

Evolution:
mechanisms, causes,
and consequences



Overview

- What is evolution, how does it work, what does it produce?
- Evolution of horns in beetles and examination of a 150 year old question: *what the heck do they use these things for?*



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Relevant Standards:

8.3.5 Identify and describe the difference between inherited traits and physical and behavioral traits that are acquired or learned.

8.3.7 Recognize and explain that small genetic differences between parents and offspring can accumulate in successive generations so that descendants may be different from their ancestors.

8.3.8 Examine traits of individuals within a population of organisms that may give them an advantage in survival and reproduction in a given environments or when the environment changes.

8.3.9 Describe the effect of environmental changes on populations of organisms when their adaptive characteristics put them at a disadvantage for survival. Describe how extinction of a species can ultimately result.

Evolution: mechanisms, causes, and consequences

1. What is evolution?

<http://en.wikipedia.org/wiki/Evolution>

Evolution is the change in the inherited traits of a population of organisms through successive generations

<http://www.biology-online.org/dictionary/Evolution>

- (1) The change in genetic composition of a population over successive generations, which may be caused by natural selection, inbreeding, hybridization, or mutation.
- (2) The sequence of events depicting the evolutionary development of a species or of a group of related organisms; phylogeny.

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2. What causes evolution?

- natural selection
- mutation
- drift

Note: Natural selection is only one of several mechanisms that can cause evolution (= change in the genetic basis of a population). So evolution is not the same as natural selection. But natural selection is believed to have caused some of the most spectacular evolutionary changes (adaptations), and that is why much teaching of evolution, including the SSI, focus on it.



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3. How does natural selection cause evolution?

- organisms differ from each other
- some of these differences are advantageous and heritable
- more “fit” individuals reproduce more effectively
- subsequent generations show an increase in the frequency of traits that confer an advantage; less fit varieties become less frequent and are eventually lost

Where does the variation come from?

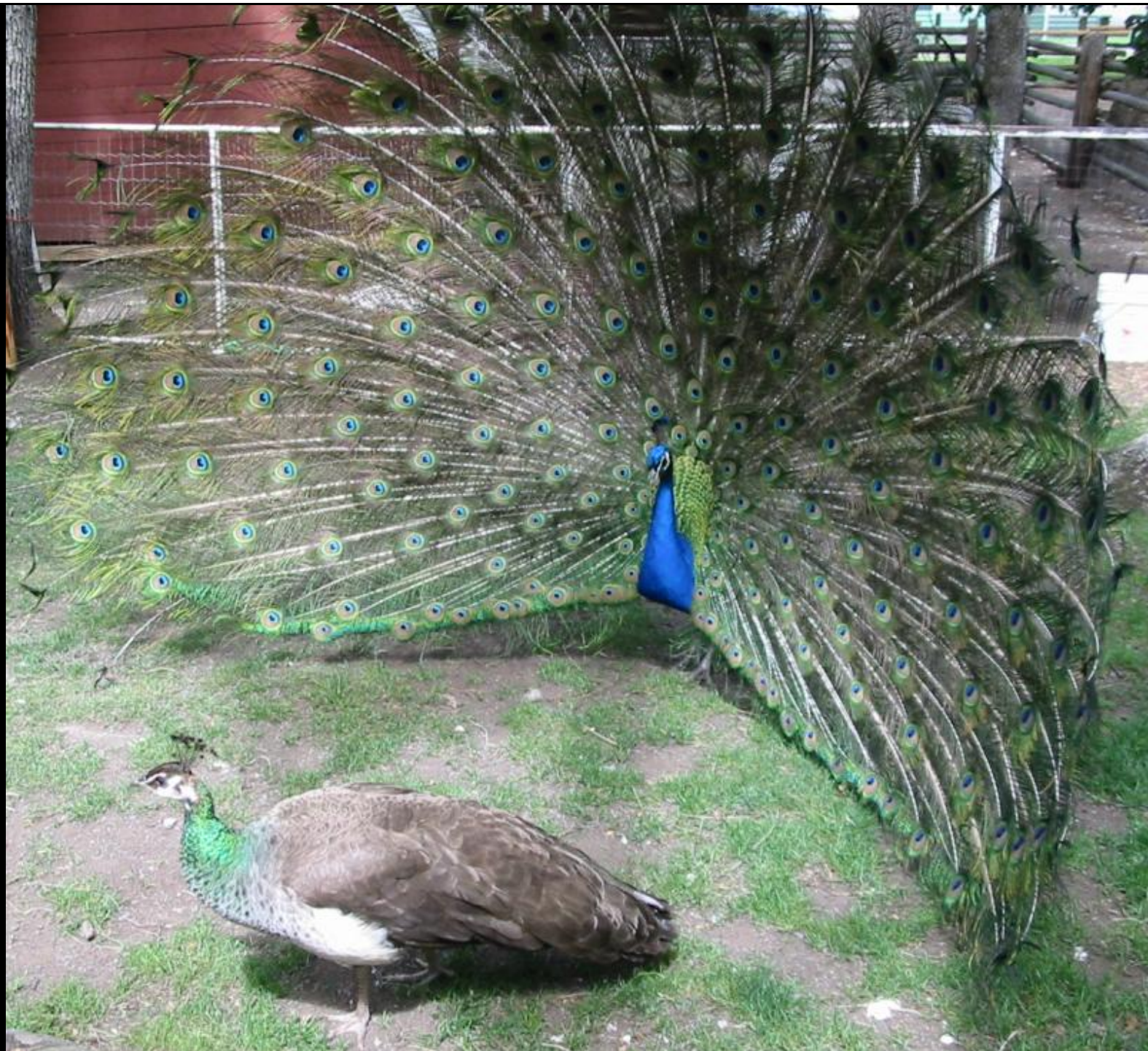
What determines whether a variant is advantageous?

Why does it need to be heritable?

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4. Natural selection causes adaptations: adapted to do what?

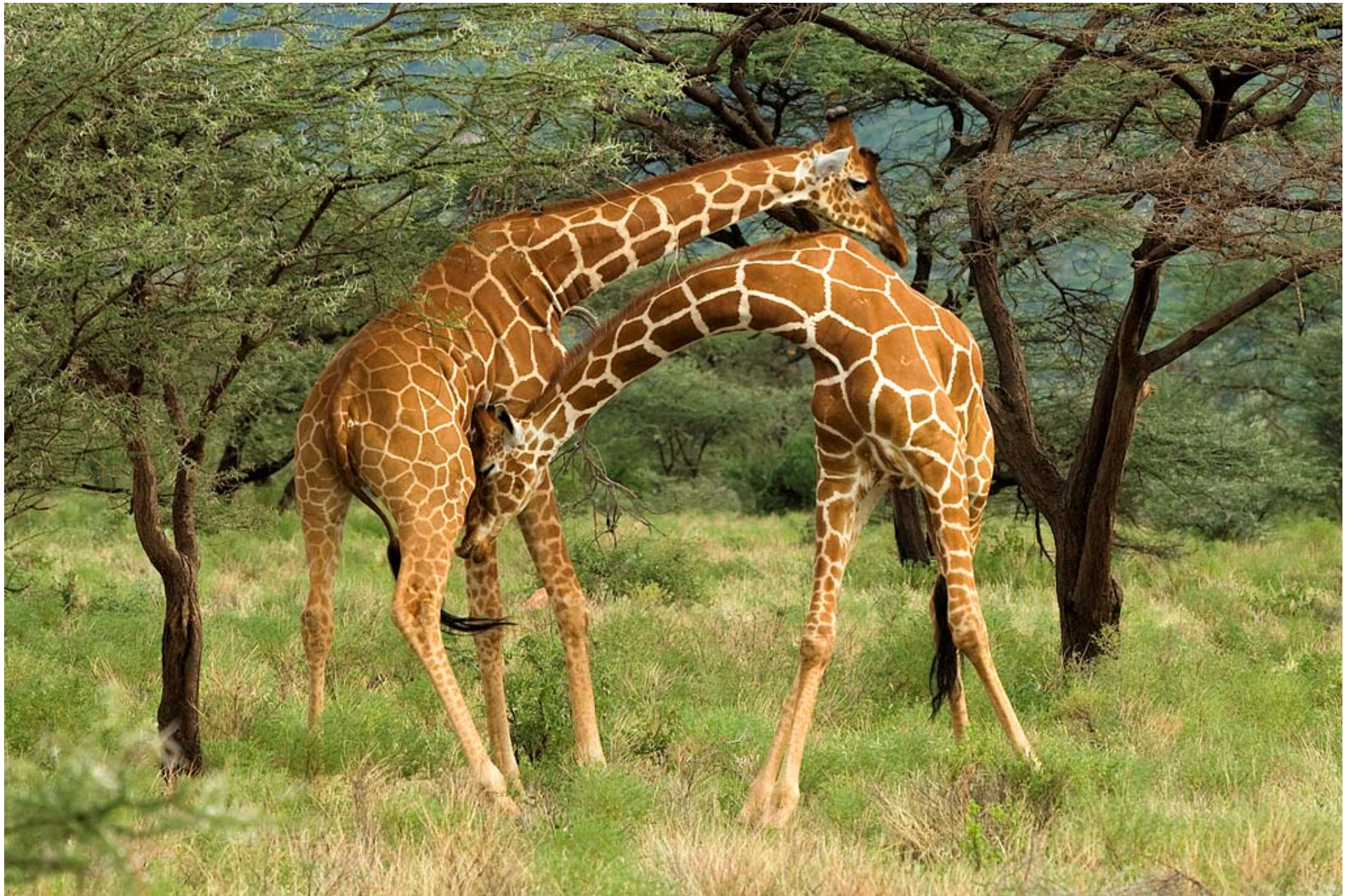
1. “*Survival of the fittest*” How important is surviving?
2. “*For the good of the species*” Do adaptations help species survive?
3. “*For the good of the family*” Do adaptations help close relatives?
4. “*To get the babes*” Do adaptations help maximize/optimize the number/type of partner?













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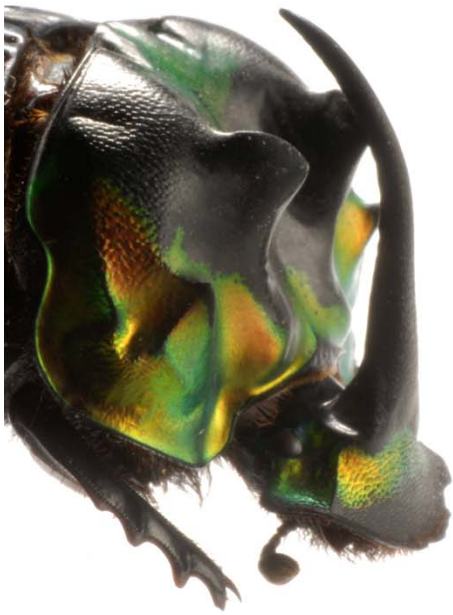
4. Natural selection causes adaptations: adapted to do what?

A couple of things to note:

It is difficult to determine what caused the initial origin of an adaptation and often much easier to determine current adaptive significance. But past and current use don't necessarily coincide.

Even if we just focus on current use, traits often have multiple contexts within which they function and it is not always obvious which one is/was most important in shaping the evolution of a given trait (e.g. giraffe neck).

*Lets see if we can figure out, or at least narrow down, what might have shaped the evolution of a very conspicuous and unusual trait: horns in Kenyan dung beetle *Onthophagus nigriventris**

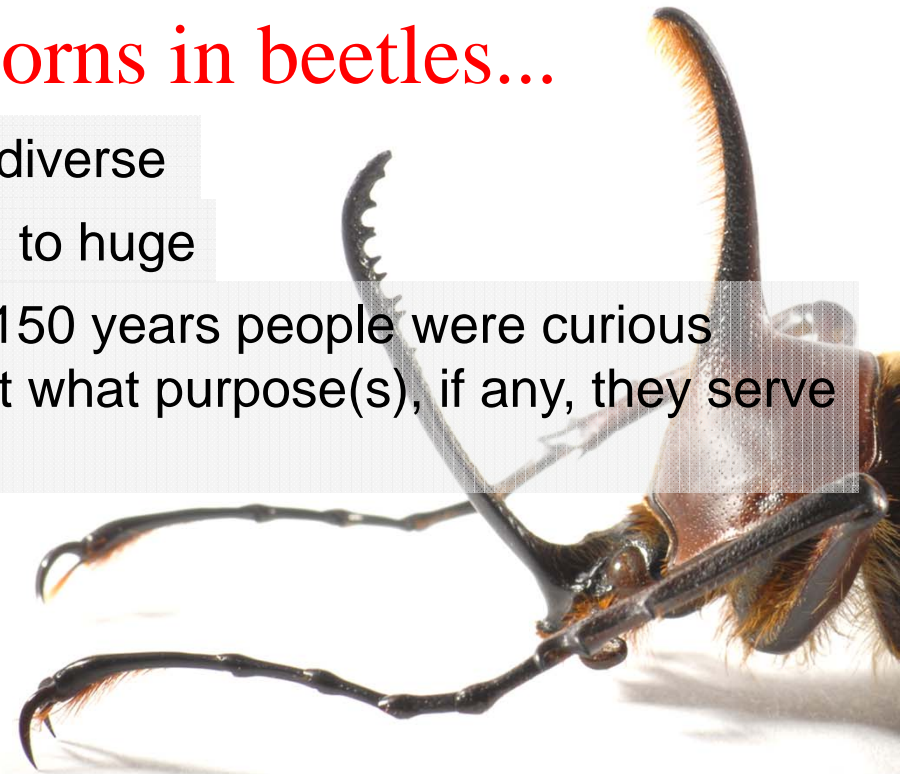


A few words about horns in beetles...

very diverse

small to huge

for >150 years people were curious
about what purpose(s), if any, they serve



Your task!

Before you are containers with ~20 individual *Onthophagus nigriventris*

Note the very conspicuous horns in at least some of the animals.

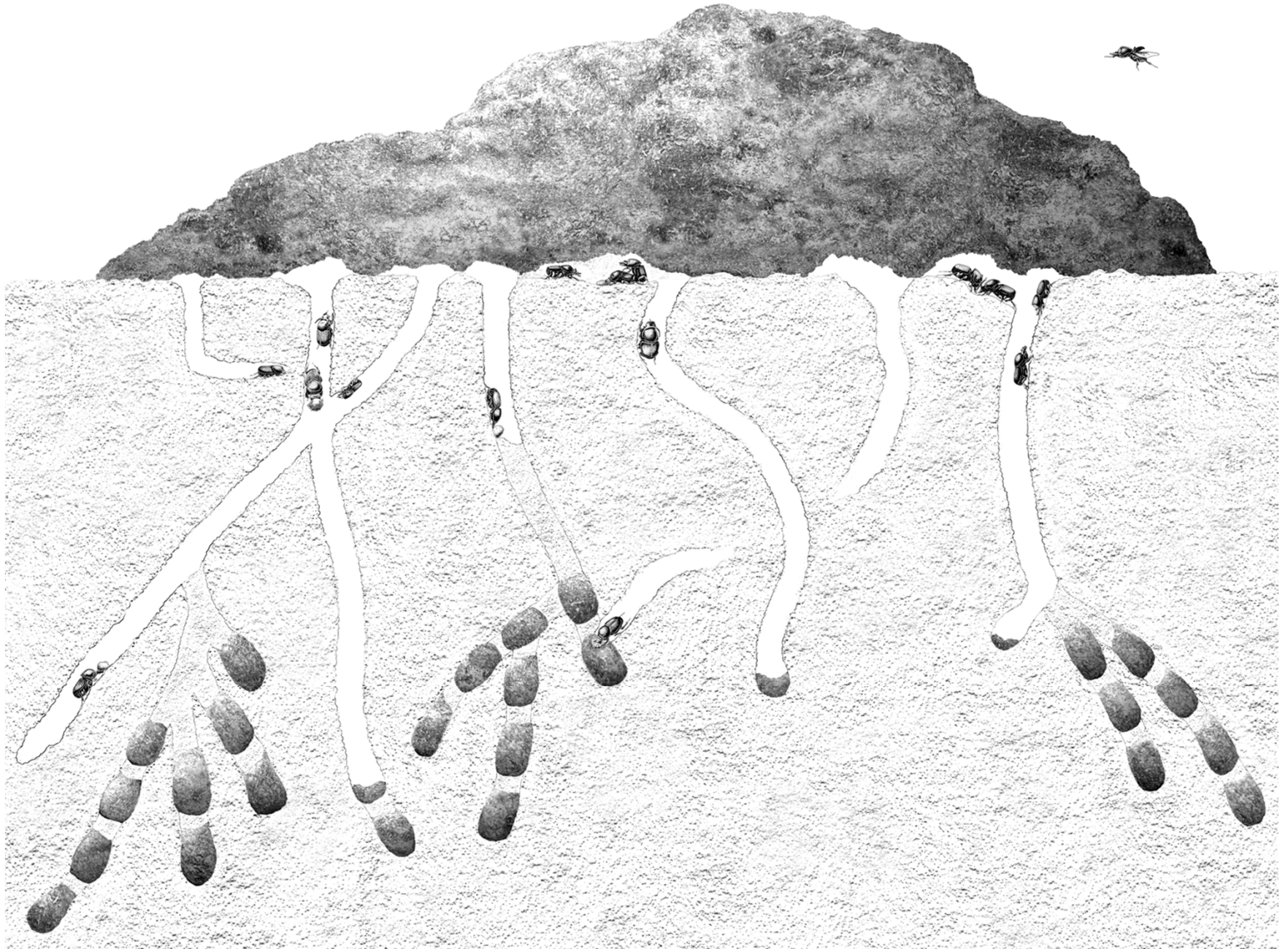
Your task is to find out what purpose those horns might serve?

Using these beetles and your observations, please develop a number of hypotheses about the potential uses of these horns.

Then brainstorm about experiments that might be used to test these hypotheses. Can you design and execute some version of these experiments with the materials here at hand?

If so, please share your experiment-idea with us and we will execute it together.

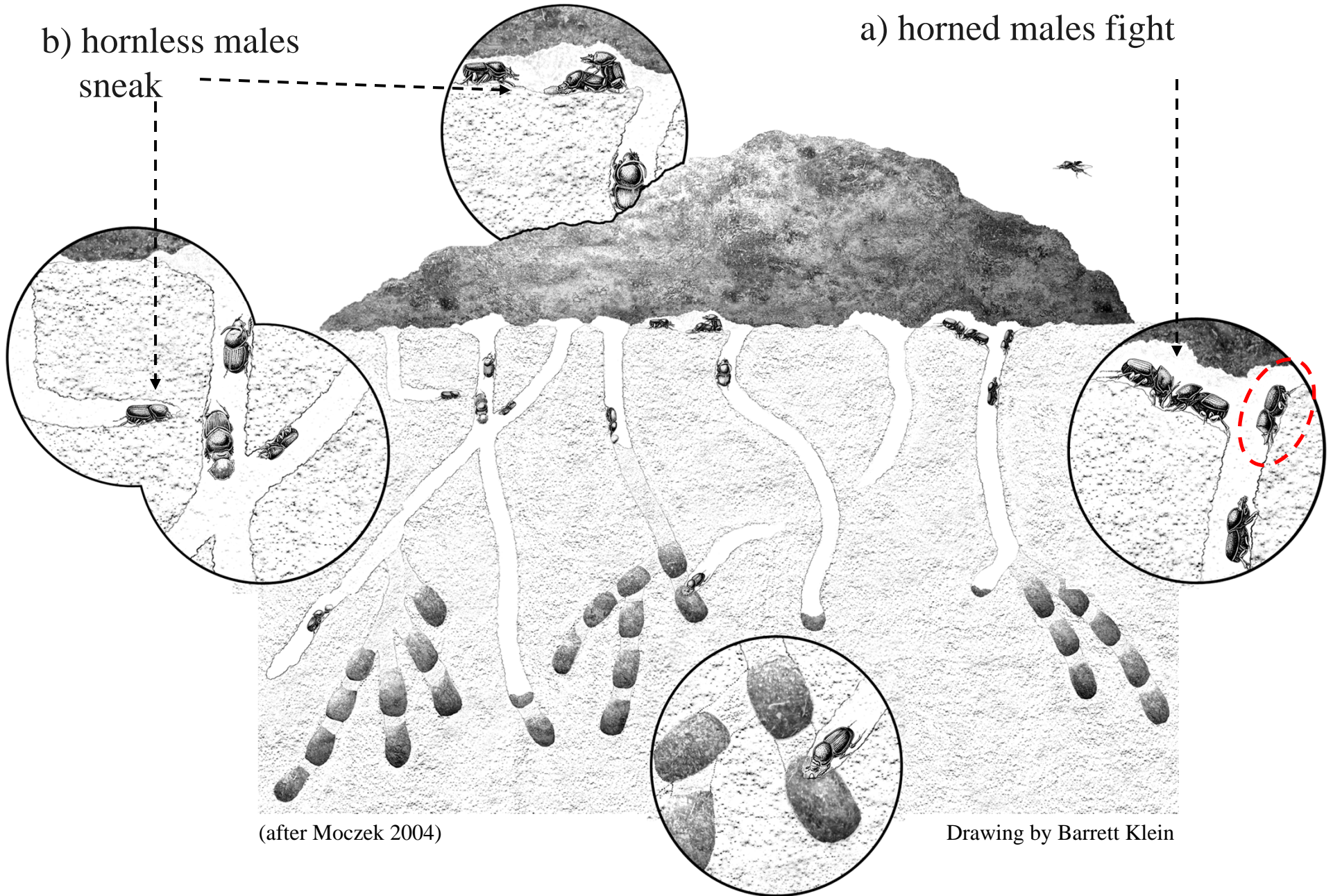
If not, still share the idea with us, and I will see if I might have data that match your experiment 😊



a) horned males fight

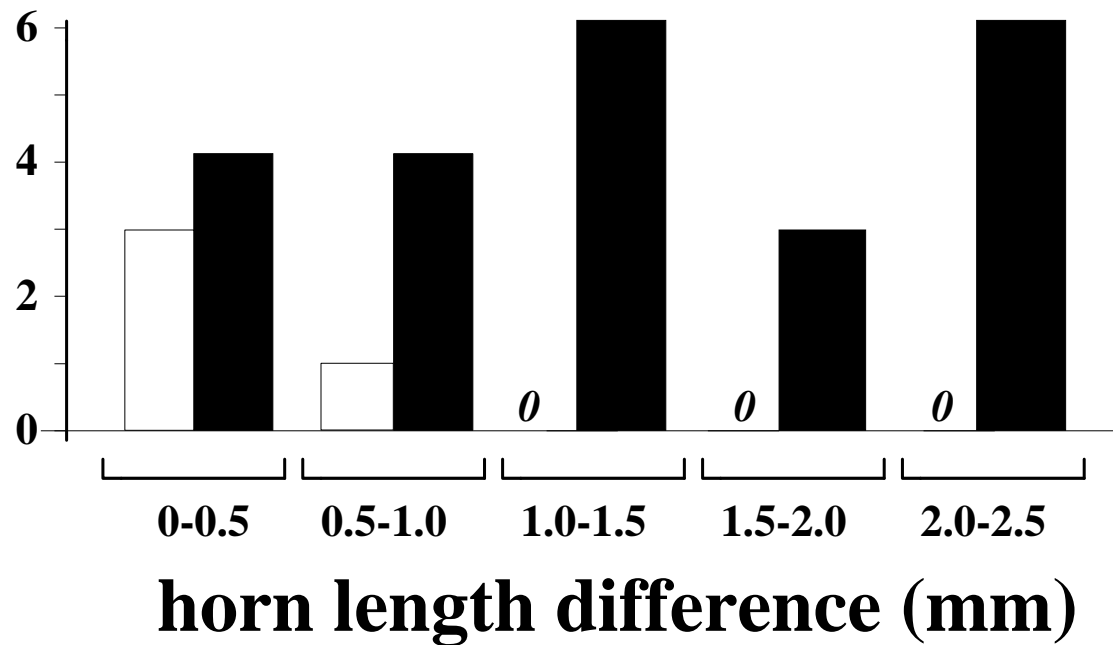
b) hornless males

sneak



number of fights

- ...won by male with
longer horns
- ...won by male with
shorter horns



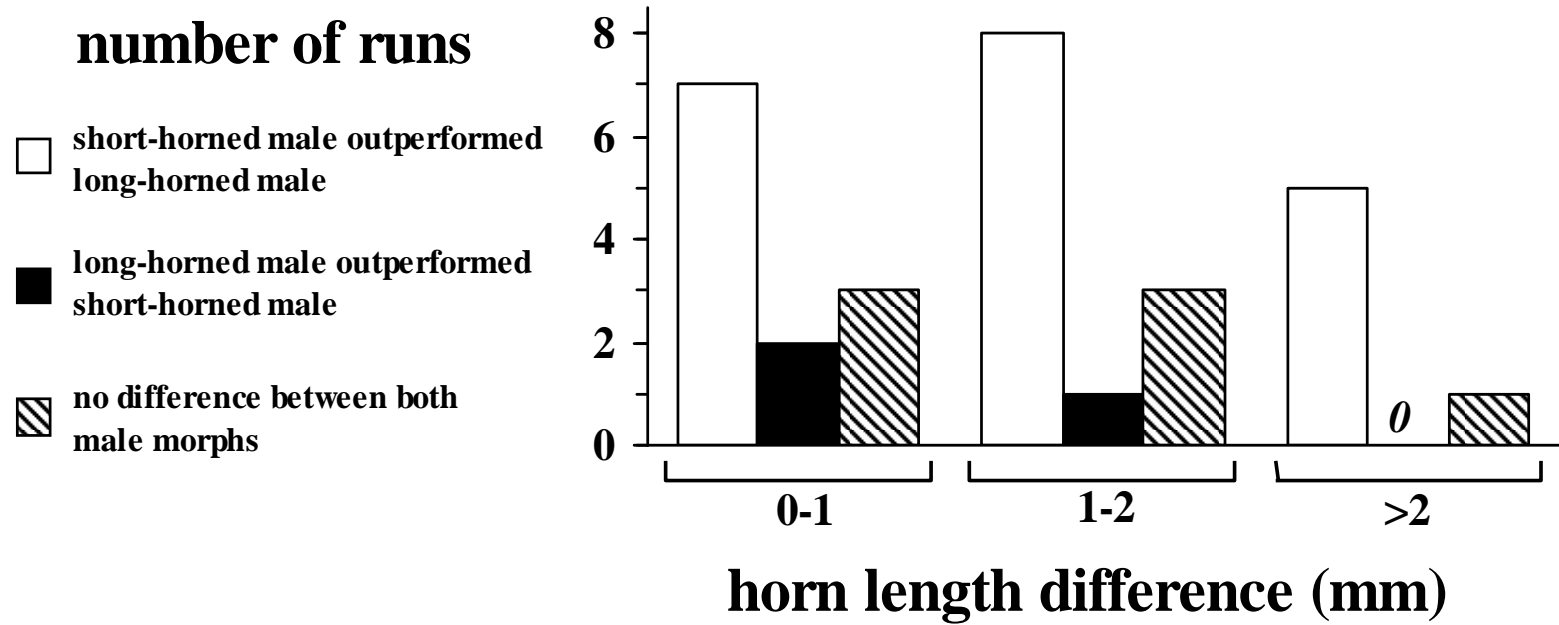


Figure 3:

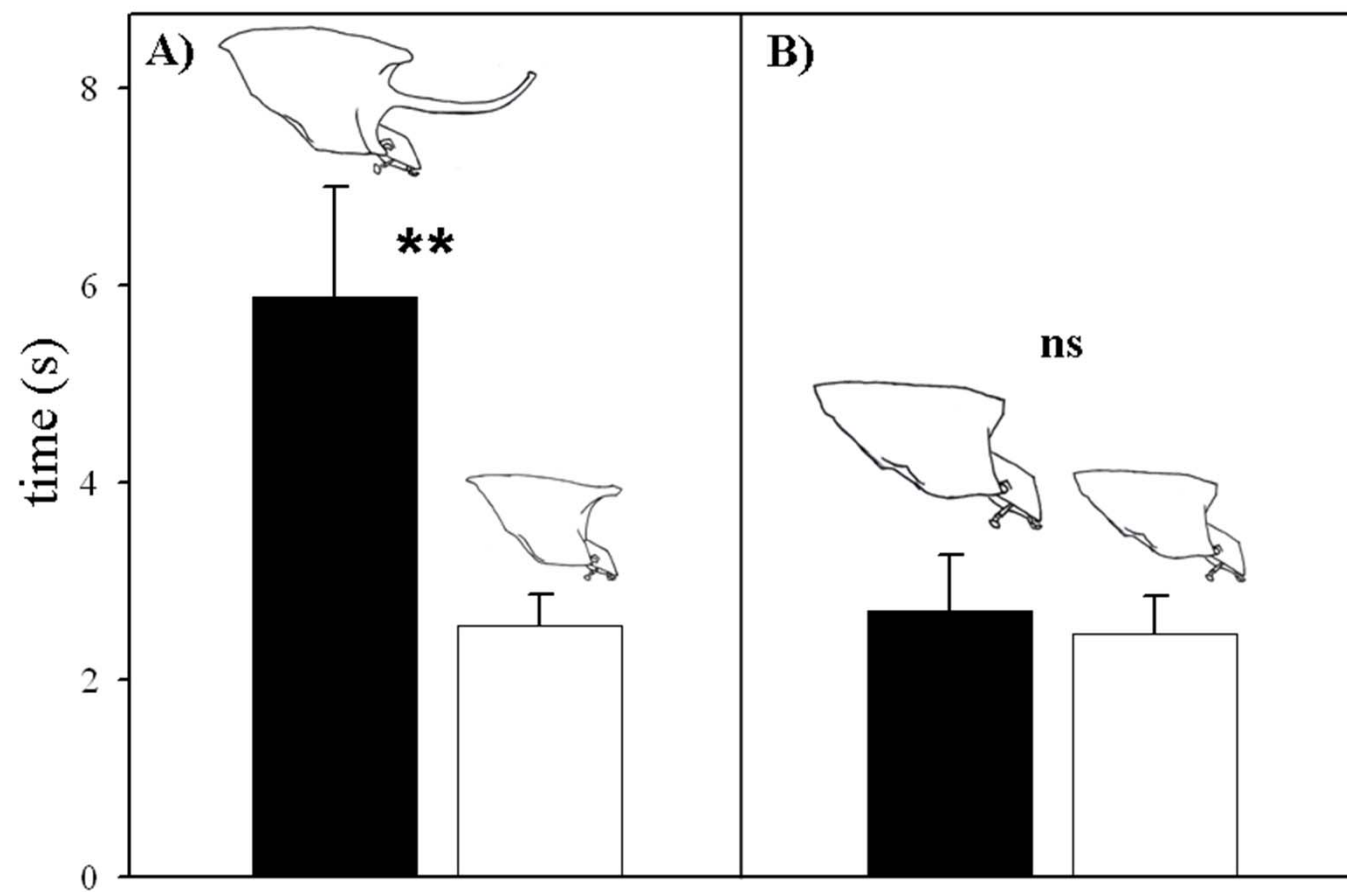
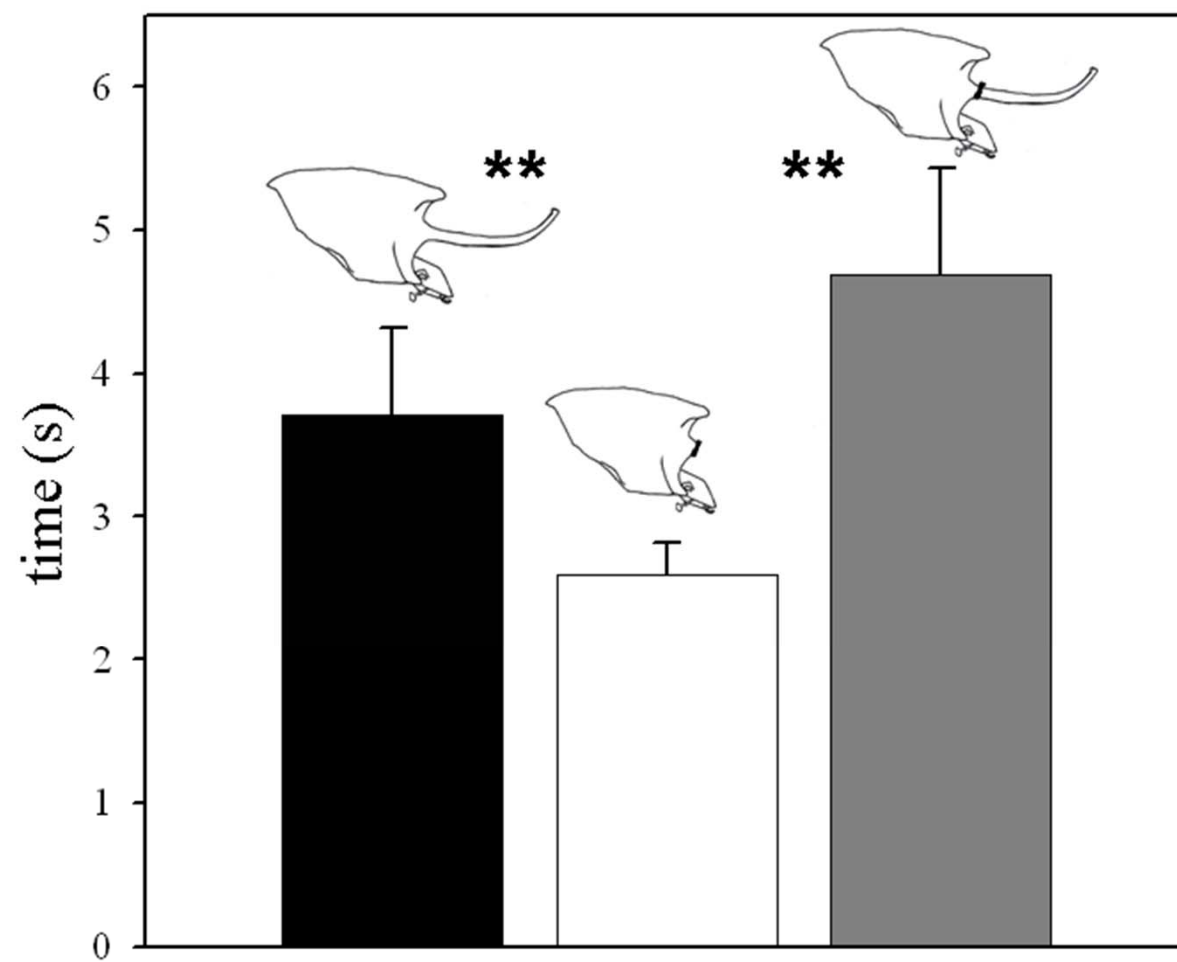
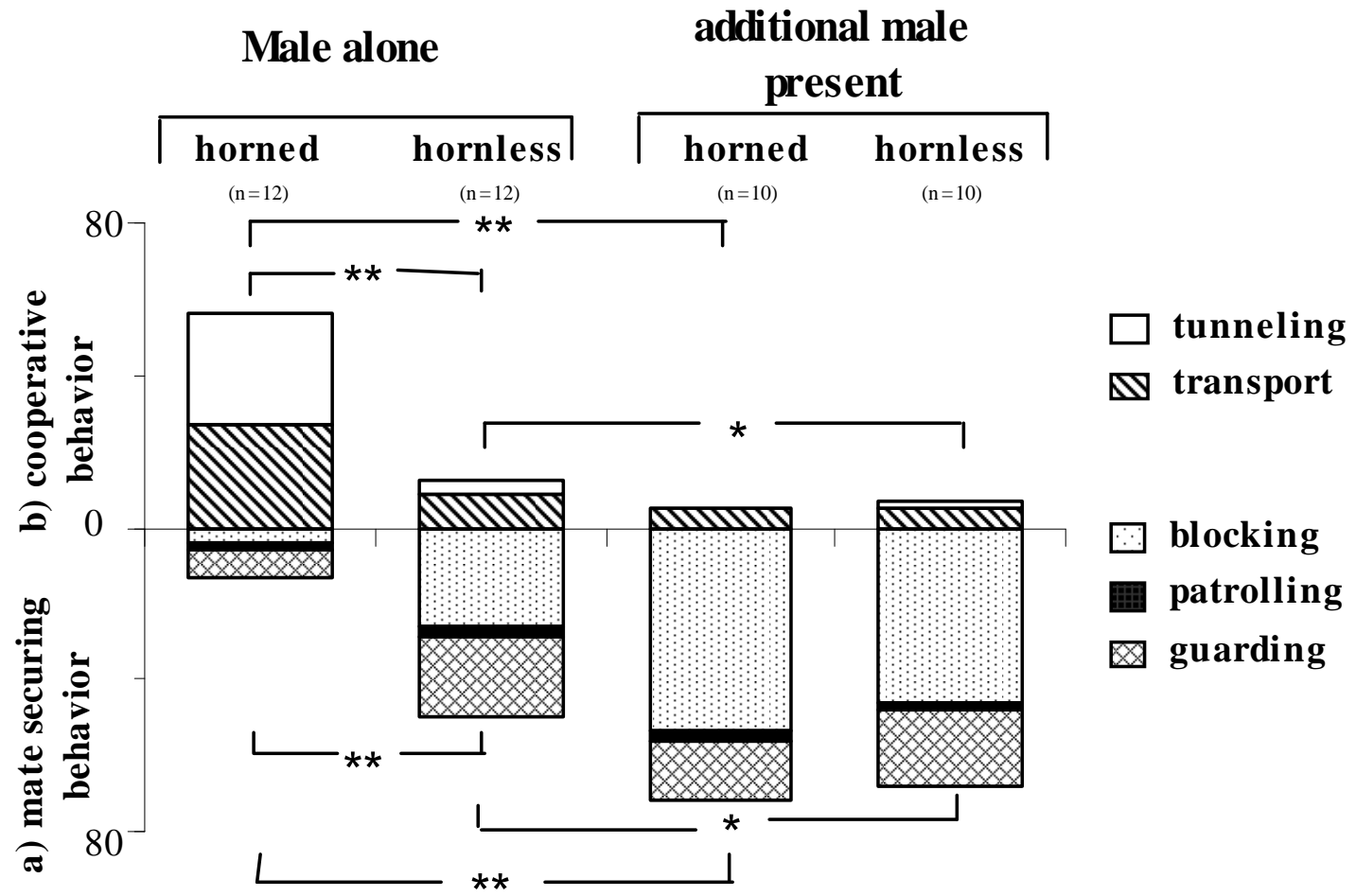


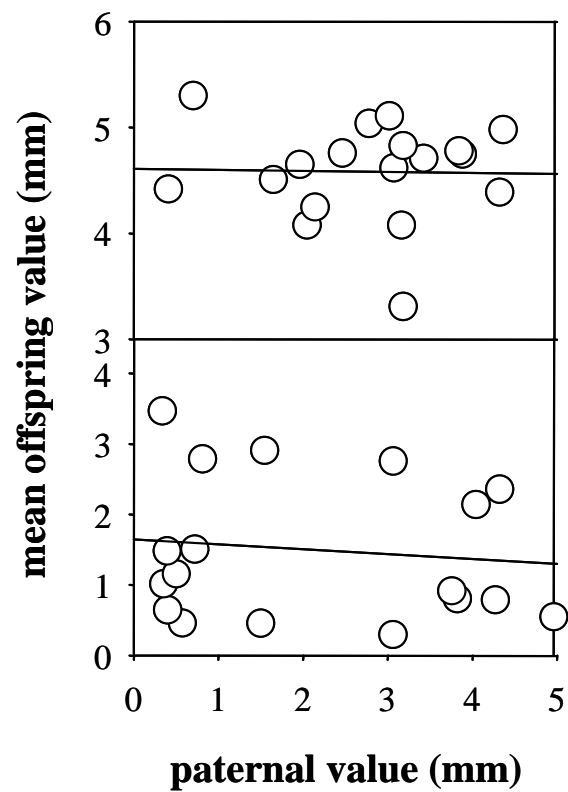
Figure 4:



proportion of time invested in:



Heritable variation



Environmental variation

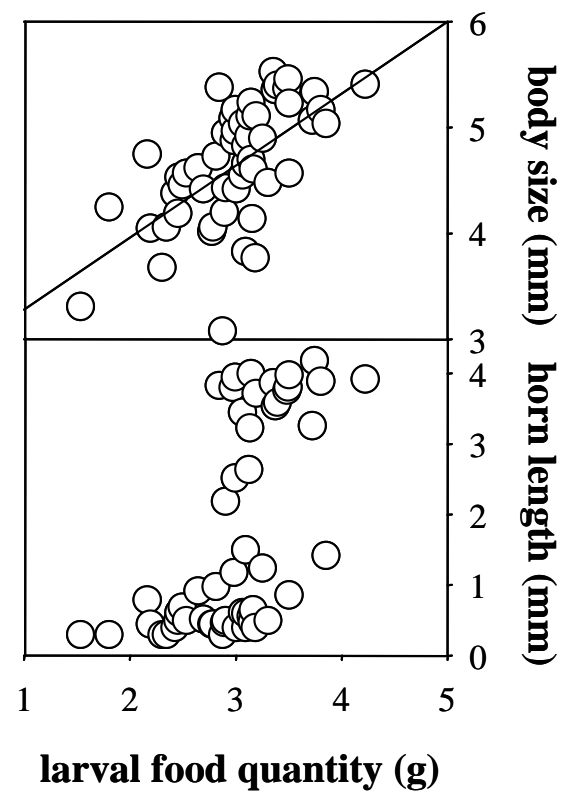


Figure 2:



A few last questions:

If horns are good for fighting, and no-horns is good for sneaking, what prevents one type from going extinct?

If you prevent all horned males from having offspring in one generation, will horns disappear from the population?

In some species females also have horns. What purpose could they serve?