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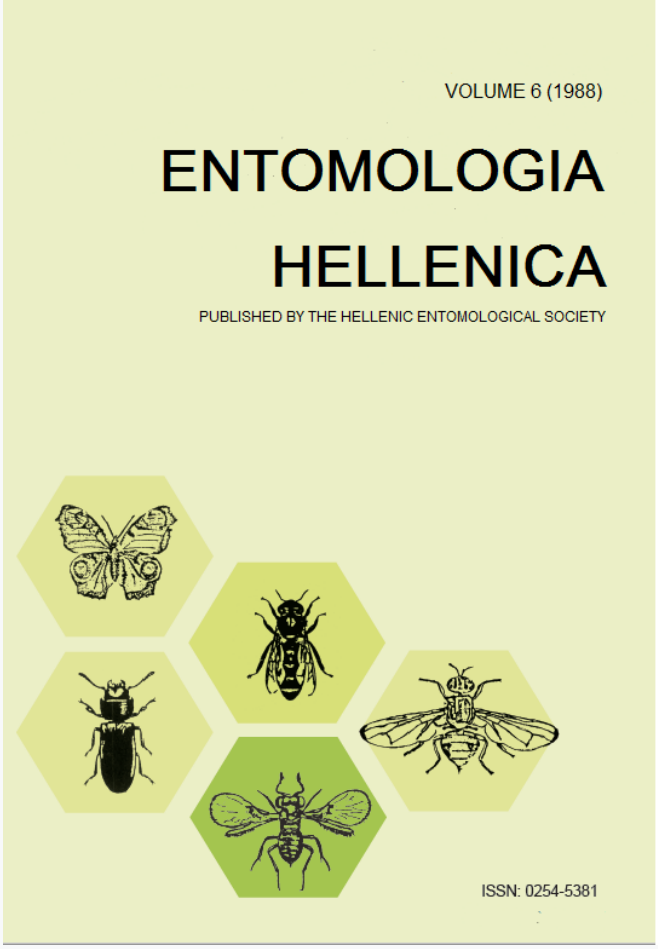

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Physokermes hemicryphus (Dalman) a Fir Scale Insect Useful to Apiculture in Greece[1]

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ABSTRACT

Physokermes hemicryphus (Dalman) is an important honeydew producing scale insect useful to apiculture. It lives mainly on *Abies cephalonica* Loud. and to a lesser degree on *Abies borisii regis* Mattf. These fir trees exist in most fir forests of Greece. It has one generation per year. Overwintering takes place in the second instar nymph. The female overwinters under the bud scales of the forks of the fir host and the male on the needles. Adults appear in spring and crawlers in July. In August the population consists mainly of first instar nymphs. The second instar nymphs start to appear in August and by late October the whole population is at the second nymphal instar, which is the overwintering one.

The insect occurs in the fir forests of Greece every year but its population level fluctuates, due to weather conditions and biological factors (parasites, predators). The coexistence on the same host plant of *P. hemicryphus* with the scale *Eulecanium sericeum* (Lindiger) and the aphid *Mindarus abietinus* (Koch) prevents the visit of honeybees to fir trees. On the other hand it favours the augmentation of the *P. hemicryphus* population. Four parasites were found, from which the Encyrtidae *Pseudorhopus testaceus* (Ratz.) and *Microterus lunatus* (Dalman), are recorded for the first time in Greek fauna.

Introduction

Honeydew producing insects are the most important source of honey production in many countries. These insects feed on various host plants and excrete honeydew. The bees visit these plants and collect the honeydew. Beekeepers bring their hives at the proper season into these bee pastures, to exploit this source. Honeydew producing insects occur in the coniferous tree forests of many European countries such as Austria, Germany, France, Italy, U.S.S.R., Poland, Czechoslovacia, Switzerland, Yugoslavia, Roumania (Muller 1967), Turkey (Ermin 1950) and other countries. In Austria, 40-70% of the honey is derived from honeydew (Pechhacker 1977a), and in Greece 65% of honey derives also from honedew (Santas 1981, 1983). In Greece, 5-10% originates from insects living on *Abies* spp. and 55-60% from insects living on *Pinus* spp.

Five honeydew producing insects were found on fir trees in Greece. These include the aphids, *Mindarus abietinus* Koch, *Cinara abieticola* (Cholodkovsky), *Cinara pectinatae* Nördl. (= *pichtae* Mordv.), and the scales *Physokermes hemicryphus* (Dalman) and *Eulecanium sericeum* (Lindiger) (Santas 1983). Amongst these five insects the soft scale *Physokermes hemicryphus* (Dalman) (Hem., Hom., Coccidae) is the most important in apiculture and widely distributed, not only in Greece, but in other countries as in Germany (Schmutterer 1965), Austria (Pechhacker 1977a), Roumania (Cirnu 1971), Czechos-

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lovakia (Haragsim 1963), and Finland (Loyttyniemi 1971). *P. hemicryphus* was found on *Picea abies* and *P. pugnes* in USA, but its value in apiculture is unknown (Williams and Kosztarab 1972).

Very little has been known about this scale insect in Greece, before the present study. Kailidis and Georgevits (1971) refer to this insect living on fir trees on Mount Parnitha without causing any damage to the trees. The population density of the scale insect is high in some years while in other it is very low. As those fluctuations greatly influence honey production, the present research was carried out to determine the factors which could affect the population density of this scale insect. So, a study on the phenology, mortality, parasitization and honeydew excretion of *P. hemicryphus* was undertaken in fir forests of Mount Parnitha, Attiki. Data were also taken from fir trees on the mountains Giona and Tymphristos (Central Greece), Aenos (Cephalonia island), Dirfys (Euboea island) and Parnon (Peloponnesus).

Materials and Methods

A survey was carried out in almost all fir forests of Greece from 1979 to 1988 in order to determine the distribution of this scale in the country. Observations were also taken from an *Abies cephalonica* forest, at an altitude of 1100 m, at Aghia Triada on Mount Parnitha, Attiki. This forest is used by apiculturists as bee pasture. Fifty fir trees infested with *P. hemicryphus* were used. Samples consisting of three to four year old infested twigs were taken at intervals from March till December. These samples were examined according to the method of Vasseur and Schwester (1957). Samples were taken once a month from November till March and at fortnight intervals from April till October. On each sample, 500 or more live scale insects and a varied number of dead ones were examined.

Observations on the phenology, mortality, parasitism and honeydew excretion were conducted according to a method used previously (Santas 1985). Samples were taken at irregular intervals from March till November from the Ainos mountain in 1986 and from Giona mountain in 1987, at an altitude of about 1100 m in both areas, to collect additional data on phenology and parasitism of the scale insect. Data on the parasitism of *P. hemicryphus* were also collected from the mountains Dirfys, Tymphristos and Parnon. Some data on the appearance of *E. sericeum* and *M. abietinus* were taken from the same place in Aghia Triada (Mount Parnitha) in May, June and July during 1981-1987. One hundred additional samples of three to four year old twigs were taken from other trees once a month to find out the number of soft scales per twig. Also, two hundred sprouts of fir trees were collected to count the ones infested by *M. abietinus*.

Results and Discussion

Distribution

P. hemicryphus was found in all sampled fir forests on *A. cephalonica* and *A. borisii-regis*. It was sampled at altitudes from 250m, on ornamental fir trees in Kiphissia, to the highest limit of fir forests on Parnassos mountain at 1500M. The scale insect was also present on ornamental fir trees in the cities Lamia (Central Greece), Grevena (Northwestern Greece) and Tripolis (Peloponnesus).

The honeydew excreted by *P. hemicryphus*, is exploited by beekeepers in nineteen counties of Greece (Table 1). A total of 2,049,031 stremas (one strema = 1,000 m^2) are used as bee pastures. Of them, 1,805,401 are covered by *Abies cephalonica* and 243,630 by *Abies borisii regis*. No data on *Abies alba* Mill. have been collected, as this species is scattered to Northwestern Macedonia and it is not used as bee pasture.

The main fir bee pastures in Greece are on the mountains of, Peloponnesus: Aroania, Chelmos, Olygyrtos, Trachy, Parnon, Menalon, Taygetos, Panahaikon, Kyllini; Central Greece: Parnitha, Kitheronas, Gerania, Elikona, Parnassos, Kalidromon, Giona, Iti, Tymphristos, Vardoussia, South Pindos, Agrafa, Lidoriki mountains, Panetolikon, Valtos mountains; Northern Greece: Tjoumerka, Northern Pindos (Orliakas), Pieria; Cephalonia island: Aenos; and Euboea island: Dirfys, Kandele, Xeros (Telethrion). There are fir forests infested with *P. hemicryphs* in some other counties as in Xanthi, Drama, Ioannina, Kastoria, Kozani, Magnisia, and others, but the beekeepers do not use these as bee pastures. Some of these forests are in precipitous areas, as in the Drama mountains, and in some other areas the infestation of fir trees by *P. hemicrythus* is very low as in Magnisia county on the mountain Othris.

General appearence

The female adult is dark brown in colour, globular and extremely irregular in shape with derm heavily sclerotized at maturity. Length,

TABLE 1. Stremas of fir forests with *P. hemicryphus* used as bee pasture in Greece.

Prefectures/counties	Number of stremas*	Species of *Abies*
PELOPONNESUS		
Korinthia	86,220	*Abies cephalonica*
Argolis	32,590	» »
Arcadia	160,000	» »
Lakonia	56,710	» »
Messinia	15,850	» »
Achaia	148,000	» »
CENTRAL GREECE		
Attiki	59,000	*Abies cephalonica*
Viotia	28,000	» »
Evritania	400,000	» »
Aetoloakarnania	239,000	» »
Phtiotis	280,000	» »
Phokis	47,000	» »
Karditsa	61,780	*Abies borisii-regis*
Trikala	177,500	» » »
NORTHERN GREECE		
Arta	66,340	*Abies cephalonica*
Grevena	4,000	*Abies borisii-regis*
Imathia	350	» » »
ISLANDS		
Euboea	157,161	*Abies cephalonica*
Cephalonia	29,530	» »
Total	2,049,031	

* One strema = 1,000 m².

soon after last molting 1.0-1.2 mm. The newly laid eggs are white, becaming later purple. They are protected by the body of female. Crawlers are light yellow, first stage nymphs dark yellow, while second stage nymphs turn to brown (Schmutterer 1956).

Phenology

In Greece, *P. Hemicryphus* has been found only on *Abies* spp. It has one generation per year, as also reported by Kailidis and Georgevits (1971) for Parnitha. Schmutterer (1956) and Sorauer (1957) report also one generation per year for Europe. The scale insect overwinters as second instar nymph forming budlike clusters, on the forks of the twigs. Early in the spring those nymphs started to develop rapidly and the first adult females appeared late in March (Table 2).

The young adults started to oviposit early in May and till July all scales were ovipositing (Fig. 1). The number of eggs laid varied from 82 to 1,486 (Table 3). Kailidis and Georgevits (1971) reported that eggs vary from 40 to 450. According to Schmutterer (1956) the number of

FIG. 1. Adults of *P. hemicryphus* at oviposition on fir forks of *A. cephalonica* in Mount Parnitha, June 1985.

TABLE 2. Percentage of *P. hemicryphus* individuals in each stage, observed on Mount Parnitha during 1983-1985.

Collection date	Total live scales	Percentage in each stage			
		Preoviposition adult	Ovipositing adult	First instar nymph	Second instar nymph
1983					
28.3	580	2	–	–	98
12.4	620	8	–	–	92
23.4	525	17	–	–	83
8.5	604	39	–	–	61
26.5	508	84	15	–	1
13.6	650	42	58	–	–
29.6	500	40	60	–	–
13.7	500	22	78	–	–
29.7	610	–	80	20	–
12.8	600	–	–	98	2
29.8	500	–	–	88	12
14.9	575	–	–	41	59
30.9	500	–	–	8	92
15.10	500	–	–	5	95
29.10	500	–	–	–	100
23.11	500	–	–	–	100
19.12	500	–	–	–	100
1984					
26.3	500	–	–	–	100
15.4	500	3	–	–	97
29.4	500	12	–	–	88
12.5	500	28	–	–	72
29.5	580	61	18	–	21
14.6	500	50	50	–	–
27.6	500	32	68	–	–
11.7	500	14	86	–	–
27.7	610	–	76	24	–
10.8	500	–	2	95	3
28.8	500	–	–	62	38
12.9	500	–	–	19	81
27.9	500	–	–	3	97
13.10	500	–	–	4	96
26.10	500	–	–	–	100
27.11	500	–	–	–	100
27.12	500	–	–	–	100
1985					
29.3	500	1	–	–	99
10.4	500	4	–	–	96
26.4	500	19	–	–	81
15.5	520	41	–	–	59
30.5	600	69	28	–	3
16.6	500	44	56	–	–
30.6	500	20	80	–	–
17.7	580	6	92	2	–
31.7	500	–	72	28	–
14.8	500	–	10	86	4
27.8	580	–	–	51	49
14.9	520	–	–	19	81
30.9	500	–	–	4	96
15.10	500	–	–	–	100
31.10	500	–	–	–	100
24.11	500	–	–	–	100
16.12	500	–	–	–	100

eggs depends on the size of the scale.

Crawlers, white and purple eggs and egg shells can be found under the adult body during July. In the same period some of the adults were alive and had their ovaries full of eggs ready to be laid, while others were dead with eggs, crawlers and egg shells. After hatching, the crawlers went out of the female adult body and wandered for 3-4 days before settling down on the forks of the twigs. In these places the scales remained fixed until maturity, next spring.

TABLE 3. Frequency distribution of eggs found in one hundred mature *P. hemicryphus* on July 17, 1985.

Number of eggs/scale	Scale insects
82-200	33
201-500	40
501-1000	18
1001-1486	9

The first molting was observed early in August and the scales entered in the second nymphal stage. Late in October all insects were in the second stage which is the overwintering one (Table 2). The males are indistinguishable from the females in the first two stages. However the males settled mainly on the needles of the tree while the females on the twigs. The first male nymphs appeared late in April and the first adult males in the middle of June (Table 4). The number of males in the population of this scale is very low, 0.2-3.6%. Schmutterer (1956) mentions that in Germany "*P. hemicryphus* is normally parthenogenetic".

The samples from Aenos and Giona in 1986 and 1987, respectively, showed that *P. hemicryphus* has one generation per year in both areas, but the oviposition and hatching of eggs occurred at different times in these two areas (Table 5). Thus, there is a difference of one month between these two areas as regards the time of hatching. The hatching of *P. hemic-*

TABLE 4. Male population of *P. hemicryphus* on *A. cephalonica* on Parnitha mountain during 1985.

Collection date	Number of scales	Nymphs	Puparia	Total	Total scales %
10.4	500	–	–	–	–
26.4	500	1	–	1	0.2
15.5	520	3	–	3	0.6
30.5	600	2	1	3	0.5
16.6	500	5	3	8	1.6
30.6	600	7	5	12	2.0
17.7	580	5	16	21	3.6
31.7	500	–	1	1	0.2
14.8	500	–	–	–	–

TABLE 5. Percentage of *P. hemicryphus* individuals in each stage observed from March till November in the mountains of Ainos and Giona.

Collection date	Percentage in each stage*			
	Preoviposition adult	Ovipositing adult	First instar nymph	Second instar nymph
Aenos (1986)				
15.3	48	–	–	52
2.4	82	–	–	18
24.4	95	2	–	3
16.5	94	6	–	–
2.6	83	17	–	–
18.6	29	69	2	–
29.6	5	92	3	–
15.7	–	68	32	–

TABLE 5 continued

28.7	–	10	85	5
14.8	–	–	72	28
1.9	–	–	2	98
28.9	–	–	–	100
25.10	–	–	–	100
19.11	–	–	–	100
Giona (1987)				
28.3	2	–	–	98
19.4	10	–	–	90
12.5	33	–	–	77
2.6	29	71	–	–
23.6	18	82	–	–
18.7	3	91	–	6
14.8	–	12	79	9
2.9	–	–	32	68
10.9	–	–	13	87
30.9	–	–	–	100
26.11	–	–	–	100

* Five hundred females per sample.

ryphus on Mount Parnitha appeared at the same time as in Giona (Tables 2, 5). After hatching, however, the development of the scale population in the three regions, was fairly similar. Thus, by the end of October all the scale population was in the second nymphal stage in Parnitha, Giona and Aenos.

Population density

One to five, on the average 2.24 scales were found on each infested fork (Table 6). However in some cases, mainly in years with high infestation as in 1988, the number of scales was larger. Occasionally from six to seventeen individuals were found.

Scale insects were found as far as the fifth fork of the stem. The first fork, that is on the top of the stem, had the highest number of scales. This number depends on the population density of *P. hemicryphus*. In low infestation, an average of about 2 individuals per first fork and about 1.5 per second fork, while in high infestation an average of about 4.5 per first fork and 2.5 per second fork were counted (Table 7).

TABLE 6. Number of scales found in one hundred infested forks, Parnitha, July 17, 1985.

Number of forks	Number of scale insects
24	1
47	2
16	3
7	4
6	5

The population of the scale insect appears to fluctuate from year to year. Counts in July,

TABLE 7. Number of scale insects per fork.

Fork	Number of forks		Number of scales		Scale insects per fork	
	1985	1988	1985	1988	1985	1988
1	273	1143	467	4884	1.71	4.27
2	205	446	231	1327	1.13	2.97
3	174	113	76	220	0.44	1.95
4	142	–	21	–	0.15	–
5	95	–	3	–	0.03	–

when the population was in the ovipositing stage, are given in Fig. 2 for a period of nine years. The counts were made on one thousand scales and from the first to the fourth fork of the stem. These fluctuations of the population might be attributed to various factors. Climate may some times have important side effects. Pechhacker (1988) mentions that it has no substantial influence on the fluctuation of this scale's population. *P. hemicryphus* can survive in extreme weather conditions, around –20 to –30°C (Schmutterer 1965, Pechhacker 1977B). In Greece such low temperatures only rarely occur. The high temperatures in the summer influence the crawlers of the scale but not the settled stage nymphs. The settled first instar nymphs of *P. hemicryphus* are protected under the bud scales of the tree host, as it happened in the summer of 1987 when during the third part of July and during August the maximal daily temperature exceeded 38°C. In that year, hatching started the first days of July and by approximately July 20 it was almost completed. In the next year, that is 1988, a rise of *P. hemicryphus* population was observed. During July, the number of adult scales in one thousand forks was 1,150 in 1987 and 1,450 in 1988 (Fig. 2). At the same time a fall of parasitization was also observed (Table 12). As the entomophagous insects are often more vulnerable to weather conditions than their insect hosts (Bodenheimer and Schiffer 1952), the extreme temperature influenced the population of the parasites and resulted in the fall of the parasitization in 1988 (Table 12).

The influence of parasitization on the popula-

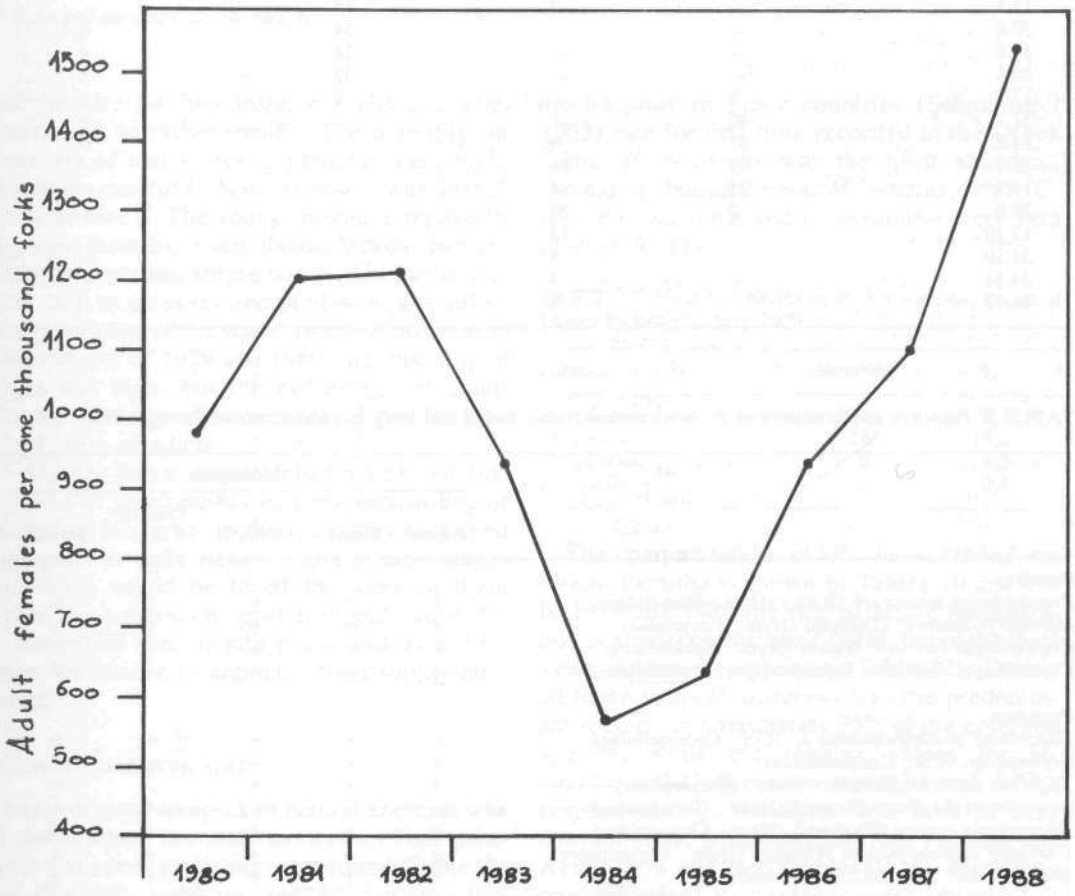

FIG. 2. Population density of *P. hemicryphus* in July in Mount Parnitha.

tion of *P. hemicryphus* is obvious in Fig. 2. The active parasitization of *P. hemicryphus* during years 1981, 1982, 1983 and 1984 was high (Table 12), while in years 1983, 1984 and 1985 the population of the scale insect showed a remarkable decrease (Fig. 2). The following years, 1985, 1986, 1987 the active parasitization was fairly low and an increase of *P. hemicryphus* population appeared in 1986, 1987 and 1988.

Mortality

In 1985, the mortality of first instar nymphs was higher, than that of the second and preoviposition adults (Table 8). Schmutterer (1965) reported that temperature and relative humidity have a marked influence on the mortality of *Physokermes* spp. when extreme weather conditions predominate in the summer, while Pechhacker (1977b) reported that the influence of

TABLE 8. Mortality in different stages of *P. hemicryphus* during March till December 1985, in Parnitha.

Collection date	Percent dead scale insects			
	First instar nymph	Second instar nymph	Preoviposition adult	Ovipositing adult
29.3	–	5	0	–
10.4	–	4	–	–
26.4	–	3	2	–
15.5	–	2	10	–
30.5	–	–	14	0
16.6	–	–	24	4
30.6	–	–	32	8
17.7	0	–	0	10
31.7	40	–	–	8
14.8	51	0	–	0
27.8	49	16	–	–
14.9	21	34	–	–
30.9	0	20	–	–
15.10	–	13	–	–
31.10	–	8	–	–
24.11	–	4	–	–
16.12	–	6	–	–

TABLE 9. Parasites and predators of *P. hemicryphus* found during this work in various mountains of Greece.

	Mountains				
	Aenos	Giona	Dirfys	Tymphristos	Parnon
Parasites					
*Pseudorhopus testaceus** (Ratz.) (Hym.: Encyrtidae)	+	+	+	+	+
*Microterys lunatus** (Dalman) (Hym.: Encyrtidae)	+	+	+	+	+
Coccophagus lycimnia Walker (Hym.: Aphelinidae)	+	+	+	+	+
Coccophagus insidiator Dalman (Hym.: Aphelinidae)	+	–	–	–	–
Predators					
Exochomus quadripustulatus L. (Col.: Coccinellidae)	+	+	+	+	+
Scymnus sp. (Col.: Coccinellidae)	+	+	–	–	+
Tjiderina gracilis (Shneider) (Neur.: Chrysopidae)	+	+	+	–	+
Anisochrysa flavifrons (Brauer) (Neur.: Chrysopidae)	–	–	–	+	–
Chrysoperla carnea (Stephens) (Neur.: Chrysopidae)	+	+	+	+	+
Chrysopa septempunctata Wesmael (Neur.: Chrysopidae)	+	+	+	+	+
*Brachytarsus** sp. (Col.: Anthribidae)	+	+	+	+	+

* Identified by scientists of the British Museum of Natural History.

TABLE 10. Percent parasitism of *P. hemicryphus* in Parnitha during 1979.

Collection date	Number of scales	Second instar	Preoviposition adults	Parasitized scales	Active parasitism
27.1	500	500	–	8	1.6
20.2	500	500	–	9	1.8
26.3	500	500	–	7	1.4
15.4	500	485	15	16*	3.2
29.4	500	440	60	21*	4.2
12.5	500	360	140	27*	5.4
29.5	580	–	353	12	2.4
14.6	500	–	250	7	1.2
27.6	500	–	160	3	0.6
11.7	500	–	70	0	0
27.7	610	–	–	–	–
10.8	500	15	–	0	0
28.8	500	190	–	0	0
12.9	500	405	–	0	0
27.9	500	585	–	0	0
13.10	500	580	–	1	0
26.10	500	500	–	3	0.6
27.11	500	500	–	2	0.4
12.12	500	500	–	0	0

* Emerged parasites 20, 30 and 30.

temperature on first instar nymphs and eggs "seems to be rather small". The mortality for crawlers of soft scales is generaly very high, but in the case of *P. hemicryphus* it was dificult to determine it. The young crawler nymphs suffer high mortality from abiotic factors, particularly showers and strong winds. The biotic factors such as parasites and predators, also affect the population of the scale. In some cases, as in the summer of 1979 and 1980, the mortality of eggs was high, but the percentage of adults having dead eggs did not exceed 3% of the total population of adults.

Another factor responsible for reduced survival of *P. hemicryphus* is the overcrowding of scales on the forks. In this case they may feed and grow at early stages, while at later stages starvation would be faced for some of them since the continuous growth would cause detachment of their mouth parts, and as a rule, they are unable to approach food supply anymore.

Parasites and predators

A very diverse complex of natural enemies was found to attack this scale in Greece. Four parasites and seven predators were found (Table 9). Of them, *P. testaceus* and *M. lunatus,* two common and very well known parasites of *P. hemicryphus* in many countries (Schmutterer 1965), are for first time recorded in the Greek fauna. *P. testaceus* was the most abundant, second in abundance was *M. lunatus,* while *C. lycimnia* was rare and *C. insidiator* very rare (Tables 9, 11).

TABLE 11. Parasitic species of *P. hemicryphus* found at Mount Parnitha in May 1979.

Parasite	Number	%
P. testaceus	101	76,5
M. lunatus	24	18,2
C. lycimnia	6	4,5
C. insidiator	1	0,8

The parasitization of *P. hemicryphus* on Mount Parnitha is shown in Tables 10 and 12. In 1979 and 1980 the rate of active parasitization is almost on the same level, but in the next years a decrease appeared (Table 12). During all these years *P. testaceus* was the predominant species, approximately 75% of the emerged species, while the relative values for *M. lunatus* and *C. lycimnia* were 20 and 4.5%, respectively. *C. insidiator* was bred in very few numbers, from samples from Parnitha and Aenos, now and then (Tables 9, 11). More than one individual *P. testaceus* were observed to emerge from one parasitized scale.

TABLE 12. Active parasitism (%) of *P. hemicryphus* in Parnitha mountain during 1979-1988.

Month	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Jan.	1.6	1.1	3.8	2.1	1.9	1.0	0.1	0.0	2.4	0.5
Febr.	1.8	3.2	8.2	6.7	2.8	2.1	1.2	2.1	3.1	1.0
March	1.4	3.4	11.4	12.8	9.7	6.7	2.4	2.8	4.7	1.5
April	3.7	4.8	10.5	14.2	12.1	8.6	3.1	3.7	4.8	1.8
May	3.8	5.7	15.4	16.4	15.8	10.2	4.2	5.8	6.2	2.1
June	1.0	4.1	7.8	6.2	3.2	2.1	1.0	2.3	4.2	2.0
July	0.0	2.2	4.6	1.2	0.8	0.0	0.0	1.8	3.0	1.4

TABLE 13. Percent *P. hemicryphus* attacked by *Brachytarsus* sp.

Month	1982	1983	1984	1985	1986	1987	1988
May	0	1	0	2	3	1	0
June	52	48	71	44	66	52	31
July	61	56	68	31	38	41	22
Aug.	33	2	0	0	0	3	0

The most important predator was found to be the egg preying *Brachytarsus* sp. The rate of predation was always high. In some years more than 60% of the ovipositing adults were infested by this predator (Table 13). *Brachytarsus* sp. does not comsume all the eggs of the scale and so it does not prevent the hatch of some of scale eggs. The crawlers emerging from these eggs are able to continue the infestation of fir trees by *P. hemicryphus*. The coccinellids *E. quadripustulatus* and *Scymnus* sp. do not seem to prefer this scale. They appeared in small numbers eating the crawlers and the first and second instars of the scale. *E. quadripustulatus* appeared in large numbers to prey on *E. sericeum* on fir trees on Mount Parnitha. *T. gracilis*, *A. flavifrons*, *C. carnea* and *C. septempunctata* were captured in lage numbers in McPhail traps in the experimental areas. *C. carnea* was bred from larva to adult on eggs and first instars of *P. hemicryphus* in the laboratory. *T. gracilis*, *A flavifrons* and *C. septempunctata* were observed to prey on the first instar of the scale but no adults were obtained. Surveys on *P. hemicryphus* in the fir forests of Aenos, Giona, Dirfys, Tymphristos and Parnon mountains gave almost the same species of parasites and predators as on Mount Parnitha (Table 9). The most abundant were *P. testaceus* and *Brachytarsus* sp.

Honeydew

Honeydew excretion starts early, that is soon after the settling of crawlers and continues till the adult instar. But the honeydew of first and second instars of the scale insect is low in quantity and it is not exploited by bees (Schmutterer 1965). During the period of first and second nymphal instars, that is in August till April (Table 2) the bees do not forage on fir trees. Beekeepers make use of abundant honeydew by bringing their hives into fir forests from April till August. This is the period when *P. hemicryphus* is in the adult stage. In general, the foraging period of honeybees in fir forests occurs from mid April till early August, but varies slightly with the area. Observations show that on Mount Parnitha the bees forage on *P. hemicryphus* from mid May till the end of July, while in Cephalonia Island from April till mid July. During that period most of the honey derives from honeydew excreted by *P. hemicryphus* but a small amount is also derived from *E. sericeum* and *M. abietinus*. *E. sericeum* was present in fir trees on Mount Parnitha during all years (1979-1988) but in very low population densities. In the infested trees no more than 2% of the twigs sampled were infested by these species (Table 14). *M. abietinus* was also present every year and infestations were observed in almost all fir trees but in very low population densities. Counts on the sprouts of fir trees during 1981-1987 showed that only 0.2% of sprouts were infested by this aphid (Table 15).

The contribution of honeydew excreted by *C. pectinatae* and *C. abieticola* to honey pro-

TABLE 14. Number of *E. sericeum* per twig of fir trees in Parnitha*.

Year	May	June	July
1981	1.2	1.8	1.4
1982	0.0	0.2	0.2
1983	1.5	1.8	2.0
1984	1.4	1.3	1.8
1985	1.8	2.0	2.0
1986	0.1	0.3	0.1
1987	0.0	0.0	0.0

* One hundred twigs per sample.

duction is some times negligible and in some other times very important. So, in the fir forest of Parnitha these two aphids occur rarely. During the period of observation (1979-1988), *C. pectinatae* and *C. abieticola* were observed to infest *A. cephalonica* only in 1982 and 1986. Their population was very low and scattered and the honeydew low in quantity. On the other hand, when the population of these aphids is very high the beekeepers bring their beehives to these places to exploit the heavy honeydew production. Thus, during the years 1984 and 1987 these aphids were observed in heavy populations on Tymphristos and Calidromos mountains of Central Greece, and gave good honey production to the apiarists of those areas.

The infestation of fir trees by *E. sericeum* and *M. abietinus* attract the ants which prevent the bees from foraging the honeydew. *P. hemicryphus* does not, or at least very rarely, attracts the ants. This is also recorded by Schmutterer (1956). During this work it was observed that fir trees infested by *P. hemicryphus* and at the same time by *E. sericeum* or *M. abietinus* attracted the ants. In these fir trees the visits of bees were quite rare. On the other hand, as DeBach et al. (1951) mention, the honeydew feeding ants prevent the oviposition of parasites and predators and reduce the parasitization of soft scales. Schmutterer (1965) reports that the same happens with the soft scale *P. hemicryphus*. It is possible therefore that the decrease of parasitization of *P. hemicryphus* in 1984, 1985, 1986 (Table 12), might be the result of the increase of infestation of these trees by *E. sericeum* in 1983, 1984, 1985 (Table 14) and by *M. abietinus* in 1984 and 1985 (Table 15).

TABLE 15. Percent infestation of fir tree sprouts by *M. abietinus* in Parnitha.

Year	May	June	July
1981	0.2	0.3	0.3
1982	0.1	0.4	0.4
1983	0.8	1.0	1.2
1984	3.4	4.1	5.1
1985	2.4	2.8	3.0
1986	0.2	0.3	0.3
1987	0.1	0.1	0.2

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Physokermes hemicryphus (Dalman) Ένα Μελιτογόνο Έντομο του Έλατου

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ΠΕΡΙΛΗΨΗ

Σύμφωνα με εκτιμήσεις των Μελισσοκομικών Οργανώσεων, κάθε χρόνο, πάνω από το 65% της συνολικής παραγωγής μελιού της χώρας μας προέρχεται από τις μελιτώδεις εκκρίσεις των εντόμων. Από το μέλι αυτό, 5-10% υπολογίζεται ότι προέρχεται από τα μελιτώματα εντόμων που παρασιτούν τα διάφορα είδη του έλατου (*Abies* spp.).

Στα έλατα της χώρας μας έχουν βρεθεί να παράγουν μελιτώδεις εκκρίσεις, που τις εκμεταλεύονται οι μέλισσες, πέντε είδη εντόμων που είναι τα κοκκοειδή *Physokermes hemicryphus* (Dalm.) και *Eulecanium sericeum* (Lind.), αμφότερα της οικογένειας Coccidae, και οι αφίδες *Mindarus abietinus* Koch., *Cinara abieticola* (Cholodk.) και *Cinara pectinatae* Nördl. που και οι τρεις ανήκουν στην οικογένεια Aphididae. Από αυτά τα μελιτογόνα έντομα, το πιο σημαντικό είναι το κοκκοειδές *P. hemicryphus*, που ενδημεί σε όλα σχεδόν τα ελατοδάση της χώρας, όμως κυρίως παρασιτεί πάνω στο είδος *Abies cephalonica* Loud. και σε μικρότερο βαθμό πάνω στο είδος *Abies borisii-regis* Mattf. Οι μέλισσες εκμεταλλεύονται τις μελιτώδεις εκκρίσεις του εντόμου αυτού από τα μέσα Απριλίου έως τις αρχές Αυγούστου.

Το *P. hemicryphus* διαπιστώθηκε ότι έχει μια γενιά το χρόνο. Διαχειμάζει ως «νύμφη» δευτέρου σταδίου. Τα μεν θηλυκά κυρίως στους ακραίους κόμβους των κλάδων του έλατου, ενώ τα αρσενικά στα βελονοειδη φύλλα. Τα ακμαία εμφανίζονται την άνοιξη και οι πρώτες έρπουσες τον Ιούλιο. Οι φαινολογικές παρατηρήσεις δείχνουν ότι τον Αύγουστο ο πληθυσμός του *P. hemicryphus* αποτελείται κυρίως από σταθεροποιηθείσες «νύμφες» πρώτου σταδίου. Οι πρώτες «νύμφες» δευτέρου σταδίου εμφανίζονται τον Αύγουστο και μέχρι τέλους Οκτωβρίου όλος ο πληθυσμός του κοκκοειδούς εισέρχεται στο δεύτερο στάδιο αναπτύξεώς του και διαχειμάζει. Οι πληθυσμοί του *P. hemicryphus* εμφανίζουν περιοδικές διακυμάνσεις που οφείλονται σε αβιοτικούς και βιοτικούς παράγοντες.

Κατά τη διάρκεια της εργασίας αυτής βρέθηκαν να παρασιτούν το *P. hemicryhus* τέσσερα παράσιτα τα *Pseudorhopus testaceus* (Ratz.) (Hym.: Encyrtidae), *Microterus lunatus* (Dalman) (Hym.: Encyrtidae), που αναφέρονται για πρώτη φορά στην πανίδα της Ελλάδας, *Coccophagus lycimnia* Walker (Hym.: Aphelinidae) και το *Coccophagus insidiator* Dalman (Hym.: Aphelinidae). Επίσης βρέθηκαν να θηρεύουν το κοκκοειδές αυτό επτά αρπακτικά από τα οποία το *Brachytarsus* sp. (Col.: Anthribidae) είναι το σπουδαιότερο.

Παρατηρήθηκε ότι η συνύπαρξη στο ίδιο έλατο του *P. hemicryphus* με το επίσης κοκκοειδές *Eulecanium sericeum* και με την αφίδα *Mindarus abietinus*, των οποίων οι μελιτώδεις εκκρίσεις προσελκύουν τα μυρμήγκια, εμποδίζει τις επισκέψεις των μελισσών στα δένδρα αυτά.