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Aspects of Courtship and Mating Behaviour of the Praying Mantid, *Sphodromantis viridis* Forskal (Mantodea: Mantidae)

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ABSTRACT

A description of some aspects of courtship and mating behaviour of the praying mantid, *Sphodromantis viridis* Forskal is presented. The precopulatory, copulatory, and post copulatory behaviors, including the time spent at each step, are described. Also, mantid's sexual cannibalism was reviewed. Male begins courting using its antennae, after antennation, the smaller male often jumps on the back of the larger female. Miscalculating the jump may mean the male become a meal for the female. If the jump was successful, the pair mate and during copulation the female may turn and devour the male head. Newly emerged adult females were not attractive to males for about 4 successive days. Courting begins when females were 5 days old and reached its maximum at 7-16 days old.

Key Words: Courtship, mating behaviour, *Sphodromantis viridis*.

INTRODUCTION

Mating behavior includes all those events surrounding fertilization and/or insemination. Alexander (1964) divided mating behavior into: insemination, which may involve a copulatory act; the events leading up to and responsible for bringing about insemination, i.e. courtship; and the events immediately following insemination.

Mating is a component of sexual reproduction, and thus it implies the existence of functional and morphological differences between partners (Parker *et al.*, 1972; Matthews and Matthews 1978).

Praying mantids are very efficient and deadly predators that capture and attack a wide variety of insects and other small preys. Males of those predatory insects may face a special problem; that is how to avoid being consumed by females before copulation has been secured. According to Van den Assem (1996), sexual cannibalism is more evident through Mantodea, the adult female usually eats the male after or during mating.

The main objective of the present study is to provide a general description of the courtship and mating behavior of *Sphodromantis viridis* Forskal and to determine the sequences of such behavior and the time spent at each step. Also, to determine the role of sexual cannibalism as a factor affecting successful mating.

MATERIALS AND METHODS

Stock Cultures

S. viridis and its preys (*Drosophila melanogaster*, *Musca domestica* and *Schistocerca gregaria*) were reared in large screen cages under the laboratory conditions; 60-75% R.H. and 22-26°C according to Zohdy and Younes (2003). Male and female individuals of *S. viridis* were isolated in separate cages. Courtship and mating behaviours were recorded for paired have the same age (from one to 18 days old). The percent of courtship and successful mating occurred were recorded to determine the most favorable ages for completing the mating.

Mating Experiments

Ten day-old mantids were used in the mating studies since a higher percentage of mating was recorded at this age than younger ones. Before placing the sexes together, *S. gregaria* nymphs were added as preys in the mating cage. To facilitate observing the sexual behaviour, three side-screened cages (40x40x40 cm) were used. Observations of each courting pair were made until the pair completed copulation or one of the two sexes departed before completing the mating. Once a contact between the two sexes occurred, care was taken not to disturb the females. Various behaviours were recorded using a stopwatch. Fifteen pairs were used as replicates. Females were maintained virgins till being used in the experiments.

Statistical Analysis

One-way analysis of variance (ANOVA) and Duncan's multiple range test of means were used (Duncan, 1955).

RESULTS AND DISCUUSION

Successful Sexual Behaviour Encounters

Data presented in Table (1) show that, no courtship was displayed before the mantid aged 5 days. Also, no successful mating was displayed before the age of 7-days or after the age of 16 days. Also, it was noticed that females avoided contact with, approaching and may devour males. Females aged 7-16 days appeared to become attractive to males. The males initiated courtship within one hour of finding the females and complete the mating. Males and females younger than 7-days or older than 16-days lost their interest for copulation (no copulation occurred). Statistically, the high percentage of courtship and also copulation were obtained from those had an age of 10 to 12 days (Table 1).

Courtship Phases and Duration

S. viridis passes through three phases of courtship, each phase takes a period differs from the other. These phases could be indicated as:

Phase I: Male orientation: Before sexual encounters, females were generally in rest while males were more active, moving randomly nearby the females. Males passed within 15 to 20 cm apart of females with no signs of

Table (1): Effect of *Sphodromantis viridis* age on the percentage of courtship and successful mating behaviour.

Adult mantid age (days)	% Courtship (mean ± SE)	% Succssful mating (mean ± SE)
04	-	-
05	16 ± 4.0a	0
06	18 ± 3.7 a	0
07	34 ± 2.4 ab	16 ± 2.4a
08	40 ± 3.2 b	18 ± 2.0a
09	48 ± 3.7 b	30 ± 3.2b
10	78 ± 2.0d	75 ± 2.4ce
11	86 ± 2.2de	78 ± 3.7e
12	93 ± 2.5 e	80 ± 3.2e
13	78 ± 2.4d	60 ± 4.8d
14	64 ± 2.4c	54 ± 2.4cd
15	50 ± 3.2b	46 ± 2.4c
16	36 ± 2.4 ab	26 ± 4.0a
17	20 ± 3.2 a	0
18	12 ± 2.0 a	0

Means followed by the same letter are not significantly different ($P<0.05$).

change in behavior. The initial male-female approach occurred when male was within 10 to 15 cm of a female. If the female did not move, the male positioned himself parallel to the female, once a parallel position was achieved; male raised its antennae up and down and held them forward at approximately 45° angle to the horizontal axis of the head. At the same time, the male moved his abdomen up and down in synchronization with the antennal drumming and gradually increased the speed of its antennal movements. This initial antennal orientation took a period varied from 0.16 to 2.2 hours, with an average of 1.4±0.19 hours (Table 2).

Table (2): Duration of courtship and mating behaviour sequence of *Shodromantis viridis*.

Sequence	Phase	Duration (hours)
Courtship	I. Male anntenal Orientation	1.40 ± 0.19 (0.16-2.20)
	II. Male Jumping	0.12 ± 0.03 (0.06-0.17)
	III. Copulatory organs conact	1.90 ± 0.24 (0.50-3.80)
Copulation		8.00 ± 2.30 (4.00-21.00)
Post copulation	Male	0.10 ± 0.02 (0.05-0.16)
	Female	0.26 ± 0.11 (0.13-0.33)

Phase II: Male jumping: This phase occurred in about 60% of the observed pairs (Fig. 1) and characterized by males jumping. Male often jumped on the back of the female, miscalculating the jump may mean the male becomes a meal for the female. If the jump was successful, receptive female responded to the male's grasp by raising one or more of its legs upward, whereupon the male assumed a mounting position above the female's body. Only 34% of the males reached phase III where the reminder were either rejected by the females and so escaped away or been eaten by the females before entering in the following phase. Completing the jump took a period varied from 0.06 to 0.17 hour, with an average of 0.12±0.03 hour (Table 2).

Phase III: Male resting and copulatory organs contact: After successful jumping, the male began to raise the pair of wings nearest the female and moved few millimeters for covering her by his body. At the same time, the male positioned his abdomen beneath the female at about a 45° angle. Phase III immediately preceded copulation and occupied a period of 0.5 to 3.8 hours with an average of 1.9± 0.24 hour (Table 2).

Copulation: When the female accepted the male, the terminal flap that covers the female's gonopore was pulled open. The abdomen of the male was bent down at nearly 45° angle, bringing the aedegus parallel to the longitudinal axis of the female, when it was inserted into the gonopore. Copulation (Fig. 4) lasted from 4 to 21 hours. From the original 20 pairs, only 4 pairs (20 %) succeeded in completing mating, 8% succeeded in escaping before being eaten by females and 12% were already eaten. The males that succeeded to escape, rested in short distance away and usually remained from 0.05 to 0.16 hours, while the females rested longer (0.13-0.33 hours), although the females sometimes moved away searching for preys.

Unsuccessful Sexual Encounters

The percentage of successful mating that resulted in the initial courtship was low (20%) that means 80% was unsuccessful. As the males began courtship 40 % departed after phase I and 26% departed after phase II (18% from those were eaten by females; (Fig. 1). Out of 34% of males reached phase III, only 14% were rejected before mating occurred, among those 6% were killed by females.

In conclusion, once *S. viridis* male has assumed the correct orientation relative to the female, and the female has become immobile (presumably in response to the male taking up the correct position), the male commences courtship. Male antennation is a common component in the courtship behavior, just before the male attempts jumping. Successful courting males went through all the precopulatory phases, however, greater variability in the time span allocated to the various mating behavior sequences. The percentage of *S. viridis* males succeeded in mating was low (20%), this was resulted from males sometimes departed after antennal orientation, unsuccessful jumping or rejected by the females which increase the percentage of unsuccessful mating. Also, females sometimes walked or flew away and became more aggressive, pushing or eaten males. This study showed that, sexual cannibalism of *S. viridis* was much resulted in miscalculating the jump on the female back, in such case the female may strike, capture and consume the male. Being eaten at this phase indicated that the conventional wisdom that assumes decapitation is a necessary prerequisite for ejaculation is incorrect. This behavior of sexual cannibalism was also observed by Howard (1986) of *Stagomantis carolina* and by Roeder (1935) of *Mantis religiosa*.

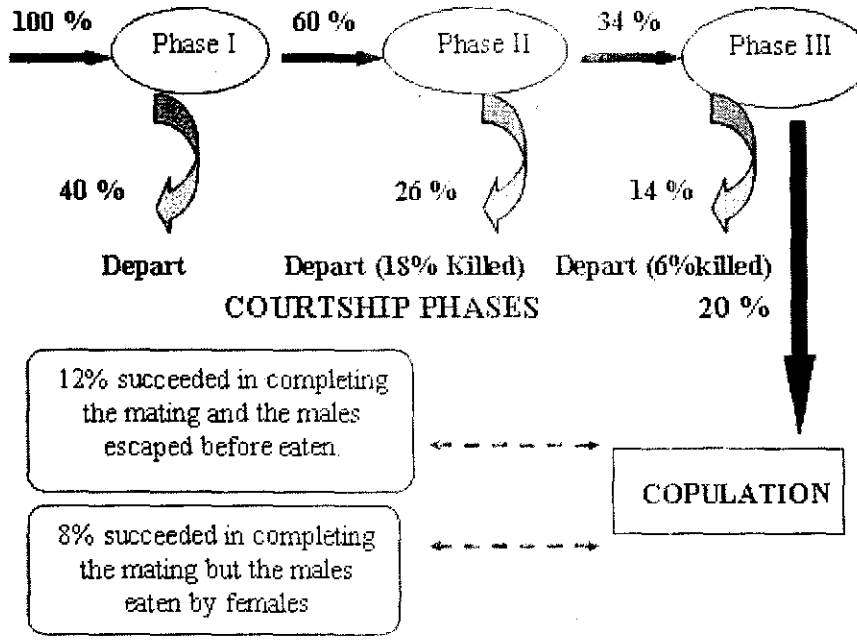

Fig. (1): Sequence of courtship and mating behaviour of *S. viridis* showing the percentage of each phase

Doubt has been cast on the function of sexual cannibalism in mantids. Some authors (Liske and Davis, 1984 & 1987) suggested that sexual cannibalism in the laboratory resulting from either confinement or feeding conditions. However, Birkhead *et al.* (1988) reported evidence that *Hierodula membranacea* female may gain significantly in fitness by eating the male.

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Figure (2): *S. viridis* male searching a female.

Figure (3): To begin the courtship.

Figure (4): A pair of copulating mantids; the male bends the tip of his abdomen downward to contact the female's genitalia.