

Doing it to death: Suicidal sex in 'marsupial mice'

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After mating, all male *Antechinus* die ... but why? Credit: badoo_tealeaf

Imagine if you only had one shot at passing on your genes before you died. It happens more often in the natural world than you might expect: suicidal reproduction – where one or both sexes of a species die after a single episode of mating – occurs in plants and some invertebrates including insects and spiders.

So what about [mammals](#)?

In a paper published in the *Proceedings of the National Academy of Sciences* today, we show why escalating stress hormones during the

breeding season of some species of small insect-eating [marsupials](#) (but in no other mammals) cause immune system collapse, haemorrhaging, infections and death after [mating](#) in all males.

(In contrast to these "semelparous" species, most insectivorous marsupials in Australia, Papua New Guinea and South America are iteroparous, which means that they breed more than once during their lives.)

The lifespan of males after breeding varies between species. About a fifth of insectivorous marsupial species with known reproductive traits have this most extreme condition of complete male die-off through a mechanism of synchronised immune collapse, and comprise four Australian genera:

Antechinus
Phascogale
Dasykaluta
Parantechinus.

A different biological clock

These animals typically do not look very impressive and have sometimes been called "marsupial mice"; however, their behaviour and demography is impressive, and nothing at all like that of mice.

As well as dramatic death, these marsupials show extreme sexual behaviour and physiology. In the 12 species of *Antechinus*, pairs mate for up to 14 hours at a time and both sexes are very promiscuous.

Just before the mating season at 11 months old, something very peculiar and counter-intuitive happens to the reproductive physiology of these males.

Although they have never mated, they stop producing sperm and their testes disintegrate, so the animals must rely on sperm stored in their epididymis (a narrow, coiled tube).

The clock starts ticking for males, because the sperm they manufactured before their testes shut down starts to be lost in their urine. The frenzied mating season lasts only a couple of weeks, and males usually die before young are born.

The manner of synchronised suicide in males is quite horrible to see. Males lose their fur and can develop ulcerations and gangrene.

Biologists used to assume that these animals fight during the mating season but we now know they don't. Despite the time pressure and rampant testosterone, overt contests between males are virtually absent, and they appear positively friendly towards one another.

In many *Antechinus* species, males huddle together in nests woven out of gum leaves in tree hollows – groups of both sexes share nests for most of the year.

By the end of the mating season males are active throughout the day, and physically disintegrating males may run around frantically searching for last mating opportunities, but by that time females are not surprisingly avoiding them.

Sperm competition

This situation, unsurprisingly, raises a lot of questions:

- why don't males fight?
- why do they have this bizarre strategy of programmed suicidal reproduction?

- why do they shut down [sperm production](#) before the mating season?
- why do they show such extreme sexual behaviour?
- why has this die-off strategy evolved multiple times in insectivorous marsupials but never in any other mammals?

We suspected that the answers to these questions are linked, because all of this is something to do with intense sperm competition.

Sperm competition is a form of post-mating sexual selection in which males compete with their sperm inside the female reproductive tract, rather than fighting to gain access to females.

Sperm competition in mammals is associated with having large testes with lots of sperm-producing tissue, and often also long mating times and mate-guarding.

Competition between males is expected to intensify as the time they have to mate declines, and females synchronise their period of sexual receptivity in time and space.

Australian researchers Tony Lee and Richard Braithwaite, authors of a seminal study published in [The American Naturalist](#) in the late 1970s, realised this when they proposed that the seasonality of food is the key factor in the evolution of suicidal reproduction in mammals.

They thought that these marsupials live in temperate (southern, high latitude) forests, where insects have a predictable peak of abundance at the same time every year, and meaning that females synchronise mating so that young are raised and weaned when this peak of food occurs.

Because even small marsupials have long periods of lactation (months, unlike ecologically analogous placental mammals), they can't fit in a

second litter. Braithwaite and Lee thought that males may as well compete to death to maximise the number of young that they father in the one brief mating season of the year.

Predicting peaks

To test these ideas about the intensity of male contests, the length of the mating season and the sperm competition mechanism, we analysed the habitats, food predictability, demography and reproductive traits of 52 species in 21 genera of insectivorous marsupials, including the four Australian semelparous genera.

We found that insect abundance in Australia, Papua New Guinea and South America shows more predictably synchronised seasonal peaks at higher latitudes than in the tropics at sites where insectivorous marsupials live, and this pattern is not just in forests but everywhere that these animals live.

We also found that seasonal predictability of insect abundance is associated with short, synchronised single mating seasons.

These results indicate that male competition is intensified by short mating seasons, which are driven by seasonal food availability and by the synchronisation of mating by females.

Simply put, competition shortens the life of males. Species with lower male survival (and in the most extreme cases, die-off accompanied by immune system collapse) have larger testes and long mating times, indicating sperm competition.

Mating to death

Small marsupials with suicidal reproduction in males "mate themselves to death" for an adaptive reason. It seems that shutting down sperm production before mating and foregoing any possible future reproduction in order to use all possible energy for mating gives these males an advantage in [sperm competition](#).

Nature documentaries tend to attribute male death before offspring are born to altruistic paternal suicide to avoid food depletion. There are several reasons why this is wrong:

- Natural selection acts at the level of individuals passing on their genes, not populations of males acting for the good of the species. The genes of males that die and forgo further reproduction for the benefit of young fathered by other males will be disadvantaged.
- There is no mechanism in these [species](#) for males to advantage their own young ("kin selection"), because males range widely during the [mating season](#) and litters have several fathers.
- Mothers do lose weight, but this is nothing to do with how much food they can find; rather, it's likely to be due to constraints on the rate of converting food to milk. Mothers with unlimited [food](#) in captivity also lose weight.

Rather than altruism, individual sexual selection leads to apparent self-sacrifice in these mammals.

Our study suggests that males gain a reproductive advantage from [death](#) in a manner parallel to suicidal mating in some spiders such as redbacks, in which [males](#) that sacrifice themselves sire more of the female's young.

More information: www.pnas.org/cgi/doi/10.1073/pnas.1310691110

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