

Stag beetle males give nasty nips despite massive jaws

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Armed with a ferocious pair of mandibles, male stag beetles appear well prepared to take on the world. 'Their jaws are not just for ornamentation, they really use them to fight', says Jana Goyens from the University of Antwerp, Belgium, adding that males grapple over the choicest patches of rotten wood for their mates to lay their eggs in. Describing a stag beetle battle, Goyens explains that one beetle grabs the other one around its body and then rears up in an attempt to hurl his opponent over his head and onto its back. 'It is clear which one is the loser', says Goyens. But something puzzled her: 'It seemed unlikely that stag beetles could bite forcefully because they have these long jaws', she says. Instead of amplifying forces, the beetles' long mandibles would reduce the forces exerted at the sharp teeth halfway along the mandibles when gripped together. Intrigued, Goyens and her supervisors, Joris Dirckx and Peter Aerts, decided to test how powerful stag beetle bites are.

They report their discovery that male stag beetles have enlarged their heads and muscles to insure that their bite force is not weakened in *The Journal of Experimental Biology*.

Although the beetles are native to Belgium, they are endangered, so Goyens turned to Asia, where betting on insect fights is popular, to obtain the animals. However, when 10 pairs of the animals arrived from Taiwan just before Christmas, the pressure was on. 'I had been told that they only live for a couple of months but I didn't know how old they were and it was the Friday before the Christmas holidays so I worked the

entire holiday to get as much data as possible while they were still alive', says Goyens, who laughs when she recalls that the beetles went on to live for another 12 months.

Testing the beetles' [bite force](#), Goyens found that the aggressive animals were extremely cooperative, biting enthusiastically on the force transducer whenever it was held before them. And when she compared the strength of the male's and female's bites, she was impressed to see that the male's jaws gripped with an impressive 7N force (which is like having a 700g weight pressing on a pin): six times stronger than the female's bite. Even when she scaled up the female's bite to take account of the female's smaller stature, the male's bites were still three times stronger. So, even though the male's long mandibles should reduce the strength of their nasty nips, they were still able to clamp on much harder than the females. They must have somehow compensated for their oversized mandibles; Goyens decided to take a closer look at the beetles' heads.

Comparing the males and females, Goyens realised that the males' heads were much wider than the females', suggesting the males had increased the size of some of the [internal structures](#) that move the mandibles to compensate for their size. Goyens then teamed up with Luc Van Hoorebeke and Manuel Dierick to take CT scans of the insects' heads to find out what was going on inside. She could clearly see that the muscle that pulls on the mandible is almost four times larger in male stag beetles than in females, and the lever on the side of the mandible that is pulled by the muscle is more than three times longer than the lever on female mandibles. And when Goyens checked the direction that the muscle pulls in, she saw that both the male's and females' muscles were perfectly oriented to generate the hardest bite. So, the males have successfully compensated for their ungainly mandibles by increasing the size of the internal structures that wield their mighty weapons.

More information: Goyens, J., Dirckx, J., Dierick, M., Van Hoorebeke, L. and Aerts, P. (2014). Biomechanical determinants of bite force dimorphism in *Cyclommatus metallifer* stag beetles. *J. Exp. Biol.* 217, 1065-1071. jeb.biologists.org/content/217/7/1065.abstract

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