New host records of West Palaearctic spider flies (Diptera: Acroceridae)

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RESEARCH ARTICLE

New host records of West Palaearctic spider flies (Diptera: Acroceridae)

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Abstract

The larvae of spider flies (Acroceridae) develop as parasitoids of spiders. Despite the discovery of this life trait in the mid-19th century, data on the host associations of individual species remain scarce. The current work documents nine new breeding records of species in three subfamilies from the western Palaearctic Region: *Acrocera* (*Acrocera*) *orbiculus* (Fabricius, 1787) from two hosts belonging to the jumping spiders (Salticidae), *Cyrtus gibbus* (Fabricius, 1794) from three funnel spider (Agelenidae) hosts and three species of Ogcodinae from four jumping spider hosts.

Keywords: Agelenidae, breeding records, Salticidae, small-headed flies.

Zusammenfassung

Larven von Kugel- oder Spinnenfliegen (Acroceridae) entwickeln sich als Parasitoide an oder in Spinnen. Obwohl dieser Umstand bereits Mitte des 19. Jahrhundert entdeckt wurde, ist über die Wirtsbeziehungen der einzelnen Arten nur wenig bekannt. Die vorliegende Arbeit dokumentiert neun neue Zuchtnachweise aus der westlichen Paläarktis für drei Unterfamilien: *Acrocera* (*Acrocera*) *orbiculus* (Fabricius, 1787) gezogen aus zwei Wirten von Springspinnen (Salticidae), *Cyrtus gibbus* (Fabricius, 1794) aus drei Wirten von Trichterspinnen (Agelenidae) und drei Arten der Ogcodinae gezogen aus vier Wirten der Springspinnen (Salticidae).

Introduction

Acroceridae is a species-poor family of orthorrhaphous Brachycera (Diptera) whose larvae develop almost exclusively as endoparasitoids in the body cavity of spiders, with the exception of the ectoparasitic *Carvalhoa appendiculata* Philippi (Gillung & Borkent 2017). Due to their larval development and their adult appearance, they are commonly known as spider flies, small-headed flies or hunch-back flies. Although the systematics of the family, with its five subfamilies, 60 genera and approximately 530 species has been largely revised in recent years (Winterton et al. 2007; Gillung et al. 2018; Gillung & Winterton 2019), only few ecological data and life-history traits are available for the family. The interactions between these parasitoid flies and their hosts have rarely been the focus of scientific studies, and most published host records are the result of accidental discoveries by arachnologists while rearing juvenile spiders to adulthood in individual containers. The currently known, geographically and temporally scattered host data were revised by Gillung & Borkent (2017), but there still remains a lot to be discovered. Here, we report nine new rearing records of Palaearctic acrocerid flies from spider hosts.

Material and methods

For details on specimen collection and identification, see the individual records below. If not otherwise stated, host spiders were identified by M. Schäfer and acrocerid flies by C. Kehlmaier. Figs. 1–2 & 19–22 were taken with a Canon EOS 5D Mark IV camera equipped with a Canon EF 100mm f2.8 L Makro IS USM or a Canon MP-E 65mm f/2.8 1-5x lens, without flash. Individual photos were stacked with Zerene Stacker. Figs. 3–6 were taken with a Zeiss Axio Zoom.V16 binocular equipped with a Zeiss Axiocam 712 Color camera using the Zeiss Zen software. Figs. 7–18 were taken with a Pentax K20D camera (*f*/16.0, 100 mm , exposure time 1/180, ISO 200, flash).

Results

Acrocerinae

Acrocera (*Acrocera*) *orbiculus* (Fabricius, 1787) reared from *Macaroeris* sp. (Salticidae)
(Figs. 1–2)

Host spider collection data: juvenile, Spain, Canary Islands, Tenerife, Los Organos, 28.35932°N 16.50188°W (WGS84), collected 6 March 2015 on *Erica arborea* (Linnaeus, 1753), leg. & coll. M. Schäfer (voucher: Te2015-94).

Larva eclosed from host: 7 April 2015.

Figs. 1–2. Male *Acrocera* (*Acrocera*) *orbiculus* (Fabricius, 1787) reared from *Macaroeris* sp. from Tenerife (Canary Islands, Spain). **1**. Dorsal view. **2**. Lateral view. (Photos: Michael Schäfer)

Fly (male) eclosed from pupa: no exact date recorded; approximately one week after the larva emerged from the host.

Identification of parasitoid: following Kehlmaier & Almeida (2014), who demonstrated a broad morphological and genetic variation for the species. Identification of host: genus identification based on comparison with morphologically identical juvenile specimens obtained from the same locality and reared to adulthood.

Acrocera (*Acrocera*) *orbiculus* (Fabricius, 1787) reared from *Pseudicius picaceus* (Simon, 1868) (Salticidae)

Host spider collection data: juvenile, Greece, Crete, Xyloskalo, 35.30748°N 23.91538°E (WGS84), collected 14 May 2018 on stones, leg. & coll. M. Schäfer (voucher: Cr2018-91).

Larva eclosed from host: 14 May 2018.

Fly (male) eclosed from pupa: no exact date recorded; approximately one week after the larva emerged from the host.

Identification of parasitoid: following Kehlmaier & Almeida (2014).

Identification of host: based on comparison with adult individuals from the same locality (Schäfer 2020), identified using Metzner (1999).

Figs. 3–6. Female *Cyrtus gibbus* (Fabricius, 1794) reared from a female *Eratigena saeva* (Blackwell, 1844) from Spain. **3**. *C. gibbus* in dorsal view. **4**. *C. gibbus* in lateral view. **5**. Vulva of *E. saeva* in dorsal view. **6**. Epigyne of *E. saeva* in ventral view. (Photos: André Reimann)

Figs. 7–14. *Cyrtus gibbus* (Fabricius, 1794) reared from male *Eratigena* sp. from Spain. **7**. *Eratigena* sp. in dorsal view. **8**. *Eratigena* sp. in lateral view and *C. gibbus* larva (indicated by arrow) in dorsal view. **9**. *C. gibbus* pupa in lateral view. **10–11**. *C. gibbus* larva in lateral view. **12**. *C. gibbus* pupa in dorsolateral view. **13**. *C. gibbus* adult in ventrolateral view. **14**. *C. gibbus* adult in lateral view. (Photos: Angel María Ares)

Figs. 15–18. Larva of *Cyrtus* sp. reared from female *Eratigena* sp. from Spain. The fly did not reach adulthood. **15**. *Eratigena* sp. in dorsal view. **16**. *Eratigena* sp. in frontal view. **17**. *Cyrtus* sp. larva in lateral view. **18**. *Cyrtus* sp. larva emerging from *Eratigena* sp. in lateral view. (Photos: Angel María Ares)

Cyrtinae

Cyrtus gibbus (Fabricius, 1794) reared from *Eratigena saeva* (Blackwell, 1844) (Agelenidae)
(Figs. 3–6)

Host spider (female) and parasitoid (female) collection data: Spain, Salamanca province, Puerto Seguro, Puente de los Franceses, 40.82707°N, 6.747936°W (WGS84), collected 27 May 1987 in between stones of a rubble wall, leg. H.-P. Tschorsnig, det. (host spider) A. Reimann, coll. Stuttgart (SMNS-DIP-007715).

Note: at the time of collecting, the sluggish adult fly, which appeared to have eclosed from its pupa recently, was sitting on the spider remains.

Figs. 19–20. Male *Ogcodes guttatus* Costa, 1854 reared from *Pseudicius* sp. from Rhodes (Greece). **19**. Dorsal view. **20**. Lateral view. (Photos: Michael Schäfer)

Identification of parasitoid: following Sack (1936). However, the genus is in need of a taxonomic revision, as suggested by unpublished morphological and molecular data.

Identification of host: following the keys to the spiders of Europe by Nentwig et al. (2023), using the structure of the female epigyne.

Cyrtus gibbus (Fabricius, 1794) reared from *Eratigena* sp. (Agelenidae) (Figs. 7–18)

Host spider #1 collection data (Figs. 7–14): adult male, Spain, Madrid, Galapagar, November 2011, leg. & det. A. M. Ares, no material preserved for further identification.

Note: the larva turned into a pupa a couple of days after eclosing from its host. The pupal period lasted for several days only. No additional information available.

Host spider #2 collection data (Figs. 15–18): adult female, Spain, Madrid, Galapagar, March 2013, leg. & det. A. M. Ares, no material preserved for further identification.

Note: the larva eclosed in March 2013 but did not develop into a pupa. No additional information available.

Ogcodinae

Ogcodes fumatus Erichson, 1846 reared from *Macaroeris nidicolens* (Walckenaer, 1802)

Host spider collection data: adult female, Bulgaria, Batak Reservoir, 42.01151°N 24.19059°E (WGS84), collected 10 May 2018 in a dry and semiruderal habitat from underneath stones, leg. A. Grabolle, coll. M. Schäfer (voucher: BG2018-05).

Larva eclosed from host: 22 May 2018.

Fly (female) eclosed from pupa: no exact date recorded; approximately one week after the larva emerged from the host.

Identification of parasitoid: following Chvála (1980a, 1980b).

Identification of host: following Metzner (1999).

Ogcodes guttatus Costa, 1854 reared from *Pseudicius* sp. Simon, 1885 (Salticidae) (Figs. 19–20)

Host spider collection data: juvenile, Greece, Rhodes, Kástro Monolithou, 36.12467°N 27.72628°E (WGS84), collected 2 November 2022 on *Cupressus* sp., leg. & coll. M. Schäfer (voucher: Ro2022-48).

Larva eclosed from host: 7 August 2023.

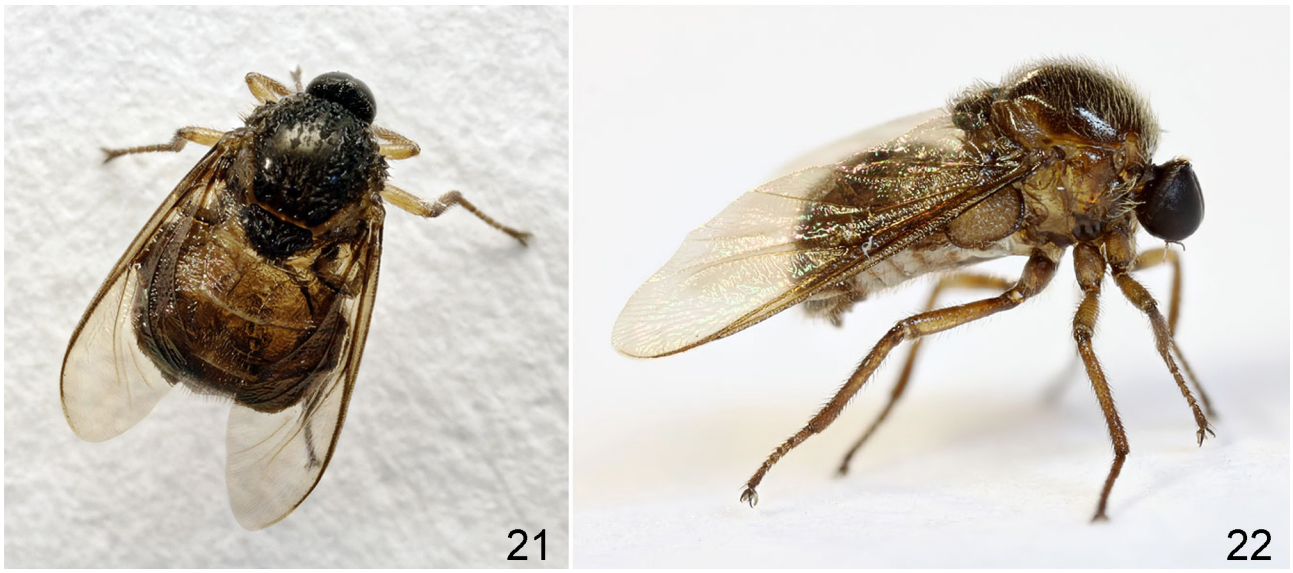
Fly (male) eclosed from pupa: 18 August 2023.

Identification of parasitoid: following Chvála (1980a, 1980b).

Identification of host: genus identification based on comparison with morphologically identical juvenile specimens obtained from the same locality and reared to adulthood.

Ogcodes reginae Trojan, 1956 reared from *Heliophanus* sp. (Salticidae)

Host spider collection data: juvenile, France, Corsica, Montemaggiore, 42.53636°N 8.873872°E (WGS84), col-



Figs. 21–22. Female *Ogcodes reginae* Trojan, 1956 reared from *Salticus* sp. from Sardinia (Italy). **21**. Dorsal view. **22**. Lateral view. (Photos: Michael Schäfer)

lected 16 May 2016 next to a small, private swimming pool, leg. J. Guttenberger, coll. M. Schäfer (voucher: JG2016-10).

Larva eclosed from host: 20 June 2016.

Fly (female) eclosed from pupa: 24 June 2016.

Identification of parasitoid: following Chvála (1980a, 1980b).

Identification of host: genus identification based on comparison with morphologically identical juvenile specimens obtained from the same locality and reared to adulthood.

Ogcodes reginae Trojan, 1956 reared from *Salticus* sp. (Salticidae) (Figs. 21–22)

Host spider collection data: juvenile, Italy, Sardinia, Gola di Su Gorroppu, 40.16298°N 9.507755°E (WGS84), collected 3 May 2013, leg. A. Grabolle, coll. M. Schäfer (voucher: Sa2013-7).

Larva eclosed from host: 21 June 2013.

Fly (female) eclosed from pupa: no exact date recorded; approximately one week after the larva emerged from the host.

Fig. 23. Adult *Cyrtus* sp. sitting on an egg-sac, presumably of *Eratigena* sp. (Photo: David Kohl)

Identification of parasitoide: following Chvála (1980a, 1980b).

Identification of host: genus identification based on comparison with morphologically identical juvenile specimens obtained from the same locality and reared to adulthood.

Discussion

Menge (1866) discovered the endoparasitic nature of acrocerid larvae over 150 years ago, but host-parasite data for these flies remain a scarce by-product of mostly arachnological studies. Gillung & Borkent (2017) summarised the available knowledge, comprising host records for at least 60 acrocerid species recorded from 25 spider families. Amongst their listings are 21 salticid hosts for at least 16 acrocerid species, and at least eight agelenid hosts for at least 13 acrocerid species. Tables 1 and 2 provide all known host spiders for the acrocerid species and all known acrocerid parasites for the spider species recorded in the current study (literature data from Gillung & Borkent [2017]). From the parasitoid's perspective, first host data could be obtained for *Cyrtus gibbus*. With the knowledge that the larvae of *Cyrtus* develop within *Eratigena*, an observation first made public in May 2015 on an internet platform dedicated to dipterology becomes most interesting (Kohl 2024). The thread shows an adult *Cyrtus* sp. sitting on the egg-sac of what is presumably an *Eratigena* specimen (Fig. 23). The photo was taken in June 2009 by David Kohl in the vicinity of Conques (France, Midi-Pyrénées), and raises the question whether female *Cyrtus*, stimulated by olfactory, actively seek out egg-sacs of suitable hosts in order to lay their eggs nearby or even on the egg-sacs. A similar behaviour was documented by Coyle (1971: 281f), who observed adult *Eulonchus marialiciae* Brimley, 1925 being attracted to freshly opened burrows of the trapdoor spider *Antrodiaetus unicolor* (Hentz, 1842) (Antrodiaetidae)—"… as if attracted by some chemical released by my digging".

Winterton & Barraclough (2017) summarised the scarce documented knowledge on the oviposition behaviour of Acroceridae in their synopsis of the life history of spider flies in the following way: "Adult females oviposit large numbers of microtype eggs, either on branches and foliage, or the eggs are scattered during flight". Koch (1872: 331) reported having found larvae of *Acrocera sanguinea* Meigen, 1804 within egg-sacs of the agelenid "Tegenaria agilis" in Tyrol: "Die Larve dieser Art findet sich in den schön gelben Eiersäcken der unter Steinen lebenden Tegenaria agilis Auss." [The larva of this species can be found underneath stones in the beautiful yellow egg-sacs of *Tegenaria agilis* Auss.]. Furthermore, he stated, about *Acrocera trigramma*: "Ich fand die Larve dieser Art in

Table 1. Species of host spiders known for the acrocerid species recorded in this study. An asterisk marks host-parasite associations presented here. Other records taken from Gillung & Borkent (2017).

Acrocerid parasite	Host spider	Host spider family
Acrocera orbiculus	*Amaurobius erberi* (Keyserling, 1893)	Amaurobiidae
	Clubiona sp.	Clubionidae
	Macaroeris sp. *	Salticidae
	Pardosa prativaga (L. Koch, 1870)	Lycosidae
	Pseudicius picaceus (Simon, 1868) *	Salticidae
Cyrtus gibbus	*Eratigena saeva* (Blackwell, 1844) *	Agelenidae
	Eratigena sp. *	Agelenidae
Ogcodes fumatus	*Philodromus cespitum* (Walckenaer, 1802)	Philodromidae
	Misumena vatia (Clerck, 1757)	Thomisidae
	Thomisus onustus (Walckenaer, 1806)	Thomisidae
	Zygiella x-notata (Clerck, 1757)	Araneidae
	Pardosa lugubris (Walckenaer, 1802)	Lycosidae
	Oxyopes lineatus Latreille, 1806	Oxyopidae
	Macaroeris nidicolens (Walckenaer, 1802) *	Salticidae
Ogcodes guttatus	Lyssomaninae gen. sp.	Salticidae
	Pseudicius sp. *	Salticidae
Ogcodes reginae	*Clubiona leucaspis* (Simon, 1932)	Clubionidae
	Evarcha jucunda (Lucas, 1846)	Salticidae
	Heliophanus sp. *	Salticidae
	Salticus sp. *	Salticidae

Table 2. Species of acrocerid parasites known for the species of spiders recorded in this study. An asterisk marks host-parasite associations presented here. Other records taken from Gillung & Borkent (2017).

Host spider	Acrocerid parasitoid	Acrocerid subfamily
Eratigena sp.	*Cyrtus gibbus* *	Cyrtinae
Eratigena saeva (Blackwell, 1844)	*Cyrtus gibbus* *	Cyrtinae
Heliophanus sp.	*Ogcodes reginae* *	Ogcodinae
Heliophanus sp.	*Ogcodes pallipes*	Ogcodinae
Heliophanus sp.	*Ogcodes zonatus*	Ogcodinae
Macaroeris sp.	*Acrocera orbiculus* *	Acrocerinae
Macaroeris nidicolens (Walckenaer, 1802)	*Ogcodes fumatus* *	Ogcodinae
Pseudicius picaceus (Simon, 1868)	*Acrocera orbiculus* *	Acrocerinae
Pseudicius sp.	*Ogcodes guttatus* *	Ogcodinae
Salticus sp.	*Ogcodes reginae* *	Ogcodinae

einem Spinneneiersacke … Dieselbe entwickelte sich im Laufe einiger Tage zum vollständigen Insect." [I found the larva of this species in an egg-sac … Within a couple of days it developed into a complete insect]. Subsequently, these observations were also cited by Brauer (1883: 61), König (1894: 163) and Kaston & Jenks (1937: 160). *Acrocera trigramma* is synonymous with *A. sanguinea* and Koch's "*Tegenaria agilis*" corresponds to *Textrix denticulata* (Olivier, 1769) in the current literature (Gillung & Borkent 2017). It has been documented that parasitized spiders produce silken sac-like structures (Montgomery 1903: 68), thick silk mats (Cady et al. 1993: 937) or irregular webbing (Kehlmaier et al. 2012: 284) shortly before the emergence of the acrocerid larva from their body, and that these are used by the parasitoid as a suitable site for pupation. Therefore, it might well be that Koch erroneously regarded such webbing as an egg-sac. However, the above documented contact of an adult *Cyrtus* with the egg-sac of a possible larval host species clearly depicts the limited knowledge of the life-history traits of Acroceridae in general and *Cyrtus* in particular.

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Dr. Hans-Peter Tschorsnig provided a detailed record of his find of *Cyrtus gibbus*. David Kohl and Diptera.info provided a high-resolution version of the photo of *Cyrtus* sp. on a spider's egg-sac and granted their approval for using it in the present paper. We thank two reviewers and Dr. Daniel Whitmore for their valuable comments and suggestions.

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