



Playing dead

T WAS EARLY SUMMER IN THE SWISS ALPS, and I was standing at the edge of a pond looking for dragonflies. They weren't hard to spot as they whizzed past me, dashing from a perch on a leaf, to hovering over the shiny water's surface, to interacting with one another in the sky. I was there to collect dragonfly eggs for laboratory testing, so I hadn't spent much time scrutinising their behaviours. But as I stood next to this pond, something peculiar happened. I was waiting for females so I could collect their eggs, as I saw a female dragonfly plummet into the ground next to me. She remained motionless, and was

lying upside down on the ground – a very unusual posture for a healthy dragonfly. This female moorland hawker (*Aeshna juncea*) was being followed by a male hawker, who flew around her motionless body for a few seconds, before giving up and flying away. Thinking her dead, I moved towards the female hawker for a closer look, but as soon as I approached, she flew away. This dragonfly was playing dead.

Moorland hawker dragonflies dominated the pond at which I witnessed this, and I had become used to seeing the winged insects diving into the grass, especially

Rassim Khelifa witnessed a female moorland hawker dragonfly doing something rather unusual to avoid a male. Such a surprising behaviour warranted further investigation...



following an altercation with another dragonfly. I hadn't originally thought it unusual for them to evade one another like this. But when I realised that when the dragonflies drop to the ground, they could actually be playing dead, I knew something more interesting was going on. What's more, after seeing the female crash-land and play-dead after being pursued by a male, I started wondering if she could have done it on purpose to escape the male. And having seen this crash-landing so often, it made me wonder if this could be a frequent behaviour.

When I was a child, I was fascinated by beetles that pretended to be dead once I picked them up – curling their legs up towards their bodies and remaining motionless, waiting for the perceived threat to be over. This behaviour, known officially as death feigning, has been observed in mammals, birds, reptiles, amphibian, fish and insects. However, I had never heard of a species death feigning in order to avoid another sex's advances. My journey with dragonflies started a decade ago in my hometown in Northeast Algeria when the first individual that I ever captured was an endemic species (the glittering demoiselle *Calopteryx exul*) that had not been observed for a century in the country. With its metallic blue coloration and remarkable flight pattern, it was the most amazing species that I had seen in nature. A few years later and I was studying a PhD

at the University of Zurich, researching the effect of warming on the phenology of dragonflies and damselflies, carnivorous aerial insects known collectively as odonates. I was very excited because it was an opportunity for me to see European species that I have never seen before, I had only previously read about them in books and scientific papers. It was during my fieldwork for this PhD that I started noticing dragonflies playing dead, and I had to find out what was really going on.

I selected two populations where the moorland hawkler species was abundant and I watched carefully in order to understand their reproductive behaviour. It generally seemed similar to that of other dragonflies: Males were more numerous than females around the water, interacting with one another and patrolling each corner of the pond. Females, on the other hand, are either away from the water, or if present, are well-hidden within patches of vegetation. But as soon as females get close to the ponds, they are intercepted by males. During mating, the male and female dragonflies perform an acrobatic aerial copulation. The male grasps the female behind her head using the tip of his abdomen. The female's genitals are at the end of her abdomen, whilst the male's are on the underside of his second abdominal segment, closer to his head. Female flexibility is therefore required, as she bends her abdomen under and forward in order to bring her genitalia into contact with his. Joining in these two places forms a closed, heart shaped 'wheel' formation.

Wheel formation takes place in the air, after which the pair land and copulate near the water. The pair then split and the female lays her eggs on her own, often within tufts of vegetation, allowing them to hide from prowling males. It becomes a real game of hide-and-seek as females that have already mated try to avoid the grasps of males. During egg laying or transition from one location to another, males may detect the female and force copulation. It is when being pursued in the air by one or multiple males, that females were seen to rapidly crash-dive into the ground, mostly within vegetation. As soon as they land, either upside down or on their feet, most (~90%) remain motionless. Their strategy works. I found that in most cases, the male seemed less likely to detect the female once motionless; they flew around the crashing area for a few seconds before going back to the pond, trying their luck somewhere else. However, if males continued to try to grab them, some females would try to hold the substrate tightly as a last ditch attempt to avoid being taken into the air by the male.

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So I saw many different layers of self protection that the females used to avoid male harassment: Hiding within vegetation during oviposition, escaping by dropping to the ground (this may involve hiding as well when crashing in vegetation), feigning death once crashed and holding tightly to the vegetation when detected and grabbed by the male.

Now I knew that sexual death feigning was not just a one off occurrence, I trawled the online literature, and searched in old odonatology journals such as *Odonatologica*, but I found no reference of any such behaviour. One study on the blue hawker (*A. cyanea*), a sister species of the moorland hawker, shortly talked about a motionless hiding of females, but without any reference to them feigning death. Furthermore,





I presented the behaviour at the European congress of odonatology in front of a specialist audience, and no-one seemed to have ever seen it before. This was a new behaviour not just for the moorland hawker, but for all odonates.

How and why did such a strange behaviour evolve? In many mating systems, males and females have different ideas of how to go about reproducing successfully. In many males that can constantly reproduce sperm cells, more matings means higher the reproductive success. However, females have a limited number of eggs that can be inseminated with a single or a few matings. In the moorland hawker, there are three main behavioral characteristics that put females at risk: Female lay eggs solitarily without male protection, males are extremely aggressive and harass females for mating, and there are far more males than females at egg laying sites. The female therefore needs ways to defend herself if she is to have any choice in who sires her limited eggs. Furthermore, she may need to protect her future reproductive potential by protecting her immediate health - the dragonfly penis is a complex structure that is adapted to remove sperm that is already present in the female reproductive tracts before transferring its own sperm. Given that the copulation can last several minutes, there is a potential damage that the male can inflict on the female after repeated copulations. This needs to be confirmed with capture-mark-recapture studies that survey the survival of females that undergo different levels of repeated copulations.

There are other interesting questions to address in the future. For the moorland hawker, it is important to look at the effect of population density on the reproductive behaviour of the species. It is likely

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that playing dead to avoid copulation is observed more often at high population densities. It would be valuable to look at the potential tradeoff between avoiding male harassment by reducing movement and laying eggs in one spot, and the survival of hatched larvae – those laid in high densities at the same time are more likely to eat each other after hatching. Moreover, the occurrence of this behaviour in the moorland hawker means it's possible that other dragonflies and damselflies adopt the same strategy, especially in species where the female is harassed and has no protection from her male mating

partner.

The moorland hawker is common in Europe, a continent in which dragonflies have been thoroughly studied. Yet, I discovered a behaviour that had never before been recorded in these insects. My story shows that, even for these commonly studied species, there are still behavioural and ecological phenomena that are waiting to be discovered. By searching through the literature I realised that sexual death feigning has been observed in only four other species besides the moorland hawker. One species of spider, one species of mantis and two species of robber flies display this remarkable behaviour. The tactic is therefore only exhibited by arthropods, at least, as far as we know. I look forward to the discoveries that tell us otherwise.

Khelifa, R. (2017). Faking death to avoid male coercion: extreme sexual conflict resolution in a dragonfly. *Ecology*, 98(6), 1724-1726.