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Research article

urn:lsid:zoobank.org:pub:C82D605B-9BE0-47D1-89E3-8C978CA48B4D

A new semi-cryptic *Filistata* from caves in the Levant with comments on the limits of *Filistata insidiatrix* (Forsskål, 1775) (Arachnida: Araneae: Filistatidae)

Ivan L.F. MAGALHAES^{1,*}, Shlomi AHARON², Zeana GANEM³ & Efrat GAVISH-REGEV⁴

¹División Aracnología, Museo Argentino de Ciencias Naturales “Bernardino Rivadavia”, Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Av. Ángel Gallardo 470, C1405DJR, Buenos Aires, Argentina.

^{2,3,4}The National Natural History Collections, Edmond J. Safra Campus, Givat Ram, The Hebrew University of Jerusalem, Jerusalem 9190401, Israel.

^{2,3}The Department of Ecology, Evolution and Behavior, Edmond J. Safra Campus, Givat Ram, The Hebrew University of Jerusalem, Jerusalem 9190401, Israel.

*Corresponding author: magalhaes@macn.gov.ar

²Email: shlomi.aharon@gmail.com

³Email: zeana.ganem@mail.huji.ac.il

⁴Email: efrat.gavish-regev@mail.huji.ac.il

¹urn:lsid:zoobank.org:author:799DF5B9-9085-4E58-BE36-371CFADED8AA

²urn:lsid:zoobank.org:author:FB5EEA73-DD16-440C-B611-07F1C0C1300B

³urn:lsid:zoobank.org:author:01B74564-251F-4586-98E9-48B526D69FB2

⁴urn:lsid:zoobank.org:author:FC073F19-2202-4C89-8B43-CEA4CC5E2D50

Abstract. We describe a new troglomorphic species of *Filistata*, *F. betarif* sp. nov., collected from two caves in central Israel, by using light and electron microscopy and by DNA barcoding of the cytochrome c oxidase subunit I (COI) gene. Sequences of this gene show more than 15% of divergence between the new species and its sibling, *F. insidiatrix* (Forsskål, 1775), which is widely distributed across the Mediterranean and the Middle East. Notwithstanding, the two species are diagnosed only by a minor morphological detail in the embolic keel of the male pedipalp; females of both species are not diagnosable based only on morphology. We also find that samples of *F. insidiatrix* from different localities have large genetic divergence values (larger than 15% in some cases), but their pedipalps are identical in males; this suggests that *F. insidiatrix* might hide an additional cryptic diversity. We take this opportunity to provide a dichotomous key for identifying the crevice-weavers (Filistatidae) of Israel and Palestine.

Keywords. DNA barcoding, Israel, Mediterranean, Palestine, troglophile.

Magalhaes I.L.F., Aharon S., Ganem Z. & Gavish-Regev E. 2022. A new semi-cryptic *Filistata* from caves in the Levant with comments on the limits of *Filistata insidiatrix* (Forsskål, 1775) (Arachnida: Araneae: Filistatidae). *European Journal of Taxonomy* 831: 149–174. <https://doi.org/10.5852/ejt.2022.831.1875>

Introduction

Crevice weavers (Filistatidae Simon, 1864) are a medium-sized family of spiders comprising 187 described species in 19 genera to date (WSC 2022). Members of this family are morphologically homogeneous and all weave cribellate capture webs, usually with threads that radiate from a central refugium in crevices, holes or under rocks (e.g., Fig. 1A–B). Filistatids are fond of dry places and vertical walls, either natural or artificial, where they can build their webs. As such, they are frequently found in synanthropic settings, especially old walls, corners and cracks of human dwellings (e.g., Legittimo *et al.* 2017: fig. 26). In natural settings, they are frequently found under rocks, but some species can be especially abundant in caves, where they may figure among the most common troglophiles (Cuff *et al.* 2021; Gavish-Regev *et al.* 2021). In fact, several filistatid species have been described from caves (see Gray 1994; Brescovit *et al.* 2016; Magalhaes 2016, 2018). In the Mediterranean region, four genera

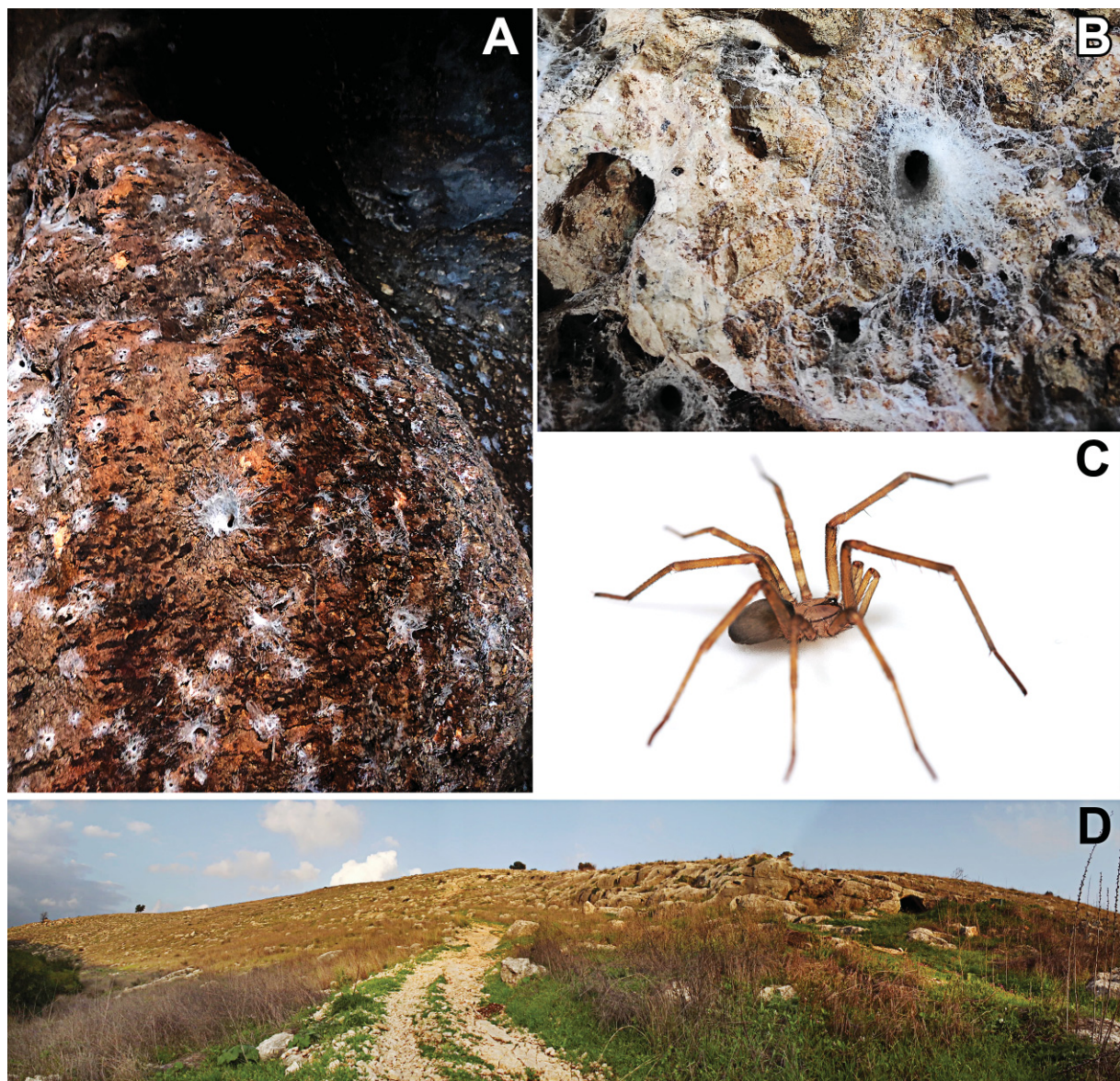


Fig. 1. A–B. Habitat and webs of *Filistata betarif* sp. nov. in Tinsheet cave. C. Paratype male in life (MACN-Ar 41793). D. Surroundings of Tinsheet cave. Note the entrance to the cave at the right side of the picture. Photos A–B by Shlomi Aharon and C–D by Ivan L.F. Magalhaes.

can be found: *Pritha* Lehtinen, 1967, *Sahastata* Benoit, 1968, *Zaitunia* Lehtinen, 1967 and *Filistata* Latreille, 1810 (Zonstein & Marusik 2016; Legittimo *et al.* 2017; Zonstein & Marusik 2019; Magalhaes *et al.* 2020).

As part of a previous project aiming at surveying the subterranean spiders from Israel and Palestine (see Gavish-Regev *et al.* 2021), specimens belonging to *Filistata* were sampled from different caves in the region. They were initially identified by us as *Filistata insidiatrix* (Forsskål, 1775) based on the morphology of the female genitalia. We sequenced the barcode region of the cytochrome c oxidase subunit I gene (COI) for some of these samples, which revealed an unexpected diversity: samples coming from two neighbouring caves (Tinshemet and Oah, Bet ‘Arif wadi, Hadom Shomeron Nature Reserve, central Israel) yielded sequences with substantial amounts of genetic divergence when compared to other samples. This raised the hypothesis that these specimens belong to a different species. However, all the specimens available to us were females, which have a simpler morphology and are more difficult to diagnose than males (see Zonstein & Marusik 2019). Thus, there was not enough morphological data to put this to the test. We therefore made a second visit to Tinshemet cave, where we found a few male individuals. These specimens are studied in detail in this contribution to test the aforementioned hypothesis.

The aim of this paper is thus to test the hypothesis that the populations from Tinshemet and Oah caves do not belong to the most common filistatid species in the region, *F. insidiatrix*, and to delimit species borders. A stricter test of this hypothesis requires a comprehensive sampling of *F. insidiatrix*, which is widely distributed in the Mediterranean region and the Middle East (Zonstein & Marusik 2019). We thus gather morphological and sequence data of samples from multiple populations of *F. insidiatrix* across its range, while focusing especially on Israel and Palestine. Finally, we take this opportunity to provide a dichotomous identification key for the crevice weavers of the region.

Material and methods

Examined specimens

Vouchers are deposited in the following institutions (see acknowledgements for curators and curatorial assistants):

AMNH	= American Museum of Natural History (New York, USA)
CAS	= California Academy of Sciences (San Francisco, USA)
CRBA	= Centre de Recursos de Biodiversitat Animal (Barcelona, Spain)
HUJ-INVA	= The National Natural History Collections, The Hebrew University of Jerusalem (Jerusalem, Israel)
MACN-Ar	= Museo Argentino de Ciencias Naturales ‘Bernardino Rivadavia’ (Buenos Aires, Argentina)
MCZ	= Museum of Comparative Zoology, Harvard University (Cambridge, USA)
MNRJ	= Museu Nacional (Rio de Janeiro, Brazil)
SMF	= Senckenberg Museum (Frankfurt, Germany)
SMNH	= Steinhardt Museum of Natural History (Tel-Aviv, Israel)
USNM	= Smithsonian Institute (Washington, USA)
ZMB	= Zoologisches Museum Berlin (Berlin, Germany)

Morphology and taxonomy

Female genitalia were digested using pancreatin solution to remove soft tissues, and examined in lactic acid; male pedipalps were cleared with clove oil. Photos were obtained with a DFC295 camera and a Leica M205A stereo microscope or a DXM1200 camera and an Olympus BH2 compound microscope. Images composed of several focal planes were obtained with Helicon Focus 7 (<https://www.heliconsoft.com/>).

Drawings were made with the aid of a camera lucida. Material for scanning electron microscopy was prepared and imaged using standard procedures described elsewhere (e.g., Magalhaes & Ramírez 2019). The format of description follows Magalhaes & Ramírez (2019), except for leg measurements which are given as total length (femur, patella, tibia, metatarsus, tarsus). Taxonomic descriptions and lists of examined specimens were automatically generated using the spreadsheets provided by Magalhaes (2019; see <https://github.com/ivanlfm/spreadsheets-taxonomy>). Specimens without coordinates in the original labels were georeferenced using Google Earth and have the coordinates between square brackets in the list of examined material.

Abbreviations used in the description

fe = femur
mt = metatarsus
ti = tibia

DNA sequence acquisition and analysis

We analysed the standard barcode fragment of the cytochrome c oxidase subunit I gene (COI). Publicly available sequences of *Filistata* were obtained from GenBank (<https://ncbi.nlm.nih.gov/genbank/>) and BOLD systems (<https://boldsystems.org/>) on 20 November 2021, corresponding to samples of *Filistata insidiatrix* from Egypt, Italy, Slovenia, France and Turkey. We here provide additional sequences of this species from Israel, Palestine, Spain, Greece, France and Morocco, as well as one sequence of *Filistata wunderlichii* Zonstein & Marusik, 2019 from Spain and of an undetermined species from Israel (here identified with the morphotype code *Filistata* IFMsp191). Collecting data and Genbank accession numbers of sequences analysed in this study are provided in Table 1.

DNA was extracted from one or two legs using the protocol by Casquet *et al.* (2012). The 700 bp barcode fragment of the COI was amplified using the universal primers HCO2198 and LCO1490 (Folmer *et al.* 1994), by using standard protocols for spiders (see Wheeler *et al.* 2017) and an annealing temperature of 48°C. Success of polymerase chain reactions was verified by running the products in 1% agarose gel stained with ethidium bromide. Products were purified using a mix of exonuclease I + alkaline phosphatase and Sanger-sequenced by third parties (<https://dna.macrogen.com/>). Chromatograms were examined by eye for the presence of stop codons and poor flanking regions were trimmed.

We aligned sequences using the MUSCLE algorithm in MEGA X (Kumar *et al.* 2018). Alignment of the sequences was trivial due to the absence of indels. Pairwise and average intra- and interspecific genetic distances were estimated using the Kimura two-parameter model using MEGA X (Kumar *et al.* 2018). A maximum-likelihood phylogeny of the COI sequences was estimated using IQtree 2 (Minh *et al.* 2020); different evolutionary models were tested using the -MFP option and the best-fitting one was chosen prior to tree inference using the Bayesian Information Criterion. Branch supports were estimated by 100 bootstrap pseudoreplicates. The tree was rooted on *Zaitunia schmitzi* (Kulczyński, 1911), a genus suggested to be sister to *Filistata* by Wheeler *et al.* (2017) and Magalhaes & Ramírez (in press).

Comparative material examined

Zaitunia schmitzi (Kulczyński, 1911)

ISRAEL • 1 ♀; near Shoham, Hadom Shomeron Nature Reserve, Tinsmet cave; 31.99938° N, 34.96813° E; 122 m.a.s.l.; 20 Feb. 2020; I.L.F. Magalhaes, E. Gavish-Regev and S. Aharon leg.; Mediterranean scrubland, under stones, outside the cave; MACN-Ar 41797.

Table 1. Voucher and collection data for sequences analysed in this study. Accession numbers marked in bold are of newly generated sequences, others are publicly available in Genbank or BOLD.

Species	DNA Code	Accession number (Genbank/BOLD)	Museum	Country	Region1	Region2	Region3	Latitude	Longitude
<i>Filistata beatrix</i>	IFM0777	ON145672	HUJ INVA 21055	Israel	HaMerkez	near Shoham	Hadom Shomeron Nature Reserve, Osh cave	32.01	34.97
<i>Filistata beatrix</i>	IFM0779	ON145673	HUJ INVA 21056	Israel	HaMerkez	near Shoham	Hadom Shomeron Nature Reserve, outside Tinsmet cave	32.00	34.97
<i>Filistata beatrix</i>	IFM2083	ON145674	MACN 41793	Israel	HaMerkez	near Shoham	Hadom Shomeron Nature Reserve, Tinsmet cave	31.999376	34.968125
<i>Filistata beatrix</i>	IFM2124	ON145675	HUJ INVA-21058	Israel	HaMerkez	near Shoham	Hadom Shomeron Nature Reserve, Tinsmet cave	31.999376	34.968125
<i>Filistata beatrix</i>	IFM2171	ON145676	MACN-Ar 41791	Israel	HaMerkez	near Shoham	Hadom Shomeron Nature Reserve, Tinsmet cave	31.999376	34.968125
<i>Filistata</i> IFMsp191	IFM2170	ON145677	MACN-Ar 41262	Israel	Golan	near Odem	Ya'ar Massada Nature Reserve, Odem forest	33.20351	35.74009
<i>Filistata insidiatrix</i>	786560	SPSL 0040-12	USNM	Slovenia			trail from Socerb to Osp	45.57	13.86
<i>Filistata insidiatrix</i>	ARA0122	SPSL 0348-13	BMH	Slovenia			trail from Socerb to Osp	45.57	13.86
<i>Filistata insidiatrix</i>	BIOLG000525-G03	TURAR1482-10	CBG	Turkey	Mugla	Aegean	Kiyikislaçik Village, Milas District	37.28	27.58
<i>Filistata insidiatrix</i>	BIOLG000525-H03	TURAR1491-10	CBG	Turkey	Mugla	Aegean	Kiyikislaçik Village, Milas District	37.28	27.58
<i>Filistata insidiatrix</i>	BIOLG14631-G06	GMEG0020-14	CBG	Egypt	Alexandria	Marlot	Mostafa Kamel Village	30.93	29.78
<i>Filistata insidiatrix</i>	IFM0272	ON145678	SMNH	Israel	Judean Hills	'Adullam Park	Midras	31.66	34.94
<i>Filistata insidiatrix</i>	IFM0778	ON145679	HUJ INVA 21052	Israel			Bemki, medium cave	32.78	35.54
<i>Filistata insidiatrix</i>	IFM0780	ON145680	HUJ INVA 21053	Israel			Sal'it cave	32.25	35.05
<i>Filistata insidiatrix</i>	IFM1702	ON145681	MACN-Ar 39461	France	Alpes-Côte d'Azur	Var	Brignoles, Gontaron	43.34	6.29
<i>Filistata insidiatrix</i>	IFM1703	ON145682	MACN-Ar 39462	France	Languedoc-Roussillon	Gard	Souviagnagues	43.81	4.15
<i>Filistata insidiatrix</i>	IFM1704	ON145683	MACN-Ar 39463	Morocco	Tafilalet	Errachidia	Aoulous, Ziz Valley	31.75	-4.20
<i>Filistata insidiatrix</i>	IFM2037	ON145684	MACN-Ar 41825	Israel	HaZafon	Hirbat Dan 'Ila, near Elon	Nahal Bezet Nature Reserve, Sharakh cave	33.074	35.2379
<i>Filistata insidiatrix</i>	IFM2059	ON145685	MACN-Ar 41261	Israel	HaZafon	Hirbat Dan 'Ila, near Elon	Nahal Bezet Nature Reserve, Sharakh cave	33.074	35.2379
<i>Filistata insidiatrix</i>	IFM2144	ON145686	MACN-Ar 41218	Israel	HaZafon	Hirbat Dan 'Ila, near Elon	Nahal Bezet Nature Reserve, Sharakh cave	33.074	35.2379
<i>Filistata insidiatrix</i>	IFM2175	ON145687	MACN-Ar 41813	Israel	Haifa	Har Ha-Karmel Nature Reserve	Karmel Ridge, Omrit cave	32.756703	34.989745
<i>Filistata insidiatrix</i>	IFM2176	ON145688	MACN-Ar 41813	Israel	Haifa	Har Ha-Karmel Nature Reserve	Karmel Ridge, Omrit cave	32.756703	34.989745
<i>Filistata insidiatrix</i>	IFM2186	ON145689	MACN-Ar 41844	Greece	Crete	Crete	Agios Nikolaos	35.31	25.58
<i>Filistata insidiatrix</i>	IFM2187	ON145690	MACN-Ar 41845	Morocco	Souss - Massa - Draâ	Quarzazate	Amezgans, Telouet	31.07	-7.14
<i>Filistata insidiatrix</i>	IFM2196	ON145691	CRBA 860	Spain	Murcia	Fortuna	Espacio Natural de Ajanque	38.15	-1.10
<i>Filistata insidiatrix</i>	IFM2198	ON145692	CRBA 861	Spain	Murcia	Fortuna	Espacio Natural de Ajanque	38.15	-1.10
<i>Filistata insidiatrix</i>	KY017720	KY017720		Italy	Toscana	Siena	4 km S San Gimignano, Fattoria Voltorna	43.47	11.04
<i>Filistata insidiatrix</i>	SMNK-ARA9081	SMNK.A208-16		France	Herauld	Minervois		43.34	2.85
<i>Filistata wunderlichii</i>	IFM2197	ON145693	CRBA	Spain	Almeria	Boca de los Frailes	Agel	36.81	-2.13
<i>Zaitunia schmitzi</i>	IFM2086	ON145694	MACN-Ar 41797	Israel	HaMerkez	near Shoham	Hadom Shomeron Nature Reserve, outside Tinsmet cave	31.999376	34.968125

Filistata albens Zonstein & Marusik, 2019

ISRAEL • 2 ♂♂, 1 imm.; central Negev, Sede Boqer, Haluqim Ridge; [30.87801° N, 34.78559° E]; 2 Jul. 1992; Y. Lubin leg.; pitfall; HUI-INVAR 21011–21013 • 2 ♂♂, holotype and paratype; same locality as for preceding; 4 May 1994; Y. Lubin leg.; HUI-INVAR 21016–21017 • 1 ♂, paratype; same collection data as for preceding; SMNH • 2 ♂♂, paratypes; western Negev, Nizzana; [30.91666° N, 34.4° E]; 6 May 1992; Y. Lubin leg.; pitfall; HUI-INVAR 21014–21015.

Filistata lubinae Zonstein & Marusik, 2019

ISRAEL • 1 ♂, holotype; Negev, near Be'er Mash'abbim, sand dunes; pitfall; [31.0019° N, 34.7538° E]; 14 Mar. 1990; Y. Ayal leg.; HUI-INVAR 21018 • 2 ♂♂, paratypes; same locality as for preceding; 21 Jul. 1990; Y. Ayal leg.; sand dunes; pitfall; HUI-INVAR 21019–21020 • 1 ♂, paratype; same collection data as for preceding; SMNH • 3 ♂♂, paratypes; same locality as for preceding; 15 May 1991; Y. Lubin leg.; sand dunes; pitfall; HUI-INVAR 21021–21023 • 5 ♂♂, paratypes; same locality as for preceding; 17 May 1992; Y. Lubin leg.; sand dunes; pitfall; HUI-INVAR 21024–21028 • 1 ♂, paratype; same locality as for preceding; 27 May 1992; Y. Lubin leg.; sand dunes; pitfall; HUI-INVAR 21029 • 3 ♂♂, paratypes; same locality as for preceding; 3 Jul. 1991; Y. Lubin leg.; sand dunes; pitfall; HUI-INVAR 21030–21032 • 4 ♂♂, paratypes; same locality as for preceding; 30 Apr. 1993; Y. Lubin leg.; sand dunes; pitfall; HUI-INVAR 21033–21036 • 1 ♂, paratype; same collection data as for preceding; SMNH • 11 ♂♂, paratypes; same locality as for preceding; 8 Jul. 1992; Y. Lubin leg.; sand dunes; pitfall; HUI-INVAR 21038–21048 • 1 ♂, paratype; same locality as for preceding; 13 May 1991; Y. Lubin leg.; HUI-INVAR 21037 • 1 ♂; same locality as for preceding; Jun. 1991; Y.D. Lubin leg.; MCZ 39913.

Filistata IFMsp99

PALESTINE • 1 ♀, possibly subadult; Dead Sea Valley, En Fashkha (= 'Enot Zuqim); [31.72358° N, 35.4575° E]; 18 Feb. 1943; A. Shulov leg.; HUI-INVAR 20277.

Filistata IFMsp191

ISRAEL • 1 ♀; Golan Heights, near Odem, Ya'ar Mas'ada Nature Reserve, Odem forest; 33.20351° N, 35.74009° E; 888 m.a.s.l.; 19 Feb. 2020; I.L.F. Magalhaes, E. Gavish-Regev, Z. Ganem, S. Aharon and M. Arnedo leg.; Mediterranean woodland; under stones; MACN-Ar 41263.

Filistata wunderlichi Zonstein & Marusik, 2019

SPAIN • 4 ♀♀; Almeria, Boca de los Frailes; [36.80564° N, 2.1322° W]; 8 Dec. 2019; J. Moya leg.; CRBA.

Results

New sequences are deposited in GenBank (accession numbers: ON145672–ON145694). We found a high genetic diversity of COI sequences in samples of *Filistata* from the Mediterranean region, with some interspecific genetic distances of more than 20% (Table 2). Sequences of *Filistata* obtained by us are divided into four clades that we here interpret to be four different species (see Discussion; each species with a different colour in the tree in Figs 2–3). Morphological results are in line with this conclusion: there are morphological differences allowing to identify males and (partially) in females of each of the four clades recovered with sequence data (see Discussion and Taxonomy below).

Table 2. Average pairwise genetic distances (estimated using the Kimura two-parameter model) among cytochrome c oxidase subunit I sequences of species analysed in this study. The diagonal represents average intraspecific distances (a dash indicates a single individual was sequenced for that species).

Species (number of samples)	<i>schmitzi</i>	<i>wunderlichi</i>	<i>insidiatrix</i>	IFMsp191	<i>betarif</i>
<i>Z. schmitzi</i> (1)	–	0.226	0.261	0.241	0.229
<i>F. wunderlichi</i> (1)	0.226	–	0.244	0.207	0.238
<i>F. insidiatrix</i> (22)	0.261	0.244	0.09	0.212	0.167
<i>F. IFMsp191</i> (1)	0.241	0.207	0.212	–	0.168
<i>F. betarif</i> (5)	0.229	0.238	0.167	0.168	0.000

Taxonomy

Class Arachnida Lamarck, 1801
 Order Araneae Clerck, 1757
 Family Filistatidae Simon, 1864
 Subfamily Filistatinae Simon, 1864

Genus *Filistata* Latreille, 1810

Filistata Latreille, 1810: 121. Type species by monotypy *Filistata testacea* Latreille, 1810 (= *Aranea insidiatrix* Forsskål, 1775).

Teratodes C.L. Koch 1839: 6. Type species by monotypy *Teratodes attalicus* C.L. Koch, 1839 (= *Aranea insidiatrix* Forsskål, 1775). First synonymized with *Filistata* by Simon (1864: 95)

Filistata – Lehtinen 1967: 234 (first large-scale re-delimitation of the genus). — Zonstein & Marusik 2019: 57 (first monographic treatment of the taxonomy of the group).

Filistata insidiatrix (Forsskål, 1775)
 Figs 2, 3C–D, I, 5 B, D, F, 6, 8H, 10A, E, Q

Aranea insidiatrix Forsskål, 1775: 86.

Filistata insidiatrix – Simon 1895: 1067.

Remarks

Please see WSC (2022) for a full synonymic list of this species, and Zonstein & Marusik (2019) for description, diagnosis, natural history, and additional distribution records.

Updated diagnosis

Males are similar to those of *F. betarif* sp. nov. and *F. albens* by having an elongate pedipalpal femur and tibia, and by a subconical copulatory bulb with a terminally hooked embolus (Fig. 6; see also Zonstein & Marusik 2019: fig. 27). Males differ from those of *F. albens* by their longer copulatory bulb and from those of *F. betarif* sp. nov. by their inconspicuous embolic keel (Fig. 8H (arrow), 5B, k) (conspicuous keel in *F. betarif* sp. nov., Fig. 5A). Females have a pair of large spermathecae that may be partially divided or undivided (Fig. 3C–D) and their variation includes the observed morphology of *F. betarif* sp. nov.; thus females are not diagnosable through morphology alone, they can be diagnosed using DNA barcoding of the COI gene.

Material examined

ANGOLA • 1 ♀; Luanda, Luanda; [8.83833° S, 13.23444° E]; N. Chatelain leg.; USNM 1656 • 1 ♀; Namibe, Baia das Pipas, in house; [14.95° S, 12.18333° E]; Jan. 1960; Brühl leg.; ZMB.

EGYPT • 1 ♀; Cairo; [30.04442° N, 31.23571° E]; O. Manley leg.; ZMB 4375.

FRANCE • 1 ♂, 1 ♀; Alpes-Côte d’Azur, Var, Brignoles, Gonfaron; 43.34158° N, 6.29443° E; 2017; M. Stockmann leg.; MACN-Ar 39461 • 2 ♂♂, 4 ♀♀; Languedoc-Roussillon, Banyuls-sur-Mer;

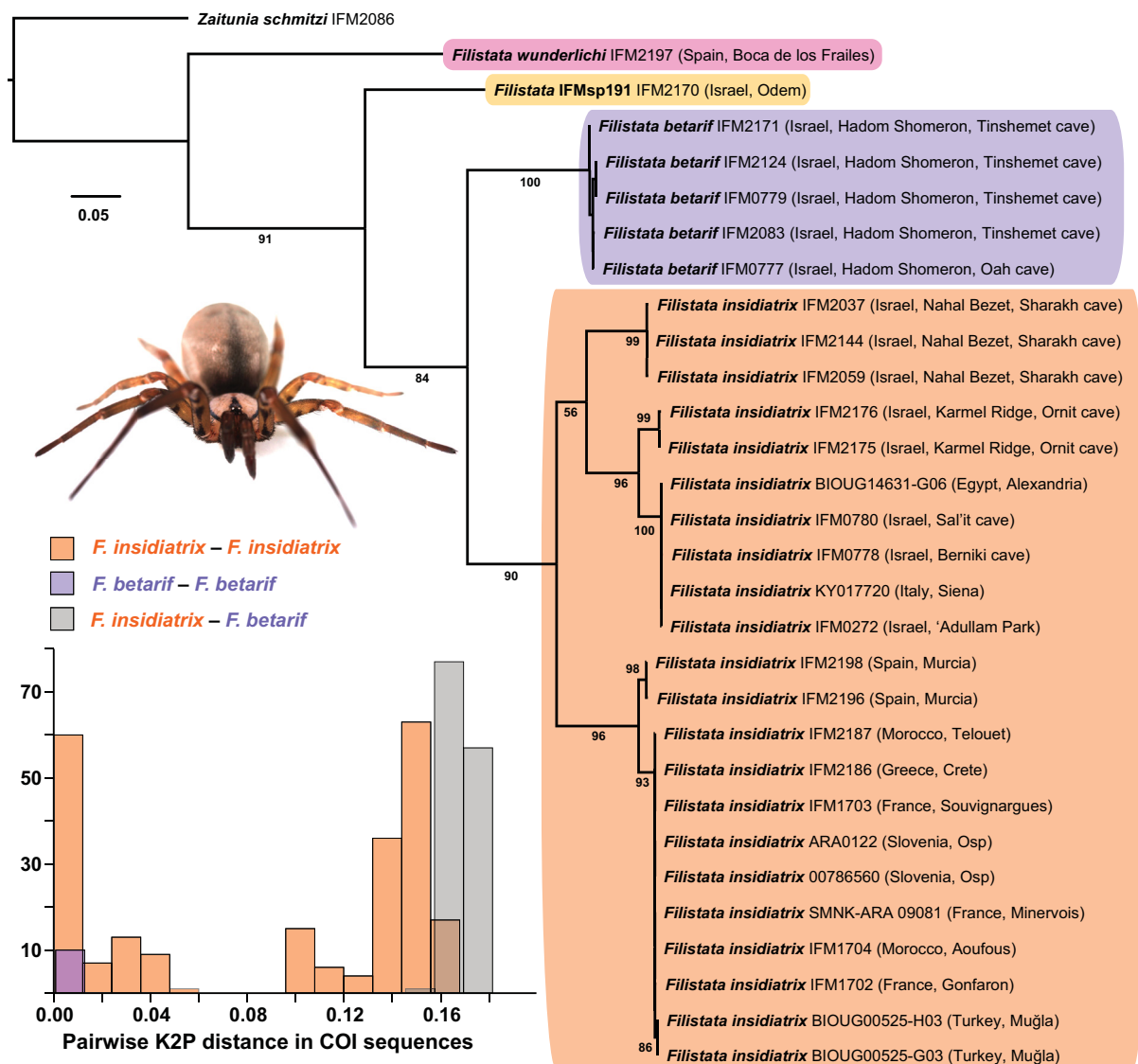


Fig. 2. Phylogenetic tree of cytochrome c oxidase subunit I haplotypes of different species of *Filistata* Latreille, 1810 inferred under maximum likelihood. Numbers below branches are bootstrap supports. The histogram shows the distribution of pairwise Kimura two-parameter genetic distances within and between *F. insidiatrix* (Forsskål, 1775) and *F. betarif* sp. nov. (for pairwise distances of other species, see Table 2). Note that some intraspecific genetic distances within *F. insidiatrix* are larger than interspecific distances between *F. insidiatrix* and *F. betarif* sp. nov., denoting a lack of a barcode gap in this group, or cryptic species within *F. insidiatrix*.

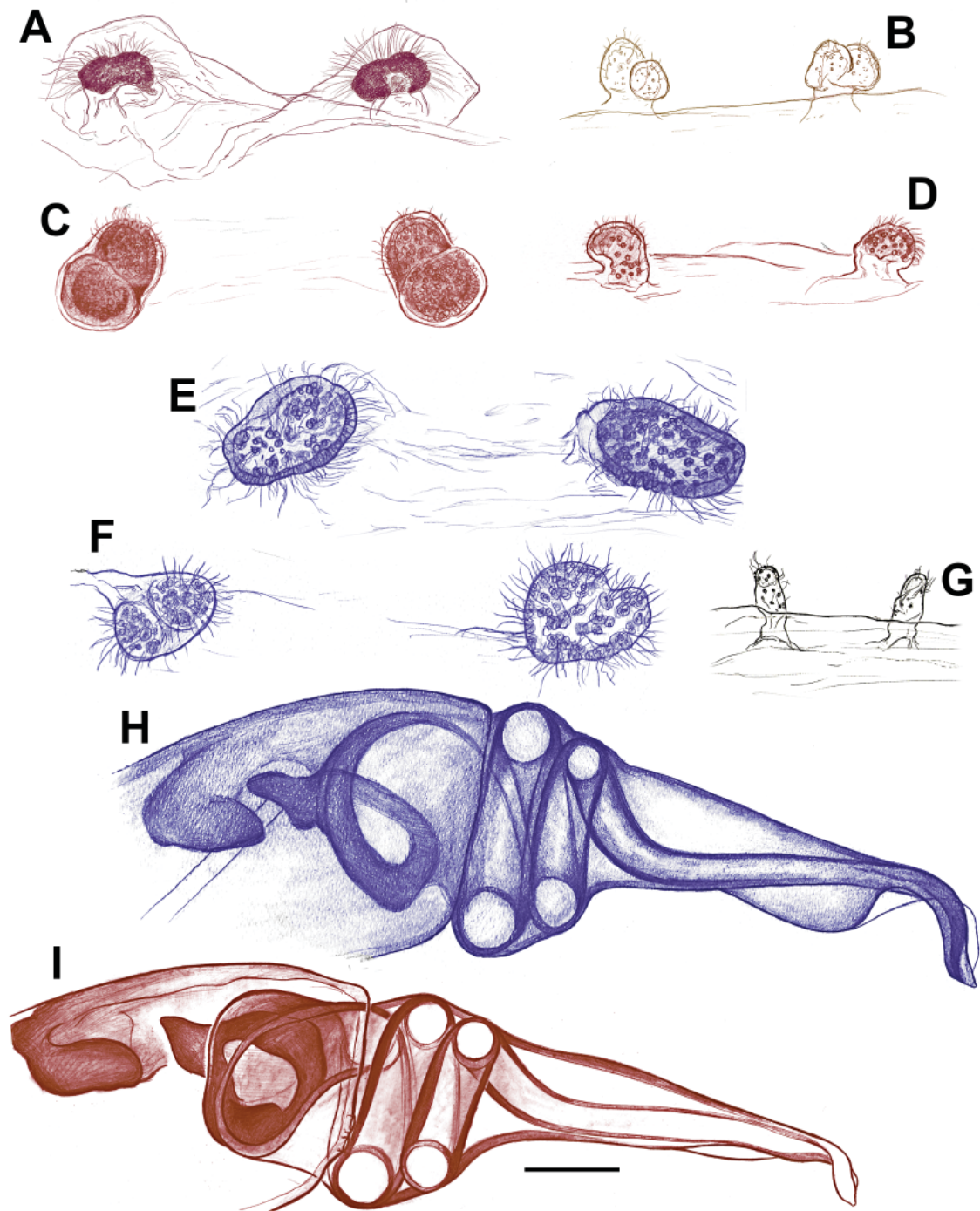


Fig. 3. A–G. Endogynes *Filistata* Latreille, 1810, ventral view. **A.** *Filistata wunderlichi* Zonstein & Marusik, 2019 from Spain, Boca de los Frailes (CRBA IFM-2197). **B.** *Filistata* IFMsp191 from Israel, Odem (MACN-Ar 41262). **C.** *Filistata insidiatrix* (Forsskål, 1775) from France, Gonfaron (MACN-Ar 39461). **D.** *Filistata insidiatrix* from Israel, Beriniki (HUJ-INVAr 21052). **E.** *Filistata betarif* sp. nov. from Israel, Oah cave (HUJ-INVAr 21055). **F.** *Filistata betarif* sp. nov. from Israel, Tinsheet cave (MACN-Ar 41222). **G.** *Filistata* IFMsp99 (subadult ♀?) from Palestine, En Fashkha (HUJ-INVAr 20277). — **H–I.** ♂♂, left pedipalp, prolateral. **H.** *Filistata betarif* sp. nov., holotype from Israel, Tinsheet cave (HUJ -INVAr 21058). **I.** *Filistata insidiatrix* from Spain, Mallorca (MACN-Ar 42346). Scale bar = 0.1 mm, all figures to scale. Colours correspond to clades in Fig. 2.

[42.48343° N, 3.12887° E]; 21 Mar. 1968; H.W. Levi, F. Levi and L.R. Levi leg.; MCZ 39864 • 1 ♀; no further data; [42.44097° N, 3.16469° E]; Spatz leg.; ZMB 1053 • 2 ♀♀; southern France; AMNH • 1 ♀; southern France; ZMB 5021.

GREECE • 1 imm.; Attica, Sounion; [37.65915° N, 24.01476° E]; 30 Nov. 1978; B. Malkin leg.; AMNH • 2 ♀♀; Crete, Akrotiri; [35.55° N, 24.13333° E]; Feb.–Mar. 1925; A. Schultz leg.; ZMB 6205 • 1 ♀; Crete, Agios Nikolaos; 35.31006° N, 25.57781° E; Jul. 2019; M. Stockmann leg.; MACN-Ar 41844 • 3 ♀♀, 1 imm.; NW Crete; [35.55° N, 24.13333° E]; A. Schultz leg.; ZMB 6208 • 1 ♀; Crete; [36.39316° N, 25.46151° E]; Oertzen leg.; ZMB 6951 • 1 ♀; Cyclades Islands, Santorini; 36.40922° N, 25.43221° E; May 1988; M.J. Ramírez leg.; MACN-Ar 20563 • 1 imm.; Kea; [37.60758° N, 24.31037° E]; 30 Sep. 1925; A. Schultz leg.; ZMB 6203 • 2 ♀♀; Kythira; [36.26327° N, 22.97737° E]; Aug. 1925; ZMB • 1 ♀; Rhodes, Kalavarda; [36.33998° N, 27.94949° E]; 7 Dec. 1978; B. Malkin leg.; AMNH • 1 ♀; Thera; [36.39316° N, 25.46151° E]; 1972; Hillas and Goerligen (?) leg.; ZMB.

ISRAEL • 1 ♂; upper Galilee, Ba'al-Shem-Tov Forest, Meron Mountains; 32.9821° N, 35.47381° E; 13–20 Nov. 2007; T. Levanony leg.; SMNH • 1 ♂, 1 ♀, 1 imm.; upper Galilee, Dan; 33.24° N, 35.655° E; 14 May 2012; S. Zonstein leg.; SMNH • 1 ♂; upper Galilee, En Ya'aqov; 33.00764° N, 35.23889° E; 4–9 Feb. 2007; I. Shtirberg leg.; pitfall; SMNH • 1 ♂; upper Galilee, Nahal Keziv; [33.04234° N, 35.17882° E]; 31 Jul. 2010; C. Drees and L. Friedman leg.; SMNH • 1 ♂; same locality as for preceding; 13 Nov. 2010; L. Friedman and C. Drees leg.; SMNH • 1 ♂, 2 ♀♀; upper Galilee, near Elon, Nahal Bezet Nature Reserve, Sharakh cave, entrance of cave; 33.074° N, 35.2379° E; 233 m.a.s.l.; 17 Feb. 2020; I.L.F. Magalhaes, E. Gavish-Regev, Z. Ganem, S. Aharon, N. Givon and M. Arnedo leg.; MACN-Ar 41218 • 1 ♂, 2 ♀♀; same collection data as for preceding; MACN-Ar 41226 • 1 ♂; same locality as for preceding; 17 Feb. 2020; I.L.F. Magalhaes, E. Gavish-Regev, Z. Ganem, S. Aharon, N. Givon and M. Arnedo leg.; twilight zone; MACN-Ar 41261 • 1 ♀; same collection data as for preceding; MACN-Ar 41825 • 1 ♂; upper Galilee, Senir; 33.23333° N, 35.66667° E; 250 m.a.s.l.; 2 Nov. 2013; S. Zonstein leg.; SMNH • 1 ♀; upper Galilee, Yehiam, in cave; [32.99611° N, 35.22109° E]; 15 Nov. 1949; A. Shulov leg.; HUI-INVAr 20290 • 1 ♀; upper Galilee, Yir'on, small cave; 33.0672° N, 35.4672° E; 28 May 2014; S. Aharon and E. Gavish-Regev leg.; HUI-INVAr 21049 • 1 ♀; upper Galilee, Yonim cave, in depth; 32.9236° N, 35.2168° E; 25 May 2014; S. Aharon and E. Gavish-Regev leg.; HUI-INVAr 21050 • 1 ♂; upper Galilee, north slope of Mount Meron, Meron Field School; 33.01667° N, 35.39167° E; 1 Nov. 2013; S. Zonstein leg.; SMNH • 2 imm.; lower Galilee, near Teverya (Tiberias), Berniki, large cave; 32.7775° N, 35.5401° E; 27 May 2014; S. Aharon and E. Gavish-Regev leg.; HUI-INVAr 21051 • 1 ♀; lower Galilee, near Teverya (Tiberias), Berniki, medium cave; 32.7768° N, 35.5413° E; 27 May 2014; S. Aharon and E. Gavish-Regev leg.; HUI-INVAr 21052 • 1 ♂; Mount Karmel, HaKarmel Nature Reserve, Karmel Ridge, Nahal Me'arot; Gamal cave; [32.6705° N, 34.96598° E]; 4 Nov. 2013; D. Rotem leg.; SMNH • 1 ♀; Mount Karmel, near Hefa (Haifa), HaKarmel Nature Reserve, Karmel Ridge; Ornit cave, inside cave; 32.7567° N, 34.98975° E; 209 m.a.s.l.; 20 Feb. 2020; I.L.F. Magalhaes, E. Gavish-Regev, Z. Ganem, S. Aharon and M. Arnedo leg.; MACN-Ar 41215 • 1 ♂, 1 ♀; same collection data as for preceding; MACN-Ar 41813 • 1 ♂; Mount Karmel, Yagur; [32.74153° N, 35.07683° E]; 4 Dec. 1939; HUI-INVAr 20283 • 1 ♀; coast of Karmel, 'Atlit; [32.69088° N, 34.94291° E]; 8 Sep. 1944; HUI-INVAr 20287 • 1 ♂; coast of Karmel, Ma'agan Mikha'el, malaise trap; [32.55871° N, 34.91782° E]; 2–28 Dec. 2010; W. Kuslitzky leg.; SMNH • 1 ♂; same locality as for preceding; 12 Oct. 1992; Y. Lubin leg.; HUI • 1 ♀; coast of Karmel, route to Zikhron-Y'aqov [32.57391° N, 34.95198° E]; 24 Mar. 1940; HUI-INVAr 20286 • 1 ♀; Judean Hills, 'Adullam National Park, Midras; 31.655° N, 34.94167° E; 15 Nov. 2012; S. Zonstein leg.; SMNH IFM-0272 • 1 ♂, 1 ♀; Judean Hills, 'Adullam National Park; [31.64474° N, 34.96089° E]; Apr. 2003; U. Columbus leg.; SMNH • 2 ♂♂; same locality as for preceding; 20 May 2002; Y. Mandelik and A. Landsman leg.; SMNH • 1 ♂; Judean Hills, Ramat Avishur; [31.65° N, 34.92° E]; 14 May 2002; Y. Mandelik leg.; pitfall trap; HUI • 1 ♀; Judean Mountains, Jerusalem; [31.78333° N, 35.2° E]; 29 May 1944; A. Shulov leg.; HUI-INVAr 20288 • 1 ♀, 1 imm.; same locality as for preceding;

Oct. 1936; A. Shulov leg.; HUI-INVAr 20284 • 1 ♀; Judean Mountains, Neve Ya'akov (= Kefar Ivri); [31.84177° N, 35.24276° E]; 30 Dec. 1939; A. Shulov leg.; HUI-INVAr 20289 • 1 ♀; Judean Mountains, Qiryat'Anavim, under bark; [31.80991° N, 35.12084° E]; 20 Jan. 1940; HUI-INVAr 20285 • 1 ♂; Samaria, Gilboa'; [32.48248° N, 35.42137° E]; 30 Jan. 2011; L. Friedman and C. Drees leg.; SMNH • 1 ♀; Samaria, Sal'it cave; 32.2454° N, 35.0456° E; 25 May 2014; S. Aharon and E. Gavish-Regev leg.; HUI-INVAr 21053 • 1 ♂; Sharon plain, Ramot Hashavim, in house; 32.16667° N, 34.88333° E; 9 Mar. 2013; T. Eshcoly leg.; SMNH • 1 ♂; Jordan Valley, Nahal HaGal; [32.6341° N, 35.534° E]; 16 Jul. 2010; C. Drees and L. Friedman leg.; SMNH • 2 imm.; Jordan Valley, Nir Dawid (= Tel' Amal); [32.50406° N, 35.45762° E]; 29 Sep. 1939; A. Shulov leg.; HUI-INVAr 21061.

ITALY • 1 ♂, 1 ♀; Sardinia, Baunei; [40.03175° N, 9.66327° E]; J. Wunderlich leg.; SMF 59579 • 1 ♂; Sardinia, Porto Torres; [40.83134° N, 8.40587° E]; 7 Apr. 1952; Esk. Zool. Just. Ffn. Leg.; SMF • 1 ♀; Sorgono; [40.0272° N, 9.10196° E]; 1917; Häuser and Krausse leg.; ZMB • 7 ♀♀, 6 imm.; Toscana, Siena, 4 km S of San Gimignano, Fattoria Voltrona; [43.46728° N, 11.04348° E]; 12 Dec. 2001; M.J. Ramírez leg.; MACN-Ar 10378 • 1 ♀; same collection data as for preceding; MACN-Ar 10379.

JORDAN • 1 ♂; Amman, Fuhais; [32.00408° N, 35.78451° E]; Dec. 1980; R. Kinzelbach leg.; SMF 57068.

MOROCCO • 1 ♀; Saffi; [32.30082° N, 9.2272° W]; Quedenfeldt leg.; ZMB • 1 ♂, 3 ♀♀; Sefrou, Travertine Falls; 33.83333° N, 4.83333° W; 25 Dec. 1986; V. and B. Roth leg.; CAS 9060650 • 1 imm.; same locality as for preceding; 25 Dec. 1996; V. Roth leg.; CAS 9057617 • 1 ♀, 1 imm.; Souss-Massa-Draâ, Ouarzazate, Amerzgane, Telouet; 31.06659° N, 7.14178° W; Oct. 2016; M. Stockmann leg.; MACN-Ar 41845 • 1 ♂, 1 ♀; Tafilalt, Errachidia, Aoufous, Ziz Valley; 31.75176° N, 4.1968° W; Oct. 2016; M. Stockmann leg.; MACN-Ar 39463.

PALESTINE • 1 ♀; Judean desert, 15 km E of Jerusalem, Fawar Spring, Wadi Qelt; [31.8401° N, 35.3489° E]; 7 Mar. 1975; H.W. Levi leg.; MCZ 39890 • 1 ♀, 1 imm.; Judean desert, Nahal Perat Nature Reserve, Inbal cave; 31.8332° N, 35.3019° E; 26 May 2014; S. Aharon and E. Gavish-Regev leg.; HUI-INVAr 21054 • 1 ♂, 1 ♀; Judean desert, Nahal Perat Nature Reserve, I'qul cave; [31.8318° N, 35.30842° E]; 26 May 2014; S. Aharon and E. Gavish-Regev leg.; HUI-INVAr 20276.

SPAIN • 4 ♀♀; Alicante, Benidorm; [38.54106° N, 0.12249° W]; 1961; K.W. Haller leg.; AMNH • 1 ♂, 1 ♀, 3 imm.; same collection data as for preceding; AMNH • 1 ♀; Almeria, 25 km from Almeria, Salinas de Cerillos; [36.70498° N, 2.66982° W]; 25 Jun. 1967; B. Malkin leg.; AMNH • 1 imm.; Balearic Islands, Mallorca, Colonia de Sant Jordi, 50 km SE of Palma, on house walls; 39.31727° N, 2.99381° E; 15 Sep. 2007; M.J. Ramírez leg.; MACN-Ar 20558 • 1 ♀; same collection data as for preceding; MACN-Ar 20560 • 1 ♀; same collection data as for preceding; MACN-Ar 20561 • 1 imm.; same collection data as for preceding; MACN-Ar 20564 • 1 ♀; Balearic Islands, Mallorca, Colonia Saint Jordi, 50 km SE of Palma, on walls of houses; [39.31727° N, 2.99381° E]; 15 Sep. 2007; M.J. Ramírez leg.; MACN-Ar 42348 • 1 ♂; same collection data as for preceding; MACN-Ar 42347 • 1 ♂; same collection data as for preceding; MACN-Ar 42346 • 1 ♀; Barcelona; [41.38504° N, 2.17347° E]; 13 Sep. 1986; J.A. Coddington leg.; caught in the middle of an imaginal molt, has two sets of spermathecae; USNM 1656 • 1 ♀; same collection data as for preceding; USNM 1656 • 2 ♂♂; Castellón, N of L'Alcora, stone walls; 40.08974° N, 0.19945° W; 300 m.a.s.l.; 30 May 2010; S. Huber and A. Schönhofer leg.; at night; SMF • 1 ♀; Cataluña, Barcelona, Barcelona; 41.40423° N, 2.54461° E; Jan. 1988; M.J. Ramírez leg.; MACN-Ar 20562 • 1 ♀, 1 imm.; Madrid; [40.41678° N, 3.70379° W]; 1961; K.W. Haller leg.; AMNH • 3 ♀♀, 1 imm.; Madrid, Navas del Rey; [40.38776° N, 4.25° W]; 1961; K.W. Haller leg.; AMNH • 9 ♀♀, 11 imm.; Madrid, Vaciamadrid; [40.35191° N, 3.53573° W]; 1961; K.W. Haller leg.; AMNH • 22 ♀♀, 6 imm.; Madrid, Vaciamadrid; 1961; K.W. Haller leg.; AMNH • 1 ♀; Murcia, Fortuna, Espacio Natural

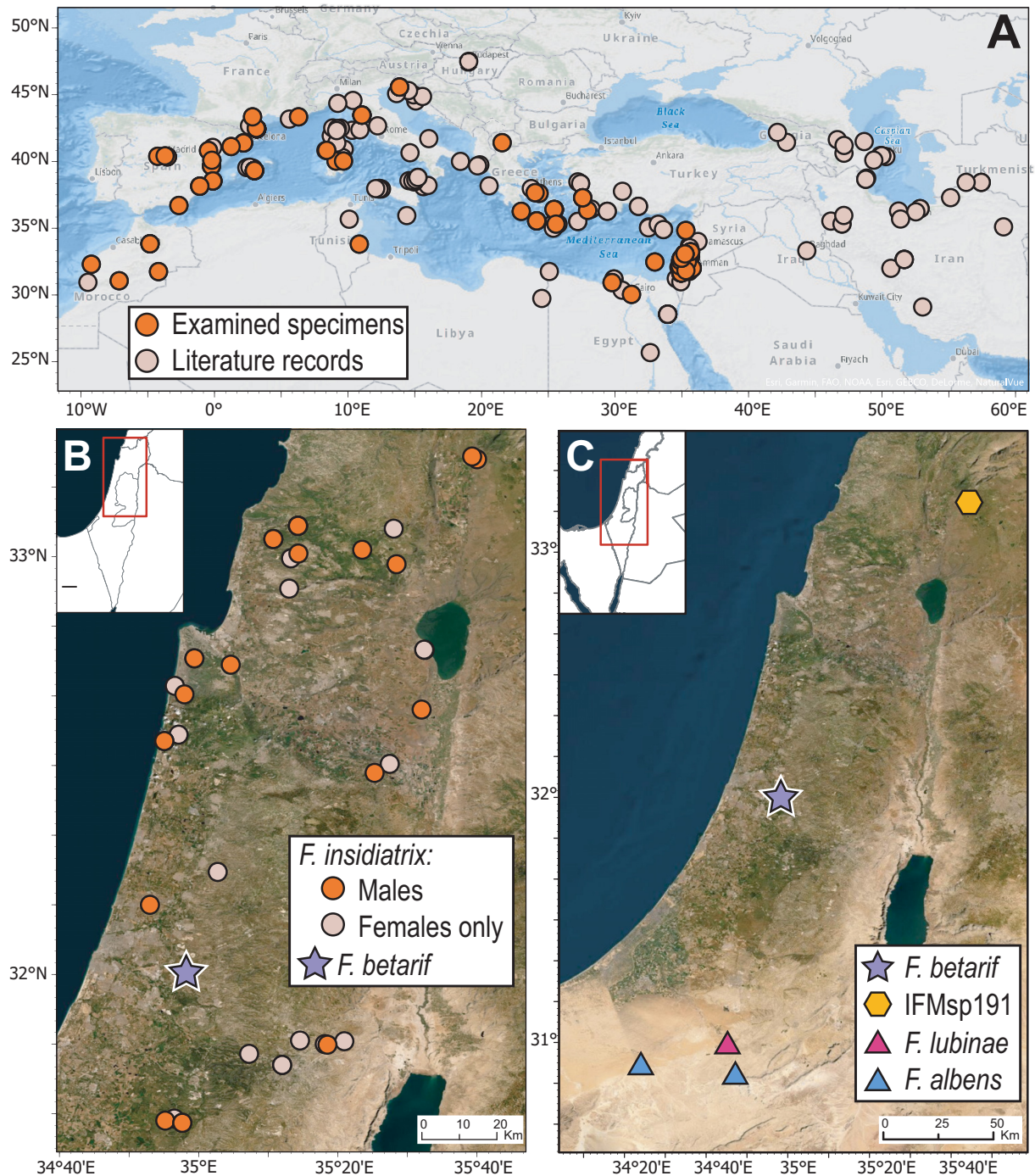


Fig. 4. Distribution maps. **A.** *Filistata insidiatrix* (Forsskål, 1775) in the Mediterranean and Middle East (note the species has been recorded from Angola, Venezuela and the islands of Socotra, Azores and Cabo Verde, but these records seem to be introduced); literature records have been taken from Benoit (1968), Brignoli (1982), Marusik & Zonstein (2014), Marusik & Zamani (2015a) and Zonstein & Marusik (2019). **B.** *Filistata insidiatrix* (circles) and *F. betarif* sp. nov. (star) in Israel and Palestine; only specimens examined by us are included in the map. Darker shades of orange are records that include at least one male specimen. **C.** Other species of *Filistata* Latreille, 1810 in Israel (except *F. insidiatrix*).

de Ajanque; [38.14949° N, 1.10128° W]; CRBA 861 • 1 ♂; same locality as for preceding; 19 Jun. 2004; CRBA 860 • 4 ♀♀, 1 imm.; Tarragona, Monte Poulet; 41.11903° N, 1.24451° E; 23 Dec. 1986; M.J. Ramírez leg.; MACN-Ar 20559 • 1 ♂; Teruel, Molinos; 40.81945° N, 0.45083° W; Apr. 1985; J. Moles leg.; MACN-Ar 20565 • 1 ♀, 1 imm.; no further data, on a slope; [39.66422° N, 0.22674° W]; 17 Jun. 1993; S. Lideese leg.; ZMB 30578.

TUNISIA • 1 ♀; Djerba; [33.8076° N, 10.84515° E]; V. Bilgner leg.; ZMB K.786.

VENEZUELA • 1 ♀; Miranda, Caracas suburbs, caves near Cementerio del Este; [10.45038° N, 66.81118° W]; Jul. 1986; J.A. Coddington leg.; USNM 3222.

NO DATA • 1 ♂, 2 ♀♀, 2 imm.; Mediterranean region; ZMB • 1 ♀; ZMB 533 • 1 ♀; ZMB 580 • 1 ♀; MNRJ 1434.

Distribution

Widely distributed in the Mediterranean region and the Middle East (Fig. 4A), with records (probably introduced) in the Azores, Socotra Island, Cabo Verde, Angola and Venezuela. In Israel, it is distributed in Mediterranean areas in the north (Fig. 4B); in some localities only females are known, and thus it is possible these records could belong to *F. betarif* sp. nov., although it is more likely these records are of *F. insidiatrix* since they broadly overlap with records of males.

Filistata betarif sp. nov.

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Figs 1, 3E–F, H, 5A, C, E, 7–9

Filistata IFMsp142 – Magalhaes & Ramírez in press: 11, 13, 16.

Diagnosis

Males are similar to those of *F. insidiatrix* and *F. albens* by having a pedipalp with elongate femur and tibia, and by a subconical copulatory bulb with terminally hooked embolus (Fig. 8A–B; see also Zonstein & Marusik 2019: fig. 27). They differ from both species by the conspicuous embolic keel (Fig. 8F (arrow), 5A, k) (inconspicuous keel in *F. insidiatrix* and *F. albens*; Figs 5B, 10O). Females have a pair of large spermathecae that appear undivided (Fig. 9); they fall within the morphological variation observed for *F. insidiatrix* (Fig. 3C–D; Zonstein & Marusik 2019: fig. 17d–h) and thus females are not diagnosable through morphology only; they can be diagnosed using DNA barcoding of the COI gene.

Etymology

The specific epithet is a noun in apposition and refers to Bet ‘Arif, the name of the ‘wadi’ (dry riverbed) in which the two caves where the species was collected (Tinshemet and Oah) are located.

Type material examined

Holotype

ISRAEL • 1 ♂; Judean hills, near Shoham, Hadom Shomeron Nature Reserve; Bet ‘Arif wadi, Tinshemet cave, inside cave; 31.99938° N, 34.96813° E; 122 m.a.s.l.; 20 Feb. 2020; I.L.F. Magalhaes, E. Gavish-Regev and S. Aharon leg.; HUI-INVAr 21058.

Paratypes

ISRAEL • 1 ♀; Judean hills, near Shoham, Hadom Shomeron Nature Reserve; Bet ‘Arif wadi, Oah cave, inside cave; 32.0053° N, 34.9722° E; 25 May 2014; S. Aharon and E. Gavish-Regev leg.; HUI-INVAr

21055 • 2 ♀♀; same locality as for preceding; 9 Mar. 2014; S. Aharon and E. Gavish-Regev leg.; HUI-INVAr 21059 • 1 ♂, 6 ♀♀; Judean hills, near Shoham, Hadom Shomeron Nature Reserve, Bet ‘Arif wadi, Tinshemet cave, inside cave; 31.99938° N, 34.96813° E, 122 m.a.s.l.; 20 Feb. 2020; I.L.F. Magalhaes, E. Gavish-Regev and S. Aharon leg.; MACN-Ar 41222 • 2 ♂♂, 3 ♀♀, 2 imm.; same collection data as for preceding; HUI-INVAr 20275 • 4 ♀♀, 1 imm.; same collection data as for preceding; MACN-Ar 41791 • 1 ♂; same collection data as for preceding; MACN-Ar 41793 • 2 imm.; same locality as for preceding, Mediterranean scrubland, outside the cave, under stones; 20 Feb. 2020; I.L.F. Magalhaes, E. Gavish-Regev and S. Aharon leg.; MACN-Ar 41829 • 1 ♀; same locality as for preceding; Mediterranean scrubland, outside the cave; 31.9994° N, 34.9681° E; 25 May 2014; S. Aharon and E. Gavish-Regev leg.; HUI-INVAr 21056 • 7 ♀♀; same locality as for preceding; inside cave; 31.99938° N, 34.96813° E; 25 May 2014; S. Aharon and E. Gavish-Regev leg.; HUI-INVAr 20301 • 1 ♀; same collection data as for preceding; HUI-INVAr 21057 • 3 imm; same locality as for preceding; 9 Mar. 2014; S. Aharon and E. Gavish-Regev leg.; HUI-INVAr 21060.

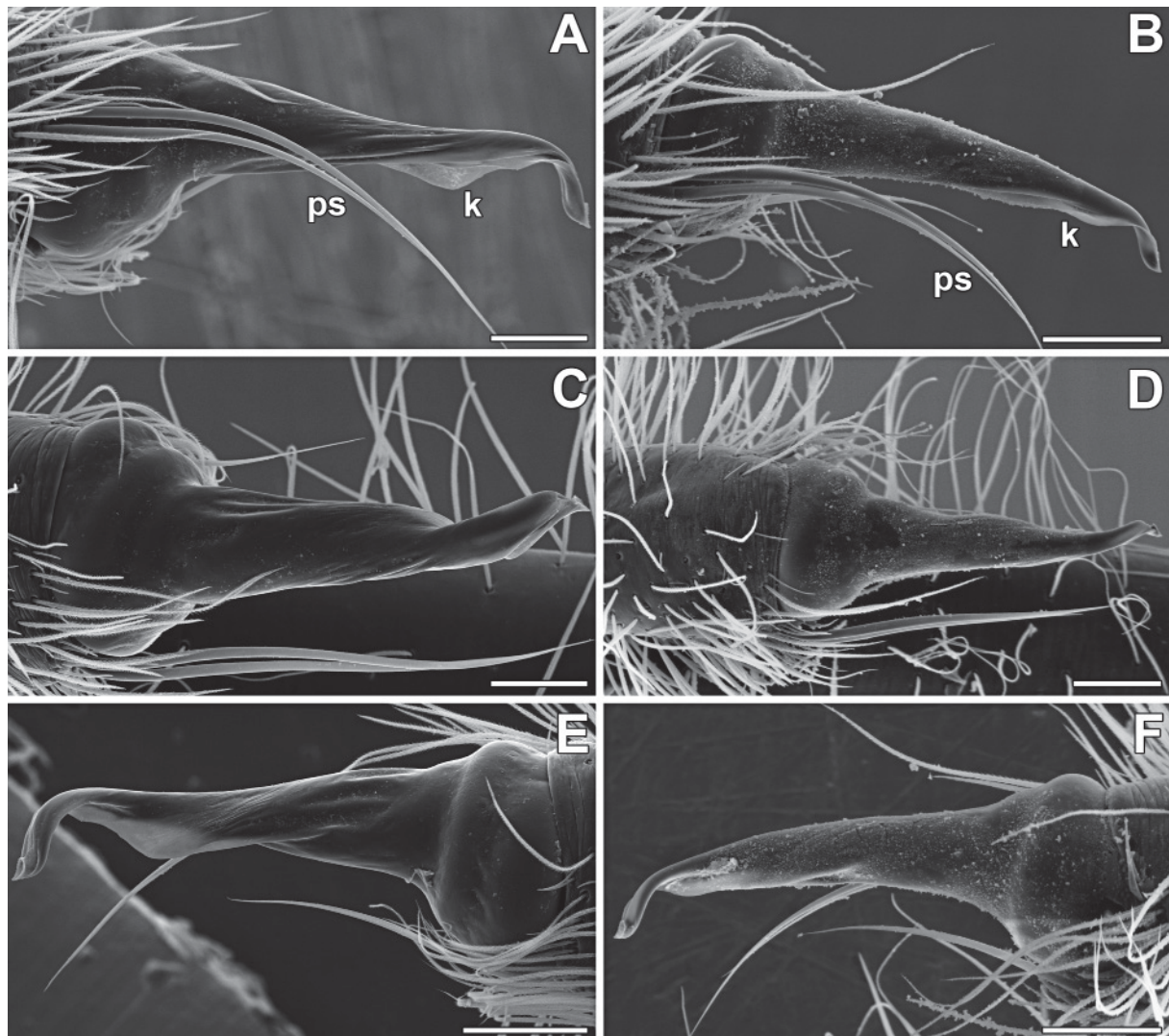


Fig. 5. **A, C, E.** *Filistata betarif* sp. nov., paratype, ♂, from Israel, Tinshemet cave, (MACN-Ar 41793), left pedipalp. **B, D, F.** *Filistata insidiatrix* (Forsskal, 1775), ♂, from Spain, Mallorca (MACN-Ar 42347), right pedipalp, mirrored. **A–B.** Prolateral view. **C–D.** Dorsal view. **E–F.** Retrolateral view. Abbreviations: k = embolic keel; ps = prolatral setae. Scale bars = 0.1 mm.

Additional material examined

None.

Description**Male** (holotype, HUI-INVAr 21058)

Coloration yellowish cream except where noted. Carapace lined with black pigment, with marbled brown clypeal markings and brown, V-shaped median pattern. Legs I–III with three brown ventral spots. Abdomen brownish gray. Anterior margin of the carapace unmodified, eye apodemes absent. Sternum subrounded, sigilla not visible. Total length 5.25. Carapace length 2.38, width 1.88. Clypeus length 0.28. Eye diameters and interdistances: AME 0.14, PME 0.15, ALE 0.20, PLE 0.18, AME–AME 0.06, PME–PME 0.14. Sternum length 1.26, width 1.05. Pedipalp: femur length 2.34, height 0.30, tibia length 2.10, height 0.34. Leg I: 14.88 (3.82, 1.09, 3.94, 3.91, 2.12). II: 11.29 (3.05, 0.94, 2.78, 3.17, 1.35). III: 10.23 (2.70, 0.84, 2.52, 2.91, 1.26). IV: 12.52 (3.57, 0.90, 3.28, 3.44, 1.33). Abdomen: length 2.97, width 1.72. Pedipalp macrosetae on ventral surface of femur. Leg macrosetae: fe I d1-0-0, dp0-0-2, ti I v0-2-2-2, mt I v2-2-2-4, fe II d1-1-0, dp0-0-2, ti II v0-2-2, mt II v2-2-4, fe III d1-0-0, dp0-0-1, dr0-0-2, ti III d1-2-2,

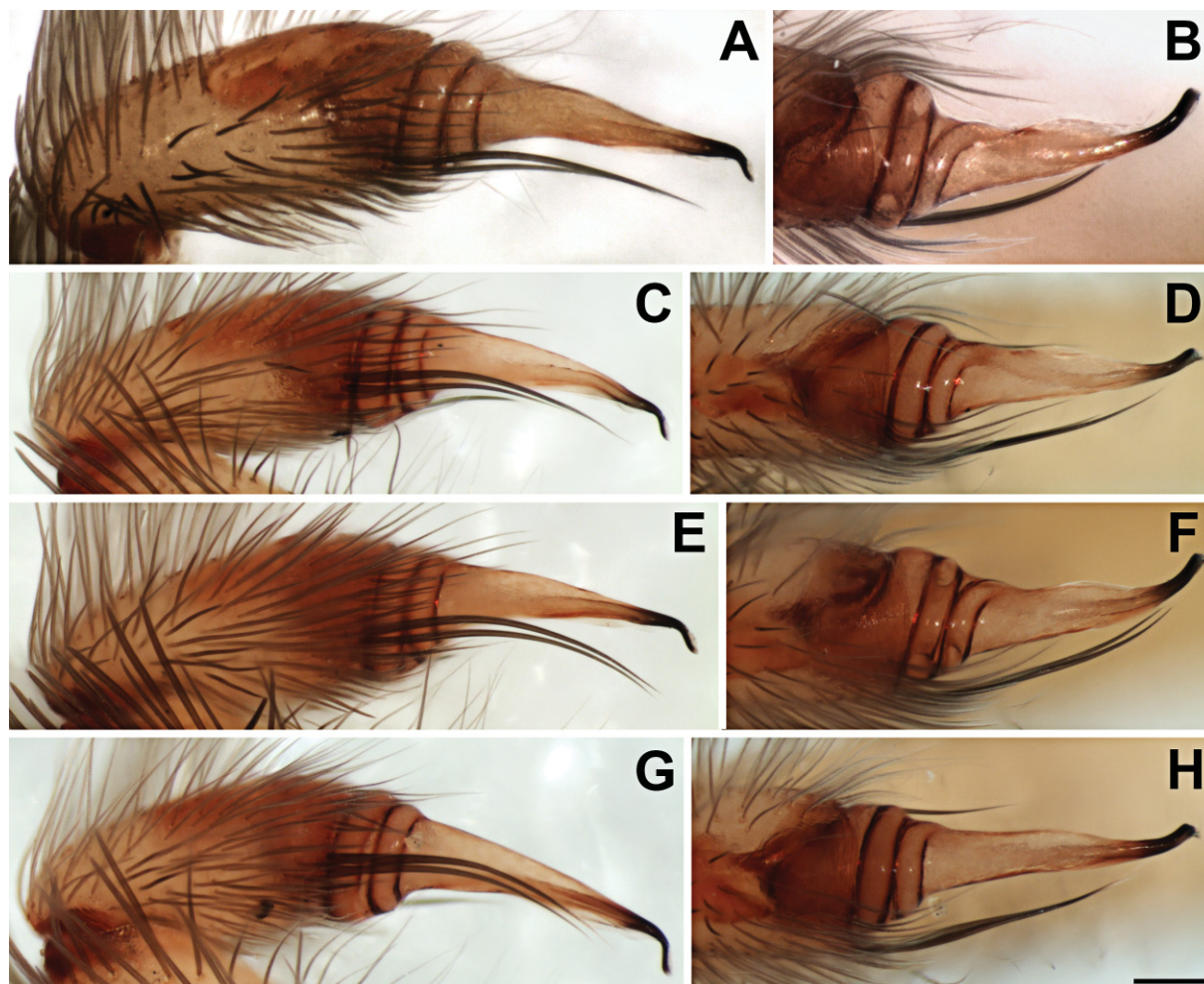


Fig. 6. *Filistata insidiatrix* (Forsskål, 1775), left bulb, prolateral (A, C, E, G) and dorsal (B, D, F, H) views. **A–B.** France (MACN-Ar 39461, ♂ collected with ♀ IFM-1702). **C–D.** Spain (CRBA IFM-2196). **E–F.** Israel, Ornit cave (MACN-Ar 41813, IFM-2175). **G–H.** Israel, Sharakh cave (MACN-Ar 41218, IFM-2144). Scale bar = 0.1 mm, all figures to scale.

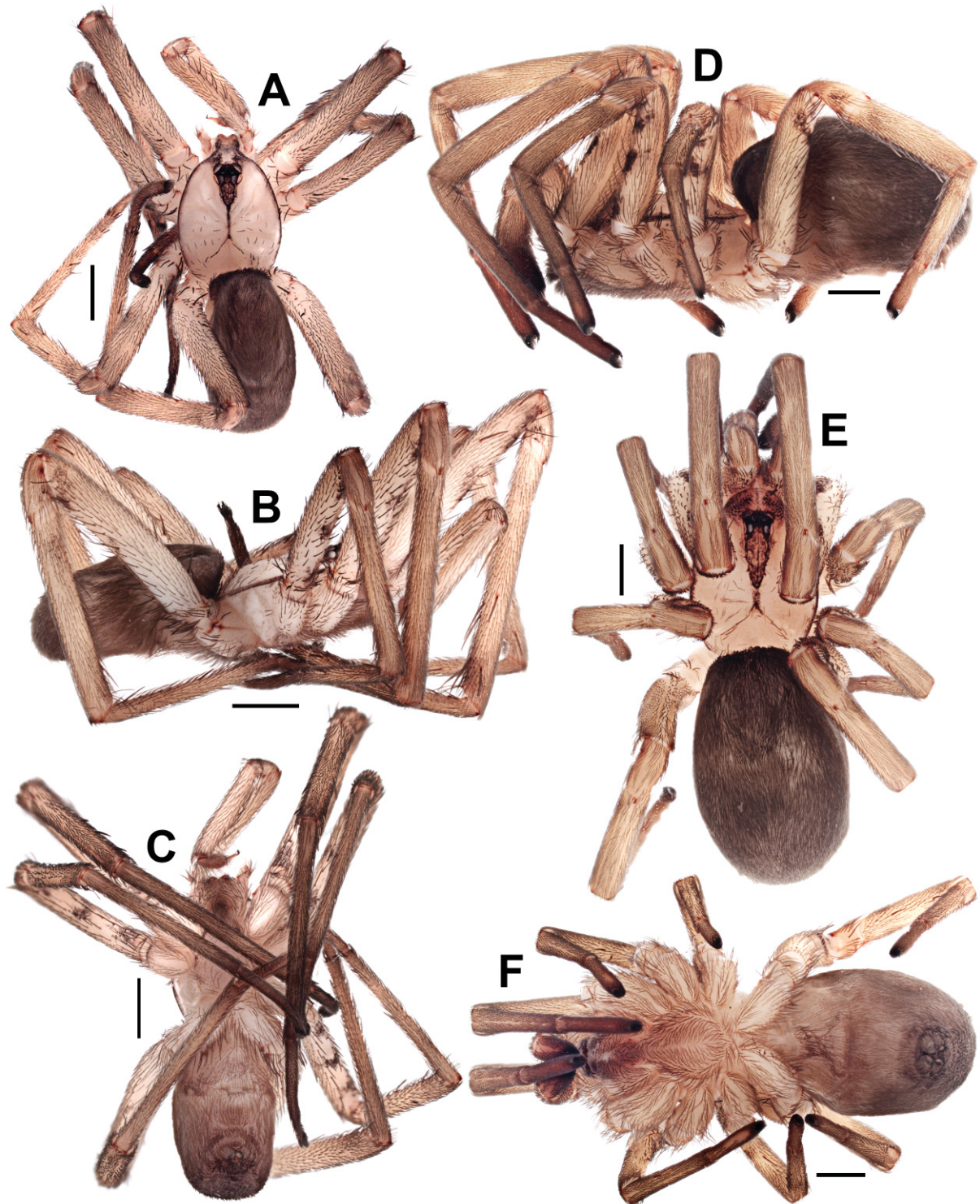


Fig. 7. *Filistata betarif* sp. nov., habitus. A–C. Holotype, ♂, from Tinshemet cave (HUJ -INVAr 21058). A. Dorsal view. B. Lateral view. C. Ventral view. — D–F. Paratype, ♀, from the same locality (MACN-Ar 41222). D. Lateral view. E. Dorsal view. F. Ventral view. Scale bars = 1 mm.

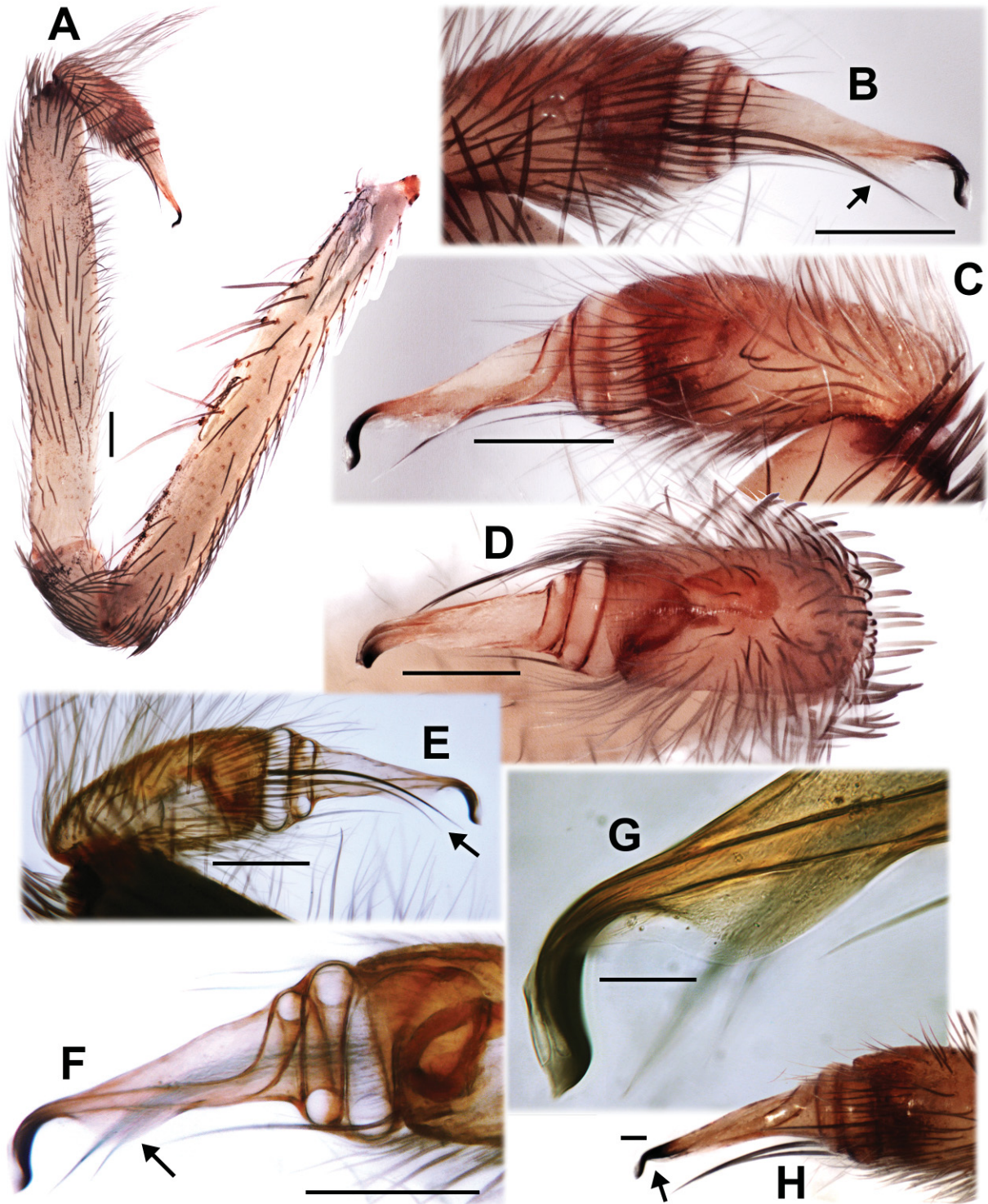


Fig. 8. A–G. *Filistata betarif* sp. nov., holotype, ♂ (HUIJ-INVAr 21058), left pedipalp. A–B, E. Prolateral view. Arrow points to prolateral strong setae in cymbium. C, F–G. Retrolateral view. Arrow points to embolic keel. D. Dorsal view. — H. *Filistata insidiatrix* (Forsskål, 1775) (MACN-Ar 39461), bulb, retrolateral view. Arrow points to embolic keel. Scale bars: A–F = 0.2 mm; G–H = 0.05 mm.

v1-1, mt III dr0-0-1, v1-2-2-4, fe IV d1-1-0, dr0-0-2, ti IV v1-1, mt IV v1-1-2-4, all tarsi with ventral macrosetae. Pedipalp as in diagnosis (Figs 5A, C, E, 8A–G). State of the specimen: good, right leg I removed for molecular analysis, left pedipalp dissected.

Female (paratype, MACN-Ar 41222)

Coloration as in male. Eye apodemes absent. Sternum subrounded, with one pair of posterior sigilla. Total length 7.76. Carapace length 3.17, width 2.51. Clypeus length 0.40. Eye diameters and interdistances: AME 0.14, PME 0.19, ALE 0.27, PLE 0.23, AME–AME 0.04, PME–PME 0.23. Sternum length 1.64, width 1.50. Pedipalp: femur length 1.70, height 0.67, tibia length 1.06, height 0.65. Leg I: 13.60 (3.66, 1.37, 3.49, 3.23, 1.85). II: 9.66 (2.84, 1.13, 2.26, 2.16, 1.27). III: 7.82 (2.34, 1.03, 1.66, 1.64, 1.15). IV: 10.54 (3.30, 1.25, 2.64, 2.27, 1.08). Abdomen: length 4.67, width 3.08. Palpal macrosetae on ventral surface of tibia and tarsus. Leg macrosetae: fe I d1-0-0, ti I v0-2-0, mt I v2-2-2-4, fe II d1-0-0, ti II v0-2-0, mt II v2-2-2-4, fe III d1-0-0, ti III d0-2-0, v0-1-2, mt III dr1-1-1, v1-2-2-4, fe IV d1-0-0, ti IV v1-1, mt IV v1-1-1-4, all tarsi with ventral macrosetae. Calamistrum with three staggered rows with < 6 setae; calamistrum gap present. Epigastric furrow unmodified. Endogyne of females from the same locality as in the diagnosis (Fig. 9). State of the specimen: good.

Variation

Males (N = 3): total length 4.89–5.67 (5.27), carapace length 2.25–2.78 (2.47), femur I length 3.62–4.04 (3.83), femur/carapace ratio 1.45–1.61 (1.56). Females (N = 5): total length 6.47–8.95 (7.79), carapace length 3.17–3.98 (3.57), femur I length 3.5–4.18 (3.86), femur/carapace ratio 1.01–1.15 (1.08). The shape of the spermathecae varies only slightly among the dissected females.

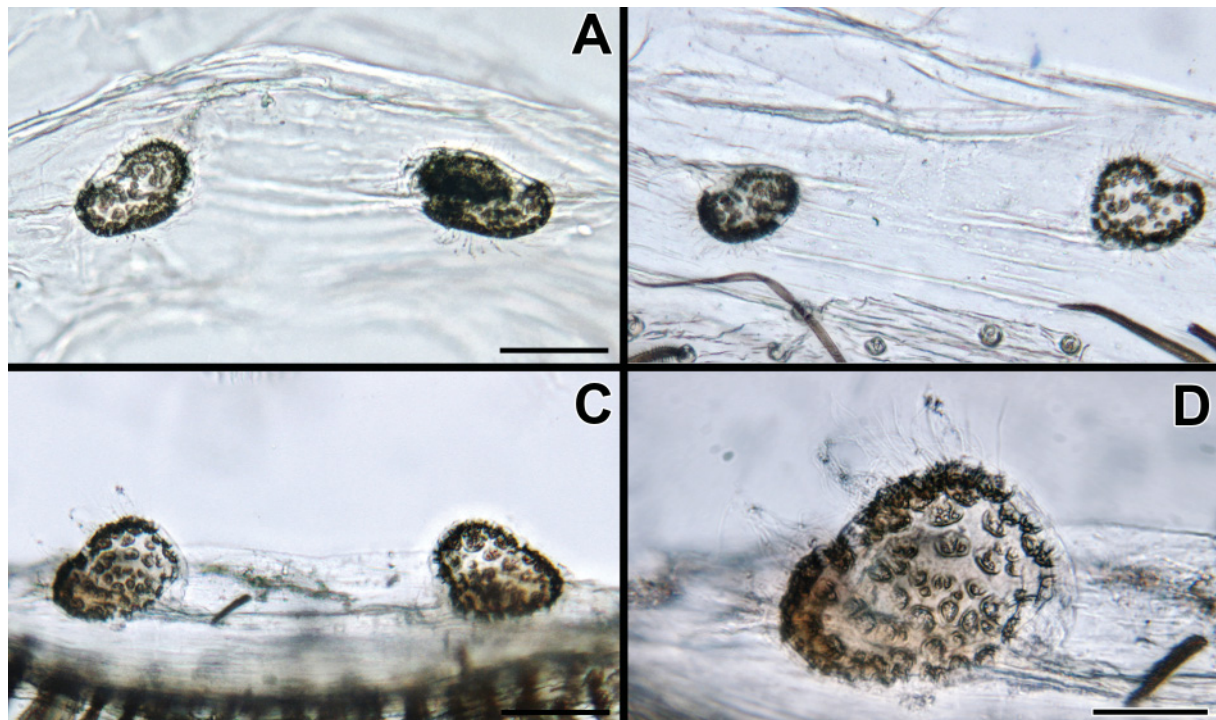


Fig. 9. *Filistata betarif* sp. nov., female spermathecae, ventral. **A.** Oah cave (HUJ-INVAr 21055). **B.** Tinshemet cave (MACN-Ar 41222). **C–D.** Tinshemet cave (MACN-Ar 41791). Scale bars: A–C = 0.2 mm; D = 0.05 mm.

Natural history

Filistata betarif sp. nov. is a troglomorphic species, inhabiting both epigeal and hypogean (caves) habitats. It is known from the mesic Mediterranean region of Israel, in scrubland habitats, and usually hides in a refugium made of cribellate silk in crevices, holes or under stones and on rocky walls (Fig. 1A–B). All specimens were collected from Bet ‘Arif wadi near Shoham, Hadom Shomeron Nature Reserve, central Israel. The species was found in low abundances outside of caves (Fig. 1D) and in very high abundances, year-around, in Tinsmet cave that is characterized by a high guano amount of the Egyptian fruit bat [*Rousettus aegyptiacus* (Geoffroy, 1810)]. Tinsmet (Arabic name: Mugharet al-Watwat) is a small to medium-sized Paleolithic cave, formed in a limestone rock of the Turonian Bina formation. It is located on the east bank of Bet ‘Arif wadi (Arabic name: Wadi Adasiyeh), 95 meters a.s.l. and 15 meters above the wadi (Frumkin *et al.* 2016). It has a main opening on the side of the cliff, and an additional chimney opening, which the frugivorous bats frequently use (personal observation). *Filistata betarif* sp. nov. was also found in lower abundances in the nearby Oah cave that houses no bats (Cuff *et al.* 2021; Gavish-Regev *et al.* 2021). Oah is a small cave, situated on the same east bank of Bet ‘Arif wadi, north to Tinsmet cave, and is formed in a similar rock and age (Boaz Langford, pers. comm.).

In both caves, *Filistata betarif* sp. nov. was found mainly at the entrance zones, on the cave walls (Fig. 1A–B). Other caves surveyed by us, at the mesic Mediterranean, semi-arid, and arid regions of Israel and Palestine, were not found to be occupied by *F. betarif* sp. nov., but instead by its sibling troglomorphic species *F. insidiatrix* [Berniki, Yir’on, Yonim (Galilee); Ezba’, Oren (Karmel); Sal’it (northern Samaria); Andartat HaBiqa’ (central Jordan Valley); Perat (northern Judean desert); Qumeran (northern Dead-Sea area)] (Cuff *et al.* 2021; Gavish-Regev *et al.* 2021).

Distribution

Known only from two caves and under stones in their surroundings in Bet ‘Arif wadi, Hadom Shomeron Nature Reserve, central Israel (Fig. 4).

Key to the *Filistatidae* of Israel and Palestine

The key below can be used to identify known species of crevice weavers from Israel and Palestine. For more information, readers are referred to recent taxonomic revisions of *Zaitunia* Lehtinen, 1967 (Zonstein & Marusik 2016), *Filistata* (Zonstein & Marusik 2019; Zamani & Marusik 2020) and *Sahastata* Benoit, 1968 (Magalhaes *et al.* 2020; Gavish-Regev *et al.* 2022). Although *Pritha* Lehtinen, 1967 has not been thoroughly revised, valuable taxonomic information for several species is available in scattered works (Brignoli 1982; Marusik & Zamani 2015b; Legittimo *et al.* 2017; Zonstein & Marusik 2019).

1. Tarsi without macrosetae; abdomen dorsally with white setae (in males, in one or two large patches) (Fig. 10H, I); female with calamistrum with three rows of inconspicuous setae (Fig. 10B); males with rigid leg tarsi, not flexible; male cymbium shorter than wide (Fig. 10L); male sperm duct with a single coil (Fig. 10L)..... **Prithinae: *Pritha*** Lehtinen, 1967 [three described species in Israel: *Pritha albimaculata* (O. Pickard-Cambridge, 1872), *Pritha hirsuta* (O. Pickard-Cambridge, 1872) and *Pritha tenuispina* (Strand, 1814), in addition to undescribed species; genus in need of revision].
 - Tarsi with macroseta (Fig. 10A; difficult to see in *Zaitunia*); white setae absent from abdomen; female calamistrum with conspicuous setae (Fig. 10C–E); males with flexible leg tarsi (Fig. 10F); male cymbium longer than wide (Figs 10M, N, 8); male sperm duct with at least two coils (Figs 10M–N, 8)..... 2 (**Filistatinae** Simon, 1864)
2. Females with continuous calamistrum, with three rows with many setae (15 or more) (Fig. 10C); large spiders (females with body length around 10 mm); females dark brown to black (Fig. 10G)

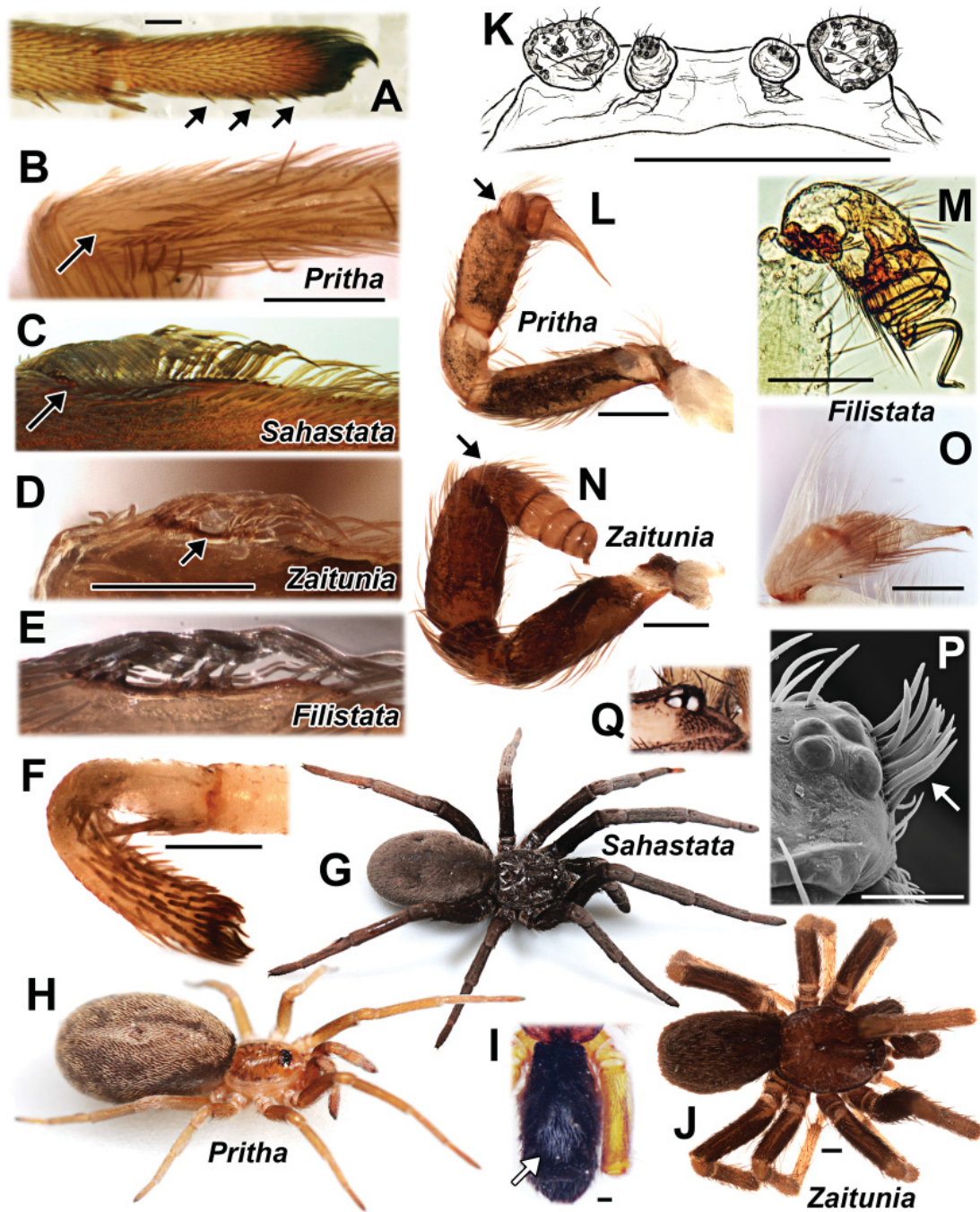


Fig. 10. Filistatid morphology. **A.** *Filistata insidiatrix* (Forsskål, 1775), ♀, leg tarsus, arrow points to macrosetae. **B.** *Pritha nana* (Simon, 1968), arrow points to right calamistrum. **C.** *Sahastata aravaensis* Ganem *et al.*, 2022, left calamistrum. **D.** *Zaitunia schmitzi* Kulczyński, 1911, left calamistrum, arrow points to gap between setae. **E.** *Filistata insidiatrix*, left calamistrum. **F.** *Filistata lubinae* Zonstein & Marusik, 2019, ♂, tarsus I. **G.** *Sahastata aravaensis*, ♀. **H.** *Pritha* IFMsp185, ♀. **I.** *Pritha* sp., male abdomen, dorsal view. **J.** *Zaitunia schmitzi*, ♂. **K.** *Zaitunia schmitzi*, spermathecae ventral view. **L.** *Pritha tenuispina* (Strand, 1914), ♂, left pedipalp, prolateral view, arrow points to cymbium. **M.** *Filistata lubinae*, left copulatory bulb, prolateral view. **N.** *Zaitunia schmitzi*, ♂, left pedipalp, prolateral view, arrow points to cymbium. **O.** *Filistata albens* Zonstein & Marusik, 2019, left copulatory bulb, prolateral view. **P.** *Zaitunia schmitzi*, male clypeus, lateral view, arrow points to stout setae. **Q.** *Filistata insidiatrix*, female clypeus, lateral view. Scale bars = 0.2 mm.

- and males light cream; males of Israeli species unknown, but based on congeners, should have pedipalpal femur with dorsal and ventral macrosetae
 *Sahastata* Benoit, 1968 [a single known species in Israel, known currently only from females, *Sahastata aravaensis* Ganem, Magalhaes, Zonstein & Gavish-Regev, 2022].
- Females with discontinuous calamistrum interrupted by a medial gap, with staggered rows with few setae (10 or less) (Fig. 10D–E); small to medium spiders (adults with body length around 3–6 mm); females brown or light cream (Figs 7, 10J); males with pedipalpal femur without dorsal macrosetae (ventral macrosetae present in *Filistata*, difficult to see in *Zaitunia*)..... 3
3. Brown spiders, with subrounded carapace (Fig. 10J); steep clypeus with strong, erect setae (Fig. 10P); females with two separate pairs of spermathecae (Fig. 10K); male cymbium without two strong and elongated prolateral setae; male pedipalpal tibia short, at most 2 times as long as wide (Fig. 10N)..
 . *Zaitunia* Lehtinen, 1967 [a single known species in Israel, *Zaitunia schmitzi* (Kulczyński, 1911)].
- Light cream spiders, with carapace longer than wide (Fig. 7); flat clypeus, without particularly strong setae (Fig. 10Q); females with a single pair of spermathecae (Fig. 9), or if with two pairs, these are partly fused (Fig. 3B–C); male cymbium with two strong prolateral setae (Fig. 8B); male pedipalpal tibia long, at least three times as long as wide (Fig. 8A).....
 4 (*Filistata* Latreille, 1810) [four described species in Israel, of those four species, only the females of *F. insidiatrix* and *F. betarif* are known, and are not morphologically diagnosable; thus, the remainder of the key refers only to males].
4. Male copulatory bulb short and stout, with long and coiled embolus (Fig. 10M); carapace subrounded..... *Filistata lubinae* Zonstein & Marusik, 2019
- Male copulatory bulb subconical (Figs 8, 10O), embolus not coiled; carapace longer than wide 5
5. Sperm duct loosely packed, with space between coils; copulatory bulb shorter (ca 80% of cymbium length), with ventral side nearly straight (Fig. 10O) *Filistata albens* Zonstein & Marusik, 2019
- Sperm duct tightly packed (Fig. 8), without space between coils; copulatory bulb longer (almost as long as cymbium), with ventral side curved inwards 6
6. Embolic keel conspicuous (Figs 3H, 8G, 5A) *Filistata betarif* sp. nov.
- Embolic keel inconspicuous (Fig. 3I, 8H, 5B) *Filistata insidiatrix* (Forsskål, 1775)

Discussion

Based on the results of the phylogenetic analysis and interpretation of the morphology of the new species, we conclude that the sequenced specimens belong to at least four different species:

- (1) *Filistata wunderlichi*, a species endemic to southern Spain (see Zonstein & Marusik 2019; Fig. 3A), which is recovered as sister to the remaining *Filistata*.
- (2) *Filistata* IFMsp191, a single female specimen collected under a stone at Odem Forest, Golan heights, and initially identified by us, based on morphology, as *F. insidiatrix*. The spermathecae of *Filistata* IFMsp191 have the typical shape of some morphological variants of *F. insidiatrix*, where the spermathecae seem to be double (Fig. 3B). The genetic divergence, however, between *Filistata* IFMsp191 and *F. insidiatrix*, is higher than 20% (Table 2), and these species do not group together (Fig. 2). It is likely a new species or a new record for the country, but until males of this population are discovered, its identity shall remain doubtful. It should be noted that males of *F. insidiatrix* have been collected in Dan and Senir, only 10 km to the west of the locality of *Filistata* IFMsp191 (Fig. 4).
- (3) *Filistata betarif* sp. nov., a species known from two caves only, Tinsmet and Oah, both located at Bet ‘Arif wadi, Hadom Shomeron Nature Reserve at the center of Israel. We initially suspected this to

be a different species after sequencing two female individuals that presented a high genetic distance from *F. insidiatrix* (16.7% on average; Table 2). However, the morphology of the females was identical to that of *F. insidiatrix*. After revisiting Tinsmet cave and finding five male individuals, we analysed their morphology and found that *F. betarif* sp. nov. has a larger embolic keel (Fig. 5). This difference is consistent in all examined males. Thus, although both species present similar ecologies and an almost identical morphology (except for the detail mentioned above), we here decide to name this lineage as a different species.

- (4) *Filistata insidiatrix*: we could obtain samples from several localities along the Mediterranean distribution of this species. They form a monophyletic group that is further divided into two main clades (Fig. 2). One of the clades includes samples from Morocco to Turkey; except for two samples from Spain, haplotypes in this clade are virtually identical, indicating a low genetic diversity of this species in the western Mediterranean, even across distances as large as 3300 km. The other clade includes samples from Israel, Egypt and Italy, with a higher genetic diversity: samples from Ornit and Sharakh caves are geographically apart by only 60 km, yet have more than 11% of pairwise genetic distance. The average intraspecific genetic distance within *F. insidiatrix* is 9% (Table 2), and some pairwise divergences within this species can be as high as 16% (see the histogram in Fig. 2), which is higher than some interspecific distances between *F. insidiatrix* and *F. betarif* sp. nov. This means that this group lacks the so-called ‘barcode gap’, when interspecific divergences are always larger than intraspecific divergences (Meyer & Paulay 2005). This could indicate that *F. insidiatrix* might potentially be a complex of cryptic species. However, we failed to find any significant differences in morphology in both females and males belonging to different clades (Fig. 6). It is a rather common situation in haplogyne spiders to have a large intraspecific genetic diversity (9–15%) without corresponding morphological diversity [e.g., mygalomorphs (Satler *et al.* 2013; Leavitt *et al.* 2015), *Loxosceles* (Tahami *et al.* 2017), *Sicarius* (Magalhaes *et al.* 2019); *Sahastata* (Magalhaes *et al.* 2020), *Hypochilus* (Ciaccio *et al.* 2022)]. It has also been demonstrated that molecular-based species delimitation frequently over-splits species, as the intraspecific geographic structure can easily be mistaken for interspecific boundaries (Sukumaran & Knowles 2017). We thus here take a conservative approach and consider samples from both clades to belong to a single species, *F. insidiatrix*.

As discussed above, *F. insidiatrix* has the highest mitochondrial genetic diversity in the eastern Mediterranean. This area also houses closely related species (*F. betarif* sp. nov., *Filistata* IFMsp191). Additionally, several congeners that are morphologically similar (and thus presumably close relatives) occur in this area or in neighboring Middle Eastern countries (e.g., *Filistata lehtineni* Marusik & Zonstein; see Zonstein & Marusik 2019; Zamani & Marusik 2020). On the other hand, all samples from the western Mediterranean are virtually identical regarding their COI haplotypes (Fig. 2), indicating a more recent population expansion into this region. With this in mind, we hypothesize that *F. insidiatrix* could have originated in the eastern Mediterranean and recently expanded its distribution into the western Mediterranean, either by natural means or human-mediated introduction. A better sampled phylogeny of *Filistata* with more species and the sequencing of further genetic markers for several populations of *F. insidiatrix* would be needed to put this hypothesis to test.

Filistata insidiatrix was found to be the second most abundant spider species in a thorough survey of caves in Israel and Palestine, especially in the mesic Mediterranean region (Gavish-Regev *et al.* 2021). It was found to be associated with entrance and twilight ecological zones in caves with average low temperature (Cuff *et al.* 2021). In contrast, *F. betarif* sp. nov., although found in high numbers in Tinsmet cave at the entrance zone, was restricted to the Bet ‘Arif wadi region, and was not found at other localities. These species of *Filistata* are troglophiles, and found in both epigean and hypogean (cave) habitats. Yet, as the distribution range of *F. insidiatrix* seems to be very wide (but consider the intraspecific genetic divergence, and possible cryptic species), our current findings suggest a narrow

distribution range for *F. betarif* sp. nov. Nevertheless, it is possible there are ecological speciation processes in *Filistata* occurring in caves in the Levant that could explain this narrow distribution and the similar phenotypes (e.g., Sharakh and Ornit caves, Fig. 2). A similar example of cave-specific cryptic species was found by us in the funnel-web genus *Tegenaria* Latreille (Gavish-Regev *et al.* 2021; Aharon & Gavish-Regev, unpublished data).

Finally, we examined a single (perhaps subadult) female of *Filistata* from En Fashkha (= ‘Enot Zuqim) in the Dead Sea Valley presenting different spermathecae with a more elongate shape (Fig. 3G) that does not fit either *F. insidiatrix* or *F. betarif* sp. nov. Since we could not sequence it, and it is a single, possibly not fully mature individual, it is not included in the maps, but additional sampling in this locality is warranted.

Acknowledgments

We are deeply indebted to curators and curatorial staff from the collections holding the material studied in this revision: L. Prendini, L. Sorkin, P. Colmenares, and the late N. Platnick (AMNH), L. Esposito, D. Ubick, C. Griswold, A. Carmichael (CAS), M. Arnedo (CRBA), M. Ramírez, C. Grismado (MACN) G. Giribet, L. Leibensperger (MCZ), A. Kury (MNRJ), D. Van den Spiegel, R. Jocqué (MRAC), P. Jäger, Julia Altmann (SMF), S. Zonstein (SMNH), D. DeRoche, J. Coddington, H. Wood (USNM), J. Dunlop and A. Friederichs (ZMB). We specially thank L. Esposito, L. Leibensperger, P. Jäger, and S. Zonstein for their warm reception during visits to their institutions by ILFM. We thank A. Frumkin, B. Langford, and E. Cohen (Israel cave Research Center) for assistance with cave data and in the field. Field work was conducted under collection permits 2013/40027, 2013/40085, 2014/40313, and 2020/42450 from the Israel National Parks Authority to E.G.-R., and was funded by the Israel Taxonomy Initiative (ITI) biodiversity survey grant and ISF (2656/20) and BSF (2019216) grants to E.G.-R. This research received further support from the SYNTHESYS+ Project (www.synthesys.info/) which is financed by the European Commission via the H2020 Research Infrastructure programme (grant IL-TAF-1327), a Vincent Roth Fund for Systematics Research from the American Arachnological Society, Fondo para la Investigación Científica y Tecnológica (PICT 2017-2689), and Consejo Nacional de Investigaciones Científicas y Técnicas (PUE 098) to ILFM. ILFM was supported by a CONICET postdoctoral fellowship, SA was supported by ITI, Ben-Gurion University of the Negev, and the Hebrew University of Jerusalem fellowships, and ZG by the Hebrew University of Jerusalem fellowship.

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Manuscript received: 31 January 2022

Manuscript accepted: 25 May 2022

Published on: 25 July 2022

Topic editor: Tony Robillard

Section editor: Rudy C.A.M. Jocqué

Desk editor: Kristiaan Hoedemakers

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Jahr/Year: 2022

Band/Volume: [0831](#)

Autor(en)/Author(s): Magalhaes Ivan L.F., Aharon Shlomi, Ganem Zeana, Gavish-Regev Efrat

Artikel/Article: [A new semi-cryptic Filistata from caves in the Levant with comments on the limits of Filistata insidiatrix \(Forsskål, 1775\) \(Arachnida: Araneae: Filistatidae\) 149-174](#)