

Effect of Reproductive Maturity, Density, Body Size, and Sex on Feeding Behavior, Body Mass, and Body Condition in Adult Burying Beetles *Nicrophorus pustulatus*

L. Augustine, S. Cline, J. Creps, V. Creps, L. Grobeck, L. Sinclair, A. Wright, and C. Rauter



Department of Biology, University of Nebraska at Omaha

Introduction

Animals using carrion as food resource face special challenges. Although carrion is a food resource of very high quality, it is not only rare but its occurrence is also unpredictable in time and space. During sexual maturation, interactions among individuals on carrion are often non-aggressive and they feed side-by-side from carrion. At sexual maturity this may change, especially when carrion is monopolized for reproduction. With increasing population density, competition over carrion usually increases leading to more aggressive interactions among individuals. Larger individuals are more likely to win aggressive interactions and gain and maintain access to carrion. Large individuals have therefore better body condition than small individuals.

The **purpose of this study** was to investigate the effects of reproductive maturity, density, body size, and sex on feeding behavior, body mass, and body condition in the burying beetle *Nicrophorus pustulatus*.



Burying Beetle *Nicrophorus pustulatus*

Nicrophorus pustulatus (Coleoptera: Silphidae) was the organism studied. These burying beetles are black with three orange spots on each elytron. They are nocturnal and are found in deciduous forests in the eastern United States.

Burying beetles have a holometabolic life cycle including eggs, larvae, pupae, teneral, and sexually mature adults. Tenerals (sexually immature beetles) use carrion only for food whereas sexually mature adults use carrion not only for food, but also for rearing their brood.

Burying beetles use carrion to reproduce. If a male, in the absence of a female, discovers a carrion, the male will release a sex pheromone to attract a female. Together, the male and female prepare the carrion by removing fur or feathers and applying secretions that contain preservative qualities. The females lay eggs underneath the buried carrion within 12 to 48 hours after encountering the carrion. *N. pustulatus* provides bi-parental care to the larvae. Care includes feeding larvae by regurgitating carrion. Both parents defend the brood from intruders. They also remove micro-organisms in order to keep the carrion clean.

Results

Feeding Behavior (Figure 1)

- All beetles spent more time feeding as they matured ($F_{1,71} = 16.17, P = 0.0001$).
- With increasing density, all beetles spent more time feeding ($F_{3,71} = 8.41, P < 0.0001$).
- Body size and sex had no effect on time spent feeding ($F_{1,71} = 0.00, P = 0.96; F_{1,71} = 1.06, P = 0.31$).

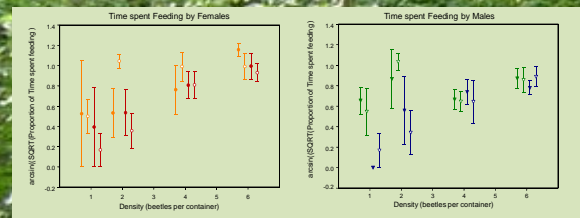


Figure 1: Effect of reproductive maturity, density, body size, and sex on time spent feeding. Means and standard errors are shown. Sexually immature beetles: orange and green; sexually mature beetles: red and blue. Large beetles: filled circles and triangles; small beetles: open circles and triangles.

Body mass

- All beetles gained body mass as they matured ($F_{1,92} = 16.14, P = 0.0001$), but females gained more body mass than males ($F_{1,92} = 10.03, P = 0.002$).
- As expected large beetles were heavier than small beetles ($F_{1,92} = 162.64, P < 0.0001$).
- Density and sex had no effect on body mass ($F_{3,92} = 2.80, P = 0.05; F_{3,92} = 2.66, P = 0.11$).

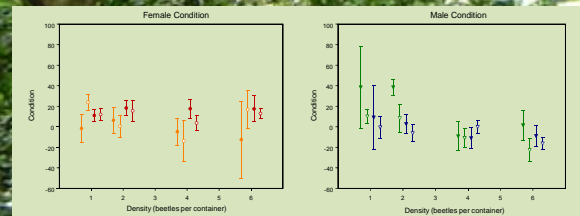


Figure 2: Effect of reproductive maturity, density, body size, and sex on condition. Means and standard errors are shown. Sexually immature beetles: orange and green; sexually mature beetles: red and blue. Large beetles: filled circles and triangles; small beetles: open circles and triangles.

Body Condition (Figure 2)

- Overall, maturation, density, body size, and sex did not affect body condition ($F_{1,92} = 0.02, P = 0.89; F_{3,92} = 1.69, P = 0.18; F_{1,92} = 0.60, P = 0.44; F_{1,92} = 0.96, P = 0.33$). Body condition of females, however, improved as they matured while the body condition of males declined ($F_{1,92} = 9.18, P = 0.003$).

Conclusions

- The increase of time spent feeding as density increased suggests that when competition over food becomes stronger, focusing on feeding may be advantageous.
- The increase in time spent feeding as beetles mature and the corresponding improvement in body condition of females supports earlier findings that egg production and parental care are energetically costly for females thus requiring large body reserves.

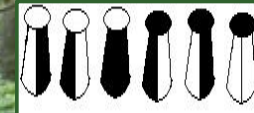


Figure 3: Paint marks on beetles

Methods

Density

- At emergence as tenerals, the beetles were assigned at random to densities of 1, 2, 4, or 6 beetles per container. Males and females were kept separately.
- The beetles were kept at 9 hours of dark and 15 hours of light at room temperature and fed wet cat food (@ Science Diet) ad libitum twice per week.

Body Size

- Body size was determined by the width of the pronotum (mean \pm se: 6.82 ± 0.03 mm; $N = 248$). Beetles with a pronotum larger than the average width of 6.82 mm were classified as large beetles, while beetles with a pronotum smaller than 6.82 mm were classified as small beetles.

Behavioral Observations

- The burying beetles were observed twice: first as sexually immature beetles 7 to 16 days after emergence and secondly as sexually mature beetles 24 to 29 days after emergence.
- To be able to identify beetles individually, each beetle was marked with a metallic marker on the pronotum, elytra, or both (Figure 3).
- At begin of each observation, 1 gram of wet cat food on a small petri-dish lid was placed in the center of each observation container (Figure 4).
- A 3x5 grid with 15 different locations was placed on the bottom of each container to observe the beetles more efficiently (Figure 4).
- The beetles' behavior was recorded every minute for 20 minutes.
- Each observer was responsible for 3 to 4 observations sessions per day with no more than 3 beetles at a time.

Body Mass and Body Condition

- All beetles were weighed twice: first as sexually immature beetle 9 to 14 days after emergence and secondly as sexually mature beetle 31 to 34 days after emergence.
- Body condition was calculated, separately for sexually immature and mature beetles, as the residuals of the regression of body mass on pronotum width (sexually immature: $r = 0.83, P < 0.0001$; sexually mature: $r = 0.95, P < 0.0001$; $N = 248$).



Figure 4: Beetle in observation container with cat food.

Acknowledgements

This research was funded by NSF STEP grant NSF-0336462.