

Courtship Behavior of the Sweet Potato Leaf Worm, *Aedia leucomelas* (Lepidoptera: Noctuidae)

Man-Young Choi*, Du Ho Kim¹, Chae-Hoon Paik, Hong Yul Seo, Jae Duk Kim, Geon-Hwi Lee², Gerhard Gries³ and Bernard D. Roitberg³

Honam Agricultural Research Institute, Songhakdong 570-080, Iksan, Korea

¹National Institute of Agricultural Sciences & Technology, Seodundong 441-857, Suwon, Korea

²Yeongnam Agricultural Research Institute, Naeiidong 627-803, Milyang, Korea

³Biological Sciences, Simon Fraser Univ. Burnaby, BC V5A186, Canada

ABSTRACT : Courtship behavior of the sweet potato leaf worm, *Aedia leucomelas* L. (Lepidoptera: Noctuidae) was observed under laboratory condition. Behavior of antennal probing and wing fanning in presence of opposite sex was observed in dark room. Both male and female exhibited similar behavior, fanning wing and raising antenna before male flew toward female. Some of moths began raising antenna 20 minutes into scotophase, and 20 minutes later both sexes started to exhibit spectacular behavior, fanning the wings intermittently in high frequency as if producing sound for attracting opposite sexes. They began mating about one day after emergence and mating activity was peaked from 4 to 6 days after emergence. Multiple mating was observed and the copulation lasted 207 minutes in average. There was an evidence that female emit sexual communication signal and male respond to it, and it seemed that the sound production is possibly a part of the courtship behavior of sweet potato leaf worm.

KEY WORDS : Sweetpotato leaf worm, *Aedia leucomelas*, Courtship behavior

초 록 : 실험실 조건에서 고구마 뒷날개흰밤나방의 교미 전 행동습성을 관찰하였다. 짝이 있고 어두운 상태에서 안테나를 치켜세우고 날개를 진동하는 습성을 보였으며, 암컷과 수컷 모두 날개를 진동하고 안테나를 치켜세우는 행동을 보이다가 수컷이 암컷에게로 날아가는 습성을 보였다. 불이 꺼진 상태로 20여분이 지나면 안테나를 치켜세우는 반응을 보이기 시작하였으며 40분이 지났을 때부터 마치 짝을 유인하는 음향을 생성하듯이 날개를 빠르게 진동하는 반응을 보였다. 짝짓기는 우화 후 이틀 날부터 관찰되었으며 대부분 4일에서 6일 사이에 짝짓기를 하였다. 짝짓기는 평균 207분 동안 지속되었고, 대부분 3회까지 반복적으로 교미를 하였다. 관찰결과를 종합적으로 분석해보면 암컷이 신호를 보내고 수컷이 이에 반응하는 것으로 보이며, 암컷이 내는 음향이 뒷날개흰밤나방의 교미전 행동습성에 관련되어 있을 가능성이 높은 것으로 판단되었다.

검색어 : 고구마 뒷날개흰밤나방, *Aedia leucomelas*, 교미전 행동습성

Aedia leucomelas L. is the most important herbivorous insect pest of sweet potato in Korea. When it is severe, larva feed almost the entire leaf area of sweet potato causing a major reduction in tuber production. They spend two or three generations a year and the larva can

be seen from mid June to early October and the population reach peak early to mid September in Southern region of Korea (Lee *et al.*, 2003). Recently in Korea, sweet potato is not only being used as food, but also for the production of starch, alcohol, processed food, and

*Corresponding author. E-mail: choimy@rda.go.kr

pigment source, and the leaf as a vegetable to make gimchi. Accordingly, the cultivation area is in a tendency of increase, and the area which was once 12,718 ha ('01) was increased to 16,570 ha in 2004 (Crop Production by Year, National Agricultural Product Quality Management Service, http://www.naqs.go.kr/html/agristat/pr_05.hwp). *A. leucomelas* was first found in sweet potato field in Haenam, Jeonnam Province 1996, and the damage is considered to be increasing as it spread rapidly year after year toward north region. *A. leucomelas* can easily be controlled by spraying chemical, but growing number of farmers are looking for other control method than the application of pesticide in order to produce insecticide free leaf (petiole) of sweet potato to meet the demand of consumer.

One of such method is to use sex pheromone (Fadamiro *et al.*, 1999; Han *et al.*, 2000) so that we tried to figure out the courtship behavior prior to proceeding research about identification of the pheromone. Our objectives were to (i) determine the sex that emits or shows response to sexual communication signals; (ii) describe calling and courtship behaviour; and (iii) determine the calling periodicity of sexual communication.

Materials and Methods

All experiments were conducted in the laboratory of the Simon Fraser University, Canada. The experimental insect being reared on sweet potato leaves were provided from Honam Agricultural Research Institute, Korea, and placed individually in petri-dishes to prevent emergent moths from mating and exposure to sexual signal at $25 \pm 5^\circ\text{C}$, 40-70% R.H. and a 10:14 (L:D) photoperiod. To observe courtship behavior both male and female sweet potato leaf worm (SPLW) exhibit, 20 female moths and 15 males were put in separate petridish (diameter 9 cm, height 3 cm) individually, and placed 10 cm apart from each other on work station, and every 10 minutes after turning off light individuals displaying typical movement assumed to be related to mating behaviour such as raising antenna and fanning wings under red light were counted.

To determine the sex emitting or responding to com-

munication signals, two 1-d-old male or female moths of *A. leucomelas* were placed in each of two screened signal cages (10×10×10 cm) suspended 75 cm apart from the ceiling of glass chamber (100×100×100 cm). One hour before the scotophase, six 1-d-old females or males were released into the chamber being illuminated with red bulb light (60 W). Moth behaviour was checked for 10 minutes in every 50 minutes. Number of moths flying around small cage or those landing on the cage and staying more than 10 seconds were counted.

Mating periodicity over the scotophase in a day and over the days after emergence was observed using eleven pairs of the moth by keeping each pair in a separate cage (40×40×60 cm), and checked once in a hour throughout the scotophase.

Results and Discussion

Both male and female moths began to show response raising their antenna 20 minutes into scotophase, and one hour into scotophase all the moths under the observation raised up their antenna straight forward in an angle about 45° against their body. About 20 minutes later the initial antennal raising, both sexes began to exhibit spectacular behavior fanning the wings in high frequency intermittently as if producing sound for attracting opposite sexes. Both wing fanning and antennal raising behavior were terminated about seven hrs into scotophase (Fig. 1). In this experiment it was unable to determine which sex calls and shows response, however it seemed that the sound production is possibly a part of the courtship behavior of sweet potato leaf worm judging from the spectacular high frequency wing vibration the female moth performed protruding the abdominal tip, which is known to be a typical pheromone releasing posture of noctuids (Birch *et al.*, 1990). Ultrasonic courtship has been described in several members of the moth families Arctiidae, Noctuidae, and Pyralidae (Conner, 1999). Many noctuid moths have also been known to produce an ultrasound when touched or stimulated by bat cries, or even during unmolested free flight (Agee, 1971) and to use it in species recognition, in male-male competition

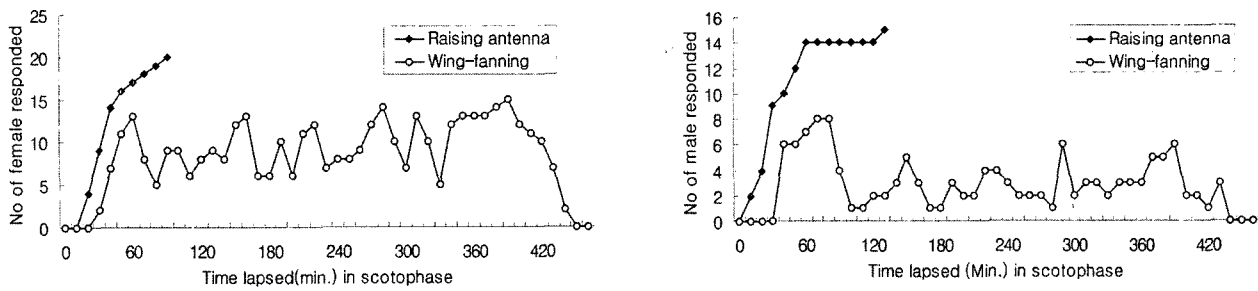


Fig. 1. Wing fanning and antennal raising response of male (right) and female (left) over the time in scotophase.

for mates and in female mate-choice system (Alcock *et al.*, 1989; Alcock and Bailey, 1995; Heller and Achmann, 1993).

In preliminary experiment it was observed that the moths that displayed most active behavior was four day old one, so that we used the four day old moths in the experiment for determining the sex that emits or shows response to communication signals. Even though both female and male moths in the small cage kept on fanning their wing intermittently, the sex of moths that showed response to signaling opposite sex in the small cage was only male indicating females emit and male respond to sexual communication signals (Fig. 1). Mate acquisition in moths typically entails long range response of males to female-produced signals, although in several species males may attract females (Birch *et al.*, 1990; Conner 1999). Female moth when they were released into the big cage did not respond to the male moth either by flying around the cage or by landing and staying for a while. Whereas male moths started showing response after about one hrs into the scotophase by flying around the small cage. It was about four hrs had passed since the moths were in scotophase when the moths were flying around or towards the signal cage most actively. The response of landing and staying on the cage had been observed between five to seven hrs, mostly after six to seven hrs into the scotophase. Copulation took place between five to eight hrs into scotophase, mostly between five to six hrs (Fig. 2). Moths spend first day before they initiated mating and peak mating activity was between four to six days after emergence. To copulate male protruded and expanded the hair pencil of the abdominal tip widely and regularly with about five

minutes interval before taking off to fly toward female and after reaching female it took the back of female turning momentarily and attempting insertion of genitalia, and repeated the similar pattern of courtship behavior until they made it.

The copulation lasted 207 minutes in average (160 to 230 minutes) remaining *in copulo* in an end to end position about the same length of time (3h) reported for *Tirathaba mundella* (Lepidoptera: Pyralidae) by Yorianta *et al.* (2002). Multiple mating was observed. Six out of eleven couples of SPLW tested mated once, three mated twice and two mated thrice in an interval of two to six days.

Female *A. leucomelas* may employ pheromonal and sonic signals to attract males. Wing fanning by calling females (Fig. 1) may help disseminate pheromone, and generate low-frequency sonic signals, as was reported for *Tineola bisselliella* (Hum.) (Lepidoptera: Tineidae) (Takács *et al.*, 2003).

This research was supported, in part, by an international

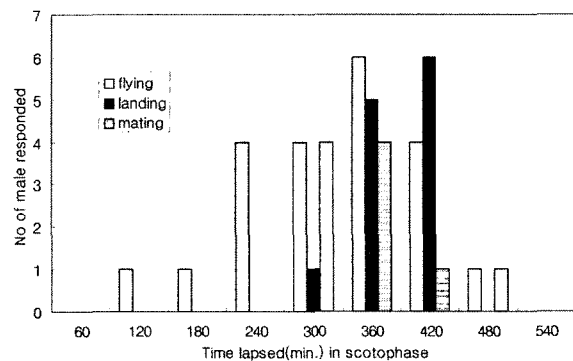


Fig. 2. Male response to female by time during a calling night, and number of couples in copulation.

cooperative research fund from Rural Development Administration of Korea, and by a research grant from Simon Fraser University, Canada to Du Ho Kim.

Literature Cited

- Agee, H.R. 1971. Ultrasound produced by the wings of adult *Hecatesia zea*. J. Insect Physiol. 17: 1267~1273.
- Alcock, J. and W.J. Bailey. 1995. Acoustical communication the mating system of the Australian whistling moth *Hecatesia exultans* (Noctuidae: Agaristinae). J. Zool. Lond. 237: 337~335.
- Alcock, J., D.T. Gwynne and I.R. Dadour. 1989. Acoustical signalling, territoriality, and mating in whistling moths, *Hecatesia exultans* (Agaristinae). J. Insect Behav. 2. 27~37.
- Birch, M.C., G.M. Popy and T.C. Baker. 1990. Scents and eversible scent structures of male moths. Ann. Rev. Entomol. 35: 25~58.
- Conner, W.E. 1999. 'Un chant d'appel amoureux': acoustic communication in moths. J. Expl Biol. 202: 1711~23.
- Fadamiro, H.Y., A.A. Cosse' and T.C. Baker. 1999. Mating disruption of European corn borer, *Ostrinia nubilalis* by using two types of sex pheromone dispensers depolyed in grassy aggregation sites in Iowa cornfields. J. Asia-Pacific Entomol. 2: 121~132.
- Han, K.S., J.K. Jung, K.H. Choi, S.W. Lee and K.S. Boo. 2000. Sex pheromone composition and male trapping of the peach fruit moth, *Carposina sasakii* (Matsumura) (Lepidoptera: Carposinidae) in Korea. J. Asia-Pacific Entomol. 3: 83~88.
- Heller, K.G. and R. Achmann. 1933. The ultrasonic song of the moth *Amyna natalis* (Lepidoptera: Noctuidae: Acotininae). Bioacoustics 5: 89~97.
- Lee, G.H., C.H. Paik, D.H. Kim, M.Y. Choi, S.Y. Na and S.S. Kim. 2003. Morphological characteristics, developmental period, seasonal occurrence, and sweetpotato consumption of *Aedia leucomelas* (L.) (Lepidoptera : Noctuidae). Kor. J. Appl. Entomol. 42: 1~7.
- Takács, S., C. Mistal and G. Gries. 2003. Communication ecology of webbing clothes moth: attractiveness and characterization of male-produced sonic aggregation signals. J. Appl. Ent. 127: 1~7.
- Yorianta S., G. Greis, and R. Gries. 2002. Sexual communication by *Tirathaba mundella* (Lepidoptera: Pyralidae). The Canadian Entomologist. 134: 251~253.

(Received for publication 11 November 2005;
accepted 13 December 2005)