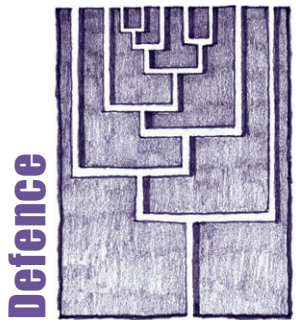
Acid defends ants against attack



An ancient war has arrived in the southern USA. The mortal enemies have, over their long bloody history, each developed a sophisticated arsenal of chemical weapons for annihilating the other. The combatants are two species of ant – the imported fire ant *Solenopsis invicta* and the tawny crazy ant, *Nylanderia fulva*. A recent article in *Science* reports that in addition to chemical weaponry, it seems that *N. fulva* also produces a chemical defence.

Solenopsis invicta (originally found in South America) is a highly disruptive invasive species in the southern USA where it displaces native ant species through its ability to produce a potent insecticide. However, in recent years, *N. fulva* (from the same geographical area as *S. invicta*) has invaded *S. invicta*'s US territory, even building nests inside *S. invicta* ant mounds. Postdoctoral fellow Edward LeBrun and his co-authors Nathan Jones and Lawrence Gilbert at the University of Texas at Austin wondered why *N. fulva* doesn't avoid *S. invicta* like other ant species do.

LeBrun and his colleagues describe how *N. fulva* charges large groups of *S. invicta* during combat, spraying venom, while *S. invicta* fires back with its own venom. The authors observed that after being sprayed with venom, *N. fulva* workers smear a secretion on their mandibles, run their front legs through their mandibles, and then groom themselves with their front legs. This suggested to LeBrun and colleagues that *N. fulva* might be able to detoxify *S. invicta*'s usually deadly venom.

To test whether the secretion could help *N. fulva* survive *S. invicta*'s venom, LeBrun and his co-authors sealed the opening to the exocrine glands that produce *N. fulva*'s secretions with nail polish in some individuals and kept it unsealed in others. They found that *N. fulva* with unsealed glands easily survived encounters with *S. invicta*, while *N. fulva* with sealed glands usually died within 8 h.

Next, as *N. fulva* has two different exocrine glands (the Dufour's gland and the venom gland) that exit the same pore, the authors wanted to know which gland produced the detoxifying agent and what that agent might be. They found that *N. fulva* survived *S. invicta* venom easily when smeared with their own venom gland secretion but not the Dufour's gland secretion. As *N. fulva* venom is mostly made of formic acid, the authors then showed that formic acid protected these ants from *S. invicta* venom.

Finally, the authors tested whether *N. fulva* reacted with their washing behaviour in response to most ant species, or reserved it for *S. invicta* attacks by staging battles where they pitted several species of ant against *N. fulva*. They found that although *N. fulva* washed after battles with any ant species, they spent the most effort detoxifying after encountering *S. invicta*.

The two ant species have a long evolutionary history together in their South American home, while sharing battlegrounds with other ant species that control both populations. However, given there are no other species around to keep them in check in the southern USA, understanding how *N. fulva* neutralises *S. invicta* venom could help humans learn to manage both species.

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Competition keeps the male mind sharp

In many animal species, males must compete fiercely with other males for access to mates. As a result, males often develop elaborate traits that will help them conquer other males, or make them more attractive to females. However, sexual competition can also select for traits that are more than just skin-deep. Courtship and mating are complex tasks requiring memory and problem-solving skills, which selection could also act on.

Brian Hollis and Tadeusz Kawecki from the University of Lausanne in Switzerland decided to investigate whether sexual competition influences cognitive performance in fruit flies (*Drosophila melanogaster*). Fruit flies have relatively simple courtship and mating rituals, but the researchers hypothesized that even in this system, competition for females might select for increased cognitive performance in males. In order to eliminate sexual selection, the authors raised three replicate populations of fruit flies for over 100 generations by randomly pairing single males with single females. In doing this, the authors eliminated all male–male competition, as well as all mate choice. The authors then tested the flies raised in enforced monogamy against males from the original population that had been kept under the naturally polygamous conditions, where males compete with each other to mate with multiple females.

First, the scientists challenged the flies to compete for mating opportunities. They found that when multiple males had to compete over females, the males from the

polygamous lines were far more likely to mate successfully with females than the males that came from 100 generations of enforced monogamy. However, there were no differences in locomotion between the flies and no differences between the flies in their mating success when a single male was paired with a single receptive female. The researchers concluded that the monogamous males had no gross abnormalities, but had lost their ability to compete with other males for mates.

In order to identify what these monogamous males might be doing wrong, the scientists put varying numbers of receptive and non-receptive females with either a single monogamous or a single polygamous male. They found that males from the lines of enforced monogamy would waste substantial effort trying to court unreceptive females, while the polygamous males targeted their courtship efforts appropriately. The scientists concluded that over the generations, the monogamous males had lost the cognitive ability to correctly identify the females that would be the most receptive to their amorous advances.

Finally, the researchers asked whether this decline in cognition was specific to courtship, or whether the monogamous males had reduced performance during other cognitive tasks. They trained the flies to associate a specific odour with an unpleasant shock and then challenged the fruit flies to solve a maze where the flies had to chose between the adverse odour and a neutral smell. The researchers found that the monogamous males were worse than the polygamous males at solving the maze. Interestingly, when they tested females from both the monogamous and polygamous lines, the scientists found that females of the two lines were equally capable of solving the maze. This result suggests that the males' decline in cognition is specific to the lack of sexual competition, rather than a result of genetic drift or a decline in overall performance in the absence of mate choice. Thus, it appears that sexual competition selects for cognitive traits, and competition is necessary to keep males sharp.

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Stressed shag chicks are short on telomeres

From the Fountain of Youth and Shangri-La, to plastic surgery and cryogenic freezing, humans have long been obsessed with circumventing the natural process of ageing. At the cellular level, ageing occurs as the protective DNA at the ends of chromosomes – called telomeres – gets shorter with each round of cell division. Telomeres act as physical shields to keep the important coding regions of DNA safe from unnecessary intervention by the enzymes that repair damaged DNA. Eventually, telomeres become too short to offer any protection, causing DNA integrity to decline and ultimately cell function to fail. Interestingly, a recent study from the laboratory of Pat Monaghan at the University of Glasgow, UK, showed that telomere length at early life stages can accurately predict future longevity in zebra finches. In a follow-up study just published in the *Proceedings of the Royal Society B*, a team from Monaghan's group – lead by post-docs Katherine Herborn and Britt Heidinger – tested whether early life stress enhances telomere loss. If so, this could explain why adverse early life experiences often lead to accelerated ageing – a phenomenon observed in many vertebrates that remains poorly understood.

The team headed out to the field to study a wild population of nesting European shags. They selected about 50 nests from the breeding colony of birds and stealthily monitored them to determine when individual chicks hatched. Ten days after the chicks hatched, the researchers moved in to obtain a blood sample from each one in the nest, and then they assigned the nest to one of three treatment groups. Shag chicks in nests from the control group were left undisturbed after the initial sampling, while chicks in the experimental groups were handled daily in order to administer an oral dose of corticosterone (the principal stress hormone in birds) dissolved in oil, or simply oil alone. The researchers knew that the handling/dosing procedure itself is an acute stresssor and causes a transient increase in plasma corticosterone, but they included a corticosterone-supplemented group to ensure that continual daily increases in this hormone occurred even when the chicks became accustomed to handling over the course of the experiment. For the next 20 days, the researchers handled and dosed the chicks in the experimental groups every day, but were careful not to disturb the chicks in the control nests. On the last day of the experiment, the researchers obtained a final blood sample from all of the chicks before waving 'bye-bye' to the birdies and heading back to the lab.

Back in Glasgow, the researchers processed the blood samples in order to measure plasma corticosterone levels and telomere length of red blood cell DNA. The initial pre-treatment corticosterone levels and telomere lengths were similar in all chicks, meaning they all started on a level playing field. However, when the team measured telomere lengths from red blood cell DNA collected on the last day of the experiment, they discovered that chicks that were handled for 20 days on a daily basis – regardless of the contents of their oral dose – had significantly shorter telomeres compared with undisturbed chicks. This means that an acute stressor, such as brief handling, experienced early in post-natal life can accelerate the loss of telomere length and ultimately impact the individual's longevity. So, the secret to a long life is a peaceful childhood! (Excuse me while I go enroll my kids in a yoga class…)

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The benefits of a stinky chick

Cuckoo chicks make terrible nestmates. First, they show up uninvited in the nests of other species. Then they hog the attention of their adopted parents. And finally, adding insult to injury, they unceremoniously dump their nestmates over the side of the nest. Or at least that is what usually happens. However, great spotted cuckoos in Northern Spain that lay their eggs in the nests of carrion crows have taken a different path; they actually help their nest mates – at least sometimes. How do they accomplish this? Daniela Canestrari and an international team of colleagues have recently shown in *Science* that the answer is as biologically clever as it is amusing: cuckoo chicks stink.

When they are harassed, great spotted cuckoo nestlings void a sulphurous and phenolic anal secretion that is both noxious and repulsive. Just how bad is this stuff? When the researchers coated chunks of meat in nestling secretions, not even feral cats would eat it! Carnivorous raptors, too, turned up their noses in disgust. But such repellence is precisely the secret of their success.

It turns out that cats and other predators cause major problems for carrion crows. They attack nests, and in some years cause most to fail. This is where the cuckoos step in. By monitoring the success of crows' nests over 16 breeding seasons, the researchers discovered that in years with particularly high rates of predation, nests with cuckoos were more successful than those lacking them. In contrast, in years when predation was limited, the nests that were invaded by cuckoos did worse.

What explains these shifting costs and benefits? Using manipulative experiments that moved cuckoos between nests, the team provided direct evidence that adding cuckoos to crows nests increased their success by almost 2-fold, where success is defined as the survival of at least one crow chick. By virtue of their malodourous stench, cuckoo chicks apparently served as a deterrent to would-be predators. But it isn't all good, as the team found that the presence of cuckoos resulted in fewer crows fledging from successful nests. Taken together, these costs and benefits seem to just about balance out; in an average year with an average amount of predation, crows with cuckoos do no better or worse than those without them.

Simply put, great spotted cuckoos are not parasites of this population of crows, at least on average. In the good years they seem to do more harm than good, while in years with widespread predation the cuckoos are instead mutualists. Because crows are unable to predict the future, they play their odds each year, tolerating their smelly houseguests and getting it right often enough. At the same time, with their simple trick of emitting a putrid stench, these cuckoos have hit upon the ideal evolutionary strategy. They've made themselves indispensable, and in doing so they ensure their persistence for generations to come.

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