Noldus
Information Technology

How to watch behavior underground and in the dark: studies on a nocturnal subterranean beetle

Anne Rasa

Using The Observer for Animal Behavior Research

The behavior of most beetles is difficult to observe in detail. When it comes to a species like *Parastizopus armaticepts* (a member of the Tenebrionidae, the flour beetles), that is not only relatively small (1.3 cm) but also active at night and performs most of its interesting behavior in a burrow underground, then the problems are compounded. Parastizopus occurs in the wind-erosion sand deserts of south-western Africa and is especially common in the southern Kalahari, where our research group studies its behavior in the field. As far as the evolution of sociality in beetles goes, this species is unique because it is the only one known where the larvae are not only cared for by both parents, who perform different tasks, but this parenting is also extended to the pupae and finally the young beetles. When they are mature enough to survive on the surface at 14-16 days old, older young then help to take care of younger ones by bringing food to the breeding burrow.

Observing burrowing behavior in the lab

All aspects of mating, parental care and sibling help take place at night or underground, making detailed behavioral observations in the field impossible. To solve this problem, we developed a method of recording behavior on videotape under semi-natural conditions in the laboratory. Female beetles come out on the surface at night to search for food, detritus, which they then carry back to the breeding burrow in their mandibles. In order to allow this search, we developed an apparatus that not only lets us observe what is going on inside the burrow but also the female's surface activity. We used a 50x50x30 cm glass terrarium into which we put a 50x49x20 cm light-colored PVC insert. This was inverted inside the terrarium so that its floor formed a surface over which the female could walk. The 1 cm difference in size between the insert and the front of the glass terrarium left a gap of 20 cm deep which was filled with Kalahari sand, which was also scattered over the insert to simulate a natural sand surface. The gap between the insert and the front wall of the terrarium was the only place where the beetles could dig their breeding burrow and their behavior inside the burrow could be easily observed through the glass.

Time-lapse video recording

Because the beetles are active throughout the night we used time-lapse video cassette recorders (Panasonic AG-6730) which, set at a time-lapse ratio of 1:4, could record the entire 12 h nocturnal activity phase on a single 3 h tape. The VCRs had a built-in time code generator (Panasonic AG-IA670). To film the behavior, we used Panasonic WV-BL600 cameras fitted with a macro-zoom lens (12.5-75 mm). A 40 W red bulb 20 cm in front of the terrarium provided enough light for filming without disturbing the beetles. The light color of the PVC insert gave maximum contrast with the beetles' black bodies and allowed even antennal movements to be seen. We distinguished between the sexes by marking the female with white waterproof paint on the sides of the elytra, these being the most easily visible parts of her anatomy while she is in the burrow. Another problem was the male, who excavates the breeding burrow, continues to extend it throughout reproduction and thus creates burrows that can reach a length of over 30 cm. This made it impossible to include an entire burrow within the focus of a single camera if the behavior of the beetles within it was to be visible. We therefore connected two cameras to a video mixer (Panasonic Color Quad WJ-450), each camera covering half the burrow. Since the 'quad' is designed to be used with four cameras, we were either able to record the behavior in two burrows simultaneously, as shown, or alternatively mount two of the cameras above the terrarium to record the female's activity on the surface.

Data collection and analysis

Films were analyzed using The Observer Video-Pro, version 3.0, on an IBM-compatible PC. The software was perfectly adequate for our purposes since we required information on the total frequency and duration of the behavior patterns we coded for both male and female. The Observer also gave us other important information, such as the latency to the first occurrence of each behavior pattern and the behavioral sequence for both sexes. The latter, however, could only be printed as raw data and has to be worked out by hand. The Observer allowed the time-consuming analysis of tapes to be completed by an experienced person in little longer than the time required to play them back, a real advantage in behavioral studies.

For anyone needing to study behavior of small, nocturnal, subterranean animals, such as Parastizopus, where direct observation is practically impossible, we can heartily recommend the above setup, which has been running successfully in our laboratory for five years. Through it, we have been able to discover some unique behavior patterns that have hitherto never been described for beetles or their larvae and to answer many of the puzzling questions as to how such complex parental behavior evolved in this species.

References

1. Rasa, O.A.E. (1997). Female mate assessment tactics in a subsocial desert beetle: a test of Janetos' models. *Ethology, Ecology & Evolution*, **9**, 233-240.
2. Rasa, O.A.E. (1999). Division of labour, extended parenting and sibling help in a subsocial desert beetle. *Ethology*, **105**, 37-56.
3. Rasa, O.A.E.; Bisch, S.; Teichner, T. (1998). Female mate choice in a subsocial desert beetle: male phenotype correlates with paternal effort and reproductive success. *Animal Behaviour*, **56**, 1213-1220.

Contact Information

Anne Rasa. Department of Ethology, Institute of Zoology, University of Bonn, Bonn, Germany
E-mail: a.rasa@uni-bonn.de