Male horn dimorphism in the scarab beetle, *Onthophagus taurus*: do alternative reproductive tactics favour alternative phenotypes?

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Fig. 1

Matt Knabel

- **Secondary sexual traits are seen in some species to be discontinuous leading to co-occurrence of two distinct phenotypes (Anderson 1994). This is seen in the horns of the Scarab beetle (discrete rather than continuous).**
  - **<u>Continuous</u>** – Wide range of variation (Hair Color)
  - **<u>Discrete</u>** – Either/or (long horns or no horns)

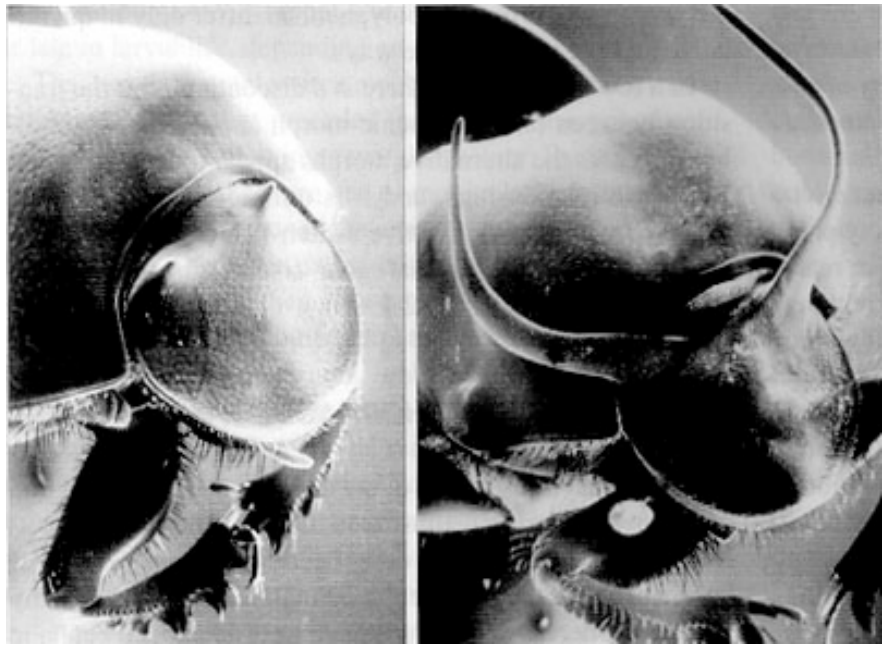
Fig. 1

The Scarab Beetle

- Feeds off of dung.
- Burrows tunnels beneath these piles.
- Intense competition for tunnels under dung pads containing mating females.
- At a critical mass, large horns grow.

Dimorphism

- **Two distinctly different phenotypes**
  - **Large-Small**
  - **Horned- Hornless**
- **Two distinctly different mating behaviors between the two phenotypes**
  - **Head-to-head**
  - **Sneaking and agility**



Drawing by Shane Richards

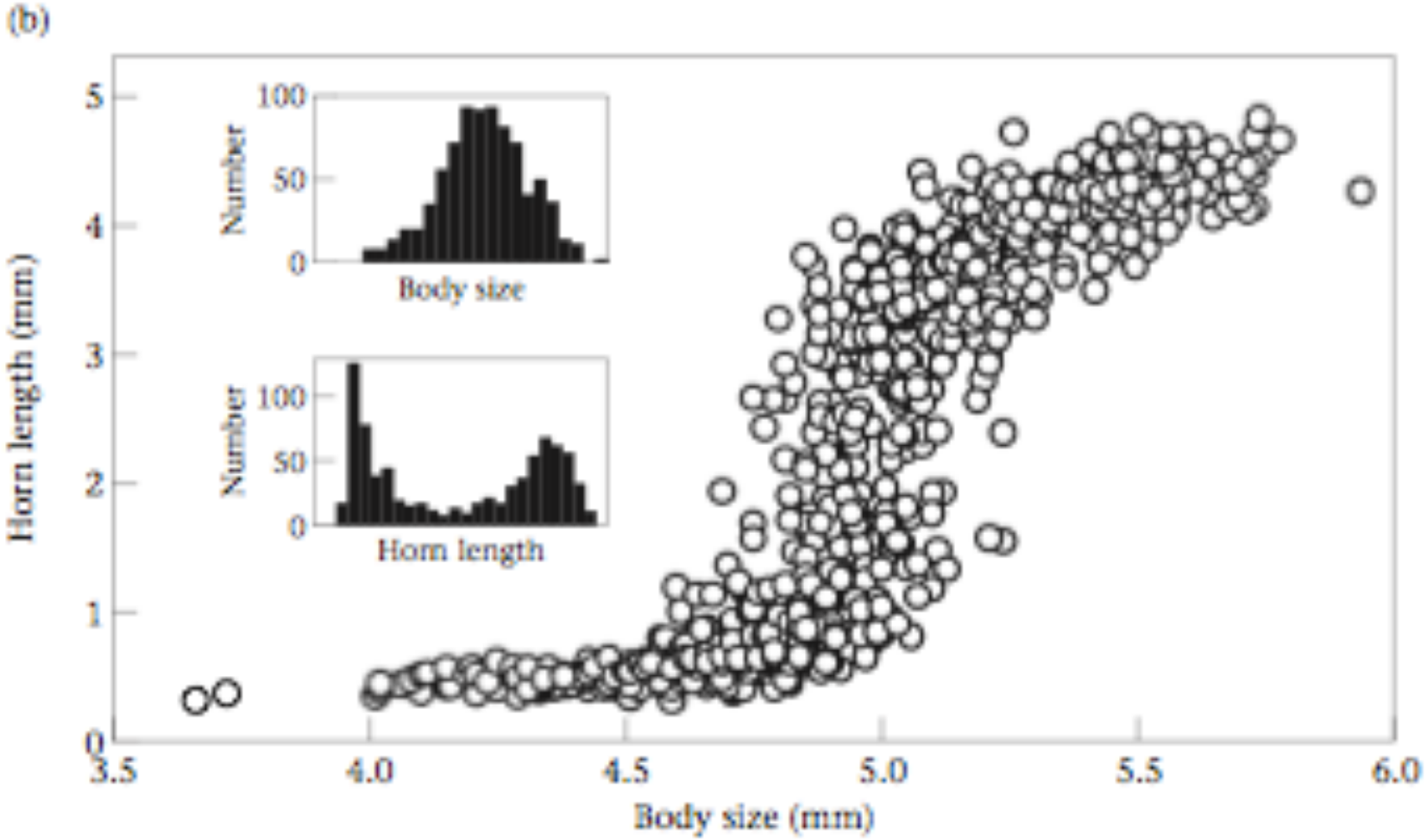


Fig. 1; Paulian 1935; Moczek 1996, 1998; Hunt & Simmons 1997; Emlen & Nijhout 1999; Moczek & Emlen 1999.

Overall Objective

- **Produce experimental and behavioral data suggesting that the alternative mating tactics selectively favor discretely different male phenotypes.**

Experimental Set Up

- **Observation nests (similar to ant farms) with with tunneling through sand/soil and dung.**
- **All imaging done dark room with red-filtered light.**
- **Competition of two males over a single female**.
  - First male given 2 hrs to adjust to the observation nests before introduction of a second male.
  - Competition was judged by which beetle left the tunnel.

Three sections of testing

- **Observation of Male Reproductive Behavior**
  - 67 competitions (19 – horned males, 17 – hornless males, and 31 – horned and hornless).
- **Male Fighting Performance as a Function of Horn Length**
  - 27 competitions between beetles of the same size, but differing horn lengths.
- **Male Agility as a Function of Horn Length**
  - Comparisons of speeds between horn lengths.

Results Horned Males

- **Head-to-head combat.**
- **Pushing and jerking of head to push the weaker male out of the tunnel.**
- **The larger beetle won the majority of competitions.**

Results Hornless Males

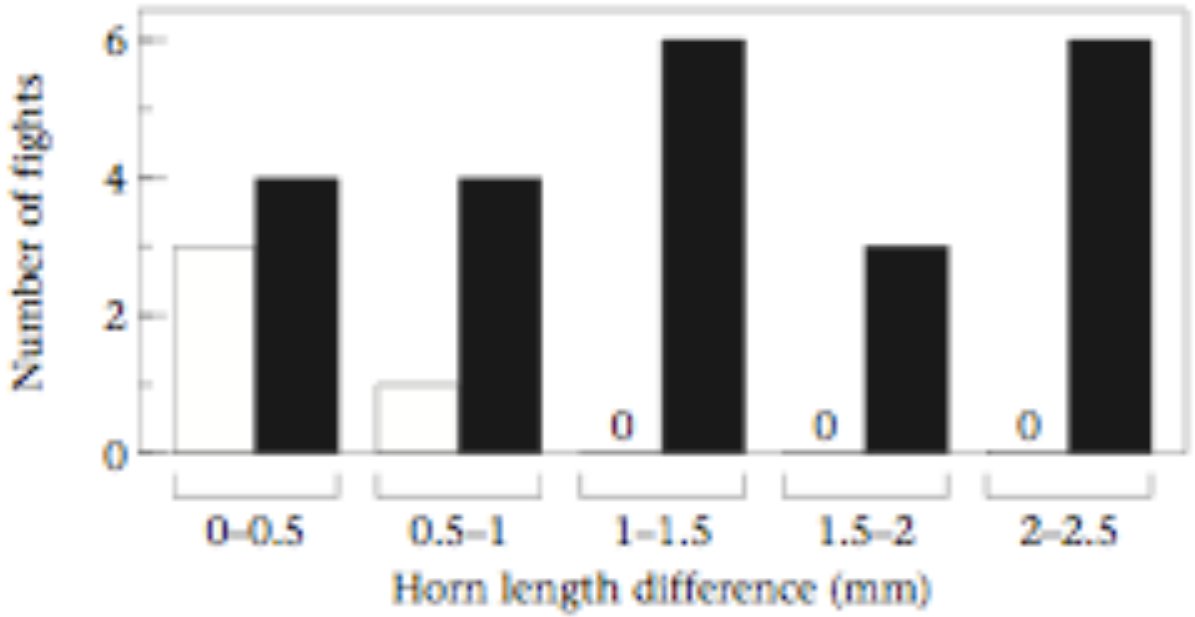
- **Head-to-head pushing and jerking.**
- **The defeated male remained close to the tunnel and repeatedly attempted to gain entry.**

Results Horned and Hornless Males

- **The behavior of the hornless males was found to differ when faced with a horned male.**
- **When head-to-head, the bigger horned beetle won quickly every time.**
- **Three ways the hornless male gained entry and mate.**
  - Quickly entered and mated (agility and maneuverability).
  - Mated while female was leaving the tunnel for dung.
  - Use of accessory tunnels to gain entry to main tunnel.

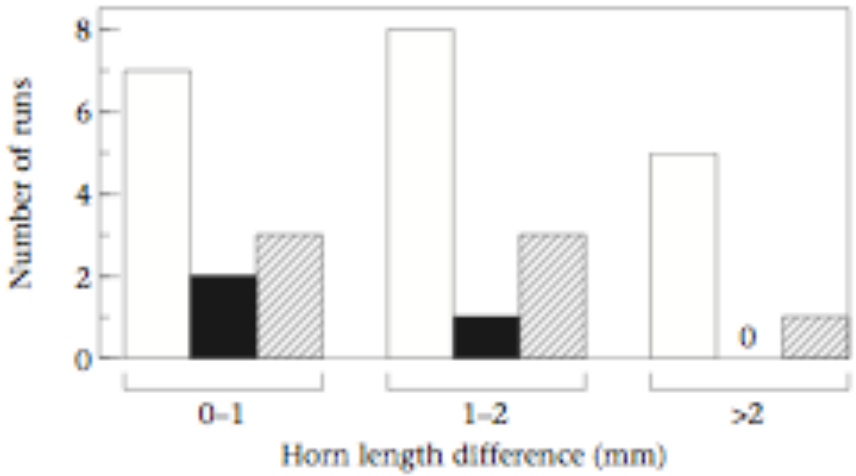
The Effects of Horn Length

- **When equally sized beetles competed, the one with the longer horn length won 22 out of 27 times.**



The Effects of Horn Length on Agility

- **Smaller horned beetles were relatively faster. (20 of 30).**
- **Times were seen to be farther apart with increased disparity in horn length between beetles**



Results

- **Horned trait was seen to affect mating**.
  - Weapon for interspecies competition over possession of tunnels containing breeding females.

- **The having horns is not a determinant in adoption of fighting behavior.**
  - Head-to-head was seen in both morphs. Those without horns had developed alternative ways of reaching the mating female.

- **The scarab beetle favors opposite horn phenotypes, which could be a main reason for the scarcity of intermediate morphologies in populations found in nature.**

Results

- **There is a body size-dependent dimorphism in the length of male horns.**
  - Long horns are advantageous for males engaging in fights with other males
  - The lack of horns is advantageous for sneaking behaviors.

Significance

- These results support the possibility of social situations allowing the coexistence of dimorphic morphologies as seem in the scarab beetles.
- This is especially interesting to evolutionary biology because few studies have explored the possibilities differences in interspecies competition having the ability to change behavioral and morphology in populations found in nature.

References

Emlen, D. J., & Moczek, A. P. 1999. Male horn dimorphism in the scarab beetle, *Onthophagus taurus*: do alternative reproductive tactics favour alternative phenotypes? *Animal Behavior*, 59 (2), 459-466.

Anderson, M. 1994. Sexual Selection. Princeton, New Jersey; Princeton University Press.

Emlen, D. J. & Nijhout, H. F. 1999. Hormonal control of horn length dimorphism in the horned beetle *Onthophagus taurus*. *Journal of insect Physiology*, 24, 45-53.

Hunt, J., Kotiaho, J. S. & Tomkins, J. L. 1999. Dung pads residence time covaries with male morphology in the dung beetle *Onthophagus taurus*. Ecological Entomology, 24, 174-180.

Moczek, A. P. 1996. Male dimorphism in the scarab beetle *Onthophagus taurus* Schreber, 1759 (Scarabaeidae, Onthophagini): evolution and plasticity in a variable environment. M.S. theis, Julius-Maximilians_university, Wurzburg Germany.

Moczek, A. P. & Emlen, D. J. 1999. Proximate determination of male horn dimorphism in the beetle *Onthophagus taurus* (Coleoptera: Scarabaeidae). *Journal of Evolutionary Biology*, 11, 27-37.

Paulian, R. 1935. Le polymorphisme des males de coleopteres. In: *Exposes de Biometrie et Staistique Biologique IV.* Actualites Scientifiques et industrielles 255 (Ed. By G. Tessier), pp. 1-33. Paris: Hermann.