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Parasitoids of *Henosepilachna vigintioctomaculata* (Moschulsky) (Coleoptera: Coccinellidae) in Kyonggido area, Korea.

큰28점박이무당벌레의 기생천적

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ABSTRACT *Henosepilachna vigintioctomaculata* (Motschulsky) (Coleoptera: Coccinellidae), important pests of agricultural crops in Korea, including eggplant and potato, were collected in the Kyonggido area each summer from 1983 to 1986. Data were recorded for rates of parasitism against each host stage and seasonal activity. The parasitoids *Nothoserphus afissae* (Watanabe), (Hymenoptera: Proctotrupidae), *Uga menoni* (Kerrich), (Hymenoptera: Chalcididae), and *Pediobius foveolatus* (Crawford), (Hymenoptera: Eulophidae) were reared from the host insects. A solitary larval parasitoid, *N. afissae*, was reared from 2nd to 4th instar larval hosts, with parasitism being highest in the 3rd instar collection. *U. menoni*, a solitary larval-pupal parasitoid, was reared from 3rd instar larvae to pupae, and parasitism was highest in the pupal collection. *N. afissae* and *U. menoni* occurred during June to September. *N. afissae* showed relatively high parasitism during the entire study period as compared with other species, while parasitization by *U. menoni* was highest in July. *P. foveolatus*, a gregarious larval parasitoid, did not generally appear until September, although it appeared in early August in the southern part of Korea. The number of *P. foveolatus* emerging from a mummy varied, ranging from 7 to 26 (mean=13.8).

KEY WORDS *Nothoserphus afissae*, *Pediobius foveolatus*, *Uga menoni*, *Henosepilachna vigintioctomaculata*, natural enemy.

抄 錄 감자, 가지등 가지과 작물을 가해하는 해충인 큰28점박이무당벌레를 1983년부터 1986년까지, 매년 6월부터 9월까지 채집하였고, 이들을 공격하는 기생천적의 종류, 각 기생천적에 따른 기주곤충의 령기별, 월별 기생률이 조사되었다. *Nothoserphus afissae* (Watanabe), (벌목 : Proctotrupidae), *Uga menoni* (Kerich) (벌목 : 수중다리 좀벌과), *Pediobius foveolatus* (Crawford), (벌목 : 좀벌과) 등 3종류의 기생천적이 큰 28점박이 무당벌레를 공격하는 것으로 조사되었다. *N. afissae*는 2령~4령때 채집한 유충에 기생하는 것으로 조사되었으며, 특히 3령때 채집한 기주에서 가장 높은 기생률도 나타났으며, 유충때 기생해서 번데기때 우화하는 *U. mononi*의 경우 3령—번데기때 채집한 기주에 기생된 것으로 조사되었고, 번데기때 채집한 기주에서 높은 기생률을 나타냈다.
*N. afiss*와 *U. mononi*는 6월부터 9월까지 전 조사기간에 걸쳐서 기주를 공격하는 것으로 조사되었으며, N. afissde는 조사된 다른 기생천적등에 보다 기생률이 월등이 높은 것으로 조사되었으며 *U. menoni*의 경우는 7월에만 높은 기생률을 나타냈다. *P. foveolatus*는 다른 두종류의 기생천적과는 달리 다배 발생하는 것으로써 남부지방에서는 8월초부터 출현하나, 경기도 지역에서는 9월초에 나타나기 시작했으며 기생된 큰 28점박이 유충 1개체로 부터 평균 13.8개체의 성충이 우화하는 것으로 조사되었다.

檢 索 語 큰28 점박이무당벌레, 기생천적, *Nothoserphus afissae*, *Pediobius foveolatus*, *Uga menoni*

A phytophagous lady beetle, *Henosepilachna* (*Epilachna*) *vigintioctomaculata* (Motschulsky), the pest of crops such as potato and eggplant, is widely distributed in various parts of the world and is well known as a

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serious crop pest in mountainous areas. It's economic importance has stimulated much ecological study (Abbas & Nakamura 1985, Iwao 1970, Katakura 1981, Nakamura & Ohgushi 1981). A parasitoid, *Pediobius foveolatus* (Hymenoptera: Eulophidae), attacking the epilachnine pest has been investigated, reared, augmented, and released into infested fields (C.I.B.C. 1982, Lall 1961, Schaefer 1983, Stevens et al 1975a) and promising results were reported (Barrows & Hooker 1981, Stevens et al. 1975b).

Various vegetable crops in Korea may be seriously damaged by *H. vigintioctomaculata*. This is particularly true in mountainous areas, where it is a serious pest of potato, an important food resource with its annual production of 575,000 metric tons (MAF 1986). However, in Korea, few studies have been made of parasitoids and other natural enemies of this important pest.

This study was conducted to learn more about the presence of endemic (indigenious) parasitoids attacking this beetle and something about their biology. Three parasitoid species, *Pediobius foveolatus* (Crawford), *Nothoserphus afissae*(Watanabe) (Hymenoptera: Proctotrupidae) and *Uga menoni* (Kerrich) (Hymenoptera: Chalcididae), were collected in the field during 1983—1986 season. Their rate of parasitism, seasonal occurrences, and host-age preferences based on field surveys were analyzed. Such studies could be helpful in assessing the impact of parasitoids as mortality factors and their role in biological control.

MATERIALS AND METHODS

Collections of *H. vigintioctomaculata* were made in the Kyonggi-do area, comprising Namyangju-Gun(Jinjung-ri, Unsu-ri, Masuk, Mt. Churyong, Hwajub-ri, Sanung-ri, Jinkwan-ri), Koyang Gun (Byokjae-ri), Yangpyung-Gun (Mt. Yongmoon, Suip-ri, Munho-ri), Pocheon-Gun (Sepa-ri, Sohak-ri), and Kwangju-kun (Namhansansung), during June to September of 1983 through 1986. A total of 15,440 *H. vigintioctomaculata* was collected. More intensive collections could be made during the 1985 and 1986 seasons due to better cropping situations. Host insects were hand collected from potato leaves in fields from June to July. After the potatoes were harvested in early August, collections were made from eggplant and *Solanum nigrum* (black nightshade). In most instances, collections were not continuous at the same sites during the study period since potato fields were not always located adjacent to or near eggplant fields. The one exception was Byokjae-ri, where collections were continued on eggplant after potatoes were harvested at the same site. To the best of our knowledge, no insecticides were applied to any of the fields surveyed.

After the collection, eggs, larvae and pupae of the host were taken to the laboratory, separated by host stage and placed in plastic screen-top containers (19.5×4.5cm) lined with paper towels. Host insects were reared to adult under laboratory conditions (25±2°C, 70±10% RH) with fresh leaves of eggplant grown in the green house supplied as needed.

Parasitized larvae assume a characteristic color or form before the parasitoid emerges from the host. The host parasitized by *N. afissae* can easily be recognized by the way that the parasitoid larva directs its head caudad of the host as it matures. After *P. foveolatus* oviposits, the color of the parasitized host changes from yellow to reddish brown and its skin become rigid, although retaining the shape of the living larvae (or

pupae). Reddish-brown, rigid pupae were also formed by parasitization of *U. menoni*. The characteristic form of the host resulting from parasitization by and of the parasitoids is termed a mummy, and this terminology is used in this report.

Total percent parsitism in this study was represented by the ratio of emerged parasitoids to total numbers of host insects collected, Since mummified hosts were more highly visible than healthy insects, and therefore, might have been selected for in the collection, they were not included in the above equation. They were, however, used in the assessment of total numbers of parasitoids emerging per *P. foveolatus* mummy. In this study, field collected mummies were individually isolated in small petri-dishes and numbers of parasitoids emerged were recorded.

RESULTS AND DISCUSSION

Table 1 shows the list of parasitoids attacking *H. vigintioctomaculata*. *Pediobius foveolatus* is known to attack various kinds of lady beetles belonging to the subfamily *Epilachninae* (Schaefer 1983). This wasp is utilized as a biological control agent against the Mexican bean beetle, not only because it is a gregarious parasitoid, but also because it has several generations per season. This species was reported from *H. vigintioctomaculata* in Japan by Takigawa in 1976 (Takigawa 1976) and in Korea by Paik in 1985 (Paik 1985). Nakamura & Ohgushi (1981) reported *N. afissae*, a solitary parasitoid, as a motality factor on *H. vigintioctomaculata* in Japan, but this is the first discription of its activity from Korea.

Although *U. menoni* was reported as parasitoids on *E. vigintioctopunctata* (Azam et al. 1974) and *E. admirabilis* (Liu 1948), this is the first report of its parasitism on *H. vigintioctomaculata* in Korea.

As mentioned by Van Driesche 1983, parasitism rates may be related to time of season and to the developmental stage of the host. Parasitism rates against each host stage and seasonal parasitism may therefore be helpful in assessing a parasitoid's potential as a motality factor. Parasitism rates against each host stage of the three parasitoids were summarized in figure 1. From this it may be seen that *P. forveolatus* emerged mostly from late instars (Barrows & Hooker 1981, C.I.B.C. 1982) prevalently instar 4, but none emerged from instars 1 and 2. However, we do not know if *P. foveolatus* can parasitize instar 2, as most instars 2 were collected in 1986 when *P. foveolatus* was very scarce.

E. vigintioctomaculata is mummified by *U. menoni* in the pupal stage. Mummies developed from hosts collected as instars 3—4 or pupae, but none developed from 2nd instars.

N. afissae emerged from mummified late larval instars. Mummies developed from collections of instars 2—4, and parasitism was heaviest in the 3rd stadium. *N. afissae* developed from 1st instars exposed in the laboratory, but it is not known if 1st instars are attacked in nature. It was difficult to collect appreciable numbers of 1st instars because of their small size and because of

Table 1. Parasitoids reared from *Henosepilachna vigintioctomaculata* Motschulsky. (1983—1986)

Hymenoptera	
Eulophidae	
Pediobius foveolatus (Crawford)	
Proctotrupidae	
Nothoserphus afissae (Watanabe)	
Chalcididae	
Uga menoni (Kerrich)	New R.O.K host record

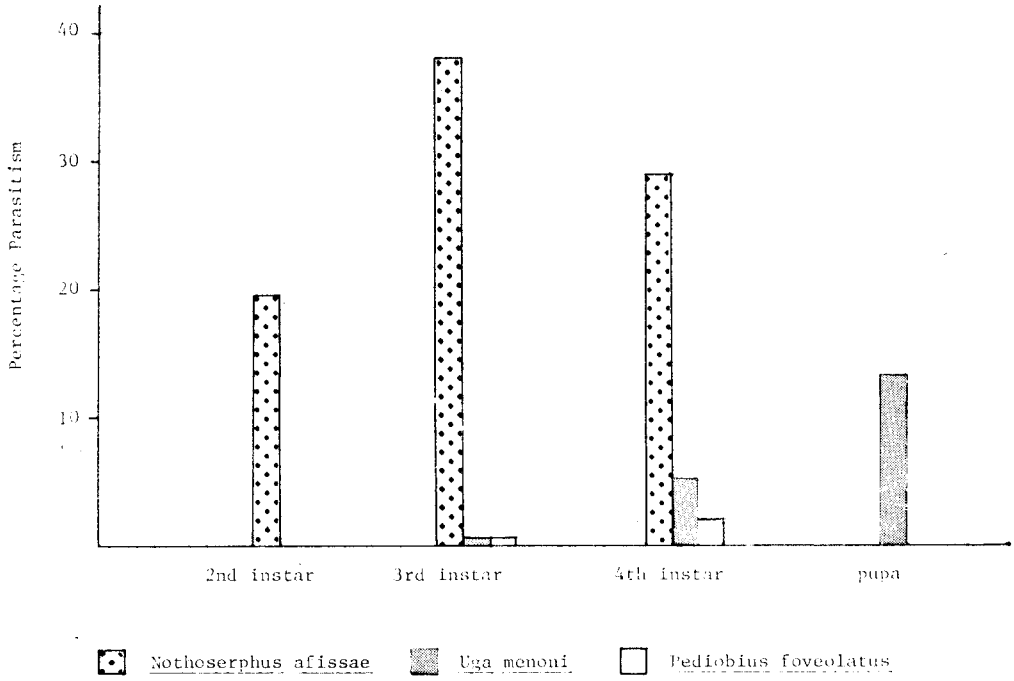

Fig. 1. Percentage parasitism by three parasitoid species at each host stage(1985—1986).

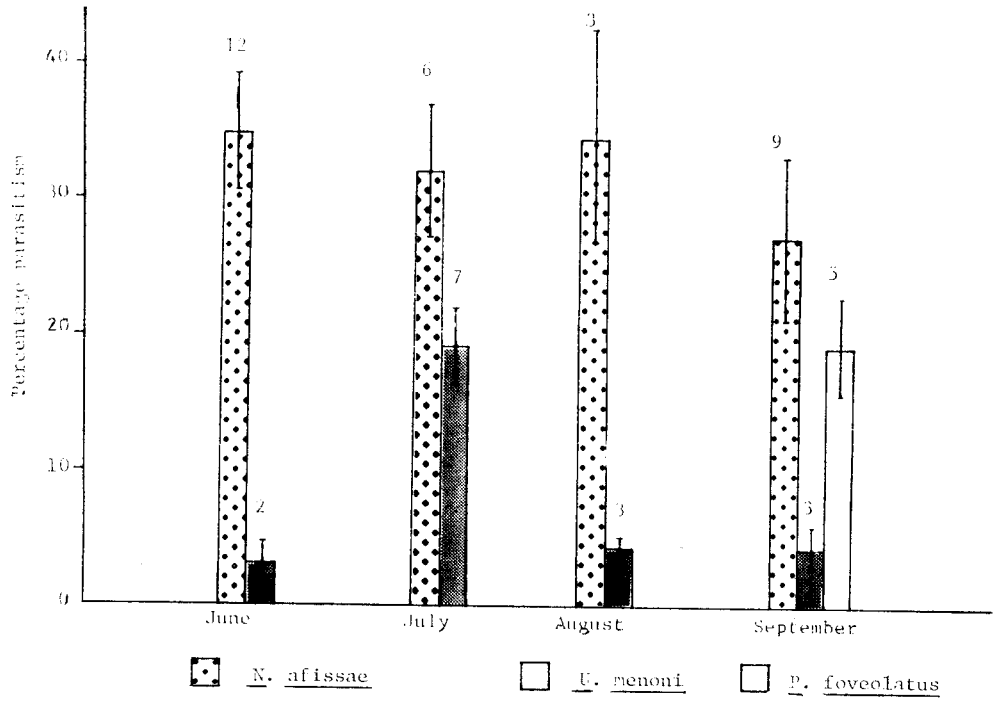

Fig. 2. Seasonal parasitism by three parasitoid species on *H. vigintioctomaculata*(Moschulsky) in Kyonggi-do area (1983—1986).

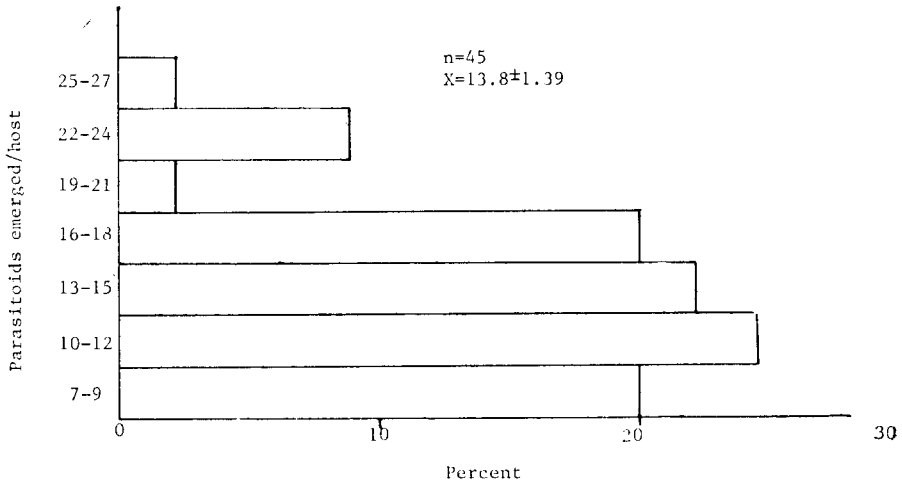

Fig. 3. Frequency distribution in number of *P. foveolatus* emerged per mummy of *H. vigintioctomaculata*.

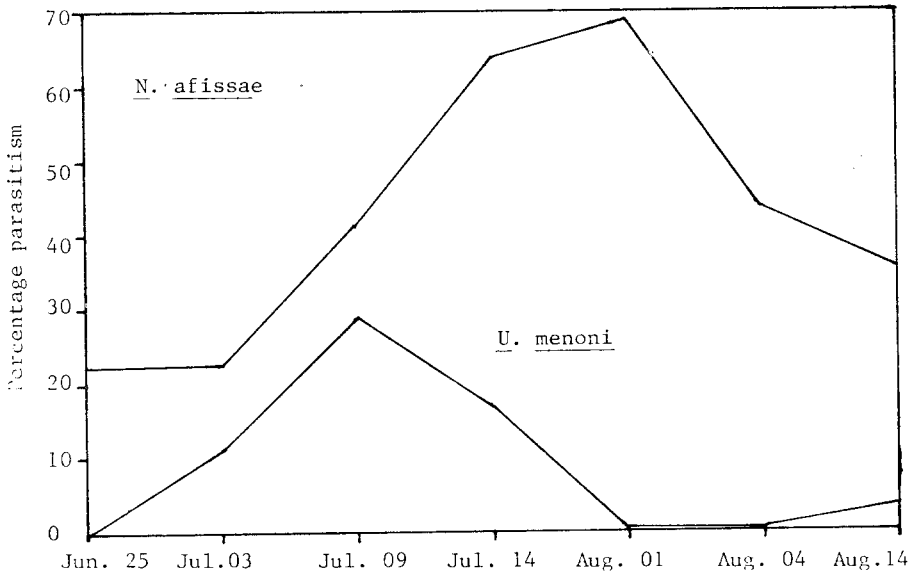

Fig. 4. Parasitoid occurrence in Byokjae-ri, Kyonggi-do(1986, June-August).

the brevity of the stadium.

In 1985 through 1986, the collecting period was June through September, and Figure 2 shows the parasitism percentages by month for each of the three parasitoids studied. Collections varied in number from 52 to 15 28(435 ± 49); only 2nd instar larvae through pupa were collected. Bars in the figure represent ratios of mummified host to 3rd-4th instar (*N. afissae*), 3rd-pupae (*U. menoni*) and 2nd-4th instar (*P. foveolatus*). Vertical lines indicate SE, and the numbers over the bars refer to number of collection sites from which parasitoids were obtained. *U. menoni* was restricted to a few sites; it was most abundant during July, although it occurred throughout the collecting period. Collections of *P. foveolatus* were generally made in September through the first killing frost in early to mid November, but in southern

Table 2. Percentage parasitism by three parasitoid species on *H. vigintioctomaculata* in three host plants in Kyonggido(1983—1986)

collection		No. host	No. parasitoids emerged(%)		
Host plant	Month	collected	Sp. 1	Sp. 2	Sp. 3
potato	6—7	7932	2663(33.6)	339(4.3)	—
eggplant	8—9	1919	398(20.7)	16(0.8)	293(15.2)
S. nigrum	9	888	408(50)	—	71(7)

Sp. 1: *N. afissae* Sp. 2: *U. menoni* Sp. 3: *P. foveolatus*

Korea the species could be found in early August. Throughout the collecting period, *N. afissae* was the most abundant parasitoid, although its percent parasitism tended to decrease in September when the parasitism by *P. foveolatus* was increasing. Combined parasitization was greatest in septemper when all three species were active.

As shown in Fig 3, a single mummy of *P. foveolatus* usually yielded an average of 13.8 individuals(range, 7—26). This is similar to what Stevens et al. (1975a) reported. *P. foveolatus* is known as a gregarious and multivoltine parasitoid with a potential of attaining high levels of parasitism in a single season. However, in our study, in spite of it's high reproductive potential, parasitis m was much lower than that of *N. afissae.*

Figure 4 shows percent parasitism throughout the sampling period for *N. afissae* and *U. menoni* in Byokjae-ri, where *H. vigintioctomaculata* could be continously collected, first on potato and later on eggplant. *N. afissae* was more abundant at this site than at others, with parasitization approaching 70% in early August. The high rate of parasitism appeaced to be explained by the continuous availability of *H. vigintioctomaculata* larvae, which, in turn, resulted from the continuous availability of host plants. The peak in *N. afissae* parasitism appears to coincide with peak abundance of host larvae, and the sharp decline in the rate of parasitism following the peak appears to relate to a decline in the abundance of early instars of *H. vigintioctomaculata.* Peak parasitism by *U. Menoni* occured about a month earlier than that for *N. afissae,* presumably enhancing the combined effectiveness of the two species.

N. afissae was found parasitizing *H. vigintioctomaculata* on all three species of host plants covered by this study (Table 2). *U. menoni* was not found in collections from *S. nigrum,* and *P. foveolatus* was not found on collections from potato. This appeared to be explained purely by the seasonality of parasitoids in contrast to that of the host plants.

S. nigrum and other non-economic Solanaceae were reported (Ganga & Chetty 1982) to offer shelter to *H. vigintioctomaculata.* It was consequently suggested that effectiveness of control efforts would be reduced unless they were extended to the non-economic hosts as well as the crops that were being damaged. However, the reservoir of *H. vigintioctomaculata* feeding on *S. nigrum* appeared to be important for the maintenance of populations of *N. afissae* and *P. foveolatus.* Therefore, it appears that spraying of *S. nigrum* with insecticies is ill advised.

Mortaliy caused by parasitoids of *H. vigintioctomaculata* appears to be underesti-

mated by tallies of parasite yield. Rahman (1970) indicated that mortality can result from the trauma of oviposition or from paralysis induced by stinging even when there is no oviposition. In our laboratory studies, we were able to confirm mortality resulting from stinging without oviposition by both *N. afissae* and *U. menoni*.

Further observations of host populations, parasitoid distribution and biology will give us a better understanding of these parasitoids and their efficacy in suppressing the population of *H. vigintioctomaculata* in all parts of Korea.

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