Redescription of *Myianoetus muscarum* (Acari: Histiostomatidae) Associated with Human Remains in Texas, USA, with Designation of a Neotype from Western Europe

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ABSTRACT Mites are receiving renewed interest in forensic entomology, but the identification of many species associated with carrion and human remains is problematic. We review the taxonomy of the mite species currently known as *Myianoetus muscarum* (L., 1758) and designate a neotype from the collection of Jean Cooreman in Brussels, Belgium. The species is redescribed based on Cooreman's specimens, specimens previously reported from California and Ontario, Canada, and a large series of new specimens collected from a human corpse in Texas. The species is compared with and distinguished from other species of *Myianoetus*.

KEY WORDS forensic entomology, taxonomy, Diptera

Histiostomatid mites of the genus *Myianoetus* are biologically associated with flies (Diptera) and are known to inhabit decaying organic materials such as manure (Scheucher 1957, Sevastyanov 1973, Bongers et al. 1985), carrion (Russell et al. 2004), guano in caves (Willmann 1937, Cooreman 1941, Zamec and Košel 2014), halophilic vegetation (Fain 1976), and the nests of vertebrates and insects (Scheucher 1957, Fain and Galloway 1993). The genus is represented in all major biogeographic regions including the subantarctic (Fain 1976). Of the 41 currently recognized species, 10 are known from both adult and heteromorphic deutonymphal (phoretic) stages, two from the adult only, and 29 from the deutonymph only. Because these mites can be associated with human remains (Russell et al. 2004), and thus is of forensic interest, accurate identification of species is of considerable importance.

Mites are receiving renewed interest among forensic entomologists (Braig and Perotti 2009, Perotti and Braig 2009, Perotti et al. 2009) after being largely ignored since the pioneering work of Mégnin (1894). Several genera of Histiostomatidae are specialists in vertebrate carrion and are known to or could conceivably occur in human remains, thus making them of potential interest to forensic entomologists (reviewed by OConnor 2009b). The genera *Spinanoetus* Scheucher, 1957, *Pelzneria* Scheucher, 1957, and *Peripatetes* Mahunka, 1976, are associated primarily with beetles (Coleoptera) in the families Silphidae and Staphylinidae (Scheucher 1957, Mahunka 1976, OConnor 2009b), while *Myianoetus* is associated with flies of numerous families. One species of *Myianoetus*, identified as *Myianoetus diadematus* Willmann, 1937 [a probable synonym of *M. dionychus* (Oudemans, 1910), see Scheucher 1957] was found in large numbers on old remains of a child found in the basement of a home in Germany (Russell et al. 2004). A large number of specimens of *Myianoetus*, including both deutonymphs and feeding stages, was collected from a human cadaver in Texas. In this paper, we properly identify and describe these mites.

There are several issues that hinder the systematic study of the genus *Myianoetus*. Among these are the loss of important reference collections including type specimens (i.e., the collections of Rita Scheucher and Karel Samšiňák), the inadequacy of original descriptions of a number of species described before the modern era, and the failure of authors to deposit voucher specimens from important studies (e.g., Carpenter and Greenberg 1960). In this paper, we rectify one major problem, that is, the identity of the type species of the genus, *Myianoetus muscarum* (L., 1758). We redescribe this species and designate a neotype from a previous study collected in the same region as the original material and preserved in a major museum.

Materials and Methods

Specimens that initiated this study were collected from a human corpse in Texas (details of the case to be published elsewhere), stored in 70% ethanol, cleared in

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Nesbitt's clearing agent, mounted on slides in Hoyer's medium, and sealed with Red Insulating Varnish (MG Chemicals, Burlington, ON, Canada). Deutonymphs were identified as *Myianoetus muscarum sensu* Hughes and Jackson, 1958, based on the good description and figures of the deutonymph in that work and examination of specimens studied by them from the United States and Canada. However, adult specimens showed a number of differences when compared with adults described as this species by Cooreman (1947), based on specimens reared from deutonymphs collected in Belgium. We examined voucher specimens from Cooreman's study housed in L'Institut royal des Sciences Naturelles (IRSNB) and noted a number of discrepancies between the specimens and Cooreman's description and figures of the adults. In fact, our specimens from Texas appear to be conspecific with Cooreman's material, based on the morphology of the deutonymph and the female (Cooreman's single male specimen is damaged, but uniquely identifying structures that are visible are consistent with our males). Cooreman figured the female with simple paraproctal setae, while in his specimens they are branched (Fig. 5D). In his figure of the male, the dorsal hysterosomal sclerite (not visible in his specimen due to damage) and raised protuberances on leg I (Fig. 5E) and the idiosomal venter, which are apparent on his specimen, are neither mentioned nor illustrated.

In the descriptions below, idiosomal and leg chaetotaxy follow the descriptions by OConnor (2009a). Measurements are given in Tables 1 and 2 and are given in micrometers (μm).

Voucher specimens from our study are deposited in the following institutions:

CNC – Canadian National Collection of Insects, Arachnids and Nematodes, Ottawa.
HNHM – Hungarian Natural History Museum, Budapest.
IRSNB – L'Institut royal des Sciences Naturelles, Brussels.
OSAL – The Acarology Laboratory, The Ohio State University, Columbus.
TAMUIC – Department of Entomology, Texas A&M University, College Station.
UMMZ – Museum of Zoology, The University of Michigan, Ann Arbor.
USNM – U.S. National Museum of Natural History, Smithsonian Institution, Washington (mite collection housed with the Systematic Entomology Laboratory, U.S. Department of Agriculture [USDA], Beltsville).
ZIN – Zoological Institute, Russian Academy of Science, St. Petersburg.

Taxonomic History

Many 18th and 19th century European microscopists and entomologists had noted small mites on the bodies of synanthropic flies (reviewed by Oudemans, 1926, 1929b, 1937 as *Acarus muscarum* and *Hypopus muscarum*). Linnaeus (1758) formally described *Acarus muscarum* as follows: "*Acarus abdomine rufo, pedibus posticis longissimis filiformibus. Fn. Suec. 1209. Habitat in Muscis.*" In the earlier, nonbinomial work referenced (i.e., "Fn. Suec. 1209"), Linnaeus (1746) had diagnosed the species as "*Acarus rufus muscarum; pedibus posticis longis filiformibus.* De Geer. *Habitat in muscis omnium minimus,*" attributing the diagnosis to De Geer. Oudemans (1926) regarded "*omnium minimus*" in this context as meaning smallest of all mites. De Geer (1778) noted that he had collected this mite from houseflies ("Mouches domestiques") in 1735, while he was living in Utrecht, The Netherlands (Oudemans, 1926). He gave the same diagnosis as Linnaeus and more fully described and illustrated the species. Given Linnaeus' original attribution of the diagnosis to De Geer, and the virtually identical diagnostic statements of the two individuals, it seems likely that the two Swedish countrymen were in communication regarding these mites. Thus, we regard De Geer's specimens as the type series and Utrecht as the type locality.

Subsequent authors placed the species in various genera of mites. Dugès (1834) included the species in his new genus *Hypopus*, and Dujardin (1849) gave a more detailed description based on specimens collected from the fly now known as *Muscina stabulans* (Fallén, 1817) from France. Following the demonstration by Mégnin (1873) that "*Hypopus*" represented heteromorphic nymphs of astigmatid mites, Berlese (1881) redescribed the deutonymph and transferred the species to the genus *Histiostoma* Kramer, a placement followed by Canestrini (1888) and Canestrini and Kramer (1899). In the same work, Berlese described adult mites for the first time, reared from deutonymphs collected from what is now known as *Muscina stabulans* in Italy. Berlese (1887), however, briefly summarized the descriptions and illustrated the male, female, and deutonymph under the name "*Hypopus muscarum* (L.) Berl." Unfortunately, given the optics of the era, Berlese's descriptions and figures do not contain sufficient detail to be diagnostic. Oudemans (1903) transferred the species to the genus *Anoetus* Dujardin, regarding this as a senior synonym of *Histiostoma* Kramer.

In a work in which he proposed a number of new genera in the family now known as Histiostomatidae, Oudemans (1929) proposed the genus *Myianoetus* with what he called "*Anoetus muscarum* (L. 1758)" as type. Cooreman (1947) provided more detailed descriptions and figures of the adult male and female based on material reared from deutonymphs collected from an undetermined species of Muscidae in Belgium. He noted apparent errors and misinterpretations in the descriptions of Berlese (1881, 1887). In the first of two detailed reviews of the family published almost simultaneously, Scheucher (1957), dealing with the fauna of central Europe, noted that the identity of this species was a serious problem for the systematics of the genus. She provided a brief description of the deutonymph and a figure under the name "*Myianoetus muscarum* (L., 1758)", although noting that she had not seen the actual specimens and that another person had prepared the figure. Hughes and Jackson (1958), without knowledge of Scheucher's work, reviewed the family and described new material from North America. Under

Table 1. Measurements of adult *Myianoetus muscarum*, all measurements in μm

Structure	Female (Texas, $n=5$)	Female (Michigan, $n=1$)	Female (Belgium, $n=3$)	Male (Texas, $n=5$)
Idiosomal length[a]	460–601	546	391–450	446–523
Idiosomal width[a]	209–387	309	246–268	323–319
Gnathosoma length[b]	94–110	92	78–87	76–83
Subcapitulum width	53–69	64	60–64	41–64
Chelicera length	76–94	85	76–81	67–76
Palpal solendion length	28–37	32	28–35	28–32
Prodorsal sclerite length	67–85	69	62–69	64–74
Prodorsal sclerite width	71–85	83	62–69	64–74
Hysterosomal sclerite length				255–281
Hysterosomal sclerite width				173–205
Leg I length[c]	239–322	317	278–290	260–285
Leg II length[c]	209–297	290	253–267	246–283
Leg III length[c]	212–304	294	253–269	251–271
Leg IV length[c]	246–338	331	294–304	299–334
Tarsus I length[d]	101–129	133	122–127	94–104
Tarsus II length[d]	83–115	115	110–115	87–99
Tarsus III length[d]	90–122	122	113–117	92–110
Tarsus IV length[d]	110–145	154	140–145	120–131
Solenidia lengths:				
ω1 I	18–19	19	19–21	17–18
ω 2 I	5–8	7	7	7–8
ω 3 I	36–48	36	28–30	15–19
φ I	25–30	28	26–28	32–35
σ' I	9–11	10	10–12	19–21
σ" I	9–10	10	9–10	10–11
ω II	17–19	20	16–17	23–25
φ II	15–17	17	13–15	15–17
σ II	7–9	8	7–9	7–9
φ III	15–19	15	10–11	15–17
φ IV	11–16	15	12–14	13–15

[a] Texas specimens overly flattened, Belgian specimens somewhat crushed.
[b] Measured from base to tip of palp, excluding palpal solenidion.
[c] Legs measured from base of trochanter to tip of pretarsal claw.
[d] Tarsi measured from base to tip, excluding pretarsus.

"*Myianoetus muscarum* (L.), 1758," they gave a good description and figures of the deutonymph based on specimens from Virginia and New York, and Ontario, Canada. They did not have adult specimens, so reprinted the figures of Cooreman (1947) and provided descriptions based on these. They made no mention of how they came to use this name for their specimens, an important consideration given that all previous illustrations and descriptions using the name "*muscarum*" are inadequate for species level differentiation. In his later revision of the European *Myianoetus* fauna, Mahunka (1972) noted once again the uncertainty of the identity of *M. muscarum*. He accepted the determination of Hughes and Jackson (1958), stating:

> "Von den die Art eingehend untersuchenden Autoren waren es Hughes & Jackson die anstatt des verloren gegangenen Holotypus einen Neotypus bzw. Plesiotypus aufstellten. Auf Grund der Nomenklatur-Regels muss dieser angenommen werden, in der Zukunft wird diese Deutonymphe als Typusart der Gattung betrachtet."

Table 2. Measurements of *M. muscarum* deutonymphs

Structure	Texas ($n=5$)[a]	Belgium ($n=3$)[b]
Idiosomal length	177–314	250 (246–250)
Idiosomal width	132–237	150 (146–159)
Subcapitulum length	20–36	25 (25–32)
Subcapitulum width	5–7	9 (9)
Palpal solenidion length	41–68	43 (x)
Prodorsal shield length	9–16	21 (16–21)
Hysterosomal shield length	136–247	225 (222–225)
Idiosomal setae:		
in (=*si*)	13–32	17 (17–19)
ex (=*se*)	9–20	14 (14–17)
c1	5–8	8 (6–8)
c2	4–7	x (5)
c3	8–15	9 (9–13)
cp	4–7	8 (6–8)
d1	5–7	6 (6)
d2	5–7	7 (6–7)
e1	6–7	7 (6–7)
e2	4–7	6 (6–7)
f2	5–7	6 (6–7)
h1	5–7	6 (6–7)
h2	4–7	6 (6–7)
h3	12–18	16 (16–18)
g	12–15	x
Leg I[c]	109–205	157 (148–157)
Leg II[c]	89–164	136 (134–141)
Leg III[c]	70–132	114 (95–116)
Leg IV[c]	50–84	73 (61–84)
Tarsus I[d]	36–55	46 (46)
Tarsus II[d]	29–49	40 (40–44)
Tarsus IV terminal seta	125–238	211 (211–232)
Tibia I	32–48	39 (37–44)
Tibia II	23–43	35 (35–36)
Genu I	23–39	32 (27–32)
Genu II	16–28	23 (21–23)
Solenidia lengths:		
ω1 I	21–25	25 (25–27)
ω 3 I	19–28	25 (25–30)
φ I	57–89	82 (80–87)
σ I	28–55	34 (34–39)
ω II	21–28	25 (24–28
φ II	33–61	49 (49–53)
σ II	7–14	11 (11–15)
φ III	27–45	41 (39–41)
φ IV	21–37	37 (37–41)
Leg setae:		
bv"F I	23–34	x (45)
l'G II	11–17	12 (12–15)
l"G II	38–78	57 (57–71)

[a] Thirty-seven undamaged specimens were measured for body length and five specimens were chosen for complete measurements representing the extremes, the mean and specimens midway between the mean and extremes.
[b] Measurements for Belgian specimens are given as neotype (range).
[c] Legs measured from base of femur to tip of pretarsus.
[d] Tarsi measured from base to tip, excluding pretarsus. x = structure not measurable.

However, Mahunka was mistaken in that Hughes and Jackson (1958) did not designate a neotype, merely plesiotypes (i.e., specimens they regarded as belonging to the species) from Ontario, Canada. Such specimens have no standing as name bearing types. Mahunka (1972) regarded the species described as *M. muscarum* by Scheucher (1957) as being different from that described by Hughes and Jackson (1958), and renamed Scheucher's species *Myianoetus scheucheri*. In the most recent discussion of this issue, Samšiňák (1979)

reiterated the seriousness of the problem of the identity of *M. muscarum*. He correctly pointed out that Mahunka's view of Hughes and Jackson's (1958) "type" designation had no nomenclatural standing. He also emended Mahunka's name, *M. scheucheri*, to "*scheucherae*", as the person honored was female, and, although noting the inadequacy of the description and figures, placed the name in synonymy with *M. muscarum* (L.). He discussed the necessity of naming a neotype for the species to fix its identity and noted the conditions required by the International Code of Zoological Nomenclature (ICZN) for such designation. However, perhaps thinking of Dujardin's (1849) redescription, he stated that a neotype would have to come from the vicinity of Paris, France, rather than what history would suggest is the original type locality, Utrecht, The Netherlands.

Systematic Account

Family Histiostomatidae Berlese, 1879
Histiostomina Berlese, 1879
Histiostomae Oudemans, 1903
Anoeteae Oudemans, 1904
Nodipalpidae Oudemans, 1923
Anoetidae Oudemans, 1923
Histiostomatini Scheucher, 1957
Histiomidae Hughes, 1976
Histiostomidae Hughes, 1976
Histiostomatidae OConnor, 1984

Genus *Myianoetus* Oudemans, 1929a
Myianoetus muscarum (L., 1758)
(Figs. 1–6)

=*Acarus muscarum* L., 1758.
Hypopus muscarum, Dugès 1834, Dujardin 1849, Berlese 1887.
Histiostoma muscarum, Berlese 1881, Canestrini 1888, Canestrini & Kramer 1899
Anoetus muscarum, Oudemans 1903.
Myianoetus muscarum, Oudemans 1929, Cooreman 1947, Scheucher 1957 (?), Hughes & Jackson 1958, Mahunka 1972, Samšiňák 1979.
Myianoetus scheucheri Mahunka, 1972, synonymy by Samšiňák 1979.
Myianoetus scheucherae Samšiňák, 1979 (*emend. nov.*).

Neotype Designation

In accordance with Article 75.3 of the International Code of Zoological Nomenclature (ICZN 1999, 2012), we here designate one of the deutonymphs from Cooreman's (1947) study as neotype of *Acarus muscarum* L., 1758 with the express purpose of clarifying the taxonomic status and type locality. Characters differentiating this species from other species of *Myianoetus* are given following the redescription below.

To ensure recognition of the neotype specimen and other specimens in the series, label data from Cooreman's voucher specimens in IRNSB are given as follows:

Slide with labels "A471" and "152-41b" contains three deutonymphs. The specimen nearest the bottom of the slide when viewed with the labels normally oriented is designated as neotype of *Acarus muscarum* L., 1758. The label information is as follows: left label: R. Mus. Hist. nat. Belg./DN./"s/Muscidae (Dipt.)"/Bruxelles/11/X/1946/ M. Collart. Right label: J. Cooreman det., 1946/*Myianoetus/muscarum* (L.)/DN/[in different hand] Hypopes ++/46.1011/ A.L. FAURE.
Slide with labels "A464" and "152-38b" contains three females. Left label, same as above. Right label: J. Cooreman det., 1946/*Myianoetus/muscarum* (L.)/Ad. (Elevage)/♀♀/46.1011/KOH Ewing.
Slide with label "A465" and "152-39a" contains two females. Left label as above. Right label: J. Cooreman det., 1946/*Myianoetus/muscarum* (L)/ Ad. ex. DN (Elevage)/2♀/46.1011/FAURE.
Slide with labels "A467" and "152-40a" contains one damaged male. Left label as above. Right label: J. Cooreman det., 1946/ *Myianoetus/muscarum* (L.)/ 1♂ Elevage ex DN/46.1011/BERL.
Slide with labels "A472" and "152-37a" contains two tritonymphs. Left label as above. Right label: J. Cooreman det., 1946/*Myianoetus/muscarum* (L.)/ [following in pencil] Elevage/2 NIII/46.1011/ FAURE.
Slide with labels "A469" and "152-38a" contains 1 tritonymph. Left label as above. Right label: J. Cooreman det., 1946/*Myianoetus/muscarum* (L.)/[pencil] Elevage/[ink] NIII/46.1011/FAURE.

To our knowledge, none of the original type specimens of Linnaeus' "*Acarus*" species are extant. No type specimens ascribed to this genus are listed in the catalogues of the Linnean collections at Uppsala University (Wallin 2001) or the Linnean Society of London (2014), nor are any present in the collection of Carl De Geer in the Swedish Museum of Natural History in Stockholm (Gunvi Lindberg, personal communication 2014). Because the original description of Linnaeus (1758) is too brief, and that of De Geer (1778) insufficient to distinguish the species from other *Myianoetus* species, we base our selection of a neotype consistent with its collection from a muscid fly (Diptera: Muscidae) from Western Europe. As indicated above, historical evidence suggests the specimen material that formed the basis for the original diagnosis and description of *A. muscarum* came from De Geer's collection at Utrecht, The Netherlands. Cooreman's specimens, from which we have selected the neotype, originated in Brussels, Belgium, which is 146 km from Utrecht. Given that this species has a very wide distribution in both Western Europe and North America, Brussels seems near enough to the original type locality to suffice. The neotype specimen and other specimens reared from the same colony are housed in L'Institut royal des Sciences Naturelles, in Brussels, an institution with a long history of preserving name-bearing types and making them accessible.

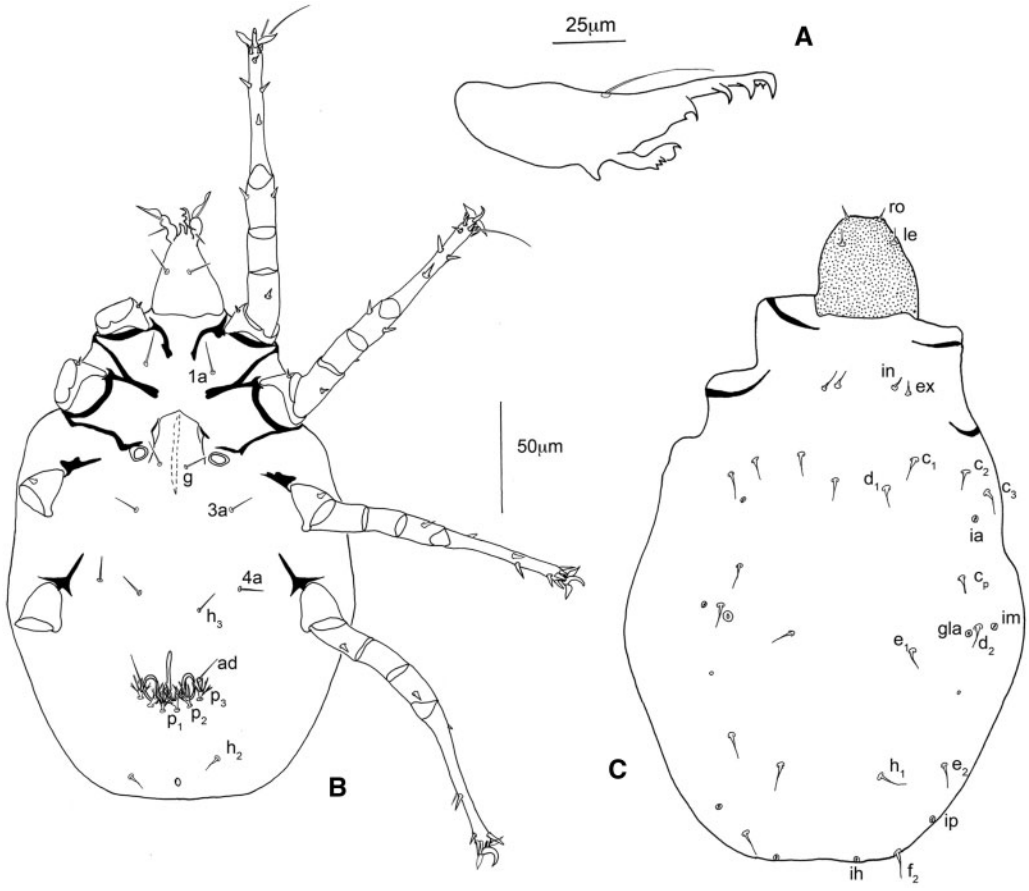

Fig. 1. *M. muscarum*, female. (A) Chelicera. (B) Venter. (C) Dorsum.

Redescription

Female (Figs. 1, 2, 5D). *Body ovoid.* Measurements for series of specimens in Table 1. Other measurements below from figured specimen.

Gnathosoma. Chelicerae (Fig. 1A), narrow, with fixed digit having a curved, scoop-like apex followed proximally by three thin ventro-apical teeth, these followed by a scoop-like process similar to the digital apex, followed by a scoop-like process bearing two apical teeth; movable digit with three apical teeth; cheliceral seta elongate, ~33 in length. Each palp relatively short, reflexed outward, with a large, sclerotized, dorsal projection basally, with membranous extensions along palpal length. Each palp with four medial membranous lobes as in male (Fig. 5a). Palpal solenidion (*ω*) elongate; ventral eupathidial seta *(ul′)* very thin, 14 in length. Subcapitulum with ventral subcapitular seta *(m)* simple, filiform.

Venter (Fig. 1B). Anterior coxal apodemes I free medially, not fused to each other. Posterior coxal apodemes I fused postero-medially to anterior apodemes II, extending dorso-laterally about one-half way around trochanters l. Anterior coxal apodemes II straight. Posterior apodemes II extending about half-way around trochanters dorsally, extending ventrally to anterior side of anterior genital papillae, ending simply. Anterior genital papillae, genital apodemes, and ovipore situated between coxal fields II. Ovipore somewhat triangular, flanked laterally by a pair of longitudinal genital apodemes; genital valves fused medially, area of fusion sclerotized internally, extending anteriad of lateral genital apodemes to ovipore. One pair of genital setae *g* well-developed, situated on fused genital valves. Anterior coxal apodemes III and IV relatively short, straight to slightly curved, with lateral extensions extending dorsally around trochanters. Posterior apodemes III and IV very weakly developed. Posterior genital papillae elongate-ovoid, situated adjacent to the posterior half of the anus. Coxal setae *1a*, *3a*, and *4a* setiform. Anus posterior ventral, length 60. Ventral hysterosomal setation with six pairs of setae here interpreted as follows: *h2* near end of body, slightly inflated basaly, *h3* well-anterior to anus, setiform; *p1-3* in oblique row laterad of posterior genital papillae and posterior quarter of anus, setae multibranched (Fig. 5D), one pair of *ad* setae laterad of anterior quarter of genital papillae, setiform. Copulatory opening near end of body, surrounded by small sclerotized ring, distance between anus and opening 68; internal spermathecal duct thin,

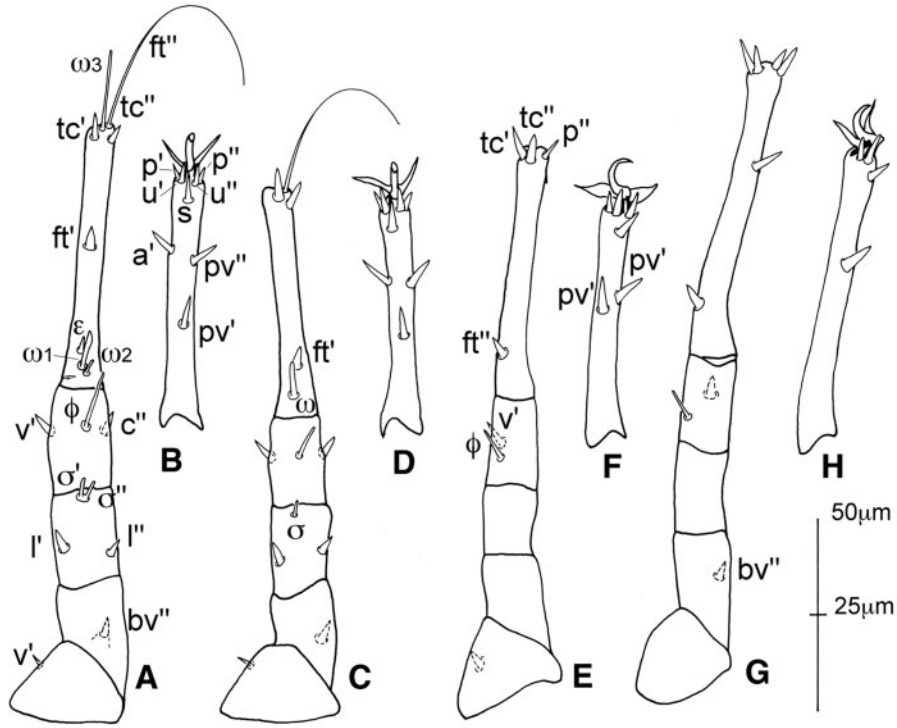

Fig. 2. *M. muscarum*, female legs. (A) Leg I, dorsal. (B) Tarsus I, ventral. (C) Leg II, dorsal. (D) Tarsus II, ventral. (E) Leg III, dorsal. (F) Tarsus III, ventral. (G) Leg IV, dorsal. (H) Tarsus IV, ventral.

70–100 in length, expanding near internal terminus; base of spermatheca somewhat sclerotized, distance between ends of ovarian ducts about 25.

Dorsum (Fig. 1C). Cuticle smooth. Propodosomal sclerite rounded posteriorly, with two posteriorly directed lateral extensions above legs I. Sejugal furrow not apparent. Propodosomal setae *ro* [=*vi*] and *le* [=*ve*] setiform, situated on sclerite, setae *ex* [=*se*] and *in* [=*si*] in a narrow trapezoid. Remainder of dorsal propodosomal and notogastral setae simple, short, curved, with slightly inflated basal half; Setae *h2* and *h3* displaced ventrally (Fig. 1A), vestigial alveoli *f1* visible about half-way between setae *d2* and *e2*. Opisthosomal gland opening *(gla)* slightly posterior-mediad of setae *d2*. Four pairs of cupules observed: *ia* between setae *c2* and *cp; im* laterad of seta *d2*; *ip* midway between setae *e2* and *f2;* and *ih* in line between setae *h1* and *h2*.

Legs (Fig. 2). Legs slender, with all five segments free. Setation typical of Histiostomatidae, chaetotaxic homologies indicated on figures: tarsi 12-12-10-10 (setae *a″* [=*aa*] absent from tarsus I), all setae spine-like except *ft″* (=*d*) I-II; tibiae 2-2-1-1, setae spine-like; genua 2-2-0-0, setae spine-like; femora 1-1-0-1, setae spine-like; trochanters 1-1-1-0, setae spine-like. Famulus ε present on tarsus I. Solenidion ω2 clearly more basal than ω l on tarsus I, ω 3 elongate, tapering, at tarsal apex, solenidia φ of tibiae I-IV, σ′ and σ″ of genu I and σ of genu II short, similar in length. Empodial claws well-developed; membranous pretarsal ambulacra bilobed with tapering processes extending laterad of empodial claws.

Male *(Figs. 3; 4; 5A, B and E).* Body form generally similar to female, ovoid to pear-shaped. Measurements in Table 1. Gnathosoma as in female (Fig. 5A).

Venter (Fig. 3A). Anterior apodemes of coxae I fused medially, forming a sternum, with scerotized extensions around trochanters. Anterior apodemes II–IV free medially. Posterior apodemes of coxae I fused medially with anterior apodemes II, extending dorsally completely around trochanters. Posterior apodemes II and anterior apodemes III contacting ventral sejugal apodemes. Anterior apodemes III with very week extensions around trochanters. Posterior apodemes III not fused with anterior apodemes IV. Posterior apodemes IV curved anteriorly. Coxal fields without surface sclerotization. Midline between coxal fields II and genito-anal region with longitudinal row of irregular sclerotized tubercles. Genito-anal region between and slightly posterior to coxal fields IV. Coxal *1a*, *3a*, *4a* setiform, and *4b* absent as in other Histiostomatidae. Genital region (Fig. 5B) conical, directed ventrally, flattened in slide-preparations. Anterior genital papillae situated just anterior to genital cone, contiguous medially; posterior pair slightly larger, positioned lateral to genital cone; both pairs surrounded by sclerotized rings. Genital setae anterior to genital region. Aedeagus directed ventrally, perpendicular to ventral body surface in life, opening at end of genital cone, hooked apically. Interior genital apodemes consisting of genital arch supporting

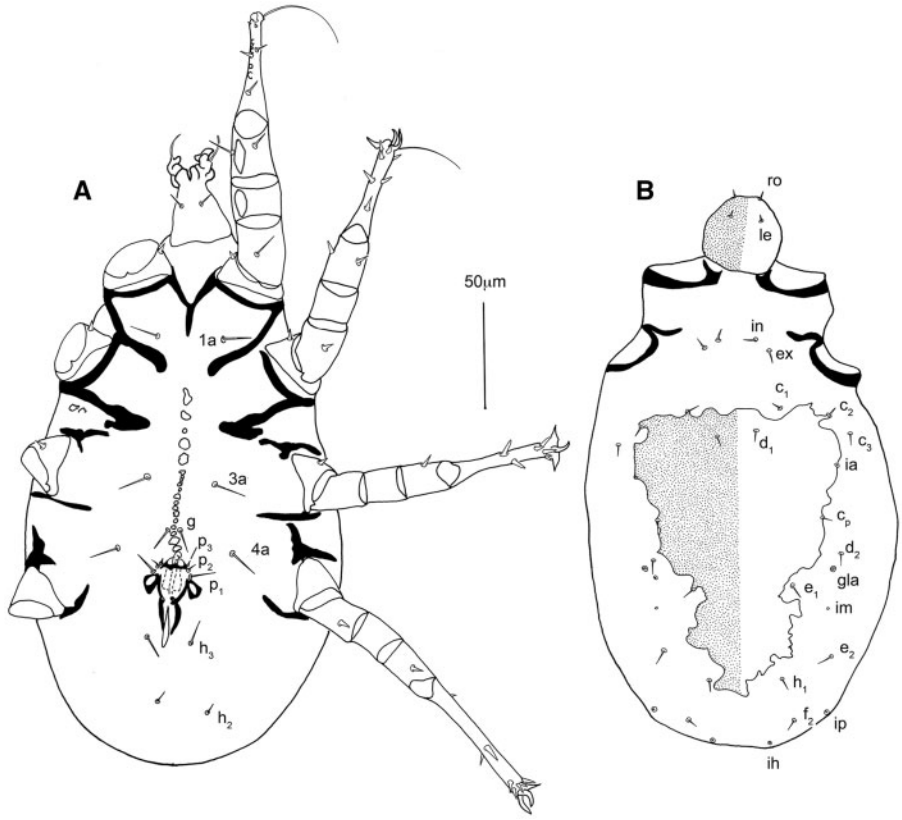

Fig. 3. *M. muscarum*, male. (A) Venter. (B) Dorsum.

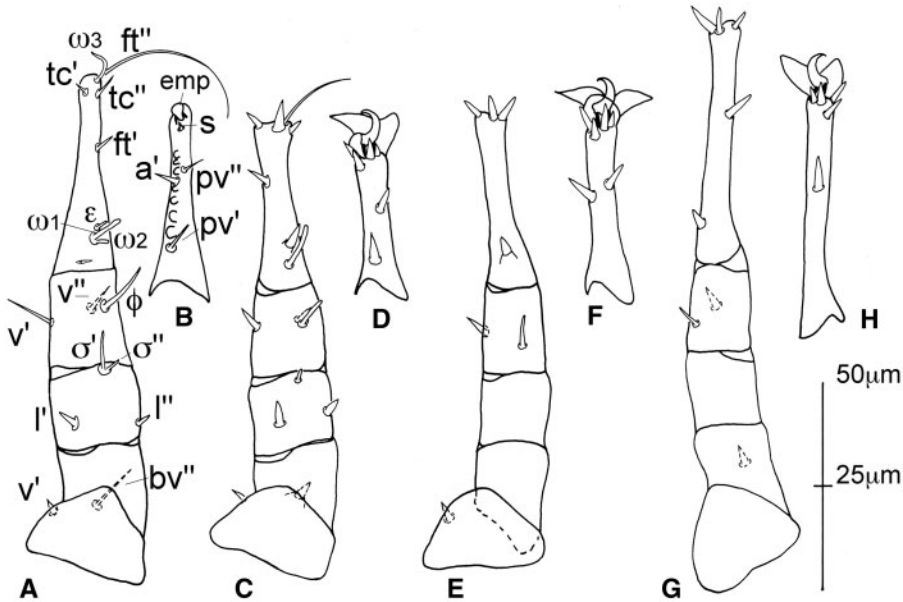

Fig. 4. *M. muscarum*, male legs. (A) Leg I, dorsal. (B) Tarsus I, ventral. (C) Leg II, dorsal. (D) Tarsus II, ventral. (E) Leg III, dorsal. (F) Tarsus III, ventral. (G) Leg IV, dorsal. (H) Tarsus IV, ventral.

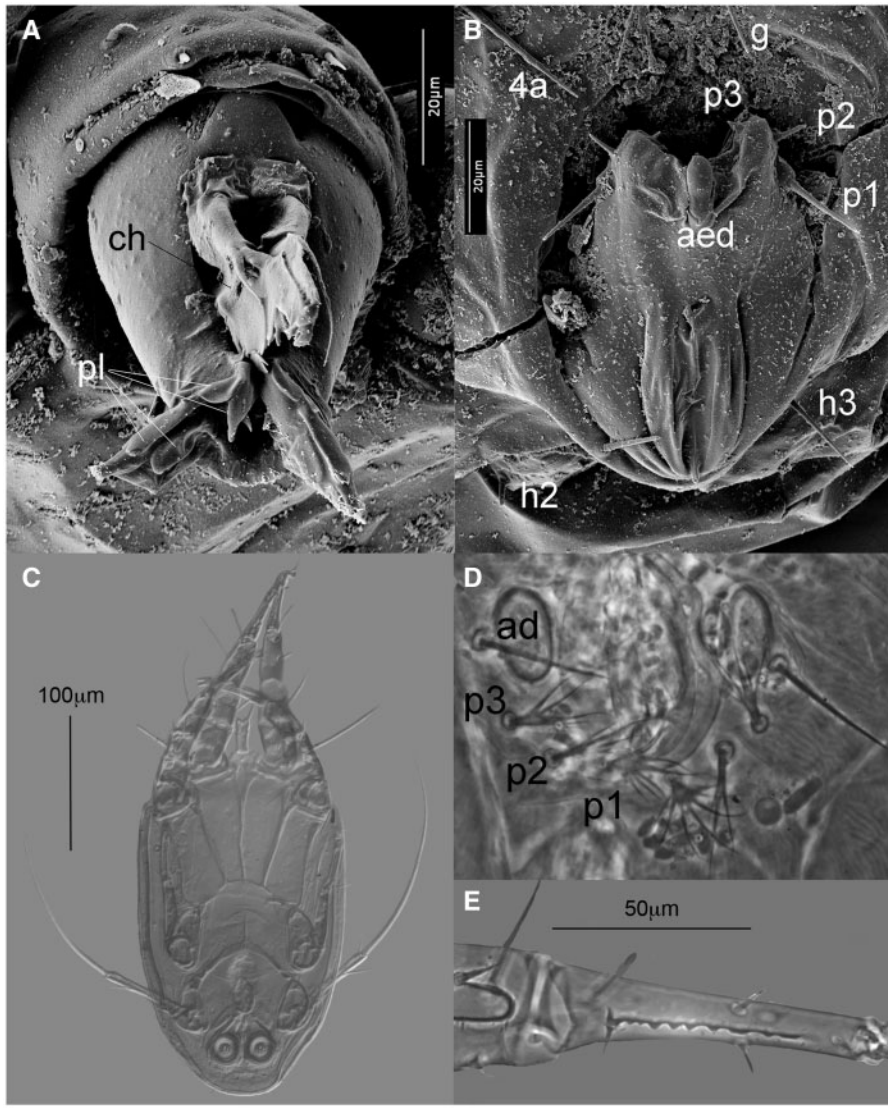

Fig. 5. *M. muscarum*. (A) Male gnathosoma, ch = chelicera, pl = palpal lobes. (B) Male genito-anal region with setae indicated, aed = aedeagus. (C) Neotype deutonymph, ventral. (D) Female, paraproctal region with setae indicated. (F) Male, tarsus I, ventral. D and E at same scale.

aedeagus and a pair of curved apodemes to anterior half of anus. Anus immediately posterior to genital region. Ventral hysterosomal and paraproctal setation here interpreted as *h2* about half-way between anus and end of body, *h3* lateral to posterior end of anus, *p1–3* lateral to aedeagus on genital cone; all setae seitform except *h2* slightly inflated basally; setae of segment P series decreasing in length from posterior to anterior.

Dorsum (Fig. 3B). Cuticle smooth. Propodosomal sclerite longer similar to that of female, bearing setae *ro* and *le* and *ve.* Dorsal continuations of coxal apodemes I–II clearly visible around trochanters I. Sejugal furrow indistinct, without dorsal sejugal apodemes. Hysterosoma with well-developed sclerite with irregular borders, broadly quadrate anteriorly, narrowing posteriorly. Setae, cupules, and gland openings positioned as in female, setae setiform to very slightly inflated basally.

Legs (Fig. 4). All legs slender, legs II–III relatively shorter than in female; form, setae, and solenidia, as in female with the following exceptions: tarsus I with row of sclerotized tubercles along ventral midline in central half of segment (Figs. 4B and 5E); tibia and genu I with ovoid, sucker-like structure with sclerotized edges on ventral surface; solenidion $\omega 3$ of tarsus I strongly hooked, shorter than in female, with a blunt apex and surrounded by a thin membrane; solenidion σ of tibia I much longer than in female, solendidia σ of genu I dissimilar, with σ' about twice the length of σ''.

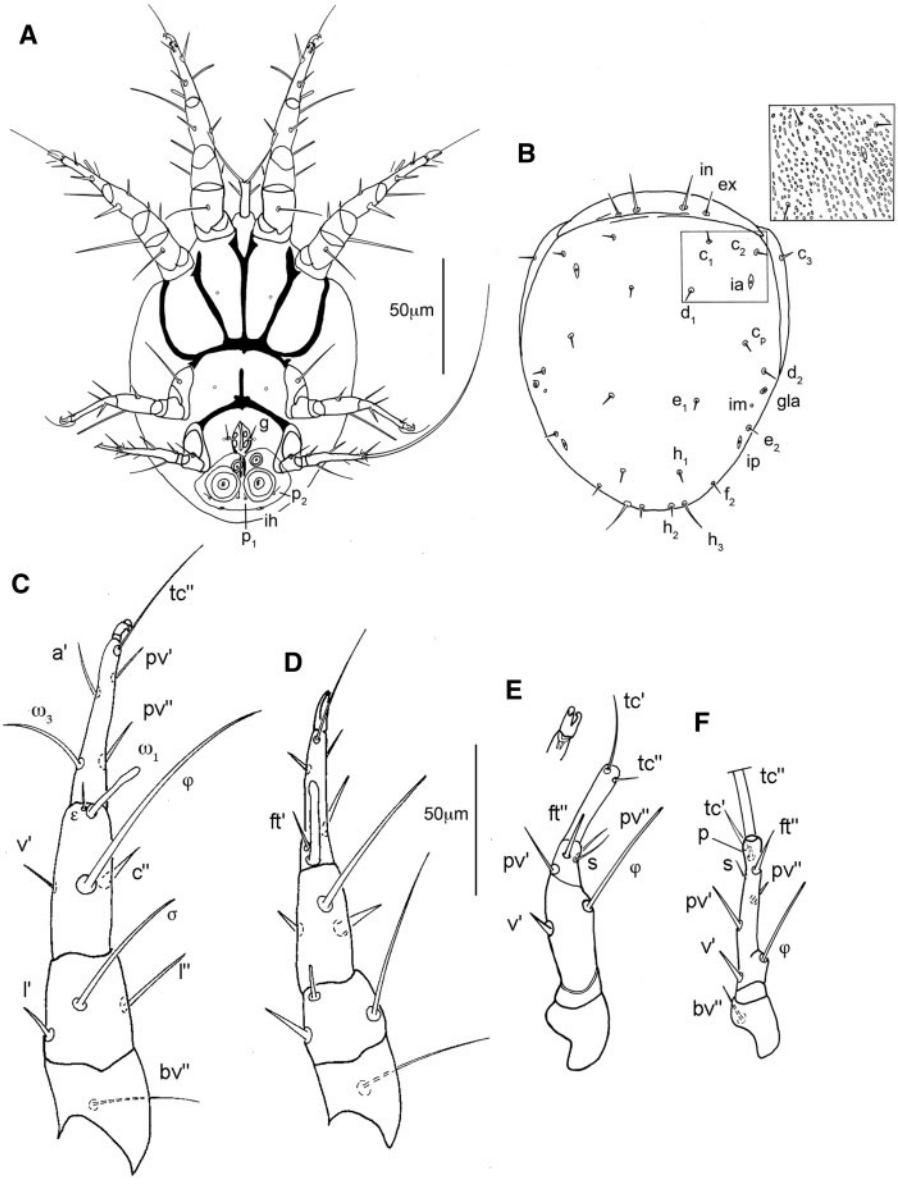

Fig. 6. *M. muscarum*, deutonymph. (A) Venter. (B) Dorsum, with detail of sculpture. (C) Leg I, femur-pretarsus, dorsal. (D) Leg II, dorsal. (E) Leg III, dorsal, with pretarsus ventral. (F) Leg IV, dorsal

Setae (*p*) and (*u*) of tarsus I absent. Pretarsal ambulacra I small, not bilobed, pretarsi II–IV bilobed with pointed apices as in female; empodial claw (Fig. 4B, emp) of pretarsus I rounded, flattened and not claw-like.

Tritonymph. Idiosomal length 355–369 (Texas $n = 3$), 223–287 (Belgium $n = 2$), width 187–250 (Texas), 173–182 (Belgium). Texas specimens overly flattened, Belgian specimens somewhat crushed. Gnathosoma as in female.

Venter. Anterior apodemes of coxal fields I reduced and triangular. Anterior apodemes II–IV free medially. Posterior apodemes I visible only as medial portion fused to anterior apodemes II, anterior part of posterior apodemes I extending dorso-laterally around trochanters I; posterior apodemes II broadly sclerotized, not fused with anterior apodemes III; posterior apodemes III–IV not observed. Two pairs of round genital papillae arranged in a trapezoid between coxal fields IV and anus. Coxal setae *1a*, *3a*, *4a* setiform. Genital setae *g* setiform, anterior to anterior genital papillae. Two pairs setae lateral to posterior half of anus, here interpreted as *p1* and *p2*. Setal pair *h3* slightly anterolateral to posterior pair of genital papillar rings.

Dorsum. Cuticle smooth. Propodosoma with ovoid anterior sclerite bearing setae *ro* and *le*, setae *ex* and *in*

together on rounded protuberances; hysterosomal setae of C and D series and *e1* on broad, elevated area with discrete anterior and posterior margins; setae *e2* not on raised protuberances, setae *f2* and *h1* on individual rounded protuberances on each side. Sejugal furrow and sejugal apodemes weakly developed. Setae *ro* and *le* short, setiform, all others short, narrowly lanceolate. Opisthonotal gland openings and cupules *im* not observed, other cupules as in female.

Legs. All legs similar to female in form and setation. Pretarsal empodial claws simple, not bifurcate.

Deutonymph (Figs. 5C and 6). Body broadly ovoid, measurements in Table 2.

Gnathosoma. Subcapitular remnant elongate. Palpal solenidia arising directly from subcapitular apex, palpal supracoxal setae positioned slightly anterior to midpoint of subcapitulum.

Venter (Figs. 5C and 6A). Anterior coxal apodemes I fused medially to form a long sternum, which fuses posteriorly with fused anterior and posterior apodemes II and anterior apodemes III, closing coxal fields I–II. Posterior apodemes I short, fused to anterior apodemes II. Anterior apodemes II well-developed. Anterior apodemes III fused with others medially, very short posterior apodematal projection from area of fusion. Anterior apodemes IV fused together medially and to longitudinal median apodeme, which extends anteriorly one-half to two-thirds the distance to fused anterior apodemes, ending freely, some specimens with weakly sclerotized extension approaching fused anterior apodemes. Genital opening surrounded by thin, crescentic apodemes, without anterior median. Two pairs of rounded genital papillae within genital atrium. Genital setae *g* setiform, positioned directly laterally of genital opening. Setae of coxal fields I, III, and IV vestigial, alveoli faint or not apparent. Attachment organ broadly pentagonal, with smooth margin. Anterior sucker: small, stalked; median suckers large, with an internal ring surrounding two vestigial alveoli. Anterior lateral, posterior median and posterior lateral cuticular suckers absent. Setae *p1-2* very short, setiform, visible only in some specimens. Cupules *ih* directly behind attachment organ, in line with central suckers. Remnant of anus situated between anterior suckers.

Dorsum (Fig. 6B). Propodosoma very reduced, setae *ex (=se)* about twice as long as *in (=si)*, both setiform. Hysterosoma with pattern of very small round to elongate pits over entire surface. Hysteronotal setae short, setiform, similar in length except *h3* about twice as long as others, evenly scierotized, with small, subequal setae Cupules *ia* and *ip* lyriform, cupules *im* simple pits near opisthosomal gland *(gla)* openings slightly posterior to setae *d2*.

Legs (Fig. 6C–F). Leg segments free except femora–genua I–II fused, femora–genua–tibiae–tarsi III–IV at least partially fused, tarsus III with midsegmental articulation in basal third, tarsus IV without midsegmental articulation. Pretarsi I–III with small membranous ambulacrum and thick, bifurcate empodial claws; pretarsus IV absent. Leg setae: I-0-1-2-2-4; II-0-1-2-2-5; III-1-0-0-1-6; IV-0-[1-0]-[1-7]. Trochanters I, II, and IV without setae; seta v' of trochanter III filiform. Femora I–II with seta bv'' filiform, bv'' IV spinelike. Genu I with setae l' and l'' setiform, l'' about twice the length of l', solenidion σ longer than segment, extending anteriorly to base of tibial solenidion σ; genu II with setae in the form of thin spines, l'' at least 2.5 times longer than l', solenidion ϕ shorter than l'; genual portions of legs III–IV without setae/solenidia. Tibiae I–II with setae v' and c'' spinelike, thicker on tibiae II, solenidia ϕ elongate, reaching to or slightly past distal ends of tarsi, solendion $\omega 1$ and famulus ε at apex of tibia I; tibiae III–IV with setae v' spinelike, solendion ϕ III extending almost to apex of tarsus, ϕ IV extending to middle of tarsus. Tarsus I with 4 setae, here interpreted as (pv) and a' thinly spinelike and tc'' filiform, a pair of tiny ventroapical points may be vestiges of proral setae, solenidion $\omega 3$ about one-fourth to one-third the length of tarsus from the base; tarsus II similar to tarsus I but shorter, spinelike seta ft' present near base of solenidion ω; tarsus III with six setae, four on basal portion of tarsus: pv' setiform at base of segment, pv'' setiform, *s* thinly setiform, ft'' spinelike arranged around articulation, tc'' short, setiform & tc' long, filiform at tarsal apex; tarsus IV with 7 setae: (pv), ft'', *s*, tc', and one proral seta *p* all spinelike, terminal seta tc'' greatly elongated.

Protonymph. Idiosomal length 223–282, width 127–164 (all Texas, $n = 5$). Gnathosoma similar to female.

Venter. Anterior coxal apodemes I–IV ending freely I; posterior coxal apodemes indistinct or absent. One pair of genital papillar rings between legs IV, immediately lateral to the anterior end of the anus. One pair of genital setae *(g)* present slightly anterior to genital papillae. Anus flanked by four pairs of setae: *h3*, *p1-3*, all setiform, P setae longer than *h3*. Setae of coxal fields I and III present, setiform.

Dorsum. Cuticle smooth. Propodosoma with weakly sclerotized sclerite bearing setae *ro* and *le*. Setae *ex* and *in* situated on protuberances. Sejugal furrow weakly developed. All notogastral setae very short, lanceolate. Dorsal hysterosomal setae situated on protuberances as in tritonymph. Opisthosomal gland opening *(gla)* and cupules as in tritonymph.

Legs. Legs similar to other histiostomatid protonymphs, with typical additions of solenidion $\omega 2$ on tarsus I, and setae ft'' (pv), (p), and (u) on tarsus IV, all setae spinelike. Pretarsi slightly bilobed, empodial claws simple, not bifurcate.

Larva not observed.

Eggs. Four eggs within female body with smooth chorion, all 125 × 89 (Texas).

Type material. NEOTYPE deutonymph and two deutonymphs, five females, one male (damaged), three tritonymphs from undetermined Muscidae, BELGIUM: Brussels, 11–X–1946, H. Collert, IRSNB.

Other material examined. United States: California; 21 deutonymphs from houseflies, Alameda Co., Berkeley, W.W. Sampson, "Let. Oct. 17.1950" (USNM Lot 50-14095), UMMZ, USNM; Michigan, one female, two

deutonymphs, one protonymph from poultry litter; Manistee Co., Norman Twp. Sect. 35, SW 1/4, 3.3 mi NW Irons, 44° 10′01″ N, 85° 58′18″ W, 28–VII–1997, B. M. OConnor (BMOC 97-0728-002), UMMZ; Texas, 72 deutonymphs, seven females, five males, three tritonymphs, four protonymphs from human corpse and associated flies, *Synthesiomyia nudiseta* (Wulp, 1883) (Diptera: Muscidae), Hays Co., Dripping Springs, 30° 11′34″ N, 98° 05′11″ W, 18–IV–2011, (BMOC 11-1219-001), CNC, HNHM, OSAL, TAMUIC, UMMZ, ZIN; CANADA: Ontario; 27 deutonymphs from *Muscina stabulans* (Diptera: Muscidae), Middlesex Co., London, 9–IX–1953, W.W. Judd (USNM Lot 55-345) CNC, UMMZ, USNM ["plesiotypes" of Hughes and Jackson (1958)].

Differential Diagnosis. Adult females of *M. muscarum* are similar to those of *M. travei* Fain, 1976, in the form of the dorsal idiosomal setae, which are short, swollen basally, then tapering. All setae are unbarbed. In other species, the setae are simply filiform/setiform (*Myianoetus vesparum* Scheucher, 1957, *Myianoetus virgatus sensu* Scheucher, 1957[5]), thickened spines [*Myianoetus dionychus* (Oudemans, 1910), *Myianoetus tuerkorum* Scheucher, 1957], or some setae are elongated with brush-like barbs distally (*Myianoetus undulatus* Hughes and Jackson, 1958[5], *Myianoetus simplex* Mahunka, 1972, *Myianoetus paganus* Sevastyanov, 1973, *Myianoetus pseudomuscarum* Sevastyanov, 1973, *Myianoetus antipodus* Fain and Galloway, 1993). Females are unique in having the paraproctal setae here interpreted as *p1, p2,* and *p3* strongly branched; they are filiform or setiform in all other species including *Myianoetus travei*. Males are unique in possessing a well developed, dorsal hysterosomal sclerite, and the linear rows of tubercles on the ventral hysterosoma and tarsus I. In other species where males are described (the males of *M. paganus* and *M. virgatus* are unknown), the dorsal hysterosoma is unsclerotized, and the hysterosomal venter and tarsus I are smooth.

Deutonymphs of *M. muscarum* belong to a group of 18 species that lack the foliate seta *tc″* on tarsi I–II, and have seta *ft″* of those tarsi more elongate than in species retaining *tc″*. Within this group, *M. muscarum* shares the strong reduction of conoidal setae *p1-2* of the attachment organ to tiny setae or vestiges with the following six species: *M. dionychus*, *Myianoetus kaszabi* Mahunka, 1967, *Myianoetus lili* Eraky, 1993, *Myianoetus longisetosus* Mašán and Kristofik, 1992, *Myianoetus microti* Sevastyanov, 1971, and *Myianoetus szaboi* Mahunka, 1978. *M. muscarum* differs from all six of these species in having the dorsal hysterosomal setae very short, less than half the length of the exobothridial setae, while in the other six species, the hysterosomal setae are distinctly longer, about the same length as the exobothridial setae.

[5] Samšiňák (1989) placed *M. undulatus* in synonymy with *M. virgatus* based on deutonymphal morphology. However, the adults attributed to these species by the original authors are clearly distinct. Hughes and Jackson (1958) reared their specimens, so their association would seem to be correct. Scheucher (1957) did not and indicated that the association of the female she described as *M. virgatus* was probable but not proven ("Die Zugehörigkeit des Weibchens zu dieser Art ist zwar wahrscheinlich, aber nicht erwiesen.")

Discussion

Both adults and deutonymphs from the Texas population showed considerable size variation, much more so than the few Belgian specimens examined. In spite of the condition of the specimens with respect to overall body size and prodorsal sclerite measurements (i.e., degree of flattening or crushing of the specimens varied between localities), measurements of the North American and Belgian female specimens showed almost complete overlap with the exception of solenidion ϕ on tibia III, which was consistently shorter in the Belgian specimens. Likewise, although the Belgian deutonymphs were all compressed laterally, thus leading to differing body width and propodosomal sclerite measurements, the other measurements all fell within the range of the Texas population. Thus, we consider all of these specimens to be conspecific.

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