

ホホイボジュズダニの室内飼育による発育期間と産卵数ならびに幼若虫期の形態

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Life History of *Epidamaeus verrucatus* ENAMI et FUJIKAWA (Acari: Damaeidae), with morphological description of its immature stage

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Abstract In laboratory, *Epidamaeus verrucatus* ENAMI et FUJIKAWA was fed with the fungus *Gloeosporium theae-sinensis* MIYAKE (*Gt*), at 17, 21 and $25 \pm 1^\circ\text{C}$, and also with *Pestalotia longiseta* SPEGAZZINI (*Pl*) and *Glomerella cingulata* (STONEMAN) SPAULDING et SCHRENK (*Gc*) at $25 \pm 1^\circ\text{C}$. The total period of development ranged from 25 (25°C) to 44 days (17°C), being shorter on *Gt* than on *Pl* and *Gc*. The total number of eggs laid was 216 (25°C) to 314 (17°C), and, at any temperature, was smaller on *Gc* than on *Gt* and *Pl*.

Damaeid mites were first reared in the laboratory by MICHAEL (1883). Thereafter the rearing method has been revised by RIHA (1951), PAULY (1956), HARTENSTEIN (1962a, b, c) and SHEREEF (1972). Damaeid mites, in general, are known to feed vigorously on a certain species of fungi. HARTENSTEIN (1962b) reported that *Belba kingi* grew most rapidly when food contained *Trichoderma koningi* OUDEM. or *Cladosporium cladosporioides* (FRES.). Since these fungi are pathogenic to plants, the damaeid mites appear to play an important role in reducing the density of agriculturally harmful fungi in the field.

In the present experiment, *Epidamaeus verrucatus* ENAMI et FUJIKAWA (1989) collected in a tea garden was fed on tea-pathogenic fungi to reveal the life cycle, oviposition and larval and nymphal morphology of this mite group.

Materials and methods

The mites were collected from the litter of a tea garden in the Tea Research Institute of Shiga Prefecture in 1987. They were reared in a mass to facilitate their oviposition. Each egg laid was then moved into a small plastic case (Fig. 1), and their development was observed at three levels of temperature, 17, 21 and $25 \pm 1^\circ\text{C}$ (approximately 100% r.h., 15L:9D photoperiod). Larvae were daily provided with a small piece of agar covered with mycelia of *Gloeosporium theae-sinensis* MIYAKE cultured in Petri dish.

To assess the nutritive quality of *Gloeosporium theae-sinensis*, I further observed the development of some larvae which were fed with other fungi *Pestalotia longiseta* SPEGAZZINI and *Glomerella cingulata* (STONEMAN) SPAULDING et SCHRENK at 25°C . In these observations the following four stages of immature were noted: larva, protonymph, deutonymph and

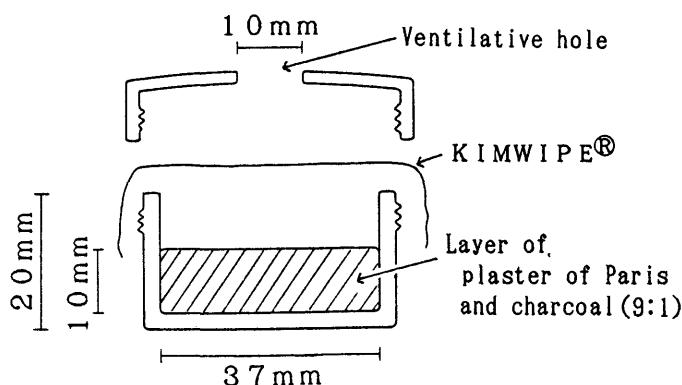


Fig. 1. Cross section of culture case.

tritonymph. Each stage was preceded by a preecdysial phase in which the larvae were nearly immobile. Since the beginning of this stage was difficult to be exactly determined, however, the ecdysis was regarded as the first phase of each stage in this study.

Sex of mites was determined by whether they produce spermatophore or not. Oviposition was observed in some plastic cases where an adult male was free to copulate an adult virgin female which was identified by the production of no spermatophore and was reared under the same conditions of temperature and food as in her partner male. Eggs deposited by the inseminated females were counted and transferred to another culture case at intervals of 2 or 3 days. When the male died, the female was moved to the other culture case in which another male had produced spermatophores.

Fungi were obtained from the strains stocked in both the Shizuoka Prefectural Tea Experiment Station and the Laboratory of Plant Pathology, Faculty of Agriculture, Shizuoka University. Each species of fungus was grown axenically on potato-dextrose-agar (PDA) in Petri dish, 100 mm in diameter, 10 mm in depth. They were cultured at 25°C until a matrix of mycelia grew over the surface of agar.

For the morphological description, some larvae and nymphs of the different growth stages were collected from culture cases, in which they were fed with *Gloeosporium theae-sinensis* at 25°C. Their morphology was examined under a microscope to reveal larval characters.

Results

Life history. As shown in Table 1, the rise of temperature shortened each developmental stage of *E. verrucatus* fed with the fungus *G. theae-sinensis* (hereafter, *Gt*), the shortening being statistically significant except between 17 and 21°C in the stage of tritonymph. At any temperature the tritonymphal stage showed the longest duration of all stages, constituting about 30% of total days required for the full growth of this mite species. This mite ate all species of fungi provided and finally grew up to adult. In the thermal condition of 25°C, the total duration of immature stages was significantly shorter in *Gt*-provided mites than those fed with *P. longiseti* (hereafter, *Pl*) or *G. cingulata* (*Gc*), mostly due to the shortening of tritonymphal stage (Table 1). This suggests that *Gt* is more nutritious for the growth of this mite species than *Pl* and/or *Gc*.

E. verrucatus laid eggs on the inside surface of culture case or on the mycelial strata of fungi. Most of the females continued oviposition to their death. Oviposition sequences under

Table 1. Developmental period of *E. verrucatus*

| Temperature | Fungus | Total no. observed | Duration of stages (in days, mean \pm SD) | | | | |
|-------------|-------------|--------------------|--|----------------|-----------------|-----------------|-----------------|
| | | | Larva | Protonymph | Deutonymph | Tritonymph | Total |
| 17°C | <i>Gt</i> * | 9 | 11.2 \pm 3.8a** | 8.7 \pm 1.5a | 11.0 \pm 3.3a | 12.8 \pm 3.0a | 43.7 \pm 6.3a |
| 21°C | <i>Gt</i> | 12 | 8.8 \pm 1.4b | 7.0 \pm 1.3b | 8.0 \pm 1.1b | 12.2 \pm 2.1a | 35.9 \pm 3.9b |
| 25°C | <i>Gt</i> | 23 | 6.3 \pm 1.0c | 5.6 \pm 1.3c | 5.6 \pm 1.8c | 7.2 \pm 1.9b | 24.7 \pm 2.2c |
| 25°C | <i>Pl</i> | 10 | 7.0 \pm 0.9c | 5.7 \pm 2.3c | 5.8 \pm 1.1c | 9.3 \pm 1.8c | 27.8 \pm 2.6d |
| 25°C | <i>Gc</i> | 9 | 6.4 \pm 1.3c | 5.1 \pm 1.1c | 5.6 \pm 1.0c | 10.9 \pm 1.4a | 28.0 \pm 1.6d |

* *Gt*: *Gloeosporium theae-sinensis* MIYAKE, *Pl*: *Pestalotia longiseta* SPEGAZZINI, *Gc*: *Glomerella cingulata* (STONEMAN) SPAULDING et SCHRENK

** Between different characters, values are significantly different at 5% level by MANN-WHITNEY's U-test.

different rearing conditions are shown in Fig. 2. In the mites fed with *Gt*, the average of oviposition periods (P) was shorter and, therefore, the mean total number of eggs (F) was smaller at higher temperature (Figs. 2A–C). When calculated below the level of 50% oviposition (Fig. 2), the regression coefficients (\bar{m}) were significantly different between 17 and 25°C (Table 2). The sequences of oviposition also varied among mites reared with different species of fungi at 25°C. Thus, the mites fed with *Pl* laid a large number of eggs within a relatively short duration (Fig. 2D), while mites reared with *Gc* ovipositioned very slowly and the total number of eggs was much smaller than those of *Pl*-provided mites (Fig. 2E), though the difference of \bar{m} was not statistically significant between these two groups of mites (Table 2).

Descriptions of immature stage (Fig. 3).

Dimension. Mean (min.–max.) body length of larva ($n=6$) 281 (255–300) μ m; protonymph ($n=3$) 322 (315–335) μ m; deutonymph ($n=6$) 406 (368–440) μ m; tritonymph ($n=4$) 548 (495–600) μ m.

Prodorsum. Larval seta *ro* short and more medially situated than *le*; *ro*, *le*, *in* and *ex*, with minute barbs. Setae *ro*, *le* and *ex* in all nymphs similar to those of larva, but *le* distinctly longer than *ro*, *in* in nymphs short, smooth on surface, with tip blunt and directed posteriorly. Sensillus flagellate in larva minutely barbed and covered conspicuously with cerotegment on distal one third, but not barbed in nymphs.

Gastronotic region. Body elliptical or almost rectangular in larva, while ovate in nymphs. Cornicle *k* of nymphs narrow, straight or slightly undulated. Setal characters and chaetotaxies in larva and nymphs as follows: All larval setae flagelliform and distinctly barbed; *dp* and *lp* very long, about 1.5 and 1.7 times as long as body length, respectively; *C*₁, *C*₂, *da* and *dm* slightly shorter than body; *lm* subequal to *C*₃ and *la* in length. A pair of *dp* closely situated on the same sclerite. All nymphal setae except *C*₃ long, flagelliform; length of barbs generally decreasing distally. Order of decreasing length of nymphal setae: *C*₁, *C*₂; *la*, *lm*; *lp*; *h*₁, *h*₃; *h*₂; *C*₃. Setae *da*, *dm* and *dp* absent in all post-larval stages. Seta *C*₃ disappearing in adult stage. Gastronotic region of proto- and deutonymph similar to that of tritonymph.

Epimeral region. Setal formula of epimeres I to IV (I to III in larva) as follows: (2–1–2) in larva, (3–1–2–1) in protonymph, (3–1–3–2) in deutonymph, (3–1–3–3) in tritonymph;

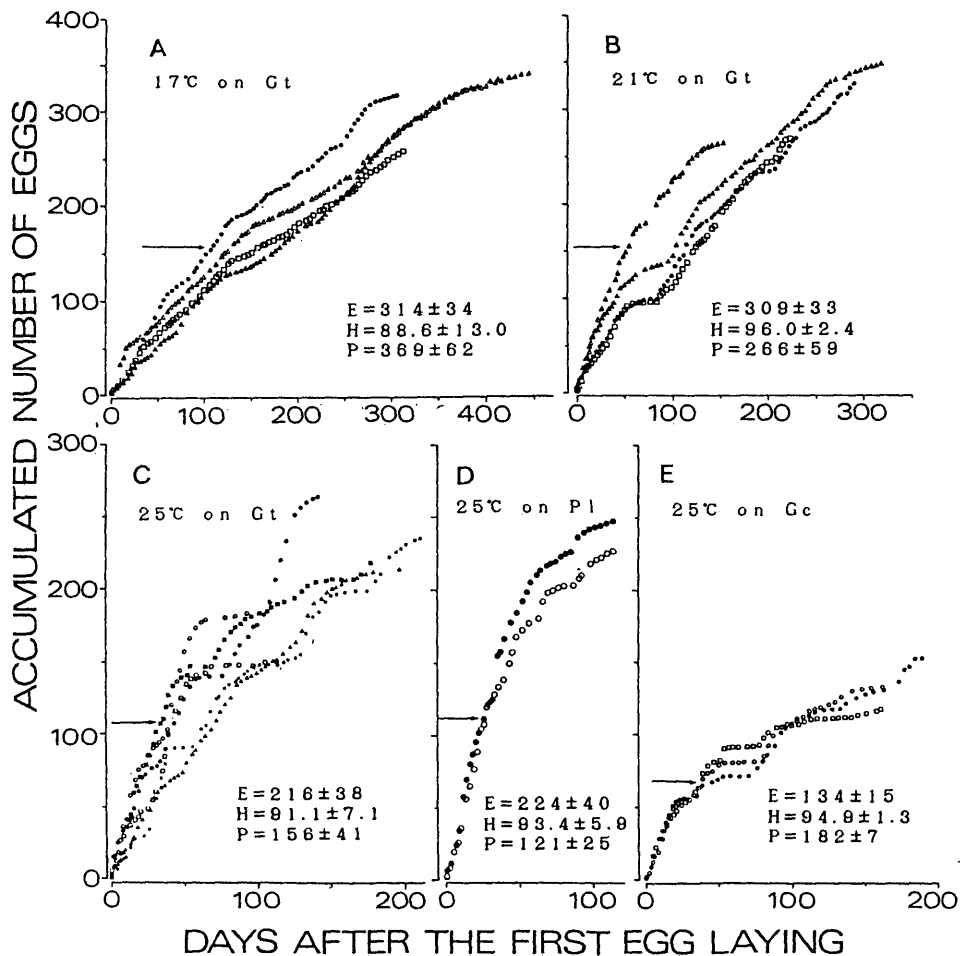


Fig. 2. Oviposition sequences of two (D) to five (C) females cultured under different conditions. E, H and P were mean values of the total number of eggs, hatchability (%) and oviposition period (days), respectively, with standard deviations. Arrows point to the level of 50% oviposition.

Table 2. The average of regression coefficient (\bar{m}) based on 50% oviposition period

| Temperature | Fungus | Total no. observed | $\bar{m} \pm SD$ |
|-------------|--------|--------------------|------------------|
| 17°C | Gt | 4 | 1.258 ± 0.231 a* |
| 21°C | Gt | 4 | 1.832 ± 0.743 ab |
| 25°C | Gt | 6 | 3.189 ± 0.976 b |
| 25°C | Pl | 2 | 4.334 ± 0.360 ab |
| 25°C | Gc | 2 | 2.149 ± 0.132 ab |

* Between different characters, values are significantly different at 5% level by MANN-WHITNEY's U-test

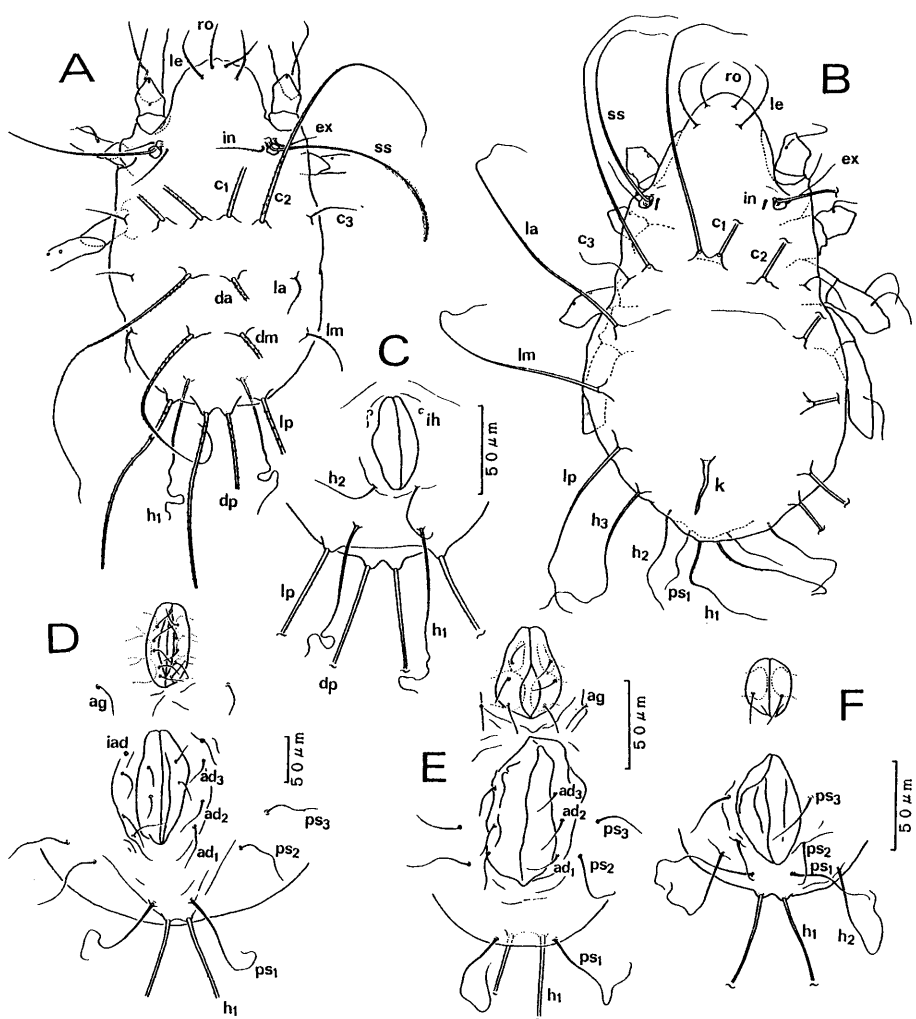


Fig. 3. *Epidamaeus verrucatus*: A) larva, dorsal aspect; B) tritonymph, dorsal aspect; C) anal region of larva; D) anogenital region of tritonymph; E) anogenital region of deutonymph, F) anogenital region of protonymph.

(3-1-3-4) in adult.

Anogenital region. Development of anogenital region as shown in Figs. 3C-F. Setal formula of pseudanal, adanal and anal segments from first stage to adult as follows: 3-3-3-3, 3-3-3 and 2-2, respectively. Ontogenetic genital and aggenital setal formula from protonymph to adult: 1-3-5-6 and 0-1-1-1, respectively.

Legs. Setal formula from trochanter to tarsus as follows: larva, I (0-2-3-4-15), II (0-2-3-3-13), III (0-2-2-3-13); protonymph, I (0-2-3-4-15), II (0-2-3-3-13), III (1-2-2-3-13), IV (0-0-0-0-7); deutonymph, I (1-4-4-5-15), II (1-4-4-4-13), III (2-3-3-4-13), IV (0-2-3-3-12); tritonymph, I (1-5-4-5-17), II (1-4-4-5-15), III (2-3-3-4-15), IV (1-3-3-4-12). Solenidial formula (genu to tarsus) as follows: larva,

I (1-1-1), II (1-1-1), III (1-1-0); protonymph, I (1-1-2), II (1-1-1), III (1-1-0), IV (0-0-0); deutonymph, I (1-2-2), II (1-1-2), III (1-1-0), IV (0-1-0); tritonymph, I (1-2-2), II (1-1-2), III (1-1-0), IV (0-1-0). All fundamental solenidia coupled with seta *d* on the tibiae and genua of immatures. Tibia I φ_1 long and curved in all stages. Seta *d* of larval genu minute in all legs.

Remarks. Setal variation of legs was found in a deutonymphal and a tritonymphal specimen in three ones examined on each stage of immature. On left leg IV of the former, tarsal seta P' is absent. The latter lacks genual seta *d* on left leg III.

Discussion

PAULY (1956) reported that the damaeid mites *Belba gracilipes* (KULCZYNSKI) and *B. clavipes* (HERMANN) required approximately 75 days and *B. geniculosa* (OUDEMANS) did 140 days for the development of immatures at 20 to 25°C, showing a longer time than 24.7 to 43.7 days in another damaeid mite *E. verrucatus* observed in this study. However, the immature took 49 to 62 days at 20°C in *Damaeus angustipes* (BANKS) (= *Belba kingi* HART., 1962; NORTON, 1977; HARTENSTEIN, 1962b), and, at 25°C, 62 to 64 days in *Spatiodamaeus subverticillipes* BULANOVA-ZACHVATKINA and 46 to 51 days in *B. meridionalis* BUL-ZACH. (SHEREEF, 1972), showing results somewhat similar to the present result. *E. verrucatus* showed the longest stage in tritonymph, as already found by PULY (1956) and HARTENSTEIN (1962b).

The present study also demonstrated that some females fed with *Gt* at 25°C laid fewer eggs about 50 days after the start of their oviposition. This is probably due to the shortage of fresh mycelia; then, if fresh food was sufficiently provided to the females, the cumulative number of eggs laid would reach the level of mites reared at 17 or 21°C, because the total number of eggs laid seems constant regardless of temperature. That is, mites appear to raise the oviposition rate in high temperature but extend the oviposition period in low temperature.

The nutritive quality of food for mites has been assessed by the feeding activity (HARTENSTEIN, 1962a), lifespan (BHATTACHARYYA, 1962) and population growth of mites (SHEREEF, 1972). WOODRING (1963) suggests that the growth of most oribatid mites is considerably dependent on the quantity and quality of food provided in immature stages. Concerning with the consequence of nutrition on immature stages, nutritious food is expected to shorten their developmental period. Then, the present study suggests that *Gt* is the most favourable but *Gc* is the worst food for *E. verrucatus* of the three fungus species used. The observation of their oviposition further suggests that *Gc* is not favorable to the adult mites either.

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摘 要

江波 義成 (京都学園高等学校 〒616 京都市右京区花園寺ノ中町 8 番地): ホホイボジュズダニの室内飼育による発育期間と産卵数ならびに幼若虫期の形態。

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茶園から採集されたホホイボジュズダニ *Epidamaeus verrucatus* ENAMI et FUJIKAWA に茶樹寄生の炭素病菌と輪斑病菌、赤葉枯病菌の菌糸を餌として与え、その発育期間と産卵数を調べるとともに、幼若虫期の形態的特徴を記載した。

- 1) 幼若虫期の発育期間は飼育温度が高いほど短くなり、炭素病菌糸を餌とした場合の発育期間は 25 (25℃)～44日 (17℃) であった。
- 2) 炭素病菌糸を餌にした場合の発育期間は、他の菌糸を与えた場合と比べて短かった。
- 3) 1 雌あたりの総産卵数の平均は、炭素病菌糸を与えた場合 216 (25℃)～314個 (17℃) であり、累積産卵曲線の傾きは飼育温度が高いほど大きくなった。
- 4) 赤葉枯病菌糸を餌とした場合の総産卵数は、他の菌糸の場合に比べて少なかった。
- 5) 幼若虫期の形態は楕円ないし卵形であり、体長は 281～548 μm であった。前体部の跗感毛(ss)は鞭状であり、若虫期の後体部背面には突起(k)を有している。第2・3若虫期の歩脚毛数に変異が見られた。

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