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Revision of the goldenrod-galling *Rhopalomyia* species (Diptera: Cecidomyiidae) in North America

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Abstract

Goldenrods (*Solidago* and *Euthamia* species) are common herbs in the eastern United States that support a large and diverse community of highly specific gall-inducing insects. The majority of these insects are gall midges, of which 16 described species are bud, leaf, stem, rhizome, or flower-head gallers belonging to the large genus *Rhopalomyia* Rübsaamen. The present work is a taxonomic revision of the goldenrod-associated *Rhopalomyia* species, which includes a key to the identification of species based on their galls and host plants and descriptions of diagnostic characters for all species. *Rhopalomyia lanceolata* Felt is designated as a new synonym for *R. lobata* Felt, and *R. albipennis* Felt and *R. carolina* Felt are designated as new synonyms for *R. solidaginis* Loew. Neotypes are designated for *R. hirtipes* Osten Sacken and *R. solidaginis*, and two new species are described—*R. gina* Dorchin n.sp. and *R. guttata* Dorchin n.sp. Descriptions include illustrations of galls, male and female morphological characters, and the first description of pupae, where available. New or additional detailed information is also provided on gall structure, phenology, and life history of the gall midges.

Key words: Gall midges, *Euthamia*, *Solidago*, Neotype, Taxonomy

Introduction

Goldenrods (*Solidago* and *Euthamia* species) are common herbs throughout the eastern United States, which have been studied extensively due to their economic importance as ornamentals, weeds, or sources of pollinators and biological control agents. Hosting a great diversity of herbivorous insects from different feeding guilds (Gagné 1968, McEvoy 1988; Maddox & Root 1990; Root & Cappuccino 1992; Fontes *et al.* 1994), goldenrods have also served as model systems for numerous studies that focused on evolutionary and ecological aspects of speciation, resistance, and tritrophic interactions (*e.g.*, Abrahamson & Weis 1997; Heard *et al.* 2006; Stireman *et al.* 2005, 2006; Wise & Abrahamson 2008, Crutsinger *et al.* 2009).

About 50 species of gall-inducing insects have been recorded from goldenrods, two thirds of which are gall midges (Diptera: Cecidomyiidae) (McEvoy 1988). Many of these species were described by Felt (1907a,b,c, 1908, 1909, 1915, 1916; see also Gagné 1989) and some of their galls were later illustrated in his book on galls and gall insects in North America (Felt 1940). Despite the good quality of his type series, Felt's treatment of the goldenrod Cecidomyiidae, as his work on gall-midge taxonomy in general, was mostly superficial. His species descriptions often lack illustrations and are based on characters of little diagnostic value. Many species were described without an association to host or from hosts that were misidentified, and some species were described several times under different names (see Gagné 1968). The dominant group of gall midges on goldenrods consists of 16 described species in the genus *Rhopalomyia* Rübsaamen, the description of which had mostly been based on body color and number of antennal flagellomeres.

Rhopalomyia is one of the largest genera of Cecidomyiidae, with over 250 species worldwide (Gagné 2004). With very few exceptions, species of this genus are restricted to plants of the family Asteraceae, on which they induce mostly complex galls in roots, stems, buds, leaves or flower heads. About 70% of the species are known from plants of the tribe Anthemidae (mainly *Artemisia* and *Chrysanthemum* species). Species life history is directly related to the phenology of the host plant and to the plant organ in which the gall develops. The number of generations per year and the larval instar that goes into diapause varies among species, but all species pupate inside their galls.

Rhopalomyia species are relatively uniform morphologically and show great reduction in taxonomically useful characters. Adults of the Holarctic species have 1–3 segmented palpi, reduced number of antennal flagellomeres, which vary within species and sometimes even in the same individual, and overall reduced setation. Larvae of most species have lost the spatula, and their remaining terminal papillae are barely visible. Pupae, on the other hand, can exhibit useful taxonomic characters (Jones *et al.* 1983), even in species whose adults are morphologically indistinguishable (*e.g.*, Russo 2007). While different combinations of the above-mentioned characters can be helpful in separating species or species groups, they do not justify erection of