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short communication

Contribution to the knowledge of the parasitoid fauna of leaf mining sawflies (Hymenoptera: Tenthredinidae) of forest plants in Hungary

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Abstract

Background and Purpose: *Despite the importance of studying the native enemy complex of the introduced and invasive leaf miner sawfly species in their native territories, few studies have been done in recent years concerning the species component and the regulating potential of their parasitoid complexes (in both native and invaded area).* Heterarthrus vagans *and* Fenusa dohrnii *are only some of the species which are native in Palearctic area, but alien invasive in North America, causing damage on forest plantations. In this short paper we provide our original data to the knowledge of parasitoid fauna associated with seven leaf mining sawflies native in Hungary.*

Material and Methods: *For a period of four years (2011–2014), several leaf miner species were collected and placed in single mine rearings. From the leafminers, belonging to the Tenthredinidae family, a total of 809 mines made by 9 different species (*Heterarthrus wuestneii, Fenusa dohrnii, Heterarthrus vagans, Fenusa pumila, Fenusella nana, Profenusa pygmaea, Metallus pumilus, Parna apicalis, Fenusa ulmi*) were collected from 19 locations across Hungary.*

Results and Conclusions: *A total of 188 specimens of 13 parasitoid species belonging to 3 families (Braconidae – 1; Ichneumonidae – 1 and Eulophidae – 11) were reared out from our samples. Parasitoid adults were obtained from 7 of the 9 species of leaf mining sawfly hosts (*Fenusa dohrnii, Fenusa pumila, Fenusa ulmi, Heterarthrus vagans, Metallus pumilus, Parna apicalis, Profenusa pygmaea*). From* Heterarthrus wuestneii *and* Fenusella nana *no parasitoid adults emerged.The parasitoid species presented in this work are typically associated with leaf mining sawflies. Several new host-parasitoid associations have been described.*

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INTRODUCTION

The Tenthredinidae family is the largest sawfly family, with at least 5,724 species worldwide (1). The family includes free feeding, gall inducing and leaf mining species (1–4). Leaf mining sawflies commonly make blotch mines on the upper side of the leaves, with irregularly deposited frass, less commonly bilateral (present on both sides) mines (5). Species pupating inside the mine, often make a disk-shaped cocoon chamber, like *Heterarthrus vagans* (Fallén, 1808). The leaf mining sawflies are regularly host specific (3).

Some of our native leaf mining sawflies are alien and invasive in North America. *H. vagans* is bivoltine in Hungary (4) and it is native throughout the Palearctic region (2, 4). In 2009 it was found (as alien species) in the southwestern part of North America (6) on *Alnus sp.*. *Fenusa dohrnii* (Tischbein, 1846), which is also monophagus on alder (*Alnus*) species, often makes more than one mine on the upper side of the leaf (3). The larva pupates outside the mine. In North America (its non-native range), as an invasive pest, it causes serious problems in alder stands (7, 8). *Fenusa pumila* (Klug, 1816), and has also been found as an alien species in Alaska on *Betula* sp. (9). It has 2-3 generations per year both in its native range (3) and in the newly invaded territories where it can locally be abundant (9). Several blotch mines can be found on a single leaf between June and September (10). The species is oligophagous on hosts belonging to Betulaceae family.

Profenusa pygmaea (Klug, 1816) is univoltine and monophagous on *Quercus* species. Its mines can be found from May until the end of July (3, 11, 12). It is common in its native range and can become really abundant in some locations (12).

On Ulmus species, *Fenusa ulmi* (Sundevall, 1847) is univoltine. The upper surface blotch mines can be found from May to June (4).

The blotch mines of *Parna apicalis* (Brischke, 1888) are located toward the margin of the leaf. The leafmier sawfly is monophagous on *Tilia* species (3).

Metallus pumilus (Klug, 1816) is oligophagous on *Rubus* species with two generations a year (4, 28). The importance of parasitoids as regulating factors of Lepidoptera species mining on trees (both native ones and aliens) is reflected in the high number of papers published in the past decade (13–19). Parasitoid complexes of leaf mining sawflies have been less studied recently, and only slightly some older publications deal with them (20–24) The Universal Chalcidoidae Database lists species associated with leaf mining sawflies only from a few works. In this short paper we provide our original data to the knowledge of parasitoid fauna associated with seven leaf mining sawflies native in Hungary.

MATERIAL AND METHODS

We studied the parasitoid complexes of various leaf mining sawflies during a four year period (2011–2014). A total of 809 mines made by 9 different species (all native in Hungary) were collected at 19 locations. The names and coordinates of the collecting locations are given in

Table 1: *Collecting locations and their coordinates (decimal degrees) with the number of mines collected in different years*

Locations	Coordinates	2011	2012	2013	2014	Total
Csörötnek	46.936365, 16.374056			11		11
Farkasgyepű	47.199201, 17.637533			1		1
Galyatető	47.914998, 19.928045			6		6
Gödöllő	47.569384, 19.381214			5		5
Gyöngyössolymos	47.823067, 19.926546		3	9	17	29
Királyrét	47.894822; 18.974878			1		1
Kötegyán	46.733336; 21.487859	33				33
Kunmadaras	47.392356; 20.810463			95		95
Mátrafüred	47.833894; 19.961676	23	47	194	10	274
Mátraszőlős	47.948090; 19.706682		9			9
Nadap	47.259462; 18.606428			26		26
Pusztamiske	47.066963; 17.442294			97		97
Püspökladány	47.332753; 21.091173			49		49
Szarvas	46.863383; 20.536829		13			13
Szeghalom	47.011884; 21.136697		64			64
Tiszabura	47.446905; 20.469560	16				16
Ugod	47.304641; 17.618547			7		7
Várgesztes	47.470887; 18.398589			10		10
Vértesacsa	47.382252; 18.564229			63		63
Total:						809

Table 2: *Foodplants and voltinism of the hosts with the number of the mines collected*

Foodplant	Sawfly host	Voltinism	2011	2012	2013	2014	Total
Acer campestre	*Heterarthrus wuestneii*	1		19	58		77
Alnus glutinosa	*Fenusa dohrnii*	2-3			154	24	178
	Heterarthrus vagans	2-3			26		26
Betula pendula	*Fenusa pumila*	2-3			39		39
	Fenusa sp.				6		6
	Fenusella nana	1-2		3			3
Quercus spp.	*Profenusa pygmaea*	1	23	36	139	3	191
Rubus spp.	*Metallus pumilus*		49		11		60
Tilia cordata	*Parna apicalis*	1		1	65		66
Ulmus spp.	*Fenusa ulmi*	1		77	86		163
Total:			72	136	574	27	809

Table 1, and the number of mines collected from different hostplants are found in Table 2.

The mines were carefully cut out from the leaf after the collection in order to avoid contamination by parasitoids attacking other insects on leaves (i.e. egg or aphid parasitoids). After a short period of drying, the samples were placed individually into air ventilated plastic rearing tubes. The parasitoids reared out were preserved in absolute ethanol and later identified by Csaba Thuróczy and George Melika. The emerging leaf miner adults were also identified to make sure that the identification of the leaf mines was correct. After the identification process, the adult insects were kept in ethanol in order to preserve them for future examinations (i.e. molecular analysis). The names of the hosts are from the Electronic World Catalogue of Symphita (1), while the names of the parasitoids follow Universal Chalcidoidae Database (25).

RESULTS AND DISCUSSION

From our samples, 188 adult parasitoid specimen emerged, belonging to 13 species of 3 families (1 Braco-

Table 3: *The number of parasitoids reared from different hosts*

		Fenusa dohrnii	Fenusa pumila	Fenusa ulmi	Heterarthrus vagans	Metallus pumilus	Parna apicalis	Profenusa pygmaea	Total
Braconidae	*Braconidae* sp.							1	1
Ichneumonidae	*Itoplectis alternans*					2			2
Eulophidae	*Achrysocharoides cilla*					7	1	5	13
	Aprostocetus sp.			1		1	1		3
	Chrysocharis eurynota							35	35
	Chrysocharis nitetis							61	61
	Chrysocharis pentheus	4	2	1				1	8
	Chrysocharis sp.							7	7
	Chrysocharis sp. *B – cf. nitidifrons*				40				40
	Closterocerus trifasciatus							1	1
	Minotetrastichus frontalis							1	1
	Pnigalio pectinicornis	4				9		1	14
	Sympiesis sericeicornis	1				1			2
Total:		9	2	2	40	20	2	113	188

nidae; 11 Eulophidae and 1 Ichneumonidae) (Table 3). No parasitoids emerged from mines of the *Heterarthrus wuestneii* (Konov, 1905) and *Fenusella nana* (Klug, 1816). The parasitism rate varied from 1.5% to 19% among localities and host species.

A total of 9 parasitoid species, belonging to 2 families (Braconidae and Eulophidae) have been identified from *P. pygmaea*. The parasitism rates varied between 12 % (n=67 leaf mines) and 15% (n=94 leaf mines). The dominant parasitoid species were the *Chrysocharis nitetis* (Walker, 1839) and *Chrysocharis eurynota* (Graham, 1963). These species showed gregarious character (more than one parasitoid developing on a single host). Five specimens of *Achrysocharoides cilla* (Walker, 1839) (koinobiont endoparasitoid) were found at only one location (Mátrafüred). The parasitoid complex of *P. pygmaea* seems to be composed of typical sawfly parasitoids (20, 22, 23, 25, 26).

Only one parasitoid species, *Chrysocharis* sp. B –cf *nitidifrons* (Graham, 1963) (n=26 leaf mines) *was* reared out from *H. vagans* mines. The "cf. *nitidifrons"* means that the specimens identified were close to *C. nitidifron*s, but due to some special signs we could not be 100% confident in the determination. *C. nitidifrons* has very few known host associates, which are the following*: Cimbex quadrimaculata* (Müller, 1766)*, Ectoedemia argyropeza* (Zeller, 1839)*, Stigmella splendidissimella* (Herrich-Schäffer, 1855) and *Emmetia angusticolella* (Duponchel, 1843)*, Emmetia marginea* (Harworth,1828) (26, 27). According to Noyes (2015) (25), this parasitoid is oligophagous on *Crataegus bus* sp. These host plants are a well-known component of mixed broadleaved forests. The Global Chalcidoidae Database lists eight species of parasitoids for *H. vagans*, none of which were reared during this research. The *C.* sp. B –cf *nitidifrons* was not listed neither by Noyes (2015) (25) nor by Schönrogge (21) as a parasitoid of *H. vagans*.

From *Fenusa dohrnii*, three species, *Chrysocharis pentheus* (Walker, 1839), *Pnigalio pectinicornis* (Linnaeus, 1758) and *Sympiesis sericeicornis* (Nees, 1834) have been reared and identified. For the samples collected in Mátrafüred, the parasitation rate was 3.1 % (n=64 leaf mines), and for the samples of Pusztamiske, was 7.2 % (n=92 leaf mines). The samples from other locations produced no parasitoids. Six species were listed by the Universal Chalcidoidae Database (Noyes 2015) as parasitoid associates of *F. dohrnii*. Despite both *C. pentheus* and *S. sericeicornis* being considered generalits, none of them have been recorded on *F. dohrnii* so far (23, 25).

Of the leaf miner sawflies mining on *Betula*, only the samples of *F. pumila* and *F. ulmi* contained parasitoids. *C. pentheus* was reared out from both of the leaf miners while *Aprostocetus* sp. only from *F. ulmi*.

The parasitoid complex of the *Metallus pumilus* was dominated by two generalist species, *A. cilla* and *P. pectinicornis* (28).

Only two parasitoid species (*A. cilla* and *Aprostocetus* sp.) were reared out from mines of *Parna apicalis* collected from *Tilia cordata.*

Overall, the parasitoid species, listed in this work, are typical parasitoids of leaf mining sawflies. Eight of them are largely polyphagous and can be found on leaf mining lepidoptera (20, 22, 23, 28, 29), as well as on invasive species (14, 19). Specialist parasitoids of leaf mining sawflies, species like *C. nitetis*, *C. eurynota* and *C.* sp. B – cf *nitidifrons* were also reared out and identified.

The natural enemy complex of a leaf miner is composed mainly from parasitoid wasp species (Hymenoptera) (30–32) but in almost all instances a preference for a particular type of host is evident. The parasitoid faunas of tree leaf-mining Lepidoptera, Coleoptera and Hymenoptera are shown to be qualitatively similar, but those of Diptera are rather different. The parasite faunas of tree leaf-miners are different also from those of leaf gall-forming insects on trees and, to a lesser degree, from those of leaf-miners on herbaceous plants. The parasite fauna associated with a tree genus is quantitatively and qualitatively characteristic and, in general, it most resembles that found on allied tree genera. Congeneric leapminers attacking the same tree species are attacked by very similar parasite faunas, although mine situation and season of development may exert some influence. These latter factors are considered especially in relation to leaf-miners of the genus Phyllonorycter for which most data are available. The parasitoid complex of the alien leaf miner species will be composed from the native parasitoid assemblages of the invaded area (14, 19, 33). *Cameraria ohridella* (Deschka & Dimic, 1986), was discovered during a mass outbreak on planted horse-chestnut trees, *Aesculus hippocastanum*, near Lake Ohrid in Macedonia. However, several peculiarities in the leafminer's biology and ecology, such as its inefficient control through natural enemies, indicate that it may be of exotic origin. In this study, the parasitism of *C. ohridella* was examined in natural and artificial horse-chestnut stands in South-eastern Europe. The size and composition of the parasitoid complex of natural stands was comparable with that known from artificial stands. No specialist parasitoid species were detected in any of the samples. The only parasitoid species found exclusively in natural stands during this investigation were the braconid *Colastes braconius* (Haliday, 1983) and the eulophid *Chrysocharis phryne* (Walker, 1839). Both are known to be polyphagous on many leafminers in Europe and *C. braconius* has been often recorded from *C. ohridella* in artificial stands in previous studies. Parasitism levels varied within the same range (3.6-21.0%. Thus at the beginning of the invasion, the native enemy complex is unable to regulate the new species (15, 34, 35).

Studying the parasitoid complexes of the leaf mining sawflies in their native range can be important, particularly because they are potential alien invasive pests in other continents/countries (ex.: *Heterarthrus vagans* and *Profenusa thomsoni*) or species with an outbreak potential in their native range (*Profenusa pygmaea*). Considering the small sample sizes and the small amount of identified parasitoids, further rearings (with larger samples from more geographic locations) will help to provide a wider knowledge of the leaf miner sawfly parasitoid fauna and its influence on host species.

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