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An updated checklist of the Sepsidae (Diptera) of Switzerland, including the first record of *Themira superba* (Haliday, 1833)

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Despite great research efforts in behavioral ecology, phylogenetics and even ecotoxicology, the faunistics of sepsid flies remain poorly understood. The occurrence of an additional species, *Themira superba* (Haliday, 1833) in Switzerland is documented. Further, an updated and commented national checklist for sepsids is provided, increasing the number of native species of Sepsidae to twenty-seven.

Keywords: Checklist, Diptera, Sepsidae, *Themira superba*

INTRODUCTION

With more than 300 described species (Ozerov 2005), sepsid flies (Sepsidae) are a medium sized family of acalypterate Diptera, generally associated to and reproducing in decaying organic matter (Pont & Meier 2002). Even though members of this family have been intensely studied in evolutionary biology, ranging from classic life-history evolution (Blanckenhorn 1999) and sexual selection research (Martin & Hosken 2004; Puniamoorthy *et al.* 2012) to recent applications of «omic technologies» (eg. Melicher *et al.* 2014), the ecology and distribution of this family has not received as much attention (except for some studies: Bährmann & Bellstedt 2012; Pont 1986; Rohner *et al.* 2015).

In Central Europe, species of the genus *Sepsis* Fallén, 1810, which generally reproduce on cattle dung, belong to the most abundant and best documented representatives of the family. In contrast, species of *Themira* Robineau-Desvoidy, 1830 are generally but not exclusively specialized on waterfowl dung. They can be common but are usually much less abundant than *Sepsis* spp., thus not as frequently recorded in national checklists.

I here document the first record of the Palaearctic *Themira superba* (Haliday, 1833) for Switzerland and provide an updated list of native sepsid species, taking into account recent nomenclatural modifications, and I discuss some relevant taxonomic issues.

MATERIAL AND METHODS

Sepsid flies were collected in early July and late August 2015 near the artificial lake at Irchelpark close to the University of Zurich Irchel (Switzerland, Canton of Zürich, CH-8057 Zürich, Winterthurerstrasse 190, Irchelpark, 47° 23' 52" N 8° 32' 41" E). Specimens were collected via sweep netting at a moist segment of the riparian vegetation which is frequently visited by waterfowl. Species were identified using Pont & Meier (2002), and «sepsidnet» (Ang *et al.* 2013: <http://sepsidnet-rmbr.nus.edu.sg/>).

RESULTS

The few sepsid flies collected on the 10th of July 2015 were identified as *Themira lucida* (Staeger 1844; 6 ♂♂) and one specimen of the enigmatic *Themira superba* (1 ♂). On the 25th of August 2015, five additional specimens of *Themira superba* were caught (2 ♂♂ and 3 ♀♀). To my knowledge, this represents the first record of this species for Switzerland. All specimens are stored at the University of Zurich (leg. Rohner).

DISCUSSION

New species record: Themira superba Haliday

Species of the genus *Themira* are characterized by unusually elaborate modifications of secondary male sexual traits, including the male foreleg, the osmeterium (a secretion organ located on the hind tibia) and specialized abdominal sternite brushes. All strongly modified structures are presumed to play important roles during mating and courtship. The modified male foreleg is used to hold onto the female wing base during copulation (Ingram *et al.* 2008), whereas the osmeterium produces chemical compounds with yet unknown evolutionary relevance (Araujo *et al.* 2014). Furthermore, the male stimulates the female in copula using its moveable abdominal

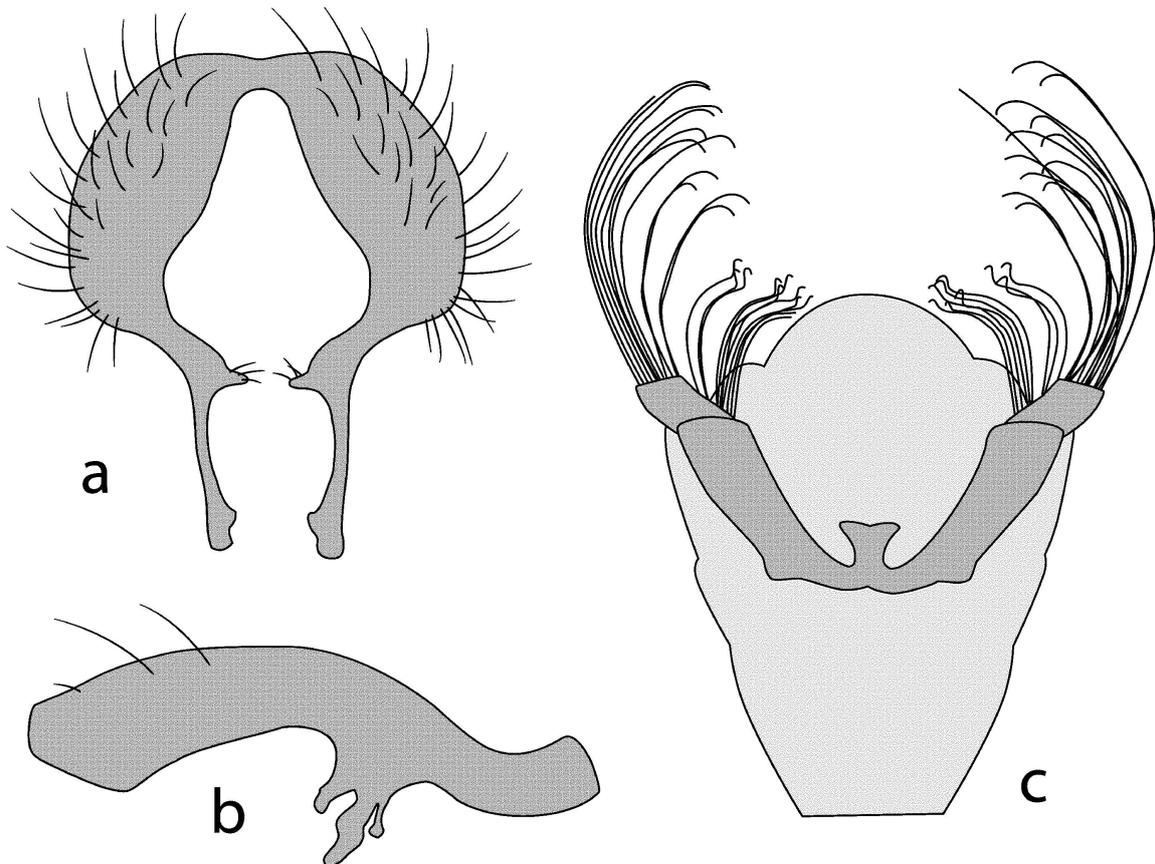


Fig. 1: *Themira superba* (Haliday) ♂. — a) Hypopygium, dorsal view; — b) fore femur, anterior view; — c) sternites 4 and 5, ventral view, including the strongly elongated sternite brushes. The outline of the abdomen is represented in light grey.

sternite brushes (eg. Puniamoorthy *et al.* 2009). These appendages, representing an evolutionary novelty (Bowsher & Nijhout 2007), have evolved convergently within the Sepsidae (Bowsher *et al.* 2013; Eberhard 2001) and might play a role in cryptic female choice (Eberhard 2001).

Themira superba is the Swiss species with the seemingly strongest modifications of male secondary sexual characters. The male adult can be recognized by the glossy katapisternum and the presence of a postpronotal seta in combination with the species specific foreleg ornamentation (Pont & Meier 2002) and the male genitalia (Fig. 1; see also http://sepsidnet-rmbr.nus.edu.sg/Themira_superba.html for excellent high-quality images and illustrations).

The ecology of this species is not well known, however, it is typically collected on waterfowl dung, and other substrates have been recorded (Pont & Meier 2002; and references therein). The species seems to be widespread, being recorded throughout Europe, also in Italy, France and Germany (Ozerov 2005). It can occur in very high densities (personal communication, Nalini Puniamoorthy), but the population in Zurich seems to be rather small.

Updated checklist

Swiss entomologists, foremost Jean-Paul Haenni (1997; 1998) and Bernhard Merz (2012) have gathered a very good record of the native sepsid fauna. As Haenni (1998) mentioned in the Checklist for Swiss Diptera, the occurrence of some additional species, especially of the genus *Themira*, was expected. Moreover, nomenclatural rearrangements or discovery of newly immigrated species can alter national species records.

Currently, five genera are recorded in Switzerland: *Meroplius* Rondani, 1874 (1 species), *Nemopoda* Robineau-Desvoidy, 1830 (3 species), *Saltella* Robineau-Desvoidy, 1830 (2 species), *Sepsis* (12 species) and *Themira* (9 species, including *Themira superba*; see Tab. 1). *Meroplius minutus* (Wiedemann, 1830), the only native species of this genus is a generalist and can be found in «exceptionally filthy habitats» (Pont & Meier 2002), such as manure and other rather liquid decaying organic matter. It is relatively rarely found in Switzerland. Members of the genus *Nemopoda*, of which *Nemopoda nitidula* (Fallén, 1820) is by far the most abundant species, can occur at any decomposing organic matter, also compost and animal carcasses (pers. observ. P. T. Rohner). *Nemopoda pectinulata* Loew, 1873, which can be difficult to distinguish from *Nemopoda nitidula*, occurs more rarely. I only know *Nemopoda speiseri* (Duda, 1926) from museum specimens and have never observed it myself.

Both species of *Saltella* frequently visit cow pats, especially older ones that have already developed a dry crust. Note that whereas *Saltella sphondylii* (Schrank, 1803), which ranges in coloration from dark brown to bright yellowish and occurs frequently in high abundances, the larger and always dark coloured *Saltella nigripes* Robineau-Desvoidy, 1830 is rarely found.

Sepsis spp. are generally common but greatly vary in their abundance, distribution and in respect to the timing of substrate colonization. Püchel (1993) demonstrated important species turnover of *Sepsis* on cow dung with some species occurring nearly instantly after dung deposition and others preferring old and dry dung. Also, differences in macro-ecological niches are apparent. *Sepsis cynipsea*

Tab. 1: Checklist of the Sepsidae of Switzerland.

* = PTR has studied at least one specimen of Swiss origin (R1: Haenni 1997; R2: Haenni 1998; R3: Merz et al. 2001; R4: Ozerov 2005; R5: Merz 2012; R6: Rohner et al. 2015).

<i>Genus</i>	<i>Species</i>	<i>Author</i>	<i>Also mentioned in</i>
<i>Meroplus</i>		Rondani, 1874	
	<i>M. minutus</i>	(Wiedemann, 1830)	*R1, 2, 4, 5, 6
<i>Nemopoda</i>		Robineau-Desvoidy, 1830	
	<i>N. nitidula</i>	(Fallén, 1820)	*R1, 2, 4, 5, 6
	<i>N. pectinulata</i>	Loew, 1873	*R1, 2, 4,
	<i>N. speiseri</i>	(Duda, 1926)	*R3
<i>Saltella</i>		Robineau-Desvoidy, 1830	
	<i>S. nigripes</i>	Robineau-Desvoidy, 1830	*R1, 2, 4, 5, 6
	<i>S. sphondylii</i>	(Schrank, 1803)	*R1, 2, 4, 5, 6
<i>Sepsis</i>		Fallén, 1810	
	<i>S. biflexuosa</i>	Strobl, 1893	*R1, 2, 4, 5, 6
	<i>S. cynipsea</i>	(Linnaeus, 1758)	*R2, 4, 5, 6
	<i>S. duplicata</i>	Haliday, 1838	*R1, 2, 4, 6
	<i>S. flavimana</i>	Meigen, 1826	*R2, 4, 5, 6
	<i>S. fulgens</i>	Meigen, 1826	*R2, 4, 5, 6
	<i>S. luteipes</i>	Melander & Spuler, 1917	*R1, 2, 4, 6
	<i>S. neocynipsea</i>	Melander & Spuler, 1917	*R2, 4, 5, 6
	<i>S. nigripes</i>	Meigen, 1826	*R5, 6
	<i>S. orthocnemis</i>	Frey, 1908	*R1, 2, 4, 5, 6
	<i>S. punctum</i>	(Fabricius, 1794)	*R2, 4, 5, 6
	<i>S. thoracica</i>	(Robineau-Desvoidy, 1830)	*R2, 4, 5, 6
	<i>S. violacea</i>	Meigen, 1826	*R2, 4, 5, 6
<i>Themira</i>		Robineau-Desvoidy, 1830	
	<i>T. annulipes</i>	(Meigen, 1826)	*R2, 4, 5, 6
	<i>T. germanica</i>	Duda, 1926	*R1, 2, 4
	<i>T. gracilis</i>	(Zetterstedt, 1847)	*R1, 2, 4, 6
	<i>T. leachi</i>	(Meigen, 1826)	*R1, 2, 4
	<i>T. lucida</i>	(Staeger in Schiødte, 1844)	*R1, 2, 4
	<i>T. minor</i>	(Haliday, 1833)	*R1, 2, 4, 5, 6
	<i>T. nigricornis</i>	(Meigen, 1826)	*R1, 2, 4, 5
	<i>T. putris</i>	(Linnaeus, 1758)	*R1, 2, 4, 5
<i>T. superba</i>	(Haliday, 1833)	*This issue	

(Linnaeus, 1758), for instance, can be found in the hundreds at fresh cowpats in the lowlands, whereas its sister species, *S. neocynipsea* Melander & Spuler, 1917 is only highly abundant at high elevations. See Rohner *et al.* (2015) for distribution maps that illustrate the great variation in both the range and abundance of Swiss *Sepsis* species.

Whereas both *Sepsis cynipsea* and *Sepsis neocynipsea* tend to be found nearly exclusively on fresh cowpats, other species are much less specialized. For instance, *Sepsis fulgens* Meigen, 1826 and *Sepsis violacea* Meigen, 1826 are commonly found at cow, pig and horse dung, as well as muck hills and manure. The Swiss fauna of sepsid flies thus features very diverse life-histories and strong niche differentiation.

Notes on taxonomy and nomenclature:

Sepsis helvetica Munari, 1985: This species was synonymized with *Sepsis luteipes* by Ozerov (1999). Genetic and morphological data lead to different species inferences, thus the taxonomic validity of *Sepsis helvetica* remains doubtful. *Sepsis helvetica* should therefore remain in synonymy with *S. luteipes* unless new evidence legitimates an elevation to species ranking (Rohner *et al.* 2014).

Sepsis nigripes Meigen, 1826: The taxonomic validity of this taxon was lately demonstrated using molecular and morphological data (Rohner *et al.* 2014). Contrary to earlier doubts (Haenni 1997), the species could be successfully contrasted to *Sepsis flavimana* Meigen, 1826 and *Sepsis biflexuosa* Strobl, 1893, the morphologically most similar taxa. Swiss specimens stem from Bernex-Signal (Geneva, Merz 2012) and Lenzerheide (Graubünden, Rohner *et al.* 2014).

Sepsis setulosa (Duda, 1926): There are only two specimens of this species ever recorded: the holotype in Germany and an additional specimen in Geneva (Merz 2012). Pont & Meier (2002) suspect that the holotype (which they studied) represents a dwarf form of *Sepsis flavimana*, a species with high morphological plasticity. Accordingly, the figures given in Duda (1926) look very similar to small *Sepsis flavimana* that were bred under laboratory conditions. Due to the high morphological plasticity in this clade (Rohner *et al.* 2014) and without further (eg. molecular, ecological or behavioral) data, *Sepsis setulosa* remains a species dubia and is thus not included in the list.

CONCLUSION

Given the lately refined species delimitations of some taxa and the new record of *Themira superba* for Switzerland, I here update the checklist of the native sepsid flies. The number of species thus increases to twenty seven (or even twenty eight, if the taxonomical validity of *Sepsis setulosa* can be comprehensively demonstrated).

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ZUSAMMENFASSUNG

Schwingfliegen (Diptera: Sepsidae) dienen als Modellorganismus in der Evolutionsbiologie, vor allem im Bezug zur Sexuellen Selektion und der Phylogenetik. Die Faunistik dieser Familie ist jedoch weniger im Fokus der aktuellen Forschung. Die Sepsiden der Schweiz sind relativ gut bekannt, wahrscheinlich sind die meisten Arten in der nationalen Checkliste und deren Nachträgen erfasst. Sehr seltene oder neu eingewanderte Arten könnten allerdings noch fehlen. Das Auftreten einer weiteren seltenen Art in der Schweiz, *Themira superba*, wird hier dokumentiert. Zusätzlich werden neuere Erkenntnisse über den taxonomischen Status einiger einheimischer Arten diskutiert. Die Anzahl der einheimischen Sepsidenarten steigt daher auf 27, wobei *Sepsis setulosa* nicht mitgezählt wird, da die taxonomische Validität dieser Art noch nicht eindeutig belegt werden konnte.

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