean islands it is evident from what is reported here, that of the seven Balearic species recognised six have “western-type” spermathecae and only *N. seldeni* has “eastern-type” spermathecae.

Interspecific relationships of N. seldeni: *Nemesia seldeni* appears to belong to a tribe of small (♀ BL=13–17 mm), wafer-door building *Nemesia* species that is here designated the *maculatipes*-group. Typical, but not unique for the species in this group, is the presence of dark pigmented blotches (maculae) on the outer faces of leg-segments (mainly on the femora, patellae and tibiae) and on the outer face of the basal segment of the PLS. Females of the *maculatipes*-group differ from those of other *Nemesia* species by a combination of characters that include “eastern-type”, twisted, receptacles (not yet established in all species), a relatively elongated carapace, dense pubescence on carapace and legs, distinct colour pattern with a wedge-shaped yellow zone on the

*Although Blasco (1985) shows more “western-type” spermathecae for *N. dubia* from Catalonia.

crest of the caput, smooth fang, a retrolateral spine on patella III, and well developed PMS with spigots on the ventral surface. The *maculatipes*-group is distributed on islands in the western basin of the Mediterranean (Majorca, Corsica, Sardinia, Sicily and smaller islands). The group contains several species, some of which may be synonymous. Further study is necessary to confirm the taxonomy of this group. Species supposedly included in the *maculatipes*-group are: *N. maculatipes*, *N. sanzoi*, *N. pavani* Dresco, 1978, *N. fertoni* Simon, 1914, *N. arenicola* Simon, 1892, *N. albicomis* Simon, 1914, *N. kahmanni* Kraus, 1955 and maybe other species.

Interspecific relationships of N. santeugenia and N. santeulalia: *Nemesia santeugenia* from Majorca and *N. santeulalia* from Ibiza seem to be close relatives and both endemic to the Balearics. Morphologically the two species are hard to distinguish. The most prominent difference is found in the PMS, which are more strongly developed and carry more spigots in *N. santeulalia* than in *N. santeugenia*. This feature may, or may not, be related to a behavioural difference shown in the structure of the burrow. The burrow of *N. santeulalia* is fully lined with silk while that of *N. santeugenia* is only partly lined. Other behavioural differences reflected in the structure of the burrow are the storage of indigestible prey-remains in the burrow walls and floor by *N. santeulalia*, and the dead-ended side tube that this species builds, in contrast to the open-ended side tube and the removal of prey-remains from the burrow by *N. santeugenia*. Based on their spermathecal structure, both species probably have their closest relatives to the west, possibly in Morocco (*N. ariasi* figured in Blasco, 1986a) or on the Iberian peninsula (*N. hispanica* figured in Buchli, 1968). More probably, however, the closest relative is an as yet unidentified species collected by Buchli in Spain.

Interspecific relationships of N. brauni: *Nemesia brauni* differs strongly in behaviour and morphology from all other Majorcan *Nemesia* species. Particularly the absence of PMS places this species apart, as does its aggressive behaviour and its extrovert way of hunting. The closest relatives of *N. brauni* are probably several species found on the Iberian peninsula (both in Portugal and Spain) with which it shares its large size, aggressive attitude, thick cork-door, burrow type and absence of PMS. A Portuguese species that has long been regarded as *N. hispanica* (Frade & Bacelar, 1931; Machado, 1944; Cardoso, 2000) was recently compared with the type of *N. hispanica* and found to be a different, as yet undescribed, species.

Interspecific relationships of N. bristowei and N. randa: Both species appear to be endemic to Majorca, where they occur in separate geographical areas (Fig. 84). *Nemesia bristowei* and *N. randa* show a number of interesting similarities in morphology (carapace shape, eye-formation, “western-type” spermathecae), behaviour (reclusive lifestyle, simple fully silk-lined burrows, modified trapdoor) and ecology (predominantly found on steep surfaces) that might indicate a mutual relationship. According to their type of spermathecae *N. bristowei* and *N. randa* seem to be

“western” species, of which the closest relatives should be expected on nearby islands or on the Iberian peninsula. However, *N. bristowei*, with its remarkable cog-wheel shaped trapdoor, might have a relative towards the east, on Sardinia, where an as yet undescribed species seems to build a somewhat similar trapdoor (though more “star-shaped”) that has been photographed by and published in Kullmann & Stern (1975).

Interspecific relationships of N. ibiza: This species seems to be a member of a larger tribe of cork-door building *Nemesia* species that has a wide distribution on the Iberian mainland and in southern France. The group probably contains *N. hispanica*, *N. caementaria* and *N. carminans*. In particular *N. ibiza* and *N. hispanica* seem to be closely related. If these two species could be proved to be synonymous this would provide the first definite record of a species with a distribution that includes both mainland and island locations.

Finally, it is unfortunate that the present study is rather incomplete. Particularly the absence of males of most species described here is an important omission. To complete the picture of the Balearic *Nemesia* fauna it will be necessary to obtain the missing males and also to study the *Nemesia* species that occur on Minorca and the smaller islands in the Balearic archipelago. It is hoped that samples from these locations and males of all species will become available for study shortly in order to complete this study and to improve our understanding of *Nemesia* diversity and distribution in the region.

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