

Orijinal araştırma (Original article)

Almond bud gall midge, *Odinadiplosis amygdali* (Anagnostopoulos) (Diptera: Cecidomyiidae), parasitoid complex and economic importance in Hatay province

Hatay İlinde Badem tomurcuk gal sineği, *Odinadiplosis amygdali* (Anagnostopoulos) (Diptera: Cecidomyiidae)'nin parazitoitleri ve ekonomik önemi

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Summary

In Hatay province, Turkey the Almond bud gall midge, *Odinadiplosis amygdali* (Anagnostopoulos, 1929) (Diptera: Cecidomyiidae), was collected from bud-galls of *Prunus dulcis* (Miller) D.A. Webb in 2011-2012. In the study morphology, biology and importance of the pest were studied and 3 species of parasitoids from 3 families of Hymenoptera, namely *Synopeas talhouki* Vluc (Platygastridae) and: *Baryscapus oophagus* (Otten) (Eulophidae) (primary ones as main mortality factors of the gall midges), and *Torymus phillyreae* Ruschka (Torymidae) (as secondary parasitoid) were found. The parasitoids were newly recorded from Turkey, and *O. amygdali* is the new host for the last two ones. The diagnostic characters of the species were illustrated and some biological data of the parasitoids were given.

Key words: Almond bud gall midges, parasitoids, Turkey

Özet

Hatay İlinde 2011-2012 yılları arasında Badem tomurcuk gal sineği, *Odinadiplosis amygdali* (Anagnostopoulos, 1929) (Diptera, Cecidomyiidae), badem ağacı, *Prunus dulcis* (Miller) D.A. Webb, tomurcuklarındaki gallerden elde edilmiştir. Çalışmada zararlının morfolojisi, biyolojisi ve ekonomik önemi çalışılmış ve Hymenoptera takımından 3 familyaya giren 3 yumurta-larva parazitoiti, Platygastridae: *Synopeas talhouki* Vluc; Eulophidae: *Baryscapus oophagus* (Otten) (primer parazitoitler gal sineğinin ana ölüm faktörleri) ve Torymidae: *Torymus phillyreae* Ruschka (sekonder parazitoit), olarak bulunmuştur. Parazitoitler Türkiye için yeni kayıtlardır ve son iki parazitoit için konukçu ilk kez belirlenmiştir. Türlerin ayırt edici özellikleri tanımlanmış ve parazitoitlerin bazı biyolojik özellikleri verilmiştir.

Anahtar sözcükler: Badem tomurcuk gal sineği, parazitoitler, Türkiye

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Introduction

The Almond bud gall midge, *Odinadiplosis amygdali* (Anagnostopoulos) (Diptera: Cecidomyiidae), were recorded by several works as a serious pest on buds of almond trees, *Prunus dulcis* (Miller) D.A. Webb in Turkey as well as Afghanistan, Greece and Lebanon (Nijveldt & Talhouk, 1976; Skuhrová & Skuhrový, 1997). In Turkey it was recorded as a (important??) pest of Almond tree in Izmir (Yargıç, 1948; Alkan, 1952; İren & Ahmed, 1973), and Ankara on *Amygdalus orientalis* (Karaca, 1956), and its occurrence in Turkey by Skuhrová et al. (2005).

Nijveldt & Talhouk (1976) studied on morphology, biology and importance of this pest in the Mediterranean countries, and stated that the early growing varieties of almond tree are preferred by the pest.

Up to now only one natural enemy, *Synopeas talhouki* Vlug, (Hymenoptera: Platygasteridae), has been recorded as larval parasitoid of *O. amygdali* by Vlug (1976) and Nijveldt & Talhouk (1976). They stated that the parasitic larva overwinter inside of host larva and completes one generation per year.

The aims of this work is to find out the morphology, biology, importance and parasitoid complex of the gall midges in Hatay province, Turkey.

Material and Method

The study was conducted in 2011-2012 in Hatay province, Turkey. The galls of *O. amygdali* on buds of *P. dulcis* were collected from the orchards including the very early-growing varieties, such as diş bademi, and Hilvani, and brought to laboratory in plastic bags, mainly in the period from December, 2011 to May, 2012. They were kept under laboratory conditions (30 °C temperature and 60-70 % relative humidity) for rearing purpose. The adults emerged from the galls were put into 96% ethyl alcohol for taxonomic studies. The hosts of the parasitoids were obtained by the study on larval morphologies of the hosts, and the remnant of the parasitoids larvae found by dissecting the galls from which the parasitoids emerged. The parasitoid species were determined by working on larval mandibles and adult morphologies as stated Doğanlar et al. 2009. The number of the parasitoids and galls on the buds of 4 branches were taken for finding effectiveness of the parasitoids. The numbers of midges and the parasitoids include the numbers of adults emerged and the numbers of larvae of each species found by dissecting the galls on buds.

Distribution of the pest in Hatay province and infestation levels were obtained by counting the healthy and infested almond trees (3-30 years old) in the villages which were selected randomly. The galls of *O. amygdali* on buds of 4 branches from different sides of the infected trees. The varieties of trees were Diş bademi, Taş bademi, Acı payam and Hilvani in the study areas. Samplings were made 2-3 times in October and November, 2011 and in the period from March to May, 2012.

The specimens of *O. amygdali* were identified by Dr. Marcella Skuhrova (Czech Zoological Society, Vinicna 7, 128 00 Praha 2, Czech Republic).

The studies are based upon the specimens of the midges and the parasitoids reared from the galls on almond buds. The wings, antenna and genitalia of the both sexes of midges and larvae of parasitoids and *O. amygdali* were slide-mounted in Canada balsam. The taxa of Hymenoptera were identified by following the keys of Vlug (1976), Graham (1991), and Graham & Gijswijt (1998) by the author.

The examined specimens were deposited in the collection of the Insect Museum of Plant Protection Department, Agriculture Faculty, Mustafa Kemal University, Hatay, Turkey (MKUI). Photographs of diagnostic characters of the species were taking by using a stereo-microscope (Askania SMT 4 Germany) with a digital camera (Nikon Coolix 4500) attached to it.

Results and Discussion

During investigations conducted in 2011-2012 in Hatay Province, Turkey, The Almond bud gall midge, *Odinadiplosis amygdali*, was recorded as a pest makes severe to minor damages on buds of almond trees, *Prunus dulcis* especially in the orchards with early-growing varieties in some villages of some towns in Hatay province.

Odinadiplosis amygdali (Anagnostopoulos)

Material examined: Turkey: Hatay, Antakya, Hanyolu, 1-15. iv. 2012, 54 ♀♀, 32 ♂♂; Turfanda, 1.5. 2012, 24 ♀♀, 19 ♂♂; Altınözü, Yanıkpınar, 13-22. iv. 2012, 21 ♀♀, 23 ♂♂; Yunushan, 12-29. iv. 2012, 40 ♀♀, 31 ♂♂, all of the specimens were reared by M. Doğanlar.

Description: The following description is mainly based on Nijveldt & Talhouk (1976) by adding some figures: The midges (Figure 1 a,b) are blackish and about 2-2.5 mm long. Male (Figure 1b, 2). Length about 2 mm. Legs brownish; claws simple, moderately curved; empodium well developed, about as long as claws. Thorax dark brown. Wings (Figure 2b): subcostal vein extending slightly beyond the basal third; third vein curved, reaching just beyond tip of wing; fifth vein forked. Abdomen blackish. Antennae (Figure 2c-e): 2 + 12, about 1.5 mm long; each flagellar segment consisting of two nodes separated by a stem and each, excepting the terminal segment, with a neck (Figure 2 d); Palpi: 2-3 segmented, first one about twice as long as second. Genitalia (Figure 2a): basal clasp segment stout, with short setae; distal clasp segment stout, with short setae; dorsal lamella short, setose, with shallow emargination, each lobe very broadly rounded, almost truncate; ventral lamella long, twice as long as dorsal lamella, wide U-shaped emargination, each lobe broadly rounded; harpes well developed; style broad, extending as far as lobes of ventral lamella.

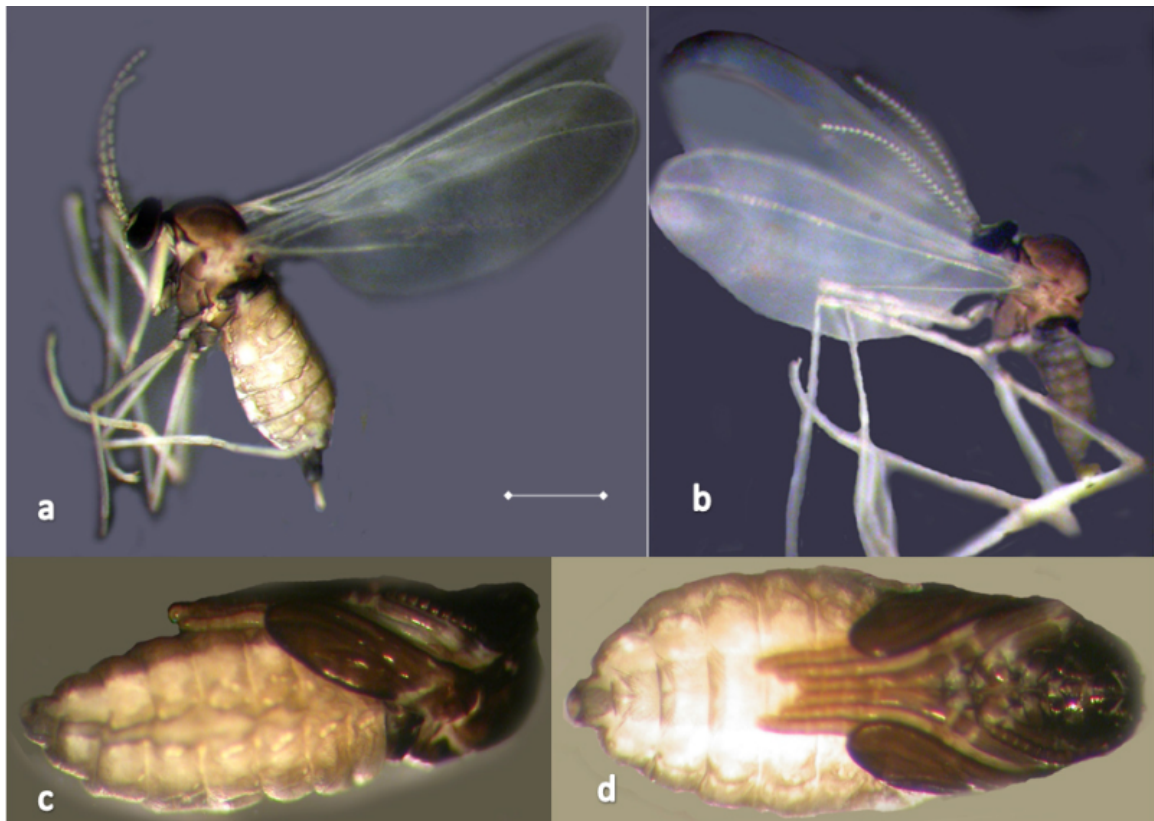


Figure 1. *Odinadiplosis amygdali* a, female; b. male; c.d. pupae, c. in lateral view; d. in ventral view. Scale bar for a and b= 0.8 mm; for c and d= 0.4 mm.

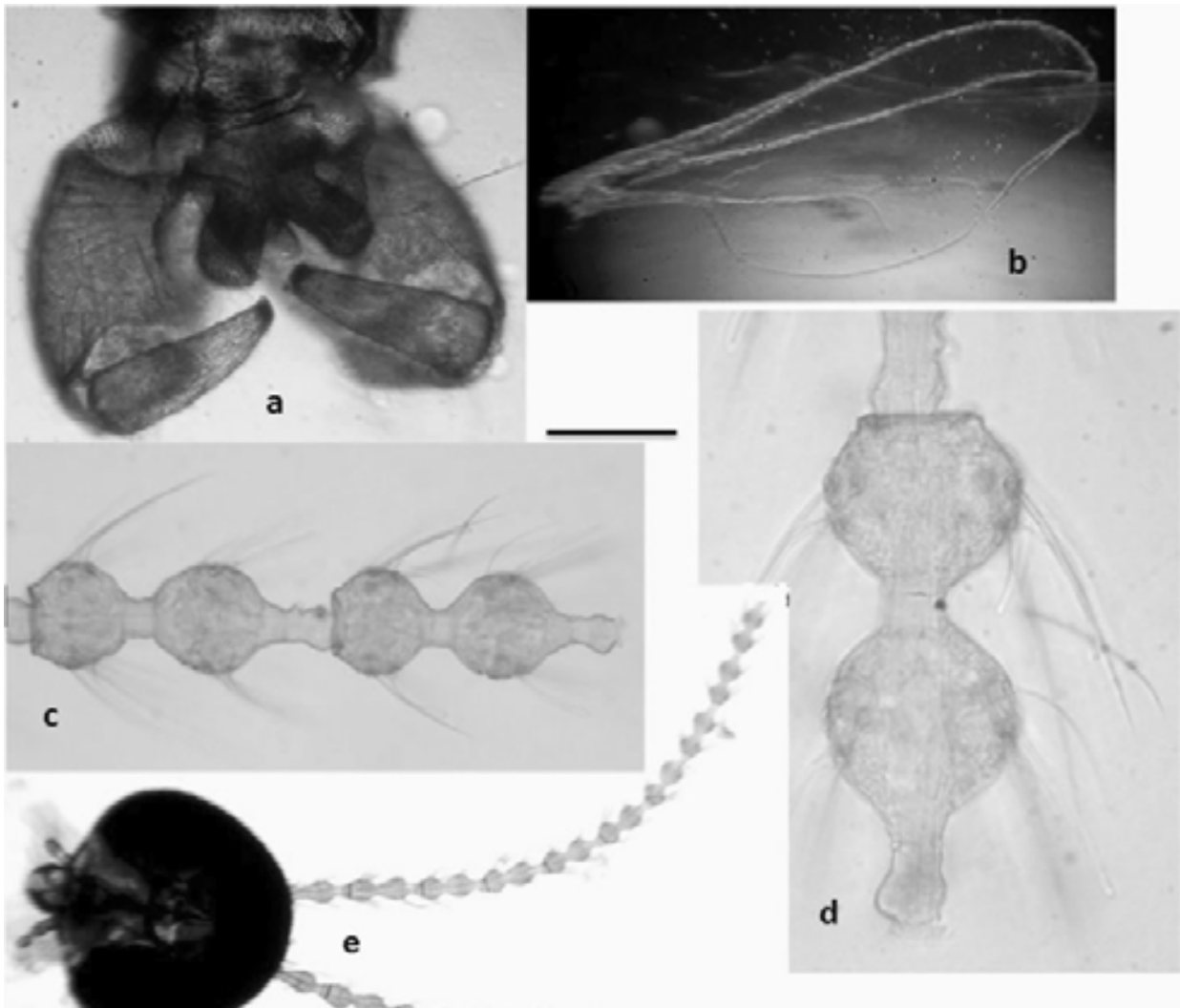


Figure 2. *Odinadiplosis amygdali*, male. a. genitalia; b. wing; c. last two segments of antenna; d. 12th segment of antenna; e. head and antenna. Scale bar for a and d= 0.01 mm; for b= 0.86 mm; for c= 0.03 mm; for e= 0.25 mm.

Female (Figure 1a, 3). Length about 2.5 mm. Similar to male excepts as follows: antennae (Figure 3b-d): 2 + 12, slightly more than 1 mm long; each flagellar segment cylindrical with small neck, basal portion bearing a basal ring of setae regularly placed, a distal ring of setae irregularly placed, and apparently a single median applied circumfilum; first flagellar segment with basal portion about three times as long as broad, neck very slightly longer than broad; third flagellar segment with basal portion about twice as long as broad, neck slightly longer than broad, three distal segments more globular; tenth flagellar segment with basal portion only slightly longer than broad, neck small, almost transverse, 12th segment with setose slightly pointed elongation (Figure 3d). Palpi: two segments, proportions as in male. Legs bright straw colored. Abdomen blackish. Ovipositor (Figure 3a) very extensile, lighter color, blunt ended, lamelliform; dorsal lamellae rounded about as long as broad, setose; ventral lamella minute. Antenna and sheaths of pupa as illustrated (Figure 1c,d).

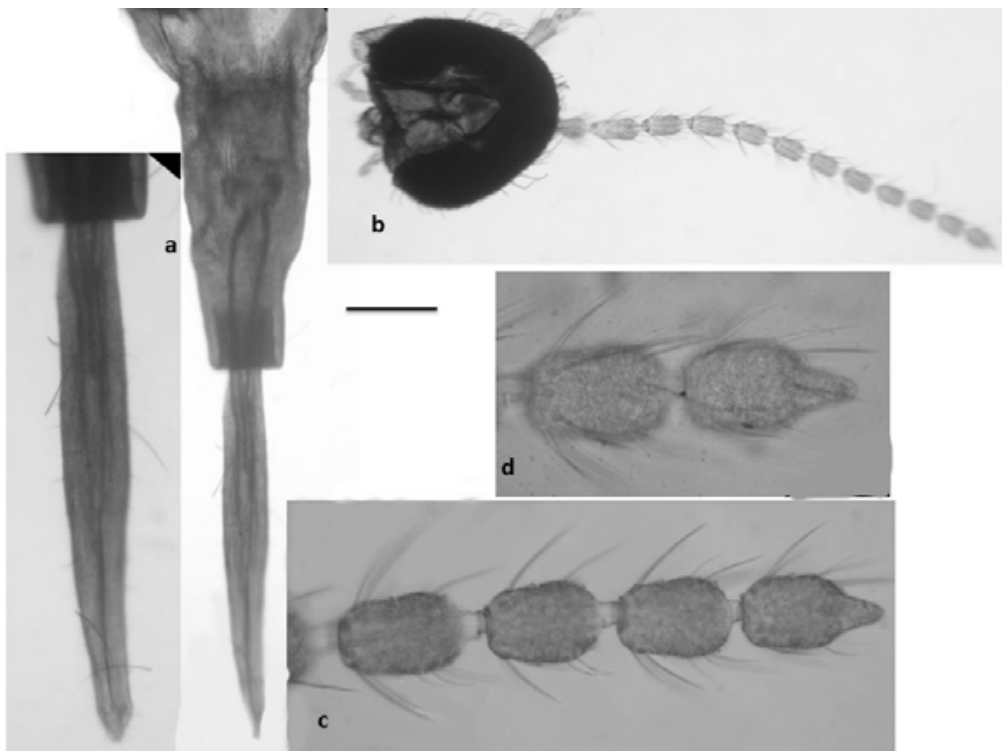


Figure 3. *Odinadiplosis amygdali*, female. a. genitalia; b. head and antenna; c. last four segments of antenna; d. 11th and terminal segment of antenna. Scale bar for a= 0.01 mm; for b=0.25 mm; for d and c= 0.03 mm.

Larva (Figure 4a). Length about 2 mm. Color yellowish white. No sternal spatula. One pair of anal papillae (Figure 4b); having stigma one pair on prothorax, and 8 pairs on abdominal segments as seen in Figure 4c,d; anal plate as seen in Figure 4e.

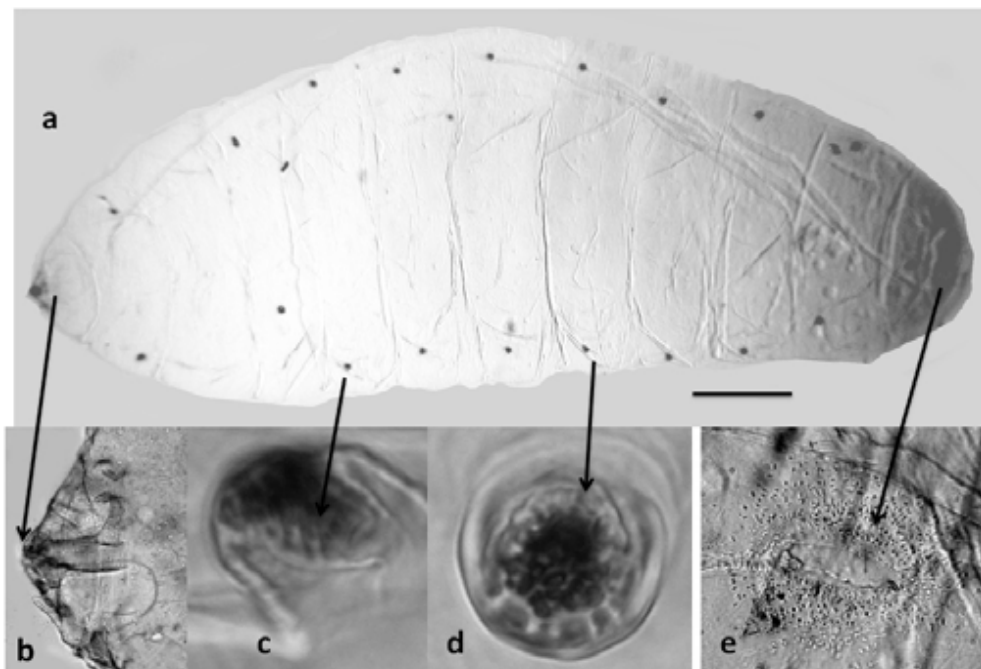


Figure 4. *Odinadiplosis amygdali*, larva. a. mature larva; b. head and mouth parts; c, d. stigma, c. in lateral view; d. in dorsal view; e. anal plate. Scale bar for a= 0.2 mm; for others= 0.005 mm.

Biology: *Odinadiplosis amygdali* is univoltine. The development of the maggot induces the plant tissue to produce a budlike gall which grows simultaneously with the growth of the maggot. These are 3-4 mm in diameter and sometimes occur in large aggregates up to 1 cm in diameter (Figure 5 a). The full-grown maggot passes the winter in diapause inside galls on almond twigs. Woody, spheroidal outgrowths can be found on the subterranean stems (Figure 6). Galls with the gall maker inside are a pale brown color. Old galls are a dark brown and usually have an exit hole. Fresh galls were present in the summer, fall, and winter months. A single larva is found inside each gall. The full-grown larva is oval-shaped and completely fills the cavity (Figure 5 b, c). Pupation occurs in the gall. When the adult is fully formed inside the pupa, the pupa breaks through the gall and crawls through the tip to the gall. A break in the pupal thorax then develops through which the midge escapes (Figure 5 d, e). Soon after emergence in March the midges fly, and copulation and egg-laying take place. The eggs are laid singly or in batches at the bases of stipules Nijveldt & Talhouk (1976).

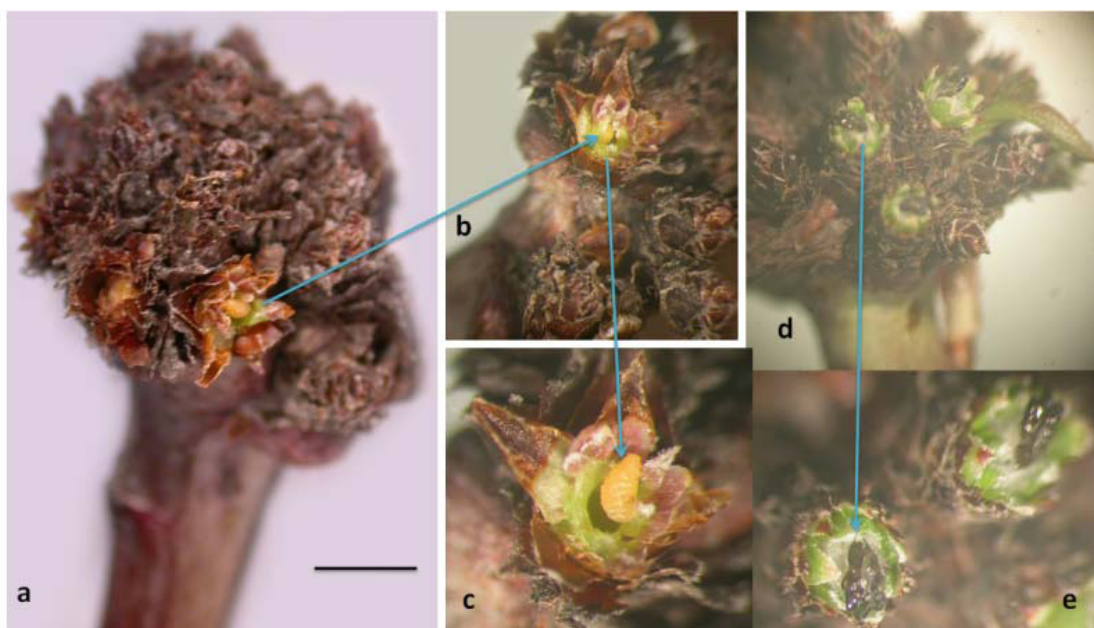


Figure 5. a. budlike gall on almond; b, c. larva in gall opened; d, e. remnant of pupae on galls from which midges emerged. Scale bar for a= 1 mm; for b and d= 0.4 mm; for c and e= 0.2 mm.

Importance of the pest in Hatay Province

The gall midge is causing severe damage because of larvae develop abnormal multiplication of buds. In winter when the trees have shed their leaves the symptoms become very clear: blackish, knotty malformations of different sizes appear on terminal as well as lateral growth (Figure 6).

Odinadiplosis amygdali makes average level of infestation on buds of almond, its infestation level in Antakya was 8.7 % of the trees in Turfanda, 10.4 % in Hanyolu, and in Altınözü about 21.0 % in Yanıkpınar and 10.9% in Yunushan (Table 1). The very early-growing varieties, such as dış bademi, and Hilvani, are severely attacked by the pest, due to this reason the infestation levels on susceptible varieties vary from 32.3-54.4% in the study areas. In other towns of Hatay province there is no infestations in the late-growing varieties, such as taş bademi, acı payam, of almond trees (Table 1). Similar results were reported from Lebanon by Nijveldt & Talhouk (1976) such as the very early-growing variety, Hilwani highly appreciated for its fruit size and good quality is subject regularly to severe attacks by the pest, the very late-growing and equally desirable varieties, grown in the same orchards, are always found free from attacks by this pest. Varieties with intermediate bud break periods suffer injuries of varying severity. On the other hand the Almond Bud Gall Midges is minor pest in Hatay province, because in total 5.7% of trees were attached by the pest, and the infestation level on buds of branches is 21.0% among the trees studied.



Figure 6. Damages of *Odinadiplosis amygdali* as blackish, knotty malformations on almond buds.

Table 1. Number of almond trees infested by *Odinadiplosis amygdali* and healthy ones in the villages, and number of the galls on branches in different sides of infested trees in Hatay Province In 2012

Sampling sites	Sampling date	No of trees	No of Infested trees	Infestation levels %	No of buds on 4 branches	No of galls on 4 branches	Infestation levels %
Altınözü Yanıkpınar	22.04.2012	43	9	21.0	164	53	32.3
Altınözü Yunushan	21.03.2012	64	7	10.9	218	74	33.9
Antakya Hanyolu	01.04.2012	52	5	10.4	95	36	37.9
Yayladağ	01.04.2012	56	0	0	176	0	0
Antakya Turfanda	01.05.2012	23	2	8.7	125	68	54.4
Belen	23.04.2012	52	0	0	186	0	0
Hassa	23.04.2012	72	0	0	103	0	0
Kırıkhan	23.04.2012	105	0	0	145	0	0
İskenderun Teknepınar	25.04.2012	34	0	0	58	0	0
Dört Yol	25.04.2012	27	0	0	67	0	0
Erzin	25.04.2012	17	0	0	95	0	0
Toplam		489	23	5.7	1156	231	21.0

Parasitoids

In the study three species of parasitoids from three families of Hymenoptera, namely *Synopeas talhouki* (Platygastridae) and *Baryscapus oophagus* (Eulophidae) (as primary ones) were found as main mortality factors of the gall midges, and *Torymus phillyreae* (Torymidae) was recorded as secondary parasitoid as secondary parasitoid on the former ones. *Synopeas talhouki* was reported from Lebanon before by Nijveldt & Talhouk (1976), and *B. oophagus* and *T. phillyreae* were newly recorded as members of the parasitoid complex of *O. amygdali*. All of the parasitoid species were newly recorded from Turkey.

Synopeas talhouki Vlug, 1976

Material examined: Turkey: Hatay, Antakya, Hanyolu, 1-15. iv. 2012, 11 ♀♀, 1 ♂; Altınözü, Yanıkpınar, 13-22. iv. 2012, 18 ♀♀, 14 ♂♂; Yayladağ, Turfanda, 1.5. 2012, 1 ♀, all of specimens were reared by M. Doğanlar).

Distribution: Blat, Lebanon (Vlug, 1976; Nijveldt & Talhouk, 1976).

Biology: Reared from larvae of *O. amygdali* as primary parasitoid.

Remarks: Vlug (1976) stated that the female of *S. talhouki* lays egg into the egg of *O. amygdali*. The development of the parasite larva occurs in the larval stage of the gall midge and hibernates in the host larva. The parasite completes one generation per year.

Baryscapus oophagus (Otten, 1942)

Tetrastichus oophagus Otten, 1942: 160; *Baryscapus oophagus* (Otten), Graham, 1991: 126-127. (New combination for *Tetrastichus oophagus* Otten).

Distribution: Europe (Pschorn-Walcher & Eichhorn, 1973; Graham 1991); Iran (Yefremova et al. 2007); Russia (Graham 1991).

Material examined: Turkey: Hatay, Antakya, Hanyolu, 1-15. iv. 2012, 13 ♀♀, 12 ♂♂; Altınözü, Yanıkpinar, 15-27. iv. 2012, 15 ♀♀, 21 ♂♂; Yayladağ, Turfanda, 1.5. 2012, 3 ♀♀, all of the specimens were reared by M. Doğanlar.

Biology: Reared from larvae of *O. amygdali* as primary parasites for the first time, and the development of the parasite larva occurs in the larval stage of the gall midge and hibernates in the host larva. The parasite completes one generation per year.

Remarks: *Baryscapus oophagus* has been recorded as primary egg parasite of *Diprion pini* (Hymenoptera:Diprionidae), *Neodiprion sertifer* (Hymenoptera:Diprionidae) (Martinek, 1963; Pschorn-Walcher & Eichhorn, 1973; Graham 1991; Yefremova et al. 2007); *Phyllocnistis citrella* (Lepidoptera: Gracillariidae) (Yefremova et al. 2007).

Torymus phillyreae Ruschka, 1921

0-341; *Callimome schiödtei* Hoffmeyer, 1930: 115; *Callimome scoparii* Hoffmeyer, 1930: 116; *Torymus tripudians* Graham, 1993: 19-21.

Distribution: Europe (Ruschka, 1921; Hoffmeyer, 1930, Herting, 1977; 1978; Nikol'skaya & Zerova, 1978; Graham & Gijswijt, 1998, Popescu et al. 2002; Askew & Harris, 2007); Armenia, Russia, Ukraine (Zerova et al. 2003).

Material examined: Turkey: Hatay, Antakya, Hanyolu, 15. iv.-2. v. 2012, 25 ♂♂; Altınözü, Yanıkpinar, 1. v. 2012, 1 ♂, all of the specimens were reared by M. Doğanlar.

Biology: The adults were reared from larvae of *S. talhouki* and *B. oophagus* as secondary parasites of *O. amygdali* for the first time. The parasitoid larva develops in the larval stage of the hosts, and hibernates in the host larva. The parasite completes one generation per year.

Remarks: *Torymus phillyreae* has been recorded as primary parasite of *Asphondylia* sp., *Asphondylia sarothamni*, *Asphondylia ulicis*, *Braueriella phillyreae*, *Stictodiplosis scrophulariae* (Diptera: Cecidomyiidae) (Nicol'skaya & Zerova, 1978; Herting, 1978, Graham & Gijswijt, 1998; Zerova & Seryogina, 2003, Askew & Harris, 2007); *Dryocosmus australis* (Hymenoptera: Cynipidae) (Herting, 1977).

Table 2. In 2012 number of specimens of *Odinadiplosis amygdali* and parasitic Hymenoptera reared from galls on buds of *Prunus dulcis* in Hatay Province

Sampling sites	Sampling date	No of galls	<i>Odinadiplosis amygdali</i> %		<i>Baryscapus oophagus</i> %		<i>Synopeas talhouki</i> %		<i>Torymus phillyreae</i> %		No of parasitoids %	
Altınözü Yanıkpinar	22.04.2012	113	44	38.9	36	31.8	32	28.3	1	0.1	69	61.1
Altınözü Yunushan	21.03.2012	71	71	100.0	0	0.0	0	0.0	0	0.0	0	0.0
Antakya Hanyolu	01.04.2012	160	87	54.4	25	15.6	23	14.4	25	15.6	73	45.6
Antakya Turfanda	01.05.2012	47	43	91.5	3	0.1	1	0.02	0	0.0	4	8.5
Total		391	245	62.6	64	16.4	56	14.3	26	6.7	146	37.3

The average level of total parasitism of *O. amygdali* was 38.3 % in Hatay province, and the highest level of parasitism was found on buds collected at the locality Yanıkpınar, Altınözü where it reached 62.5 %. The parasitism level was in Hanyolu 45.6 %, and in Turfanda 9.3 % and, in other localities the parasitoids were not found (Table 2), while in Hanyolu 15.6 % of the parasitism belongs to the secondary parasitoid, *T. phillyreae*. The average level of adults of *O. amygdali* was 62.6 (38.9-100) %; of *B. oophagus* 16.4 (0.0-31.8); of *S. talhouki* 14.3 (0.0-28.3) and of *T. phillyreae* 6.7 (0.0-15.6) %.

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