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Authors: Kehlmaier, Christian, Schäfer, Michael, Reimann, André, and Ares, Angel María

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RESEARCH ARTICLE

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

CHRISTIAN KEHLMAIER¹, MICHAEL SCHÄFER², ANDRÉ REIMANN¹ & ANGEL MARÍA ARES³

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.

Key words: 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 Paläarkt 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-



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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 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.

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 acrocid species recorded in this study. An asterisk marks host-parasite associations presented here. Other records taken from GILLUNG & BORKENT (2017).

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

Table 2. Species of acrocid 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	Acrocid parasitoid	Acrocid subfamily
<i>Eratigena</i> sp.	<i>Cyrtus gibbus</i> *	Cyrtinae
<i>Eratigena saeva</i> (Blackwell, 1844)	<i>Cyrtus gibbus</i> *	Cyrtinae
<i>Heliophanus</i> sp.	<i>Ogcodes reginae</i> *	Ogcodinae
<i>Heliophanus</i> sp.	<i>Ogcodes pallipes</i>	Ogcodinae
<i>Heliophanus</i> sp.	<i>Ogcodes zonatus</i>	Ogcodinae
<i>Macaroeris</i> sp.	<i>Acrocera orbiculus</i> *	Acrocerinae
<i>Macaroeris nidicolens</i> (Walckenaer, 1802)	<i>Ogcodes fumatus</i> *	Ogcodinae
<i>Pseudicius picaceus</i> (Simon, 1868)	<i>Acrocera orbiculus</i> *	Acrocerinae
<i>Pseudicius</i> sp.	<i>Ogcodes guttatus</i> *	Ogcodinae
<i>Salticus</i> sp.	<i>Ogcodes reginae</i> *	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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Authors' addresses:

¹Senckenberg Natural History Collections Dresden, Königsbrücker Landstraße 159, 01109 Dresden, Germany; e-mails: christian.kehlmaier@senckenberg.de (CK, corresponding author), andre.reimann@senckenberg.de (AR);  <https://orcid.org/0000-0001-9622-0566> (CK),  <https://orcid.org/0009-0006-3087-4931> (AR)

²Abendseglersteig 48, 12589 Berlin, Germany; e-mail: michael.schaefer@kleinesganzgross.de;  <https://orcid.org/0009-0006-3097-5716>

³Carretera de Torrelodones 24–2, 28260 Galapagar, Madrid, Spain; e-mail: conmenblas@telefonica.net

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Autor(en)/Author(s): Kehlmaier Christian, Schäfer Michael, Reimann Andre, Ares Angel Maria

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