

Notes on the Seasonal Dynamics of Some Paederinae (Coleoptera: Staphylinidae) Species in the Vineyards of Manisa, Western Anatolia

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ABSTRACT

Paederinae (Coleoptera: Staphylinidae) specimens were collected via two light traps which were established in a vineyard in Sarıgöl district of Manisa between April 15th and November 15th in 2018-2019 in this study. Thus, the densities and seasonal activities of the species obtained were evaluated. At the end of the study, a total of 7.274 specimens were identified based on seven species, which are *Astenus melanurus* (Küster, 1853), *A. procerus* (Gravenhorst, 1806), *Luzea graeca* (Kraatz, 1857), *Medon dilutus pythonissa* (Saulcy, 1865), *Paederus fuscipes* Curtis, 1826, *Scopaeus bicolor* Baudi Di Selve, 1848 and *S. debilis* Hochhuth, 1851. It seems all recorded species are predators. The most abundant species are *S. debilis* with 7.006 specimens and *P. fuscipes* with 204 specimens. The identified species were found to be intense and active especially from mid-May to the end of July in general. According to the observations during field studies, it was found that *P. fuscipes* species was a predator of *Aphis illinoisensis* Shimer, 1866 and *A. gossypii* Glover, 1877 (Homoptera, Aphididae) species. This species is most active at the beginning and the end of dry summer.

Key words: Light trap, Paederinae, *Paederus fuscipes*, *S. debilis*, predator, Turkey, *Vitis vinifera*.

INTRODUCTION

Turkey provides opportunity for the production of agricultural products due to its climatic and geographical characteristics. One of these products is grape. Although grape (*Vitis vinifera* Linnaeus, 1753) is a plant grown in many places worldwide, its homeland is Anatolia and its neighboring regions. Therefore, it is grown in many different geographical regions of Turkey. Turkey is ranked sixth in the world in grape production and about 30% of the vineyard area is located in Manisa province in Turkey (Semerci, Kızılituğ, Çelik, & Kiracı, 2015). There are many insects which damage the grape plant. Therefore, many studies have been carried out on insects which damage the grape plant because of its economic importance. For that reason, mostly insecticides have been used in the control against grape plant pests. However, studies on the determination of natural enemies of grape plant pests and their potential for use in pest control are extremely limited.

Staphylinidae is represented by about 65.000 species in 33 subfamilies in the worldwide, is the largest family of the Coleoptera order (Newton, 2017; Irmiler, Klimaszewski, & Bethz, 2018). Paederinae, one of the largest subfamilies of this family, is represented by more than 6,000 species, belonging to 225 genera (Herman, 2001). The species belonging to the Paederinae subfamily are found in almost all habitats, but mostly in moist areas. However, they are generally abundantly found in stream, lake and riversides, moist grassy areas, humic parts of the soil and agricultural areas. As many of the Paederinae species are predators, they are agriculturally beneficial.

Since some of the Paederinae species exhibit light-directed behavior, it is possible to collect and examine them by light traps. However, studies on the collection and evaluation of Paedarinae species with light traps are very few. These studies are generally faunistic studies and ecological studies are very limited. Few ecological studies on Paederinae species have been conducted by Bohac & Bezdek (2004), Abdullah & Sina (2009), Nasir, Akram, & Ahmed (2012), Tezcan & Anlaş (2009), Özgen, Anlaş, & Eren (2010) and Anlaş, Özgen, Yağmur, & Örgel (2017).

Although it is known that some of the Paederinae species are predators, it is not known which Paederinae species are the predators of which pest species. In addition, no specific study has been conducted with light traps on these species up to date. It is known that among Paederinae subfamily *Paederus* species, which is also of medical importance, and especially *Paederus fuscipes* Curtis, 1826 species, are abundant in agricultural areas (cotton, cereal, rice, corn and various vegetable fields) and that they are predators of many pests of such genera as *Corcyra* spp. (Lepidoptera, Pyralidae), *Heliothis* spp. (Lepidoptera, Noctuidae) and *Aphis* spp. (Homoptera, Aphididae) and therefore they are known to be useful for agriculture (Berglind, Ehnstram, & Ljungberg, 1997; Krakerb, Van Huis, Van Lenterenb, Heonge, & Rabbingea, 2000; Komala-Devi, Yadav, & Anand, 2003; Nasir et al, 2012). Apart from this, no study has been found regarding which invertebrate species are preys of Paederinae species. However, some species have been stated to be general predators, as mentioned. For example, it has been observed that *Achenium depressum* (Gravenhorst, 1802) and *Scopaeus*

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mitratus Binaghi, 1935 are known as predators in cotton fields (Garcia-Ruiz et al, 2018), *Paederus limnophilus* Erichson, 1840, *Paederidus rubrothoracicus* (Goeze, 1777) and *P. ruficollis* (Fabricius, 1775) are known as general predators in agricultural areas (Kolasa, Kubisz, Mazur, Scibior, & Kajtoch, 2018).

No specific studies on Paederinae species found in vineyards have been conducted up to now. In this study, Paederinae species in vineyard areas were collected for the first time with the aid of light traps in Sarıgöl district, Manisa, western Anatolia. It was attempted to reveal the seasonal activities of the identified species, by determining the density of the collected specimens according to the species. It is also aimed to determine the presence of predatory Paederinae species.

MATERIAL AND METHODS

In this study, light traps were used to determine which Paederinae species occur in a selected vineyard area in Sarıgöl District, Manisa province. This area is located in Western Anatolia, includes in the Mediterranean climate, which is characterized by dry, hot summers and mild, moist winters. Average temperature and average rainfall amount of studied localities are provided in Fig. 1. Two light traps were set between April 15th and November 15th in 2018-2019 with a two-year study.

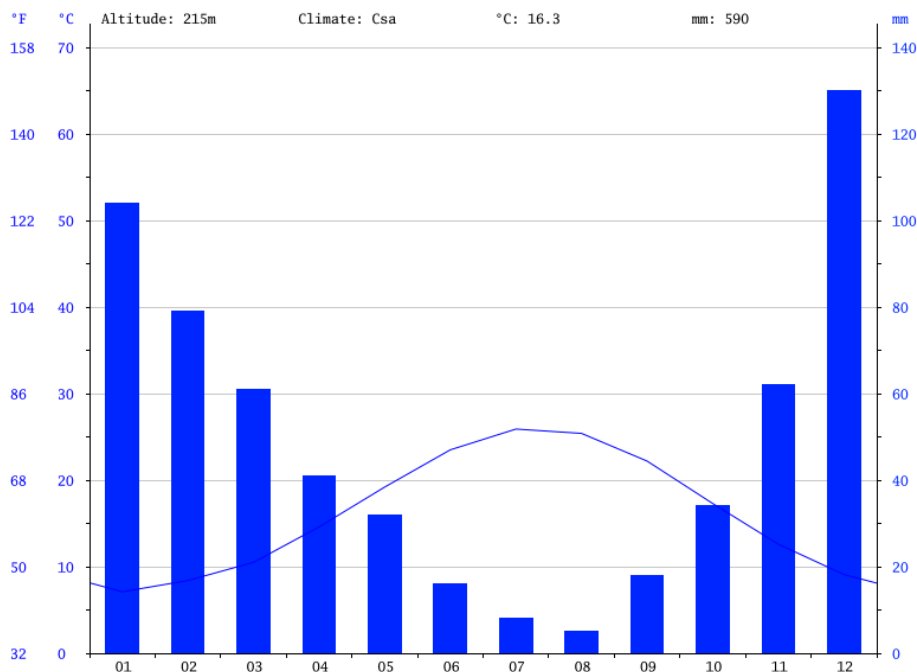


Fig. 1. Average temperature and average rainfall amount in Sarıgöl District, Manisa, Turkey (Source: tr.climate-data.org).

The vineyard area is 9 da in total and has a coarse textured soil. The vineyard has 3-year-old „Thompson seedless“ grape variety. The planting space is 3.00 X 1.8 meters and it was set with semi pergola training system. All cultural practices in the vineyard were done under farmer conditions. Light traps were set at 38°14'18.93"N, 28°42'25.35"E and 38°14'19.57"N 28°42'29.38"E (Fig. 2). A 60 watt Philips energy saver white day light bulb was used at each trap and traps were cleared at two weeks' intervals.

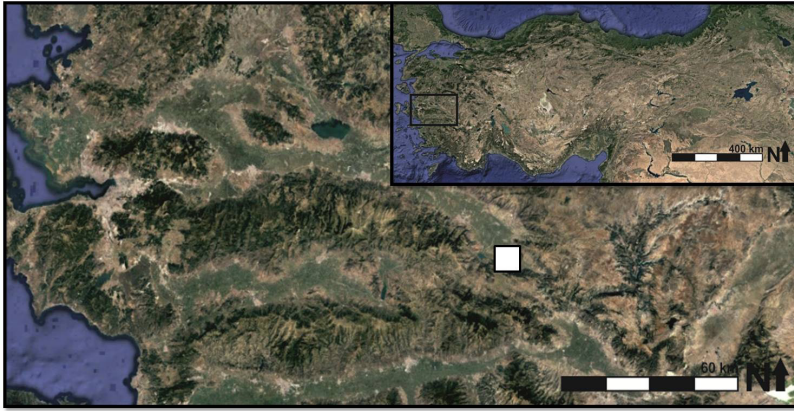


Fig. 2. The locality of light trapping study area in Sarıgöl, Manisa, Turkey.

In the vineyard area where the study was carried out, insecticide was applied against *Anaphothrips vitis* Priener in April and May, against *Lobesia botrana* Denis & Schifferrmüller in May, June and July and against *Planococcus citri* Risso in May and June by spraying. Unlike 2018, a broad spectrum insecticide with Deltamethrin effective substance was used in the first application (on 12.05.2019) for *L. botrana* in 2019.

The morphological studies were conducted using a Stemi 508 microscope (Zeiss, Germany). The photographs of the habitus, forebody and aedeagus of the studied species were taken with a digital camera (Zeiss Axiocam ERC5s). All photographs were edited with the Helicon Focus v. 6, and Coreldraw X5 software. The map was made using the software Google Earth Pro (2019). The materials were identified by the first author and were deposited in the Alaşehir Zoological Museum, Manisa, Turkey (AZMM).

RESULTS

Species composition

In this study, Paederinae samples were collected through two light traps set in a vineyard area in Sarıgöl district, Manisa, western Anatolia between April 15 and November 15, in 2018-2019. At the end of the study, a total of 7.274 specimens were collected to seven species. These species are *Astenus melanurus* (Küster, 1853), *A. procerus* (Gravenhorst, 1806), *Luzea graeca* (Kraatz, 1857), *Medon dilutus pythonissa* (Saulcy, 1865), *Paederus fuscipes* Curtis, 1826, *Scopaeus bicolor* Baudi Di Selve, 1848 and *S. debilis* Hochhuth, 1851 (Table 1).

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Table 1. Number of specimens of the recorded species in the studied locality in Sangöl, Manisa between April 15th and November 15th in 2018-2019.

Species	Year	30.04	15.05	30.05	15.06	30.06	15.07	30.07	15.08	30.08	15.09	30.09	15.10	30.10	15.11	TOTAL
<i>Scopaeus debilis</i> Hochhuth	2018	68	131	952	432	945	658	577	339	403	295	21	33	1	-	4855
	2019	52	65	77	234	713	403	235	123	129	88	8	22	-	2	2151
<i>Scopaeus bicolor</i> Selve	2018	3	1	-	-	-	-	-	-	-	-	-	-	-	-	4
	2019	4	2	5	-	-	-	-	-	-	-	-	-	3	3	17
<i>Paederus fuscipes</i> Curtis	2018	24	35	19	2	12	7	4	-	-	-	-	8	3	2	116
	2019	15	23	18	7	2	2	1	1	-	2	6	11	-	1	89
<i>Astenus procerus</i> (Gravenhorst)	2018	-	2	1	1	-	-	-	-	-	-	-	1	-	-	5
	2019	-	-	-	-	-	-	-	-	-	-	1	1	-	-	2
<i>Astenus melanurus</i> (Kluster)	2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2019	2	-	1	-	-	-	-	-	-	1	-	-	-	-	4
<i>Luzea graeca</i> (Kraatz)	2018	1	-	2	1	-	1	-	-	-	1	-	2	1	-	9
	2019	3	2	-	1	1	2	1	-	-	2	1	4	-	-	17
<i>Medon dilutus pythorissa</i> (Saulcy)	2018	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
	2019	-	-	-	-	-	-	-	1	2	-	-	1	-	-	4
TOTAL (for years)	2018	96	169	975	436	957	666	581	339	403	296	21	44	5	2	4990
	2019	76	92	101	242	716	407	237	125	131	93	16	39	3	6	2284
TOTAL		172	261	1076	678	1673	1073	818	464	534	389	37	83	8	8	7274

When the specimen numbers of the identified species were examined, it was observed that most specimens belong to *S. debilis* (Fig. 3; for more illustrations of this species see Frisch, 1999) with 7.006 specimens. Belonging to this species, 4.855 specimens were collected in 2018 and 2.151 in 2019. Following this species, the most abundant species is *P. fuscipes* (Fig. 4) with a number of 204 specimens. Others than these two species were examined, it was observed that very few specimens belonging to these species could be collected. For this reason, it is thought that these species are found incidentally in Sarigöl vineyards or are represented by very few specimens. When these species and the number of the collected specimens were examined; 26 specimens of *L. graeca* species, 21 specimens of *S. bicolor* species, seven specimens of *A. procerus* species, five specimens of *M. dilutus pythonissa* and lastly four specimens of *A. melanurus* species were determined.

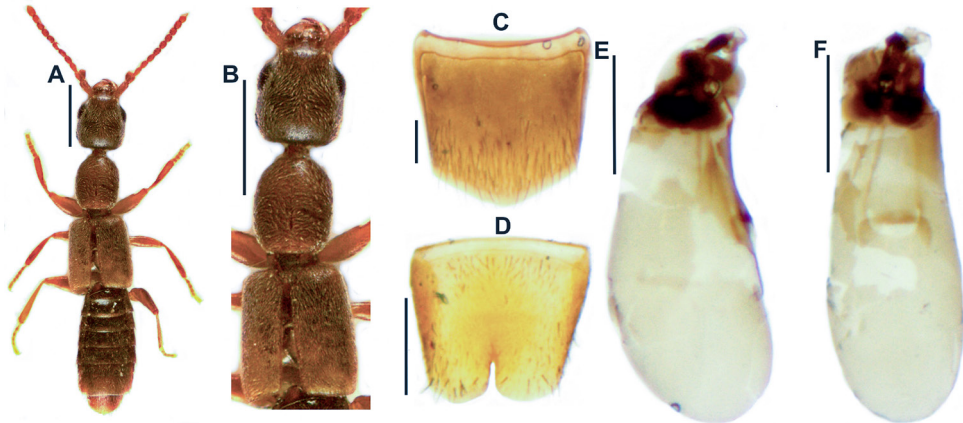


Fig. 3. *Scopaeus debilis* Hochhuth, 1851. A-habitus; B-forebody; C-male sternite VII; D-male sternite VIII; E-aedeagus, lateral view; F-aedeagus, ventral view. Scale bars: 0.5 mm (A-B); 0.2 mm (C-F).

Seasonal dynamics

It was seen that most specimens belong to the species *S. debilis*. Considering the distribution of the specimens by months, it was observed that the most samples for the year 2018 fell into the traps at the end of May with a number of 952 samples. At the end of June, this number was 945 specimens. Only one specimen was collected at the end of October and none in mid-November. Evaluating the year 2018 in general, it was seen that 68 samples were captured on April 30, then the number of samples increased until May 30, then decreased to 432 and then increased again and reached 945 on June 30. After that, it was observed that the number of specimen decreased and reached 658 on July 15, and then continued to decrease 577 on July 30, and decreased to 339 on August 15. It was seen that 403 specimens were collected with very little growth in the following period, and then the samples collected decreased gradually and no samples were collected on November 15. When the year 2019 was evaluated, it was observed that the period in which most specimens were collected

was the end of June. In this period, 713 samples were collected. No sample could be collected on October 30. When the seasonal activity of the species was examined, 2018 and 2019 were found to be almost the same (Fig. 5).

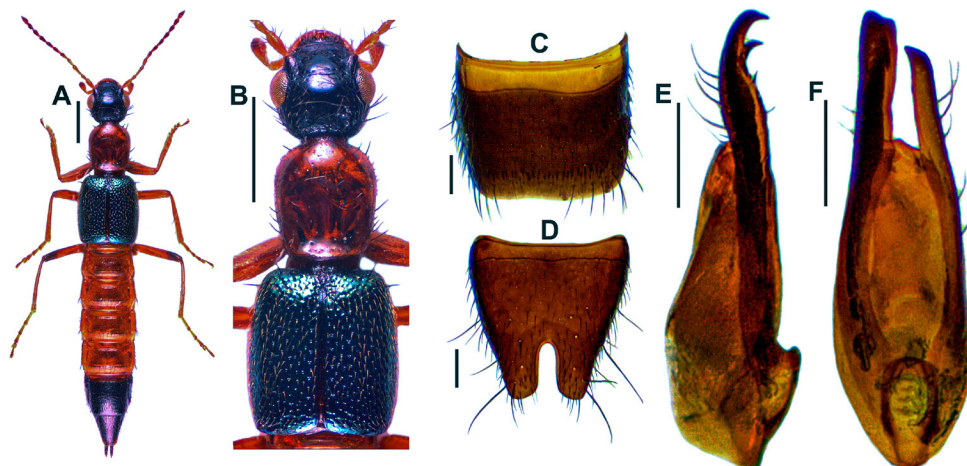


Fig. 4. *Paederus fuscipes* Curtis, 1826. A-habitus; B-forebody; C-male sternite VII; D-male sternite VIII; E-aedeagus, lateral view; F-aedeagus, ventral view. Scale bars: 1 mm (A-B); 0.2 mm (C-F).

P. fuscipes species is the most caught species after *S. debilis*. 116 specimens belonging to this species were recorded in 2018 and 88 in 2019. When the seasonal activity of the species was analysed, it was observed that most number specimens fell into the traps in April and May, few or no specimens fell into the traps during summer months and that the number of specimens in autumn months was still higher than the summer though it was not as much as spring months (Fig. 5). The seasonal activity of the *P. fuscipes* species was previously investigated by Anlaş et al (2017) for the Aegean Region, and due to few samples obtained in this study, it could not be fully compared with the previous results. According to this study, it was observed that the numbers of *P. fuscipes* species began to increase as of May, reached a high level at the beginning and in the middle of June, decreased in the dry period, that is July and August, and reached the highest numbers at the beginning and in the middle of September (Anlaş et al, 2017).

Accordingly, as a result of this study, it was detected that the density of *P. fuscipes* specimens collected with the help of light traps are almost similar to Anlaş et al (2017). The most important difference is that few samples were collected in the Sarigöl vineyard areas during autumn months. When other recorded species were examined after *S. debilis* and *P. fuscipes* species, it was observed that very few specimens of these species were collected. For this reason, it is thought that these species are found incidentally in Sarigöl vineyard areas or are represented by very few specimens. Seasonal activities could not be evaluated appropriately due to few specimens of these species.

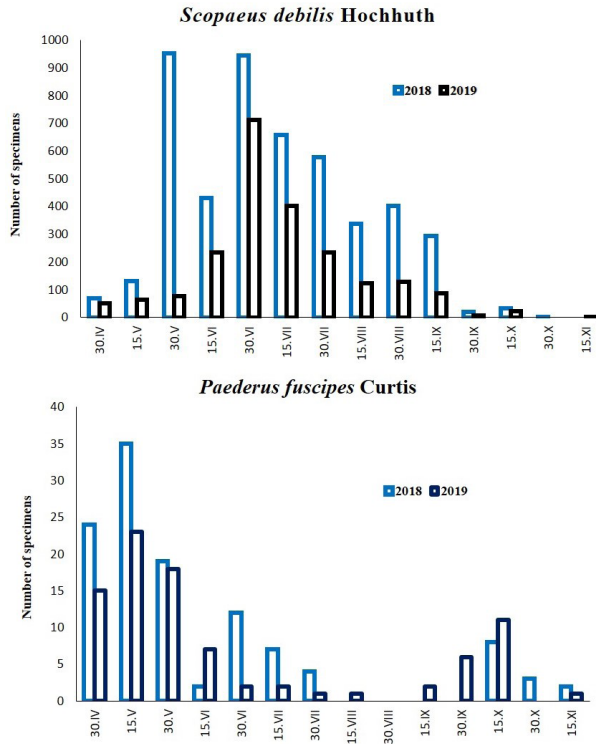


Fig. 5. Seasonal dynamics of *Scopaeus debilis* and *Paederus fuscipes* in the vineyard in Sarigöl, Manisa between April 15th and November 15th in 2018-2019.

When the seasonal activities of the species in Sarigöl vineyards were evaluated in both 2018 and 2019 together by considering all the samples of the seven species determined at the end of this study, it was seen that a total of 172 specimens were caught at the end of April, which was the first collection. After that, it was found that in the middle of May, the number increased to 261, after that, at the end of May, the number of the samples collected increased significantly to 1.076. After this date, the number of samples decreased to 678 in the collection in mid-June. By the end of June, it was observed that the most specimens were collected in this period by 1673. Then, the number of specimens fell to 1073 and then to 818. After that, the number of specimens continued to decrease in the middle of August and fell to 464 and at the end of the month, it reached 534 specimens with a small increase. In the collection made in the middle of September, the number of collected specimens decreased again to 389 specimens, then the number of the specimens decreased further, first to double digit numbers and then to eight specimens in late October and mid November. To sum up, it was understood that they reached the highest numbers at the end of May and June, they were also present in the summer months and their numbers were gradually decreasing in the autumn months.

Observations on recorded species

Apart from the light traps set within the scope of the study, various survey studies were carried out in the vineyard area in an attempt to observe the obtained species. As a result of the field studies, it was seen that the Paederinae species in the vineyard area were not active during the daytime and their full activities started in the evening and night hours. Accordingly, the bottom parts of the stones in the vineyard and its surrounding areas, the underneath of the barks and the leaves, the surroundings of the weeds and the areas where they can hide were investigated during the daytime. As a result of the investigation, some species belonging to Staphylinidae family were found in these areas and it was observed that these species were generally different from the species caught by light traps. The species identified in these areas were generally species of *Ocypus* spp., *Philonthus* spp. and *Quedius* spp. (Staphylinidae, Staphylininae) The species belonging to these genera are generally those which live on the soil and feed on small invertebrates, but no related species have been collected by light traps. Some of the identified Paederinae species were observed, though in small numbers, on and around the grape plant.

Accordingly, it has been observed that *P. fuscipes* species is active at night but it can be found in moist or wet areas around the vineyard during the day. It has been also observed that this species attack especially nymphs, sometimes adult plant lice, that is *Aphis* species. Two of these aphid species have been determined and identified as *Aphis illinoisensis* Shimer, 1866 and *A. gossypii* Glover, 1877 (Homoptera, Aphididae).

Some observations have been made regarding *S. debilis* species, which are the most abundant within the study. It was observed that this species attacked the nymphs of the *A. illinoisensis* species, similarly *P. fuscipes*. However, according to observations, *P. fuscipes* was found to be more predatory than *S. debilis*. The reason for this may be the fact that *P. fuscipes* has a larger body than *S. debilis* and carries a strong toxic substance in its hemolymph. However, existence of this species in small numbers in the vineyards restricts its effectiveness. Apart from this, no other observations could be made with the other species, which are *A. melanurus*, *A. procerus*, *L. graeca*, *M. dilutus pythonissa* and *S. bicolor*. The reason for this may be that these species exist in small numbers in the vineyard. However, as it is very difficult to distinguish between *S. bicolor* species and *S. debilis* species in the field with the naked eye, it is thought that *S. bicolor* species may also attack these pests in addition to the *S. debilis* species, which are thought to be predators of the above mentioned species. In addition, in a few observations, some Reduviidae (Heteroptera) species have been observed to attack *S. debilis* species.

DISCUSSION

This study, which was carried out between 2018-2019 in order to determine predator Paederinae species in Sarıgöl vineyards and to monitor their seasonal activities, is the first study of its kind in Turkey. As a result of the study, a total of seven species have been determined. These species are *Astenus melanurus* (Küster), *Astenus procerus*

(Gravenhorst), *Luzea graeca* (Kraatz), *Medon dilutus pythonissa* (Saulcy), *Paederus fuscipes* Curtis, *Scopaeus bicolor* Baudi Di Selve and *Scopaeus debilis* Hochhuth. A few studies related to the collection of samples by using only light traps have been conducted in Turkey so far on this subject.

When the species identified in these studies were compared to other studies on rove beetles, it was observed that *M. dilutus pythonissa*, *P. fuscipes* and *S. bicolor* species were collected through light traps from organic cherry orchards in Kemalpaşa (İzmir) in the study previously conducted by Tezcan & Anlaş (2009). While *S. debilis* Hochhuth species was determined to be the dominant species in this study, it was seen that the dominant species was *S. bicolor* in the study conducted by Tezcan & Anlaş (2009).

In another study, Özgen et al (2010) determined eight species belonging to the Paederinae subfamily with light traps in pistachio and cotton fields in Diyarbakır, Batman, Siirt and Mardin provinces in the Southeastern Anatolia Region. The species of *A. melanurus* and *P. fuscipes* collected in that study were also found in our study. Apart from this, while *Luzea graeca* species was found in our study, *Luzea nigrifolia* (Erichson, 1840) species of the same genus, was found in the study conducted by Özgen et al (2010). Likewise, in our study, *M. dilutus pythonissa* species was found, while in this study *Medon semiobscurus* (Fauvel, 1875) species of the same genus was found. It has been seen that in the study published by Özgen et al (2010), the most abundantly found species was *Scopaeus ebneri* Scheerpeltz, 1929.

Anlaş et al (2017), studied on the seasonal activity of *P. fuscipes* Curtis, which is an important species regarding medical and public health terms, in the Aegean Region, found this species in abundance from many light trap localities. This species, which is also useful in agriculture, was identified in this study. However, in our study, it was seen that this species could not be collected in large numbers. According to Nasir et al (2012), this species is affected by intensive agricultural spraying. Considering the intensive insecticide applications of Sarıgöl vineyard areas, where the project was carried out, this result could be considered normal. Nasir et al (2012) collected *P. fuscipes* with different methods in his study in many agricultural fields in Pakistan. A large number of specimens of this species were recorded with the help of one of these methods, that is light trap. In the light of the samples collected, the seasonal activity of the species in Pakistan was discussed. They also stated that *P. fuscipes* fed on aphids and other soft-bodied insects and carmine spider mites and larvae of fruit flies. In this study, it was found that this species attacked some types of aphids, too. In their study in the Czech Republic, Bohac & Bezdek (2004) determined 26 species belonging to Staphylinidae using light trap. It is understood that only the *P. fuscipes* species belongs to the Paederinae subfamily. However, it is seen in that study that this species is not abundant and not dominant. Apart from that, it is stated that the light trap can be used as an effective method to capture Staphylinidae species.

Except for Paederinae species, a large number of species of Aleocharinae (*Aleochara* sp., *Atheta* sp., *Drusilla* sp., *Oxytropa* sp.), Pselaphinae, Tachyporinae (*Mycetoporus* sp., *Tachinus*, *Tachyporus* sp.), Oxytelinae (*Anotylus* sp., *Bledius* sp., *Carpelimus* sp., *Platysetethus* sp.), Steninae (*Stenus* sp.) and Staphylininae (*Gabrius*

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sp., *Philonthus* sp., *Platydracus* sp., *Quedius* sp., *Xantholinus* sp.) subfamilies were also collected in this study. However, as most of them could not be identified in terms of species level, they could not be evaluated in this study.

At the end of the study, while 4.990 specimens were collected in 2018, 2.284 specimens were found in 2019. Hereby, it was observed that the number of specimens collected in 2018 constituted 68.6% of the total material, while this rate remained at 31.4% in 2019. It is believed that the number of specimens collected in 2019 was less than the previous year, due to climatic causes and especially insecticide applications made before some collection periods. It is thought that the reason for the low number of samples collected on May 30, 2019 in the study compared to 2018 is due to the use of non-selective deltamethrin active ingredient-containing insecticide. The seasonal activities of the detected species in general show us that the predator Paederinae species are especially intense and active from mid-May to the end of July. The number of specimens collected in this period was remarkably higher than other periods. When the species and abundances obtained as a result of the study are evaluated in general, Paederinae species diversity in the Sarıgöl vineyards is considered to be weak. It has been determined that there are few other species other than *S. debilis* species, which is predominantly present and constitutes 96.3% of all samples. The most intense among these is *P. fuscipes* with 204 specimens. Although there is little Paederinae species diversity in the Sarıgöl vineyard areas, there are many dominant predator species of Staphylinidae (e. g. *Aleochara* sp., *Ocypus* sp., *Philonthus* sp., *Quedius* sp., *Xantholinus* sp., *Tachyporus* sp.). This is considered important as it shows that this area has not yet lost its biodiversity.

ACKNOWLEDGMENTS

We would like to thank Dr. S. Örgel (Alaşehir), S. Yaman (Akhisar) and Doruk Köksal (Aydın) for their contributions and Fatma Musluoğlu (Alaşehir) for proof-reading the English manuscript. This study was supported by the Manisa Celal Bayar University Scientific Research Projects Coordination Unit (BAP, project no. 2018- 095).

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Received: May 15, 2020

Accepted: April 28, 2021