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Field observations on courting, mating and exposition behaviour in *Oedaleus senegalensis* Krauss (Orthoptera: Acrididae)

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ABSTRACT

Some aspects of the behaviour of *Oedaleus senegalensis* were studied during the daylight hours in the northern Sudan savanna zone of Nigeria. Courting, copulation and oviposition took place on bare ground or in sparsely vegetated areas. Males initiated courtship. Stridulation, posturing and vision were used in communication. At any moment, one to four males courted a female. Males mounted females from the side or the rear. Females rejected males by aggressive kicking, creeping away, hopping or flying off, raising or lowering the end of the abdomen or by raising the hindlimbs. Males sometimes mounted one another whereas no female was observed mounting other hoppers. Mean duration of copulation in the morning was 38.75±2 min and in the evening 24,67±4.5 min. About 84.2% of the 19 copulations observed occurred in the morning (0730 - 12.00h) and the rest in the evening. Males resumed search for females shortly after disengaging. Probing the soil by some females for egg laying was discontinued due to interference by males or unsuitable soil condition. The mean duration of egg laying was 60 ± 12 min. (range, 47-75 min.) Females covered the egg-pods with sand after laying.

INTRODUCTION

In the northern Sudan savanna and Sahel zones of West AFrica, the Sahelian plague grasshopper, *Oedaleus senegalensis* Krauss is a serious pest of millet (*Pennisetum americanum* L. (K. Schum) and minor pest of sorghum (*Sorghum bicolor* (L.) Moench). When the insect occurs in large populations, farmlands and gardens are heavily infested and millet leaves and grains may be completely eaten. At night, it usually swarms at street lights and in houses, thus constituting a nuisance to man. In some cases, the insect had chewed cloths left around the light at night.

The ecology and crop damage of 0. *senegalensis* have been extensively studied (Golding, 1934; Phipps, 1968; Hergert, 1975; Cheke *et al.*, 1980b; Amatobi, 1982). These studies contain scanty information

on the behaviour of the insect. Cheke et al. (1980a) reported on the behaviour of *O. senegalensis* but this did not contain detailed information on the courting, mating and oviposition of the insect. In early October 1986, a large population of grasshopper ocurred in Kano State of Nigeria. This provided an opportunity to study the courting, mating and oviposition behaviour of the insect in the field.

MATERIALS AND METHODS

Some observations on the behaviour of *O. senegalensis* were made at the Agricultural Research Station (A.R.S.) garden in Kano (12^{o}N, $8^{o}4'$E) situated in the northern Sudan savanna zone of Nigeria. The garden measured about 90m x80m and was bordered by a row of neem (*Azadirachta indica* A. Juss.) trees on the northern and southern parts. It had some bare ground as well as areas of dense and sparse vegetation. The predominant annuals consisted of two species of grasses, namely, *Brachiaria xantholeuca* (Hack ex Schinz) Stapf and *Dactylocteniuym aegytium* (Linn.) P. Beauv. and a herb, *Zornia glochidiata* Reichb ex DC. An observation plot measuring 5m x 4 m was demarcated in the garden with white ribbon. It was four metres from the nearest neem tree and had sparse vegetation.

Observations on courting in the grasshopper were carried out on 9 and 10, copulation on 112 and 12 and egglaying on 13 and 14 October, 1986. On each day, observations began at 07.00 h local time. To observe the grasshoppers, a worker walked slowly and cautiously towards the plot and stood or sat in the shade of a neem tree and recorded the behaviour of the insect. Occasionally, an 8 x binocular was used to view the grasshoppers at a distance. The pairs and individual grasshoppers respectively copulating and laying eggs in the plot were counted. Those that did not initiate their copulation in the plot were not counted. The time of commencement and termination of copulation and egglaying was noted. Those courting could not be estimated because the number involved in this activity ranged from several to many at any given moment. The use of the field glass combined with the sparse vegetation enabled the observer to view the insects.

RESULTS

Courting Behaviour

Courting was initiated by the males, and the females were approached from the front, rear or side. In frontal approach, a male hopped or flew towards a female, stopped momentarily and stridulated in a low key. Then it began posturing and stridulating probably to display itself. The female strudulated in response and the male hopped nearer orientating the body so that it was side by side with the female. Sometimes, as the male approached, the female kicked vigorously. In response, the male might stop the approach but more often it continued. The male moved slightly to the side and

suddenly hopped on to the back of the female. Sometimes, a male trailed and mounted it from the rear. In both cases, if the female was non-receptive, a struggle ensued as the female kicked aggressively to dislodge the male. A non-receptive female sometimes allowed the male to mount without showing aggression but raised or lowered the end of the abdomen to prevent copulation. A rejected male would sometimes continue to court the same female by tapping it with the forelimbs. Sometimes, a female prevented a male from mounting by lifting the hind femur above the dorsum. Females escaped from the harassing approach of males by creeping, hopping or flying away.

Males courted or mounted females irrespective of their level of receptiveness. Males usually competed for females and the number courting the same female at any one occasion ranged from 1 to 4. However, a receptive female could allow only one male to mount it at a time. Others were kicked away. A male also warded off other males from a female by positioning itself near the female and stridulating aggressively.

No female initiated courtship approach and there was no courting encounter between females. Stationary females were less attractive to males than mobile ones. Courting occurred on the ground or in areas with sparse vegetation and was usually terminated if the female escaped into an area with dense vegetation.

Males were attracted to the females but the mechanism operating was not investigated. A male striudlated vigorously when courted by another. However, some males still mounted others. A male dislodged another male with kicking movements similar to those of resisting females.

Copulating Behaviour

Nineteen pairs of *O. senegalensis* were observed copulating during the two days (Fig. 1). Four of the females carrying the males while laying eggs copulated with the males immediately after egglaying. The rest of the females did not readily copulate with males. Thus, males approached several to many females without success. A receptive female kept the end of the abdomen horizontal to the substratrum. To copulate, the male mounted the female and bent own abdomen to the left side of the female's abdomen; then turned the end of the abdomen upwards to brin ; it in contact wih the abdominal end of the female. As the copulation occurred, the female tapped its hindlimbs on the sustratum. The male sat on the female for a while and was soon dislodged through female kicking but without disengaging at the distal ends of their abdomens so that the pair were positioned side by side or end to end. The female dragged the male which was always smaller, as it moved and the male stridulated during every movement. Movements were few and slow in order to prevent premature disengagement. A pair in copulation repulsed interference

from other males by aggressively tapping their hindlimbs on the substratum. Approaching males strudlated in response, tapped their hindlimbs on the soil surface and sometimes moved away. Several attempts were made by non-copulating males to disengage a copulating pair. The females unlike the males fed while copulating.

To disengage, a copulating female hopped a little, stopped momentarily, crept a little and then disengaged. It rested for a while, crept and took a long flight of about 10m. The male rested briefly, crept and resumed search for another female.

Of the 19 copulating pairs observed, 84.2% of them occurred in the morning between 07.30 h and 12.00 h and 15.8% in the evening (Fig.1). The mean duration of mating in the morning (38.75±2.0 min) was not significantly ($P > 0.05$) longer than that in the evening (24.67±2.0 min)

Oviposition Behaviour

A gravid female ready to lay eggs had extended abdomen. It crept slowly with the tip of the abdomen on the ground or nearly touching it. It moved randomly and probed the soil apparently searching for a suitable site to lay its eggs.

To probe the soil, a female stretched the limbs so that the body was lifted from the soil surface (Plate 1). It spread the limbs apart and gripped the ground firmly with the claws. It bent the abdomen at an angle to the body axis so that the end pointed downwards. It then exerted downward pressure by pumping the abdomen up and down and at the same time moving it sideways. While probing, it rotated the body. As the abdomen penetrated the ground, it raised up one of the hindlimbs and moved it forward and backwards probably to increase probing pressure, while the fore-and the mid-limbs still gripped the soil. When the abdomen was well inserted into the soil, it moved the hindlimbs close to the abdomen and folded them (Plate 1).

Egg deposition probably began at this time. A femlae laying eggs did not readily move away when disturbed. Males mounted it without any resistance. As it deposited the eggs, it gradually withdrew the abdomen from the soil and at the same time stretched the limbs. On completion of egglaying, the female withdrew the abdomen from the soil and stood or fully stretched limbs (Plate 2). It moved a little forward and scraped the soil surface over the top of the hole leading to the eggpod with the claws of the hindlimbs. After the hole was covered, the grasshopper crept away from the spot, rested momentarily, hopped and finally took a long flight (between 20 - 30m).

Probing of the soil did not always lead to oviposition. As a result only six successful egglayings were observed. Approach of males during probing of the soil often caused the females to move away. Egglayings were always performed in bare ground areas. Throughout the observations, the females probed a total of 33 points; 18.2% (6 probings) of these resulted in egglaying (with a mean duration of

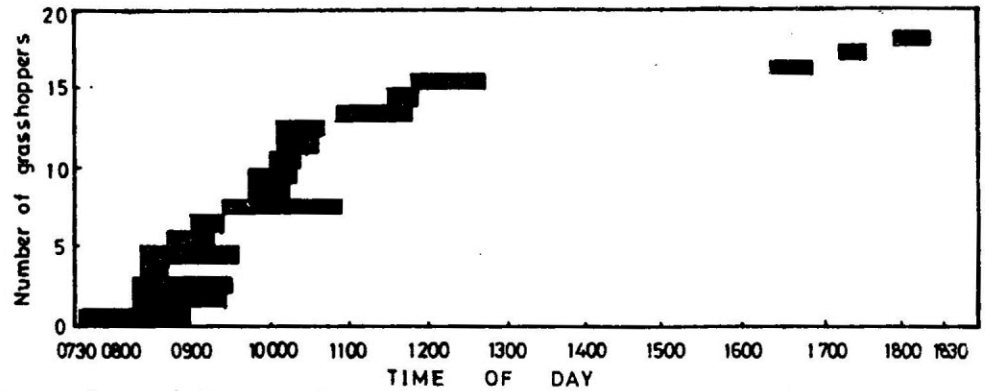

Fig. 1: Cummulative number of copulations of S. senegalensis and duration of the copulations during october 11 and 12 1986.

Plate 1 A female O. senegalensis egg laying position

(17.7±12 min), 27.3% (9 probings) were terminated due to unsuitable soil (with a mean duration of 22.2±7.6 min) and 54.5% (18 probings) failed due to male interference. (Fig. 2). Termination of soil probing was attributed to unsuitable soil condition if the females abandoned probing voluntarily. Results showed that 83% of the egglaying and 78% of the probings terminated due to unsuitable soil condition occurred between 0.900 h and 11.00 h. The harassing approach of males was pronounced between 11.00 h and 12.00 h (Fig. 2) during which 55.6% of probings were terminated due to male interference.

DISCUSSION

The peak period of courting activity coincided with decline in feeding activity. Amatobi (1982) found that *O. senegalensis* fed little in the late morning and early afternoon hours. This suggests that these activities are temporarily separated so that at any given time, one activity is usually dominant.

Four patterns of behaviour (striudlation, posturing, vision and caressing with forelimbs) were involved in courting. Stridulation, posturing and caressing were probably used in stimulating females, while vision and stridulation were important in locating and identifying females. It is speculated that pheromones from the Gomstock Kellog gland was involved in attracting male to female. Fraser and Nelson 91984) observed that in the Madagascan hissing cockroach, sound production and posturing by males were important in courtship which in that insect did not follow a rigid sequence of behaviour. This is similar to that of *O. senegalensis* in this study. However, the tendency of some males to court or mount other males even after exchange of stridulation was difficult to explain. It perhaps suggests that stridulation was not a precise means of communication, and that vision and stridulation were inadequate means of gender identification. Chapman (1969) noted that this pattern of courting behaviour was particularly common in some insects when females were scarce. This suggestion by Chapman seems to be the situation because up to four males were found courting a female.

The readiness with which females copulated with males immediately after egglaying seems to suggest that egglaying stimulates females to accept males. This is in contrast to the finding that some female insects may reject the males soon after oviposition (Chapman, 1969). It is also probable that the males of *O. senegalensis* exploited the open nature of the ovipositor and the favourable position of the abdominal end of the females after egglaying for easy insertion of their aedeagus. The bare ground or sparsely vegetated areas were probably preferred for copulation by the insect because these areas provided freer movement and less interference of vegeta-

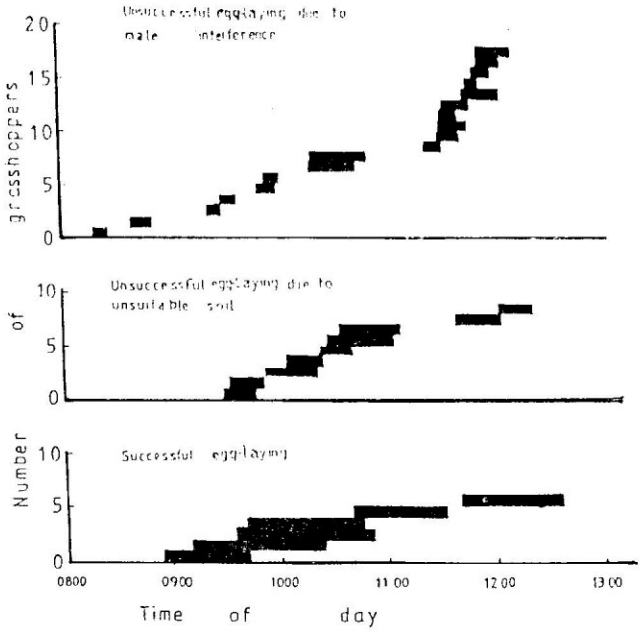

Fig.2: Cummulative number of soil probings without egg-laying and successful egg-layings by O. senegalensis and the duration of both activities during October 13and 14, 1986

Plate.2: A female O. senegalensis after egglaying

tion which could lead to abrupt disengagement. In contrast, vegetated areas were preferred for copulation by other grasshoppers such as *Kraussaria angulifera* Krauss (Bindra and Amatobi, 1981).

Dislodging of a male copulation was not achieved through interference by another male. In contrast, Ewing and Ewing (1984) found that in *Drosophila melanogaster*, interference by other males led to decamping or displacement. Eggs were not laid in areas with rough and large soil particles or on soils covered with litter. Other factors influencing the choice of oviposition sites of grasshoppers include physical and chemical nature of the soil such as soil particle and pH (Woodrow, 1965; Oyidi, 1975), availability of the food plants for the emergent nymphs (Chapman, 1969) and the amount of vegetation or bare ground (Clark, 1947); Cheke et al., 1980b; Amatobi, 1982). The choice of bare ground for oviposition would likely expose the egg pods to predators, adverse weather conditions and other physical damage. To protect the eggs, the females covered the egg pods with sand (Cheke *et al.*, 1980b; Uvarov, 1977).

The reproductive behviour of *O. senegalensis* can be exploited for its control. In a small scale outbreak of this geophilous pest species, one effective control measure would be to expose the egg-pods to desiccation by soil tillage after the first rain of the season (Amatobi, 1985) particularly in the areas with wind erosion. In the areas with less problem of wind erosion, egg-infested soil can be tilled a few months before the onset of rains. Popov (1980) also suggested that planting of millet could be delayed in the first rains in the areas with high egg-pod density of *O. senegalensis* until the emergent weeds had sufficiently grown to provide alternative food for the grasshopper. This control method may not be feasible in areas with very short rainy season where a little delay may adversely affect the maturity and grain yield of the crop. Egg-beds of the grasshopper could also be dusted with insecticidal chemicals just before the emergence of the nymphs so that the nymphs pick up the chemicals immediately after emergence. The incubation period of the grasshopper eggs after the first heavy rain of the season ranges from 8 to 10 days (Amatobi, 1985).

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