

GALL MIDGES (DIPTERA: CECIDOMYIIDAE) IN FOREST ECOSYSTEMS

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INTRODUCTION

The family Cecidomyiidae is one of the largest of the Diptera. Gall midges are small, inconspicuous flies, but they may be very important both in forest ecosystems and in agroecosystems. Many phytophagous gall midge species attack forest trees, and some of them can be serious pests, such as the *Dasineura rozhkovi* Mamaev and Nikolsky, which develops in bud galls of *Larix sibirica* Ledeb (Isaev et al. 1988). More than 1,200 species in 125 genera are known to occur in the Nearctic Region (Stone et al. 1965), and about 2,200 species in 300 genera occur in the Palearctic Region (Skuhrová 1986). It has been estimated that the world fauna of gall midges includes four or five thousand species.

Adult gall midges have small bodies, usually only 0.5 to 3 mm long, rarely up to 8 mm long, and long antennae. Adults do not take food and therefore cannot cause damage to humans in any way. The larvae of gall midges feed and develop in various environments. On the basis of larval feeding habits, gall midges may be divided into three ecological groups: the mycophagous (= fungivorous), the phytophagous, and the zoophagous (Skuhrová et al. 1984). The majority of described species belong in the group of phytophagous gall midges, the larvae of which develop in, or on, various organs of many host plant species, where they feed by sucking sap from the tissues. Many of them induce development of some type of abnormal plant growth, called galls. The larvae of gall-producing species develop on most plant parts: roots, stems, vegetative tops, leaves, flowers, and fruits.

Gall midges usually have only one generation per year, although some species have two or more generations per year. Adults have very short lives, sometimes only several hours long, sometimes 1 to 4 days. Males usually perish shortly after mating, females very soon after oviposition. The typical life cycle begins early in the spring with emergence of the adults either from the gall or from the soil where they hibernate as larvae. Females lay their eggs on the surface of the organs of the host plants. Galls develop and the larvae develop inside them, sucking sap. Development of the larvae from hatching to maturity (three or four stages) requires usually 2 or 3 weeks. Many species drop to the soil, where they hibernate. Larvae of other species live in their galls through pupation.

Gall Midges as Forest Pests

Barnes (1951) has reviewed of about 240 gall midge species associated with coniferous and broad-leaved trees in the world. The larvae of 80 species develop on various species of 14 genera of coniferous trees, making galls on buds, terminal shoots, needles, fruits, seeds, and cones, or living under bark, in resin masses, in scolytid burrows, and in aphid galls. In Europe only seven species may be

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considered serious pests: *Thecodiplosis brachyntera* Schwagr. on needles of *Pinus silvestris* L. and *P. mugo* Turra, *Resseliella piceae* Seitner on seed of *Abies alba* Mill., *Plemeliella abietina* Seitner on seed of *Picea excelsa* Link., *Dasineura kellneri* Henschel (= *Dasineura laricis* [F. Low 1878]) on bud of *Larix decidua* Mill., *Paradiplosis abietis* Hubault on needles of *Abies alba* Mill., *Taxomyia taxi* Inchtald on terminal buds of *Taxus baccata* L., and *Janetiella siskiyou* Felt (= *Craneiobia lawsoniana* de Meijere) on the seed of *Chamaecyparis lawsoniana* Parl. imported from North America. The larvae of about 160 gall midge species develop on various species of 35 genera of broad-leaved trees in the world, producing various types of galls on terminal buds, stems, twigs, leaves, petioles, flowers, flower-stalks, fruits, and pods, or living under the bark, in decaying wood and bark, or as predators in the galls of mites or aphids.

Most gall midges cannot be considered pests, but some of them may increase and then attain the status of pest. For example, in Central Europe, in Czechoslovakia, more than 500 gall midge species have been identified (Skuhrová 1987), 92 of which are associated with forest trees and may be considered as actual or potential pests. Thirteen species develop on coniferous trees and 79 develop on broad-leaved trees (Skuhrová 1983). At present, the following eight species of gall midges damage forest tree species and are actual pests: *Contarinia fagi* Rubsaamen on young trees of *Fagus sylvatica* L., in forest nurseries or planted trees in submontane and montane areas; *Contarinia quercicina* Rubsaamen on young oaks, *Quercus robur* L. and *Q. petraea* Liebl., in hilly country; *Dasineura irregularis* Bremi (= *Dasineura acercispans* [Kieffer]) on developing young leaves on terminal parts of the twigs of maple, *Acer pseudoplatanus* L., in lowlands and hilly countries; *Harrisomyia vitrina* Kieffer and *Drisina glutinosa* Giard. on leaves of young, medium-aged and old maple trees, *Acer pseudoplatanus* L., in submontane regions; *Dasineura fraxinea* Kieffer on leaves of young, medium-aged and old ashes, *Fraxinus excelsior* L., in hilly regions; *Dasineura thomasiana* Kieffer on leaf buds of young trees of *Tilia platyphyllos* Scop. and *Tilia cordata* Mill. in hilly areas; *Dasineura kellneri* Henschel (= *D. laricis* F. Low) on buds of larch, *Larix decidua* Mill., in central and southwestern parts of Bohemia.

The following 15 gall midge species represent potential pests of forest trees in Czechoslovakia: *Thecodiplosis brachyntera* Schwagr. and *Contarinia Caeri* Prell. on *Pinus silvestris* L. and *P. mugo* Turra; *Paradiplosis abietis* Hubault on *Abies alba* Mill., *Taxomyia taxi* Inchtald on *Taxus baccata* L., *Plemeliella abietina* Seitner on *Picea excelsa* Link., *Resseliella piceae* Seitner on *Abies alba* Mill., *Contarinia marchali* Kieffer on *Fraxinus excelsior* L., *Mikiola fagi* Hartig on *Fagus sylvatica* L., *Dasineura fraxini* Bremi on *Fraxinus excelsior* L., *Zygiobia carpini* F. Low on *Carpinus betulus* L., *Didymomyia tiliacea* Bremi on *Tilia platyphyllos* Scop. and *Tilia cordata* Mill., *Dasineura tortilis* Bremi on *Ahnus glutinosa* Gaertn., *Dasineura populeti* Rubsaamen on *Populus tremula* L., *Wachtliella rosarum* Hardy on various species of *Rosa*, and *Dasineura (Rhabdophaga, Helicomyia) saliciperda* Dufour on various species of willows, *Salix* sp. The distribution areas of some of these gall midge species in the Palearctic Region were elaborated by Skuhrová (1987).

Gall Midges as Members of Forest Ecosystems

In relation to ecosystem studies, most gall midges may be considered part of the grazing food chain: the majority of gall midge larvae suck the sap of the plant tissues making or not making the galls. Another, but smaller part of the gall midge population belongs to the detritus food chain in which those species occur which suck sap from decaying or dead plant matter, i.e. the phytosaprophagous and mycophagous gall midges. Data about species composition, seasonal dynamics and function of gall midges in two types of forest ecosystems were obtained from studies organized within the International Biological Program on the Territory of Czechoslovakia. In 1973, stationary emergence traps were used to collect spiders, harvestmen, and insects, including Diptera, from the soil in a spruce monoculture at Kunicky, in the area of the Drahanska vrchovina Highlands, about 16°E and 49°N, at an elevation of 620 m a.s.l. The plant community was a type of unnatural woodland with unsuitable composition of *Picea excelsa* Link. The soils belong to the acid brown forest soil type (Vanhara 1983). In 1973, from the beginning of May up to the beginning of November, 1,108

specimens of adult gall midges emerged from soil under the tree traps. The majority of gall midges emerged in the spring. In terms of composition, most belonged to the zoophagous genera, *Lestodiplosis* (57 percent) and *Trisopsis* (11 percent). About 19 percent belonged to the phytosaprophagous species *Porricondyla neglecta* Mamaev. Strictly phytophagous gall midge species formed only 1 percent of the emerging specimens (Table 1).

In 1971, 1972, and 1981, other ecosystem studies were carried out in a lowland forest of the Ulmeto-Fraxinetum-Carpineum type near Lednice na Morave using the sweep samples (Vanhara 1981, 1986). In all, 7,815 specimens of Diptera were obtained in 1971, among them 3,417 specimens representing 711 species (9 percent) of gall midges. In lowland forest ecosystems, the family Cecidomyiidae is one of the richest families of Diptera.

From late April to early October in 1981, 319 adult gall midges were collected. In lowland forests, the flight period of gall midges has two peaks, the vernal maximum in May and the autumnal one in early September. The species composition is more varied than that in the monoculture of *Picea excelsa*, with a predominance of the phytophagous species, *Contarinia tiliarum* and *Dasineura thomasiana* (Table 2).

Table 1. The composition of gall midge species emerging in 1973 from soil of a spruce monoculture (*Picea excelsa* Link.) at Kunicky in the Dražanská vysočina Highlands, Czechoslovakia, by means of stationary collecting emergence traps.

Species or genus	Number of individuals			Percent of total	Feeding habits ¹
	Males	Females	Adults		
<i>Lestodiplosis</i>	254	373	627	57	Z
<i>Porricondyla neglecta</i>	80	126	206	18.5	PS
<i>Trisopsis</i>	54	71	125	11	Z
<i>Thecodiplosis brachyntera</i>	2	4	6	0.5	P
<i>Kaltenbachiola strobi</i>	2	3	5	0.5	P
Cecidomyiidae, undetermined	46	93	139	12.5	-
T o t a l:				100	

¹Abbreviations: Z = zoophagous, PS = phytosaprophagous, P = phytophagous.

Table 2. The gall midge species composition in the flood plain forest, Ulmeto-Fraxinetum-Carpineum type, near Lednice na Morave, Czechoslovakia, obtained by the sweeping method in 1981

Species or genus	Number of individuals			Percent of total	Feeding habits ¹
	Males	Females	Adults		
<i>Contarinia tiliarum</i>	30	46	76	24	P
<i>Porricondyla neglecta</i>	19	40	59	18.5	PS
<i>Lestodiplosis</i>	16	44	60	19	Z
<i>Clinodiplosis cilicrus</i>	13	30	43	13.5	PS
<i>Mycodiplosis</i>	10	6	16	5	PS
<i>Dasineura thomasiana</i>	3	8	11	3.4	P
<i>Macrolabis</i>	4	7	11	3.4	PI
<i>Craneiobia corni</i>	1	5	6	1.8	P
<i>Dasineura</i>	6	-	6	1.8	PI
<i>Trisopsis</i>	2	2	4	1.2	Z
<i>Jaapiella</i>	3	-	3	0.9	PI
<i>Lasioptera tiliarum</i>	-	2	2	0.6	PI
<i>Didymomyia tiliacea</i>	1	1	2	0.6	P
<i>Tricholoba</i>	-	2	2	0.6	PI
<i>Aphidoletes aphidimyza</i>	1	-	1	0.3	Z
<i>Parallelodiplosis galliperda</i>	1	-	1	0.3	PI
<i>Therodiplosis persicae</i>	1	-	1	0.3	Z
Cecidomyiidae, undetermined	8	7	15	4.8	-
T o t a l :				100	

¹Abbreviations: P = phytophagous (gall-producing), PI = phytophagous--inquilines, PS = phytosaprophagous, and Z = zoophagous

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