

**LIFE-HISTORY TRAITS OF *Stethorus gilvifrons* (MULSANT)
(Coleoptera: Coccinellidae)
ON PHYTOPHAGOUS MITES *Eutetranychus orientalis* KLEIN (Acari : Tetranychidae)**

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ABSTRACT

The research aims to know the life cycle, feeding and mating behavior of predatory beetle *S. gilvifrons*, and was conducted at entomology laboratory of Assessment Institute for agricultural technology Malang - East Java. The treatments involved feeding behavior and capacity of the various instars and imago of *S. gilvifrons*. The number of mites consumed within 24 hours by each stage of beetle was also recorded. The average voracity of five individual predators for each instar was determined. The result showed that average life cycle of *S. gilvifrons* feed on *E. orientalis* was 4.11 ± 0.78 ; 8 ± 1.10 ; 3.83 ± 0.41 , respectively for egg, larva and pupa. The predator caught the preys from the front side, then chewed and sucked the body contents of adult preys or consumed the whole egg. The feeding capacity was greater in egg-laying than that in non egg-laying females and males. The smallest size of the cage (1.5 cm diameter x 5 cm long) and clear weather were the most preferred situation for *S. gilvifrons* mating, which usually occurs on the upper leaf surface. The male positioned itself over the female body and extended its aedeagus to reach the female.

Keywords: Life-history, *Stethorus gilvifrons*, phytophagous mites

INTRODUCTION

Sustainable agriculture and food safety are major issues that call for judicious use of pesticides. The Indonesian government, in

response, institutionalized the integrated pest management (IPM) concept in agriculture. The decision to use IPM was also strengthened by the realization that pesticide use in many high value commodities has resulted in the development of insecticide resistant pests, undesirable residues in crops and contamination of environment. IPM emphasizes on the use of biological control agents such as predators and parasites, planting of resistant varieties, sanitation and other cultural methods, and chemical control as a last resort (Stern *et al.*, 1959; Kogan, 1998; Untung, 2000).

Stethorus sp. (Coleoptera: Coccinellidae) is one of the biological control agents of spider mites (Chazeau, 1985; Roy *et al.*, 2003; Roy *et al.*, 2005; Biddinger *et al.*, 2009). In East Java-Indonesia, one species of *Stethorus* has been observed feeding on spider mites attacking papaya, cassava, mango, apple, and some weeds for around 25 years (Kalshoven, 1981). The genus *Stethorus* comprises a group of ladybird beetle predators belonging to the family of Coccinellidae, under the order of Coleoptera. There are several species under this genus that are used as biological control agents against spider mites (Pollock and Michels, 2007; Biddinger *et al.*, 2009; Roache, 1960). Upon emergence, the female imago needs approximately 25 days before mating. Under laboratory condition, female reproductive phase was around 32 to 65 days after pre-oviposition. The longevity of male and female imago was about 449 days, with male to female sex ratio of 50.5:49.5 (Putman, 1955; Arbabi and Singh, 2008). Unlike other genera, female *Stethorus* does not have spermathecal glands (Hodek, 1967; Kovář, 1996). This necessitates that the female mate

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frequently in order to produce fertile embryos (Putman, 1955).

The continuous presence of this predator and its capability to feed on several species of spider mites aroused the interest of the author to work on the area of biological control. The beetle was brought to the Philippines and was identified as *Stethorus gilvifrons* (Mulsant) (Coleoptera: Coccinellidae) by Ms Jessamyn Adorada, a coccinellid systematist from National Crop Protection Center. This was the first report of the presence of this species in Indonesia, specifically in East Java.

There is a dearth of information about *S. gilvifrons* in the literature. Few articles published were from Iran and Turkey. Haji-Zadeh *et al.* (1996) and Afshari *et al.* (2001) reported that *S. gilvifrons* could feed on eggs and adults of *Panonychus ulmi*, *Tetranychus urticae*, *T. turkestanii* and *Oligonychus sacchari* by sucking their tissues after destroying the exoskeleton. Its feeding capacity was high and specific in both larval and adult stages. Its searching capacity and activity were highly constant over a wide temperature range. It was found that adult beetles preferred high prey density. With addition of prey density, the duration of different instar larvae decreased and feeding capacity increased. The feeding capacity of adult beetles increased when the temperature was raised to 40°C (Roy *et al.*, 2002). Based on the rationale above, this study was proposed to generate basic information on life-history, feeding and mating behavior of predatory beetle *S. gilvifrons* for future ecological Integrated Pest Management program in this country.

MATERIALS AND METHODS

The study was conducted at entomology laboratory of Assessment Institute for Agricultural Technology Malang - East Java, from November 2003 to June 2004. Adult *S. gilvifrons* were collected from papaya plants using a mouth aspirator. The beetles were placed in cylindrical plastic cages (10 cm in diameter and 20 cm in height) to mate. The copulating beetles were then transferred into 3-month-old papaya plants planted in polybags which were previously infested with mites (*Eutetranychus orientalis* Klein). The mites were collected from papaya plants grown at Karangploso Experimental Farm - Malang.

To determine the life cycle, 100 *S. gilvifrons* eggs were picked up from the mass culture and were placed singly on Huffaker cells. The eggs were observed daily for color change and hatchability. The newly emerged larvae were fed with *Eutetranychus orientalis* Klein on papaya leaf until pupation. To prolong the freshness of the papaya leaf, a piece of wet tissue paper was placed under the leaf. The larvae were observed daily for its larval and pupal duration. Egg, larva and imago were measured under a binocular microscope.

The feeding behavior and capacity of the various instars and imago of *S. gilvifrons* were also evaluated. One beetle was introduced into several prey on specific host such as an orange (*Panonychus citri* McGregor), apple (*Eotetranychus cendanae* Rimando) and rose (*Oligonychus biharensis* Hirst) leaf that had been previously infested with mites as follows: 10 mites for the first instar, 20 for the second instar, 40 for the third instar and 70 for the fourth instar and imago. Each leaf was enclosed with a 10 cm diameter x 15 cm long cylindrical cage. The number of mites consumed within 24 hours by each beetle was recorded. The average voracity of five individual predators for each instars was determined. Collected data was analyzed by analysis of variance, and to know the significant difference among the treatment, Tuckey test was used at $p = 0.05\%$.

Mating behavior was also studied during the process of transferring adult predators from mass culture to the various cages, including the mouth aspirator, small vial (1.5 cm diameter x 7.5 cm long), small cylindrical plastic cage (10 cm diameter x 20 cm long), big cylindrical plastic cage (27 cm diameter x 70 cm long), and during mass rearing of the beetle in 60 cm diameter muslin cloth cage. Mating behavior was described by number of days before the first acceptance of female to male, site and time of mating, and position of the beetle during mating.

RESULTS AND DISCUSSION

Life Cycle of *Stethorus gilvifrons*

Preliminary data indicated that eggs of *S. gilvifrons* were deposited singly near the preys, close to midrib of lower surface of leaves. The eggs are relatively small, oval, around 0.33 mm long and 0.20 mm wide, pale white to orange

when first laid but gradually changed to light red as the time went on.

Larvae were gray to dark red, alligator-like with 13 segments and three pairs of prominent legs. Larvae grew from less than 1 mm to about 2.0 mm in length, comprised four instars. The last instar remained inactive before attaching its posterior part to leaf surface to pupate. Pupae were uniformly dark and flattened with prominent wing pads and bear posterior with white larval exuvia.

The newly emerged adults were light brown, and then gradually turned black from anterior to posterior. They were about 1.5 mm long and 1.2 mm wide (Figure 1), and relatively smaller than other coccinellids. They posed yellow legs and hard and thick forewings which were covered with slightly long and smooth white hairs. A few hours after emergence, the adults started searching for preys and mates. The partial life cycle of this predator is presented in Table 1.

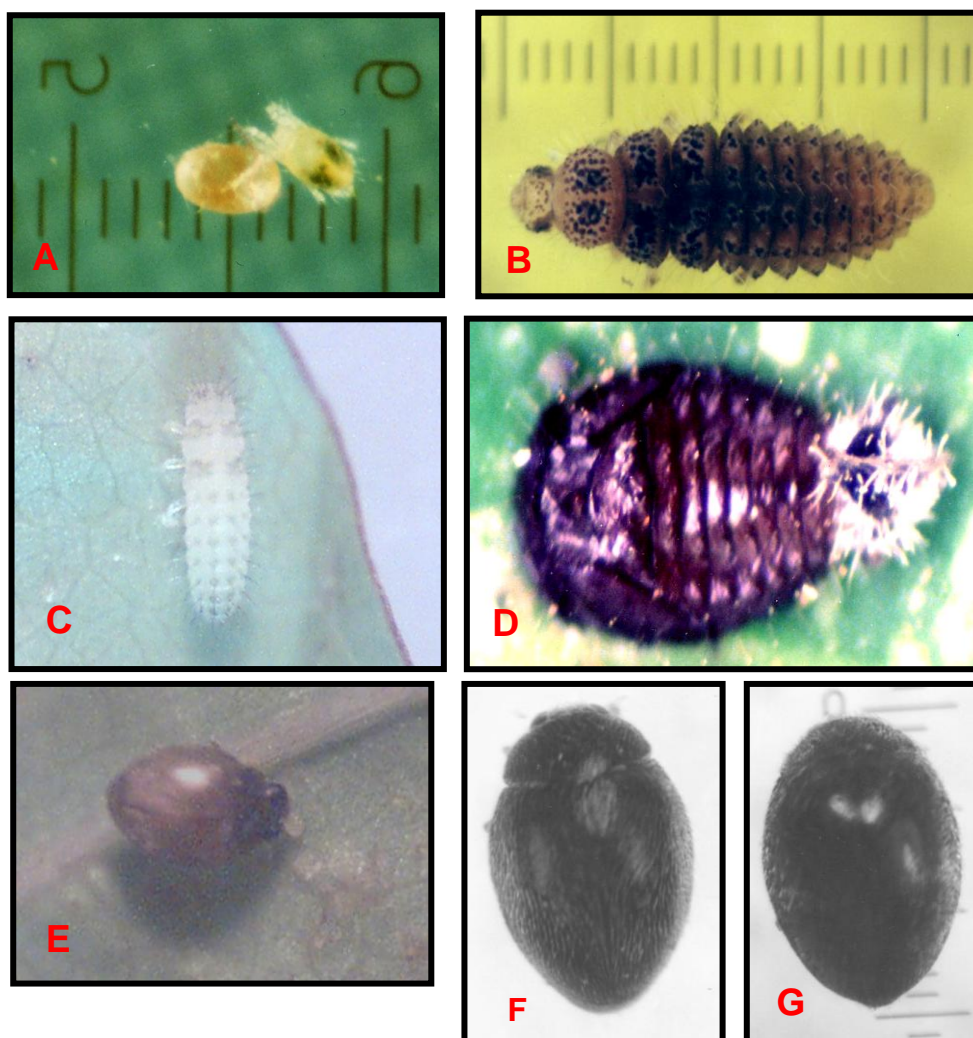


Figure 1. The developmental stages of *S. gilvifrons*; (A) egg (20X), (B) larva instar 3 (15X), (C) prepupa (10X), (D) pupa (15X), (E) newly emerged adult (10X), (F) male adult (15X), and (G) female adult (15X)

Male and female of *S. gilvifrons* have oval body shape. Ventrally, the posterior part of the male body was pointed while the female's was blunt. The terminal portion of the abdomen was rounded and hairy in males but flattened without hairs in females (Figure 2). The Male:female ratio of the insect was 1:1.34.

Feeding Behavior

The *Stethorus* predator fed from the front or the side of the prey. Predators usually

chewed and sucked the content of their prey by inserting their mouthparts (mandible) into body regions of the prey (Figure 3). The predator chewed and consumed the whole egg. Feeding capacity was greater in egg-laying than that in non egg-laying females and males (Haji-Zadeh *et al.*, 1996; Afshari *et al.*, 2001).

Table 3 shows that prey's host significantly affected the feeding capacity of *S. gilvifrons*.

Table 1. Developmental stages of *S. gilvifrons* at 27 °C and 80% RH

Stage	Duration (days)	Mean	Number of individuals
Egg	3 – 5	4.11 ± 0.78	100
Larva	7 – 10	8 ± 1.10	60
Pupa	3 – 4	3.83 ± 0.41	60

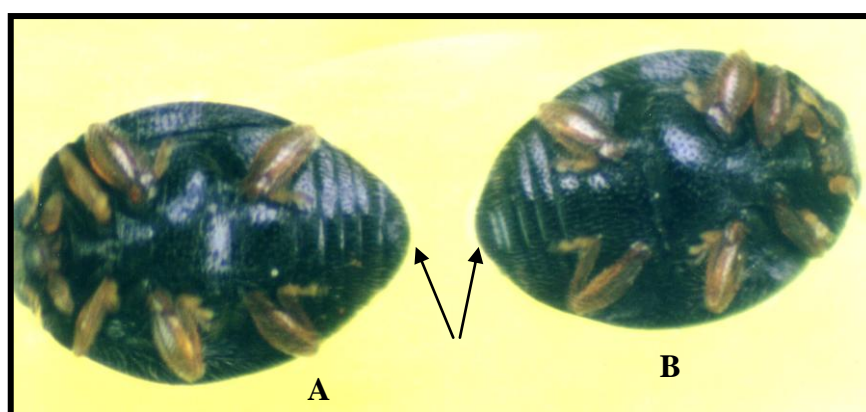


Figure 2. Ventral view of the male (A) and female (B) of *S. gilvifrons* (10X)

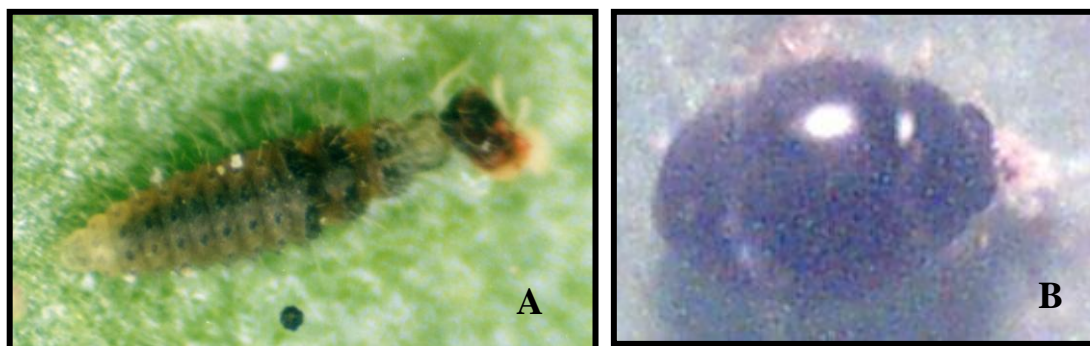


Figure 3. (A) Larva and (B) adult of *S. gilvifrons* feeding mite

Table 3. Feeding capacity of *Stethorus gilvifrons* on mites *Panonychus citri* of orange, *Eutetranychus cendanae* of apple, and *Oligonychus biharensis* of rose

Preys	Number of mites fed by stages of <i>S. gilvifrons</i>				
	Instar-1	Instar-2	Instar-3	Instar-4	Imago
<i>P. citri</i>	2.600 a	5.600 a	14.40 a	52.60 a	52.20 a
<i>E. cendanae</i>	1.400 b	3.400 c	9.800 b	40.40 b	44.00 b
<i>O. biharensis</i>	2.400 a	5.000 b	13.20 ab	44.00 ab	49.20 ab

Remarks= ^{*)} values within column followed by different letters differ significantly under Tuckey-test 5 %

Mating Behavior

Until four days after emergence, mating was not observed on one or several pairs of adult *S. gilvifrons* placed in 27.5 cm in diameter x 70 cm in height of cage. However, it happened when a pair of adults was placed in a smaller cage (10 cm in diameter x 20 cm high). The mating activities were even more frequently observed when the beetles were placed in a much smaller cage (1.5 cm in diameter x 5 cm high), and mouth aspirator as well. These conditions implied that the size of the cage was a major factor to the successful mating of reared *S. gilvifrons*. A smaller cage contributed to the frequent contact between male and female adults which stimulated mating activities. Mating was also observed to be more frequent during

clear weather either in the morning or in late noon and less frequent during cloudy weather. Similar research by Taghizadeh *et al.*, (2008) and Perumalsamy *et al.*, (2010) was showed that temperature and relative humidity greatly affected fecundity, survivorship and life-table parameters of *S. gilvifrons*, and that 35°C was a suitable temperature for population growth of this predator.

The predators moved and searched for female when mating time came. However, not all of the females were willing to mate. To resist the male advances, the female would expand its fore wings, move in circles until its energy was spent, and then it would expand its second pair of wings and die (Figure 4).

Figure 4. The female *S. gilvifrons* reject the male for mating



Figure 5. A pair of mating *S. gilvifrons*

Mating usually occurs on the upper leaf surfaces. One mating period can last for more than one hour. The male positioned itself over the female body and extended its aedeagus to reach the female (Figure 5). The male exhibited minimal movement during copulation. In *S. panperculus*, on the other hand, the anterior part of the male moved from left to right directions during the mating process.

CONCLUSIONS

Average life cycle of *S. gilvifrons* fed on *E. orientalis* was 4.11 ± 0.78 ; 8 ± 1.10 ; 3.83 ± 0.41 , respectively for egg, larva and pupa. *S. gilvifrons* fed from the front or the side of the prey, then chewed and sucked the body contents of adult prey or consumed the whole egg. Feeding capacity was greater in egg-laying than that in non egg-laying females and males.

The smallest size of the cage and clear weather were situation preferred for mating of *S. gilvifrons*. Mating occurred on the upper leaf surfaces, and male positioned itself over the female body and extended its aedeagus to reach the female.

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