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Horns of a dilemma

The male horned beetle has to choose between being a Casanova and a prolific father. **Monojit DasGupta** reports

Life is not fair. It often throws difficult choices at us humans, or for that matter every living thing on this planet. And no one knows this better than the horned beetle (*Onthophagus nigriventris*). A male beetle with well-developed horns has, like a Casanova, better chances of acquiring partners for mating. But this success comes at a trade-off — it has smaller testes and low fecundity.

Now, an Australian researcher and his American collaborator have examined the trade-off between investment of evolutionary resources in testes required for reproduction and investment in sexual traits and weapons used to acquire mates. The details of their study appear in the online edition of the journal *Proceedings of the National Academy of Sciences*.

Leigh Simmons, professor of evolutionary biology at the University of Western Australia, says, “Our study bridges two bodies of work — life history evolution and sexual selection. Life history evolution looks at how organisms budget available resources to maximise their reproductive success, or the number of offspring they contribute to the next generation.” This allocation of resources to reproduction comes at a cost — lower resources for body maintenance, and thus life span. Hence, highly fecund organisms have shorter life spans than those that produce very few offspring, adds Simmons, who is also the lead author of the study.

On the other hand, sexual selection or mating competition theorises that some individuals enjoy certain sexual advantages over other organisms of the same sex and species. And these advantages (secondary sexual organs) translate into greater success in mating. This is particularly true for a majority of males. In other words, sexually selective traits (like the peacock’s tail) or weapons (the beetle’s horns) help a male to attract more mates.

However, unlike in humans, the “virtue” of monogamy is rare in the animal kingdom. This means that a female has more-than-harmless flings with many males during a reproductive cycle. As a result, the sperms from different males must compete to fertilise the available eggs in a female. This sperm competition spurs adaptations (primary sex organs like testes) in males that favour increased sperm production, says Simmons. “It’s rather like a lottery — the more tickets (sperms) a male has in the lottery, the greater is the probability that he will win the prize (paternity),” he explains.

So most male animals must first compete to acquire females, and then again indulge in sperm competition. Simmons observes that the males are thus faced with the dilemma of how much resource to allocate to obtaining females (displaying and fighting) and how much to invest in sperm production, while at the same time keeping reserves to maintain other bodily functions. He adds, “Our study set out to test this basic premise that males trade off between fighting for mates and competing for fertilisations.”

The two researchers chose the horned beetles to test their premise because these organisms are notable for the size and diversity of their horns (secondary sexual organs). The males use their horns to block entrance to breeding tunnels containing females and keep competitors at bay. Therefore, the horns of these beetles “represent typical sexually selected weapons that increase the number of matings,” the

researchers write. At the same time, the minor or hornless males, who have bigger testes, adopt the alternative mating tactic of sneaking copulations with females that are guarded by the horned males. The researchers add, “The proportion of sneaking males in a population (of horned beetles) is associated with both the relative sizes of the testes and the numbers of sperms produced. Thus sperm competition favours large testes in these beetles.”

For their study, the researchers destroyed the tissues in the developing larvae that develop into horns in an adult male. They found that adult males that were prevented from forming horns had diverted their resources to the development of testes. A previous study had done the reverse. Researchers had destroyed the tissue that would become the genitalia and found that emergent beetles invested more in horn growth. “This shows us that resources are traded during the development of sexual weapons and testes,” says Simmons.

The researchers also compared the patterns of horn and testes growth across 25 species of beetles that varied in the degree of horn development. They found that species with large horns were characterised by controlled growth of testes, which helped to protect the genitalia for competing for resources with developing horns. They also observed that in species with intense sperm competition (that is, with a high population of sneaking males), the evolutionary origin of horns was constrained to the head region rather than the thorax, which is nearer to the testes. “Thus, evolution seems to have shifted the location of developing horns away from regions where they would have competed with the testes for resources,” says Simmons.

This suggests that evolution favours patterns of development that protect testes from the trade-off, rather than the other way round. This proves that testes are the “real thing,” while horns are secondary to reproduction. And even the female beetles, the original architects of sperm competition, think so. They are unimpressed by the males’ weapons, and instead prefer “to focus on the quality of courtship males deliver”, says Simmons.

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