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Autor(en): **Skuhravá, Marcela / Stöcklin, Jürg / Weppler, Tina**

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Geomyia n. gen. *alpina* n. sp. (Diptera: Cecidomyiidae), a new gall midge species associated with flower heads of *Geum reptans* (Rosaceae) in the Swiss Alps

MARCELA SKUHRAVÁ[1], JÜRG STÖCKLIN[2] & TINA WEPPLER[2]

[1] Bitovská 1227, CZ-420 00 Praha 4 – Michle, Czech Republic; e-mail: skuhrava@quick.cz
[2] Institute of Botany, University of Basel, Schönbeinstrasse 6, CH-4056 Basel, Switzerland; e-mails: juerg.stoecklin@unibas.ch; tina.weppler@unibas.ch
Corresponding author: PD Dr. Jürg Stöcklin.

We describe *Geomyia* Skuhravá n. gen. *alpin*a Skuhravá n. sp. and we illustrate its taxonomically important structural characteristics. Larvae develop in flower heads of the alpine pioneer plant *Geum reptans* L. (Rosaceae) sucking sap of developing seeds. Only one generation is formed per year. Flower heads infested by *Geomyia alpina* Skuhravá n. sp. were first found in the Alps in eastern Switzerland, on the foreland of the Scaletta glacier at an altitude of 2400 m a.s.l.

Key words: Taxonomy, new species, Diptera, Cecidomyiidae, *Geomyia*, Palaearctic region, plant-insect interactions, *Geum reptans*, Rosaceae

INTRODUCTION

In 2002, in the course of a population-biological study (Weppler & Stöcklin 2005) on *Geum reptans* L. (Rosaceae), an alpine plant species growing on glacier forelands in the central European Alps, larvae of an unknown gall midge species were discovered in the flower heads of this plant. Larvae consumed the developing seeds of the host plant. Gall midge species associated with *Geum reptans* were not described in the literature before. Only Buhr (1964–1965) mentioned the occurrence of many red larvae of an «Ungeklärte Gallmücke» (Nr. 3028) developing in slightly swollen flower heads of *Geum reptans* that he found in the Botanical Garden in Rostock (Germany) on plants originating from Selva in Southern Tyrol (Buhr 1939). According to his information, these larvae lived among the strongly reduced central parts of flowers, occurred only in the years 1936 and 1937 and disappeared afterwards.

Larvae found in 2002 in flower heads of *Geum reptans* and females caught in 2004 at the moment of oviposition in flower heads at the Scaletta glacier, 2400 m a.s.l., Swiss Alps, were examined and are described as a new species and a new genus of gall midge. This species and genus is associated with the alpine plant *Geum reptans*, and is adapted to survive in the harsh environmental conditions at high altitude.

Here, we describe the new species *Geomyia alpina*, n. sp., and we summarize the available information about its biology. For more detailed ecological information, for the effects of predispersal seed predation by *Geomyia alpina*, n. sp., seed set, germinability of predated seeds and demography of *Geum reptans* see Weppler & Stöcklin (2006).

MATERIAL AND METHODS

Sampling of gall midge larvae and of female adults was done during field work on the foreland of the Scaletta glacier situated at the end of the Dischma Valley, 15 km southeastern of Davos (2400 m a.s.l., latitude 46°42' N, longitude 9°57' E) in eastern Switzerland, where populations of *Geum reptans* were studied during several years. The gall midge specimens were caught on flower heads of *G. reptans* and gall midge larvae found in flower heads in 2002 and 2004 were preserved in 70 % alcohol and were then sent to M. Skuhravá for identification and morphological examination.

Specimens were mounted on slides either in Canada Balsam medium (in this case it was necessary to transfer specimens successively into 96 %, then into 100 % alcohol and in the end 100 % xylene), or in Liquido Faure medium where the specimens were transferred directly from 70 % alcohol. Morphological studies were then made using a stereo-binocular microscope Amplival (Carl Zeiss, Jena, Germany) and drawings were made with the aid of a projection microscope Visopan (Reichert, Austria, 1977). Terminology of morphological characters of adults and larvae is according to Sylvén & Tastás-Duque (1993) and Skuhravá (1997). Specimens were identified based on the keys of Skuhravá (1997) and Fedotova (2000).

The holotype and paratypes of *Geomyia alpina*, n. sp. are stored in the collection of Marcela Skuhravá in the National Museum in Praha, Czech Republic. The first author is responsible for the identification and description of the new gall midge genus and species, while the second and last author are responsible for field and laboratory work and for the observation of the feeding habit of larvae and adults of *Geomyia alpina*, n. sp. in the field.

RESULTS

Geomyia Skuhravá n. gen.

Type-species: *Geomyia alpina*, n. sp.

Only the female is known. Eyes separated at vertex. Mouthparts enlarged, frontoclypeus strongly sclerotized. Palpi four-segmented. Antennae 2+12-15 segmented, flagellomeres cylindrical, without stems, first and second flagellomeres fused; flagellomeres decrease towards the tip. Each flagellomere densely covered with microtrichia, with sensorial thread forming a ring, and with a basal whorl of long setae; several sensorial pores are situated in the middle of each flagellomere. Terminal flagellomere usually elongated and formed of two fused flagellomeres. Wings with costa, R_1 and R_5 strongly sclerotized, R_1 joining costa in the middle of anterior margin; the field between costa and R_1 fumose. R_5 slightly bent backwards, meeting costa at the wing apex. Cu forked. Analis developed, strongly sclerotized at the wing base up to the wing middle, then evanescent. Legs very long and slender densely covered with long setae and scales. Claws simple on all legs, slender, moderately bent, empodium a little longer than claws. Abdominal segments covered with caudal row of long setae; the last three segments bent downwards. Ovipositor protrusible and long, tapering towards the tip, upper lamella slender and soft, densely covered with microtrichia and with several long setae, lower lamella small.

Differential diagnosis. *Geomyia* n. gen. belongs to the tribe Oligotrophini which are characterized by simple tarsal claws and long empodia (Skuhravá 1986). In the key to Palaearctic genera in Skuhravá (1997), *Geomyia* n. gen. may be placed in this tribe behind the couplet 3 as the opposite that the females have eyes separated at vertex. Only males of *Phegomyia* Kieffer have eyes separated at vertex, females have eye-bridge developed in usual form. *Geomyia* n. gen. differs from the females of *Masakimyia* Yukawa and Sunose which also have eyes separated at vertex but they have the ovipositor ending with a pair of cerci and three-segmented palpi. *Geomyia* n. gen. has enlarged and sclerotized mouthparts; this is quite unusual in the family Cecidomyiidae and occurs only in few Palaearctic genera, viz. *Ozirhincus* Rondani, *Potentillomyia* Fedotova, 1990, and *Androsacemyia* Fedotova, 1992. Species of the genus *Ozirhincus* Rondani belong to the tribe Lasiopterini and have wings with the vein R_5 close to costa in contrast to *Geomyia* n. gen. where the vein R_5 is joining costa at the wing apex. *Geomyia* n. gen. differs from *Potentillomyia* due to the shape of mouthparts which are heavily sclerotized in *Geomyia* and not sclerotized, quite translucent and covered with small bristles in *Androsacemyia*, and from *Potentillomyia* the mouthparts of which are much more prolonged and the vein R_5 does not reach the wing apex.

Geomyia alpina Skuhravá n. sp.

Type material. Holotype: female, slide number 7729; Switzerland: Scaletta glacier, 2400 m a.s.l. 15 km south of Davos, caught 22.7.2004 on the flower heads of *Geum reptans* L. (Rosaceae), leg. Tina Weppler. Paratypes: 23 females, same data; all deposited in the collection of M. Skuhravá in the National Museum, Praha, Czech Republic.

Description. Female (Figs 1, a–f, Fig. 3). Body size: 1.9 mm; wing length 2.1 mm, wing width 0.8 mm. Body appears to be black in fresh condition, under microscope examination the head, antennae, thorax, legs and abdomen are dark brown and terminal part of ovipositor is cream coloured. Head of normal size and position, eyes separated at vertex. Eyes with circular ommatidia. Mouthparts enlarged, strongly sclerotized. Palpi four-segmented, situated on a maxillar bulbus; first and second segments nearly ovoid, third segment longer and the fourth segment is the longest. Palpal segments densely covered with microtrichia and each with several setae. Frontoclypeus with a group of long setae. Antennae 2+14 segmented (variability of other females 2+12–15), flagellomeres cylindrical, dark brown coloured, without stems. Scape obconical, pedicellus subglobular, both basal segments covered densely with microtrichia and with several setae; first and second flagellomeres fused. Flagellomeres decrease towards the tip. Each flagellomere densely covered with microtrichia, with sensorial thread forming a ring, and with a basal whorl of long setae. Several sensorial pores are situated in the middle of each flagellomere. Terminal flagellomere is elongated and formed of two fused flagellomeres.

Wings with costa, R_1 and R_5 strongly sclerotized, joining costa in the middle of anterior margin; the field between costa and R_1 fumose. R_5 slightly bent backwards, meeting costa at the wing apex. Cu weakly sclerotized forked, veins distally disappearing. Analis well developed, strongly sclerotized at the wing base up to the wing middle, then evanescent. Legs very long and slender, densely covered with long setae and scales. Claws simple on all legs, slender, moderately bent, empodium

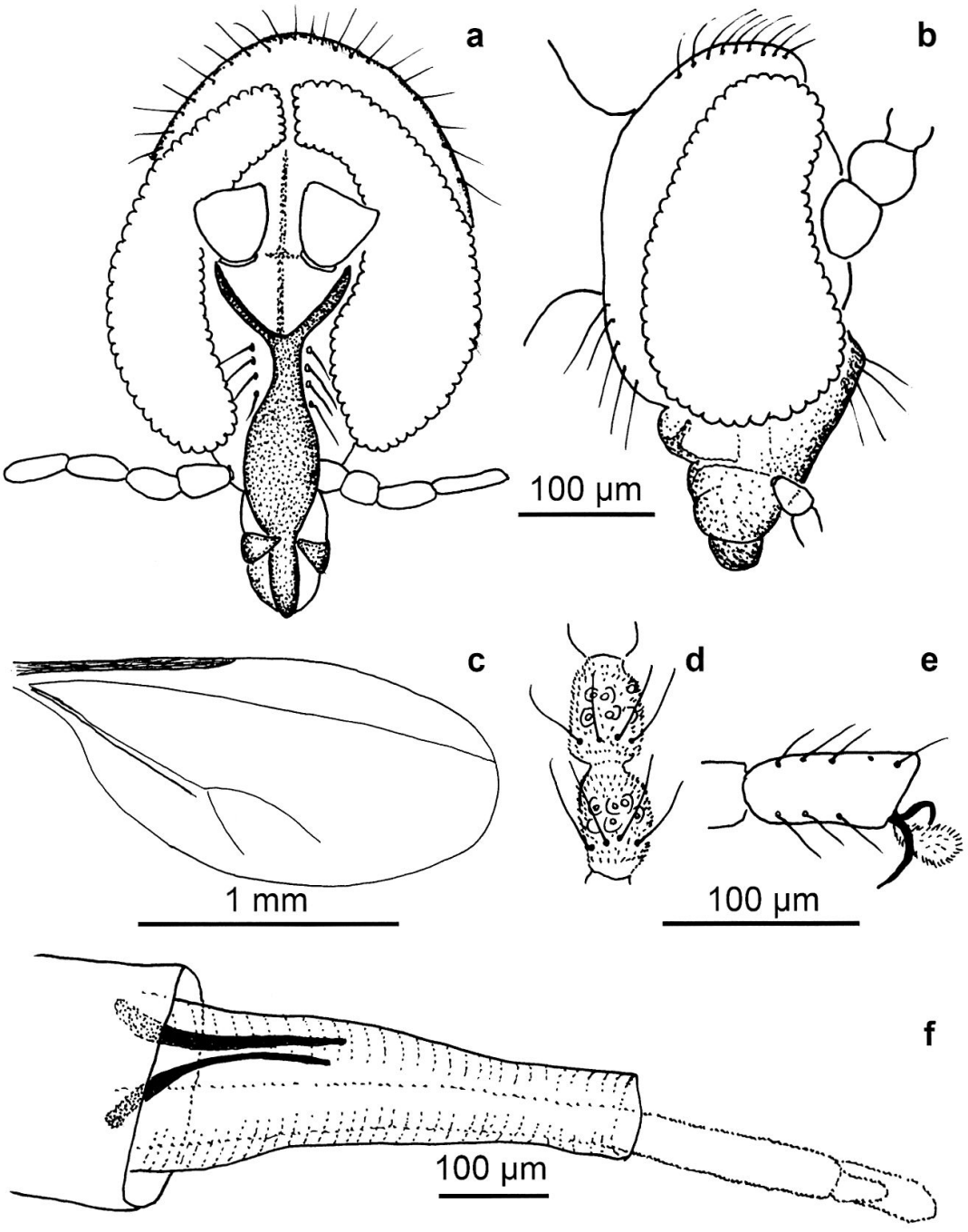

Fig. 1, a–f. *Geomyia alpina* Skuhravá, n. sp., female: – a) head, frontal view. – b) head, lateral view. – c) wing. – d) first and second flagellomeres. – e: fifth tarsomere with claws. – f: ovipositor.

a little longer than claws. Abdominal segments with tergits covered with caudal row of long setae; the last three segments bent downwards. The 8th abdominal segment is strongly sclerotized, formed of dark and bright rings. Its tergit is divided into two longitudinal, strongly sclerotized rods. Ovipositor is long, protrusible and tapering towards the tip; upper lamella is slender and soft, densely covered with microtrichia and with several long setae; lower lamella is small.

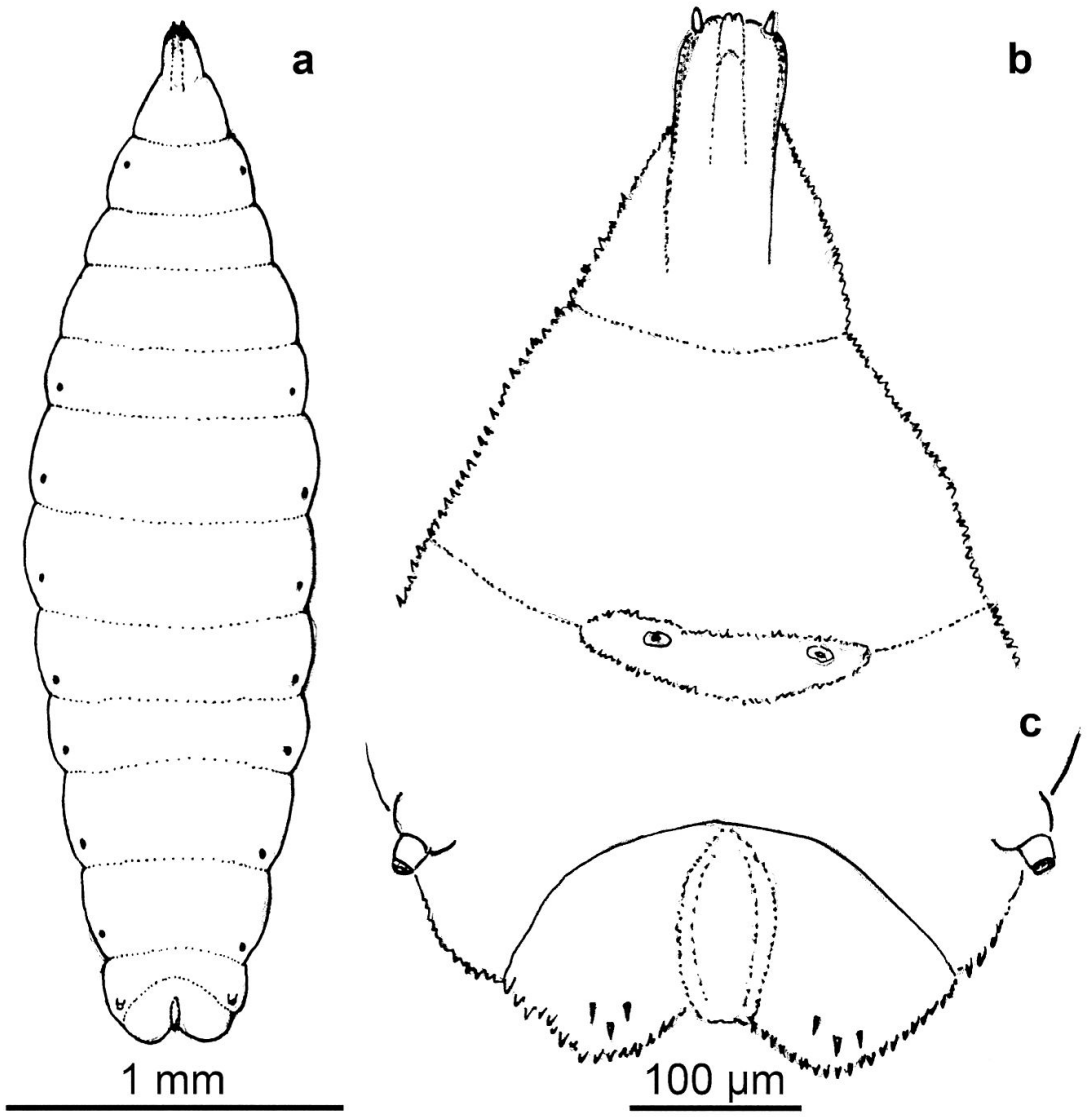

Fig. 2, a–c. *Geomyia alpina* Skuhravá, n. sp., larva (third instar): – a) shape of the body.– b) head and prothoracal segment, ventral view. – c) terminal segment.

Male unknown.

Larva (third instar) (Fig. 2, a–c; Fig. 4): Larva is 2.5–3.2 mm long, 0.9 mm broad, bright orange coloured. The integument of ventral side is smooth, the integument of dorsal side is formed by very small, pointed plates. Without spatula sternalis on the ventral side of the prothoracal segment. Three terminal papillae on both lobes with very small setae.

Host plant. *Geomyia alpina* n. sp. is specificly associated with *Geum reptans* (Rosaceae).

Life history. *Geomyia alpina* n. sp. is a univoltine species. Adults emerge from the soil at flowering time of *Geum reptans* at the end of June and development of larvae is completed at fruiting time in October. Larvae develop within flower heads and leave them for overwintering. Beside the occurrence of larvae, there were no

Fig. 3. A female of *Geomyia alpina* Skuhravá, n. sp.

external symptoms of infestation. Females search for host plants and lay their eggs into flower heads of *Geum reptans* (Fig. 4). Pupation takes place in the soil. As a consequence of the infestation by *Geomyia alpina* n. sp. seed weight is reduced by ca. 25 % and the germinability of the seeds is heavily reduced.

Distribution. *Geomyia alpina* n. sp. is a Central-European and Alpine species that is well adapted to survive harsh environmental conditions at high altitudes.

Name derivation. The generic name is derived from the generic name of its host plant, *Geum reptans*, and the specific name from its occurrence in the Alps.

DISCUSSION

Only twenty of 163 gall midge species found in Switzerland are known to occur in the Alpine zone (Skuhravá & Skuhravý 1997a, b; Skuhravá 1998). Now this guild of Alpine species is enriched by *Geomyia alpina* n. sp. The discovery of a new genus and new species in Central Europe is a relatively rare event because the family Cecidomyiidae is well explored, mainly its group of phytophagous species. The new genus and species show some morphological traits that may be considered as adaptation to life in the harsh environmental conditions at high altitude. Densely haired cover of the body, haired legs and wings protect females from the cold. Dark brown to black colouration of the body increase solar heat gain.

Fig. 4. Larvae of *Geomyia alpina* Skuhravá, n. sp. feeding sap from developing seeds in a flower head of *Geum reptans*.

Considering nutrition, the Cecidomyiidae are included in the group of non-feeding Diptera (Hövemeyer 2000). The mouthparts of adults are developed either well or are reduced in various degree, but they usually are not used for feeding at this developmental stage. Gall midges feed in the larval stage by sucking fluids from plant tissues of developing galls (Skuhravá *et al.* 1984, Shorthouse & Rohfritsch 1992). Well developed mouthparts, with strongly sclerotized frontoclypeus indicate that the females of *Geomyia alpina* n. sp. may suck phloem or xylem sap in flower-heads of *Geum reptans* in the pre-reproductive phase before oviposition. In contrast, females of *Rhopalomyia tripleurospermi* Skuhravá with rudimental mouthparts are not able to suck (Skuhravá & Hinz 2000).

The fact that only females of *Geomyia alpina* n. sp. and no males occur in flower heads of *Geum reptans* at altitudes about 2500 m a.s.l. in the Alpine zone may indicate that this species is reproducing parthenogenetically. Indeed no males have ever been found. Also of the gallmidge *Androsacemyia alatavica* Fedotova, which was found in the Alpine belt of the mountain Alatau in Kazakhstan between 2350–3175 m , only females are known (Fedotova 1992). Larvae of this gall midge cause bud galls on *Androsace lehmanniana* (Primulaceae). Similarly as *Geomyia alpina* n. sp. this species appears to reproduce parthenogenetically.

Parthenogenesis, reproduction without fertilisation by a male, is known only in few families of Diptera, e.g. Psychodidae, Chironomidae, Simuliidae and Cecidomyiidae. In Cecidomyiidae, parthenogenesis is known only in phylogenetically

primitive forms, e.g. *Miastor* and *Heteropeza* and its relatives of the subfamily Porricondylinae, where so called paedogenesis, i.e. reproduction in larval or in early pupal stage, occurs (Wyatt 1961). As far as we know, neither paedogenesis nor parthenogenesis are known in the subfamily Cecidomyiinae. In Chironomidae, boreal populations are parthenogenetic, while southern populations are sexual (Ashburner 2000). Cold conditions (low temperatures during the main part of the year) at high mountains may negatively influence the development and the occurrence of males.

Larvae of *Geomyia alpina* n. sp. are seemingly well adapted to the life in flower heads of *Geum reptans*. Their body is fusiform tapering toward the head. Larvae feed by sucking sap from the developing seeds. Larvae of *Geomyia alpina* n. sp. do not possess spatula sternalis, the unique organ on the ventral side of the prothoracic segment which separates members of the family Cecidomyiidae from all other families of Diptera (Harris, 1994). This organ is usually used by larvae to form the escape opening from galls and movement through tissue. For the larvae of *Geomyia alpina* n. sp., which live freely among the developing seeds in flower heads, the spatula sternalis lost his function and obviously disappeared in the course of phylogenetic development.

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