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Parasitoid abundance of *Archips rosana* (Linnaeus, 1758) (Lepidoptera: Tortricidae) in organic cherry orchards

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Abstract. *Archips rosana* (Linnaeus, 1758) (Lepidoptera: Tortricidae), a highly polyphagous pest species, has potential economic importance on fruit crops. The present study aimed to gather data on species composition of parasitoids of *Archips rosana*. It was carried out in the years 2010-2011 in organic cherry orchards in the province of Edirne (Turkey). Twenty-two parasitic hymenopteran species belonging to three families (Ichneumonidae, Braconidae and Chalcididae) and one dipteran species (Tachinidae) were determined. Braconidae was found to be the most frequently represented family with 13 species, followed by Ichneumonidae 8, Chalcididae and Tachinidae with one species, respectively. Parasitoids from the superfamily Ichneumonoidea (Braconidae and Ichneumonidae) turned out to be the most effective, and the dominating species was endoparasitoid *Itoplectis maculator* (Fabricius, 1775). *Archips rosana* was found for the first time to serve as a host for *Pimpla spuria* Gravenhorst, 1829; *Scambus buolianae* (Hartig, 1838); *Bracon* (*Habrobracon*) *hebeto*r Say, 1836; *Bracon* (*Bracon*) *intercessor* Nees, 1834; *Meteorus versicolor* (Wesmael, 1835) and *Meteorus rufus* (DeGeer, 1778). This information should be helpful in the development of biological control programs to manage *A. rosana* in cherry orchards.

Keywords: Parasitoid, *Archips rosana*, Hymenoptera, Tortricidae, Lepidoptera, cherry orchards.

Introduction

Cherry orchards are one of the major crops in northwestern part of Thracian region of Turkey. In the last decade, the application of ecological cherry production methods has been studied in a project in the important cherry production areas of western Turkey. In order to avoid potential serious side effects of conventional agriculture on human health and environment, organic agriculture practices have been initiated in all the countries of the world (Tezcan & Kocarek 2009). The importance of parasitic wasps in ecological agricultural systems cannot be underestimated. For all these reasons, this paper has been produced to reveal the beneficial parasitic insect fauna in cherry orchards of Turkey.

The environment has been given harm due to high levels of insecticide applications over the last decades and the intensive cultivation activities, which caused serious damage to the environment and natural habitats. In addition, the absence of pest management and ignorance of the parasitoid complex role represented reasons to start our studies on the current the parasitoid biocenosis (Patriche 2008). Parasitic insects are very important ecologically and economically for the control of the other insect populations. Parasitoid insects have been introduced into a variety of ecosystems as biological control agents, and there have been many successful cases of their use to control pest populations. Parasitic hymenopteran that lay their eggs either in or on their hosts are important regulators of insect pests and comprise a wide range of Hymenoptera (Tobias 1986, Quicke 1997). Considering the important role of parasitoids, identification of these agents can be the first step in reestablishment of natural balance in agroecosystems (Loftalizadeh 2010).

The rose tortrix, *Archips rosana* (Linnaeus 1758), is a moth of the family Tortricidae (Lepidoptera). This species plays an important role in plant protection due to a large number of harmful species and frequent occurrence on different cultivations. In recent years the observations conducted in orchards have shown that the population and the economic importance of these phytophagous species is increasing, which often makes the use of chemical control necessary. However, tortricids are attended by a big number of natural enemies, and that is why a lot of attention is given to the preparation of programs of controlling them by means of selective treatment (Kot 2007, Aydogdu and Beyarslan 2012). In recent years an integrated control system has been started to be used to keep pest populations below a critical value by using all possible control methods and techniques taking into consideration the popula-

tion dynamics of pest species and their interactions with the environment. In such a control system, identification and monitoring of pests are key points to obtain successful results. In particular, life histories of pests as well as their hosts and natural enemies should be well-known (Lotfalizadeh et al. 2009, Lotfalizadeh 2010, Polat & Tozlu 2010).

The European leafroller (ELR), *A. rosana*, is native to the Palearctic region, but it is distributed all over the world, except the Far East, and in Siberia ELR is a primary or sometimes secondary pest on cherry orchards depending on the time and location. This pest is univoltine, and its life cycle starts with the larvae hatching from overwintering eggs in late February. The larval period is about 6–8 weeks. Pupation takes place within the rolled and webbed leaves. In southern Turkey pupation occurs at the end of May and early June. Adult emergence begins in the second week of June, and usually continues through mid- August. Adults live for 2–4 weeks. The pest feeds on a large variety of shrubs and trees (Doğanlar 2007, 2008, Ulu 1983).

Archips rosana is an important pest species causing various levels of economic losses in different fruit trees such as apple (*Malus sp.*), pear (*Pyrus* sp.), cherry (*Prunus avium*), quince (*Cydonia oblonga)*, apricot (*Prunus armeniaca*), pomegranate (*Punica granatum*), almond (*Prunus dulcis*), plum (*Prunus domestica*), walnut (*Juglans* sp.), hazelnut (*Corylus avellana*), loquat (*Eriobotrya japonica*), citrus fruits, blackberry (*Rubus fruticosus*) and raspberry (*Rubus idaeus*). In studies performed on *Archips* species on stone fruit trees, it was shown that species of this genus caused serious damages up to 90% on cherry and apricot trees (Kovancı et al. 2003, Özdemir & Özdemir 2002, Özdemir et al. 2005).

Most of the significant impact on reduction of agricultural pest populations are caused by an important number of parasitoids whose diversity biologies lead them to use a variety of pests as their host organisms. Mayer and Beirne (1974) distinguished 28 different parasitoid species attacking *A. rosana* larvae and pupae collected from apple trees. Up to now, more than 100 parasitoid species have been identified on *A. rosana* (AliNiazee 1977, Yu et al. 2006). The goal of our research was to observe how the parasitoids limit *A. rosana* populations on cherry orchards in Turkey, and to reveal host-parasitoid relationships.

Material and Methods

Insects

The studies were carried out in the years 2010-2011 in organic cherry orchards in the vicinity of Edirne (northwestern Turkey). A total of 1139 larvae and 679 pupae was collected in selected study areas, and the larvae were reared in Petri dishes on artificial diet. Larvae were also collected in several instars during the course of spring-summer and were reared individually in Petri dishes (Razmi et al. 2011). Each individual larvae was maintained in large Petri dishes (10 cm diameter) containing honey-water (1:1 ratio) absorbed on cotton pieces and cherry leaves and kept under laboratory conditions at 25 ± 2°C, 16:8 hours Light:Dark cycle and 70% relative humidity. In the laboratory, different parasitoids species were reared from hosts, and the species composition and their abundance were determined.

Statistical analysis

Shannon-Weiner index was used to characterize species diversity of parasitic insects by months. Furthermore, similarities of the months for species dynamics (both species and numbers of the individuals) were determined by using Bray-Curtis similarity index (Krebs 1999).

Results

Studies were made in cherry orchards in northwestern Turkey in 2010-2011, during which 1139 larvae and 679 pupae of *A. rosana* were collected. Twenty-two hymenopteran species belonging to three families (Ichneumonidae, Braconidae and Chalcididae) and one parasitic dipteran species (Tachinidae) were determined (Table 1). Braconidae was found to be the most frequently represented family with 13 species (41.99%), followed by Ichneumonidae with 8 species (37.67%), Chalcididae (14,63%) and Tachinidae (5,69%) with one species, respectively. *Itoplectis maculator* was found to be the most common parasitoid (25.20%) and was followed by *Brachymeria tibialis* (14.63%), *Bracon (B) variegator* (10.57%) and *Apanteles (A) sodalis* (6.78%). The other parasitoids were less abundant.

The degree of parasitization of larvae and pupae of *A. rosana* in particular years of studies in the cherry orchard without chemical protection is presented in Table 2. The total parasitization of tortricids by Ichneumonidae, Braconidae, Chalcididae and Tachinidae during the two years of studies was 20.2%.

According to Shannon-Weiner index, it was found that May was the month with the most species diversity (H'=1.157). While April and June had similar species diversities (H'=0.762), July was

Table 1. The parasitoids reared from *A. rosana* larvae and pupae in cherry orchards of Edirne (Turkey) in 2010-2011.

Parasitoids	Number of individuals (in specimens)		Total Number of individuals (in specimens)	%
	2010	2011		
Ichneumonidae				
Pimplinae				
Itoplectis maculator (Fabricius, 1775)	55	38	93	25.20
Itoplectis alternans (Grav.,1829)	4	2	6	1.63
Pimpla spuria (Grav.,1829)	2	-	2	0.54
Scambus calobatus (Grav.,1829)	4	8	12	3.25
Scambus buolianae (Hartig, 1838)	3	4	7	1.90
Tryphoninae				
Exyston sp. Schiødte,1839	1	-	1	0.27
Phytodietus polyzonias (Forst, 1771)	5	7	12	3.25
Cryptinae				
Gelis sp. Thunberg, 1827	2	4	6	1,63
Braconidae				
Agathidinae				
Bassus dimidiator (Nees, 1834)	1	-	1	0.27
Braconinae				
Bracon (*B.*) *variegator* Spinola, 1808	14	25	39	10.57
Bracon (*H.*) *hebetor* Say, 1836	3	1	4	1.08
Bracon (*B.*) *intercessor* Nees, 1834	4	3	7	1.90
Cheloninae				
Ascogaster quadridentata Wesm.,1835	6	8	14	3.79
Ascogaster rufipes (Latreille, 1809)	2	2	4	1.08
Chelonus oculator (Fabricius,1775)	1	3	4	1.08
Euphorinae				
Meteorus ictericus (Nees, 1811)	12	9	21	5.69
Meteorus rufus (DeGeer, 1778)	5	3	8	2.17
Meteorus versicolor (Wesmael, 1835)	6	7	13	3.52
Macrocentrinae				
Macrocentrus linearis (Nees, 1811)	8	3	11	2.98
Microgasterinae				
Apanteles (A.) sodalis (Haliday, 1834)	14	11	25	6.78
Microgaster globata (Linnaeus, 1758)	4	-	4	1.08
Chalcidoidea				
Chalcididae				
Brachymeria tibialis (Walker, 1834)	32	22	54	14.63
Diptera				
Tachinidae				
Eumea linearicornis (Zett., 1844)	8	13	21	5.69
Total	196	173	369	%100

Table 2. Parasitization of *A. rosana* larvae and pupae in cherry orchard of Edirne (Turkey) in 2010-2011.

Year	Number of collected larvae and pupae	Parasitic Entomofauna								Total parasitism	
		Ichneumonidae		*Braconidae*		*Chalcididae*		*Tachinidae*			
		specimens	%	specimens	%	specimens	%	specimens	%	specimens	%
2010	945	76	8	80	8.4	32	3.3	8	0.8	196	20.7
2011	873	63	7.2	75	8.5	22	2.5	13	1.4	173	19.8
Total	1818	139	7.6	155	9	54	3.5	21	1.1	369	20.2

found to have the poorest (H'=0.271) (Table 3).

Also, according to Bray-Curtis Index, May and June were found to be most similar, with 39% for the dynamics of parasitoids (Fig. 1). April and June were found to be least similar (11%), and the similarity ration between May and June is not a high value. Additionally, although the species diversity was found to have same value for April and June, these months were not similar to each other because of the dynamics for parasitoid species.

Table 3. The number of individuals of parasitoid species between April and July of 2010-2011.

Parasitoids	April	May	June	July
Itoplectis maculator	5	32	43	13
Itoplectis alternans		5	1	
Pimpla spuria	1	1		
Scambus calobatus	4	8		
Scambus buolianae	1	6		
Exyston sp.		1		
Phytodietus polyzonias	2	10		
Gelis sp.		6		
Bassus dimidiator		1		
Bracon (*B.*) *variegator*	4	31	4	
Bracon (*H.*) *hebetor*		4		
Bracon (*B.*) *intercessor*		7		
Ascogaster quadridentata		14		
Ascogaster rufipes		4		
Chelonus oculator		3	1	
Meteorus ictericus		14	7	
Meteorus rufus		4	4	
Meteorus versicolor		5	8	
Macrocentrus linearis			11	
Apanteles (A.) sodalis	7	18		
Microgaster globata		4		
Brachymeria tibialis		3	45	6
Eumea linearicornis		7	14	
Shannon H'Log Base 10 (Species diversity index)	0. 762	1.157	0.762	0.271
Number of individuals	24	188	138	19

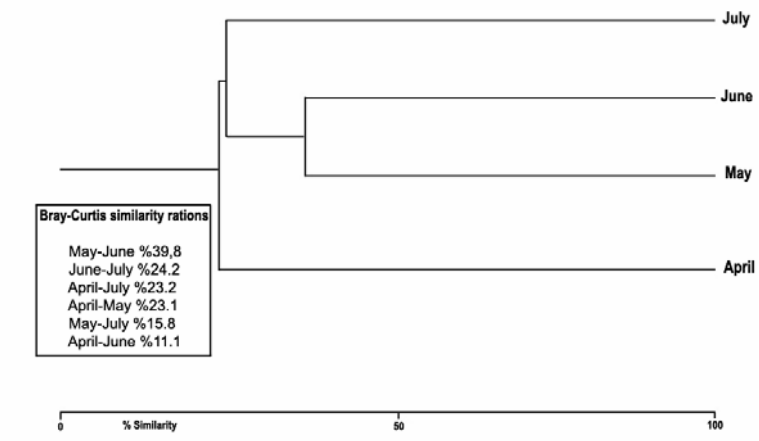

Figure 1. The dendrogram of similarity of months based on parasitoid species (single-linkage, Bray-Curtis, log base 10).

Discussion

The aim of the studies was to determine abundance of parasitoids as biocontrol agents against the *A. rosana* in cherry orchards. Twenty-three parasitic insects (hymenopteran and dipteran species) were determined in larvae and pupae of *A. rosana* obtained from organic cherry orchards in 2010 and 2011 years (April, May, June and July). Parasitoids from the superfamily Ichneumonoidea (Braconidae and Ichneumonidae) turned out to be the most effective, and the dominant species was

endoparasitoid *Itoplectis maculator* (Fabricius, 1775). Two possible hyperparasitoids (*Brachymeria tibialis*, *Gelis sp.*) were reared from leafrollers in the Thracian organic orchards and six species (*Pimpla spuria, Scambus buolianae*, *Bracon* (*Habrobracon*) *hebeto*r, *B.* (*Bracon*) *intercessor*, *Meteorus versicolor* and *M. rufus*) represented new parasitoid records for the leafroller complex.

A. rosana spends winter season in Thrace as egg forms laid under tree barks. Hatching larvae were reported to feed first on buds by mid-April, while the following instars feed densely on foliage, to which they cause harm by enclosing individual leaves in cigar form (April-May). Larvae were observed to pupate by the end of May and in June, thus allowing adults to emerge by the end of May and beginning of July. The moths are on wing from June to August depending on the location area. In a study in eastern Turkey, Polat and Tozlu (2010) reported that *A. rosana* produced only one generation in a year (Pralya et al. 1995, Kovancı et al. 2003). In the present study, *A. rosana* was found to have only one generation in Thrace region, meaning that it is univoltine.

In the present study, *Itoplectis maculator* was found to be the most commonly reared parasitoid in the organic cherry orchards. Similar results were obtained by Kot (2007), Miczulski and Anasiewicz (1972) and Polat and Tozlu (2010), who stated that the main role in limiting the population of tortricids was played by ichneumon wasps. Polat and Tozlu (2010) determined *I. maculator* was the dominant species on *A. rosana* pupa but it was obtained from both larvae and pupa in the present study, showing that the time range of the parasitoid wasp to parasitize *A. rosana* lied in extended period of time (Table 3). At the same time, *I. maculator* was the most abundant parasitoid and *Brachymeria tibialis* (Walker) (Hymenoptera: Chalcididae) ranked second of *A. rosana* pupae, and the chalcid specis is a hyperparasitoid of *I. maculator*.

Most of the obtained parasitoids turned out to be solitary endoparasitoids. However, *Scambus calobatus, S. buolianae* and *Phytodietus polyzonias* were recorded as solitary ectoparasitoids, and *Bracon* (*B.*) *variegator, B.* (*H.*) *hebetor, B.* (*B.*) *intercessor* and *Apanteles (A.) sodalis* as gregarious parasitoids.

Our research showed that the role of parasitoid species is important in limiting the dangerous Tortricidae populations of cherry orchards. Ichneumonidae, Chalcididae, Braconidae and Tachinidae limited populations of caterpillars and pupae of *A. rosana*. *Itoplectis maculator* (25.20%), *Brachymeria tibialis* (14.63%), *Bracon (B) variegator* (10.57%) and *Apanteles (A) sodalis* (6.78%) represent the predominant parasitoid species. Therefore, detailed investigation is needed in the future on the biology and parasitoids of *A. rosana* to develop effective integrated pest management programs.

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References

AliNiazee, M.T. (1977): Bionomics and life history of a filbert leafroller, *Archips rosanus* (Lepidoptera: Tortricidae). Annals of the Entomological Society of America 70: 391-401.

Aydogdu, M., Beyarslan, A. (2012): A review of the genus *Ascogaster* Wesmael, 1835 (Hymenoptera, Braconidae, Cheloninae) in Turkey, with a new host record for *Ascogaster bicarinata* (Herrich-Schaffer, 1838). North-Western Journal of Zoology 8(1): 31-40.

Doğanlar, O. (2007): Distribution of European leaf Roller, *Archips rosanus* (L.) (Lep., Tortricidae) egg masses on different apple cultivars. Asian Journal of Plant Sciences 6 (6): 982-987.

Doğanlar, O. (2008): Temperature-dependent development and degree-day model of European leaf roller, *Archips rosanus*. Journal of Plant Protection Research 48(1): 63-72.

Kot, I. (2007): Parasitic entomofauna of leaf tortricids (Lepidoptera: Tortricidae) occurring in apple orchards. EJPAU 10(1): art.#27.

Kovancı, B., Gençer, N.M., Kaya, M., Akbudak, B. (2003): Uludağ Üniversitesi Ziraat Fakültesi Elma Bahçesinde Elma Yaprakbükeni, *Archips rosanus* (L.) (Lepidoptera:Tortricidae)'un Ergin populasyon dalgalanması Üzerinde araştırmalar. Atatürk. Üniversitesi Ziraat Fakültesi Dergisi 34(4): 35-40.

Krebs, C.J. (1999): Ecological Methodology. Addison-Wesley Educational Publishers, Inc., Menlo Park, California, 620 pp.

Lotfalizadeh, H. (2010): The genus *Metaphycus* Mercet (Hym.: Encyrtidae) of the Iranian fauna with description of a new species. North-Western Journal of Zoology 6(2): 255-261.

Lotfalizadeh, H., Ezzati-Tabrizi R., Masnadi-Yazdinejad, A.(2009): *Diplolepis fructuum* (Rübsaamen) (Hym.: Cynipidae) a new host for *Exeristes roborator* (Fabricius) (Hym.: Ichneumonidae) in Iran. Biharean Biologist 3(2): 171-173.

Mayer, D.F., Beirne, B.P. (1974): Occurrence of apple leafrollers (Lepidoptera:Tortricidae) and their parasites in the Okanagan Valley, British Columbia. Journal of the Entomological Society of British Columbia 71: 22-24.

Miczulski, B., Anasiewicz, A. (1972): Materiały do znajomosci pasożytniczej entomofauny kompleksu motyli zwójkowatych (*Tortricidae*) występujšcych na porzeczce czarnej – *Ribes nigrum* L. i czerwonej *R. rubrum* oraz na agrescie – *R. grossularia* L. w okolicach Lublina [*The materials to knowledge the complex of tortrix moths' (Tortricidae) parasitic entomofauna occurring on black currant – Ribes nigrum L. and red currant R. rubrum and gooseberry – R. grossularia L. in area of Lublin*]. Polish Journal of Entomology 42(1): 211-222. [in Polish]

Quicke, D.L.J. (1997): Parasitic Wasps. Chapman and Hall, London.

Özdemir, Y., Özdemir, M. (2002): Orta Anadolu Bölgesinde *Archips* türlerinde (Lep.: Tortricidae) saptanan Ichneumonidae (Hym.) türleri. Bitki Koruma Bülteni 42(1-4): 1-7.

Özdemir, M., Özdemir, Y., Seven, S., Bozkurt, V. (2005): Orta Anadolu Bölgesinde Kültür Bitkilerinde Zararlı Tortricidae (Lepidoptera) Faunası Üzerine Araştırmalar. Bitki Koruma Bülteni 45(1-4): 17-44.

Patriche, G. (2008): The primary and secondary parasitoids relationships in the parasitoid complex belonging to the Lepidoptera defoliators in the cabbage crops. Natura Montenegrina Podgorica 7(3): 87-96.

Polat, A., Tozlu, G. (2010): Erzurum'da *Archips rosana* (Linnaeus, 1758) (Lepidoptera: Tortricidae)'nın kısa biyolojisi, konukçuları ve parazitoitleri üzerine araştırmalar. Türkiye Entomoloji Dergisi 4: 529-542.

Pralya, I.I., Sen'kova, E.A., Sahapar, M.V. (1995): Methods of counting orchard leafrollers (Lepidoptera: Tortricidae). Zoolgicheskii Zhurnal 71(4): 131-138.

Razmi, M., Karimpour, Y., Safaralizadeh, M.H., Safavi, S.A. (2011): Parasitoid complex of cabbage large white butterfly *Pieris brassicae* (L.) (Lepidoptera, Pieridae) in Urmia with new records from Iran. Journal of Plant Protection Research 51(3): 248-251.

Ulu, O. (1983): İzmir ve Manisa illeri çevresi taş çekirdekli meyve ağaçlarında zarar yapan *Archips (=Cacoecia* spp.) (Lepidoptera: Tortricidae) türleri, tanımları, konukçuları, yayılışları ve kısa biyolojileri üzerinde araştırmalar. Tarım ve Orman Bakanlığı, Bornova Bölge Zirai Mücadele Araştırma Enstitüsü Müdürlüğü Yayınları Araştırma Eserleri Serisi 45: 165. [In Turkish, only Abstract in English]

Tezcan, S., Kocarek, P. (2009): Dermaptera fauna of the ecologically managed cherry orchards in Western Turkey. Munis Entomology and Zoology 4(2): 572-576.

Tobias, V.I. (1986): [Order Hymenoptera. Family Braconidae]. In: Medvedev G.S. (ed.), 'Opredelitel Nasekomych Evrospeiskoi Tsasti SSSR 3, Peredpontdatokrylye 4. Opr. Faune SSSR.' 145: 1–501. [*Keys to the insects of the European part of USSR. Hymenoptera* - English translation. Lebanon, U.S.A.].

Yu, D.S., van Achterberg, C., Horstmann, K. (2006): World Ichneumonoidea 2004. Taxonomy, Biology, Morphology and Distribution (Braconidae). Taxapad 2005 (Scientific Names for Information Management) Interactive Catalogue on DVD/CDROM. Vancouver.