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Biology of *Menochilus sexmaculatus* Fab. and *Coccinella undecimpunctata* L. (Coccinellidae: Coleoptera) on Alfalfa Aphid *Therioaphis trifolii* Monell

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Abstract Biology of *Menochilus sexmaculatus* Fab. and *Coccinella undecimpunctata* L. on alfalfa aphid *Therioaphis trifolii* Monell were investigated during winter season at Tando Jam, Sindh, Pakistan. The latent period of *M. sexmaculatus* was 31.7±0.3 and *C. undecimpunctata* 6.7±0.1 seconds. Duration of copulation in *M. sexmaculatus* and *C. undecimpunctata* were 81.8±5.4 and 64.5±6.1 minutes. The oviposition and post-oviposition period of *M. sexmaculatus*, were 27.4±4.1 and 4.5±0.3 days and *C. undecimpunctata*, were 19.9±5.2 and 3.8±0.4 days. Fecundity per female was observed 602±75.3 for *M. sexmaculatus* and 761±85.2 for *C. undecimpunctata*. The mean egg periods of *M. sexmaculatus* and *C. undecimpunctata* were 8.6±1.2 and 7.3±1.0 days. Larval duration for first, second, third and fourth instars of *M. sexmaculatus* were 7.3 ±0.6, 4.3±0.2, 3.8±0.3 and 6.7±1.1 days. The pupal period of *M. sexmaculatus* was 3.6± 0.3 and *C. undecimpunctata* was 5.1±0.5 days. The adult period of *M. sexmaculatus*, (female and male) under this study was 34.9±4.8 and 29.7±1.2 days.

Key words alfalfa aphid, berseem, biology, *Coccinella undecimpunctata*, *Menochilus sexmaculatus*

Introduction

Suppression of pest insects in agricultural crops by natural enemies is generally thought to be the result of direct density dependent process such as the functional and numerical response with increasing prey density (Elliott *et al.*, 2002). Several aphid predators, primarily Coccinellidae, Chrysoidae, and Nabidae, prey upon aphids in alfalfa *(Medicago sativa* L.) fields (Elliott and Kieckhefer, 1990). Interest in these predators stems from the observation that they play an important role in keeping aphid densities low in alfalfa and some other field crops (Rice and Wilde, 1988). These predators obtain resources necessary for their survival and reproduction from a variety of habitats. Aphids are tiny soft-bodied insect pests which suck the sap of plants. These sucking insect pests not only weaken the host through direct feeding but also transmit plant viruses (Rassoulian, 1999). Alfalfa aphid has rapidly spread and found infesting alfalfa throughout the United States (Stern *et al.*, 1980; Lamp *et al.*, 1994; Zarrabi *et al.*, 1995). Feeding by aphid induces a toxic reaction in alfalfa that can cause deformation of leaves, stunting, and plant death (Kristopher *et al.*, 2002).

Lady beetles are small, brightly colored insects and belong to family Coccinellidae. Among these beetles, the zigzag *(Menochilus sexmaculatus)* and 11-spotted (*Coccinella undecimpunctata*), have gained much importance as biological control agents for aphids in India (Faruqi *et al.*, 1986; Raga *et al.*, 1990). The adults of *M. sexmaculatus* are bright yellow in color with black vertical zigzag lines, whereas, *C. undecimpunctata* is 11-spotted lady beetle. The adults and larva prey upon all stages of aphids. Many aphid species are serious pests of different cereal crops, in Sindh, Pakistan (Buriro, 1996). Besides, they also attack fodder, vegetable and oilseed crops (Bhagat *et al.*, 1990). Among aphid species, the berseem aphid, *Therioaphis trifolii* is one of the serious pests (Niazi, 1997). Under Sindh conditions these aphids are mostly females (males absent) that reproduce parthenogenetically (Buriro, 1996) and give birth to nymphs (Lake, 1999). Aphids have short life-cycles and high reproduction rates. On any crop aphid population can increase suddenly and rapidly (Hamid, 1987). Under natural conditions, however, aphids are eaten by predatory lady beetles (Kristopher *et al.*, 2002). In the present study, our objective was to determine biological parameters of the lady beetles, *M. sexmaculatus*, and *C. undecimpunctata*, consuming the alfalfa aphids that feed on berseem. These parameters include the development and fecundity of the lady beetles.

Materials and Methods

Biological parameters of *M. sexmaculatus* and *C. undecimpunctata*

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For studies of the mating behavior and biological parameters, adults of two lady beetles *M. sexmaculatus* and *C. undecimpunctata* were collected from berseem field and reared in the laboratory at 20±2℃ on alfalfa aphid (*Therioaphis trifolii*) during winter season from December 1999 to March 2000 at Tando Jam, Sindh, Pakistan. Alfalfa aphids were confined in wide-mouth, plastic jars secured by muslin cloth. Fresh stocks of berseem leaves with aphids were provided daily. The eggs laid by female beetles on aphid-host leaves were transferred to petri-dishes (9 cm diameter) having a circular paper sheets spread over the bottom for egg developmental study. Percent egg hatch was recorded daily. The beetle larvae obtained were used to determine larval stage and were reared singly in Petri dishes. The observations pertaining to obvious morphological changes and molting were recorded. The same procedure for the pupal period was applied. Oviposition and post-oviposition periods, fecundity, fertility and longevity of adults and their sex ratio and emergence rate were also recorded on alfalfa aphid. Observations were recorded daily on *M. sexmaculatus* and *C. undecimpunctata*. Each treatment had 10 replications.

Courtship behavior

The same source of lady beetles as above was used for studies of the courtship behavior. Newly emerged adult beetles were released in petri-dishes in pairs to record the video observation through digital microscope on courtship behavior and duration of mating. 10 pairs of each beetle were observed. This included latent period (duration of a male standstill between genital contact and first bout of body shaking in second), copulation (time period of male mounted on the female) and post copulation period (period after first mating to first egg laying).

Morphometric parameters

Ten eggs, which were more than five hours old, were selected randomly and measured for their length and width on a micrometer under microscope. The larvae from each representative instars were randomly selected, killed and measured with the help of micrometer. The pupal stage of beetle was also determined and measured for recording their length and width. The body of male and female adults was also measured from head to end of abdomen, by the help of micrometer under electronic microscope.

Results and Discussion

Courtship behavior

Mating behavior of *M. sexmaculatus* and *C. undecimpunctata* (Coleoptera: Coccinellidae) was studied. The most frequent sequence of mating behavior displayed by a male which walked slowly towards the female, at closer distance pause with its maxillary palps vibrating rapidly. The male may also ran towards the female when approaching jumped and mounted on the female and copulated. On most occasions, *M. sexmaculatus* female remained motionless when the male touched, caressed and subsequently mounted on it. On lesser occasion the female refused to mate when the male tries to mount and copulate, and attempted to escape. In the case of *C. undecimpunctata*, it was in contrast to *M. sexmaculatus*. On most occasions, female refuses to mate when the male tries to mount and copulate, and attempts to escape. To counteract, the male then circles around the female while continually attempting to mount onto the female's back. On lesser occasion female, remains motionless when the male touches and mounts. During copulation, the male performed a body shaking behavior signaling the transfer of sperm. This behavior also serves as a copulatory courtship. After copulation, and to a lesser extent during copulation, the *M. sexmaculatus* male "licks" the female elytra and pronotum while circling on the female's dorsal surface. Consequently, the copulated male's sperms maintain a high probability of fertilizing the eggs.

Latent period, duration of copulation and post-copulation

It is observed that the latent period in male *M. sexmaculatus* and *C. undecimpunctata* in this study was 31.7±0.3 and 6.7±0.1 seconds. The latent period of *C. undecimpunctata* is shorter than that of *M. sexmaculatus*. It is reported that, the latent period of *H. axyridis* is approximately 35 second (Obata, 1987). The duration of copulation in *M. sexmaculatus* and *C. undecimpunctata* mated pairs are 81.8±5.4 and 64.5±6.1 minutes, respectively. The post-copulation behavior is well reported in insects other than coccinellids. A post-copulation behavior in male insects was a strategy to insure the sperm would successfully fertilize the female's eggs (Alcock and Gwynne, 1991). This is necessary because the female can still receive and store sperm from another male. Table 1 indicates that, after 85.9±5.4 and 70.6±5.4 minutes of copulation, the males of *M. sexmaculatus* and *C.*

Table 1. Courtship behavior of *Menochilus sexmaculatus* Fab., and *Coccinella undecimpunctata* Linn. reared on alfalfa aphid, where N = 10

Courtship behavior	*Menochilus sexmaculatus*	*Coccinella Undecimpunctata*
Latent period (seconds)	31.7±1.4	6.7±0.7
Copulation period (minutes)	81.8±3.2	64.5±4.9
Post-copulation period (minutes)	85.9±1.5	70.6±5.4

undecimpunctata are still mounted on the female, though there is no more body shaking. By then, the sperm transfer process has been completed. Similarly, Obata (1987) reported that, the function of body shaking was to ensure successful sperm transfer.

Biological parameters

Egg period. The data on the biological parameters of *M. sexmaculatus* and *C. undecimpunctata*, reared on alfalfa aphid. The mean egg periods of *M. sexmaculatus* and *C. undecimpunctata* were 8.6±1.2 and 7.3±1 days, respectively (Table 2) under 20±1℃. The egg period varies with temperature; higher the temperature the shorter was the egg period (Veeravel, 1996). The literature on the biology of these two beetles under Sindh (Pakistan) conditions (in particular) is not available. However, Esbijerg (1980) from Denmark (relatively cold country) reported that the incubation period of the eggs of *C. septempunctata*, was about a week.

Larval period. Table 2 depicts that the larval period (days) for first, second, third and fourth instars of *M. sexmaculatus* recorded were 7.3±0.6, 4.3±0.2 , 3.8 ±0.3 and 6.7±1.1, respectively. However, Sharma (1975) reported that larvae completed their development in 17 days when reared on *Rhopalosiphum maidis*. This difference must be due to different prey species. The larval period for the first, second, third and fourth instars of *C. undecimpunctata*, were 5.2±0.5, 4.4± 0.1, 4.6±1.1 and 5.3±2.1, respectively. However, Buriro (1996) reported that under lab temperature 20 ±2℃, the average (days) durations of first, second, third and fourth instars were 3.1, 2.4, 2.5 and 4.8 days, respectively for *C. septempunctata*. Rajput (1990) also reported that the average duration of first, second, third and fourth instars (larvae) were 2.8, 2.2, 2.3 and 4.6 days, respectively.

Pupal period. Table 2 shows that the pupal period of *M. sexmaculatus* reared on alfalfa aphid under laboratory conditions was 3.6±0.3 days. These findings are close with Ria (2002) who reported that the

Table 2. Biological parameters of *Menochilus sexmaculatus* Fab. and *Coccinella undecimpunctata* Linn. reared on alfalfa aphid, where N = 10

Parameters	*Menochilus sexmaculatus*	*Coccinella Undecimpunctata*
Egg period (days)	7.3± 1.0	8.6±1.2
Larvae		
1st instar (days)	7.3± 0.6	5.2±0.5
2nd instar (days)	4.3± 0.2	4.4±0.1
3rd instar (days)	3.8± 0.3	4.6±1.1
4th instar (days)	6.7± 1.1	5.3±2.1
Total larval period (days)	22.1± 2.9	19.5±2.8
Pupa period (days)	3.6± 0.3	5.1±0.5
Adult		
Female	34.9± 4.8	56.7±5.8
Male	29.7± 1.2	50.7±4.2
Oviposition (days)	27.4± 4.1	19.9±5.2
Post-oviposition (days)	4.5± 0.3	3.8±0.4
Fecundity (No. of eggs)	602.3±13.8	761.6±1.0
Hatching rate (%)	72.4± 9.5	70.8±5.2

average pupal period was 2.68±0.14 days. The pupal period of *C. undecimpunctata* was 5.1±0.5 days. The results are also in agreement with Rajput (1990) who reported that pupal period was 3 to 6 days with an average of 4.7 days in case of *C. septempunctata.*

Adult period. Data in Table 2, also indicate that adult period of *M. sexmaculatus*, (female and male) under this study was 34.9±4.8 and 29.7±1.2 days, respectively. However, Saha (1987) observed that the adult life span of *M. sexmaculatus* was 80 days, the reason may be disparity of prey and temperature, these results are also in agreement with Khan (1986) who observed the inverse linear relation ships between temperature and adult life span. Adult life span of *C. undecimpunctata* (female and male) under this study is 56.7±5.8 and 50.7±4.2 days (Table 2).

Oviposition period. Table 2 show that, the oviposition and post-oviposition period of *M. sexmaculatus*, were 27.4±4.1 and 4.5±0.3 days, respectively. Perzada (1995) reported oviposition and post-oviposition period of *M. sexmaculatus* averaged 38.00±9.30 and 3.5± 10.77 days, respectively when provided the maize aphid as prey. The difference may be due to aphid species. The oviposition and post-oviposition periods of *C. undecimpunctata*, were 19.9±5.2 and 3.8±0.4 days respectively. However, Ria (2003) reported that in female *C. septempunctata* oviposition period was 25.4±0.34 days, that variation can be due to change of predator.

Table 3. Emergence rate and sex ratio (male/female) of *M. sexmaculatus* reared on alfalfa aphid under laboratory conditions

Date 2000	Pupa observed	Emerged		Emergence rate (%)
		Male	Female	
01.1	50	20	22	84.00
15.1	41	14	16	73.16
01.2	60	23	25	79.49
15.2	66	25	28	71.10
01.3	80	34	35	86.50
Mean	59.40	23.20	25.20	79.75

Table 4. Emergence rate and sex ratio (male/female) of *C. undecimpunctata* reared on alfalfa aphid under laboratory conditions

Date 2000	Pupa observed	Emerged		Emergence rate (%)
		Male	Female	
01.1	50	20	21	82.00
15.1	41	13	14	65.84
01.2	60	22	24	76.65
15.2	66	22	25	71.10
01.3	80	31	31	77.50
Mean	59.40	21.60	23.00	74.60

Table 5. Morphometric parameters of various life stages of *M. sexmaculatus*

Life stage	N	Length (mm)	Width (mm)
Eggs	50	1.07±0.04	0.48±0.02
Larvae			
1st instar	30	1.41±0.14	0.49±0.06
2nd instar	30	2.84±0.54	0.77±0.16
3rd instar	30	5.37±0.64	1.47±0.19
4th instar	30	8.42±0.54	2.78±0.34
Pupae	40	4.54±0.39	3.11±0.20
Adults			
Male	30	4.07±0.35	3.14±0.20
Female	30	4.96±0.36	3.46±0.31

Table 6. Morphometric parameters of various life stages of *C. undecimpunctata*

Life stage	N	Length (mm)	Width (mm)
Eggs	50	1.06±0.01	0.41±0.01
Larvae			
1st instar	30	1.30±0.11	0.37±0.06
2nd instar	30	2.64±0.44	0.71±0.15
3rd instar	30	4.47±0.59	1.40±0.16
4th instar	30	7.42±0.41	2.70±0.33
Pupae	40	4.44±0.31	3.04±0.18
Adults			
Male	30	3.07±0.31	3.02±0.01
Female	30	3.66±0.33	3.12±0.11

Fecundity and hatching rate. The mean number of eggs per female was 602±75.3 for *M. sexmaculatus* and 761±85.2 for *C. undecimpunctata* when reared on alfalfa aphid. Buriro, (1996) reported that 416.1 eggs per female were recorded when *C. septempunctata* was fed greenbug. Rajput (1990) recorded 637.6 eggs per female when fed on mustard aphid. Saha (1987) reported that, *M. sexmaculatus*, female laid 1391 eggs, per day when reared on *Aphis gossypii* on cotton in the laboratory. Variation in the number of eggs per day can be either due to species or change in prey.

Table 2 further shows that hatching rate of eggs in *M. sexmaculatus* and *C. undecimpunctata*, were 72.4±9.5, and 70.8±5.2%, when reared on alfalfa aphid, under laboratory conditions. Our results are in agreement with those of Rajput (1990) and Dean (1983) who reported 88.1 to 90% hatching when *C. septempunctata* females were reared on mustard aphid.

Emergence rate and sex ratio of *M. sexmaculatus* and *C. undecimpunctata* reared on alfalfa aphid under laboratory conditions. The work was conducted on emergence rate and sex ratio of *M. sexmaculatus* and *C. undecimpunctata* in laboratory. Varied numbers of pupa were kept for observation. Tables 3 and 4 show that total emergence rate of pupal *M. sexmaculatus* was 79.75%, while that of *C. undecimpunctata* was 74.60%.

Morphometric parameters of various life stages

Egg. Tables 5 and 6 show that, the eggs of *M. sexmaculatus* are measured with a mean 1.07 mm in length and 0.48 mm in width and the eggs of *C. undecimpunctata* are measured with a mean 1.06 mm in length and 0.41 mm in width.

Grubs (Larvae). The results in Table 5 reveal that the length and width of *M. sexmaculatus* (in brackets) of first, second, third, and fourth instar averaged (in mm) 1.41±0.14 (0.49±0.06), 2.84±0.54 (0.77±0.16), 5.37±0.64 (1.47±0.19) and 8.42±0.54 (2.78±0.34), respectively. The Table 5 shows that length and width of *C. undecimpunctata* (in brackets) of first, second, third, and fourth instar averaged (in mm) 1.30±0.11 (0.37±0.06), 2.64±0.44 (0.71±0.15), 4.47±0.59 (1.40±0.16) and 7.42±0.41 (2.70±0.33), respectively.

Pupa. The results in Table 5 indicate that the length

and width of (*M. sexmaculatus*) pupa averaged 4.54±0.39 mm and 3.11±0.20 mm, respectively. The results in Table 5 further indicate that the length and width of (*C. undecimpunctata*) pupa averaged 4.44±0.31 mm and 3.04±0.18 mm, respectively.

Adults. Table 5 shows that, body length and width of female adult beetle averaged 4.96±0.36mm and 3.46±0.31 mm as compared to male that averaged 4.07±0.35 and 3.14±0.20 mm, respectively in *M. sexmaculatus*, in case of *C. undecimpunctata* body length and width of female adult beetle averaged 3.66 ±0.33 mm and 3.12±0.11 mm as compared to male that averaged 3.07±0.31 and 3.02±0.01 mm, respectively. These results are near to results shown by Campbell *et al.* (1980) who reported that the length of male and female *M. sexmaculatus* adult beetle averaged 4.39±0.15 mm and 5.07±0.10 mm, respectively.

Literature Cited

Alcock, J. and D.T. Gwynne. 1991. Evolution of insect mating systems: the impact of individual selectionist thinking. pp. 10-41, in Reproductive behaviour of insects. Individuals and Populations, Eds. W.J. Bailey and J. Ridsdill-Smith. Chapman & Hall, London.

Bhagat, K.C., D.R. Kotwal, S. Roshan and R. Singh. 1990. On the occurrence of wheat and barley aphid *Sitobion avenae* Fab. (Homoptera: Aphididae) and its natural enemies in Jammu (Jammu and Kashmir). J. Adv. Zool. 11: 48-52.

Buriro, A.S. 1996. Studies on varietals resistance of wheat cultivars to aphids (Aphididae: Homoptera). 223pp. Ph.D. Dissertation. Department of Plant Protection, Sindh Agri. University of Tando, Jam, Pakistan.

Compbell, R. K., T.N. Farris, T.M. Perring, M.E. Leonard, B.D. Lartwright and R.D. Eikenbary. 1983. Biological observations of *Menochilus sexmaculatus* Fab., reared on *Schizaphis graminum*. Ann. Entomol. Soc. Am. 73: 153-157.

Dean, G.J. 1983. Survival of some aphid predators with special reference to their parasites in England (U.K). Bull. Entomol. Res. 73: 469-480.

Elliot, N.C. and R.W. Kieckiiefer. 1990. A thirteen year survey of the aphidophagous insects of alfalfa. Prairie Nat. 22: 87-96.

Elliot, N.C., R.W. Kieckiiefer, G.J. Michels and K.L. Giles. 2002. Predator abundance in alfalfa fields in relation to aphids, within- field vegetation, and landscape matrix. Environ. Entomol. 31: 253-260.

Esbijerg, P. 1980. The seven spotted ladybird beetle, *Coccinella septempunctata* Lin. Appl. Entomol. 69: 1842.

Faruqui, S.A., K.C. Pandey and B.D. Patil. 1986. Field population studies and natural control of spotted alfalfa aphid. Ind. J. Ecol. 13:120-122.

Hamid, S.1987. Fecundity potential of graminaceous aphids in Pakistan. J. Zool. 20: 103-107.

Khan, A. and M. Yousuf. 1986. Temperature and food requirement of *M. sexmaculatus*. Environ. Entomol. 15: 800-802.

Kristopher, L., I. Giles, C. Richard, Berberet, A. Z. Ali, and W. D. Jack. 2002. Influence of alfalfa cultivar on suitability of *Acyrthosiphon kondoi* (Homoptera: Aphididae) for survival and development of *Hippodamia convergens* and *Coccinella septempunctata* (Coleoptera: Coccinellidae). J. Econ. Entomol. 95: 552-557.

Lake, A.W.H. 1989. Spotted alfalfa aphid survival and reproduction on annual medics with various levels of aphid resistance. Austr. J. Agri. Res. 40: 117-123.

Lamp, W. O., D. Liewehr, C. Fuentes and G.P. Dively. 1994. First report of the blue alfalfa aphid (Homoptera: Aphididae) in Maryland: natural enemies and biotype. J. Kansas. Entomol. Soc. 67: 129- 132.

Niazy, N.K. 1997. Demography of alfalfa aphid (*Therioaphis trifolii*) on berseem. 88pp. MS. Thesis, Department of Plant Protection, Sindh Agri. University of Tandojam, Pakistan.

Obata S. 1987. Mating behavior and sperm transfer in ladybird beetle, *Harmonia axyridis* Pallas (Coleoptera: Coccinellidae). Appl. Entomol. Zool. 22: 434-442.

Pirzado, M.D., M.K. Lohar, and G.M. Juno, 1999. Biological observations of zig-zag beetle, *Menochilus sexmaculatus* Fab. reared on maize aphid, *Rhopalosphum maidis*, Pak. J. Zool. 31: 35-38.

Raga, V., S. granvena, S.A.de Bortoli, J. Arai and G.N. Wassano. 1990. Insect survey and arthropod predator activity in tomato crop of determined growth. Jaboticabal, sp, Brazil. Anais-da-Sociedade-Entomologica-do-Brasil. 19: 253-271.

Rai, M. K., V.V. Ramamurthy and P.K. Singh. 2002. Bionomics of the Coccinellid predator *Micraspis discolor* (Fab.). Shashpa 9: 121-125.

Rai, M. K., V. V. Ramamurthy and P. K. Singh. 2003. Observation on the biology of the Coccinellid predator, *M. sexmaculata* Fab. on *Aphis craccivora*. Ann. Plant Prot. Sci. 11: 7-10.

Rajput, M.R. 1990. Behavioural studies of 7-spotted beetles, *Coccinella septempunctata* Linn. on mustard aphid, *Lipaphis* erysimi Kalt. 36pp. MS. Thesis, Department of Entomology. Sindh Agricultural University, Tandojam, Pakistan.

Rassoulian, G.R. 1989. Effects of two aphid species *Acyrthosiphon pisum* (Harris) and *Therioaphis trifolliforma* (Buckton) on protein and yield losses of alfalfa in Karaj, Iran. Iranian J. Agri. Sci. 20: 21-26.

Rice, M.E., and G.E. Wilde. 1988. Experimental evaluation of predators and parasitoids in suppressing green bugs (Homoptera: Aphididae) in sorghum and wheat. Environ. Entomol. 17: 836-841.

Saha, J.J.L. 1987. Studies on the fecundity, hatchability, mortality and longevity of *M. sexmaculatus* (Coloptera: Coccinellidae). J. Aphidology 1: 47-50.

Sharma, J.C. 1975. Development of *M. sexmaculatus* as influenced by feeding different species of aphids. Indian J. Entomol. 35: 343-344.

Stern, V.M., R. Sharma, and C. Summers. 1980. Alfalfa damage from *Acyrthosiphon kondoi* and economic threshold studies in Southern California. J. Econ. Entomol. 73: 145-148.

Veeravel, R. and P. Baskaran. 1996. Temperature-dependent development, adult longevity, fecundity and feeding potential of two coccinellid predators under laboratory conditions. J. Entomol. 21: 13-18.

Zarrabi, A. A., R.C. Berberet and J.L. Caddel. 1995. New biotype of *Acyrthosiphon kondoi* (Homoptera: Aphididae) on alfalfa in Oklahoma. J. Econ. Entomol. 88: 1461-1465.