Rev. Biol. Trop. 36 (2B): 437-440, 1988.

Reproductive biology and behavior of *Doru taeniatum* (Forficulidae)

R. Daniel Briceño* and Wolfganf Schüch**
* Apartado 904, 1000 San José, Costa Rica.
**Spessartstraβe 83, 6465 Biebergemünd 1, West Germany.

(Rec. 12-I-1988. Acep. 21-VI-1988)

Abstract: This study deals with the biology of *Doru taeniatum,* (Forficulidae), particulary the habitat, feeding, reproduction, maternal care, and nymphal stages. The density of adults is higher in the older corn plants. The earwings were more often found at the top, where the leaves form a sheath in young plants. Corn fields are apparently colonized during the early stages of growth by males and females: this permits the development of a least one generation. Complex and sterotyped fights occur among males and the secondary sexual modifications of the cerci play an important role. During courtship, vibratory movements of the abdomen of the male were observed an many occasions. The power spectrum of the signal showed peaks at several frecuencies (5.4 Hz was the strongest) probably, the main function of these signals is to make the females more receptive during countship.

The distribution of Forficulidae is very wide, including 436 species within 65 genera (Sakai 1973). Very few species have been studied as regards general biology and behavior, probably because the order is small, mainly tropical, and most species are cryptic. In addition, earwings are not economically significant.

The present study deals with the biology of *Doru taeniatum,* particulary habitat, feeding, reproduction, maternal care, and nymphal stages.

MATERIAL AND METHODS

Field research was carried out between March and October, 1983. Samples were taken from a cornfield in the Provincia de Alajuela (Estación Experimental Fabio Baudrit, Universidad de Costa Rica). Voucher specimens have been donated to the Museo de Zoología, Universidad de Costa Rica and to the Museum of Comparative Zoology in Cambridge, Massachussettes (U.S.A.).

Counts were done from July through August. Samples were taken from two corn fields of approximately the same size (1500 m^2), with plants one and four months in age. In both fields, rows of aproximately 50 corn plants were chosen at random, and all individuals found on each plant were collected (468 plants were sampled in the old field and 315 in the young field).

The lenght of left cerci and both lenght and width of elytra were measured with a micrometer installed in a stereoscope. The reproductive state of females was determined by dissection. A micrometer was used to measure the lengths of eggs, with 95% confidence limit of ± 0.006mm.

An accelerometer pickup B & K 4375 connected to a preamplifier B&K 2735, was utilized to measure male courtship vibrations. A video camera with close up lenses, was used to record the movements simultaneously with the amplified signal on an oscilloscope.

Experimental animals were breed in captivity using dog food mixed with small quantities of yeast and pollen. Courtship, oviposition and maternal care data were obtained in the laboratory, unless other wise stated.

RESULTS

Diurnal activity and diet

The individuals studied, unlike some other Dermaptera, are active both day and night. Very little is known about the feeding habits of forficulids; some species are omnivores (Crum *et al.* 1941). Dissections of eight adults of *D. taeniatum* showed traces of vegetable matter including parenchyma and mesenchyma cells, as well as corn pollen in their digestive tracts. On two occasions adults were seen feeding on pollen during the day.

Nature and defense of refuges

The spaces between the leaf and the stem of corn (Fig. 1a) are used as shelters, mating sites, eggs deposites and for parental care of the nymphs. They probably provide protection against predators as well as the proper humidity for eggs and the nymphs.

The density (0.61 individuals per plant: 99 females, 96 males in 315 plants) in the older field was higher than that (0.22 per plant: 51 females, 55 males in 415 plants) in the younger field ($P < 0.01$, x^2 Test). The differences in the nymphal population were greater (2.06: 615 nymphs vrs. 0.03: 12 nymphs, per plant $P < 0.01$). The earwings were more often found at the top of the plant where the leaves form a sheath in young plants.

The elytra of fermales were smaller ($\bar{x}$ 3.17 ± 1.31 mm, n = 120) than those of males (3.40 ± 0.83 mm, n = 106) ($P < 0,01$, student-t Test). A positive relation exists between elytron length and cercus length in males (r = 0.51) (Fig. 1b). Figure 1b compares lengths of the cerci of paired and solitary males. Cerci of paired males were significantly larger (average 3.97 vs 3.65 mm, $P < 0.01$ student-t Test).

Complex and stereotyped fights among males were observed both on corn plants and in captivity. The secondary sexual modifications of the cerci play an important role in these fights. This behavior will be described in another paper (Briceño and Eberhard, in preparation). The males detend seech sites against intruders when aroused; they move backward and block the entrance with their cerci. If the intruder persists, the resident leaves the refuge and fights.

Courtship behavior

Courtship lasted from 1 to 45 minutes before copulation (n = 8). The male approches the female from behind and touches her with the antennae, then he turns 180° to direct his cerci towards the female. Subsequently he moves closer to the female, moving his cerci from one side to the other, until reaching her cerci. The male intermintenly tries to mate, turning the posterior part of the abdomen 180° and inserting it under her abdomen. If the female is not receptive, she moves away and/or pushes the pygidium against the substrate, rendering copulation impossible. In many cases the male responds to this behavior by quickly vibrating his body and/or rubbing the female's abdomen with his cerci for a few seconds to later make a new miting attempt. When the female is receptive she raises the posterior part of the abdomen and copulation occurs: the male's cerci are now against the ventral side of her abdomen (n = 8, d.s. = 3.87); after this, there generally was a second copulation.

During courtship, rapid movements of the male abdomen were observed on many occasions, often when the male first established contact with the female. No air borne sound was detected with a stethoscope made from rubber tubes connected, from the ears of the observer, to the interior of the observation chamber. Measurements with the accelerometer showed that the male movement transmits vibrations to the sustrate.

Here, each group of vibrations is called a *series*, each consisting of vibrations separated by pauses (Fig. 1c). Using the accelerometer and a videotape, 22 signals in eight series were evaluated in one male; the mean duration of a vibration was 266 ± 97 milliseconds, while the mean pause was 1533 ± 640 miliseconds. The mean duration of vibratory movements, according to the video-analisis, was 248 ± 36 milliseconds, and vibratory movements ocurred while vibration was recorded.

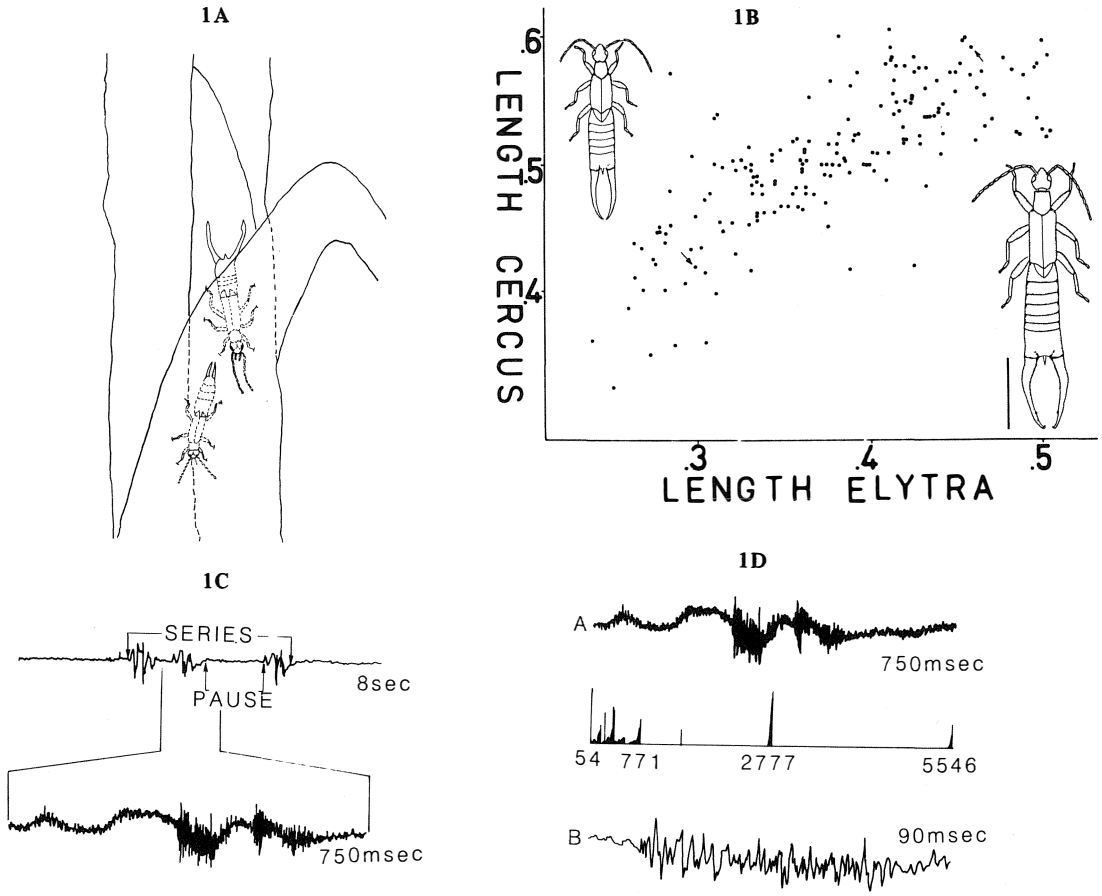

Fig. 1a. Males and females of *Doru taeniatum* are frequently encountered alone or in pairs between the stalk and the leaf of corn plant in the field. The males defend seech sites against intruders by moving backward and blocking the entrance with their cerci. If the intruder persists, the resident leaves the refuge and fights. Fig. 1b. Relation between body size (elytrum) and cercus length of males of *D. taeniatum* (coefficient of correlation = 0.51). Fig. 1c. When a male *D. taeniatum* detects a female, he produces a series or 1-6 vibratory signals that are similar in duration and regulary spaced. Fig. 1d. Power spectrum of vibratory signal of male *D. taeniatum*. There are several peaks, the strongest at 5.4 Hz.

The power spectrum of the signal (Fig. 1d) showed peaks of various frecuencies, 5.4 Hz being the strongest.

Additional information was obtained from a video-tape analysis of six other males: the series showed a mean duration of 544 ± 70 milliseconds, with no significant difference between males (F-test, F = 2.45, N1 = 5, N2 = 40, P > 0.05). The interval between two signals is 1277 ± 100 millisencods (n = 43), The F-test showed no significant differences between male individuals (F = 2.37, N1 = 5, N2 = 60, P > 0.05).

Oviposition and maternal care

The interval between copulation and egg laying is 1-30 days (n = 12. d.s. = 2.57). The eggs, which are oval and cream colored, were usually found near, or on, the sponge that was used to maintain humidity in the petri dish. Egg laying took from 1 to 2 days. The females laid most eggs at the initiation of oviposition, but added a few later. In captivity the mean number of eggs per clutch was 40.3 ± 4.05 (n = 33) while in the field the average was of 53.37 ± 2.58 (n = 25) ($P < 0.05$). The

average length of the eggs was 0.95 mm one day after laying. Hatching ocurred a mean of 8.9 ± 1.4 days after oviposition (n = 22). Hatching lasted from 1 to 2 days within a litter. Hatching percentaje in the laboratory was high (80% ± 4.4, n = 31).

The female manipulates the eggs with her mouth, rotating them with quick movements of the palps. This behavior has been interpreted as a form of cleaning (Lamb 1976), and in the absence of *D. taeniatum* females in the laboratory, the eggs were quickly attacked by fungi and mites.

The females generally moved the eggs one by one with the mouth, especially when the dish was handled. They defended the eggs agressively, pointing the cerci towards the cause of disturbance, and trying to pinch it.

One day, the position of three females with respect to their eggs was recorded at 30 minute intervals for four hours; 76 % of the time they were above the eggs; occasionally they were besides the eggs (23%) and very rarely at a short distance from the eggs (3%). Females apparently feed while defending eggs, although occasionally, when annoyed they may eat the entire clutch.

During the hatching period some nymphs nibble the eggs (the female showed no agressiveness towards these nymphs) and finally ate them. After hatching, the nymphs remained in groups (4-6 days). Maternal care consisted of protecting the numphs under the female abdomen. As time elapsed, agressiveness between nymphs increased in the form of interactions with antennae and cerci. Groups of nymphs covered by a female were also observed in the field.

Individuals needed from 5 to 6 moults to reach maturity and the total nymphal stage lasted a mean of 66.3 days ± 10.73 (n = 15).

DISCUSSION

The fact that there were more individuals in the older cornfields could be due to one or both of the following causes: (1) mature cornfields may have better microclimatic conditions for reproduction; (2) migrating individuals accumulate as the corn grows. Corn is an annual crop that takes about four months to reach maturity. Therefore, cornfields are short term habitats. Cornfields are apparently colonized during the early stages of growth by both males and females of *D. taeniatum:* this permits the development of a least one generation (75,2 days). In the Central Valley of Costa Rica there are corn fields growing in some areas throughout the year. Although the species is abundant, it has not been reported as a problem in corn cultivation.

Communication by means of substrate vibration during courtship and mating is common among arthropods (Markl 1969, 1973, Michelsen 1982, Keuper and Kuhne 1983). This investigation shows, for the first time, the use of this type of signal in a dermapteran. In this species the main function of the signals probably is to make the female more receptive during courtship. This interpretation is supported by the fact that the male movements increased when the female was unresponsive.

ACKNOWLEDGMENTS

We thank F. G. Stiles, L. Hilje and especially W. Eberhard for criticizing preliminary versions of the manuscript, H. Steinman for identifying the earwings, the Vicerrectoría de Investigación of the Universidad de Costa Rica, D.A.A.D. and Smithsonian Tropical Research Institute for financial support.

REFERENCES

Crumb, S. E., P. M. Eidi & A. E. Bonn. 1941. The european earwing. Tech. Bull. U. S. Dept. Agric. No. 766.

Keuper, A. & R. Kuhne. 1983. The acoustic behavior of the bushcricket. *Tettigonia cantans* II. Transmision of airborne-sound and vibration signals in the biotipe. Behav. Proc. 8: 125-145.

Lamb, R. J. 1976. Parental behavior in the Dermaptera with special reference to *Forticula auricularia* (Dermaptera: Forficulidae). Canadian Ent. 108.

Markl, H. 1969. Verstandigung durch vibrations signale bei arthropoden. Naturwissenschaften 56: 459-505.

Markl, H. 1973. Leistungen des vibrationssinnes bei wirbellosen Tierres. Fortschr. Zool 21: 99-118.

Michelsen A. 1982. Plants as transmission channels for insect vibrational songs. Beh. Ecol. Sociobiol 11: 269-281.

Sakai, S. 1973. Dermapterum Catalogus IV. Diato Bunka University, Tokyo, Japan.