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NOTE

Population dynamics of *Coccinella septempunctata* (Coleoptera: Coccinellidae) in the region of Edremit Gulf in West Anatolia (Mount Ida)

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Abstract. This study reports seasonal presence of *Coccinella septempunctata* L. (Coleoptera: Coccinellidae) in Southeast Turkey, in 2008, 2009 and 2010. Samples were collected from crops in agricultural areas at altitudes of 10 m, 800 m and 1400 m from stands of wild herbaceous plants , and at 1750 m from stone debris fields. First *C. septempunctata* adults were collected at the beginning of June at Tentcamp (800 m) and Tozlu (1400 m), early in July at Sarikiz (1700 m) when the mean air temperature reached 30°C. Adults became active in spring, after aestivating around Sarikiz and overwintering there under snow. First adults emerged on 2nd April in 2009 around Edremit Gulf when mean air temperature reached 14.8°C. Adult and immature stages of *C. septempunctata* were recorded attacking aphid populations till the end of June. *C. septempunctata* was present there for only one period each year during which they completed one generation. Adult individuals of this generation returned to Mount Ida to aestivate. Maximum numbers of adults present on Mount Ida in the first week of August in 2009 and 2010 were recorded. *C. septempunctata* adults aestivate and overwinter at Sarıkız on Mount Ida after completing their development on aphids in April, May and June around Edremit Gulf.

INTRODUCTION

Coccinella septempunctata L. 1758 (Coleoptera: Coccinellidae), is one of the most common species of ladybird in the Palearctic (Hodek, 1966) and recently spread to America (Evans, 2004). This species feeds mostly on aphids (Aphididae) (Kuznetsov, 1975; Formusoh & Wilde, 1993). It mainly occurs in fields, orchards and meadows where there are bushes and herbaceous plants infested with aphids. *C. septempunctata* is especially effective in reducing the population of aphids on grain crops in spring (Hauge et al., 1998).

C. semptempunctata, usually has only one generation per year in temperate regions and avoids starvation when aphids are scarce during hot and arid periods by aestivating (Hagen, 1962). According to Honek (1989) some individuals of *C. septempunctata* diapause under rocks and weeds when air temperature is high in August, whereas others remain active until October in Central Europe. Diapausing individuals aggregate on mountains mostly in large groups, while others remain on the plains and hibernate individually in winter (Hodek, 1960, 2012). Honek (1989) reports that in the former Czechoslovakia adults of *C. septempunctata* aggregate at aestivo-hibernation sites. According to Bodenheimer (1943) and Ricci et al. (2005) in areas that experience high temperatures in the Mediterranean region *C. septempunctata* adults move to higher altitudes in June after spending early spring reproducing. Similarly, *C. septempunctata* aggregates in Greece on Mount Kitheron from July, after actively reproducing in April and June in the lowlands (Katsoyannos et al., 1997a). In Turkey, *C. septempunctata* is reported to spend summer and winter months diapausing on mountains (Bodenheimer, 1943; Güven et al., 2015).

Several studies have shown that the durations of the aestivation and overwintering periods determine the number of generations *C. septempunctata* can complete each year. For instance, *C. septempunctata* is univoltine in Western and Central Europe (Hodek, 1959; Hagen, 1962) and bivoltine in Eastern and Southern Europe (Dyadechko, 1954). Bodenheimer (1943) assumes that the 2nd generation of *C. septempunctata* is completed in autumn because it aestivates in July and August in Israel, where the mean annual temperature is very high.

In this study, we aimed to determine the population changes of *C. septempunctata* that occur in agricultural and non-agricultural areas in the region of Edremit Gulf, where the variation in daily temperature is high, and at aestivo-hibernation sites on Mount Ida.

MATERIALS AND METHODS

Sampling in cultivated areas in the region of Edremit Gulf

In the region of Edremit Gulf in the Aegean sea, samples were collected every 2 weeks at 10 randomly selected sites in olive orchards and other cultivated areas at altitudes between 10 and 250 m from March to September in 2009–2010. At each sampling site, *C. septempunctata* adults were collected using 100 sweeps

Fig. 1. Locations at which *Coccinella septempunctata* was sampled around Edremit Gulf and in Mount Ida National Park.

of insect net and the number of eggs, larvae and pupae of *C. septempunctata* on 10 aphid-infested plants were recorded. In 2010, most of the sweep net sampling was done in a clover field close to Burhaniye (39°32´N; 27°00´E, see Fig. 1).

Aestivo-hibernation sites of *C. septempunctata* in Mount Ida National Park

The locations of aestivo-hibernation sites of *C. septempunctata* were recorded at 3 different altitudes in Mount Ida National Park. The numbers of individuals of *C. septempunctata* were recorded on 25 randomly selected aphid-infested plants of *Cirsium arvense* L. and *Rumex obtusifolius* L. in June in 2009–2010 in Mount Ida National Park at Tentcamp (39°32´N; 27°00´E) (800 m) and Tozlu (39°42´N; 26°53´03E) (1400 m) (Fig. 1).

Sampling at the highest point on Mount Ida, Gooseyard (39°42´N; 26°51´E) (1710–1750 m), started in August 2008 and continued at 1–2 week intervals until November. In winter, one sample was recorded at least once a month. From the first sampling date to the onset of snow cover, adult counts were first recorded at the highest point at Gooseyard (1750 m altitude) and then along a line extending to the south and north with a further 50 sample sites in each direction. Adults were counted in a 1m^2 area at each sample site, with a total of 100 samples in each sampling period. The number of samples was decreased to a total of

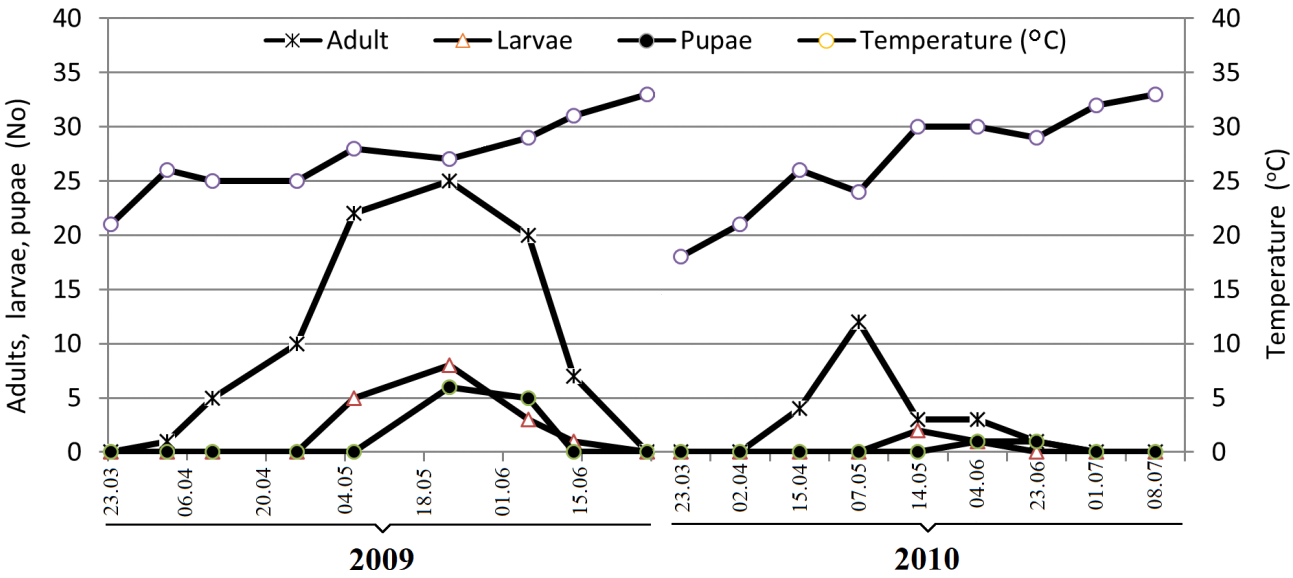

Fig. 2. Population development of *Coccinella septempunctata* in the lowlands in the region of Edremit Gulf in spring and summer.

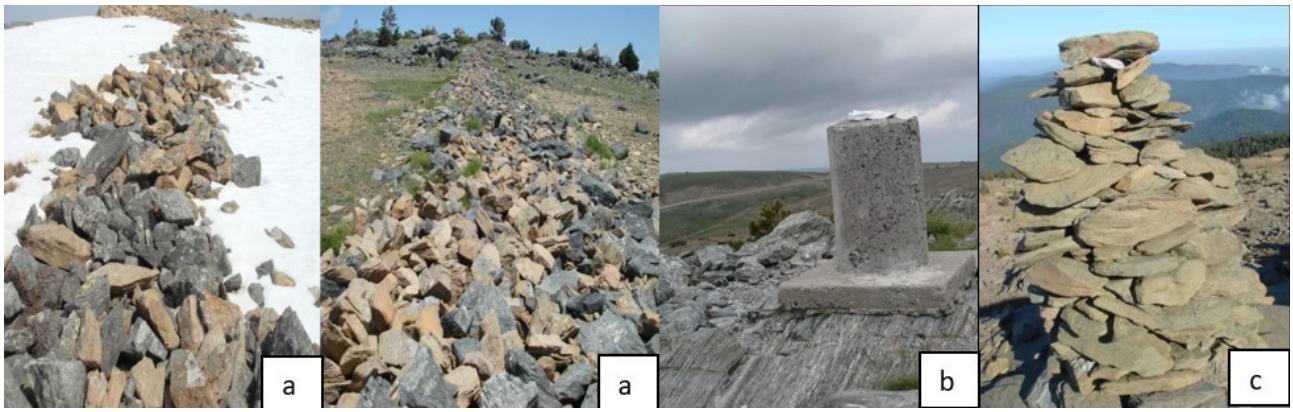

Fig. 3. Aestivo-hibernation sites of adult *Coccinella septempunctata* at Sarıkız. a – Gooseyard; b – mark at top of hill; c – pile of stones.

10 with 5 samples recorded south and 5 recorded north of this location when it was covered with snow.

Temperature and humidity were recorded at each sample site using a digital thermo hygrometer (Pro-ser Testing Technologies) at 11:00–15:00. Altitude and coordinates were determined using a GPS device (Garmin). Climate data was also obtained from one meteorological station located at an altitude of 1660 m and another at the Edremit Meteorology Institute.

RESULTS

Population of *Coccinella septempunctata* in the region of Edremit Gulf and in Mt Ida National Park

First adults of *C. septempunctata* were recorded on weeds in an olive orchard at an altitude of 260 m in Mount Ida National Park where the mean temperature on 02.iv.2009 was 14.8°C. First aphids were observed on *Cirsium arvense* L. on 10.iv.2009. On the same day, 6 adults of *C. septempunctata* were recorded on weeds in another olive orchard at an altitude of 27 m (39°34´N; 26°50´E) (Fig. 2).

The number of overwintered adults recorded peaked (25 adults) on May 22. First larvae (5 larvae) and first pupae produced by the overwintered adults of *C. septempunctata* were recorded on May 3 and May 22, respectively. Various developmental stages of *C. septempunctata* (9 larvae, 6 pupae, 2 egg batches and 25 adults) were also recorded on May 22. A total of 20 adults, 3 larvae and 5 pupae were recorded in the first week of June when the daily temperature was over 25°C. Seven adults and 1 larva were also recorded in a clover field close to Burhaniye on 13.vi.2009. Last adult was recorded on July 7 when daily mean temperature was over 28°C.

Thus, there was only one period of occurrence of *C. septempunctata* in both 2009 and 2010 in the region of Edremit Gulf. The maximum number of adults was recorded at the end of May and maximum number of pupae in the first week of June. Individuals of *C. septempunctata* in the area close to Edremit Gulf completed their development and started to move to aestivation sites on Mount Ida when temperatures were above 30°C.

Similarly, first adults were recorded on 15.iv.2010 and continued to be recorded until the beginning of June in clover fields. The abundance of *C. septempunctata* in 2010 was lower than in 2009. A total of 17 adults, 3 larvae and 2 pupae were recorded.

Estivo-hibernation sites of adult *Coccinella septempunctata* on Mount Ida

The examination of locations at different altitudes revealed that adults of *C. septempunctata* prefer to aestivate at above 1700 m and overwinter in Mount Ida National Park. Adults were recorded aggregating mainly at Gooseyard, where there is an abundance of stone stacks (Fig. 3a, Table 1).

Some adults were also collected from other areas (rocky cliff and marked hill) at the same altitudes on Mount Ida. In the forested part of Mount Ida, *C. septempunctata* adults were recorded at Tentcamp (800 m) and Tozlu (1400 m) feeding on aphids on *C. arvense* and *Rumex obtusifolius* in 2009 and 2010 (Fig. 4 and Table 1). In both years, *C. septempunctata* adults were first recorded at Tentcamp and Tozlu when the numbers of adults in the area of Edremit Gulf started to decrease in June. The presence of a *C. septempunctata* larva at Tentcamp on 04.vi.2010 proved that this insect reproduced at this location.

Changes in the numbers of adults of *Coccinella septempunctata* recorded at Gooseyard on Mt. Ida

The relation between the number of adults of *C. septempunctata* and temperature at Gooseyard on Mount Ida from 2008–2010 is shown in Fig. 5.

Table 1. Numbers of *Coccinella septempunctata* recorded at different altitudes in Mount Ida National Park.

Sampling		Altitude (m)	Number recorded [1]	
Date	Location			
06.viii.2008	Sarıkız (Gooseyard)	1715–1750	32.50	*
18.x.2008	Tentcamp	750–800	0.00	
18.x.2008	Rocky cliff	1540–1555	0.00	
18.x.2008	Nomads' place	1590–1600	0.40	
18.x.2008	Sarıkız (Gooseyard)	1710–1750	17.50	*
02.xi.2008	Sarıkız (Gooseyard)	1710–1750	24.90	
20.i.2009	Sarıkız (Gooseyard)	1720–1750	91.25	**
02.iv.2009	Sarıkız (Gooseyard)	1720–1750	116	**
17.iv.2009	Marked hill	1700–1730	48.50	
17.iv.2009	Pile of stones	1540–1555	38.00	
13.vi.2009	Tentcamp	800	19.00	+
13.vi.2009	Tozlu	1400	11.00	+
26.vi.2009	Tentcamp	800	3.00	+
26.vi.2009	Tozlu	1400	44.0	+
07.vii.2009	Tentcamp	800	0	
07.vii.2009	Tozlu	1400	0	
22.vii.2009	Tentcamp	800	0	
22.vii.2009	Tozlu	1400	0	
04.vi.2010	Tentcamp	800	3.00	+
23.vi.2010	Tozlu	1400	1.00	+
23.vi.2010	Tentcamp	800	2.00	+
07.vii.2010	Tozlu	1400	2.00	+
07.vii.2010	Tentcamp	800	2.00	+

[1] mean data, * active adults, ** adults between rocks under snow, + aphid presence.

Fig. 4. Adults of *Coccinella septempunctata on Rumex obtusifolius* (a) and *Cirsium arvense* (b) infested with aphids at Tentcamp and Tozlu.

On 06.viii.2008 adults of *C. septempunctata* were present at different sites at Sarıkız but preferred to aggregate between and under the rocks at Gooseyard. Active adults were observed on rocks in September and October on sunny days with some of them mating. After the beginning of November when the temperature was below 5°C (13:00–15:00 h) the number of active adults decreased and they started to aggregate between and under rocks. Sampling on 21.i.2009 showed that adults overwinter under snow after snowfall. In spring with a 90–95% snow cover at the summit of Mount Ida, some of the adults were active where snow had started to melt on 02.iv.2009 and other adults were still under the snow. One week after this date (on 10.iv.2009) most of the adults had aggregated under rocks and in weeds where snow had melted. Most of the adults were scattered around on the next sampling date (17.iv.2009) when most of the snow had melted. One week later (25.iv.2009) mostly only single adults were observed on rocks and weeds. Number of adults started to decrease (1–9/m^2) on 03.v.2009. On 12.v.2009, snow had mostly melted except on the northern slopes of the mountain and the adults were observed in groups consisting of 3–5 individuals. The number of adults had decreased considerably on 02.vi.2009 when the temperature was 23°C. On the next sampling occasion no further change in the number of adults was recorded.

Active movement and decrease in the numbers of the adult beetles at the beginning of April at the aestivo-hibernation sites were consistent with the discovery of the first adult at an altitude of 260 m in the region of Edremit Gulf on 02.iv.2009. The number of adults continued to increase throughout April at different locations in the region of the Edremit Gulf (Fig. 2). Number of the adults on Mount Ida was the lowest in May and June and highest in the region of Edremit Gulf. Number of adults started to decrease in the region around the Gulf when the mean temperature exceeded 25°C in July, which coincides with new adults being recorded at Gooseyard. Number of the adults there peaked and no adults were recorded in the Gulf region in the first week of August, when adults of *C. septempunctata* were only recorded at aestivo-hibernation sites, as in the previous year. Sometimes adults were so abundant at aestivo-hibernation sites that it was not possible to count them. Number of active adults was higher when temperatures (15–20°C) were high and some adults were also observed mating. With the decrease in temperature the number of active adults decreased and they started to overwinter under and between rocks as in the previous year.

Similar to the previous year, the presence of and flying adults were observed when snow on Mount Ida was melting on 02.iv.2010 and 15.iv.2010. Adult numbers increased throughout July and peaked in the first half of August. After the beginning of September, adults continued to be present at aestivo-hibernation sites until the beginning of December. Adult numbers were around 5–7 on each sampling occassion. Sampling ended when it started snowing. As in 2009 high temperature was an important factor in determining the flight of adults to aestivo-hibernation sites. The changes in the numbers of *C. septempunctata* were similar in both years.

One result of this study is that adults of *C. septempunctata* were recorded in agricultural and nonagricultural areas around the Gulf

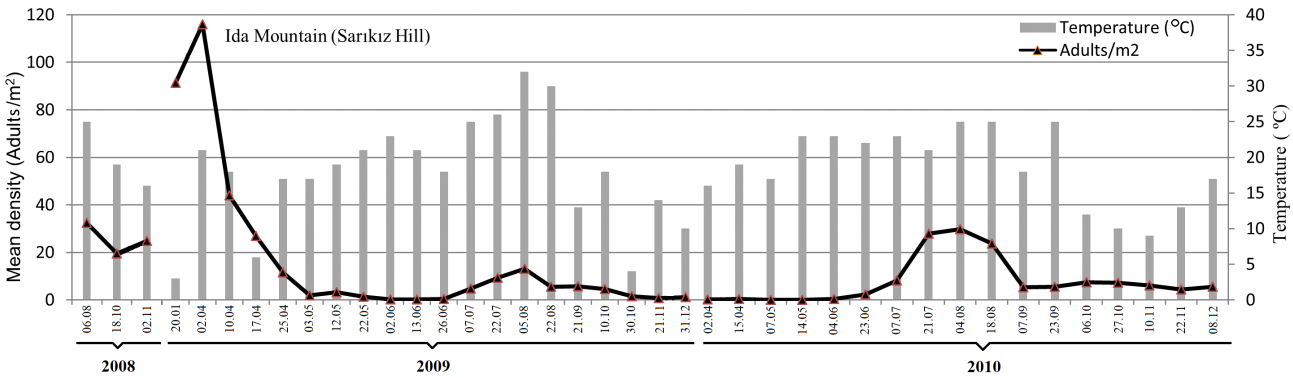

Fig. 5. Number of adults of *Coccinella septempunctata* recorded on Mount Ida at Gooseyard (1710–1750 m).

of Edremit from the beginning of April. Aphids, which are the main prey of *C. septempunctata*, were observed on *Cirsium arvense* plants one week after the first adults were recorded. First larvae were recorded at the beginning of May and the number of adults leaving aestivo-hibernation sites peaked in the middle of May. The maximum number of pupae of the new generation was recorded in the first week of July. The adults that emerged from these pupae started to move to aestivo-hibernation sites throughout June when the temperature exceeded 25°C and the number of adults in area of the Gulf then started to decrease until the first week of July when no adults were recorded.

DISCUSSION

In the area around Edremit Gulf *C. septempunctata* was only recorded from April to June. According to Sarospataki & Marko (1995) the maximum numbers of flying adults of *C. septempunctata* were recorded at the beginning of May and end of June.

C. septempunctata developed on aphids infesting plants of *Cirsium arvense* and *Rumex obtusifolius* in the area of the Gulf at an altitude of 800 m in June and 1400 m 10–15 days later on Mount Ida. Based on these observations it is suggested that aphids present at different altitudes might be used by adult *C. septempunctata* and store more energy during their flight to aestivo-hibernation sites and also for limited reproductive activity. Based on a similar observation, Hodek (1962) speculates that the migration of *C. septempunctata* is partially related to a decrease in aphid abundance.

Evaluation of both years' results shows that adults of *C. septempunctata* aggregate at an altitude of 1700 m at Sarıkız after the beginning of July. Adults were also observed overwintering under and between rocks covered with snow at Gooseyard. According to another study from Turkey the number of adults of *C. septempunctata* at aestivo-hibernation sites peak in June (Güven et al., 2015). Nedved et al. (2001) and Hodek (1960) record that adults of *C. septempunctata* start to aggregate at aestivo-hibernation sites in August in Europe. Hodek et al. (1977), Honek (1989) and Ceryngier (2000) report that the adults prefer to aggregate at locations above 1500 m. Ricci et al. (2005) also mention that *C. septempunctata* migrates to Monte Vettore in August and overwinter under snow in different habitats above 1950 m in Mid Italy. In Greece, where the ecological conditions are similar to those in the areas we studied, Katsoyannos et al. (1997a, b) report that most adults of *C. septempunctata* migrate to aestivo-hibernation sites on mountains in June. They report that *C. septempunctata* is reproductively active in the lowlands in April and June, aestivate in July and August, and overwinter from December to February. Even though the number of adults of *C. septempunctata* aggregating at aestivo-hibernation sites differed from year to year, they peaked in the first half of August in both years. Active and mating adults were recorded in September and October when daily mean temperatures exceeded 15°C. Number of active adults at aestivo-hibernation sites decreased after November as the temperature decreased and adults overwintered under the snow. According to Honek & Martinkova (2005) the number of adults aggregating at aestivo-hibernation sites varies from year to year. Hodek & Landa (1971) report that ovaries of females do not develop completely in autumn, but testicular follicles of males are active until temperatures fall below 12°C at aestivo-hibernation sites. We also observed that *C. septempunctata* adults tend to aggregate at the highest point at aestivo-hibernation sites. This is also reported by Güven et al. (2015) who attribute it to the hypsotactic tendency of migrating adults.

Adults of *C. septempunctata* were found on a plant of *Solanum nigrum* infested with aphids at an altitude of 90 m on 13.x.2010, when most of the adults were at aestivo-hibernation sites. This indicates that some adults do not go to aestivo-hibernation sites and feed on aphids even during the hibernation period. Similarly, Hagen (1962) mentions that some adults are able to survive and reproduce without migrating to aestivo-hibernation sites. According to Hodek (1962), the univoltine *C. septempunctata* migrate to aestivo-hibernation sites but the multivoltine individuals remain in lowlands and continue to reproduce by feeding on aphids.

Number of adults decreased at the aestivo-hibernation sites on Mt Ida when temperatures rose above 14–15°C and snow cover melted in April, and numbers at these sites were lowest in May. At the same time the number of adults in the Gulf area increased, which we relate to the migration from aestivo-hibernation sites. Hodek (2012) reports that migration from aestivo-hibernation sites is a reaction to increasing temperature and that the number of adults is the lowest at aestivo-hibernation sites at the end of May, which parallels the rise in temperature. According to Sarospataki & Marko (1995), there is a positive correlation between adult flight and air temperature: flight to aestivo-hibernation areas starts when temperatures increase to 15°C and is at a maximum at 22°C.

We conclude that from April to June adults of *C. septempunctata* forage for aphids in the lowland area around Edremit Gulf and spend the remaining 9 months at Sarıkız (1700–1750 m) on the summit of Mount Ida. Migration is closely linked to temperature changes in their environment. Adults of *C. septempunctata* started to migrate to aestivo-hibernation sites when the temperature rose above 25°C around the Edremit Gulf. Accordingly migration was not recorded on the northern side of Mount Ida at Çanakkale where the temperatures are generally lower. Adults that overwinter on Mount Ida return to the region around Edremit Gulf in April.

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