Size matters: How the size of a male's weapons affects its anti-predator tactics

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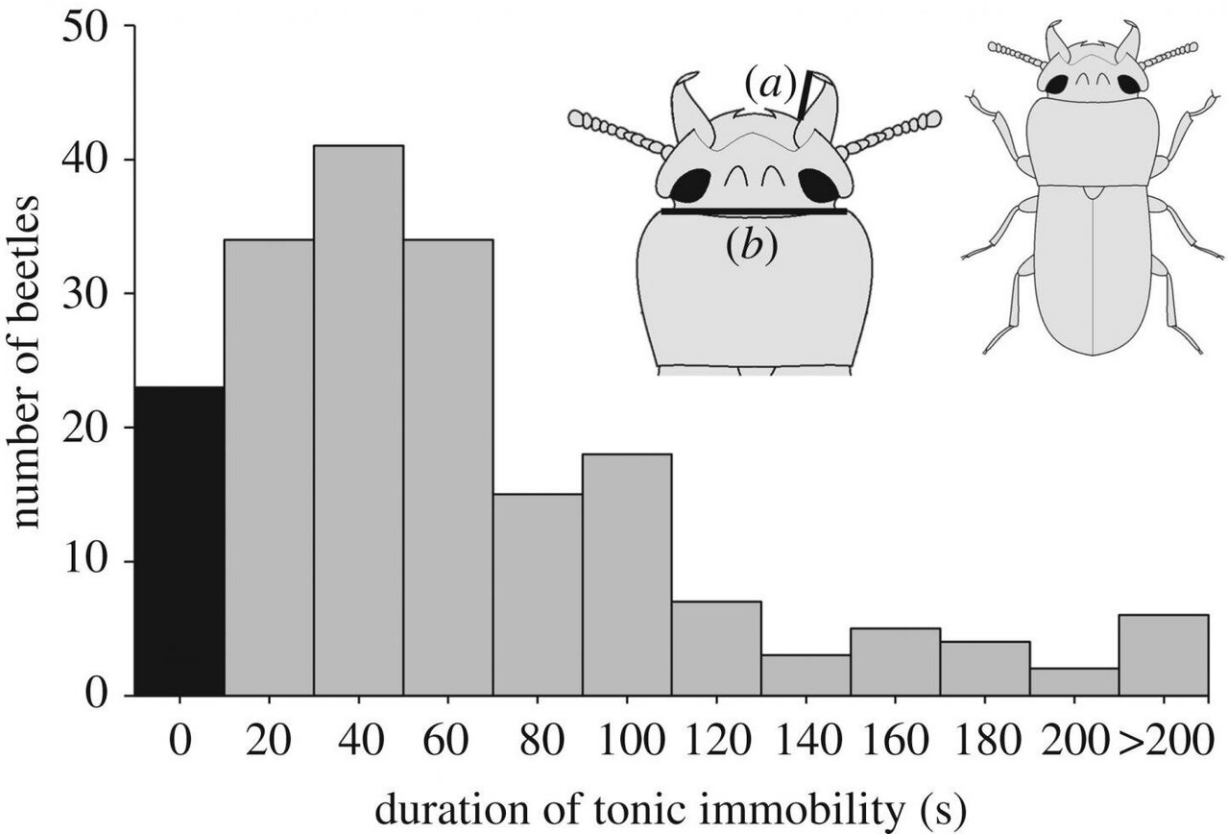

The black-filled bar shows beetles that did not exhibit tonic immobility. The straight lines in the beetle illustrations indicate the mandible length (a) and prothorax width (b). Many beetles had shorter durations, while a few had longer durations (range 0-563.31 s, mean ± s.d. = 58.44 ± 73.27 s). Credit: 2020 Biology Letters, 2019 Okayama University

Across many animal species there is great evolutionary pressure on males, who often engage in combat for the rights to copulation. This phenomenon, called sexual selection, often ends up favoring males with larger weapons, such as horns or pincers. Interestingly, scientists have noted that males endowed with smaller weapons adopt alternative reproductive tactics in some species. For example, instead of fighting other more powerful males, they may try to sneak around or disperse in search of a lonely female.

Variability in sexual behavior according to a male's weapon size has been widely studied. However, it's worth noting that bigger is not always better. Though larger weapons usually help in fights for reproductive rights, they can also be a hinderance because they lower the animal's overall mobility. This has been proven in males of a species of Japanese rhinoceros beetle, who fall prey to predators more easily when their horns, which they use as weapons, are bigger. Could it be that, just as males with smaller weapons adopt alternative sexual tactics, males with larger weapons adopt different anti-predator strategies?

In a recent study published in *Biology Letters*, a team of scientists from Okayama University, Japan, proved that this is most likely the case. Led by Professor Takahisa Miyatake, they focused on a species of beetle called Gnathocerus cornutus, the males of which bear large mandibles as weapons for male-on-male combat. When threatened, G. cornutus exhibits two very distinct behaviors: escape or tonic immobility, also called death feigning. The team investigated whether differences in weapon size caused males to behave differently when faced by a predator.

They obtained nearly two hundred male G. cornutus beetles from a laboratory and conducted two types of experiments. First, they pitted male beetles against one of their natural predators, a jumping spider. When attacked by the spider, most beetles froze in place, which seemed

to cause the spider to quickly lose interest. On the other hand, the beetles that tried to struggle or run away were repeatedly attacked by the spider and killed. These initial experiments proved that tonic immobility is a useful anti-predator strategy.

In the second series of experiments, the researchers measured the size of the mandibles of male beetles and then tried to get them to exhibit tonic immobility by gently touching their abdomen with a thin stick. Unlike previous behavioral studies, which exclusively focused on the duration of tonic immobility once triggered, the team also quantified the frequency of tonic immobility. Whereas no statistical relationship was found between weapon size and tonic immobility duration, a link was very apparent between weapon size and frequency; individuals with larger mandibles were generally more prone to exhibit tonic immobility when stimulated. Excited about the results, Dr. Kentarou Matsumura remarks: "For animals that fight with weapons, the costs of having larger weapons are well known. However, this is the first time we have scientifically determined that anti-predator tactics can vary among males according to their weapon size."

The results and the research strategy adopted by the team will help biologists unravel the mysteries of the evolution of behaviors, as Miyatake explains: "As the first study of predator-avoidance tactics in animals that have weapons for male-to-male fighting, we believe this is an opportunity to delve deeper on the relationship between the evolution of weapons and anti-predator behavior." Miyatake also states that these new discoveries will spawn a new research topic in the evolution of survival tactics, which in turn will increase our overall scientific understanding of this challenging field in the future.

What other fascinating evolutionary secrets could be hiding out there in the behaviors of different animals? Let us hope this study acts as a springboard for finding the answers.

More information: Kentarou Matsumura et al, Anti-predator behaviour depends on male weapon size, *Biology Letters* (2020). DOI: 10.1098/rsbl.2020.0601

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