STUDIES ON THE DISTRIBUTION OF THE EPILACHNID BEETLES IN GUMMA PREFECTURE, JAPAN

by

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(Received September 15, 1964)

CONTENTS

INTRODUCTION

It is well known that the three Epilachnid species belonging to Epilachninae, Coccinellidae inhabit in Japan. In these beetles *Epilachna** *vigintioctomaculata* MOTSCHULSKY and *E. sparsa* (HERBST) mainly attack the Solanaceous vegetables, and *E. pustulosa* KÔNO feeds on thistles.

In Gumma-pref., *E. 28-maculata* is distributed at every place where potato-plants, egg-plants, tomato-plants, etc. are cultivated. *E. pustulosa* was firstly recorded from Doai, Minakami-machi in June of 1951 by YASUTOMI, and hereafter from several places near there (ASAHINA, NAKANE and HASEGAWA 1951, TAKEI 1956), and *E. sparsa* is found mainly in the southeastern plain part, expanding its distribution northwardly year after year.

The authors intended to study the detailed distribution of these species in Gumma-pref. from 1956 and got a considerable quantity of knowledges about it until present. This report gives the results of this research.

Before going further the authors wish to express their hearty thanks to

* LI and COOK (1961) established a new genus *Henosepilachna* instead of *Epilachna* and treated *E. pustulosa* as a variety of *E. 28-maculata*, including the both into *Henosepilachna vigintioctomaculata*. This treatment, however, must be revised by the future studies.

Mr. K. KANAI, the Head of Numata Girl's High School, the Educational Committee of Gumma-pref., Messrs. S. HISADA, Y. KINOUCHI and Y. TAKAHASHI for their continuous encouragements. Thanks are also due to Dr. T. SHIMIZU, Shinshu University and to Messrs. Y. HARAGUCHI, B. TAKEI, M. KATAYAMA, T. TSUKAGOSHI, H. NAKAN, T. SHIMIZU, M. NAKAZAWA, M. KOBAYASHI, Y. FUEKI, F. MATSUI, K. SEKINE and K. YAMADA, who assisted them through this work.

RESEARCH RESULTS

1. Distribution of the Epilachnid Beetles in Gumma-pref.

The junior authors visited almost all places of Gumma-pref. from 1956 to 1964 and collected the lady beetles observing their ecological behaviors. The specimens obtained were sent to the sinior author to identify.

E. sparsa (Photo 1・2 in Pl. I, Photo 22~24 in Pl. IV)

As shown in Table 1, *sparsa* is distributed over the southeastern plain part of Gumma-pref., where the altitude is less than 400m and has small snowfall. The species feeds chiefly on potato plants from May to July and completes the first generation. After the harvest of potatoes the beetles migrate to egg-plants, ground cherries, cucumbers and so on. The number of generation is two or three in a year.

At the northernmost place of the distribution, for example in Shibukawa-shi, *sparsa* becomes abundant on the leaves of ground cherries after the beginning of August (KOIKE 1963). At the southern places such as Isezaki-shi, Ôgo-cho and Maebashi, *sparsa* grows, in general, intermingled with *28-maculata* even in one host plant. On the other hand, at the northernmost place the density of *sparsa* is more recessive than that of *28-maculata* segregating from each other at the different parts of a food field. Up to the present we could not discover the species from any places with exception of the above-mentioned places.

In the field, the host plants of *sparsa* are potato-plant (*Solanum tuberosum* L.), egg-plant (*S. melongena* L.), black nightshade (*S. nigrum* L.), box-thorn (*Lycium chinense* MILL.) and ground cherry (*Physalis Alkekengi* L.), and cannot complete its life cycle on cucumber (*Cucumis sativus* L.), pumpkin (*Cucurbita moschata* DUCH.), etc. of the Cucurbit plants which are sometimes eaten by the adult. The best host plant for the species is considered to be ground cherry (KOYAMA 1958・62).

E. 28-maculata (Photo 3~6 in Pl. I, Photo 19・20 in Pl. IV)

This species has the widest distribution among the three species in Gumma-pref. (Table 2). The distribution map is shown as in Fig. 1. The species inhabits everywhere, excepting for the northern and the southeastern mountainous regions, where potato-plants are cultivated. Ozegahara, Tone-gun (1300~1500m above the sea level) is only an exceptional case, because no individual of *28-maculata* could appear, whereas a potato farm had been settled. The reason seems to be due to a long distance beyond the flighting power of the species as suggested by INAGAKI (1950), KOYAMA (1959) and IWAO (1964). The highest limit of the distribution will be 1300m in Gumma-pref.

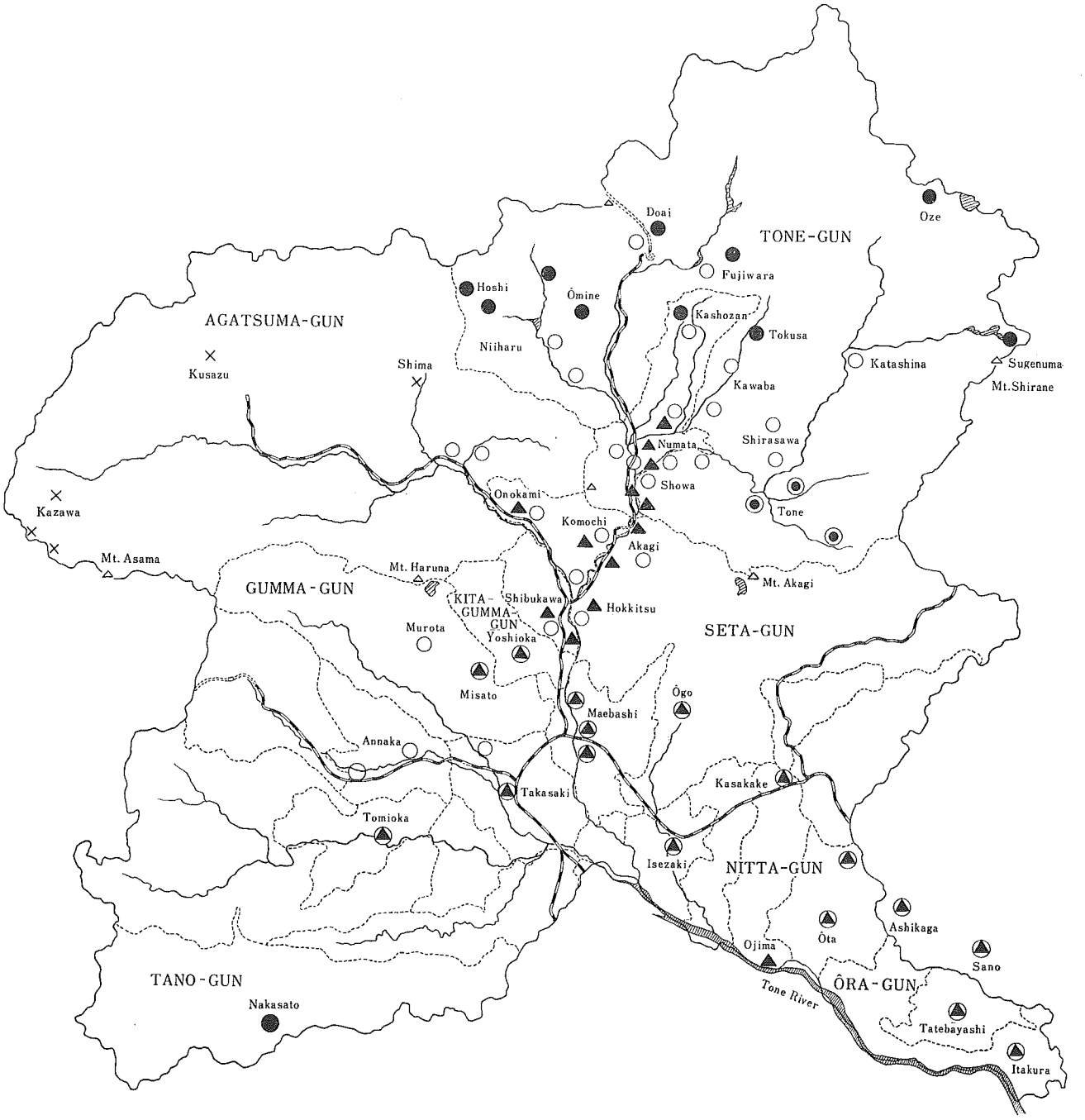


Fig. 1 Distribution map of the Epilachnid beetles in Gumma-pref.
○ *Epilachna vigintioctomaculata* ● *E. pustulosa* △ *E. sparsa*

Table 1 Records of *E. sparsa*

Place	Date	Stage	Feeding plant
Iwagami-cho, Maebashi-shi	19 VI '60	Larva	Potato
Kamikoide, 〃	1 VI '63	Larva, adult	Potato
Tokashinden, 〃	1 VII '63	Adult	Egg-plant
Kamiizumi-cho, 〃	4 VII '63	Adult	Potato
Wadatanaka, Takasaki-shi	26 VI '60	Adult	Potato
Kamisano, 〃	15 VIII '62	Adult	Egg-plant
Shimonakai, 〃	15 VIII '62	Adult	Egg-plant
Motoyaba, Ôta-shi	26 VIII '60	Adult	Egg-plant
Maruyama, 〃	26 VIII '60	Adult	Egg-plant, cucumber
Akoda, Tatebayashi-shi	10 VIII '63	Adult	Egg-plant
Hanetsuke, 〃	12 IX '64	Adult	Egg-plant
Itakura, Itakura, Ôra-gun	20 VI '63	Adult	Potato
Nakanosetojyuku, Ôra, 〃	22 VI '63	Adult	Ground cherry
Shimohada, Sano-shi, Tochigi-pref.	22 VI '63	Adult	Potato
〃 〃	18 VIII '63	Adult	Egg-plant
Hachiman, Ashikaga-shi, 〃	17 VIII '63	Abult	Egg-plant
Takezawa, Kasakake, Nitta-gun	26 VI '60	Larva, adult	Potato
Maegoya, Ojima, 〃	25 V '64	Adult	Potato
Ôta-cho, Isezaki-shi	2 VII '61	Adult	Egg-plant
Tomioka, Tomioka-shi	10 VIII '59	Adult	Egg-plant, tomato
Ôgo-cho, Ôgo, Seta-gun	3 VII '60	Larva, pupa, adult	Potato
Kawarahama, Ôgo, 〃	21 VI '62	Larva, pupa	Potato
Hassaki, Hokkitsu, Seta-gun	25 V '61	Adult	Potato
Tsukuda, Akagi, 〃	17 VI '62	Adult	Potato
Tanashita, Akagi, 〃	23 VI '63	Larva, adult	Potato
Ishihara, Shibukawa-shi	14 V '61	Adult	Potato
Shimogô, 〃	17 VI '62	Larva, adult	Potato
Handa, 〃	10 VI '62	Adult	Potato
Ôishi, 〃	24 VI '62	Larva, pupa	Potato
Oibara, Misato, Gumma-gun	15 VII '59	Adult	Egg-plant, tomato, potato
Kaminota, Yoshioka, Kitagumma-gun	10 IX '60	Adult	Egg-plant
Murakami, Onokami, 〃	24 VI '62	Larva	Potato
Nakago, Komochi, 〃	1 VII '62	Larva	Potato
Nyubara, Shôwa, Tone-gun	29 VIII '63	Adult	Egg-plant
Nishikurauchi, Numata-shi	8 VIII '62	Egg, larva	Ground cherry
Numasu, 〃	20 VIII '62	Adult	Ground cherry
〃 〃	7 VI '64	Adult	Potato
Higashikurauchi, 〃	21 VIII '62	Adult	Box-thorn
Iwamoto, 〃	1 VI '64	Adult	Potato
Okanoya, 〃	6 VI '64	Adult	Potato

Table 2 Records of *E. 28-maculata*

Place	Date	Stage	Feeding plant
Mitsumata, Maebashi-shi	9 X '59	Adult	Egg-plant, potato
Kamikawabuchi, 〃	9 X '59	Adult	Egg-plant
Amagawara-cho, 〃	22 VI '61	Larva, pupa, adult	Potato
Shinmachi, 〃	22 VI '61	Larva, pupa, adult	Potato
Iwagami-cho, 〃	19 VI '60	Larva, pupa, adult	Potato
Kamikoide, 〃	1 VI '63	Larva	Potato
Tokashinden, 〃	1 VII '63	Adult	Egg-plant
Kamiizumi-cho, 〃	4 VII '63	Adult	Potato
Wadatanaka, Takasaki-shi	26 VI '60	Adult	Potato
Oki, 〃	10 VI '61	Larva	Potato
Shimonakai-cho, 〃	15 VIII '62	Adult	Egg-plant
Kamisano, 〃	15 VIII '62	Adult	Egg-plant
Motoyaba, Ôta-shi	26 VIII '60	Adult	Egg-plant
Maruyama, 〃	26 VIII '60	Adult	Egg-plant, cucumber
Akoda, Tatebayashi-shi	10 VIII '63	Adult	Egg-plant
Shimohada, Sano-shi, Tochigi-pref.	22 VI '63	Adult	Potato
Takezawa, Kasakake, Nitta-gun	26 VI '60	Larva, adult	Potato
Maegoya, Ojima, 〃	25 V '64	Adult	Potato
Ôta-cho, Isezaki-shi	2 VII '61	Adult	Egg-plant
Tomioka, Tomioka-shi	10 VIII '59	Adult	Tomato, egg-plant
Ôgo-cho, Ôgo, Seta-gun	3 VII '60	Pupa, adult	Potato
Kawarahama, Ôgo, 〃	21 VI '62	Larva, pupa	Potato
Miyama, Akagi, 〃	10 VIII '59	Adult	Egg-plant
Tsukuda, Akagi, 〃	10 VIII '59	Adult	Egg-plant
〃 〃	17 VI '63	Larva	Potato
Shikishima, Akagi, 〃	17 VI '63	Larva	Potato
Fujimi-mura, 〃	10 V '61	Larva	Potato
Hassaki, Hokkitsu, 〃	25 V '61	Pupa, adult	Potato
Oibara, Misato, Gumma-gun	5 VII '59	Adult	Tomato, Potato, egg-plant
Shimomurota, Haruna, 〃	10 VI '61	Larva	Potato
Mitsudera, Gumma, 〃	10 VI '61	Larva	Potato
Kamigô, Shibukawa-shi	6 IX '59	Adult	Egg-plant, ground cherry
Akutsu, 〃	23 IX '59	Adult	Egg-plant, ground cherry
Yagihara, 〃	17 VI '61	Larva	Potato
Handa, 〃	17 VI '61	Larva	Potato
Ishihara, 〃	14 V '61	Adult	Potato
Shimogo, 〃	17 VI '62	Larva	Potato
Akima, Annaka-shi	10 V '61	Adult	Potato
〃 〃	20 IX '61	Adult	Egg-plant
Higashiyokono, 〃	10 VI '62	Larva	Potato
Nakago, Komochi, Kitagumma-gun	1 VII '62	Larva	Potato
Kamishiroi, Komochi, 〃	16 VI '63	Larva	Potato
Kuresawa, Komochi, 〃	16 VI '63	Larva	Potato
Kaminota, Yoshioka, 〃	10 IX '60	Adult	Egg-plant
Murakami, Onokami, 〃	24 VI '62	Larva, pupa	Potato

Nagaoka, Shinto, Kitagumma-gun	13 IX '59	Adult	Egg plant
Haramachi, Agatsuma, Agatsuma-gun	10 VII '62	Adult	Potato
Nakuta, Nakanojo, 〃	9 VI '63	Larva, adult	Potato
Tadanori, Nakanojo, 〃	9 VI '63	Larva, adult	Potato
Anabara, Tone, Tone-gun	10 VII '56	Adult	Potato
Kakidaira, Tone, 〃	20 IX '59	Adult	Egg-plant, pumpkin, *Brassica chinensis* L.
Neri, Tone, 〃 〃	2 VI '63	Larva, adult	Potato
Kamata, Katashina, 〃	13 IX '59	Adult	Pumpkin, Egg-plant, ground cherry, cow-pea, *Brassica pekinensis*
Sukagawa, Katashina, 〃	13 IX '59	Adult	Egg-plant
Kamikokubu, Shirasawa, 〃	20 IX '59	Adult	Indian corn (maybe only staying)
Namae, Shirasawa, 〃	19 V '63	Larva	Potato
Yubara, Kawaba, 〃	4 VIII '64	Adult	Egg-plant, cucumber
Doai, Minakami, 〃	11 IX '59	Adult	Egg-plant
Asaji, Niiharu, 〃	11 IX '59	Adult	Egg-plant
Nyubara, Shôwa, 〃	28 VIII '63	Adult	Egg-plant
Okose, Shôwa, 〃	29 VIII '57	Adult	Egg-plant
Kawahake, Shôwa, 〃	1 VI '64	Larva, adult	Potato
Togano, Numata-shi	15 V '56	Adult	Potato
Numasu, 〃	7 VI '64	Larva	Potato
Shinmachi, 〃	7 VI '64	Larva	Potato
Nishikurauchi, 〃	10 VI '56	Larva	Potato
Higashikurauchi, 〃	24 V '63	Adult	Potato, box-thorn
Kamihocchi, 〃	18 VIII '59	Adult	Tomato, egg-plant
Okanoya, 〃	6 VI '64	Adult	Potato
Iwamoto, 〃	1 VI '64	Larva, adult	Potato

After the harvest of potatoes the adults disperse and give severe damage to egg-plants and tomatoes. If these food plants are withered, the adults attack ground cherries, red-peppers, cucumbers, pumpkins, cow-peas, some Cruciferous vegetables, etc.

The true host plants of *28-maculata* are the Solanaceous plants excepting for ground cherry and red-pepper in Gumma-pref. Ground cherry, though being the best host for *sparsa*, could not work as the host for *28-maculata*. This is the remarkable difference between the feeding habits of the two species as KOYAMA pointed out (1958 • 62).

E. pustulosa (Photo 7~18 in Pl. II and III, Photo 21 in Pl. IV)

As precedingly described, this species was firstly found by YASUTOMI (1952 a) in 1951 from Doai (900m above the sea level) near Shimizu Tunnel in Gumma-pref. In 1956 KOYAMA came across to discover a few individuals of *pustulosa* from a population of *28-maculata* which inhabited in potato farm of Anabara, Tone-mura, Tone-gun. This fact suggested that the distribution of *pustulosa* would not limited only in such a high altitude as in Doai. Thus the detailed research started in 1957. The results are shown in Table 3 and in Fig. 1.

Up to the present it has been known that *pustulosa* is, to some extent,

Table 3 Records of *E. pustulosa*

Place	Date	Stage	Feeding plant
Anabara, Tone, Tone-gun	10 VII '56	Adult	Potato, egg-plant
〃 〃	20 IX '58	Adult	Thistle
〃 〃	27–28 VII '59	Adult	Thistle
Kakidaira, Tone, 〃	20 IX '59	Adult	Thistle
Akagizawabashi, Tone, 〃	20 IX '59	Adult	Thistle
Neri, Tone, 〃	26 VI '60	Larva	Thistle
〃 〃	10 VII '60	Larva	Thistle
〃 〃	2 VI '63	Larva(L), Adult(A)	Thistle (L), potato (A)
Hikagenango, Tone, 〃	1 VII '60	Larva	Thistle
Sugenuma, Katashina, 〃	5 VIII '59	Larva	Thistle
Yamanohana, Katashina, 〃	25 VII '60	Adult	Thistle
Akakura, Kawaba, 〃	3 IX '59	Adult	Thistle
Tokusa, Kawaba, 〃	28 VI '64	Egg, larva, adult	Thistle
Tsukiyonomachi, 〃	21 V '61	Adult	Thistle
Fujiwara, Minakami, 〃	24 V '59	Adult	Thistle
〃 〃	12 VIII '63	Adult	Thistle, egg-plant
〃 〃	10 V '64	Adult	Thistle
〃 〃	27 VII '64	Adult	Thistle
*Doai, Minakami, 〃	18 V '64	Adult	Thistle
Akazawa, Niiharu, 〃	2 VI '63	Adult	Thistle
Hôshi, Niiharu, 〃	2 VIII '59	Adult	*Boehmeria tricuspis* (maybe only staying)
Kawafuru, Niiharu, 〃	2 IX '59	Adult	Thistle
Kamihocchi, Numata-shi	5 VI '60	Larva, adult	Thistle
〃 〃	23 IX '60	Adult	Thistle
〃 〃	4 VI '61	Egg, adult	Thistle
Sebayashi, Nakasato, Tano-gun	2 VIII '63	Adult	Burdock

* YASUTOMI (1951) and IKEMOTO (1954) collected the beetle from the same place.

distributed in the northeastern (NE) part and also in the southwestern (SW) part limitedly. The habitat of *pustulosa* is generally in valley where the thistle, *Cirsium nipponicum* (MAXIM.) MAKINO var. *inconptum* (FR. et SAV.) KITAM., grows in rich and has heavy snowfall (KOYAMA 1961). The lowest habitat of this beetle is in 600m in NE part and in 400m in SW part. In NE part *pustulosa* is comparatively abundant at Anabara, Nango, Akagizawabashi and at Neri along the Tone River, Doai, Fujiwara and at Tokusa along the Usune River, while is poor at Kashozan, Hoshi and Tsukiyonomachi. Notwithstanding the host thistle is found in the northwestern mountainous region, no individual of *pustulosa* has not yet been discovered. According to KOBAYASHI and KOIKE (1956) and KOYAMA (1961), the species was collected from Karuizawa, Nagano-pref., in 1959. This place is very near the present prefecture, so it may arise to discover the species from Gumma side in future.

The host plant of *pustulosa* is almost limited in only one species of thistles, *Cirsium nipponicum* (MAXIM.) MAKINO var. *inconptum* (FR. et SAV.) KITAM., Compositae. This is the great difference in the feeding habit from *28-maculata*, which cannot complete its life cycle on thistles (YASUTOMI 1952 b)

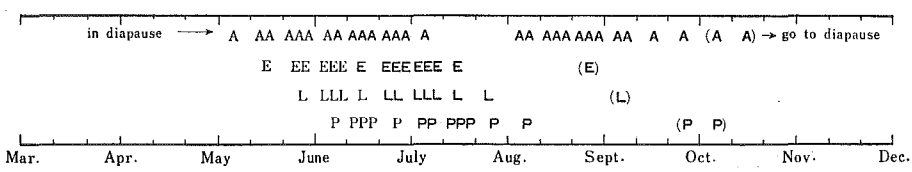
It is, however, necessary to note here the following facts. In Anabara, Neri and Fujiwara *pustulosa* fed on the Solanaceous vegetables together with *28-maculata*. The same phenomenon was reported by YASUTOMI (1952 c) and IKEMOTO (1954). This is not certain whether *pustulosa* occasionally visited there or usually migrated when all the thistles were eaten up. The morphological characters of these *pustulosa* have not any difference from those of the others, which feed only on the thistle. No individual has still been found, which seems to be a hybrid between the two species, though they can produce a hybrid by artificial breeding (YASUTOMI 1954, KOYAMA 1961). Additionally KOIKE (1964) observed that a number of the adults of *pustulosa* were feeding on the leaves of burdocks at Sebayashi, Nakasato-mura, Tano-gun. Anyway *pustulosa* not only grows on potato leaves (YASUTOMI 1954) but also on the Composit plants besides the host thistle in room experiment. The beetle, therefore, has a certain capacity to eat some other plants.

2. Seasonal Occurrence of the Epilachnid Beetles in Gumma-pref.

E. sparsa

As shown in Table 1, the hibernated beetles appear in the field from about the middle of May, and oviposit the eggs from the end of June. The hibernated beetles disappear after laying the eggs till the beginning of June. The egg stage is about one week. The larvae from these eggs hatch out at the end of May and their time continues to the middle of June. The larval stage is 16 to 20 days. At the beginning of June the first pupae come out. The pupal stage is about 5 days. The first and the second generations are almost mixed in every stage and we can see the species in any time of May to September on the Solanaceous vegetables. The adults of the second generation appear at the beginning of August and disappear at the end of September. If the food supply is sufficient to the beetles, some individuals occurred at early August oviposit the eggs keeping their life cycle until the middle of October. On the other hand, some individuals emerged at last September occasionally oviposit the eggs which could not grow. In the light of the above data *sparsa* in Gumma-pref. passes usually two generations but rarely three generations. Table 4 shows the occurrence of the species in a year.

Table 4 Life cycle of *E. sparsa* in Gumma-pref.

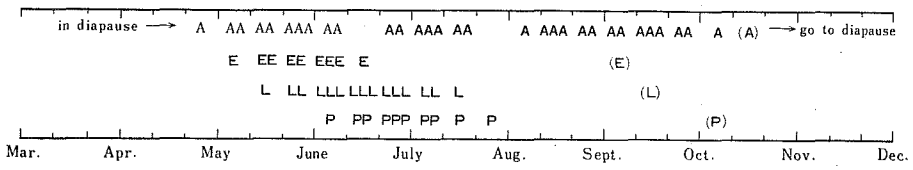


Remarks A : adult, E : Egg, L : Larva, P : Pupa
Standard letters show the hibernated adults and their succeeding stages. Parenthesized letters indicate occasional cases.

E. 28-maculata

This species appears at the earliest time among the three species. Though the earliest example was observed by KOIKE (1960) at Numata-shi on April 3, 1959, the hibernated active beetles occur generally at the end of April in the southern district and at the beginning of May in the northern district, just when potato leaves grow 10 to 15cm in length. The hibernated adults feed severely on potato leaves ovipositing the eggs, from which the larvae hatch out at the middle of May. The larvae are observed until the middle of July. The pupation takes place at the biginning of June and the pupal time continues to the end of August. The new adults emerge at the end of July to beginning of August. There happens a temporary disappearance of the adults of the first generation. This is perhaps arisen by the migration of the beetles to some other cooler places to find shelter. The same phenomenon is reported by INAGAKI (1949 • 50), KOYAMA (1959) and IWAO (1964).

Table 5 Life cycle of *28-maculata* in Gumma-pref.



Remarks A : Adult, E : Egg. L : Larva, P : Pupa.
Gothic letters show the 1st generation. Parenthesized letters indicate the 2nd generation.

Thus the species generally completes one life cycle in a year. Some individuals, however, seem to have an opportunity making the second generation, if the host plants are available enough to the growth. But in the hot season such as August the beetles are unable to lay the healthy eggs because of the ovarian reduction by the extreme high temperature (INAGAKI 1950).

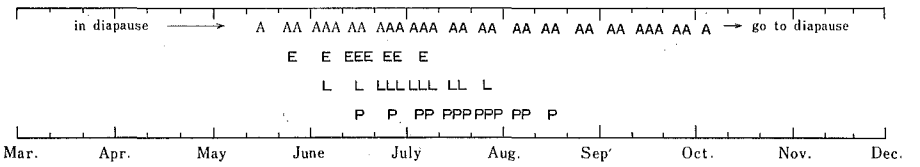
The life cycle of *28-maculata* in Gumma-pref. is shown in Table 5.

E. pustulosa

The threshold of occurrence of *pustulosa* in Gumma-pref. is considerably different according to localities. It may be dependent upon the time of the thaw. For example, at Anabara, Neri, Tokusa, Kashozan and Uenohara the thaw is over at the middle of March to the beginning of April, when the host thistles covered with more than 1m height of the snow begin to grow and reach 30~100cm high at the middle of May. Before or after the hibernated adults appear and feed on the newly grown leaves. On the other hand, at Doai, Fujiwara, Tokura and Sugenuma the thaw is later than in the above places and the beetles appear at the end of May or later.

The hibernated adults oviposit the eggs from the end of May and die at

Table 6 Life cycle of *E. pustulosa* in Gumma-pref.



Remarks A : Adult, E : Egg, L : Larva, P : Pupa.
Gothic letters show the 1st generation.

the end of June. The egg stage is about 8 days. The larvae come out at the beginning of June, disappearing at the end of July. The larval stage is 20~25 days. The pupal time continues from the middle of June to the middle of August. The new adults begin to emerge at the end of June intermingled with the hibernated adults. Then we can see *pustulosa* of every stage at the end of June. The adults of the first generation are generally found until early October, hereafter going to diapause.

The whole life cycle is shown in Table 6. The number of generation of the species is only one in Gumma-pref.

3. Northward Limit of the Distribution of *E. sparsa* in Gumma-pref.

E. sparsa is a species distributed over the warm temperature zone and is said to inhabit in the south district of Kanto District and along Tokaido and more southern parts of Japan. According to TAKAHASHI (1925 • 32), NAKATA

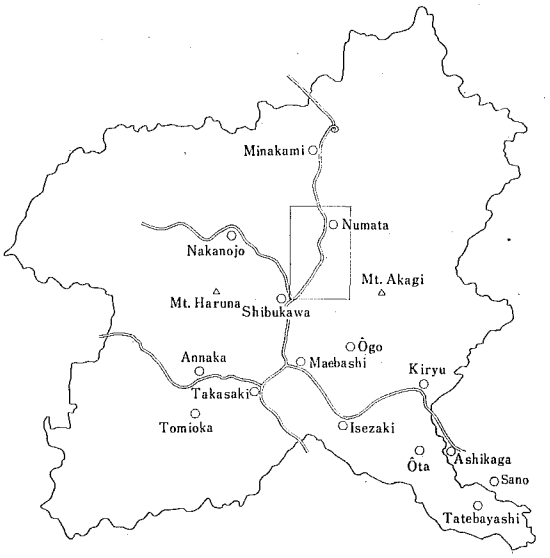


Fig. 2 Problematical place on the northward distribution of *E. sparsa* in Gumma-pref., rectangularly indicated.

(1949 • 50) and to KINOSHITA (1951), the species were found in the places where the climatic temperature was more than 14.5°C in annual average. This made the northward limit line of the distribution of *sparsa* in Kanto District. The line ran through Odawara, Matsuda, Nakuri, Kumagaya, Mamada, Tochigi,

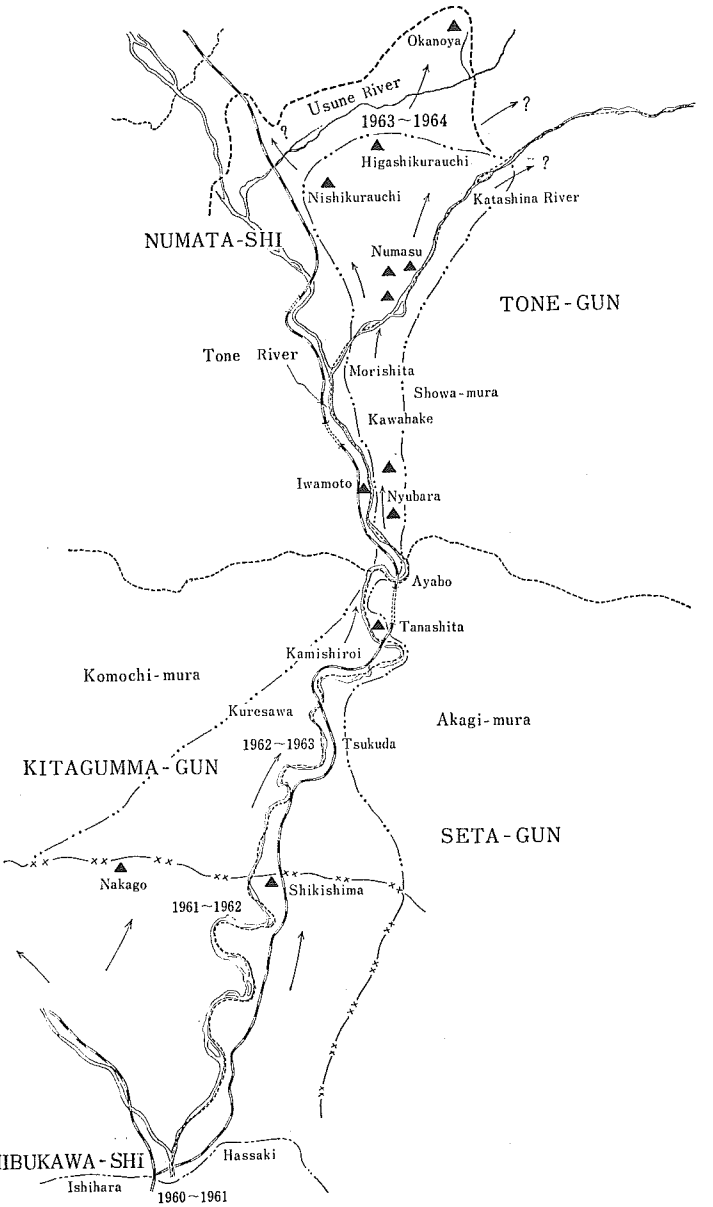


Fig. 3 Successive distribution of *E. sparsa* (▲) in the locality indicated in Fig. 2.

—— – – —— 1960~1961 ——× ×—— 1961~1962
—— • • —— 1962~1963 ..... 1964~

Matsudo and Hakota (Fig. 2). The limit line, however, did not pass into Gumma-pref., so that the beetles had not been believed to be distributed in the north part of Kanto District since that time. After several years KOMORI (1956) discovered some *sparsa* adults at Takasaki and Maebashi, indicating that the species had expanded its distribution more northwardly year by year. Further YASUE (1963) collected the species from egg-plants cultured at the above places in August, 1959.

Then the authors have researched precisely the distribution of *sparsa* in Gumma-pref. up to the present, and obtained the following results (Fig. 2 • 3).

At the southern plain places of Gumma-pref. with less than 200m altitude such as Takasaki, Maebashi, Ôgomachi, Isezaki, Kasakakemura, Ôta, Tatebayashi and their boundaries, *sparsa* and *28-maculata* are intermingled with each other feeding on the Solanaceous vegetables, so as in the other places of Japan (INAGAKI 1949, IWAO 1954, SHINBO et al. 1952, YASUE & HAMADA 1954). The annual average of climatic temperature is 14.0° C at Ôgomachi, 14.5°C at Takasaki, 15.0~16.0°C at the other places. These places have seldom the snowfall yet being very cold in the winter season. In the more northward places with 200~300m altitude such as the mountain foots of Mt. Akagi and Mt. Haruna, and Shibukawa, Kitagumma-gun and Seta-gun (Akagi-mura) located between the both mountains, *sparsa* lives in low density. And *sparsa* is segregated in habitat from *28-maculata*. In these places the snowfall is larger than in the plain places and the annual average of the climatic temperature is 14.0°C or below.

Tracing up northwardly along the Joetsu Line and the River Tone from Shibukawa, we can reach Ayado where Mt. Komochi and Mt. Akagi make their boundary. With the boundary of this place, the climatic and geographical differences occur between the south part and the north part. Numata-shi and Tone-gun are situated in this part.

In Numata no individual of *sparsa* could be found until 1961. But KOIKE discovered a lot of the beetles feeding on ground cherries from there in the next year. Succeedingly in 1964 the beetles feeding on potato leaves were observed. On the other hand, at Tanashita near Ayado the *sparsa* larvae were found on potato leaves in 1963, besides at Nyubara of Tone-gun the adults were collected in 1963 and 1964.

Now, let us show in Fig. 4 the limiting lines of the *sparsa* habitat in Kanto District, which have been offered by the three researchers. According to this figure, it is obvious that the distribution of *sparsa* is greatly expanded northwardly by NAKATA (1950) as compared with by TAKAHASHI (1925•32), namely the new limiting line runs through Nakuri, Kumagaya and Utsunomiya. Since the above time, however, we can see the distribution has been expanded more and more northwardly until it is removed to the newer limiting line combining every place of Tomioka, Takasaki, Shibukawa, Ôta, Nozaki and Mito in 1964.

It will be a noteworthy fact that such a northward expansion of the distribution is more remarkable towards Gumma-pref. Is this reason dependent upon the thirmal condition of this region which could accept the completion

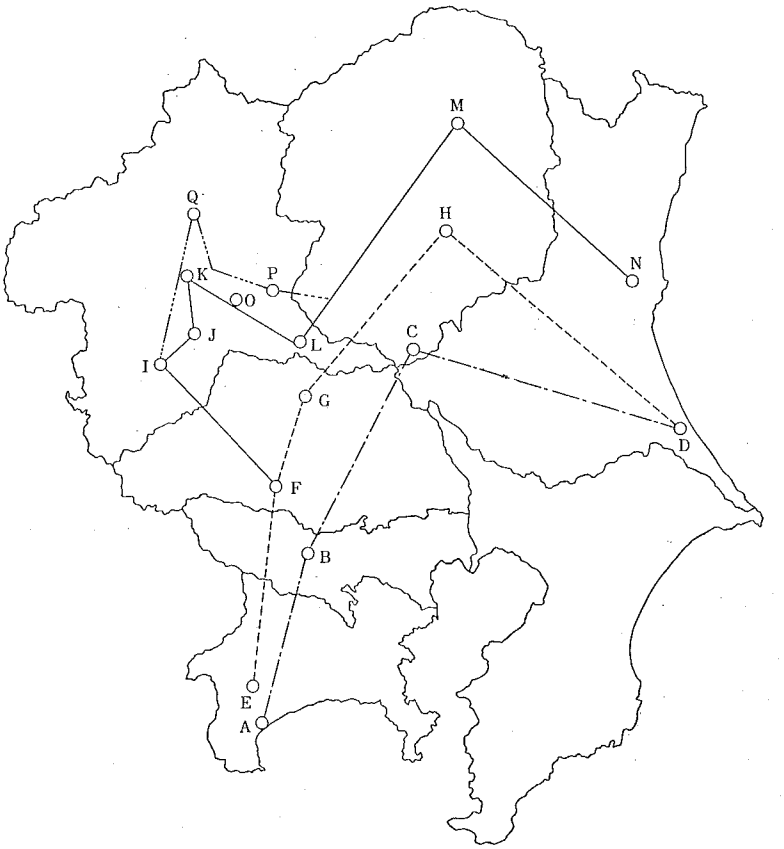


Fig. 4 Northward expansion of the distribution of *E. sparsa* in Kanto District.
—·—·— Takahashi (1925)
---------- Nakata (1950)
———————— Yasue, Koike (1962)
————·—·———— Present (1964)
A : Odawara, B : Haijima, C : Mamada, D : Narage, E : Matsuda,
F : Nakuri, G : Kumagaya, H : Utsunomiya, I : Tomioka
J : Takasaki, K : Shibukawa, L : Ôta, M : Nozaki, N : Mito,
O : Ôgo, P : Kiryu, Q : Numata

of life cycle of *sparsa* ? According to the data of the Maebashi Branch of Meteorological Observatory, Numata is below 13.0°C in the annual average of climatic temperature from 1958 to 1963 and less than 20.5°C in the average temperature of summer season from 1961 to 1962. The critical low temperature controlling the northward limitation in *sparsa* is said to be 14.0°C in the annual average by TAKAHASHI (1925•32) and 20.5~21.5°C in the summer average by WATANABE (1954), though the latter is likely more suitable. The problematical region, however, has a rather cooler temperature than these indicative temperatures. We will, therefore, be requested to study the yearly

microclimate in this region and the acclimatization to the tolerable limit of colder temperatures of the species as YASUE and KAWADA (1961) and YASUE (1963) reported.

Anyway it is not only noticeable for ecological problem but also very important for agriculture that *sparsa* is expanding its distribution northwardly year after year and is becoming as a new face of pest to the Solanaceous vegetables and some other plants in Gumma-pref.

SUMMARY

The authors have studied the distribution of the Epilachnid beetles in Gumma-pref. since 1956, and the following results are obtained as summary.

1. *Epilachna sparsa* is recognized to be distributed to some extent at the southern plain places of Gumma-pref. such as Tomioka, Takasaki, Maebashi, Ogomachi, Isezaki, Ôta, Tatebayashi, Kasakakemura and their neighbors, where the altitude is less than 150m (Fig. 1). At these places *sparsa* lives intermingled with *28-maculata*.

2. At the higher places with 150~300m altitude such as Shibukawa, Onogami, Yoshioka, Misato, Akagimura, Hokkitsumura, Komochimura and their neighbors (Fig. 1), *sparsa* tends to live being segregated from *28-maculata* in the same farm.

3. The species feeds usually on the Solanaceous plants, among which ground cherry is the best host plant. The number of the generation is generally two but rarely three.

4. *E. 28-maculata* is the species having the widest distribution in Gumma-pref. (Fig. 1) and we can see it everywhere, potatoes, egg-plants and tomatoes are planted, with exception of one place near Ozegahara. The highest limit of the distribution may be 1300m.

5. The host plant of *28-maculata* is the Solanaceous plants with the exception of ground cherry and red-pepper, on which the larvae cannot grow. The number of the generation is one but very rarely may be two.

6. *E. pustulosa* inhabits mainly at the northern places of Gumma-pref. such as Anabara, Hikagenango, Neri, Akagizawabashi, Tokusa, Kashozan, Akakura, Doai, Fujiwara, Uenohara, Sugenuma, Hôshi and Ômineyama. All these places are located along the Tone River system with more than 600m altitude and have heavy snowfall (Fig. 1). However, *pustulosa* is also found at Sebayashi of Tano-gun in the southwest Gumma.

7. The true host plant of *pustulosa* is the thistle (*Cirsium nipponicum* (MAXIM.) MAKINO var. *incomptum* (FR. et SAV.) KITAM. belonging to Compositae in Gumma-pref., but the beetle eats sometimes the Solanaceous plants especially potato-plant. With an exceptional case the authors observed that the adults were attacking burdock leaves.

8. The distribution of *sparsa* is expanding northwardly year after year in Kanto District and the northern limit of the distribution runs along the line denoted in Fig. 3 and 4 at present.

9. This phenomenon is not only noticeable for ecological problem, but

also very important for agriculture because the beetle probably gives a fear of attacking the Solanaceous vegetables as a new pest in the new habitats.

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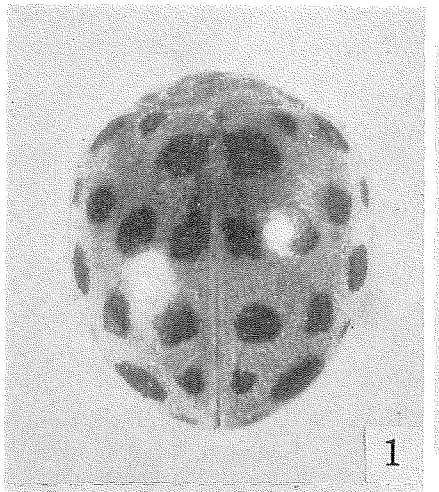
Plate I

Photo. 1. *Epilachna sparsa* from Numasu, adult, dorsal view.
2. Ditto, lateral view.
3. *E. 28-maculata* from Numasu, adult, dorsal view.
4. Ditto, lateral view.
5. *E. 28-maculata* from Takasaki, adult, dorsal view.
6. Ditto, lateral view.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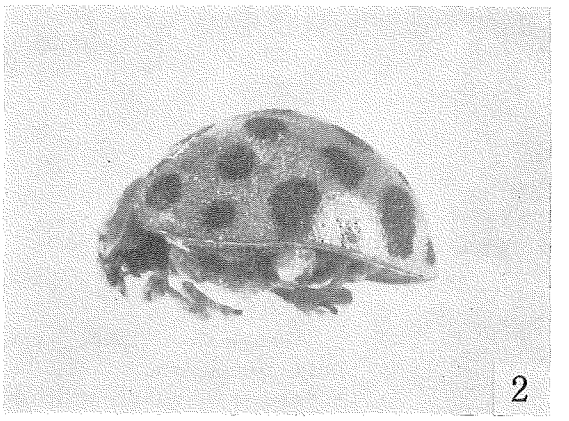
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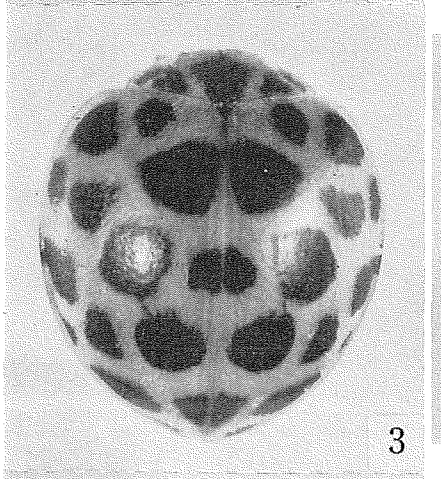
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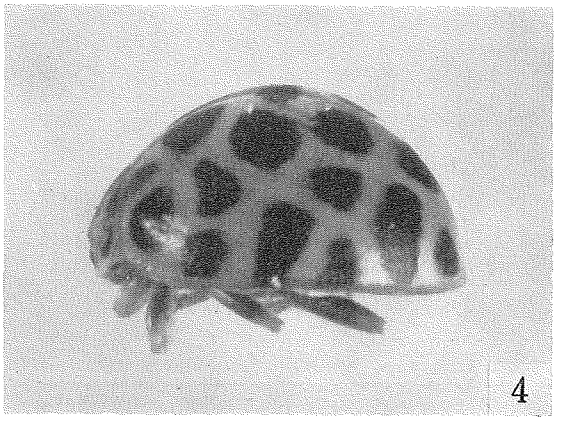
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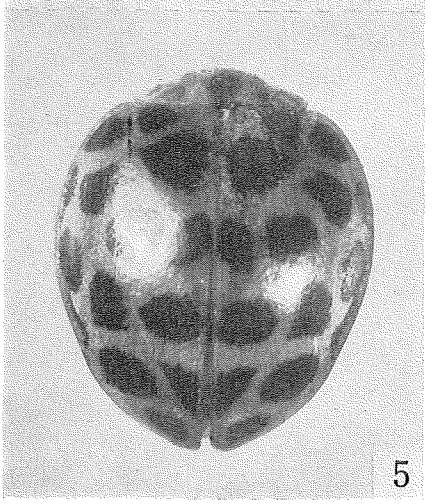
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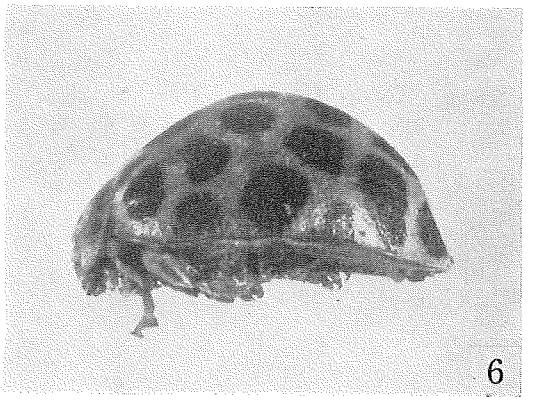
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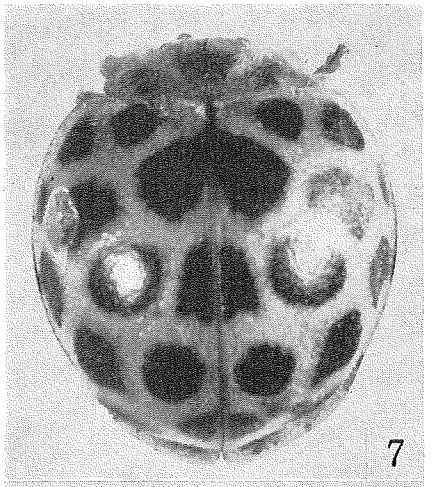
Plate II

Photo 7. *Epilachna pustulosa* from Fujiwara, adult, dorsal view.
8. Ditto, lateral view.
9. *E. pustulosa* from Tokusa, adult, dorsal view.
10. Ditto, lateral view.
11. *E. pustulosa* from Doai, adult, dorsal view.
12. Ditto, lateral view.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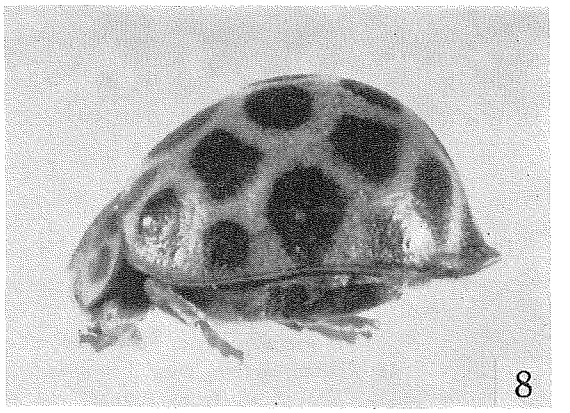
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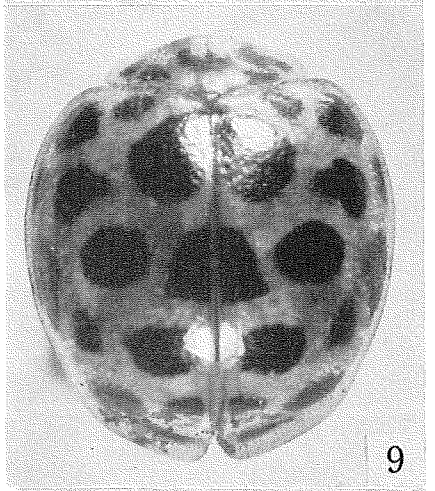
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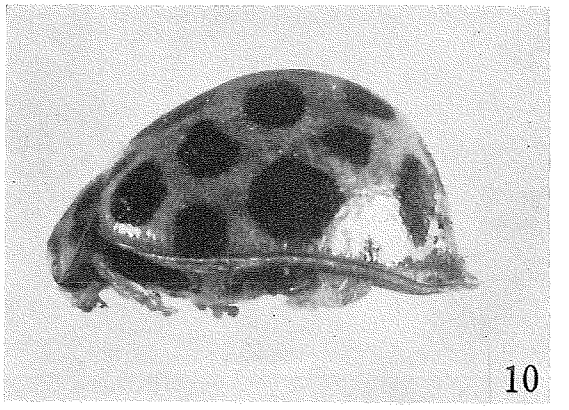
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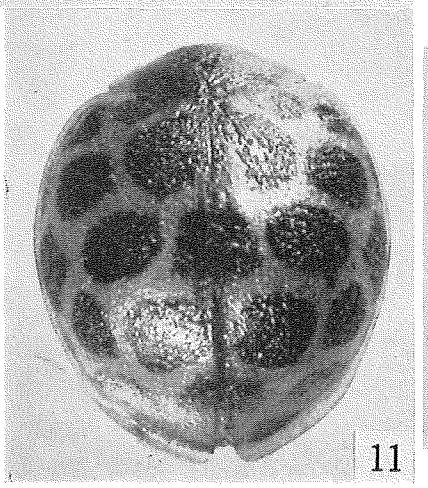
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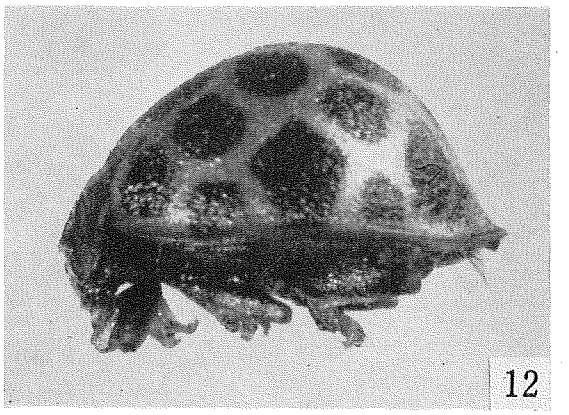
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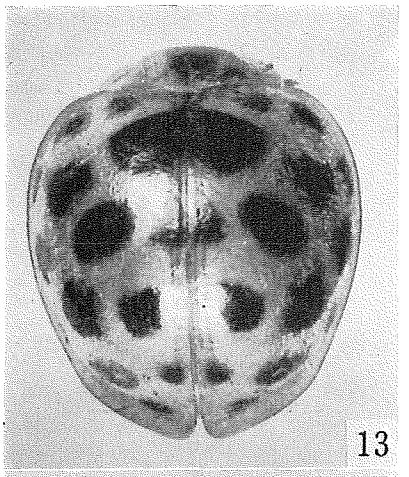
Plate III

Photo 13. *Epilachna pustulosa* from Anabara, adult, dorsal view.
14. Ditto, lateral view.
15. *E. pustulosa* from Sebayashi, adult, dorsal view.
16. Ditto, lateral view.
17. *E. pustulosa* from Tokusa, the 3rd instar larva.
18. Ditto, pupa.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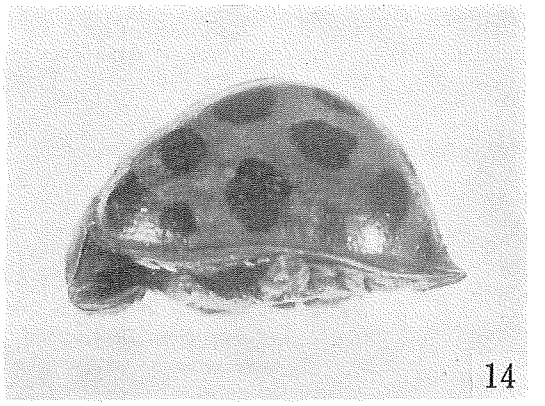
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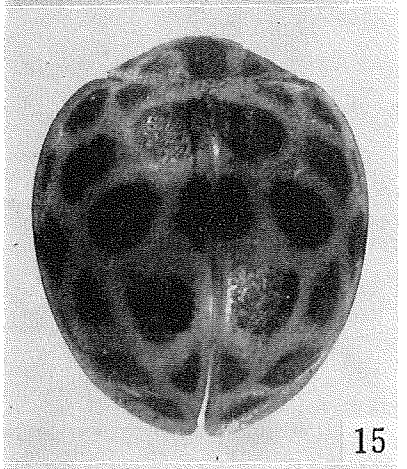
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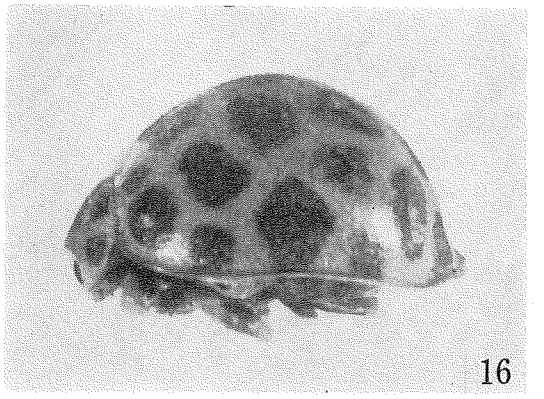
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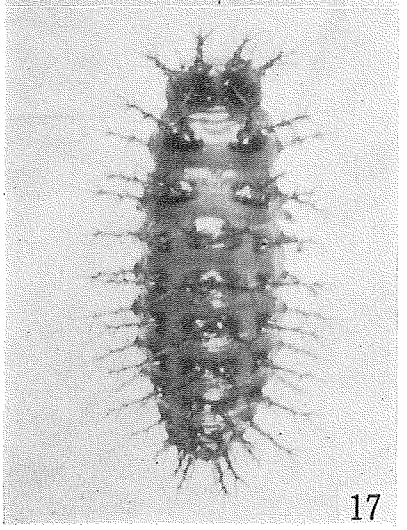
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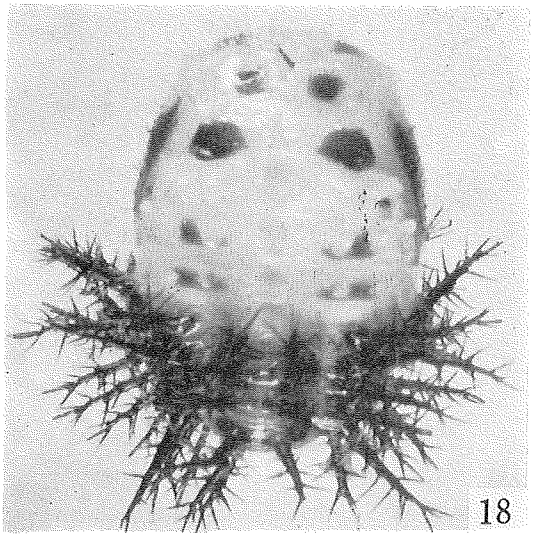
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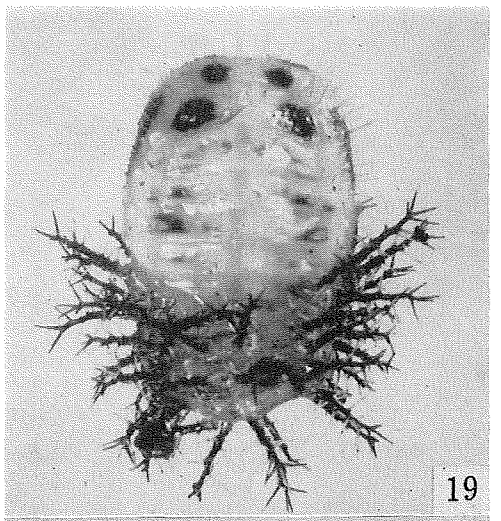
Plate IV

Photo 19. *Epilachna 28-maculata* from Numasu, pupa.
20. Ditto, the full grown 4th instar larva.
21. *E. pustulosa* from Doai, pupa.
22. *E. sparsa* from Meabashi, the 4th instar larva.
23. Ditto, pupa.
24. *E. sparsa* from Numasu, pupa.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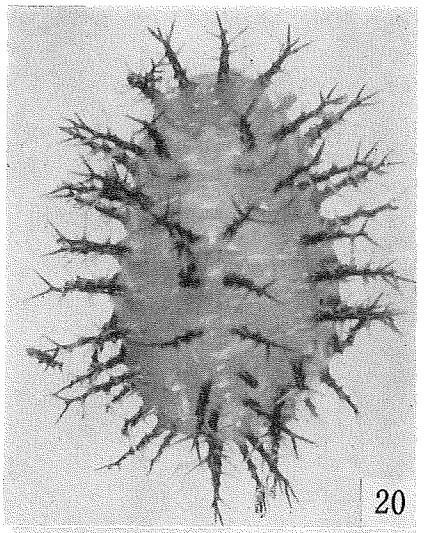
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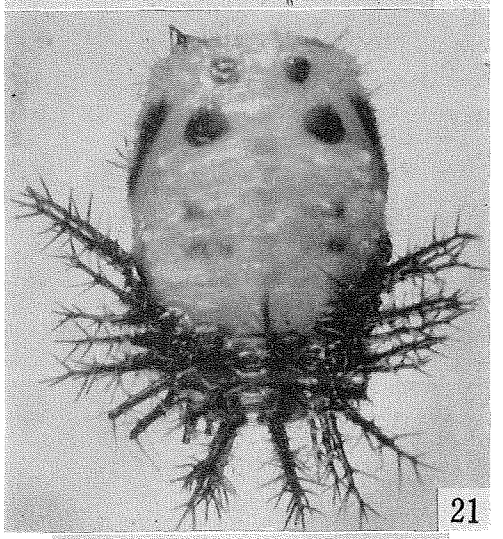
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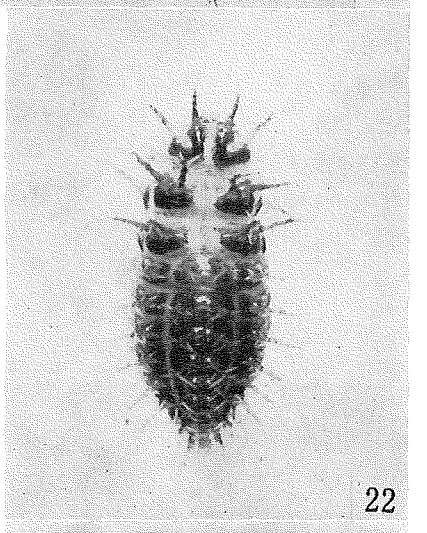
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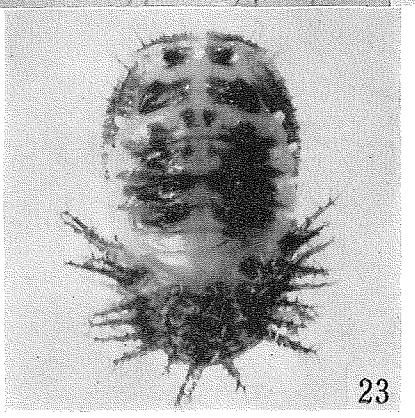
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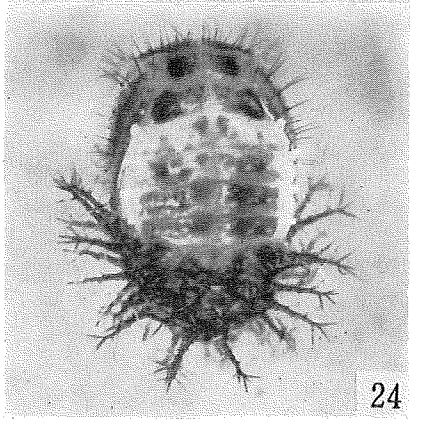
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