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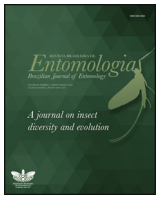

The leaf-miner *Nemorimyza* Frey, 1946 in the Neotropical region: key to species and first record of *Nemorimyza posticata* (Meigen, 1830) from Brazil (Diptera, Agromyzidae)

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ABSTRACT

Nemorimyza Frey, 1946 (Diptera, Agromyzidae) is a genus of leaf-miner flies, with only five known species, some potentially polyphagous. *Nemorimyza posticata* (Meigen, 1830) is recorded from Brazil here for the first time. We provide a diagnosis of this species, including images of the male terminalia. We also provide a key for the five Neotropical species of the genus *Nemorimyza*, with host and distribution information for each species.

Introduction

Nemorimyza Frey, 1946 was first described as a monotypic subgenus of *Dizygomyza* Hendel, 1920, including only *Nemorimyza posticata* (Meigen, 1830). *Nemorimyza* was later treated as a subgenus of *Phytobia* Lioy, 1864 by Frick (1959), and Nowakowski (1962) treated it as genus based on its distinctive male genitalia. More recently, Zlobin (1996) observed morphological and biological similarities between *Nemorimyza* and three species previously included in the *Amauromyza* Hendel, 1931 subgenus, *Annimyzella* Spencer, 1981, recombining them as *N. maculosa* (Malloch, 1913), *N. fuscibasis* (Malloch, 1913) and *N. rachograndensis* (Spencer, 1973).

All *Nemorimyza* species are present in the Neotropical region, with *N. posticata* and *N. maculosa* extending far outside of the region (Boucher, 2010). The other species, *N. pterocaula* (Valladares, 1998), *N. fucibasis* and *N. ranchograndensis* are distributed in South America countries (Martinez and Etienne, 2002). Only two *Nemorimyza* had been previously registered in Brazil: *N. maculosa* and *N. fuscibasis*, both in São Paulo (Spencer, 1963). Recently, Monteiro et al. (2019) also recorded *N. maculosa* in Pará state.

Most *Nemorimyza* species have been associated with Asteraceae hosts, a large number of genera in this family were registered, some with more than one species (e.g. *Solidago* L. and *Symphyotrichum* Nees). The leaf-miner *N. posticata* has been considered a polyphagous species, although Mlynarek and Heard (2018) indicated with molecular data that it is actually a complex of more host-specific lineages. *N. posticata* is a common leaf-miner on *Solidago canadensis* L., a native plant in North America that is cultivated in Europe (Spencer and Stegmaier, 1973). This fly was recorded from several states in the United States on different hosts of Asteraceae (Eiseman and Lonsdale, 2018). The larvae form large irregular blotch mines (Spencer and Stegmaier, 1973; Mlynarek et al., 2016) and the liquid frass is brown, scattered or concentrated in the center of the leaves (Eiseman and Lonsdale, 2018).

In this paper, we record *N. posticata* from Brazil and we provide images of adults and terminalia of the male. A key to the identification of the five Neotropical species of *Nemorimyza* is also presented.

Material and methods

The material was collected with Malaise trap in Guaraciaba do Norte, in Ceará state of Northeast of Brazil. Male terminalia was dissected and macerated in hot 10% KOH for 30 minutes, immersed in glacial acetic

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acid for neutralizing KOH and then placed in slides with glycerin for dissection and analysis under optical microscope. To identification of species, we compared with diagnosis and illustrations present in Spencer and Stegmaier (1973), Spencer and Steyskal (1986) and Zlobin (1996). As well as for provide the complete diagnosis (e.g. using information about female, that were not analyzed) and for elaboration of the key, the characters were taken from these literatures.

The adult was photographed using a Leica M205 C with software version 4.8.0. Digital images of the male terminalia were made using an optical microscope NIKONECLIPSE E200 MV R, with the software Zen 2 (version 2.0). Terminology followed Cumming and Wood (2017), except "ori" for inferior orbital setae and "ors" for superior orbital setae as in Lonsdale (2011). All material was deposited at the Diptera collection of Museu Nacional, Universidade Federal do Rio de Janeiro (MNRJ), part mounted on entomological pins and part immersed in absolute alcohol (MNRJ-ENT1-67203-67208).

Results

Taxonomy

Genus *Nemorimyza* Frey

According to Zlobin (1996) (see to consult complete diagnosis), some characteristics can define the genus *Nemorimyza*, as: general color black; lunule often with silvery or greyish pubescence; three dorsocentral postsutural setae, presutural sometimes present; Fore tibia with a lateral seta; epandrium and surstylus without black spines; surstylus entirely separated from epandrium by a suture.

Key to the species of *Nemorimyza* Frey

1. Dorsocentral presutural seta absent; abdomen partially yellow in male; distiphallus not bifid at end (Figures 2C, D)..... ..... *N. posticata* (Meigen)
- Dorsocentral presutural seta present; abdomen entirely blackish in male; distiphallus bifid at end..... 2
2. Calypter fringe white to silvery..... 3
- Calypter fringe black..... 4
3. Wing length 2.1 mm in male; halteres white, with an oval black spot above..... *N. maculosa* (Malloch)
- Wing length 2.8 mm in male; halteres entirely black .... *N. pterocaula* (Valladares)
4. Frontal setae long; acrostichal setae in three rows..... ..... *N. fuscibasis* (Malloch)
- Frontal setae short; acrostichal setae in six rows..... ..... *N. ranchograndensis* (Spencer)

Nemorimyza posticata (Meigen, 1830) (Figures 1, 2)

Holotype ♂ in Muséum National D'histoire Naturelle, Paris.

Agromyza posticata Meigen, 1830: 172

Agromyza virgauriae Kaltenbach, 1869: 195. (Syn. Hendel, 1920).

Agromyza terminalis Coquillett, 1895: 318. (Syn. established by Malloch 1913: 309).

Agromyza taeniola Coquillett, 1904: 191. (Syn. established by Malloch, 1913: 309)

Agromyza parvicornis (Loew, 1869: 49). (misidentification, in part. Melander, 1913: 254)

Dizygomyza (*Dendromyza*) *posticata* Hendel, 1927: 30

Dizygomyza (*Nemorimyza*) *posticata* Frey, 1946: 42.

Phytobia (*Phytobia*) *posticata* Frick, 1952: 390

Phytobia (*Nemorimyza*) *posticata* Frick, 1959: 377; Sasakawa, 1961: 363 (details of the male and female terminalia)

Nemorimyza posticata Nowakowisk, 1962: 97 (new comb.); Stone et al., 1965: 798 (catalogue); Spencer, 1969: 161 (new record); Spencer, 1972: 63 (diagnosis); Spencer, 1973: 328 (comments); Spencer, 1976: 308; Spencer, 1981: 162 (diagnosis); Spencer, 1983: 53 (new record); Spencer, 1990: 278 (figures); Spencer and Stegmaier, 1973: 95 (diagnosis); Spencer and Steyskal, 1986: 87 (synopsis and new record); Sasakawa, 1992: 27 (new record); Zlobin, 1996: 275; Martinez and Etienne, 2002: 40 (list); Benavent-Corai et al., 2005: 32 (list of host plant); Kahanpää, 2014: 298 (new record); Mlynarek et al., 2016: 220 (DNA identification); Scheffer and Lonsdale, 2018: 81 (mine figure); Eiseman and Lonsdale, 2018: 62 (records in the US); Mlynarek and Heard, 2018: 888 (host associations); Černý and Bächli, 2018: 127 (new record).

Material examined. BRASIL, CE, Guaraciaba do Norte, 6♂, 24.v-12vii.2017, Malaise trap 04°54'27.7"S 037°20'42.3"W 841 m, Sousa, V.R. col. in MNRJ (MNRJ-ENT1-67203-67208).

Diagnosis. Wing length 2.1-2.7 mm (♂), 3.3 mm (♀); lunule small, semicircular, broader than a long; gena narrow, 1/10 height of eye. ***Chaetotaxy.*** Two ors upcurved, two ori inner curved; one row of fronto-orbital setulae; arista minutely pubescent; 0+3 strong dorsocentral setae; acrostichal setulae in 6 rows; prescutellar setae well developed; two pairs of strong scutellar setae, one at base and one apically; fore tibiae with one small median seta; mid tibiae with 2 strong median setae. ***Coloration.*** Body predominantly dark brown; antenna entirely dark brown; arista brown; frons opaque dark brown; fronto-orbital plate shining dark black; lunule silvery (Figure 1C); clypeus and palpi dark brown; labellum yellow; mesonotum and scutellum shining dark brown; calypter with margin and fringe silvery to white; halters light yellow; legs

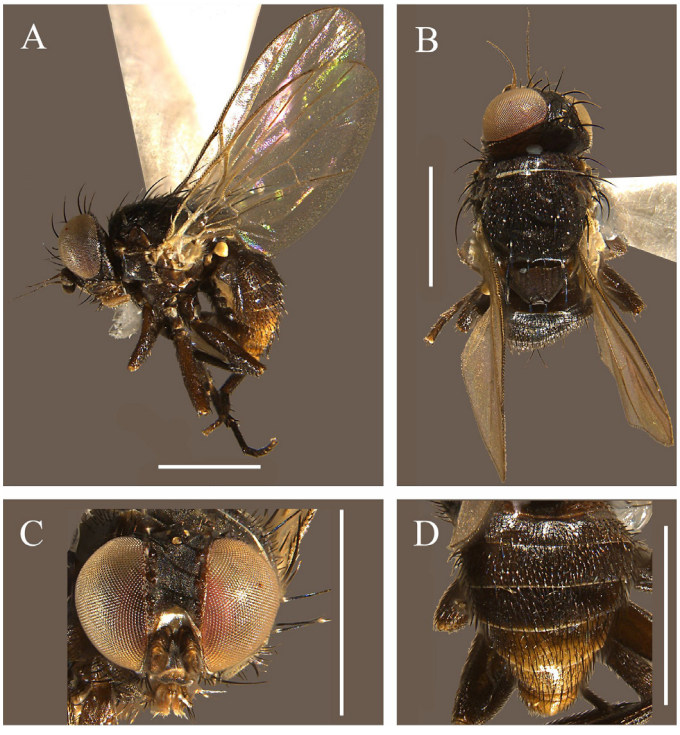

Figure 1 (A-D). *Nemorimyza posticata* (Meigen), adult male: (A) lateral view; (B) dorsal view; (C) head, frontal view; (D) abdomen, dorsal view. Scale bars: 1 mm.

dark brown, with fore and mid knees yellow tinged; abdomen slightly shiny brown, with T5 yellow, brown tinged at base, T6 and terminalia yellow (Figure 1D). ***Male terminalia.*** Epandrium rounded; subepandrial sclerite with a pair of strong spines, downward directed; cerci not too long, with a long seta apically; surstylus separated from epandrium by a suture, with long setae and about 12 spines (Figure 2A); postgonite well sclerotized, with a prominence and one seta basally (Figure 2B); hypandrium U-shaped, with large arms; basiphallus tubular; mesophallus forming an arc in lateral view; distiphallus well sclerotizated, with a distinct shape (Figures 2C, D); ejaculatory apodeme short, slightly enlarged at apice and narrow at base, sperm pump bulbous, membranous but sclerotized near to base of blade (Figure 2E).

Host-plants. The adults of this species have been reared from 39 species of Asteraceae, including: *Aster amellus* L., *A. bellidiastrum* (L.), *Baccharis halimifolia* L., *Buphthalmum salicifolium* L., *Bellidiastrum michelii* Cass., *Doellingeria umbellata* (Mill.) Nees, *Elephantopus carolinianus* Raeusch., *E. elatus* Bertol., *Emilia sonchifolia* (L.) DC. Ex, *Erichtites hieraciifolia* (L.), *Euthamia graminifolia* (L.) Nutt., *Helianthus* L., *Oclemena acuminata* (Michx.) Greene, *Polymnia canadensis* L., *Solidago* sp., *Solidago altissima* L., *S. bicolor* L., *S. caesia* L., *S. canadensis* L., *S. flexicaulis* L., *S. gigantea* Ait., *S. juncea* Aiton, *S. latissimifolia* Mill., *S. nemoralis* Aiton, *S. puberula* Nutt., *S. rugosa* Mill., *S. sempervirens* L., *S. tortifolia* Elliott, *S. virgaurea* L., *Symphyotrichum cordifolium* (L.) G.L. Nesom, *S. laeve* (L.) Á. Löve& D. Löve, *S. lanceolatum* (Willd.) G.L.Nesom, *S. lateriflorum* (L.) Á. Löve& D. Löve, *S. novae-angliae* (L.) G.L. Nesom, *S. puniceum* (L.) Á. Löve& D. Löve, *S. undulatum* (L.) G.L. Nesom, *Verbesina virginica* L., *Vernonia baldwinii* Torr. and *V. gigantea* (Walter) Trel. It has also been reared from one species of Lamiaceae: *Teucrium canadense* L. (The information about the host plants was taken from Mlynarek et al., 2016; Mlynarek and Heard, 2018; Scheffer and Lonsdale, 2018; Eiseman and Lonsdale, 2018)

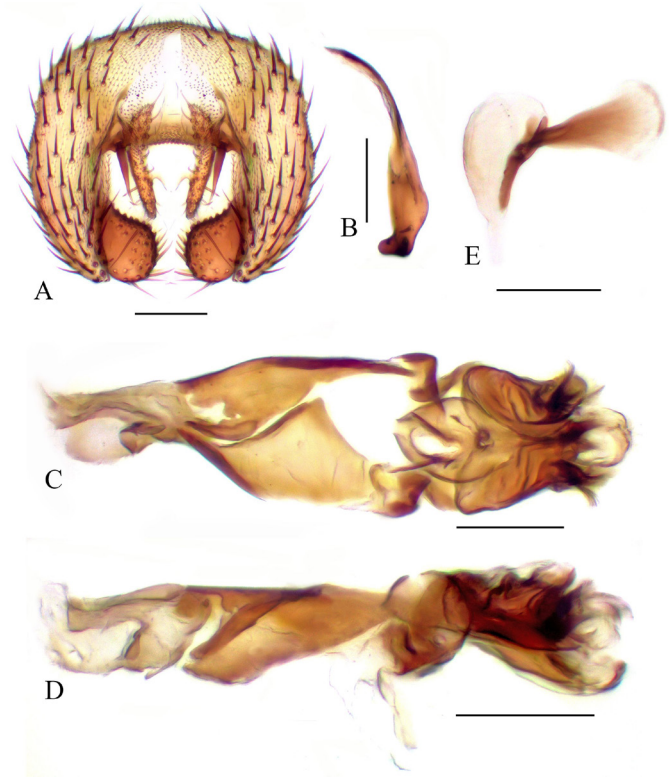

Figure 2 (A-E). *Nemorimyza posticata* (Meigen), adult male terminalia: (A) cercal plate; (B) postgonite; (C) phallus, ventral view; (D) phallus, lateral view; (E) ejaculatory apodeme. Scale bars: 0.01 mm.

Distribution. *North America:* Canada and United States; *Central America:* Costa Rica; *South America:* Brazil **(new record)** and Venezuela; *Europe:* Austria, Belarus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Great Britain, Hungary, Ireland, Italy, Lithuania, Poland, Netherlands, Norway, Spain, Sweden and Switzerland; *Asia*: China and Japan. (list provide by Černý and Bächli, 2018).

Comments. The examined specimens of *N. posticata* from Brazil present small differences from specimens registered in other regions, for example, the calypter fringe is white, while Spencer and Stegmaier, 1973 mentioned fringe silvery in specimens from Florida and Costa Rica. The base of the distiphallus is more triangular (e.g. specimens from Florida (Spencer and Stegmaier, 1973) and California (Spencer, 1981). *N. posticata* is morphologically similar to *N. maculosa*, but differs by the absence of presutural dorsocentral seta; male T5, T6 and the terminalia yellow and by the phallus as a single distinct ornamented tube, not bifid. *N. posticata* was previously recorded in the Neotropical Region from Florida, Costa Rica (Spencer and Stegmaier, 1973) and Venezuela (Sasakawa, 1992). The species is also recorded in the Nearctic (Spencer, 1969), Palearctic and Oriental regions (Martinez and Etienne, 2002).

The presence of *N. posticata* also in Brazil, shows the wide biogeographic range of this species, suggesting that it is a potential species for population studies, since it may become a pest in the future. Unfortunately, the host plant of this species in Brazil is still unknown, so we encourage further studies in order to discover this interaction.

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Conflicts of interest

The authors declare no conflicts of interest.

Author contribution statement

VSR conducted the study conception, collections of the field, the identification and wrote the manuscript. MSC elaborated the key and also wrote the manuscript.

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