INSIDE JEB

Muscle testosterone supply keeps male birds topped up out of season

A downy woodpecker (*Dryobates pubescens*), Searsmont, ME, USA. Photo credit: Fyn Kynd, license CC BY 2.0.

Many creatures live life on the energetic limit, so when they don't need a particular organ, they simply allow it to wither away to save energy until required again. Snakes' digestive tracts atrophy between meals, migrating birds also reduce the mass of their digestive systems while en route and many male birds allow their testes to downsize out of the mating season. But this does not mean that male birds are not able to brag boastfully when their testes are out of action. Male woodpeckers are still capable of high-speed drumming, powered by their strong neck muscles, to warn other males off their territories, which made Eric Schuppe (University of California, San Francisco, USA) and Matthew Fuxjager (Brown University, USA) wonder whether the woodpecker's impressive out-of-season percussive performances could be due to testosterone produced in the muscle itself.

Schuppe headed out into the North Carolina woods to capture territorial downy woodpeckers (*Dryobates pubescens*) during and after the mating season, to measure the quantity of testosterone circulating in their blood and in various tissues – including the powerfully drumming neck muscle and their testes. Back in the lab, Schuppe and Daniel Tobiansky (Brown University) discovered that the levels of testosterone in the drumming muscle during the breading season were six times higher than in the bird's flight muscles, which are required year-round. The testosterone levels even remained high in the percussive muscle during the winter and autumn, when the hormone had all but disappeared from other tissues in the body. And when the team checked for evidence of the key enzymes that are essential for producing the potent hormone from the basic cholesterol building block, all of the key enzymes turned up in the neck muscle at high levels. Woodpeckers are capable of beefing up their masculine drumming neck muscles by producing testosterone within the muscle itself. But could the magnificent performances of other males also benefit from a boost of *in situ* testosterone?

This time, the team turned their attention to chattering male white-breasted nuthatches (*Sitta carolinensis*) and zebra finches (*Taeniopygia guttata*), both of which serenade females, to find out whether their superfast voice box muscles benefit from a self-produced shot of testosterone. Sure enough, all of the necessary enzymes for producing the masculine hormone from scratch turned up in the trilling birds' voice boxes. Serenading nuthatches and zebra finches probably produce testosterone in their voice box muscles to enhance their acoustic pyrotechnics to attract females.

Having confirmed that testosterone can be produced in organs that become souped up to catch the attention of passing females, Schuppe, Fuxjager and colleagues wondered whether the hormone could also enhance the performance of other superfast muscles, such as those that drive swift eye swivels. Sure enough, all of the critical enzymes turned up in the fast-contracting eye muscles of lab mice and at much higher levels than occur in other muscles that never contract as fast.

It seems that the organs that male birds depend upon when courting females are capable of producing their own internal testosterone supply to enhance their performance, and it turns out that some other muscles that are capable of super-fast contractions can also produce the hormone, which may enhance blisteringly fast contractions. So male woodpeckers, nuthatches and zebra finches don't need to depend on testosterone produced by their testes when defending their territories and serenading females out of season: their own internal muscle supplies keep them topped up and in tip-top condition.

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