OBSERVATIONS OF INTERACTIVE BEHAVIOR IN *PARANDRA GLABRA* (COLEOPTERA: CERAMBYCIDAE)[1]

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ABSTRACT: The first observed behavioral interactions for a species of Parandrinae (Coleoptera: Cerambycidae) are reported. Two sets of observations between males and females of ***Parandra glabra*** were made under artificial conditions: 1) individual male/female interactions; 2) interactions of multiple males in the presence of each female. Results of individual interactions indicate consistent patterns of behavior including antemation, mandibulation, genitalic exsertion, mounting, and dorsal-obliquemating posture. Males display aggression in first encounters with females, but subsequent antemation leads to mounting and copulation attempts. When more than one male is present with a female, these behavioral categories are directed toward other males more frequently than to the female.

Intraspecific interactions in longhorn beetles can range from violent, indiscretionary encounters to complex, deliberate engagements, but the literature contains few descriptions of these. Most observations are simply noted in more expansive papers concerning other biological or systematic issues. Michelsen (1966) focussed on interactive behavior when he provided the most detailed and widest coverage for behavior (especially with regard to courtship and copulation) in longhorned beetles. He provided data on species representing four different subfamilies of longhorns (Aseminae, Spondylinae, Lepturinae, Cerambycinae). His behavioral observations were placed into 25 categories and a wealth of additional anecdotal information was included. Other referentes are restricted to fewer (usually one) species and often are much more general: Webster (1904) made interesting observations on ***Oberea ulmicola*** Chittenden (Lamiinae); Goldsmith (1987a, 1987b, 1989) examined mating systems of three species, ***Trachyderes mandibularis*** Dupont, ***Perarthrus linsleyi*** (Knull), and ***Stenaspis verticallis arizonicus*** Casey (all Cerambycinae); Hughes (1981) examined mating behavior in ***Monochamus scutellatus*** (Say) (Lamiinae); Piper (1977) discussed mating behavior in ***Hippopsis lemniscata*** (Fabricius) (Lamiinae); Chemsak (1965) commented on habits of ***Oeme costata*** LeConte (Cerambycinae); Chemsak and Linsley (1971) observed mating behavior in ***Rosalia funebris*** Motschulsky (Cerambycinae); and Wang, et al. (1990) looked at the complex mating behavior of ***Paraglenea fortunei*** Saunders (Lamiinae). This study on ***Parandra glabra*** (DeGeer) represents the first information on behavior in Parandrinae.

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MATERIALS AND METHODS

This study was undertaken at Monteverde Biological Reserve, Monteverde, Costa Rica. Three males and three females of ***Parandra glabra*** (DeGeer) were collected at lights, measured, and their date of collection noted. Measurements were taken of the total body length (from the base of the mandibles to the apex of the elytra; body width (distance between elytral humeri); length of mandibles (from the base to farthest point along medial axis) for correlation analyses. These data are listed in Table 1.

Table 1. Data for specimens of ***Parandra glabra*** (DeGeer) used in this study.

Specimen code (sex/#)	Length	Width	Mandible length	Date of Capture
M1	29 mm	9.5 mm	5.0 mm	22/May/1993
F2	31 mm	9.5 mm	3.0 mm	22/May/1993
M3	30 mm	10.0 mm	5.0 mm	23/May/1993
F4	28 mm	9.0 mm	2.5 mm	25/May/1993
F5	32 mm	10.5 mm	3.0 mm	28/May/1993
M6	32 mm	10.0 mm	6.0 mm	30/May/1993

Specimens were marked on the base of the right elytron with an indelible black-ink marker. The beetles were simply coded with the number of the collection, "1-6". The beetles were kept separately in a small plastic container which was equipped with plastic dividers creating twelve separate holding cells. Damp wood was placed in each cell with the beetles.

After several days of observing the beetles, their highest activity appeared to be at night, from 22:00 - 02:00. Formal observations were made during this period under low light conditions. Although specimens were strongly phototaxic to acute sources of light, low and diffuse lighting did not appear to alter their behavior.

Two sets of investigations were made. The first involved nine pair comparisons of behavior between each male and female. The last focussed on interactive behavior when each female was placed with all three males. Each combination was observed for 20 minutes.

RESULTS

Observations: one on one male/female interactions

Noted behaviors included antemation, mandibulation, genitalic exsertion, genitalic contact with substrate, mounting, and copulation. The number of incidents (or merely presence/absence) of these behavioral activities for each 20 minute observation period is indicated in Table 2.

Antennation and mandibulation

Males and females each opened their mandibles widely after initial contact. In most cases, the male relaxed and closed his mandibles after antennation of the female. In two instances, males bit the females upon initial contact but this was never repeated after further antemation.

Genitalic exsertion and substrate contact

In most cases, after prolonged antemation of the terminal abdominal segments of the female, the males exserted their genitalia partially or distended the region between the last two ventrites. This occurred an average of 2.9 times per male for each 20 minute observation period. In most cases the males would rub their genitalia on the substrate (the wood, container bottom, or container side) and in several cases on the female (the prothorax, mandibles, or elytra). It was distinctly obvious that muscular control of the genitalia, directing it downward, was being affected, and in most cases, the males would reverse walking direction several times during this behavior, rubbing the genitalia back and forth.

Mounting

Mounting of the female occurred an average of 2.2 times for each 20 minute observation period. In two pair combinations it did not occur. Both of these instances involved female #2, the only female not observed to copulate. Mounting usually occurred after contact with the female and antemation by the male, usually around her terminal abdominal segments. Usually in this scenario the females continued walking, somewhat oblivious to the male antemation. The male would then follow the female, maintaining contact and would mount her. In many cases, mounting would occur from the side as the female became "trapped" in a corner or against the piece of wood. This method was similar to that observed commonly in *R. funebris* (Cerambycinae) (Chemsak and Linsley, 1971). In some cases, after head-to-head contact between the pair, the male climbed on top of the female opposite her orientation, and in some cases, exserted his genitalia so it contacted her mandibles and prothorax. Often, a mounting involved probing by the male genitalia in search of the female's. The ratio of mountings to copulations was 4:1.

Copulation

Copulation is here defined as a visible, sustained contact between male and female genitalia. Transfer of sperm to the female could not be determined and thus was not a criterion for this category. Copulations were observed in four of the nine pair combinations. In one pair combination (male #1; female #5), copulation occurred twice during the twenty minute observation period. Copulations ranged in duration from 50 to 240 seconds, averaging 101 seconds. I interrupted a copulation in one instance as I was attempting to document it with a photograph. In every instance, despite preliminary mounting orientation, copulations occurred with the male atop the female in a slightly oblique position (ca. 30° from female central axis). The males extended their terminal abdominal

segments outward and probed with their genitalia for the female genital opening. The males did not forcibly extrude the female ovipositoras has been witnessed in other longhorn species (Michelsen, 1966). In many other longhorn species, Michelsen (1966) observed the male to actually leave the female's dorsum during copulation and in many cases face the opposite direction. During four of the five copulations, the female showed motility. In the one copulation where the female remained stationary (the second copulation of male #1 and female #5), pulsation of the male occurred about 45 times (about once every 5.5 seconds). This pulsation behavior was also noted in *R. funebris* by Chemsak and Linsley (1971). They witnessed this to last from 30 to 60 seconds and occur about once every four seconds. During this time the female remained motionless during the four-minute copulation. Interestingly, four of the five copulations involved female #5; female #2 had no copulations; and female #4 had only one.

Observations: all males in presence of individual females

For each of the three females, all three males together were placed with her and their actions were observed for about 20 minutes. Copulation was never observed in any of the three sets of observations; genitalic exsertion and rubbing on other males was observed in the presence of each female; same-sex mounting was observed in each combination; and a few instances of aggression between males was observed.

Femaie #2

All three males contacted and mounted one another. Antennation of another male's sternites by each male was observed. Two instances of aggression were observed (male #6 biting male #1; male #6 biting male #3). Genitalic exsertion among the males was common during their juxtaposition, and they often rubbed their genitalia on one another. Mounting of the female occurred only once (by male #6); otherwise attention by males was directed toward other males.

Female #4

The same behaviors as above were noted with the addition of the following: male #6 was seen rubbing his genitalia on the container. For a few minutes, all the males were in contact with the female and began mounting one another with their genitalia exserted.

Femaie #5

Little attention was given to her as the males continued to mount and congregate with one another.

DISCUSSION

Because of the artificial conditions of this study and the small sample size of individuals, interpretation and generalization of the observations is made with caution. No correlations between size and exhibited behavior were evident from this study. Antennation seems to play an important role in the identification of females by males. Although observations of antennation were focussed on and biased toward males, it is evident that antennae are used to a greater extent by males than females. Obvious female antennation subsequent to a male encounter was rarely observed. Based on the rapidity in which males determined females by antennal contact (and then relaxed their mandibles and aggressive behavior), the antennae may have a great sensitivity to some chemical exudate of the female. Once the male established the presence of the female, subsequent contacts were the stimulus for his genitalic exsertion. In many of these instances, the male would rub his genitalia on the substrate and/or female. Based on observations of this behavior in both sets of experiments, it is possible that the male may be secreting some chemical, perhaps as a stimulus to cause the female to be receptive for copulation or as a chemical indicator of his presence to other males.

Further study, both in natural conditions and with individual, laboratory reared specimens, is essential to understand the observations and interpretations presented herein. The phenomena of sperm precedence, male and female pheromones, body and mandible size correlations to mating success, and average number of mountings for each copulation or number of copulations required for successful sperm transfer, are interesting questions that may be addressed upon further study of the Parandrinae.

Table 2. Summary of behaviors expressed by *Parandra glabra* (DeGeer) during the individual male/female pair combinations. A = antemation; MA = mandibulation; GE = genitalic exsertion; GS = rubbing of genitalia on substrate; MO = mounting; C = copulation. For each category, numbers indicate number of observations of behavior, except for antemation which occurred numerous times in all pairs and is simply indicated with a checkmark. Duration of the five copulations is measured in seconds.

Pair code (sex/# X sex/#)	A	MA	GE	GS	MO	C
M1XF2	√	0	1	1	0	0
M1XF4	√	0	4	2	3	1 (50s)
M1XF5	√	0	4	1	5	2 (65s & 240s)
M3XF2	√	1	3	1	2	0
M3XF4	√	0	2	0	1	0
M3XF5	√	0	5	3	4	1 (60s)
M6XF2	√	1	2	1	0	0
M6XF4	√	0	1	0	1	0
M6XF5	√	1	4	1	4	1 (90s)

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