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New records, a completed list and identification key of mites (Acari) associated with the stable fly, *Stomoxys calcitrans* (L.) (Diptera: Muscidae)

Jenő Kontschán[a] , Sándor Hornok[b]

[a] Plant Protection Institute, Centre for Agricultural Research, Hungarian Academy of Sciences, H-1525 Budapest, P.O. Box 102, Hungary.
[b] Department of Parasitology and Zoology, University of Veterinary Medicine, H-1400 Budapest Pf. 2, Hungary.

Original article

ABSTRACT

The stable fly, *Stomoxys calcitrans* (L.) is a blood-sucking muscid fly species, with a worldwide distribution and high veterinary-medical importance. In this study, four mite species were collected from stable flies in Hungary. One mite species (*Trichotrombidium muscarum* (Riley, 1878)) from the family Microtrombidiidae was parasitic on the flies, collected in high numbers from their bodies. The other three species were found in small numbers on the flies, which they use only for transportation. The latter included the phoretic female of *Pediculaster mesembrinae* (Canestrini, 1881) (Acari: Siteroptidae), the phoretic deutonymph of the *Halolaelaps sexclavatus* (Oudemans, 1902) (Acari: Halolaelapidae) and *Macrocheles subbadius* (Berlese, 1904) (Acari: Macrochelidae). This is the first record of an association between the stable fly and two mite species (*Trichotrombidium muscarum* and *Halolaelaps sexclavatus*). A new, completed list and identification key of known stable fly associated mites are also provided.

Keywords dog fly; phoresy; new host; Hungary
Zoobank http://zoobank.org/E7B6320D-49E5-4EE8-BF0E-77EB1924429E

Introduction

The stable fly or dog fly, *Stomoxys calcitrans* (L.) (Diptera: Muscidae), is a widely distributed member of the genus *Stomoxys*. This fly species occurs both in the tropical and temperate climatic zones (Showler & Osbrink 2015) and, as an economically important pest, causes severe problems for livestock and pets due to blood sucking activity and transmission of vector-borne pathogens (Baldacchino *et al.* 2013).

To date numerous mite species have been recorded from different groups of flies (Samšiňák 1979, 1989, Mumcuoglu & Braverman 2010, Perez-Leanos 2017), but mites associated with the stable fly have been scarcely investigated. McGarry & Baker (1997) listed twelve mites species associated with *Stomoxys calcitrans* from the families Ereynetidae, Pygmephoridae, Winterschmidtiidae, Acaridae, Histiostomatidae, Macrochelidae, Digamasellidae, Halolaelpidae, Uropodidae, Eviphididae. Other studies only focused on stable fly associated mites from the family Macrochelidae (Beresford & Sutclife 2009, Mumcuoglu & Braverman 2010, Mašán 2003).

Recently, stable flies were collected in several regions of Hungary and a few fly specimens were found infested by mites. Mites living on the body of the flies constitute a highly neglected area of the Hungarian acarology (Horváth *et al.* 2010). Only Kobulej (1951) presented some

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Corresponding author
Jenő Kontschán:
kontschan.jeno@agrar.mta.hu

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mites form *Musca domestica* Linnaeus, 1758, whereas Erőss & Mahunka (1971) reported a macrochelid mite species from the stable fly.

Materials and methods

Stable flies were collected manually (by using butterfly nets) at two-week intervals, from September to November 2017, in six locations in Hungary (data not shown). Mite-infested stable flies were only found at the location providing the most fly specimens, i.e. near a beef cattle herd in northern Hungary (Pásztó, 47°55'34.5"N, 19°40'49.8"E). Mite specimens were removed from the flies using a 00 or 0 paint brush under a BTC binocular microscope. Mites were cleared in lactic acid and placed on slide for morphological identification. Drawings were made with the aid of a drawing tube on a Leica 1000 microscope. All specimens are stored in 75% ethanol and are deposited at the Plant Protection Institute, Centre for Agricultural Research, Hungarian Academy of Sciences and at the Department of Parasitology and Zoology, University of Veterinary Medicine. Photos were taken with a VHX-5000 digital microscope (Keyence Co., Osaka, Japan). Measurements are presented as ranges of minimum to maximum. Measurements and the scales in the figures are given in micrometres (µm).

Results

List of species found in Hungary

Acari

Mesostigmata

Macrochelidae

Macrocheles subbadius (Berlese, 1904)

Distinguishing characters of female. All dorsal setae smooth and needle-like, except setae j1 which are smooth and robust. Ventral setae also smooth and needle-like, sternal shield ornamented with small pits. Ventrianal shield pentagonal with three pairs of needle-like setae anterior to anal opening (Figure 1, A & B).

Notes. This is the species most frequently collected from the bodies of stable flies. This association was reported from Hungary (Erős & Mahunka 1971), France (Niogret *et al.* 2008), Slovakia (Mašán 2003), Israel (Mumcuoglu & Braverman 2010), United Kingdom (McGarry & Baker 1997) and Canada (Beresford & Sutcliffe 2009). *Macrocheles subbadius* is a coprophilous detriticole species and a typical phoretic mite, which does not parasitize the stable fly, but use it only for transportation between different habitats (like dung pads, compost heaps etc.).

Halolaelpidae

Halolaelps sexclavatus (Oudemans, 1902)

Distinguishing characters of the deutonymphs. All dorsal setae short, smooth and needle-like. Ventral setae also smooth and needle-like, three pairs club-like setae visible on the gnathosoma (setae h4 or subcoxal setae), and on coxae II and III (Figure 1, C & D).

Notes. This is the first report of this mite in association with the stable fly. The deutonymph of *H. sexclavatus* is known to be present on the body of various insect species (like: beetles Bahrami *et al.* 2011) or in bird nests (Krištofík et al 2013), but it was never collected from stable flies. Nevertheless, McGarry & Baker (1997) listed a *Halolaelaps* species from this fly species in the UK. *Halolaelps sexclavatus* is not a parasitic mite: this species occurs in compost and dung, therefore we suppose that this species uses the host only for dispersal between different sites.

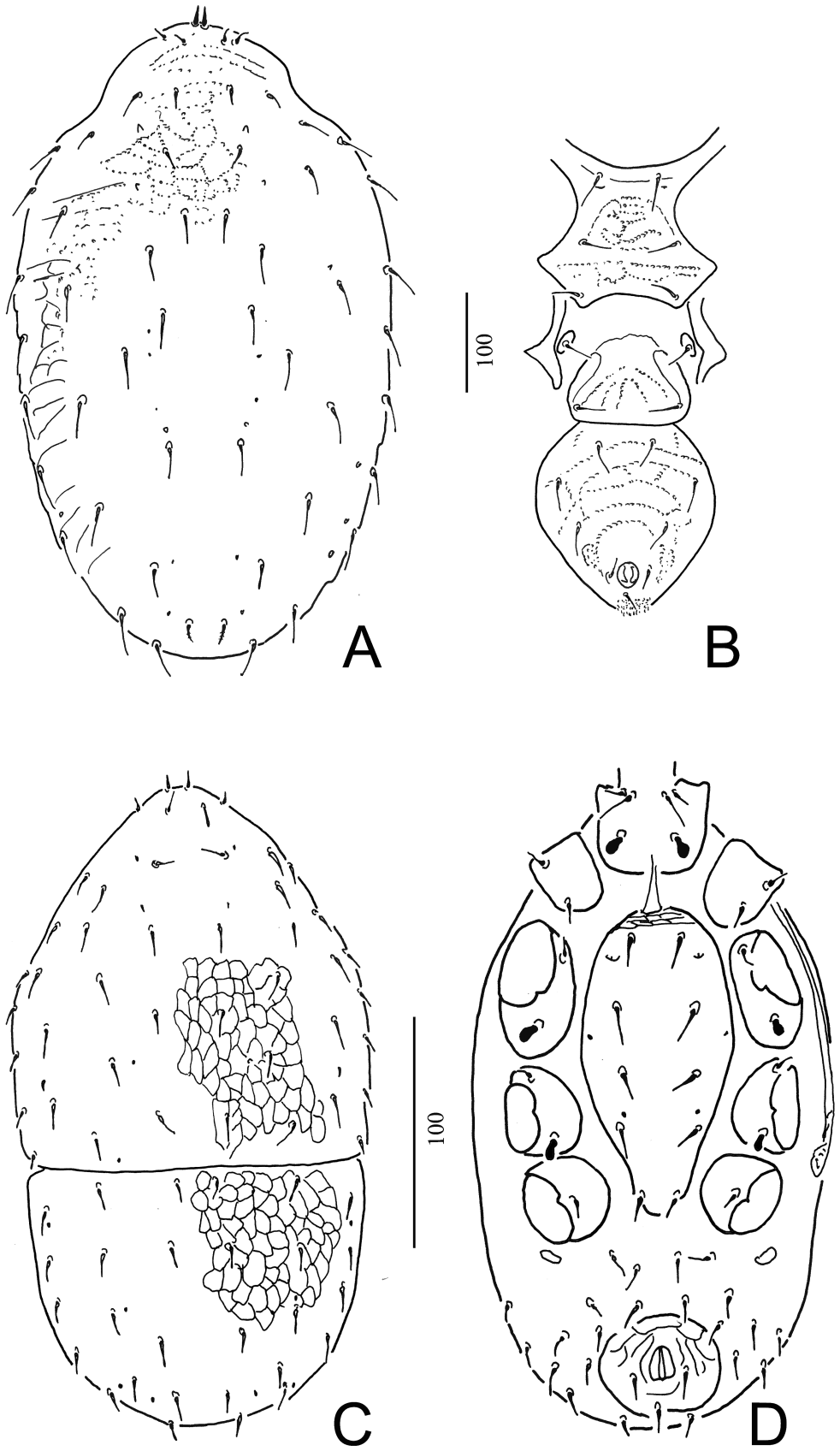

Figure 1 Mites associated with stable fly I: A – dorsal view of *Macrocheles subbadius* (Berlese, 1904), female, B – ventral view; C – dorsal view of *Halolaelps sexclavatus* (Oudemans, 1902), deutonymph, D – ventral view. Scale bars in μm.

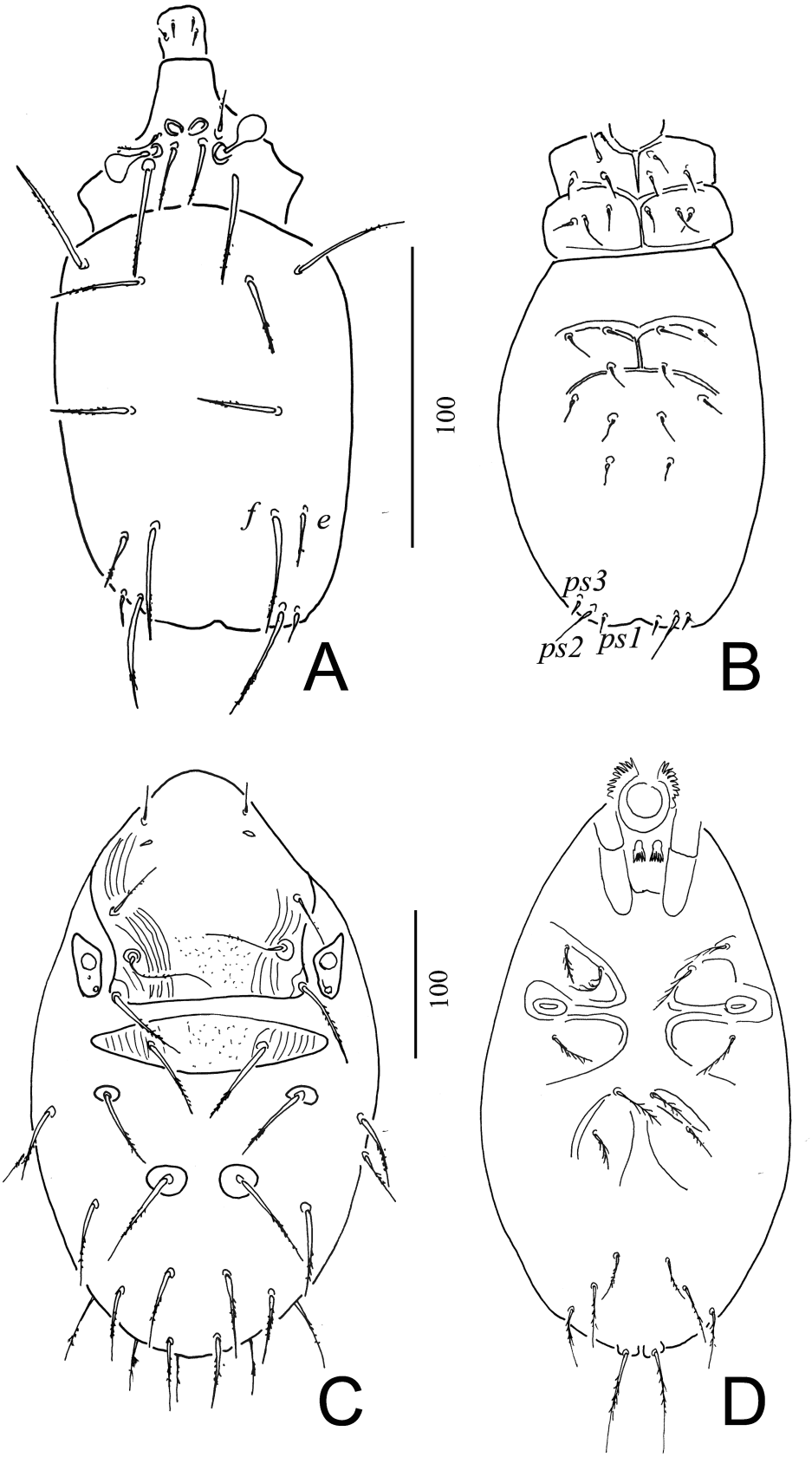

Figure 2 Mites associated with stable fly II. A – dorsal view of *Pediculaster mesembrinae* (Canestrini, 1881), phoretic female, B – ventral view; C – dorsal view of *Trichotrombidium muscarum*, larva, D – ventral view. Scale bars in μm.

Prostigmata

Siteroptidae

Pediculaster mesembrinae (Canestrini, 1881)

Distinguishing characters of the phoretomorphic female. First sternal plates with 6-6 setae. Setae *e* shorter than setae *f*, setae *ps2* two times longer than setae *ps1* and *ps3* (Figure 2, A & B).

Notes. This mite species was recorded from stable flies (McGarry & Baker 1997) in the UK. *Pediculaster mesembrinae* occurs in places where dung or dung inhabiting flies are found (Mahunka 1972). This species is not parasitic on stable flies, and similarly to the previously mentioned two species, uses them only for transportation.

Trombidiformes

Microtrombidiidae

Trichotrombidium muscarum (Riley, 1878)

Distinguishing characters of the larvae. Scutellum 3.5 times wider than long, wider than scutum. Scutum and scutellum with punctuation on central part and with longitudinal striae on lateral parts. Number of dorsal setae 28, setae AM smooth, other setae on dorsum slightly barbed, trichobothria narrow and very finely barbed (Figure 2, C & D).

Notes. This species is the senior synonym of *T. hemistriatum* (Womerslay, 1942) (Welbourn

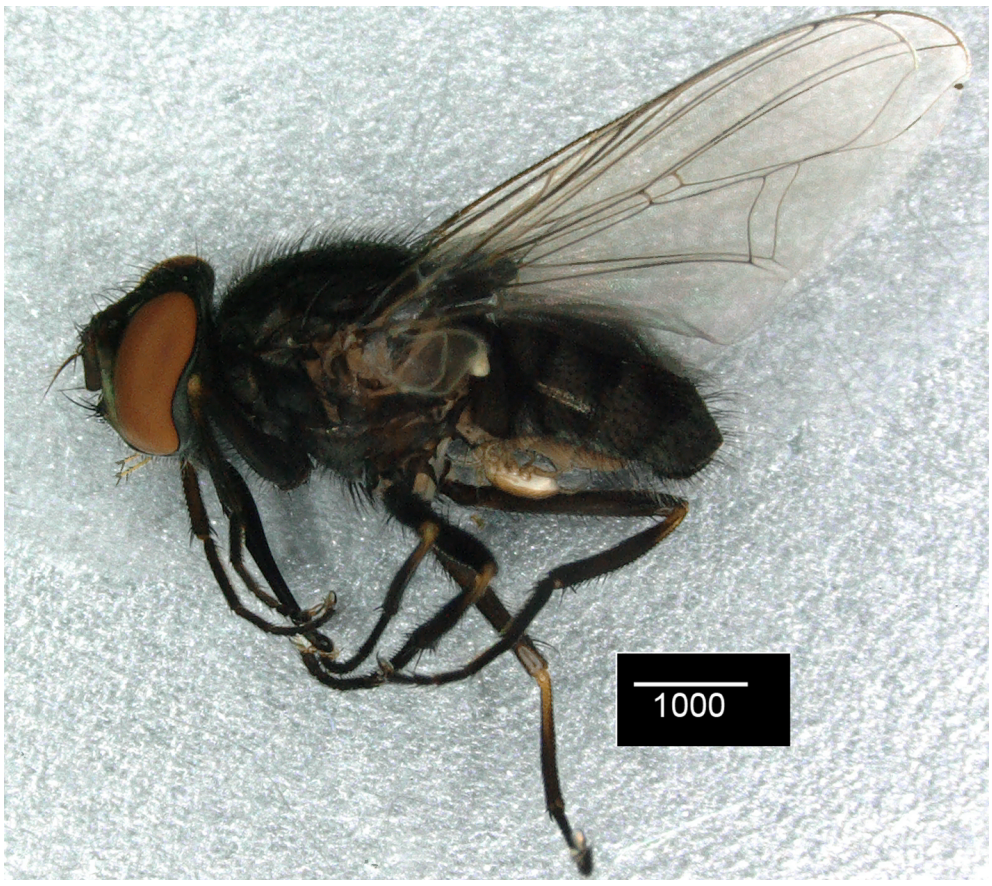

Figure 3 *Macrocheles subbadius* (Berlese, 1904) female attached to stable fly. Scale bars in μm.

1985) and *T. rafieiae* Saboori, 2002 (Hakimtabar & Saboori 2018). Kobulej (1951) described a new species *Trichotrombidium muscae* Kobulej, 1951, which is also a junior synonym of *T. muscarum* (Riley, 1878). Saboori (2002) mentioned *T. muscarum* in the key to *Trichotrombidium* species as *T. hemistriatum* Kobulej, 1951 which is an erroneous name (maybe mixed names of the species of Womersay and Kobulej). The name *T. muscarum* was also mentioned in Suhas and Rhao (1986) as "*Trichotrombidium muscarum* Kolonev" (sic!), which is another misuse of this name.

This is a true parasitic species, known from *Musca domestica* only from Iran (Saboori 2002) and from Turkey (Karakurt & Sevsay 2013), and from a species of the family Ulidiidae (Diptera) (Hakimtabar & Saboori 2018), but never mentioned from stable fly. McGarry *et al.* (1992) reported *Trichotrombidium muscarum* (Riley) from flies from Libya and mentioned it from stable fly from Romania without citing references, so this association is questionable.

The rate of the infection

Only 5 stable flies were infested by mites from the collected 350 specimens. During our investigation of mites associated with stable flies only four mite species were collected. Two species were represented by only single specimens, namely the halolaelapid *Halolaelaps sexclavatus* and the siteroptid *Pediculaster mesembrinae*. The other two species were more abundant, one or two specimens of *M. subbadius* were found on the venter of the body of the flies (Figure 3). High numbers (8-37 specimens) of *T. muscarum* infested the flies (Figure 4) and these were found all over the body, adhering to the membranous cuticle between the tergites and sternites of abdomen and the parts of thorax.

Discussion

To date only few records are available on the mites of stable flies (Table 1). Most known associations were reported from the Palearctic, from the UK, Israel, France, Slovakia and Hungary. Only two mite species are known from the Nearctic region and another two species are described from the Afrotropical region.

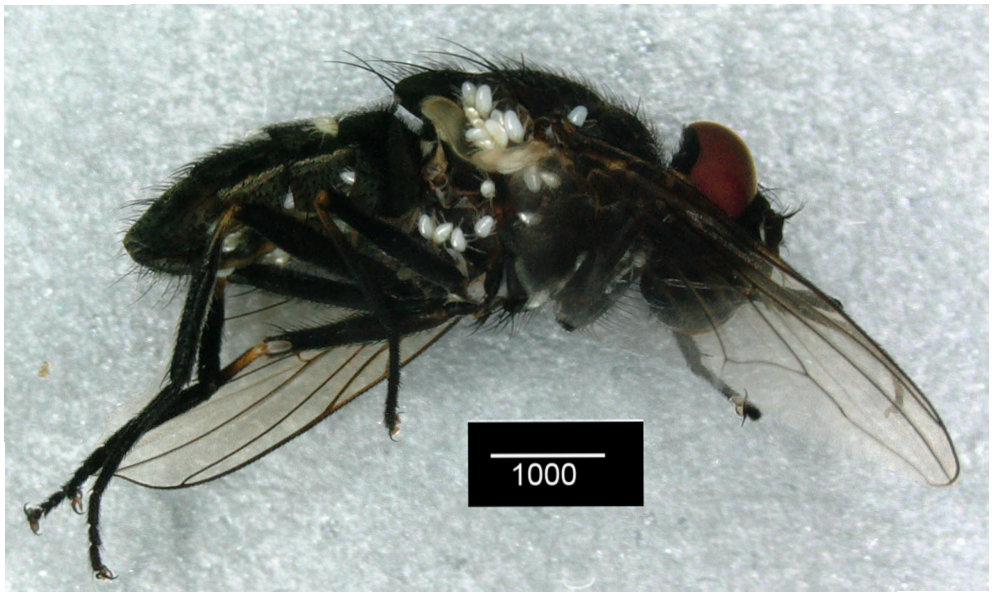

Figure 4 *Trichotrombidium muscarum* (Riley, 1878) larvae attached to stable fly. Scale bars in μm.

Table 1 Mites associated with stable flies.

Mite catagory	Mite family	Mite species	Biogeographical region	Country	References
Mesostigmata	Macrochelidae	*Macrocheles subbadius* (Berlese, 1904)	Palearctic	Hungary	Erős & Mahunka (1971)
			Palearctic	UK	McGarry & Baker (1997)
			Palearctic	Slovakia	Mašán (2003)
			Palearctic	France	Niogret et al. (2006)
			Palearctic	Israel	Mumcuoglu & Braverman (2010)
			Nearctic	Canada	Beresford & Sutcliffe (2009)
		Macrocheles muscadomesticae (Scopoli, 1772)	Palearctic	UK	McGarry & Baker (1997)
			Palearctic	Israel	Mumcuoglu & Braverman (2010)
			Palearctic	France	Niogret et al. (2006)
			Nearctic	Canada	Beresford & Sutcliffe (2009)
		Macrocheles bertrandi Niogret & Nicot,2008	Afrotopical	Gabon	Niogret & Nicot (2008)
		Macrocheles ovoidalis Niogret & Nicot, 2008	Afrotopical	Gabon	Niogret & Nicot (2008)
		Macrocheles glaber (J. Müller, 1860)	Palearctic	France	Niogret et al. (2006)
		Macrocheles perglaber Filipponi & Pegazzano, 1962	Palearctic	France	Niogret et al. (2006)
	Digamasellidae	*Digamasellus* sp.	Palearctic	UK	McGarry & Baker (1997)
	Halolaelapidae	*Halolaelaps* sp.	Palearctic	UK	McGarry & Baker (1997)
		Halolaelaps sexclavatus (Oudemans, 1902)	Palearctic	Hungary	present study
	Protodinychidae	*Protodinychus* sp.	Palearctic	UK	McGarry & Baker (1997)
	Eviphididae	*Thinoseius* sp.	Palearctic	UK	McGarry & Baker (1997)
Prostigmata	Ereynetidae	*Ereynetes* sp.	Palearctic	UK	McGarry & Baker (1997)
	Siteroptidae	*Pediculaster mesembrinae* (Canestrini, 1881)	Palearctic	UK	McGarry & Baker (1997)
			Palearctic	Hungary	present study
Astigmata	Winterschmidtiidae	*Procalvolia zacheri* (Oudemans, 1929)	Palearctic	UK	McGarry & Baker (1997)
	Acaridae	*Acarus farris* (Oudemans, 1905)	Palearctic	UK	McGarry & Baker (1997)
	Histiostomatidae	*Copronomia* (=*Bonomia*) *spherocerae* Vitzthum, 1922	Palearctic	UK	McGarry & Baker (1997)
	Histiostomatidae	*Myianoetus* sp.	Palearctic	UK	McGarry & Baker (1997)
Trombidiae	Microtrombidiidae	*Trichotrombidium muscarum* (Riley, 1878)	Palearctic	Hungary	present study

The mite species most frequently collected from stable flies are *Macrocheles subbadius* and *M. muscadomesticae* (Scopoli, 1772). Both species use the fly only for transportation from one habitat to another. In general, most mite species reported from stable flies are phoretic, except *Trichotrombidium muscarum*, which is an obligate parasitic mite of Muscidae. Knowledge of mites associated with stable flies is fragmented, therefore we can expect to find more species in future. To help with their identification, we compiled a key to the known mites associated with stable flies.

Key to the known mites associated with stable fly

1. Stigmata present 2
— Stigmata absent 14

2. Stigmata close to coxae of legs 3
— Stigmata close to gnathosoma 12

3. Dorsal shield divided into two plates 4
— Dorsal shield entire 6

4. Anal opening large . . . . . *Digamasellus* sp., deutonymph
— Anal opening small 5

5. Subcoxal setae, and setae on coxae II and III club-like *Halolaelaps sexcavatus*, deutonymph

— Subcoxal setae, and setae on coxae II and III needle-like ..... *Halolaelaps* sp., deutonymph

6. Large and separate metapodal shields present ..... *Protodinychus* sp., deutonymph
— Large and separate metapodal shields absent 7

7. Anal shield present ..... *Thinoseius* sp., deutonymph
— Ventrianal shield present 8

8. Setae j1 short, smooth and robust ..... *Macrocheles subbadius*
— Setae j1 long and pilose 9

9. All setae smooth, except j1 and J5 10
— Some setae on dorsal shield pilose 11

10. Dorsal setae shorter, length ¼ the distances between insertions of setae next behind .....
..... *Macrocheles bertrandi*
— Dorsal setae longer, length 1/2 the distances between insertions of setae next behind .....
..... *Macrocheles glaber/Macrocheles perglaber**

11. Setae j3 and j4 pilose ..... *Macrocheles muscadomesticae*
— Setae j3 and j4 smooth ..... *Macrocheles ovoidalis*

12. Dorsal body with two large and some smaller shields . *Trichotrombidium muscarum*, larvae
— Dorsal body without visible shields 13

13. Setae sc1 bulbous ..... *Pediculaster mesemrinae*, phoretic female
— Setae sc1 narrow, flagelliform and pilose ..... *Ereynetes* sp., tritonymph

14. Terminal eyes present ..... *Procalviola zacheri*, hypopi
— Terminal eyes absent 15

15. Suckers present on coxal field I ..... *Miyanoetus* sp., hypopi
— Suckers absent on coxal field I 16

16. Eye-like structure present on lateral margins of idiosoma . *Bonomia spheroceratae*, hypopi
— Eye-like structure absent on lateral margins of idiosoma ..... *Acarus farris*, hypopi

*Notes: The differences between the *M. glaber* and M. *perglaber* are very weak based on female morphology (Halliday 1986), but Mašán (2003) listed some characters (e.g. shape of some dorsal setae) of females, which can help to separate these two species. On the other hand, the level of individual variability is very high, therefore identification without the males seems to be impossible.

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References

Bahrami F., Arbabi M., Shoushtari R.V., Kazemi, S. 2011. Mesostigmatic mites associated with Coleoptera and biodiversity calculation of these mites phoretic on dung beetles in Golestan Province (North of Iran). Middle-East J. Sci. Res., 9(3): 345-366.

Baldacchino F., Muenworn V., Desquesnes M., Desoli F., Charoenviriyaphap T., Duvallet G. 2013. Transmission of pathogens by *Stomoxys* flies (Diptera, Muscidae): a review. Parasite, 20: 26. doi:10.1051/parasite/2013026
Beresford D.V., Sutcliffe J.F. 2009. The effect of *Macrocheles muscaedomesticae* and *M. subbadius* (Acarina: Macrochelidae) phoresy on the dispersal of *Stomoxys calcitrans* (Diptera: Muscidae). Syst. Appl. Acarol., 23: 1-30. doi:10.11158/saasp.23.1.1
Berlese A. 1904. Acari nuovi. Manipulus IIus. Redia, 1: 258-280.
Canestrini R. 1881. Contribuzione allo studio degli Acari parassiti degli insetti. Atti della Societ/l. Veneto-Trentina di Scienze Naturali, Padova, VII (II): 154-155; 168-169, Tav. 19, 22.
Erőss J., Mahunka S. 1971. Investigations on coprophilous and stercoricolous Macrochelids (Acari, Gamasina) in Hungary, as possible agents in the control of synanthropous flies. Parasitol. Hung., 4: 215-226.
Hakimitabar, M., Saboori, A. 2018. Synonymy in the genus *Trichotrombidium* (Acari: Microtrombidiidae). Syst. Appl. Acarol., 23(6): 1024-1026. doi:10.11158/saa.23.6.2
Halliday, R.B. 1986. Mites of the *Macrocheles glaber* group in Australia (Acarina: Macrochelidae). Aust. J. Zool., 34: 733-752. doi:10.1071/Z09860733
Horváth E., Kontschán J., Mahunka S. 2010. Hungarian acarological literature. Opusc. Zool. Budapest, 41(2): 97-174.
Karakurt I., Sevsay S. 2013. A new species of *Trichotrombidium* Kobulej, 1951 (Acari: Prostigmata: Microtrombidiidae) for the Turkish fauna. Mun. Ent. Zool., 8(2): 739-744.
Krištofík J., Mašán P., Šustek Z., Nuhličkov S. 2013. Arthropods (Acarina, Coleoptera, Siphonaptera) in nests of hoopoe (*Upupa epops*) in Central Europe. Biol., Bratislava, 68(1): 155-161.
Kobulej T. 1951. Novi vis trombidiidnovo kleschcha. Eine neue Trombiiden-Art, Trichotrombidium muscae gen. n. et spec. n. – Microtrombidiinae Sig Thor, 1935. Acta Vet. Acad. Sci. Hung., 1: 83-105.
Mahunka S. 1972. Tetűatkák – Tarsonemina. – Magyarország Állatvilága (Fauna Hungariae), XVIII. 16. Akadémiai Kiadó, Budapest, pp. 215.
Mašán P. 2003. Macrochelid Mites of Slovakia (Acari, Mesostigmata, Macrochelidae). Bratislava, Institute of Zoology, Slovak Academy of Sciences. pp. 149.
McGarry J.W., Baker A.S. 1997. Observation on the mite fauna associated with adult *Stomoxys calcitrans* in the UK. Med. Vet. Entomol., 11: 159-164. doi:10.1111/j.1365-2915.1997.tb00307.x
McGarry J.W., Gusbi A.M., Baker A., Hall M.J.R., el Megademi K. 1992. Phoretic and parasitic mites infesting the New World screwworm fly, *Cochliomyia hominivorax*, following sterile insect release in Libya. Med. Vet. Entomol., 6, 255-260. doi:10.1111/j.1365-2915.1992.tb00615.x
Mumcuoglu K., Braverman Y. 2010. Parasitic and phoretic mites of Diptera in Israel and the Sinai Peninsula, Egypt. Israel J. Entomol., 40: 195-203.
Nigoret J., Nicot A. 2008. Combined approach using morphology and ITS-sequences for description of three new species of *Macrocheles* (Acari: Macrochelidae). Zootaxa, 1873: 39-49.
Niogret J., Lumaret J-P., Bertrand M. 2006. Review of the phoretic association between coprophilous insects and macrochelid mites (Acari Mesostigmata) in France. Elytron, 20: 99-121.
Oudemans A.C. 1902. New list of Dutch Acari, second part. With remarks on known and description of a new subfamily, nem genera and species. Tijdschr. Entomol., 45: 1-52.
Perez-Leanos A., Loustalot-Laclette M.R., Nazario-Yepiz N., Markow T.A. 2017. Ectoparasitic mites and their *Drosophila* hosts. Fly, 11(1): 10-18. doi:10.1080/19336934.2016.1222998
Riley 1878. First Annual report of the United States Entomological Commission for the Year 1887 relating to the Rocky Mountain Locust, 306-313.
Saboori A. 2002. Two new species of larval mites (Acari: Microtrombidiidae, Erythraeidae) from Iran. Biol., Bratislava, 57(5): 547-552.
Samšiňák K. 1979. Mites of Saudi Arabia. Acari from Musca domestica. Fauna of Saudi Arabia, 1: 69-74.
Samšiňák K. 1989. Mites on flies of the family Sphaeroceridae. II. Acarologia, 30(2): 85-105.
Scopoli J.A. 1772. Annvs V. Historico-naturalis. I. Emendationes et additamenta ad Ann. I. II. III. IV. II. Tentamen mineralogicum I. De minera argenti alba. III. Tentamen mineralogicum II. De sulphure. IV. Tentamen mineralogicum III. De pseudogalena, auripigmento, aliisque. V. Observationes zoologicae. 1-128.
Showler A.T., Osbrink W.L. 2015. Stable Fly, *Stomoxys calcitrans* (L.), Dispersal and Governing Factors. J. Insect Sci., 21(7): 19-25.
Suhas Y., Rhao K.J. 1986. *Trichotrombidium muscarum* Kolonev, a new acarine parasite on house fly. J.Bombay Nat. Hist. Soc., 83: 446.
Welbourn W.C. 1985. Phylogenetic studies of trombidioid mites. Dissertation. The Ohio State University, pp. 268.
Womersley H. 1942. Additions to Acarina of Australia (Trombidiidae and Calyptostomidae. Rec. South Aust. Mus., 7: 169-181.