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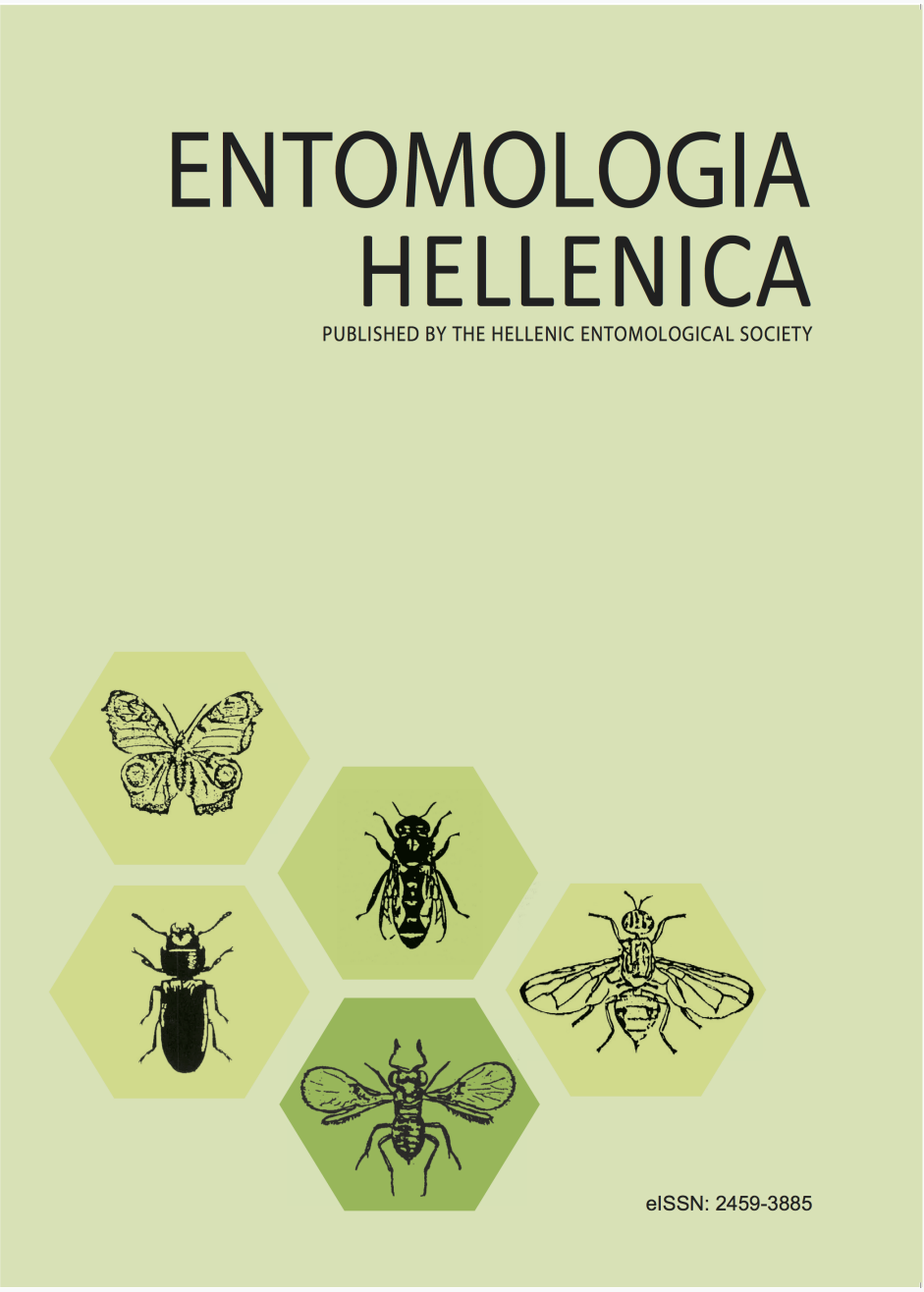

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Natural Enemies Associated with Black Parlatoria Scale, *Parlatoria ziziphi* (Lucas) in Citrus Orchards at El-Qualubia Governorate, Egypt

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ABSTRACT

A survey on black parlatoria scale, *Parlatoria ziziphi* (Lucas), natural enemies present at El-Qualubia Governorate, Egypt, during the season 2010-2011, was carried out in an orchard of navel orange. Identification of the collected samples indicated that the most abundant enemies were the ectoparasitoid *Aphytis hispanicus* (Mercet), the endoparasitoid *Prospaltella inquirenda* (Silvestri) and two predatory mites *Cheletogenes ornatus* (Canestrini&Fanzago) and *Amblyseius swirskii* (Athias-Henriot). *Aphytis hispanicus* preferred to parasitize on males more than females and nymphs, whereas *P. inquirenda* preferred to attack females more than males and nymphs. The activity of parasitoids was not observed during the two main periods, the first from July to August, and the second from January to March. On the other hand, the predatory mites, *C. ornatus* and *A. swirskii*, prefer nutrition to females more than males and nymphs. The percentage of their population was high during the winter-spring and autumn host generations.

KEY WORDS: *Parlatoria ziziphi*, parasitoids, predatory mites, Egypt.

Introduction

The black parlatoria scale, *Parlatoria ziziphi* (Lucas) (Hemiptera: Diaspididae), has long been considered one of the major pests of citrus in certain areas of the world (Ismail, 1989; Miller and Davidson, 1990; Coll & Abd-Rabou, 1998), and the Mediterranean region (Franco *et al.* 2006; and Jendoubi, 2012). Heavy infestations of this scale cause chlorosis and premature drop of leaves, twig and branch dieback, stunting and distortion of fruit, and fruit drop before maturation. Perhaps the most important damage is the virtually irremovable scale cover on the fruit (Quayle, 1938). *Parlatoria ziziphi* has seven generations per year in Taiwan, (Chang and Tao, 1963) and in Egypt three annual generations: summer (15 weeks, from the beginning of May until the first week of August), autumn (17 weeks, from mid-August to first week of December) and winter-spring (26 weeks, from mid-December to first week of June) (Faskha, 2012). Generally, four parasitoid species have been recorded on *P. ziziphi*, namely *Aphytis chrysomphali* (Mercet) (Hymenoptera: Aphelinidae), *Aph. proclia* (Walker), *Aspidiotiphagus citrinus* (Craw) (Hymenoptera: Aphelinidae) and *Asp. buryi* (Berlege & Paoli) (Chang and Tao, 1963). Coll and Abd-Rabou (1998) reported that three parasitoid species are associated with *P. ziziphi* in Upper Egypt: *Encarsia*

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citrina (Craw) (Hymenoptera: Aphelinidae), *Habrolepis aspidioti* (Compere & Annecke) (Hymenoptera: Encyrtidae) and the hyperparasitoid *Marietta leopardina* (Motschulsky) (Hymenoptera: Aphelinidae). There are also two coccinellid predators associated with this scale species; *Chilocorus bipustulatus* (L.) and *Rhyzobius lophanthae* (Blaisdell) in Greece (Stathas *et al*., 2008).

Considering the important role of these natural enemies in suppressing pest populations in the agro-ecosystem preserving and enhancing their activity is highly important within the framework of Integrated Pest Management (IPM) strategies. The objective of the present work was to identify the most abundant enemies of the black parlatoria scale as well as their seasonal activity at El-Qualubia Governorate, Egypt.

Materials and Methods

A survey of black parlatoria scale natural enemies was carried out in 15-year-old navel orange tree orchard (*Citrus sinensis* L.) var. Washington, at the Faculty of Agriculture, Ain Shams University, El-Qualubia Governorate, where no control measures have been undertaken for several years.

To determine the seasonal variation of the population density of *P. ziziphi* present enemies (parasitoids and predators) in those generations, regular weekly excursions were made to this orchard from 2 May 2010 to 5 June 2011. Random samples of 50 infested leaves were taken from the middle shoots of the trees at ca. 1.5m height from the ground and transported to the laboratory in plastic bags. One cm^2 of the upper surface of 10 leaves was examined under a stereoscopic microscope. The black parlatoria scale, *P. ziziphi*, is a sessile insect; the only mobile instar is the crawler. Therefore, dead individuals accumulate from one generation to the next. In each examination the following were recorded: the number of alive scales of all developmental stages, the number of dead scales due to several reasons, the number of parasitized and predated scales, as well as the number of parasitoid species and predatory mites. The means (and ±SE) and percentages (%) of the above numbers were counted weekly. Additionally, separate infested leaves were placed in a wooden box equipped with holes, with adapted glass tubes, to collect emerged adult parasitoids. Meanwhile all other pests on the leaves were discarded. For classifying the inspected species of scale insects, as well as their natural enemies, slides were prepared using Hoyer's medium and examined microscopically at a 10-15x magnification. Specimens were identified by the Scale Insects and Mealybugs Division, Plant Protection Institute, Agricultural Research Center, Egypt and by the keys of parasitoids by Muma and Selhime, (1966), Rosen and DeBach (1979) and Heraty *et al.* (2008). The results are shown separately for each generation of the host.

Results

1. Identification of the natural enemies and their activity against *P. ziziphi*

Identification of the natural enemies indicated the presence of one ectoparasitoid, *Aphytis hispanicus* (Mercet), one endoparasitoid, *Prospaltella inquirenda* (Silvestri) and two mite predators: *Cheletogenes ornatus* (Canestrini & Fanzago) and *Amblyseius swirskii* (Athias-Henriot). Results are listed in Table 1.

Data of the summer generation (May to August 2010) revealed that the mean percentages of mortality caused by other causes and natural enemies were moderate. The mean percentages of mortality by other causes were 5.25, 7.98 and 4.51% for nymphs, females and males, respectively. The mean percentages of mortality caused by natural enemies were 1.59, 4.62 and 4.08% for the three stages, respectively. The mean percentage of mortality caused by other causes and natural enemies across all *P. ziziphi* stages, were 6.59 and 3.45% respectively. Regarding the autumn generation (August to

December 2010), the mean percentages of mortality caused by other causes in the three stages was the lowest among the three generations, being 2.96, 3.56 and 9.5% for nymphs, females and males, respectively. Mortality caused by natural enemies was relatively low for either nymphs or males being 0.99 and 3.20% respectively but higher in females, being 9.82%. The mean percentage of mortality in the total population recorded by other causes and by natural enemies was 5.4 and 3.98%, respectively. Considering the winter-spring generation (December 2010 to June 2011) the mortality caused by other factors was relatively high for the three stages nymphs, females and males as well as the total population, being 8.52, 14.09, 11.42 and 10.48%, respectively. Mortality due to natural enemies in nymphs, females, males and total population being 2.12, 9.24, 2.49 and 3.89%, respectively.

From the above-mentioned data, it could be concluded that the natural enemies seemed to be more effective on the different developmental stages during autumn and winter-spring generations, whereas they were relatively less effective during the summer generation.

2. Seasonal activity of the parasitoids on the black parlatoria scale, *P. ziziphi*

2.1. The ectoparasitoid *Aphytis hispanicus*

The seasonal activity for this parasitoid is presented by the actual numbers and percentages of parasitism on different stages of the host as well as the total population, throughout the three annual generations of the host (Table 2 and Figure 1). It is obvious that *A. hispanicus* seemed to prefer males than females and nymphs. During the summer generation (May to August 2010), the mean percentage of parasitism was 0.74, 0.94, 2.3 and 1.07% on nymphs, females, males, and total population, respectively.

During the autumn generation (August to December 2010), the activity of the parasitoid *A. hispanicus* was also low at the beginning of this generation and then increased in successive samples. The mean percentage of parasitism was 0.46, 0.92, 1.62 and 0.93% on nymphs, females, males and the total population, respectively. On the contrary, the parasitoid *A. hispanicus* reached its highest activity level during winter-spring generation (December 2010 to June 2011), where the mean percentage of parasitism on nymphs, females, males and total population was 0.92, 1.15, 0.52 and 0.71%, respectively.

Thus, it can be concluded that the ectoparasitoid *A. hispanicus* attacked all three stages, nymphs, females and males but male scales were the most preferred host stage. Activity of the parasitoid was low from mid-July to mid-August 2010 and between late January to late March 2011, but it was higher during May and October.

2.2. The endoparasitoid *Prospaltella inquirenda*

The results obtained are given in Table 3 and graphically illustrated in Figure 2. This endoparasitoid parasitized females, nymphs and males of its host, but seemed to prefer females than nymphs and males. The mean percentage of parasitism of females was 1.36, 1.46 and 1.25% in summer, autumn and winter-spring generation, respectively. The mean percentage of parasitism on nymphs was 0.63, 0.31 and 0.81% in summer, autumn and winter-spring generation, respectively.

Percentage parasitism of males was 0.72, and 0.39% in summer and winter-spring generation respectively, but in autumn generation, there was no recorded parasitism of males.

The endoparasitoid *P. inquirenda* was the only endoparasitoid on the black parlatoria scale *P. ziziphi* and it was more active during April, May and September.

TABLE 1. The total counts and the mean (±SE) of different alive and dead developmental stages of *Parlatoria ziziphi*, and the percentage of the mortality causes, natural enemies and other causes, throughout annual generations at El- Qualubia Governorate, during the 2010- 2011 season.

Gene-ration		Nymph total no / 1cm²		Dead nymphs				Female total no / 1cm²		Dead females				Male total no / 1cm²		Dead males				Popul. total no / 1cm²		Dead popul.			
		Living	Dead	*O.F.		**N.E.		Living	Dead	O.F.		N.E.		Living	Dead	O.F.		N.E.		Living	Dead	O.F.		N.E.	
				No.	%	No.	%			No.	%	No.	%			No.	%	No.	%			No.	%	No.	%
Summer (15 weeks)	Total	252.8	16.4	14.1	78.73	2.3	23.78	288	44.9	28.1	119.75	16.8	69.34	165.8	12.1	7	67.64	5.1	61.26	706.6	73.4	49.2	98.91	24.2	51.69
	Mean	16.85	1.09	0.94	5.25	0.15	1.59	19.20	2.99	1.87	7.98	1.12	4.62	11.05	0.81	0.47	4.51	0.34	4.08	47.11	4.89	3.28	6.59	1.61	3.45
	±SE	2.14	0.13	0.14	0.4	0.05	0.6	1.33	0.52	0.29	0.82	0.25	0.85	1.06	0.1	0.03	0.61	0.09	1.26	2.49	0.57	0.21	0.63	0.39	0.85
Autumn (17 weeks)	Total	362.7	13.9	10.9	50.39	3	16.76	289.7	37.7	11.1	62.06	26.6	166.99	301.5	44.5	33	161. 5	11.5	54.39	963.8	96.1	55	91.8	41.1	67.6
	Mean	21.34	0.82	0.64	2.96	0.18	0.99	17.04	2.22	0.65	3.65	1.56	9.82	17.74	2.62	1.94	9.50	0.68	3.20	56.69	5.65	3.24	5.40	2.42	3.98
	±SE	2.02	0.08	0.08	0.34	0.04	0.3	1.78	0.15	0.05	0.33	0.16	1.58	0.57	0.3	0.18	0.85	0.14	0.63	2.74	0.49	0.22	0.44	0.3	0.48
Winter-spring (26 weeks)	Total	285.6	30.8	26.3	221.58	4.5	55.21	211.6	55.2	31	366.41	24.2	240.31	284.6	42.6	34.9	296.87	7.7	64.62	781.8	128.6	92.2	272.58	36.4	101.22
	Mean	10.98	1.18	1.01	8.52	0.17	2.12	8.14	2.12	1.19	14.09	0.93	9.24	10.95	1.64	1.34	11.42	0.30	2.49	30.07	4.95	3.55	10.48	1.40	3.89
	±SE	0.84	0.07	0.09	0.62	0.03	0.47	1.51	0.26	0.15	1.46	0.14	1.01	0.97	0.1	0.1	0.69	0.06	0.53	1.84	0.29	0.14	0.38	0.22	0.56

* = other factors
** =natural enemies

TABLE 2. The total counts, means (±SE) and mean percentage parasitism of different stages of *Parlatoria ziziphi* by the ectoparasitoid *Aphytis hispanicus* on navel orange trees at El- Qualubia Governorate, during the 2010-2011 season.

Generation		Nymph			Females			Males			Total		
		Mean of total nymph no	*A. hispanicus*		Mean of total female no	*A. hispanicus*		Mean of total male no	*A. hispanicus*		Mean of total popul. no	*A. hispanicus*	
			No.	%		No.	%		No.	%		No.	%
Summer (15 weeks)	Total	269.2	1.3	11.11	332.9	3.4	14.05	177.9	2.7	34.51	780	7.4	16.03
	Mean	17.95	0.09	0.74	22.19	0.23	0.94	11.86	0.18	2.30	52.00	0.49	1.07
	±SE	2.22	0.03	0.24	1.69	0.06	0.2	0.98	0.06	0.82	2.05	0.13	0.29
Autumn (17 weeks)	Total	376.6	1.1	7.78	327.4	2.3	15.69	346	5.9	27.56	1050	9.3	15.86
	Mean	22.15	0.06	0.46	19.26	0.14	0.92	20.35	0.35	1.62	61.76	0.55	0.93
	±SE	2.06	0.03	0.2	1.72	0.02	0.2	0.63	0.09	0.4	2.75	0.1	0.18
Winter-spring (26 weeks)	Total	316.40	1.80	23.98	266.80	3.70	30.02	327.20	2.50	13.48	910.40	8.00	18.49
	Mean	12.17	0.07	0.92	10.26	0.14	1.15	12.58	0.10	0.52	35.02	0.31	0.71
	±SE	0.87	0.02	0.28	1.72	0.03	0.23	1.05	0.04	0.19	2.04	0.08	0.17

TABLE 3. The total counts, means (±SE) and mean percentage parasitism of different stages of, *Parlatoria ziziphi* by the endoparasitoid *Prospaltella inquirenda*on navel orange trees at El- Qualubia Governorate, during the 2010-2011 season.

Generation		Nymph			Females			Males			Total		
		Mean of total nymph no	*P. inquirenda*		Mean of total female no	*P. inquirenda*		Mean of total male no	*P. inquirenda*		Mean of total popul. no	*P. inquirenda*	
			No.	%		No.	%		No.	%		No.	%
Summer (15 weeks)	**Total**	269.2	0.7	9.45	332.9	5.1	20.45	177.9	0.9	10.77	780	6.7	14.46
	Mean	17.95	0.05	0.63	22.19	0.34	1.36	11.86	0.06	0.72	52.00	0.45	0.96
	±SE	2.2	0.02	0.31	1.69	0.1	0.34	0.98	0.02	0.21	2.05	0.13	0.28
Autumn (17 weeks)	**Total**	376.60	0.60	5.23	327.4	4.8	24.82	346	0	0	1050	5.4	8.22
	Mean	22.15	0.04	0.31	19.26	0.28	1.46	20.35	0.00	0.00	61.76	0.32	0.48
	±SE	2.06	0.01	0.17	1.72	0.07	0.32	0.63	0.00	0.00	2.75	0.06	0.08
Winter- spring (26 weeks)	**Total**	316.40	1.60	21.00	266.8	5.1	32.54	327.2	1	10.08	910.40	7.70	18.91
	Mean	12.17	0.06	0.81	10.26	0.20	1.25	12.58	0.04	0.39	35.02	0.30	0.73
	±SE	0.87	0.02	0.22	1.72	0.06	0.27	1.05	0.01	0.12	2.04	0.07	0.14

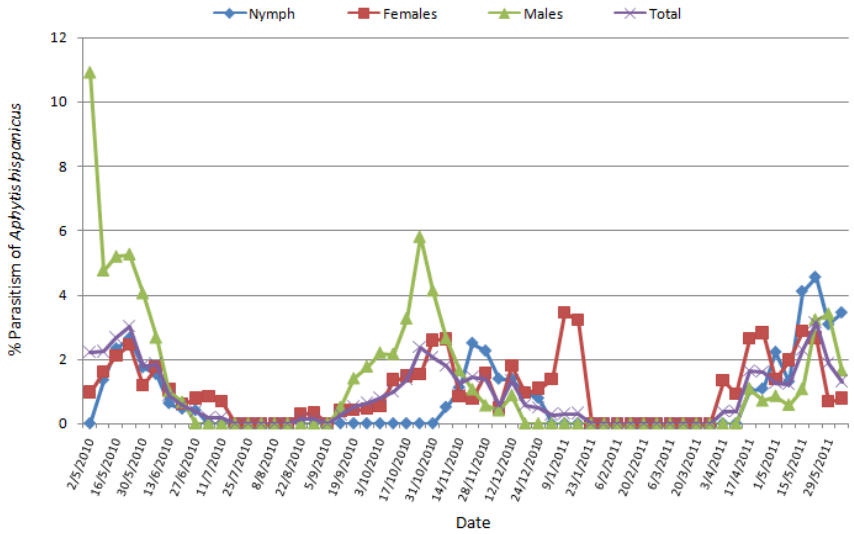

FIG.1: Percentage of parasitism of different stages of *Parlatoria ziziphi* by the ectoparasitoid *Aphytis hispanicus* at El-Qualubia Governorate, during the 2010-2011 season.

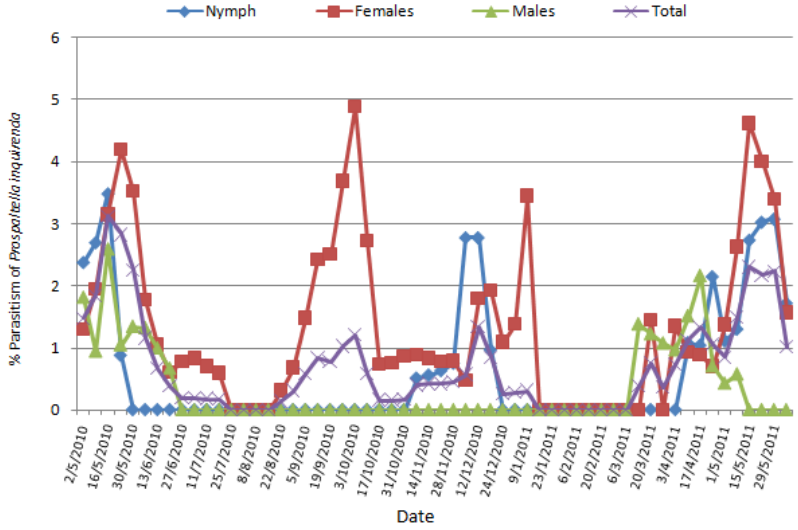

FIG. 2: Percentage of parasitism of different stages of *Parlatoria ziziphi* by the endoparasitoid *Prospaltella inquirenda* at El-Qualubia Governorate, during the 2010-2011 season.

3. Seasonal activity of the two predatory mite species, *Cheletogenes ornatus* and *Amblyseius swirskii*, on the black parlatoria scale, *P. ziziphi*

The two predatory mites, *C. ornatus* and *A. swirskii* fed on all stages of their host but they mostly preferred females (Tables 4 and 5, and Figure 3). They were found to be less active during the summer generation than the previous generation. For *C. ornatus*, the mean percentage scale predation was 1.1, 0.46, 0.08 and 0.62% for females, males, nymphs and total population, respectively. For *A. swirskii*, the mean scale predation percentage was 1.23, 0.61, 0.17 and 0.87% for females, males, nymphs and total population, respectively. The activity of *C. ornatus* and *A. swirskii* was moderate on *P. ziziphi* during the autumn generation. The mean scale predation percentage of *C. ornatus* was 4.68, 1.09, 0.14 and 1.57% for females, males, nymphs and total population, respectively. Whereas, the mean scale predation percentage of *A. swirskii* was 2.76, 0.49, 0.23 and 0.97% for those stages, respectively.

During the winter-spring generation, *C. ornatus* was not observed during January. The scale predation percentage was 3.95, 1.06, 0.39 and 1.43% for females, males, nymphs and total population, respectively. As for *A. swirskii*, it was not observed from early February to early March; the mean scale predation percentage was 2.89, 0.52, 0.09 and 1.01% for females, males, nymphs and total population, respectively. These results suggest that the predatory mites, *C. ornatus* and *A. swirskii* attacked all stages of *P. ziziphi*, but mostly preferred females. *C. ornatus* was present throughout the whole year except late July 2010 and January 2011, whereas the predatory mite, *A. swirskii*, was not recorded from late June to mid-July 2010, and February 2011.

Generally, abundance of predators was high in both winter-spring and autumn generations. The activity of *C. ornatus* reached its peak on females scales between the 27th of June and 24th of October 2010 and between the 20th March and 19th of June 2011. In contrast, the peak of *A. swirskii* activity was recorded in late May, late October and late December 2010 and between early April and the 21st of August 2011.

Discussion

Our study showed that mortality of different stages of *P. ziziphi* caused by abiotic factors was moderate, low and high during the summer, autumn and winter–spring generation, respectively. In contrast, mortality caused by natural enemies was low during the summer and autumn generations and relatively higher during the winter-spring generation. Miller and Davidson (2005) suggested that climatic conditions, temperature and humidity, limit the range and abundance of scale insects. Many species are adversely affected by high humidity which favors the development of parasitic fungi, whereas extensive summer heat and drought could be the main cause of mortality of crawlers of some armored scale insects.

The natural enemies associated with *P. ziziphi* in this survey were the ectoparasitoid *Aphytis hispanicus*, and the endoparasitoid *Prospaltella inquirenda*. The highest percentage of scale parasitism by *A. hispanicus* was 3.45, 4.55 and 10.91% on adult females, nymphs and adult males, respectively, whereas parasitism by *P. inquirenda* was 4.89, 3.49 and 2.6% respectively. In a comparable study, Gerson (1977) recorded these two parasitoids attacking also the chaff scale *P. pergandeii* Comstock (Hemiptera: Diaspididae). Both parasitoids were more abundant during spring and autumn; however *P. inquirenda* was found attacking all chaff scale stages except ovipositing females, whereas *A. hispanicus* attacked only second-stage nymphs, females and males. The highest rate of scale parasitism by *A. hispanicus* was 16.4, 4.6 and 6.2 for adult females, nymphs and adult males respectively.

TABLE 4. The total counts, means (±SE) and mean percentage predation of different stages of *Parlatoria ziziphi* by the predatory mite *Cheletogenes ornatus* on navel orange trees at El-Qualubia Governorate, during the 2010-2011 season.

Generation		Nymph			Females			Males			Total		
		Mean of total nymph no	*C. ornatus*		Mean of total female no	*C. ornatus*		Mean of total male no	*C. ornatus*		Mean of total popul. no	*C. ornatus*	
			No.	%		No.	%		No.	%		No.	%
Summer (15 WEEKS)	Total	269.2	0.1	1.16	332.9	3.6	16.5	177.9	0.8	6.84	780	4.5	9.37
	Mean	17.95	0.01	0.08	22.19	0.24	1.10	11.86	0.05	0.46	52.00	0.30	0.62
	±SE	2.22	0.01	0.08	1.69	0.04	0.18	0.98	0.02	0.15	2.05	0.05	0.11
Autumn (17 WEEKS)	Total	376.6	0.7	2.34	327.4	11.4	79.62	346	4	18.57	1050	16.1	26.66
	Mean	22.15	0.04	0.14	19.26	0.67	4.68	20.35	0.24	1.09	61.76	0.95	1.57
	±SE	2.06	0.02	0.07	1.72	0.12	1.0	0.63	0.06	0.25	2.75	0.18	0.29
Winter- spring (26 WEEKS)	Total	316.4	0.9	10.24	266.8	7.6	102.57	327.2	2.5	27.47	910.40	11.00	37.17
	Mean	12.17	0.03	0.39	10.26	0.29	3.95	12.58	0.10	1.06	35.02	0.42	1.43
	±SE	0.87	0.02	0.18	1.72	0.05	0.86	1.05	0.03	0.33	2.04	0.09	0.36

TABLE 5. The total counts, means (±SE) and mean percentage predation of different stages of *Parlatoria ziziphi* by the predatory mite *Amblyseius swirskii*on navel orange trees at El-Qualubia Governorate, during the 2010-2011 season.

Generation		Nymph			Females			Males			Total		
		Mean of total nymph no	*A. swirskii*		Mean of total female no	*A. swirskii*		Mean of total male no	*A. swirskii*		Mean of total popul. no	*A. swirskii*	
			No.	%		No.	%		No.	%		No.	%
Summer (15 weeks)	**Total**	269.2	0.2	2.51	332.9	4.7	18.39	177.9	0.7	9.12	780	6.3	13.09
	Mean	17.95	0.01	0.17	22.19	0.31	1.23	11.86	0.05	0.61	52.00	0.42	0.87
	±SE	2.20	0.01	0.11	1.69	0.08	0.3	0.98	0.02	0.26	2.05	0.1	0.21
Autumn (17 weeks)	**Total**	376.60	0.60	3.83	327.4	8.1	46.84	346	1.6	8.3	1050.0	10.20	16.52
	Mean	22.15	0.04	0.23	19.26	0.48	2.76	20.35	0.09	0.49	61.76	0.60	0.97
	±SE	2.06	0.01	0.1	1.72	0.08	0.54	0.63	0.03	0.17	2.75	0.11	0.19
Winter- spring (26 weeks)	**Total**	316.40	0.20	2.33	266.8	7.8	75.16	327.2	1.7	13.61	910.40	9.60	26.35
	Mean	12.17	0.01	0.09	10.26	0.30	2.89	12.58	0.07	0.52	35.02	0.37	1.01
	±SE	0.87	0.01	0.07	1.72	0.06	0.54	1.05	0.02	0.2	2.04	0.08	0.21

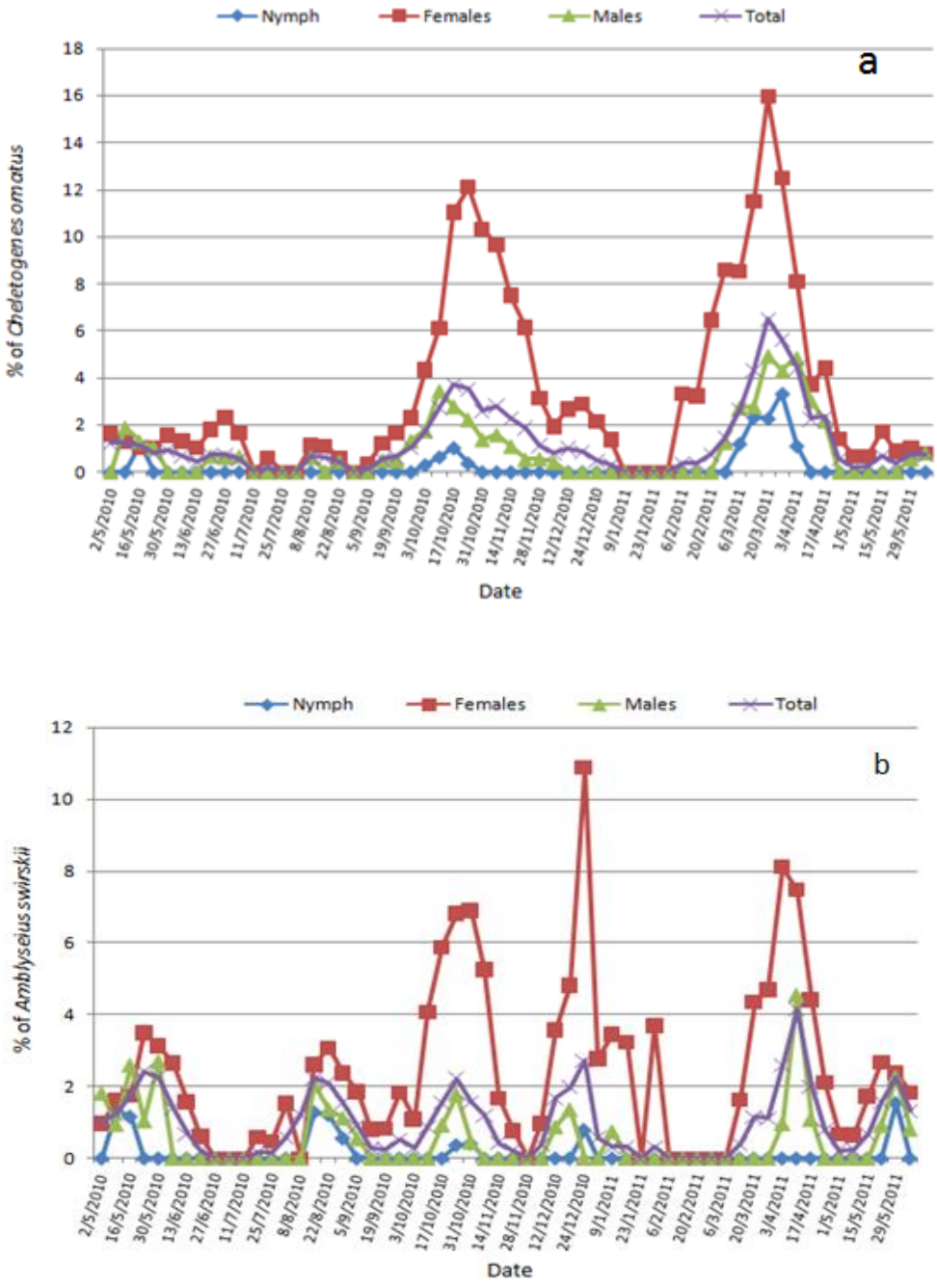

FIG. 3: Predation percentage of different stages of *Parlatoria ziziphi* by the predatory mite *Cheletogenes ornatus* (a) and *Amblyseius swirskii* (b) at El-Qualubia Governorate, during the 2010-2011 season.

Moreover, the highest rate of scale parasitism of *P. inquirenda* was 12.5, 1.2 and 3.7 on adult females, nymphs and adult males respectively. Coll and Abd-Rabou (1998) indicated that three parasitoid species associated with *P. ziziphi* in Upper Egypt are *Encarsia citrina* (Craw), *Habrolepis aspidioti* (Compere & Annecke) (Hymenoptera: Encyrtidae) and the hyperparasitoid *Marietta leopardina* (Motschulsky) (Hymenoptera: Aphelinidae). Other parasitoids associated with *P. ziziphi* are *Aphytis proclia, E. citrina, E. lounsburyi and H. aspidioti* (Jendoubi, 2012).

Fasulo and Brooks (2004) reported that a number of parasitoids and predators attack *P. ziziphi* but it is unlikely that they are effective biological control agents. Some of the parasitoids have exerted up to 40% parasitism. In general, our survey showed that the activity of natural enemies was higher during spring and autumn, which is consistent with studies by Gerson, (1977) and Saker, (1994), who similarly found that low density of the black scale *Chrysomphalus ficus* (Ashmead) in Qualubia Governorate was attributed to the activity of the ectoparasitoid *A. holoxanthus* (DeBach), three endoparasitoids, *Aspidiophagus citrinus* (Craw), *A. lounsburyi* (Dozier) and *H. pascuorum* (Mercet) and the entomopathogenic fungus *Cladosporium cladosporioides* (Fresenius) which was more prominent during the winter and the spring generation of *C. ficus*. These natural enemies were less active during summer and therefore, summer sprays are not harmful for them, whereas winter sprays are detrimental to the natural enemy populations.

References

Chang, L. C., and C. C. Tao. 1963. Black par1atoria, *Par1atoria zizyphus* (Lucas). Taiwan Agric. Res. Inst., 12: 34- 47.

Coll, M. and S. Abd- Rabou. 1998. Effect of oil emulsion sprays on parasitoids of the black parlatoria, *Parlatoria ziziphi*, in grapefruit. BioControl. 43: 29– 37.

Faskha, S. M. 2012. Potential of Certain Novel Pesticides in Management of Citrus Pests. Ph.D. Thesis, Faculty of Agriculture university of Ain Shams. Egypt. Pp 220.

Fasulo, T. R. and R. F.Brooks. 2004. Scale Pests of Florida Citrus, series ENY-814 of the Entomology and Nematology. http:// www. edis.ifas.ufl.edu/.

Franco, C. J., F. Garcia- Marí, A. P. Ramos and M. Besri. 2006. Survey on the situation of citrus pest management in Mediterranean countries. Bulletin IOBC/wprs.29 (3): 335- 346.

Gerson, U. 1977. The scale insect *Parlatoria pergandei* Comstock and its natural enemies in Israel. (In Spanish.) Seminar on biological control of scale-insects and aleurodids on citrus. Boletin del Servicio de Defensa contra Plagas e InspeccionFitopatologica. 3: 21- 53.

Heraty, J. M., A. Polaszek and M. E. Schauff. 2008. Systematics and biology of *Encarsia*. In. Gould, J.; K. Hoelmer; and J. Goolsby (Eds), Classical Biological Control of *Bemisiatabaci* in the United States. A review of interagency research and implementation. (Pp 71-87). Springer Science and Business Media.

Ismail, M.1989. The citrus insect pests of Egypt. Econ. Ser. 18: 98–106.

Jendoubi, H. 2012. Current status of the scale insect fauna of citrus in Tunisia and biological studies on *Parlatoriaziziphi* (Lucas). PhD thesis. Catania, University of Catania. Pp 125.

Miller, D. R. and J. A. Davidson. 1990. A list of the armored scale insect pests. In: D. Rosen (ed). Armored scale insects, their biology, natural enemies and control. (Pp 299– 306). Elsevier Science Publishers. New York.

Miller, D. R. and J. A.Davidson. 2005. Armored Scale Insect Pests of Trees and Shrubs. Cornell Univ. Press, Ithaca. NY. Pp 442.

Muma, M. H. and A. G. Selhime.1966. Aphytis Howard (Hymenoptera: Eulophidae) on Florida Citrus. Proceedings of the Florida State Horticultural Society.79: 86- 91.

Quayle, H. J. 1938. Insects of Citrus and other Subtropical Fruits. Comstock Publishing Company, Ithaca, New York, USA. Pp 583.

Rosen, D. and P. DeBach. 1979. Species of Aphytis of the world (Hymenoptera: Aphelinidae). W. Junk BV Publishers, The Hague-Boston- London, ISBN 90 6193 127 4. Pp 801.

Saker, H. E. 1994. Studies on some natural enemies attacking scale insects and mealy bugs in Qalubia province. M. Sc. Thesis, Faculty of Agric. Ain Shams Univ. Egypt. Pp 156.

Stathas, G. J., P. A. Eliopoulos, and G. Japoshvili. 2008. A study on the biology of the diaspidid scale *Parlatoriazizipphi* (Lucas) (Hemiptera: Coccoidea: Diaspididae) in Greece. In: Branco M, Franco JC, Hodgson C (eds)Proceedings of the XI International Symposium on Scale Insect Studies, ISA Press, Lisbon, 95-101 pp.

Φυσικοί εχθροί σχετιζόμενοι με τη μαύρη ψώρα *Parlatoria ziziphi* (Lucas) σε οπωρώνες εσπεριδοειδών στο κυβερνείο El-Qualubia της Αιγύπτου

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ΠΕΡΙΛΗΨΗ

Το χρονικό διάστημα 2010-2011 διεξήχθη έρευνα για τους φυσικούς εχθρούς της μαύρης ψώρας, *Parlatoria ziziphi* (Lucas), που είναι παρόντες σε οπωρώνες πορτοκαλιάς Navel στο κυβερνείο El-Qualubia της Αιγύπτου. Η αναγνώριση των συλλεχθέντων δειγμάτων έδειξε ότι τα είδη σε μεγαλύτερη αφθονία ήταν το εκτοπαράσιτο *Aphytis hispanicus* (Mercet), το ενδοπαράσιτο *Prospaltella inquirenda* (Silvestri), καθώς και δύο αρπακτικά ακάρεα, τα *Cheletogenes ornatus* (Canestrini& Fanzago) και *Amblyseius swirskii* (Athias-Henriot). Το *A. hispanicus* έδειξε προτίμηση ως προς τον παρασιτισμό αρσενικών ατόμων σε σχέση με τα θηλυκά και τις νύμφες, ενώ το *P. inquirenda* έδειξε προτίμηση προς τα θηλυκά άτομα σε σχέση με τα αρσενικά και τις νύμφες. Δεν παρατηρήθηκε δραστηριότητα των παρασιτοειδών κατά τη διάρκεια των δύο βασικών περιόδων (από τον Ιούλιο ως τον Αύγουστο και από τον Ιανουάριο ως το Μάρτιο). Από την άλλη, τα αρπακτικά ακάρεα *C. ornatus* και *A. swirskii* έδειξαν προτίμηση προς τα θηλυκά άτομα και λιγότερο στα αρσενικά και τις νύμφες. Το ποσοστό του πληθυσμού τους ήταν υψηλό κατά τις γενεές χειμώνα-άνοιξης και φθινοπώρου του ξενιστή τους.

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Additional records of hoverflies (Diptera: Syrphidae) from Samos island, Greece

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ABSTRACT

In connection with the 10th International Symposium on Syrphidae in Lesbos, a pre- and post-Symposium collecting expedition was held on the island of Samos, Greece in September 2019. In total 62 species were collected of which 19 are new to the island of Samos. Moreover, *Ischiodon aegyptius* and *Paragus compeditus* are generally new to Greece. The genera *Eumerus* and *Merodon* are well investigated in the SE Mediterranean area, and especially the Greek islands. The discovery of respectively five and two new species for Samos, during this very short visit, shows that with more effort many new species regarding the Shyrphidae fauna of this island are to be expected.

KEY WORDS: checklist, *Eumerus*, *Merodon*, new fauna records.

Introduction

The family Syrphidae is a well-studied group of flies (Diptera), especially in Europe, with an increasing knowledge on Mediterranean species (Vujić et al. 2020b). The Greek Syrphidae fauna consists of 418 species of which 88 are known from Samos (Vujić et al. 2020b). Thirty of the previously recorded hoverfly species of Samos belong to the genera *Eumerus* Meigen, 1822 and *Merodon* Meigen, 1803.

Larvae of the species of these genera depend on a diversity of bulbous plants for their larval development. Adults are known to visit the flowers of their larval food sources. These genera have been investigated intensively in the SE Mediterranean basin, during the last decades (e.g. Chroni et al. 2018, Grković et al. 2017, Radenković et al. 2017, Ståhls et al. 2016, Vujić et al. 2020a).

In September 2019, a small group of Dipterists visited Samos, during the 10th International Symposium on Syrphidae in Lesbos, Greece, to enlarge the knowledge on the Syrphidae fauna of the island.

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Materials and Methods

The expedition was conducted during 2-7 and on the 17th of September 2019. Several localities were visited during the expedition for handnet collecting of Syrphidae. These localities are described below in more detail. Initially it was also planned to set up Malaise traps, but this was skipped because there were no suitable patches to place the traps partly due to present goat herds. The species were identified using the commonly known literature (Van Veen 2006, Speight and Sarthou 2017). Ana Grković and Ante Vujić checked at least one voucher specimen of all species of the genera *Eumerus* and *Merodon*.

Plants are identified with their names from the World Flora online website (WFO 2021), the predecessor of "The Plant List" a working list of all plant species as established by the collaboration between the Royal Botanic Gardens, Kew and Missouri Botanical Garden.

Photos of the habitat were taken by JSA using a Nikon Coolpix P510 camera or by ASW using a Sony DSC HX400V with Canon Close-Up lens 500D. The figures of the species have been compiled from multiple photos using a Canon EOS D6 with a canon MP-E 5x macro-zoom lens and a Yongnuo YN14EX macro ring flash. The photos were- processed by Zerene Stacker to get an entirely in focus picture. This picture was further edited in GIMP 2.8.22 to create the figures as given in this paper.

Most of the collected specimens are deposited in the private collections of the authors, indicated by the acronyms given in the address section. Some specimens have been transferred to alcohol for DNA barcoding and are deposited in either the Department of Biology and Ecology, Faculty of Sciences, University of Novi Sad, Serbia, the Canadian National Collection of Insects, Arachnids and Nematodes, Agriculture and Agri-Food Canada, Ottawa, Canada or the Zoologisches Forschungsmuseum Alexander Koenig, Bonn, Germany.

FIG 1. Map with collecting localities on Samos, Greece.

Collecting localities (Fig. 1)

1. Pythagorio, Maritsa's Bay. Rocky shore with flowering *Crithmum maritimum* L., 37°41'53"N, 26°58'05"E, 5 m a.s.l., visited 2-IX.
2. Mykali wetland, Mykali Beach, Psili Ammos, 1,8 km SE of Mesokampos. Situated at the south site of the island along the beach. Reedland with small freshwater pools (Fig. 3C) containing *Phragmites australis* (Cav.) Trin. ex Steud., *Arundo donax* L. and *Typha latifolia* L. Also, light brackish vegetation with some flowering plants such as *Mentha longifolia* (L.), *Lycopus europaeus* L., *Pulicaria dysenterica* (L.) Gaertn. *Epilobium* sp. and *Cirsium palustre* (L.) Coss. ex Scop. On the beach also flowering *C. maritimum*. Visited 2-IX (2a) and 7-IX (2b), 37°42'27"N, 26°59'11"E, 2 m a.s.l.
3. Psili Ammos, *Foeniculum vulgare* Mill. on rock debris on the border of an olive grove, 37°42'40"N, 26°59'44"E, 12 m a.s.l., visited 2-IX.
4. Between Myli and Agius Prodromus, flowering *F. vulgare* at the border of alluvial *Platanus orientalis* L. forest, 37°41'32.9"N, 26°49'47.8"E, 205 m a.s.l. (Fig. 4A), and a bean field on the border of the alluvial *P. orientalis* forest, with some flowering *Daucus*

FIG 2. Collecting sites. A. Valeondades houses with flowering *Trachelospermum jasminoides* and *Bougainvillea* sp., locality 6a. B. Mt Lazaros. Orchard with *Hedera helix* bush along the gravel road, locality 7a. C. Abandoned field with *Foeniculum vulgare* East of Agios Konstantinos, locality 8. D. *Colchicum variegatum* at the top of Mt Lazaros, locality 7c.

carota L., 37°41'33"N, 26°49'59"E, 300 m a.s.l., both visited 3-IX.

5. Myli, Imvressos river, path crossing the river with a patch of flowering *M. longifolia* in a small gap in *P. orientalis* alluvial forest, 37°40'42.4"N, 26°51'00.0"E, 66 m a.s.l. and Myli, near village, border of arable field with *F. vulgare* and *Rubus ulmifolius* Schott., 37°40'43.0"N, 26°51'11"E 57 m a.s.l., visited 3-IX.
6. Valeondades 1-1,8 km South of Agios Konstantinos, situated on the North side of the island in the famous Nightingale valley with old *P. orientalis* trees and many *Hedera helix* L. along a stream with running water. A little upstream there was a stand of natural, partly evergreen forest with *Laurus nobilis* and a small, abandoned field full of flowering *F. vulgare* visited between 4-IX and 9-IX.
   a. Surroundings of the houses of Valeondades on flowering *Trachelospermum jasminoides* (Lindl.) Lem. (Fig. 2A) and *Bougainvillea* sp., 37°47'44.94"N, 26°49'40.39"E, 90 m a.s.l.
   b. Abandoned field along the road with *F. vulgare*, 37°47'35.65"N, 26°49'38.12"E, visited 4-IX and 6-IX, 110 m a.s.l.
   c. Seepage area and small stream with *M. longifolia* and *Euphorbia* sp.,37°47'33.10"N,26°49'34.40"E, visited 4-IX, 130 m a.s.l.

FIG 3. Collecting sites. A. Mt Lazaros, mountain top, locality 7c. B. Mt Lazaros, slope with open area in *Pinus halepensis* forest, locality 7b. C. Mykali wetland with small freshwater pool, locality 2b. D. Fourniotikos river estuary, East of Karlovasi, with *Crithmum maritimum*, locality 10.

7. Mount Lazaros. The second highest mountain of the central Ampelos mountains near the highest mountain top of Karvouni (1153 m).
   a. Orchard along a road under Lazaros summit, 2,6 km S of Vourliotes orchard (apple) in a *Pinus halepensis* Mill. forest with diversity of scrubs: *Crataegus* sp., *Prunus* sp., *Quercus* sp. and *Pistachio* sp. Small spring in orchard with *H. helix* (Fig. 2B), *D. carota*, *M. longifolia* and *P. dysenterica* (L.) Gaertn., 37°45'39.36"N,26°50'56.13"E, 810 m a.s.l., 4-IX, 5-IX (7a1) and 17-IX (7a2).
   b. Slope directly under the steep part of Lazaros mountain, close to a dirt road in young *P. halepensis* forest with open patches (Fig. 3B) with *Pteridium aquilinum* (L.) Kuhn., *Carlina corymbosa* L. and *Taraxacum* sp., 37°45'24.04"N, 26°50'49.03"E, 930 m a.s.l. 4-IX, 5-IX (7b1) and 17-IX (7b2).
   c. Summit exposed bare rocky dolomite hilltop (Fig. 3A) of Mount Lazaros (1025 m) with many limestone rocks and scattered scrubs, mainly *Juniperus* sp. and *Quercus coccifera* L., with some flowering *Colchicum variegatum* L. (Fig. 2D), 37°45'27.97"N, 26°50'57.04"E, 1025 m a.s.l. visited 5-IX (7c1) and 17-IX (7c2).
8. East of Agios Konstantinos, Kakorema river, abandoned field near the sea, with flowering *F. vulgare* (Figs 2C, 5C) and *Rubus ulmifolius*, 37°48'19.64"N, 26°49'43.96"E, 1 m a.s.l. visited 4-IX and 6-IX.
9. Megalo, Karlovasi, dry riverbed overgrown with grasses with reed, *Typha* sp., *M. longifolia*, *F. vulgare*, *Persicaria* sp., 100m from sea, 37°47'55.30"N, 26°42'03.41"E, 5m a.s.l. visited 5-IX.
10. Fourniotikos river estuary, E of Karlovasi, grass overgrown dry riverbed (estuary) with a pool, *Typha* sp., reed and a seashore with pebbles and *M. longifolia*, *Persicaria* sp., *C. maritimum* (Fig 3D), 37°48'17.76"N, 26°42'58.14"E, 1 m a.s.l., visited 5-IX.
11. "Airport", a wetland 2.25 km SW of the airport between Ireo and Potokaki. Cattle grazed grass- and reedland with dry ditches. *Phragmites australis* and *Arundo donax*, with flowering *M. longifolia* and *Dittrichia graveolens* (L.) Greuter, 37°40'42.43"N, 26°53'40.82"E, 1 m a.s.l., visited 7-IX.
12. Imvressos estuary East of Ireo, river outlet with a pool surrounded with reed and waste land, *M. longifolia*, *Lycopus europaeus*, *Cynanchum acutum* L., 37°39'56.90"N, 26°53'3.59"E, 1 m a.s.l., visited 7-IX.
13. Bridge over Imvressos river 1 km E of Myli, riverbed with streaming water at the bridge, and flowering *F. vulgare*, 37°40'44"N, 26°52'07"E, 20 m a.s.l., visited 7-IX (Fig. 4D).
14. Kerkis Mountains, Kallithea forest. Situated on the west site of the island. Mainly dry pine and juniper forest with a few natural springs with wet vegetation containing flowering *M. longifolia*. Most specimens of hoverflies were collected in a steep valley with some very old *P. orientalis* trees often fully grown over by *H. helix*. This valley also contained some running water. Unfortunately, this site was also in use by local beekeepers outcompeting many

of the wild bees, Syrphidae and other natural pollinators.

a. Water tank along road, Kerkis mountain, 1.6 km E of Kalithea, moist area, *M. longifolia*, 37°43'51"N, 26°35'58"E, 550 m a.s.l., visited 6-IX.
b. River valley near the side of forest road, Kerkis mountain, 1.5 km S of Drakei, River valley and stream. Old *Platanus* trees with flowering *Hedera*, 37°44'46"N, 26°36'50"E, 500-580 m a.s.l., visited 6-IX (Fig. 4B).
c. Roadside near curve and dried out stream, Kerkis mountain, 1.3 km NE of Kalithea, *H. helix* and *F. vulgare*, 37°44'14"N, 26°35'46"E, 200 m a.s.l., visited 6-IX.
d. Field at entrance of Kalithea, Kerkis mountain, 0.2 km N of Kalithea. Vineyard with flowering *F. vulgare*, 37°44'06"N, 26°34'51"E, 200 m a.s.l., visited 6-IX.

FIG 4. Collecting sites. A. Agius Prodromus, flowering *Foeniculum vulgare* at the border of alluvial *Platanus orientalis* L. forest, locality 4, photo ASW. B. Kerkis Mountains, Kallithea forest, River valley near edge of forest road with huge *P. orientalis* trees overgrown by flowering *Hedera helix*, locality 14b, photo LJEW. C. Abandoned field with *F. vulgare* East of Agios Konstantinos, locality 8, photo WSB. D. Bridge over Imvressos river, flowering *F. vulgare*, locality 13. photo WSB.

15. Kokkari Centre, opposite one of the town bakeries, 37°46'42"N, 26°53'33"E, 8 m a.s.l., flowering *Pandorea jasminoides* (Lindl.) K.Schum., visited 4-IX.

Results

On Samos, at the end of the dry season, only a few plants and scrubs are in flowering, and running or standing freshwater is scarce. Therefore, of the many visited localities all over the island, there was only a limited number at which more than 10 specimens of hoverflies were collected. This was mainly in humid valleys, especially with running fresh water, and from coastal wetland areas with standing fresh water. Many specimens and species were collected on flowering *Foeniculum vulgare* and *Hedera helix*, also on dry arable fields and along roadsides. Furthermore, quite some specimens were collected hilltopping on Mount Lazaros, part of them on the few flowers and shrubs around or sitting on bare rocks.

The species records were as follows:

Callicera aurata (Rossi, 1790) (Fig. 5A, 7A)

Widespread Mediterranean species, recorded in Greece (Vujić et al. 2020b).

First record for Samos.

New records. 7a1: 28♀; 7a2: 5♀; 7c1: 1♀.

Remarks. Found along a road below Mount Lazaros visiting flowers of *H. helix*. Only females, several at one time, rather slowly flying around the bush and hovering at some distance from the flowers before landing and feeding on the flowers.

Callicera macquartii Rondani, 1844 (Fig. 6A)

Widespread Mediterranean species, recorded in Greece (Vujić et al. 2020b).

First record for Samos.

New records. 7a1: 11♂, 7♀; 7a2: 1♀; 14b: 1♀; 14c: 1♀.

Remarks. Males and females visited *H. helix*. On Mount Lazaros together with many *C. aurata* and one *C. rufa*. This species was mostly found at medium height or low in the bush and feeding on more hidden flowers than *C. aurata*. Seems to fly a bit faster than *C. aurata* and less often seen hovering near the flowers. Also recorded from the West side of Samos.

Callicera rufa Schummel, 1842 (Fig. 6B)

Widespread Mediterranean species, in Greece only recorded from Lesvos (Vujić et al. 2020b).

First record for Samos.

New records. 7a2: 1♀.

Remarks. Collected on a flowering *H. helix* bush together with *C. aurata* and *C. macquarti*. Its small size and even more shiny appearance compared with the large *C. aurata* and the small but less shiny *C. macquarti* stood out in the field. This specimen was flying along the bush and hovering in front of the flowers.

Ceriana vespiformis (Latreille, 1809) (Fig. 8A)

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 4: 1♂; 5: 6♂, 6♀; 6b: 1♀; 11: 2♀; 13: 1♂, 2♀; 14d: 2♂, 8♀.

Remarks. Found in several low to mid elevational areas. Males often fly low through *F. vulgare* and females and sometimes males visit the flowers of *F. vulgare*.

Cheilosia soror (Zetterstedt, 1843)

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 6b: 9♂, 2♀; 6c: 1♀; 7a1: 1♂; 14a: 1♀; 14b: 3♂.

FIG 5. Adult Syrphidae feeding on *Hedera helix*. A. *Callicera aurata* female. B. *Milesia semiluctifera* male.

Remarks. Males were found hovering 2 to 3m above the ground in a *P. orientalis* forest in semi-shady conditions. Males and females were also found on flowering *F. vulgare* in the same *P. orientalis* forest. Also found on Mount Lazaros and on Mount Kerkis on Hedera helix and on old *P. orientalis* trees covered by *H. helix*.

Chrysogaster mediterraneus Vujić, 1999 (Fig. 6C)

Rare East-Mediterranean species and in Greece also rare with one record from Samos (Vujić 1999, Vujić et al. 2020b).

New records. 6b: 1♀.

Remarks. Found on *F. vulgare* in a small, abandoned field in a *P. orientalis* forest with a nearby water filled stream.

Chrysotoxum intermedium Walker, 1851

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 2b: 1♀; 6b: 1♂, 1♀; 8: 3♀; 9: 1♀.

Remarks. Found on *F. vulgare* in orchards and abandoned fields.

Dasysyrphus albostriatus (Fallén, 1817)

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 6b: 4♂, 1 intersexe 7a1: 1♂.

Remarks. Five males and an intersexe were collected. One male on *H. helix* in a *Pinus halepensis* forest and the other specimens on *F. vulgare* in a *P. orientalis* forest.

Episyrphus balteatus (De Geer, 1776)

Widespread Mediterranean species, also widespread in Greece (Vujić et al. 2020b).

First record for Samos.

New records. 6a: 1♀; 6b: 1♀.

Remarks. Only two females of this otherwise very common species were collected near the small settlement of Valeondades.

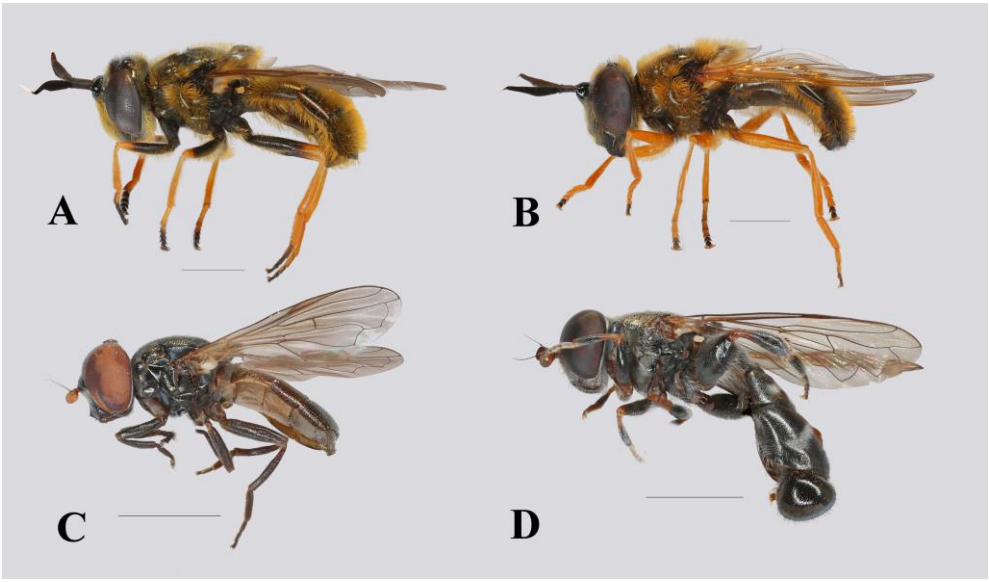

FIG 6. Adult habitus, lateral view. A. *Callicera macquarti* female. B. *C. rufa* female. C. *Chrysogaster mediterraneus* female. D. *Eumerus clavatus* male. Scale 2,5 mm.

Eristalinus (*Lathyrophthalmus*) *aeneus* (Scopoli, 1763)

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 2b: 1♀; 8: 1♂, 2♀; 9: 3♂, 2♀; 10: 1♂, 1♀.

Remarks. Found along the seashore flying low above the ground, settling on rocks and feeding on *C. maritimum*.

Eristalinus megacephalus (Rossi, 1794)

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 2b: 2♀; 8: 1♀; 12: 1♂; 13: 1♂.

Remarks. Found along the Southern seashore along reedbeds or herbrich meadows. Visiting flowers of *P. dysenterica*.

Eristalinus taeniops (Wiedemann, 1818)

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 7c1: 1♀; 8: 1♂, 6♀; 9: 1♀; 12: 1♀; 14d: 1♂, 1♀.

Remarks. Found in several localities throughout the island in a wide range of habitats visiting flowers of *C. variegatum*, *F. vulgare* and *H. helix*. The species was collected near the sea, but also in the mountains and even on a mountain top.

Eristalis arbustorum (Linnaeus, 1758)

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 7a2: 1♂; 14d: 1♀.

Remarks. Only two records of this otherwise common and widespread species. Found on *D. carota* in an apple orchard within a *P. halepensis* forest.

Eristalis similis (Fallén, 1817)

Widespread Mediterranean species. also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 14b: 4♀.

Remarks. Only found on Kerkis mountain on flowering *H. helix* in a *P. orientalis* forest.

Eristalis tenax (Linnaeus, 1758)

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 6b: 1♀; 7a1: 2♀; 7a2: 1♂, 1♀; 7c1: 9♂, 2♀; 8: 5♀; 9: 3♀; 12: 1♀; 14a: 1♂; 14b: 1♀; 14d: 2♀.

Remarks. Found throughout the island along the coast and in the mountains, even hilltopping at Mount Lazaros. Visiting flowers of a wide range of plant species like *C. maritimum*, *F. vulgare*, *H. helix* and *L. europaeus*.

Eumerus amoenus Loew, 1848

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 7a1: 1♂; 7a2: 4♂, 2♀; 7c2: 2♀.

Remarks. Only found on Mt Lazaros, mainly in an apple orchard on *D. carota* and *F. vulgare*, females were found visiting *C. variegatum* at the summit of Mt Lazaros.

Eumerus argyropus Loew, 1848 (Figs 9A, 9B)

Widespread Mediterranean species, also widespread in Greece (Vujić et al. 2020b).

First record for Samos.

New records. 7b2: 1♀.

Remarks. Found on Mt Lazaros in a thistle field at the upper edge of the *P. halepensis* forest.

Eumerus armatus Ricarte & Rotheray in Ricarte et al. 2012

Rare and restricted East Mediterranean species, also recorded in Greece including Samos (Vujić et al. 2020b).

New records. 7b2: 1♀.

Remarks. Found on Mt Lazaros in a thistle field at the upper edge of the *P. halepensis* forest.

Eumerus basalis Loew, 1848

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 1: 4♂, 2♀; 4: 2♂; 5: 7♂, 3♀; 6b: 40♂, 18♀; 6c: 3♂, 2♀; 7a1: 10♂, 5♀; 7a2: 6♂, 2♀; 7b1: 1♂; 8: 2♂, 1♀; 14d: 1♂.

Remarks. Found on several mountains in open areas within *P. halepensis* and *P. orientalis* forests visiting flowers of *F. vulgare*.

Eumerus clavatus Becker, 1923 (Fig. 6D)

Rare Mediterranean species and in Greece only recorded from Lesbos (Vujić et al. 2020b).

First record for Samos.

New records. 7a1: 2♀; 7a2: 3♂; 14b: 1♂, 1♀.

Remarks. Found in the Kerkis mountains in a *P. orientalis* forest on *H. helix* and at Mt Lazaros in an apple orchard on *H. helix* and *P. dysenterica*.

Eumerus lucidus Loew, 1848 (Figs 9C, 9D)

Rare Mediterranean species, also recorded in Greece (Vujić et al. 2020b).

First record for Samos.

New records. 7a1: 1♀; 7c2: 1♀.

Remarks. One female specimen was found at Mt Lazaros in an apple orchard in a *P. halepensis* forest. It was collected along an irrigation ditch at non-flowering low herbs with bright green leaves on an open sunlit

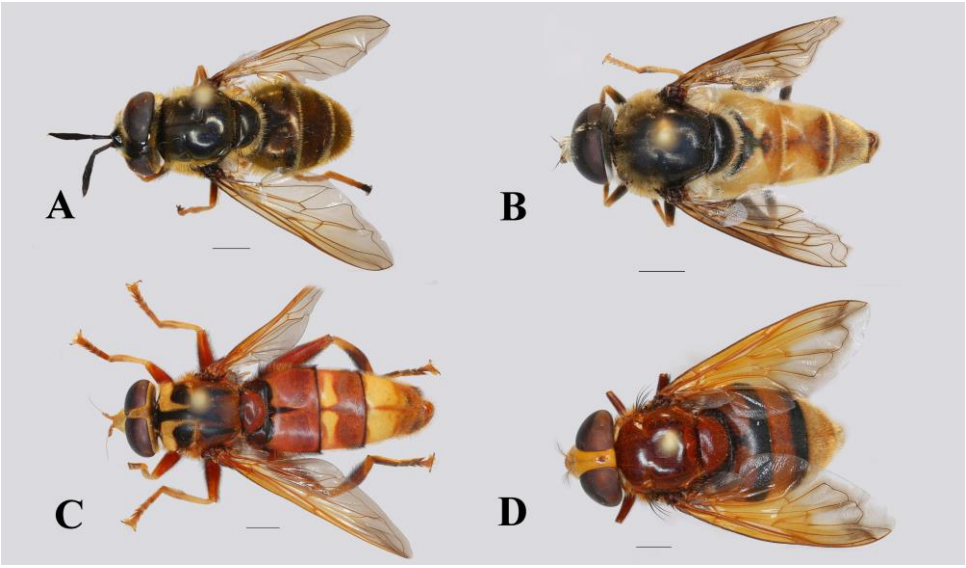

FIG 7. Adult habitus, dorsal view. A. *Callicera aurata* female. B. *Merodon pruni* male. C. *Milesia crabroniformis* male. D. *Volucella zonaria* female. Scale 2.5 mm.

spot under brambles. The other female was found at the hilltop of Mt Lazaros.

Eumerus niveitibia Becker, 1921 (Fig. 8B)

Rare East Mediterranean species, also recorded in Greece (Vujić et al. 2020b).

First record for Samos.

New records. 7a1: 1♂, 7a2: 1♂; 7b1: 6♂, 6♀; 7b2: 1♂; 7c1: 34♂, 4♀; 7c2: 28♂, 1♀.

Remarks. High numbers of males were found on Mt Lazaros hilltop, sitting on rocky outcrops, and making swift but short flights chasing other Diptera, especially males of the same species. Also, some records of males and females from less barren parts lower down on the mountain in a small meadow and an orchard, mostly flower visiting or sitting on rocky ground.

Eumerus pusillus Loew, 1848

Widespread Mediterranean species, also widespread in SE Greece and Samos (Vujić et al. 2020b).

New records. 8: 1♀.

Remarks. One female was collected on an abandoned field close to the sea while visiting flowers of *F. vulgare*.

Eumerus torsicus Grković & Vujić, 2015

Rare species, only found in Chios and Cyprus (Grković et al 2015, van Steenis et al 2019, Vujić et al. 2020b).

First record for Samos.

New records. 7b1: 1♀, 14b: 1♀.

Remarks. One female was collected on a slope directly under a steep part of Lazaros mountain, close to a dirt road, the other on a branch covered with moss along a stream in an old *P. orientalis* forest.

Eupeodes corollae (Fabricius, 1794)

Widespread Mediterranean species, also widespread in Greece (Vujić et al. 2020b).

First record for Samos.

New records. 6b: 2♀; 7a1: 2♂, 4♀; 7a2: 5♂, 1♀; 7b1: 1♂; 7b2: 2♂; 7c1: 1♀; 7c2: 2♂, 1♀; 8: 1♀.

Remarks. Most records are from Mt Lazaros on flowers of *H. helix*.

Heringia heringi (Zetterstedt, 1843)

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 7a1: 3♂, 32♀; 7a2: 6♀; 7b1: 1♀.

Remarks. Several specimens were found on Mt Lazaros in an apple orchard within a *P. halepensis* forest, visiting flowers of *H. helix*.

Ischiodon aegyptius (Wiedemann, 1830) (Fig. 10A)

Oriental and Asian species, with recent records from the western Mediterranean basin; France and Spain (Lebard et al. 2019, Speight, 2020).

First record for Samos and Greece.

New records. 8: 2♂, 1♀; 12: 1♀.

Remarks. Collected along the North coast on abandoned fields visiting flowers of *F. vulgare* or flying swiftly through the vegetation. Also, on the south coast at a river estuary with reed beds.

Ischiodon scutellaris (Fabricius, 1805) (Fig. 10B)

Rare Mediterranean species, also recorded from NE Greece (De Courcy Williams et al. 2011) and Chios (Vujić et al. 2020b).

First record for Samos.

New records. 8: 1♂; 12: 2♂; 14d: 8♂, 1♀; 15: 1♂.

Remarks. Found in the Kerkis mountains in an orchard with *F. vulgare* fields flying swiftly through and visiting flowers of *F. vulgare*. Also found in the town centre of Kokkari flying around a flowering *P. jasminoides*.

Meliscaeva auricollis Zetterstedt, 1822

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 6a: 2♀, 6b: 1♀.

Remarks. Only one female of this otherwise common species was collected in the small settlement of Valeondades. One additional female was observed, but not collected, along a forest road at vegetation along a seepage from a water tank in a pine forest on Kerkis mountain (loc 14a).

Merodon albifrons Meigen, 1822

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 7a2: 1♀; 7b1: 1♂; 7b2: 1♂, 1♀; 7c2: 7♂;

Remarks. Found on Mt Lazaros where males were seen hilltopping and females lower down in thistle field or an apple orchard. Almost all specimens were collected at the end of the trip on the 17th of September.

Merodon aurifer Loew, 1862 (Fig. 8C)

Widespread Mediterranean species, also widespread in Greece (Vujić et al. 2020b).

First record for Samos.

New records. 2a: 1♂; 5: 2♂, 2♀; 7b1: 3♂; 7c1: 12♂, 1♀; 7c2: 14♂; 8: 3♀; 11: 1♂; 12: 1♂, 1♀; 13: 3♂; 14d: 2♂, 1♀.

Remarks. Males were collected on a hilltop sitting on barren ground and rocks and flying away very rapidly, when approached. Other males and females were collected throughout the island visiting flowers of *F. vulgare*.

Merodon avidus (Rossi, 1790)

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 2b: 1♀; 6a: 1♂; 7a1: 1♂, 1♀; 7a2: 3♂, 2♀; 7b1: 3♂, 8♀; 7b2: 1♂, 2♀; 7c2: 1♀.

Remarks. Found at lower elevation, mostly on Mt Lazaros in an apple orchard.

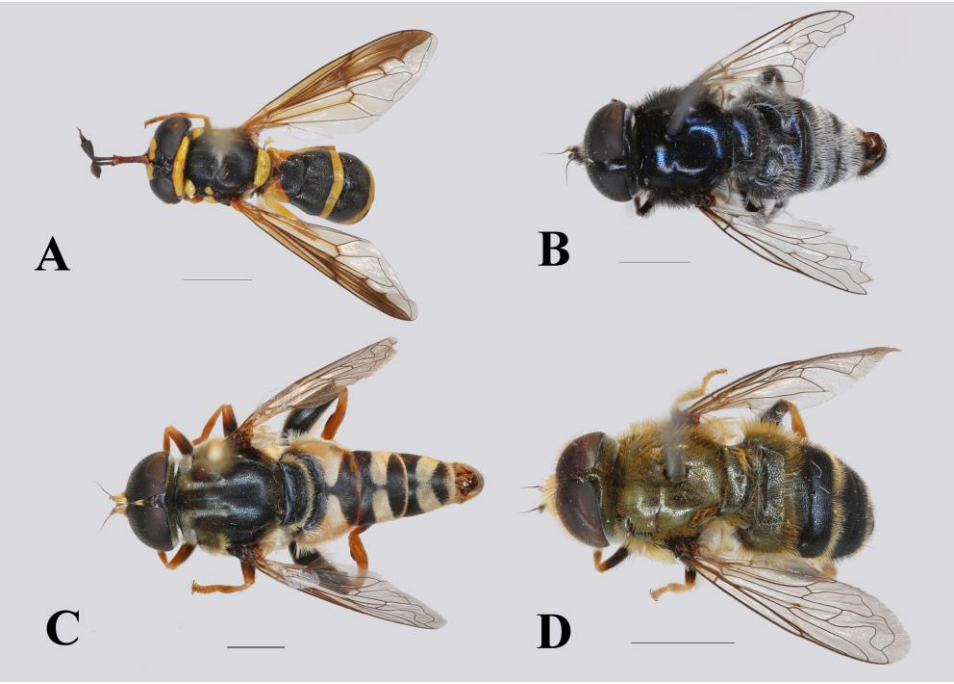

FIG 8. Adult habitus, dorsal view. A. *Ceriana vespiformis* female. B. *Eumerus niveitibia* male. C. *Merodon aurifer* male. D. *Merodon sapphous* male. Scale 2.5 mm.

Merodon erevanicus Paramonov, 1925

Widespread East Mediterranean species and common in Greece, on East Aegean islands including Samos (Vujić et al. 2020b).

New records. 5: 1♀.

Remarks. The female was collected on *F. vulgare*.

Merodon italicus Rondani, 1845

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 7b1: 2♀.

Remarks. Only two females were collected on Mt Lazaros in an apple orchard.

Merodon neofasciatus Vujić, Ståhls & Radenković, 2018

Widespread species on the East Aegean islands including Samos (Vujić et al. 2020b).

New records. 2b: 1♂.

Remarks. One male was collected at Mykali wetland in a flower rich area at the border of the reedbed.

Merodon pruni (Rossi, 1790) (Fig. 7B)

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 7a1: 1♂; 7b1: 5♂, 1♀; 8: 1♂, 1♀.

Remarks. Collected on Mt Lazaros in *P. halepensis* forest and two records from an abandoned field along the coast.

Merodon sapphous Vujić, Pérez-Bañon & Radenković, 2007 (Fig. 8D)

Rare Mediterranean species and in Greece only recorded from Lesbos (Vujić et al. 2020b).

First record for Samos.

New records. 7a1: 1♂, 2♀; 7a2: 2♂, 8♀; 7b1: 3♂, 1♀; 7b2: 11♂, 7♀; 7c1: 1♀.

Remarks. Found on Mt Lazaros in a *P. halepensis* forest. Most specimens were seen sitting on the ground or flying through vegetation of Thistles and ferns, sometimes close to *Taraxacum* spp. as if wanting to feed on the flowers. Also found in an extensive orchard visiting flowers of *H. helix* and *Pulicaria dysenterica* or along a water filled irrigation ditch sitting on bare ground or leaves of low herbs.

These specimens differ slightly from specimens from other Greek islands and might belong to a different species.

Milesia crabroniformis (Fabricius, 1775) (Fig. 7C)

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 6a: 1♂, 3♀; 6b: 1♂, 4♀; 7a1: 6♂, 8♀; 7a2: 1♂, 3♀; 14a: 1♀; 14b: 2♂, 2♀.

Remarks. Found in several mountainous areas, predominantly on *H. helix* bushes.

Females often visit the flowers of *Bougainvillea* spp., *H. helix* and *T. jasminoides*, and males are patrolling these bushes. While in flight, strongly resembling the workers of *Megascolia maculata* (Drury, 1773) (Hymenoptera) flying around the same bush. While flowers visiting no special behavioural mimicry could be observed. They do keep their wings partly spread to show the abdomen continuously, but since the wasps do cover their abdomen with the wings this seems not to be mimicry behaviour.

Milesia semiluctifera (Villers, 1789) (Fig. 5B)

Widespread Mediterranean species, also widespread in Greece (Vujić et al. 2020b).

First record for Samos.

New records. 6a: 1♀; 6b: 1♀; 7b1: 2♂, 1♀; 7c1: 1♂, 2♀; 8: 1♂; 14d: 1♀.

Remarks. Collected throughout the island, only in low numbers. Mainly found while flower visiting on *C. corymbosa* and *H. helix*, also seen flying low through *F. vulgare* fields.

Myathropa florea (Linnaeus, 1758)

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 6b: 5♀; 7a1: 5♂, 5♀; 7a2: 2♂; 8: 1♂; 14a: 1♂; 14b: 2♂; 14d: 1♀.

Remarks. Found at Mt Lazaros in *P. halepensis* forest and on Kerkes mountain in *P. orientalis* forest often visiting flowers of *H. helix*.

Neoascia podagrica (Fabricius, 1775)

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 2b: 1♂, 1♀; 5: 1♂; 6b: 1♂, 3♀; 6c: 27♂, 9♀; 14a: 1♂; 14b: 1♂.

Remarks. Found in great numbers on a small area with roadside vegetation of *M. longifolia* and *Euphorbia* sp. growing alongside a small stream with running water in a *P. orientalis* forest. Other scattered records are from other wet areas on the island.

Paragus bicolor (Fabricius, 1794)

Widespread Mediterranean species. also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 6b: 1♂, 7a1: 1♂, 1♀.

Remarks. Found in an apple orchard at Mt Lazaros and in an abandoned field along the

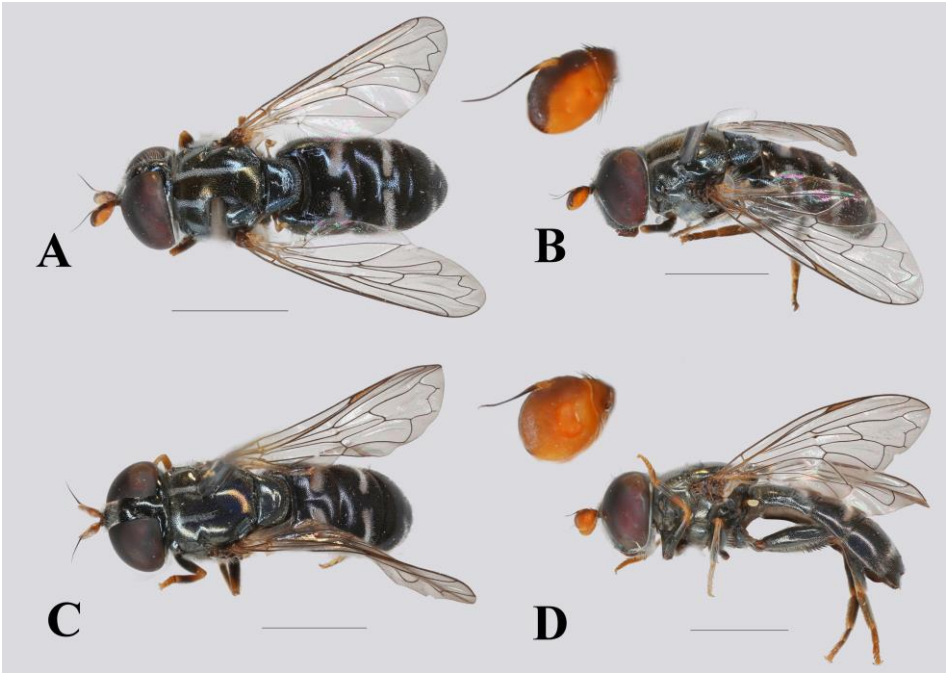

FIG 9. Adult habitus, A, C dorsal view; B, D lateral view. A, B. *Eumerus argyropus* female. C, D. *E. lucidus* female. Scale 2.5 mm. Antennae, lateral view; enlarged.

road, near Valeondades. Most of the Mediterranean specimens of *P. bicolor* could in fact be identified as *P. romanicus* Stănescu, 1992 (Tot et al. 2018) however the text in this paper is somewhat difficult to understand and it is possible the specimens on Samos actually belong to *P. bicolor*.

Paragus compeditus Wiedemann, 1830 (Fig. 10C)

Widespread Mediterranean species (Vujić et al. 2020b).

First record for Samos and Greece.

New records. 12: 27♂, 4♀.

Remarks. Found abundantly at the Imvressous estuary on Mentha longifolia, together with *P. haemorrhous* and *P. quadrifasciatus*. The type locality of this species is Egypt and occurrence on the east Mediterranean islands is expected. From Europe it is only known from Italy, Ukraine and Cyprus (van Steenis et al. 2019, Speight 2020), and now from Greece.

Paragus haemorrhous Megerle in Meigen, 1822

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 7a1: 2♂; 9: 1♀; 12: 2♂; 14d: 1♀.

Remarks. Found in low numbers throughout the island from coastal areas to Mt Lazaros.

Paragus pecchiolii Rondani, 1857

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 6b: 6♂; 7a1: 10♂, 1♀; 7a2: 4♂, 2♀; 7b1: 1♀.

Remarks. Found at Valeondades and Mt Lazaros.

Paragus quadrifasciatus Meigen, 1822

Widespread Mediterranean species. Previously recorded from Samos (Vujić et al. 2020b).

New records. 8: 1♀; 12: 3♂, 3♀; 14d: 1♂.

Remarks. Found in a vineyard with abundant *F. vulgare* and at the Imvressous estuary on *M. longifolia*.

Paragus tibialis (Fallén, 1817)

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 2b: 1♂; 7a2: 1♂.

Remarks. Two males, one from an apple orchard on Mt Lazaros and the other from Mikali beach reedbeds.

Parhelophilus versicolor (Fabricius, 1794) (Fig. 10D)

Rare Mediterranean species and in Greece only recorded in the northern parts (Vujić et al. 2020b).

First record for Samos.

New records. 2a: 2♂, 2♀; 2b: 28♂, 9♀; 12: 1♂, 1♀.

Remarks. Found in the morning in large numbers in a marsh area along the seacoast with a freshwater pond. Many males were collected along the pond shore flying through the vegetation and settling on leaves of *P. australis* and *T. latifolia*. In the late afternoon only found outside this pond flying through the vegetation and flower visiting *M. longifolia, L. europaeus* and *P. dysenterica*. Also found at Imvressous estuary along the South coast.

Pipiza noctiluca (Linnaeus, 1758)

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 7a2: 1♂.

Remarks. Found sitting on leaves of *H. helix*.

Scaeva dignota (Rondani, 1857)

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 6a: 1♀: 6b: 3♀; 7c1: 2♂, 1♀.

Remarks. Several males were found hilltopping early morning on Mt Lazarus around *Juniper* scrubs.

Scaeva mecogramma (Bigot, 1860)

Rare Mediterranean species and in Greece only recorded from Lesvos (Vujić et al. 2020b).

First record for Samos.

New records. 7c1: 1♂, 1♀.

Remarks. Like *S. dignota* two specimens of *S. mecogramma* were found hilltopping early morning on Mt Lazarus around *Juniper* sp. scrubs.

Scaeva pyrastri (Linnaeus, 1758)

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 6a: 1♀.

Remarks. Found around the houses of Valeondades.

Sphaerophoria rueppellii (Wiedemann, 1830)

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 2a: 2♂, 1♀; 2b: 3♂, 2♀; 8: 1♂; 9: 1♂; 11: 2♂; 12: 10♂, 1♀.

emarks. Only found along the coast in wet to dried out habitats.

Sphaerophoria scripta (Linnaeus, 1758)

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 2a: 1♂; 6b: 1♀; 7a1: 4♂, 7a2: 1♂; 11: 1♂, 3♀; 12: 5♂, 2♀.

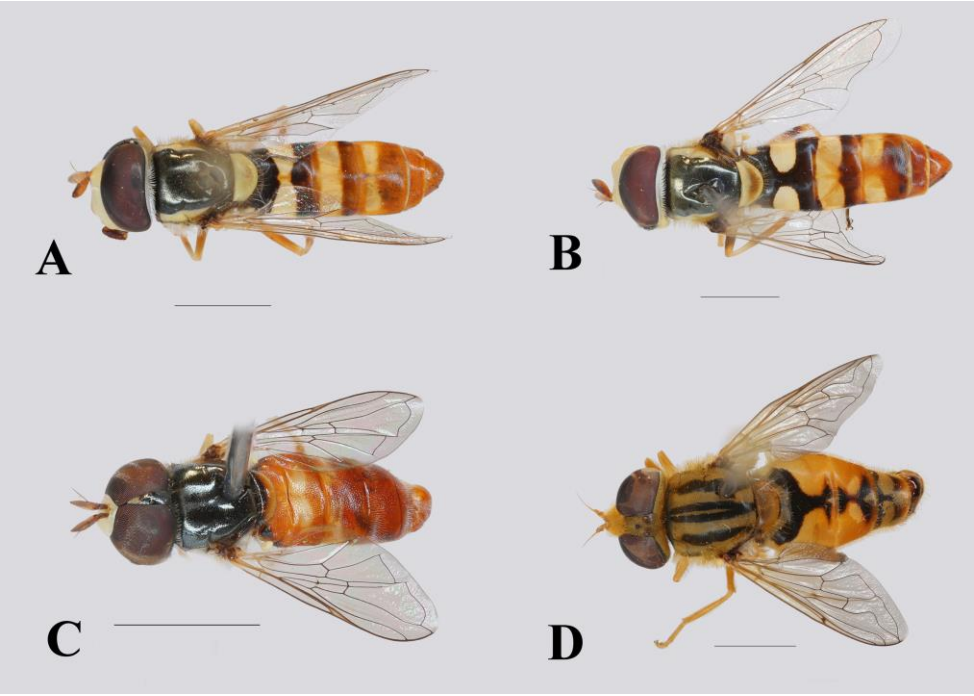

FIG 10. Adult habitus, dorsal view. A. *Ischiodon aegyptius* male. B. *I. scutellaris* male. C. *Paragus compeditus* male. D. *Parhelophilus versicolor* male. Scale 2.5 mm.

Remarks. Found in several localities throughout the island.

Sphegina elegans Schummel, 1843

Widespread Mediterranean species also recorded from Greece including Samos (Vujić et al. 2020b).

New records. 6b: 9♂, 8♀.

Remarks. Like *N. podagrica* found in efficient numbers on a small area with roadside vegetation of *M. longifolia* and *Euphorbia* sp. growing alongside a small stream with running water in an evergreen *P. orientalis* and *L. nobilis* forest.

Syritta pipiens (Linnaeus, 1758)

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 1: 3♂, 1♀; 2a: 2♂, 1♀; 2b: 5♂, 3♀; 5: 5♂, 2♀; 6b: 5♂, 5♀; 8: 2♂, 1♀; 9: 3♂, 2♀; 11: 2♂; 12: 1♂, 1♀; 14a: 2♂, 14b: 1♂; 14c: 1♂; 14d: 4♂, 2♀.

Remarks. Found throughout the island.

Triglyphus escalerai Gil Collado, 1929

Rare Mediterranean species. In the East Mediterranean only known from two sites in coastal Croatia and Montenegro (Vujić 1994, van Steenis et al. 2015) and in Greece from Lesvos and Samos (Vujić et al. 2020b).

New records. 6b: 1♀.

Remarks. Almost all observations of this species were recorded in spring, so our record is an exception. Found on a field of *F. vulgare* near Valeondades. Nearby and along a stream with running water with a forest of *L. nobilis* and *P. orientalis* trees.

Volucella inanis (Linnaeus, 1758)

Widespread Mediterranean species, also widespread in Greece including Samos, especially in mountain regions (Vujić et al. 2020b).

New records. 6b: 1♀, 7a1: 3♀; 14a: 3♀, 14b: 7♀.

Remarks. Found in *P. orientalis* forests in the higher parts of the island, mostly collected while visiting flowers of *H. helix*.

Volucella zonaria (Poda, 1761) (Fig. 7D)

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 6a: 2♀; 6b: 6♀; 7a1: 5♀; 7c2: 1♀; 14b: 4♀.

Remarks. Like the previous species, found in *P. orientalis* forests in the higher parts of the island. Often flying together and feeding on similar to *H. helix* plants.

Xanthandrus comtus (Harris, 1780)

Widespread Mediterranean species, also widespread in Greece (Vujić et al. 2020b).

First record for Samos.

New records. 6b: 1♀.

Remarks. One female collected near an abandoned field along the road in Valeondades valley. The field bordered a *P. orientalis* and *P. halepensis* forest.

Xanthogramma dives Rondani, 1857

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 7a1: 1♂, 2♀.

Remarks. Found in an orchard on Mt Lazaros, flying through the vegetation or feeding on *H. helix*.

Xylota segnis (Linnaeus, 1758)

Widespread Mediterranean species, also widespread in Greece including Samos (Vujić et al. 2020b).

New records. 7a1: 2♂.

Remarks. Two males were collected in an apple orchard on Mt Lazaros.

Discussion

During our eight-day collecting trip, 62 species were encountered of which 19 (31%) species were new to the island, adding up to a total of 107 known hoverfly species. Several species occurring on Samos were not encountered during the trip as their flight period is in spring or mid-summer (Vujić et al. 2020b). Even for the well sought-after genera *Eumerus* (9) and *Merdon* (21), this trip resulted in an increase of 56% and 10%, respectively, of the total number of species of these genera. This shows that many more species are expected to occur on the island. Based on the geographical distribution of hoverflies in Greece and adjacent Turkey, we believe that at least another 50 species are expected to occur on Samos.

Most of the species (21) collected during our trip, have an aphidophagous trait, followed by those which are phytophagous (17) on bulbs and roots, and one on mushrooms. Aquatic species were next in line with a total of ten species, followed by the saproxylic species (9) and finally two species living as larvae in nests of large wasps. The genera *Eumerus* and *Merodon* were anticipated to be represented by many species, as their larvae live in bulbs and rhizomes. The Mediterranean Basin is one of the hotspots for these plants (Blondel & Aronson 1999) and therefore for these two hoverfly genera as well (Vujić et al. 2011, Grković et al. 2015, 2017, Ståhls et al. 2016, van Steenis et al. 2017). The recording of three new species of *Callicera*, all saproxylic rot-hole breeders, is noteworthy, as these are spectacular Syrphidae that tend to visit flowers regularly, and as such are often easy to collect (e.g., Ssymank 2013, van Steenis et al. 2019). The relatively many, new to

Samos aphidophagous (6) species were surprising. Possibly, these species show strong population fluctuations over the years and can be virtually absent for long periods. In the warm and dry Mediterranean climate aphid population dynamics and abundancy are lower than in the temperate parts of Europe (Dixon et al. 1987, Peccoud et al. 2010). The aphidophagous species *Episyrphus balteatus* and *Eupeodes corollae* are very widely spread throughout Europe and their flight period is almost year-round (Vujić et al. 2020b).

Samos is the first region of Europe where both species of *Ischiodon* co-occurred. This was, however, not surprising as both species are known to extend their former SE Palaearctic and Oriental range tremendously (Lebard et al. 2019, van Steenis et al. 2019, De Courcy Williams et al. 2011, Vujić et al. 2020b).

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References

Blondel, J. and J. Aronson. 1999. Biology and wildlife of the Mediterranean region. Oxford University Press, USA. 328 pp.

Chroni, A., A. Grković, J. Ačanski, A. Vujić, S. Radenković, N. Veličković,M. Djan, and T. Petanidou. 2018. Disentangling a cryptic species complex and defining new species within the *Eumerus minotaurus* group (Diptera: Syrphidae), based on integrative taxonomy and Aegean palaeogeography. Contributions to Zoology, 87 (4) 197-225.

De Courcy Williams, M.E., M. Toussidou and M.C.D. Speight. 2011. Hoverflies (Diptera, Syrphidae) new to Greece from the Rhodope Mountains of Thrace and eastern Macedonia, including *Simosyrphus scutellaris* new to Europe. Dipterists Digest. 18:181–198.

Dixon, F.G., P. Kindlmann, J. Leps and J. Holman. 1987. Why there are so few species of aphids, especially in the tropics. The American Naturalist, 129: 580–592

Grković, A., A. Vujić, S. Radenković, A. Chroni and T. Petanidou. 2015. Diversity of the genus *Eumerus* Meigen (Diptera, Syrphidae) on the eastern Mediterranean islands with description of three new species. Annales de la Société entomologique de France (N.S.), 51(4): 361-373. http://dx.doi.org/10.1080/00379271.2016.1144483

Grković, A., A. Vujić, A. Chroni, J. van Steenis, M. Đan, and S. Radenković. 2017. Taxonomy and systematics of three species of the genus *Eumerus* Meigen, 1822 (Diptera: Syrphidae) new to southeastern Europe. Zoologischer Anzeiger 270: 176–192. https://doi.org/10.1016/j.jcz.2017.10.007

Lebard, T., M. Canut, and M.C.D. Speight. 2019. Première observation en France d' *Ischiodon aegyptius* (Wiedemann, 1830) et découverte en Corse d' *Eumerus narcissi* Smith, 1928 (Diptera, Syrphidae). Revue Française d'Entomologie Générale. 1(3): 203-210.

Peccoud, J., J-C. Simon, C. Von Dohlen, A. Coeur d'Acier, M. Plantegenest, F. Vanderberghe-Masutti and E. Jousselin. 2010. Evolutionary history of aphid-plant

associations and their role in aphid diversification. Comptes Rendus Biologies, 333 (6–7): 474-487. https://doi.org/10.1016/j.crvi.2010.03.004

Radenković, S., L. Šašić Zorić, M. Djan, D.O. Vidaković, J. Ačanski, G. Ståhls, N. Veličković, Z. Markov, T. Petanidou, N. Kočiš Tubić and A. Vujić. 2017. Cryptic speciation in the *Merodon luteomaculatus* complex (Diptera: Syrphidae) from the eastern Mediterranean. Journal of Zoological Systematics and Evolutionary Research. 00: 1–22. https://doi.org/10.1111/jzs.12193

Speight, M.C.D. and J-P. Sarthou. 2017. StN keys for the identification of the European species of various genera of Syrphidae Clés StN pour la détermination des espèces Européennes de plusieurs genres des Syrphidae 2017, vol. 99, Syrph the Net publications, Dublin, 139 pp.

Speight, M.C.D. 2020 Species accounts of European Syrphidae, 2020. Syrph the Net, the database of European Syrphidae (Diptera), vol. 104, Syrph the Net publications, Dublin, 314 pp.

Ssymank, A. 2013. Contribution to the fauna of hoverflies (Diptera: Syrphidae) of northeastern Greece, with special focus on the Rhodope Mountains with the Natura 2000 site Periochi Elatia, Pyramis Koutra. Studia dipterologica 19 (2012): 17–57.

Ståhls, G., A. Vujić, T. Petanidou, P. Cardoso, S. Radenković, J. Ačanski, C. Pérez-Bañón and S. Rojo. 2016. Phylogeographic patterns of *Merodon* hoverflies in the Eastern Mediterranean region: revealing connections and barriers. Ecology and Evolution 6(7): 2226–2245. doi: 10.1002/ece3.2021

Tot, T.J., Z.S. Nedeljković, S.R. Radenković and A.A. Vujić. 2018. Taxonomic study of the genus *Paragus* Latreille, 1804 (Diptera: Syrphidae) in the collections of the department of biology and ecology at the university of Novi Sad (FSUNS), Serbia. Matica Srpska J. Nat. Sci. Novi Sad, 135: 119-127. https://doi.org/10.2298/ZMSPN1835119T

Van Steenis, J., W. van Steenis, A. Ssymank, M.P. van Zuijen, Z. Nedeljković, A. Vujić and S. Radenković. 2015. New data on the hoverflies (Diptera: Syrphidae) of Serbia and Montenegro. Acta entomologica serbica, 20: 67-98.

Van Steenis, J., M. Hauser and M.P. van Zuijen. 2017. Review of the *Eumerus barbarus* species group (Diptera: Syrphidae) from the western Mediterranean Basin. Bonn Zoological Bulletin 66(2): 145–165.

Van Steenis, J., M.P. van Zuijen, W. van Steenis, C. Makris, A. van Eck and X. Mengual. 2019. Hoverflies (Diptera: Syrphidae) of Cyprus: results from a collecting trip in October 2017. Bonn Zoological Bulletin, 68: 125–146.

Van Veen, M.P. 2004. Hoverflies of Northwest Europe: Identification keys to the Syrphidae. KNNV Publishing, Utrecht, 254 pp

Vujić, A. 1994. Description of male of species *Triglyphus escalerai* Gil Collado, 1929 (Diptera: Syrphidae). Graellsia 50: 21-24

Vujić, A. 1999. The tribe Chrysogasterini (Diptera: Syrphidae) in the Balkan Peninsula, with the description of three new species. Studia dipterologica, 6: 405-423.

Vujić, A., M.A. Marcos-García, S. Sarıbıyık and A. Ricarte. 2011. New data on the *Merodon* Meigen 1803 fauna (Diptera: Syrphidae) of Turkey including description of a new species and changes in the nomenclatural status of several taxa. Annales de la Société Entomologique de France (NS), 47(1–2): 78–88. https://doi.org/10.1080/00379271.2011.10697699

Vujić, A., S. Radenković, L. Likov, A. Andrić, M. Janković, J. Ačanski, G. Popov, M. de Courcy Williams, L. Šašić Zorić and M. Djan, M. 2020a. Conflict

and congruence between morphological and molecular data: revision of the *Merodon constans* group (Diptera: Syrphidae). Invertebrate Systematics, 34: 406–448 https://doi.org/10.1071/IS19047

Vujić A., M. Speight, M. de Courcy Williams, S. Rojo, G. Ståhls, S. Radenković, L. Likov, M. Miličić, C. Pérez-Bañón, S. Falk and T. Petanidou. 2020b. Atlas of the Hoverflies of Greece (Diptera: Syrphidae). Brill, Leiden. 384 p.

WFO. 2021. World Flora Online http://www.worldfloraonline.org Accessed on: 17 March 2021.

Πρόσθετες καταγραφές ειδών Syrphidae (Diptera) από το νησί της Σάμου, Ελλάδα.

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ΠΕΡΙΛΗΨΗ

Παράλληλα με το 10ο Διεθνές Συμπόσιο για τα Syrphidae που διεξήχθη στη Λέσβο, στην Ελλάδα, τον Σεπτέμβριο του 2019, πραγματοποιήθηκαν δύο συλλεκτικές αποστολές στο νησί της Σάμου, μια πριν το συμπόσιο και μία μετά. Κατά τη διάρκεια των αποστολών αυτών, συλλέχθηκαν συνολικά 62 διαφορετικά είδη Syrphidae, από τα οποία τα 19 είναι νέα για το νησί της Σάμου. Επιπλέον, τα είδη *Ischiodon aegyptius* και *Paragus compeditus* αποτελούν νέες καταγραφές για την Ελλάδα. Εξάλλου, τα γένη *Eumerus* και *Merodon* διερευνούνται ενδελεχώς στη ΝΑ Μεσόγειο, και ιδιαίτερα στα ελληνικά νησιά. Η, κατά τη διάρκεια αυτής της πολύ σύντομης επίσκεψης, καταγραφή πέντε και δύο νέων ειδών αντιστοίχως, υποδεικνύει ότι με περισσότερη προσπάθεια αναμένεται η παρουσία πολλών νέων ειδών για το νησί της Σάμου.

