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Ectoparasitoid braconids (Hym.: Braconidae) of certain species of leafrollers (Lep.: Tortricidae) of fruit trees

ALECU DIACONU¹ & AUREL LOZAN²

As a result of the rearing of leaf-roller larvae collected from species of *Malus*, *Pyrus*, *Prunus* and *Cerasus* in several localities situated in the north-eastern part of Romania, between 1992 and 1998, 5 species of braconids have been obtained as larval ectoparasitoids (*Bracon hebetor* SAY., *B. picticornis* WESM., *B. variator* NEES, *B. variegator* SPIN. and *Oncophanes laevigatus* RATZB.), belonging to the Braconinae and Doryctinae subfamilies. 16 host-parasitoid relationships have been recorded, most of them new to science. The role played by these parasitoids in the limitation of leaf-roller populations on fruit trees is generally minor, the parasitization ratio being below 1%. Also, some cases of double parasitism of *Bracon picticornis* and *Oncophanes laevigatus* with certain Hymenoptera species of Eulophidae (*Colpoclypeus florus* WALK., *Sympiesis acalle* WALK.) or Ichneumonidae (*Scambus planatus* HARTIG) should be mentioned. The paper also discusses some aspects on the biology, ecology and behaviour of these braconid species.

Keywords: fruit trees, leafrollers, ectoparasitoids, braconids.

INTRODUCTION

In Romania, leafrollers are constantly found in apple-tree, pear-tree, plum-tree and cherry-tree orchards (DIACONU, 1997a, 1997b). The species that hibernate as immature larvae (*Hedya dimidioalba* RETZ., *H. pruniana* HB., *Adoxophyes orana* F.V.R., *Pandemis heparana* DEN. & SCHIFF., *P. cerasana* HB., etc.) attack especially the buds (bud moths). Many species which hibernate as eggs (*Archips rosanus* L., *A. crataeganus* HB.) or have a bi- or trivoltin biological cycle (*Adoxophyes orana* F.V.R., *Pandemis heparana* DEN. & SCHIFF., *P. cerasana* HB., *Archips podanus* Sc., *Acleris variegana* DEN. & SCHIFF.), may become carpophagous pests (moths of the fruits' peel).

Under the normal orchard conditions of our country, the level of attack of such pests is maintained under the economic threshold of damage, either by the complex of phytosanitary treatments applied in an intensive orchard, or by the natural enemies of such pests in the case of orchards not subjected to chemical treatment. Among the entomophagous representatives of these tortricids, a special part is played by parasitoid species (mainly Hymenoptera).

In order to increase the role of the biological means of control in the integrated fight against such pests, the studies devoted to parasitoid complexes should be extended. In this respect, special mention should be made of the research initiated by PAPP & REICHART (1973) in Hungary, CARL (1974) and CHARLES (1974) in France, Italy, Austria, Germany and Switzerland, MICZULSKI & KOŚLIŃSKA (1976) in Poland, EVENHUIS & VLUG (1983) in the Netherlands, ZEROVA *et al.* (1989) in the European part of the former USSR and others.

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Tab. 1: Characteristics of the ecosystems from which tortricid caterpillars were collected.

No.	Locality	Characteristic	Phytosanitary condition
1.	Iași-Botanical Gardens	mixture of a large floristic diversity – trees and bushes from spontaneous and cultivated flora	Untreated
2.	Iași-Șorogari	plantation for slope's consolidation, consisting of forest and fruit trees and bushes	Untreated
3.	Tg. Neamț (NT)	massive surface of intensive apple orchards, 80 ha	Intensely treated with insecto-fungicides until 1989
4.	Crăcăoani (NT)	mixed private orchards, below 0.5 ha	Untreated
5.	Bogdănești (BC)	massive classical orchards of apple-, pear-, plum- and cherry-trees, 70 ha	Intensely treated with insecto-fungicides until 1989

Up to now, in Romania, the studies devoted to such problems have been rather scarce, only few references existing on some parasitoid species (PĂTRĂȘCANU, 1968; VARVARA, 1972).

The present paper, discussing some aspects on the parasitization of such pests by braconid species behaving as ectoparasitoids, is only part of a more ample study devoted to the tortricids' complexes of parasitoids present in the Romanian orchards.

It is also known that braconids' ectoparasitism represents an ancestral indicator on the evolutive-phylogenetic line of the representatives of this family, while, out of the 18 component subfamilies, only 2 (Braconinae and Doryctinae) behave in this manner (TOBIAS *et al.*, 1986).

MATERIAL AND METHODS

Between 1992 and 1998, caterpillars of leafrollers were collected from fruit trees belonging to *Malus*, *Pyrus*, *Prunus* and *Cerasus* from several anthropogenic ecosystems – orchards especially.

The localities in which samples have been taken are situated in the eastern part of Romania, in the Moldavian Central Plateau and in the sub-mountainous region of the Oriental Carpathians.

The characteristics of the ecosystems from which samples have been taken are listed in Tab. 1.

The caterpillars were reared isolatedly up to the apparition of tortricid or parasitoid adults, their food being the leaves of trees from which they had been taken.

For the determination of host-caterpillars, information from several studies of CHAMBON (1986), JONG & VLUG (1974), SWATSCHEK (1958) has been used, completed by our own observations on the morphology, biology and ecology of the obtained tortricid species.

The determination of parasitoids is based on the papers of PAPP (1965), TOBIAS *et al.* (1986), VAN ACHTERBERG (1990), BELOKOBYLSKIJ (1993), LOZAN & CHIRIAC (1995).

RESULTS AND DISCUSSION

From a total number of 10 tortricid species, 5 species of parasitoids have been recorded, belonging to two subfamilies of braconids, Braconinae and Doryctinae,

Tab. 2: The parasitoid-host relationships.

No.	Parasitoid	Host
1.	<i>Bracon hebetor</i> SAY	<i>Neosphaleroptera nubilana</i> HB.
2.	<i>Bracon picticornis</i> WESM.	<i>Adoxophyes orana</i> F.V.R. <i>Hedya dimidioalba</i> RETZ. <i>Hedya pruniana</i> HB. <i>Rhopobota naevana</i> HB.
3.	<i>Bracon variator</i> NEES	<i>Acleris variegana</i> DEN. & SCHIFF. <i>Rhopobota naevana</i> HB.
4.	<i>Bracon variegator</i> SPIN.	<i>Adoxophyes orana</i> F.V.R. <i>Pandemis heparana</i> DEN. & SCHIFF.
5.	<i>Oncophanes laevigatus</i> RATZB.	<i>Adoxophyes orana</i> F.V.R. <i>Ancylics selenana</i> GN. <i>Archips rosanus</i> L. <i>Hedya dimidioalba</i> RETZ. <i>Hedya pruniana</i> HB. <i>Rhopobota naevana</i> HB. <i>Spilonota ocellana</i> DEN. & SCHIFF.

which behave as larval ectoparasitoids. The recorded parasitoid-host relationships are presented in Tab. 2.

The data on the recorded parasitoids have been arranged in the following order: host / fruit-tree genus / locality / date of collecting / date of emergence (hatching) / individuals (♀ ♀ and ♂ ♂) obtained.

1. *Bracon hebetor* SAY. (= *brevicornis* WESM., *juglandis* ASHM., *vernalis* SZÉPL., *flavus* TEL., *turcestanicus* TEL.) obtained from: *Neospahaleroptera nubilana* / *Prunus* / Iași-Botanical Gardens / 5.05.1995 / 25.05.1995 / 2 ♀ ♀.

Hosts: obtained from several Lepidoptera species, such as: *Ostrinia nubilalis* HB., *Pexicopia malvella* HB., *Etiella zinckenella* TR., *Heliotis armigera* HB. and others (ZEROVA *et al.*, 1989; TALITZKII & KUSLITZKII, 1990).

This is quite an important parasitoid, utilized successfully in the biological control of some species of *Ephestia*, *Plodia* and *Galleria*, known as main pests in cereal storage silos (TOBIAS *et al.*, 1986).

According to the literature consulted by the authors of the present study, the host-parasitoid relationship is new to science.

2. *Bracon picticornis* WESM. obtained from: *Adoxophyes orana* / *Malus* / Iași-Șorogari / 1.06.1992 / 15.06.1992 / 1 ♀, 1 ♂; *Hedya dimidioalba* / *Malus* / Iași-Șorogari / 9.05.1992 / 2.06.1992 / 2 ♀ ♀; idem / 1.06.1992 / 15.06.1992 / 1 ♀; idem / 8.05.1994 / 25.05.1994 / 2 ♀ ♀; idem / *Pyrus* / Iași-Șorogari / 8.05.1994 / 15.05.1994 / 2 ♂ ♂; *Hedya pruniana* / *Prunus* / Iași-Botanical Gardens / 10.05.1994 / 25.05.1994 / 4 ♀ ♀; *Rhopobota naevana* / *Malus* / Iași-Șorogari / 17.05.1992 / 3.06.1992 / 2 ♀ ♀, 1 ♂; idem / 1.06.1992 / 15.06.1992 / 10 ♀ ♀, 5 ♂ ♂; idem / 19.07.1993 / 31.07.1993 / 1 ♀; idem / 8.05.1994 / 25.05.1994 / 8 ♂ ♂.

Hosts: several Coleoptera species (TALITZKII & KUSLITZKII, 1990).

All four host-parasitoid relationships are new to science.

3. *Bracon variator* NEES (= *explorator* SZÉPL., *breviventris* SZÉPL., *ornatulus* TEL., *praecox* WESM., *bipartitus* WESM., *maculiger* WESM.?, *dichromus* WESM., *col-*

laris TEL., *pumilionis* ROMAN) obtained from: *Acleris variegana* / *Malus* / Iași-Șorogari / 26.08.1996 / 3.09.1996 / 3 ♂♂; *Rhopobota naevana* / *Malus* / Iași-Șorogari / 31.07.1997 / 10.08.1997 / 1 ♂; idem / 16.07.1997 / 27.07.1997 / 2 ♀♀.

It is characterized by a considerable morphological variability – which actually explains its name. The colour of its body may vary from yellow (in steppe, arid regions) up to black (in wet areas) – which provides an explanation for its high number of synonyms.

Hosts: it is known from quite a large number of hosts, belonging mainly to the Coleoptera and Lepidoptera (TOBIAS *et al.*, 1986; ZEROVA *et al.*, 1989; TALITZKII & KUSLITZKII, 1990).

The two host-parasitoid relationships are new to science.

4. *Bracon variegator* SPIN. (= *nanulus* SZÉPL.) obtained from: *Adoxophyes orana* / *Malus* / Târgu Neamț (NT) / 31.05.1995 / 11.06.1995 / 2 ♀♀, 1 ♂; *Pan-demis heparana* / *Malus* / Crăcăoani (NT) / 30.05.1995 / 15.06.1995 / 3 ♂♂.

As the precedent species, it is characterized by a large morphological variability; also, it is a valuable parasitoid, being frequently and successfully used in biological control actions.

Hosts: it is known from several Coleoptera and Lepidoptera species, having quite a large spectrum of hosts (TOBIAS *et al.*, 1986; ZEROVA *et al.*, 1989; TALITZKII & KUSLITZKII, 1990).

The two host-parasitoid relationships are new to science.

5. *Oncophanes laevigatus* RATZB. (= *minutus* WESM., *lanceolator* NEES) obtained from: *Adoxophyes orana* / *Malus* / Iași-Șorogari / 25.05.1993 / 10.06.1993 / 8 ♀♀, 2 ♂♂; idem / 8.05.1994 / 25.05.1994 / 1 ♀; idem / 19.07.1994 / 10.08.1994 / 3 ♀♀; idem / 25.07.1997 / 4.08.1997 / 1 ♂; idem / 31.07.1997 / 15.08.1997 / 5 ♀♀, 1 ♂; *Ancylis selenana* / *Malus* / Iași-Șorogari / 23.06.1993 / 8.07.1993 / 2 ♀♀; idem / 26.06.1993 / 5.11.07.1993 / 8 ♀♀, 3 ♂♂; idem / 1.07.1993 / 8–13.07.1993 / 27 ♀♀, 8 ♂♂; idem / 3.07.1993 / 8–16.07.1993 / 32 ♀♀, 9 ♂♂; idem / 5.07.1993 / 11–18.07.1993 / 26 ♀♀, 8 ♂♂; idem / 7.07.1993 / 13–21.07.1993 / 17 ♀♀, 6 ♂♂; idem / 12.07.1993 / 14–25.07.1993 / 14 ♀♀, 6 ♂♂; idem / 15.07.1993 / 16–26.07.1993 / 61 ♀♀, 18 ♂♂; idem / 19.07.1993 / 20.07–3.08.1993 / 36 ♀♀, 7 ♂♂; idem / 29.07.1993 / 3.08.1993 / 2 ♀♀, 1 ♂; idem / 4.08.1993 / 6.08.1993 / 1 ♀; idem / 7.10.1997 / 18.04.1998 / 1 ♂; *Archips rosanus* / *Prunus* / Iași-Botanical Gardens / 3.06.1998 / 18.06.1998 / 2 ♀♀, 1 ♂; idem / *Cerasus* / 3.06.1998 / 19.06.1998 / 12 ♀♀, 2 ♂♂; *Hedya dimidioalba* / *Malus* / Iași-Șorogari / 13.06.1992 / 22.06.1992 / 10 ♀♀, 2 ♂♂; idem / 8.05.1994 / 25.05.1994 / 7 ♀♀, 2 ♂♂; idem / *Pyrus* / Bogdănești (BC) / 11.05.1995 / 27.05.1995 / 20 ♀♀, 2 ♂♂; *Hedya pruniana* / *Prunus* / Iași-Șorogari / 18.04.1994 / 5.05.1994 / 1 ♀, 1 ♂; idem / Iași-Botanical Gardens / 5.05.1995 / 27.05.1995 / 1 ♀, 1 ♂; *Rhopobota naevana* / *Malus* / Iași-Șorogari / 1.06.1992 / 11–15.06.1992 / 9 ♀♀, 2 ♂♂; idem / 25.05.1993 / 10.06.1993 / 9 ♀♀, 3 ♂♂; idem / 5.07.1993 / 18.07.1993 / 2 ♀♀, 1 ♂; idem / 8.05.1994 / 25.05.1994 / 3 ♀♀, 1 ♂; *Spilonota ocellana* / *Malus* / Iași-Șorogari / 8.05.1994 / 25.05.1994 / 1 ♀.

Hosts: it is known from several species of Lepidoptera belonging to several families, but mostly to Tortricidae (EVENHUIS & VLUG, 1983; TOBIAS *et al.*, 1986; ZEROVA *et al.*, 1989; TALITZKII & KUSLITZKII, 1990). TOBIAS *et al.* (1986) consider the literature data referring to this species as a parasitoid of certain Coleoptera as probably wrong.

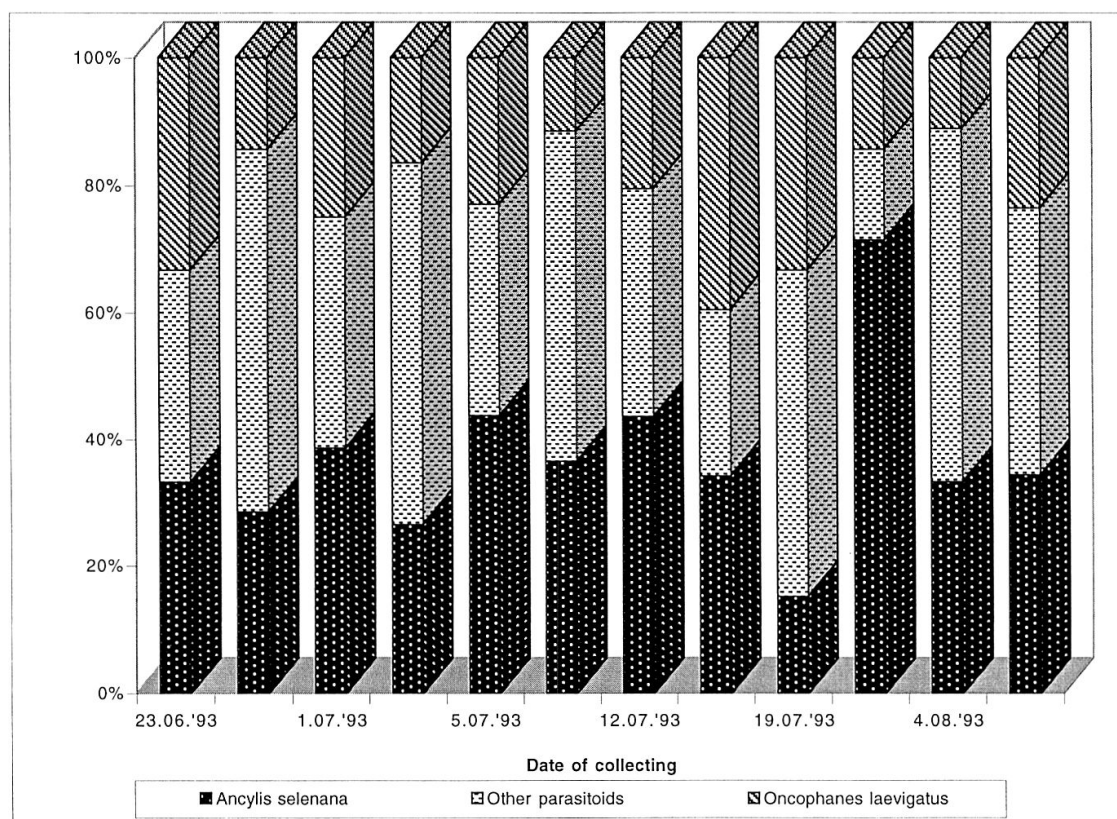


Fig. 1: The role played by *Oncophanes laevigatus* RATZB. in limiting the population of *Ancylis selenana* GN. – Iași-Șorogari / 1993.

The host-parasitoid relationships with *Ancylis selenana*, *Hedya pruniana* and *Rhopobota naevana* are new to science.

The role played by these parasitoids in the limitation of leafroller populations on fruit trees is generally minor, the parasitization ratio being below 1%. An exception to the rule was represented by *Oncophanes laevigatus* RATZB., in 1993, in Iași-Șorogari, when the highest values of *Ancylis selenana* GN. caterpillars' parasitization were recorded. Thus, out of 404 caterpillars collected between 23.06 and 4.08.1993, 265 individuals (65.6%) were destroyed by various parasitoid species; from this number, 95 (i.e. 23.5%) were destroyed by *Oncophanes laevigatus*, the parasitism ratio reaching 39.5% in the sample taken on 15.07.1993 (Fig. 1). Although *A. selenana* has been constantly found each year, such a situation was not repeated in the period over which observations were made, so that *O. laevigatus* behaved like the other species of ectoparasitoid braconids.

The number of individuals that may develop on a single host depends mainly on the braconid species. Thus, for the *Bracon* species, up to 4 individuals/host (most frequently: 2–3 individuals/host) have been recorded. In the case of *O. laevigatus*, an average number of 7–8 individuals/host – up to 22 – has been recorded.

An important factor influencing this parameter is the host's size. Thus, in the case of tortricids whose mature larvae are of 1.1–1.2 cm (*Ancylis selenana*, *Rhopobota naevana*), 3–4 individuals/host (up to 7/host), have most frequently been obtained. For the tortricids whose mature larvae are of 1.8–2.0 cm (*Adoxophyes orana*, *Archips rosanus*, *Hedya dimidioalba*, *H. pruniana*), 5–8 individuals/host have been usually recorded, up to 14 for *A. rosanus*, or 22 for *H. dimidioalba*.

The behaviour of such parasitoids towards host-tortricids is quite uniform. The braconid female first paralyses the caterpillars found inside the feeding shelter and then deposits several eggs on the surface of the body, usually in the intersegmental folds of the abdomen. The mature parasitoid larvae leave the host's body and build – inside the caterpillar's feeding shelter – a silky, whitish to light brown cocoon.

Under the normal climatic conditions of Iași, the embryonic development takes up to 2–3 days, while that of the feeding larva 4–5 days. However, the stages of mature larva and pupa (the cocoon phase), last 15–20 days.

The annual biological cycle of these braconids involves 2–4 generations – depending on thermal conditions. Hibernation occurs in the stage of mature larva, inside the cocoon. The first adults appear towards the end of April, and the last by the end of September, beginning of October.

The sex ratio differs for the two braconid genera. Thus, for *Bracon* species (more obvious in the case of *Bracon picticornis*), the female/male ratio is about 1/1, for *Oncophanes laevigatus*, it is 3.6/1.

The polyphagous character of these braconids is evident as regards this Lepidoptera family. Thus, out of the 30 species of leafrollers recorded, these parasitoids have been obtained from 10 hosts – actually the ones having a constant presence on the previously mentioned fruit trees. Also, most of the hosts obtained have a bivoltin biological cycle (*Adoxophyes orana*, *Ancyliis selenana*, *Rhopobota naevana*), or an univoltin one, but with the larval stage continuing until the parasitoids' flight begins (*Archips rosanus*, *Hedya dimidioalba*, *H. pruniana*).

For the braconids *Oncophanes laevigatus* RATZB. and *Bracon picticornis* WESM. several cases of double parasitism have been reached with other Hymenoptera species behaving also as larval ectoparasitoids. Such cases have been found on several hosts, collected on *Malus* in Iași-Șorogari. The order in which the obtained data are presented is the following: host / date of collecting / date of braconid (parasitoid-I) emergence / braconid individuals (♀♀ and ♂♂) obtained // date of parasitoid-II emergence / parasitoids-II individuals (♂♂ and ♀♀) obtained:

– *Oncophanes laevigatus* and *Sympiesis acalle* WALK. (Eulophidae) have been obtained from: *Hedya dimidioalba* / 8.05.1994 / 25.05.1994 / 1 ♀ // 27.05.1994 / 1 ♀, *Rhopobota naevana* / 1.06.1992 / 11.06.1992 / 1 ♀ // 15.06.1992 / 1 ♀,

– *Oncophanes laevigatus* and *Colpoclypeus florus* WALK. (Eulophidae) have been obtained from *Adoxophyes orana* / 19.07.1994 / 10.08.1994 / 2 ♀♀ // 12.08.1994 / 9 ♀♀, 4 ♂♂,

– *Bracon picticornis* and *Sympiesis acalle* WALK. (Eulophidae) have been obtained from: *Adoxophyes orana* / 1.06.1992 / 15.06.1992 / 1 ♀, 1 ♂ // 17.06.1992 / 1 ♀, *Hedya dimidioalba* / 9.05.1992 / 2.06.1992 / 2 ♀♀ // 4.06.1992 / 1 ♀.

– *Bracon picticornis* and *Scambus planatus* HARTIG (Ichneumonidae) have been obtained from: *Hedya dimidioalba* / 1.06.1992 / 15.06.1992 / 1 ♀ // 15.06.1992 / 1 ♂, *Rhopobota naevana* / 1.06.1992 / 15.06.1992 / 2 ♂♂ // 15.06.1992 / 1 ♂.

These four cases of double parasitism demonstrate a reduction in the number of braconids that were able to develop on a host, especially in the case of *Oncophanes laevigatus*.

RÉSUMÉ

Braconides (Hym.: *Braconidae*) issus de larves de tordeuses (Lep.: *Tortricidae*) collectées sur des arbres fruitiers. – De 1992 à 1998 des chenilles de tordeuses phyllophages ont été récoltées sur des arbres des genres *Malus*, *Pyrus*, *Prunus* et *Cerasus* dans des vergers et des écosystèmes influencés par l'homme dans le Nord-Est de la Roumanie. Cinq espèces de braconides ectoparasites larvaires appar-

tenant aux sous-familles Braconinae et Doryctinae ont émergés de ces chenilles élevées en laboratoire, soit: *Bracon hebetor* SAY., *B. picticornis* WESM., *B. variator* NEES, *B. variegator* SPIN. et *Oncophanes laevigatus* RATZB. Seize relations hôte-parasitoïde presque toutes inconnues à ce jour ont été enregistrées, ainsi que quelques cas de double parasitisme des braconides *B. picticornis* et *O. laevigatus*. D'autres parasitoïdes ont également été recensés tels que *Colpoclypeus florus* WALK., *Sympiesis acalle* WALK. (Eulophidae), et *Scambus planatus* HARTIG (Ichneumonidae). Le rôle de ces parasitoïdes dans la limitations des tordeuses phyllophages des arbres fruitiers s'est avéré faible, les pourcentages de parasitisme ne dépassant pas 1 %. Quelques aspects de biologie, d'écologie et de comportement des braconides obtenus sont présentés.

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