

## Impact of mating on the post-embryonic development of *Coranus soosaii* Ambrose and Vennison (Insecta—Heteroptera—Reduviidae)

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MS received 17 April 1989; revised 14 August 1989

**Abstract.** Post-embryonic development of assassin bug *Coranus soosaii* Ambrose and Vennison was studied in the offsprings of 4 categories of females, viz. (i) virgins, (ii) mated once with a male of the same age, (iii) lived continuously with a male of the same age and (iv) lived with 3–4 males of different ages. Mating shortened the pre-oviposition period, enhanced the fecundity and hatchability, hastened the emergence and extended the adult longevity.

**Keywords.** *Coranus soosaii*; mating; oviposition pattern; hatchability; development.

### 1. Introduction

Reduviidae constitute an important group of predatory insects of southern India. The nutritional and reproductive adaptations of reduviids have reached a high degree of precision and efficiency (Ambrose 1980, 1987). Many of the reduviids are potential predators of many insect pests (Ambrose 1985, 1988).

*Coranus soosaii* is found to predate on insect pests like *Odontotermes obesus* Rambur, *O. assumthi* Holmgren and *Chrotogonus* sp. Efforts are being made to mass rear this bug and to use it as a biological control agent against various insect pests. Therefore detailed studies on the bioecology, ecophysiology and ethology of this bug are essential.

The effect of mating on oviposition pattern and hatchability has been studied in several species of insects (Riegert 1965; Loher and Edson 1973; Bentur and Mathad 1975; Subramaniam *et al* 1988). Among Heteropterans, mating influenced the size of egg batches, shortened the preoviposition period and enhanced the rate of oocytes development (Lee 1954; Ryckman 1958; Odhiambo 1968; Odhiambo and Arora 1973; Gorden and Bandal 1967). Similar observations were reported in reduviids, such as, *Acanthaspis pedestris* Stål, *A. siva* Distant, *Rhinocoris marginatus* Fabricius, *R. kumarii* Ambrose and Livingstone (Ambrose and Livingstone 1979, 1985a, b, 1987) and *R. fuscipes* Fabricius (Vennison and Ambrose 1986). However, no data are available on the influence of mating on the post-embryonic development of any reduviid. Hence, the present investigation is aimed at studying the effect of mating on oviposition pattern hatchability and nymphal development of *C. soosaii*.

### 2. Materials and methods

*C. soosaii* Ambrose and Vennison (Ambrose and Vennison 1989) is a harpactorine reduviid found in the scrub jungles, semiarid zones and tropical rain forests of Tamil Nadu. Gravid females were collected from the Maruthuvazhmalai scrub

jungle (latitude, 77°, 50' E and 8°, 7 N), a legendary hillock in Tamil Nadu. They were maintained in plastic containers (220 ml) in the laboratory (32°C, RH 75–85%, photoperiod 11–12 h) on housefly (*Musca domestica* Linnaeus), black ant (*Camponotus compressus* Fabricius) and grasshopper (*Chrotogonus* sp.). The mating behaviour was studied in sex-starved individuals. The spermatophore index was calculated by using the following formula proposed by Ambrose (1980).

$$SI = \frac{LS}{LI} + \frac{WS}{WI},$$

where *LI* = length of male insect, *LS* = length of spermatophore, *SI* = spermatophore index, *WI* = width of male insect and *WS* = width of spermatophore.

To study the impact of mating on oviposition pattern and hatchability, adult females were kept under the following conditions: (i) no males (virgins), (ii) mated once with a male of the same age, (iii) lived continuously with a male of the same age and (iv) lived with 3–4 males of different ages. The containers were examined daily for the ejected spermatophore capsule that resulted from successful mating. The number of batches of eggs and number of eggs in each batch were recorded and each batch of eggs was allowed to hatch in an individual containers under optimum incubating conditions (temperature 30–35°C, RH 75–85%). Hatching percentage of each batch of egg and the longevity of the females were recorded. Indices of oviposition days (the percentage of egg laying days in total adult life of the female) were calculated (Ambrose 1980).

The laboratory-hatched nymphs of (ii), (iii) and (iv) categories were used to study the impact of mating on stadial period. Biological parameters like nymphal mortality, nymphal growth, sex-ratio and adult longevity were worked out individually and compared. All the experiments mentioned here were adequately replicated and statistically analysed.

### 3. Results

The longest pre-oviposition period (9.25 ± 0.5 days) was observed for virgins (i). Among the mated females, the shortest preoviposition period (7 ± 1) was observed in group (iv). The influence of mating on the preoviposition period was highly significant ( $P = 0.05$ ) (table 1).

Mating also influenced the fecundity of *C. soosaii*. The group (iv) females laid the highest number of eggs (74.5 ± 14.87) with highest number of batches of eggs (28). The (iii) and (ii) group females laid 45.5 ± 18.64 eggs in 16.25 ± 7.76 batches and 43.75 ± 11.67 eggs in 27.25 ± 12.04 batches respectively (table 1).

All the 4 categories of test individuals laid atleast one egg per batch. Virgins laid a maximum of 3.25 ± 0.5 eggs per batch which was comparatively lower than the maximum number of eggs per batch deposited by the mated categories, i.e. 5.5–5.67. Though the maximum number of eggs per batch laid by mated categories was significantly higher than that of the virgins, no significant variation was observed among the mated categories.

The highest oviposition index (75.67 ± 8.73) was observed in the group (iv) females followed by the females of groups (ii) and (iii) (53.57 ± 6.28 and 55.94 ± 6.28). The lowest oviposition index was recorded for virgins (i) (48.96 ± 8.06).

The eggs laid by the females of (iii) and (iv) groups hatched after 8.5 ± 1.29 and

**Table 1.** Impact of mating on oviposition pattern in *Coranus soosaii*, n=6,  $\pm$ SD.

Parameters	Categories of females			
	(i)	(ii)	(iii)	(iv)
Pre-oviposition days	9.25 $\pm$ 0.5	9.25* $\pm$ 1.5	8.5 $\pm$ 1.29	7.0** $\pm$ 1.0
Number of eggs	27.5 $\pm$ 6.45	43.75** $\pm$ 11.67	45.5* $\pm$ 18.64	74.5 $\pm$ 14.87
Number of batches of eggs	16.5 $\pm$ 1.29	27.25 $\pm$ 12.04	16.25 $\pm$ 7.76	28.0 $\pm$ 0.0
Minimum number of eggs per batch	1.0	1.0	1.0	1.0
Maximum number of eggs per batch	3.25 $\pm$ 0.5	5.5* $\pm$ 1.73	5.5* $\pm$ 1.73	5.67* $\pm$ 2.31
Oviposition index	48.96 $\pm$ 8.06	53.57* $\pm$ 6.28	55.94* $\pm$ 4.22	75.67* $\pm$ 8.73

Significance shown at \* $P < 0.1$ ; \*\* $P < 0.05$ .

(i) No males (virgin); (ii) mated once with a male of the same age; (iii) lived continuously with a male of the same age; (iv) lived with 3-4 males of different ages.

9.25  $\pm$  1.5 days respectively. The eggs of group (ii) females had the shortest incubation period, and the eggs of group (iv) had the longest incubation period. Mating extended the incubation period in *C. soosaii* (table 2).

Eggs laid by virgin females did not hatch. The highest number of nymphs hatched from the eggs of the group (iv) females followed by the eggs of group (iii) females. The group (iii) females laid the lowest number of viable eggs. The hatching percentage was highest among the females of group (iv). Thus, mating had a positive proportionate impact on the hatchability of *C. soosaii* (table 2). The data further indicated that the older females laid more nonviable eggs than the younger females.

The shortest first stadium (8.9  $\pm$  1.92) was observed in the offsprings of (ii) group females. The offsprings of (iv) group females had the shortest second stadium (6.46  $\pm$  0.9) while the (ii) and (iii) groups had similar stadia (6.71 days). The longest (8.89  $\pm$  1.47) and shortest third stadia (7.2  $\pm$  1.71) were observed among the offsprings of groups (iv) and (iii) females respectively. The duration of fourth stadium was similar to that of the first stadium.

Mating had influenced emergence of males from the fifth nymphal instars as evidenced by table 3. Both male and female offsprings of group (ii) emerged after 21.33  $\pm$  12.54 and 27.53  $\pm$  12.93 days respectively, while the groups (iii) and (iv) males and females emerged between 9.4  $\pm$  2.7 to 11  $\pm$  0 days.

The total nymphal period (I instar to adult) was significantly ( $P = 0.05$ ) lower in the groups (iii) and (iv) than that of the group (ii). The present observation further indicated that the shortening of the total nymphal period in the groups (iii) and (iv) led the quicker emergence of adults of these categories.

Lowest nymphal mortality was observed among the offsprings of group (ii), though they had the longest stadia period. There was no significant difference in the nymphal mortality of offsprings of groups (iii) and (iv). From the present observations, no relationship could be established between the impact of mating and the nymphal mortality (table 4).

Mating had a positive, proportionate and significant ( $P = 0.1$ ) influence on the longevity of males and females of *C. soosaii*. Male and female offsprings of group (iv) lived longer (23.5  $\pm$  1.29 and 37.0  $\pm$  4.24 days respectively). The shortest longevity was observed among the offsprings of group (ii) (19.28  $\pm$  1.5 and

**Table 2.** Impact of mating on incubation period and hatchability in *Coranus soosai*, n = 6,  $\pm$  SD.

Parameters	Categories of females		
	(ii)	(iii)	(iv)
Incubation period in days	7.64 $\pm$ 1.58	8.2 $\pm$ 0.84	8.6 $\pm$ 1.12
Number of nymphs hatched	19.25 $\pm$ 3.6	22.75* $\pm$ 4.2	3.8 $\pm$ 4.8
Hatching percentage	43.18 $\pm$ 7.12	49.05* $\pm$ 8.02	50.65* $\pm$ 9.6
Frequency of 0% hatching	6.0 $\pm$ 3.12	4.0* $\pm$ 3.46	3.67* $\pm$ 2.52
Frequency of 100% hatching	3.0 $\pm$ 2.32	4.75* $\pm$ 2.59	5.03* $\pm$ 2.08

\*Significance shown at  $P < 0.1$ .**Table 3.** Impact of mating on stadial period in days in *Coranus soosai*.

Categories of females	Stadial period						
	I to II	II to III	III to IV	IV to V	V to male	V to female	I to adult
(ii)	8.9 $\pm$ 1.92 (77)	6.71 $\pm$ 1.43 (58)	7.64 $\pm$ 1.8 (40)	7.5 $\pm$ 1.65 (29)	21.33 $\pm$ 12.54 (7)	27.53 $\pm$ 12.93 (4)	55.21 $\pm$ 19.53 (11)
(iii)	8.98 $\pm$ 2.14 (86)	6.71 $\pm$ 1.51 (55)	7.2 $\pm$ 1.71 (44)	8.0 $\pm$ 2.21 (31)	9.4 $\pm$ 2.7 (6)	12.0 $\pm$ 0.0 (3)	41.59 $\pm$ 8.92 (9)
(iv)	8.98 $\pm$ 2.04 (78)	6.46 $\pm$ 0.9 (50)	8.89 $\pm$ 1.47 (37)	8.38 $\pm$ 2.55 (28)	10.4 $\pm$ 0.89 (4)	11.0 $\pm$ 0.0 (3)	43.41 $\pm$ 7.4 (7)

Numbers in parentheses indicate the number of observations.

**Table 4.** Impact of mating on nymphal mortality (%) in *Coranus soosai*.

Categories of females	Nymphal stages					
	I	II	III	IV	V	I to V
(ii)	16.88 (77)	20.69 (58)	12.5 (40)	17.24 (29)	16.5 (18)	49.35 (77)
(iii)	29.67 (86)	9.09 (65)	15.9 (44)	29.03 (31)	6.35 (16)	54.65 (86)
(iv)	28.20 (78)	14.0 (50)	8.10 (37)	17.86 (28)	23.53 (17)	52.56 (78)

Numbers in parentheses indicate the number of observations.

20.25  $\pm$  1.5 days for males and females respectively). The male and female offsprings of group (iii) lived for 22.83  $\pm$  3.54 and 24.66  $\pm$  1.15 days respectively (table 5).

Offsprings emerging from all the 3 mated categories were male biased. But the highest female ratio was found in the offsprings of group (iv) (table 5). Further studies are needed to establish the impact of mating on the sex ratio of *C. soosai*.

#### 4. Discussion

Mating significantly influenced the length of preoviposition period in *C. soosai*. Similar observations were already reported by Odhiambo (1968), Odhiambo and

**Table 5.** Impact of mating on adult longevity in days and sex ratio in *Coranus soosaii*,  $\bar{X} \pm \text{SD}$ .

Categories of females	Adult longevity		Sex ratio	
	Male	Female	Male	Female
(ii)	19.28 $\pm$ 1.5 (7)	20.25 $\pm$ 1.5 (4)	1.0 (7)	0.57 (4)
(iii)	22.83 $\pm$ 3.54 (6)	24.66 $\pm$ 1.15 (3)	1.0 (6)	0.5 (3)
(iv)	23.5 $\pm$ 1.29 (4)	37.0 $\pm$ 4.24 (3)	1.0 (4)	0.75 (3)

Numbers in parentheses indicate the number of observations.

Arora (1973), Ambrose and Livingstone (1979, 1985a, b, 1987) and Vennison and Ambrose (1986). Further, mating enhanced the rate of fecundity in this reduviid. Virgins laid comparatively less number of eggs with less amount of cementing material and the eggs shrank after a few days as reported by Lee (1954), Ryckman (1958), Odhiambo (1968), Ambrose and Livingstone (1979, 1985a, b, 1987) and Vennison and Ambrose (1986). Virgins also laid less number of batches of eggs. Total loss or less fecundity was also reported in *Haematosiphon inorodorus* (Lee 1954) and *Hesperocimex sonorensis* (Ryckman 1958). Similar observations were also recorded in other oriental reduviids, such as, *A. pedestris*, *A. siva*, *R. marginatus* and *R. kumarii* (Ambrose and Livingstone 1979, 1985a, b, 1987). Results showed that number of matings had a positive influence on the fecundity of *C. soosaii*, unlike in *R. fuscipes* (Vennison and Ambrose 1986).

Mating had profound influence on hatchability too. Hatchability was directly proportional to the fecundity as reported for *A. pedestris*, *A. siva*, *R. marginatus* and *R. kumarii* (Ambrose and Livingstone 1979, 1985a, b, 1987). Thus mating had a positive proportionate impact on the hatchability. This might be due to the higher frequencies of 100% hatching and lower frequencies of 0% hatching. Therefore, it is also presumed that the possibility of receiving viable sperms was better ensured in (iv) group females. Under natural conditions these bugs were observed to migrate from one locality to another in search of prey which might provide with more opportunities of polyandry for the females. This facility might be enhanced by the availability of more number of younger males as their longevity (23.5  $\pm$  1.29) was considerably less than that of the females (37  $\pm$  4.24). Thus polyandry serves as an effective measure for maintaining a steady level of natural population of this bug. This observation corroborates the earlier observations of Ambrose and Livingstone (1979, 1985a, b, 1987) and differs from that of Vennison and Ambrose (1986). The data further indicated that the females parental ageing caused non-viability of eggs. Similar observation was also reported by Rabinovich (1972).

The highest hatchability recorded in the (iv) group females might be due to the least frequency of 0% hatching (3.67  $\pm$  2.08) recorded in this group. In the groups (ii) and (iii) too, a direct correlation could be established between the frequencies of 0% and 100% hatching and the hatchability as observed in the females mated with different males of different ages. This suggests that the higher fertility observed in the females of groups (iii) and (iv) might be due to the availability of more number

of viable sperms as reported by Rabinovich (1972) and Ambrose and Livingstone (1979, 1985a, b).

The present observations show that mating had no positive impact on moulting but on emergence. Though mating did not have significant influence on nymphal mortality and sex ratio it certainly extended the longevity of *C. soosai*. In summary, mating shortened pre-oviposition period, enhanced both fecundity and hatchability, hastened the emergence and extended adult longevity.

### Acknowledgements

The authors are grateful to Rev. Fr. G Packiaraj S J and Rev. Fr. Stephen T de Souza S J for facilities. One of the authors (DPA) acknowledges the financial assistance from the Department of Environment, Ministry of Environment, Forests and Wildlife, New Delhi:

### References

- Ambrose D P 1980 *Bioecology, ecophysiology and ethology of reduviids (Heteroptera) of the scrub jungles of Tamil Nadu*, Ph.D. thesis, University of Madras, Madras
- Ambrose D P 1985 Assassin bugs of Tamil Nadu and their role in biological control (Insecta: Heteroptera: Reduviidae); *Proceedings of the National seminar on Entomophagous insects and other Arthropods*, Calicut, pp 16–28
- Ambrose D P 1987 Biological, behavioural and morphological tools in the biosystematics of Reduviidae (Insecta: Heteroptera: Reduviidae); *Proc. Indian Acad. Sci. (Anim. Sci.)* **96** 499–508
- Ambrose D P 1988 Biological control of insect pests by augmenting assassin bugs (Insecta: Heteroptera: Reduviidae); *Bicovas Proc.* **2** 25–40
- Ambrose D P and Livingstone D 1979 The impact of mating on the oviposition pattern and hatchability in *Acanthaspis pedestris* Stål. (Reduviidae: Acanthaspidinae); *Entomon.* **4** 269–275
- Ambrose D P and Livingstone D 1985a Impact of mating on adult longevity, oviposition pattern, hatchability and incubation period in *Rhinocoris marginatus* Fabr. (Insecta: Heteroptera: Reduviidae); *Environ. Ecol.* **3** 92–102
- Ambrose D P and Livingstone D 1985b Mating behaviour and its impact of oviposition pattern and hatchability in *Acanthaspis siva* Distant (Heteroptera: Reduviidae); *Uttar Pradesh J. Zool.* **5** 123–129
- Ambrose D P and Livingstone D 1987 Mating behaviour and the impact of mating on oviposition pattern and hatchability in *Rhinocoris kumarii*; *Environ. Ecol.* **5** 156–161
- Ambrose D P and Vennison S J 1989 A new species of *Coranus* Curtis (Heteroptera: Reduviidae: Harpactorinae) from south India; *Acta Entomol. Bohemoslov.* **86** 67–71
- Bentur J S and Mathad S B 1975 Dual role of mating in egg production and survival in *Plebeiogryllus guttiventris*; *Experientia* **31** 539
- Gordon H T and Bandal S K 1967 Effects of mating on egg production by the large milkweed bug *Oncopeltus fasciatus* (Hemiptera: Lygaeidae); *J. Econ. Entomol.* **16** 483–490
- Lee R D 1954 Oviposition by the poultry bug; *J. Econ. Entomol.* **47** 224–226
- Loher W and Edson K 1973 The effect of mating on egg production and release in the cricket *Telogeoryllus commodus* Walker; *Entomol. Exp. Appl.* **16** 487–490
- Odhiambo T R 1968 The effect of mating on egg production in cotton stainer *Dysdercus fasciatus*; *Entomol. Exp. Appl.* **11** 379–388
- Odhiambo T R and Arora G K 1973 A comparative study of oocyte development in cotton stainer *Dysdercus* sp. (Pyrrhocoridae) and factors that control egg production; *Entomol. Exp. Appl.* **16** 455–470
- Rabinovich J R 1972 Effect of parental female age upon percents of egg hatching in *Triatoma phyllosoma pallidipennis* (Hemiptera: Reduviidae); *Ann. Entomol. Soc. Am.* **65** 740–741
- Riegert P W 1965 Effects of grouping, pairing and mating on the binomics of *Melanoplus bilituratus* (Walker) (Orthoptera: Acrididae); *Can. Entomol.* **97** 1046–1051

- Ryckman R E 1958 Description and Biology of *Hesperocimex sonorensis*, new species, an ectoparasite on Purple Martin (Hemiptera: Cimicidae); *Ann. Entomol. Soc. Am.* **51** 33–47
- Subramaniam M, Haniffa M A and Pandian T J 1988 Effect of multiple matings on egg production in *Grylloides sigillatus* (Walker) (Orthoptera: Gryllidae); *Entomon* **13** 317–320
- Vennison S J and Ambrose D P 1986 Impact of mating on oviposition pattern and hatchability in *Rhinocoris fuscipes* (Heteroptera: Reduviidae) a potential predator of *Heliothis armigera*; *J. Soil. Biol. Ecol.* **6** 57–61