Spotlights flip the switch on an evolutionary arms race

When lights go on, moths drop their guard against predatory bats.

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Cape serotine bats (*Neoromicia capensis*) do not normally eat moths — in the dark.

Flip on a light in the middle of the night and the average kitchen cockroach or mouse will scurry away. In the same situation, however, some species of moth tend to drop their defences and end up as a bat's lunch.

Bats and moths have been evolving to one-up each other for 65 million years. Many moths can hear bats' ultrasonic echolocation calls, making it easy for the insects to avoid this predator. A few species of bat have developed calls that are outside the range of the moths' hearing, making it harder for the moths to evade them[1]. But humans short-circuit this evolutionary arms race every time they turn on a porch light, according to a study in the *Journal of Applied Ecology*[2].

In field experiments, ecologist Corneile Minnaar of the University of Pretoria and his colleagues examined the diet of Cape serotine bats (*Neoromicia capensis*) both in the dark and under artificial light in a national park near Pretoria. The bat, an insect-eating species common in South Africa, has an echolocation call that moths can hear. Minnaar and his team determined both the species and quantity of available insect prey at the test sites using a hand-held net and a stationary trap.

Cape serotine bats do not normally eat many moths. As the scientists expected, they caught more during the lighted trials than in the dark. What was surprising, however, was the discovery that the insects formed a greater share of the bats' diet during the lighted trials. The percentage of moths eaten in bright areas was six times larger than in dark zones, even though moths represented a smaller share of the total insect population under the lights than in the shade.

But surprisingly, though moths represented a smaller share of the total insect population in the lighted areas, they played a larger role in the bats' diet. Moths made up six times more of the bats' diet in the light than in the dark, even though moths accounted for a slightly lower percentage of the insect populations around the lights than in dark areas.

Moth models

Because it is difficult to observe bats in the act of catching their prey, Minnaar created mathematical models to explain this change in the bats' diet. One model, for example, supposed that the moths were easier to detect than the other insects; another, that the moths were the largest insects that the bats could catch.

The models that best matched the experimental results showed that the moths took effective evasive action in the dark, but gave up their defensive behaviour under the artificial lights.

The findings are in line with established research, says Aaron Corcoran, a biologist who studies bat and moth co-evolution at Wake Forest University in Winston-Salem, North Carolina. He would like to see the findings confirmed with more behavioural experiments, as relying on modelling alone may magnify errors.

Minaar is planning a global project to examine the cascading effects on light pollution on entire ecosystems, from predators to plants, and a citizen-science programme on light pollution. Minnaar is focusing on European bat species because more data is available.

For now, however, the implications of his recent findings have sent Minnaar back to the library, not the field. His work suggests that bat species with calls that cannot be heard by moths may face a greater risk of extinction because of light pollution than generalist bat species. Moth-hunting specialists tend to be rare, to avoid lights and to fly more slowly than other bats, which makes them vulnerable to owls and bat hawks.

“From our preliminary analysis it seems that, in Europe at least, light pollution is having an impact on the extinction risk for these species of bats,” says Minnaar.

That “is quite a worrying sign”, he adds. Policy decisions about lighting tend to focus on saving energy and reducing carbon emissions. Without an analysis showing that species may be at risk, he says, “The impact of light pollution on ecosystems is not part of the discussion.”

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References

1. Pavey, C. R. & Burwell, C. J. *Oikos* **81**, 143–151 (1998).
2. Minnaar, C., Boyles, J. G., Minnaar, I. A., Sole, C. L. & McKechnie, A. E. *J. Appl. Ecol.* http://dx.doi.org/10.1111/1365-2664.12381 (2014).