

Work smarter, not harder: The parasitic plan of the cuckoo bumblebee queen

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A far cry from the bumbling, flower-loving species we know and love, some bumblebees have given up collecting pollen in favour of a more devious method of parental care. But whether this helps or hinders them in the long run remains to be seen.

A queen's work is never done

Being a bumblebee is hard work, especially if you are a queen. A queen spends the winter alone, hidden away underground, trying to survive the cold. Should she make it through to spring, the hungry queen will have an even more daunting task ahead of her - founding her own colony.

First, she must find enough pollen and nectar to regain the energy stores she lost over the long winter. Then, she will need to set out to find a nest site. As keen recyclers, bumblebees like to repurpose the nests of birds or mice from previous years. She may have to travel hundreds of kilometres to find a prime location, as human-altered habitats simply do not have enough suitable spots. When she has decided, our queen will need to repair any damage from the winter, create a bed of nectar and pollen, and hope that the previous tenants do not come back.

And still a queen's work is not done! Until she rears enough worker bees, she will be responsible for laying eggs, sitting on them to keep them warm, and of course flying backwards and forwards collecting food for her young. With over 50% of colonies dying before the first workers hatch, it's not surprising that some bumblebee queens like to cheat.

A smarter strategy

At first glance, the cuckoo bumblebee queen appears very similar to other bumblebee queens, even mimicking their distinctive stripes. But look closer, and her body is purpose built for a very different objective...

Larger than her colony-building cousins, the cuckoo queen has a much tougher exoskeleton and a powerful sting, ready for a fight.

Whilst the more honest queens are braving the chill to build their nests, a cuckoo queen will enjoy a bit of a lie-in. Once things start to warm up a little, the cuckoo queen will wander out of her hiding place and mill about nearby flowers. Eventually, she might wander a little further afield, on the hunt for a colony ripe for the taking.

She cannot pick a very young colony, as there will not be enough workers to rear her young. If she picks a colony that is too old, there will be too many workers and the cuckoo queen will be forced out, or even killed. She needs to find something just right. With her target acquired; the cuckoo queen will storm into the nest, defending herself against the host workers' attacks using her armoured exoskeleton as she fights her way towards the queen.

Even up against a queen determined to defend her nest, the cuckoo queen has the upper hand. With her big, strong jaws and mighty sting, she will subdue or simply kill her rival. She will then compel the remaining host workers to accept her into their nest through mimicking both the appearance and smell of her new nestmates. Of course, by eating the host eggs, the cuckoo queen will give the workers very little choice in the matter. The intimidated host worker bumblebees, at a loss for what to do, will set about caring for the next generation of cuckoo queens.

Not quite so smart after all

Unfortunately for cuckoo bumblebees, cutting corners comes with its own set of problems. Cuckoo bumblebees are now completely dependent on other bumblebees for reproduction. With five of the six cuckoo bumblebee species in the UK in decline alongside their hosts, it seems that the cuckoo queen's underhand tactics might be her own downfall.

Cuckoo bumblebees need a minimum number of suitable nests in an area in order to maintain their own population; when host bumblebee numbers dip below this number in an area, the cuckoos will disappear. And even if there are enough host nests available, rising temperatures could alter the spring behaviour of cuckoo bumblebees, leading them to emerge at the wrong time. If this happens, the cuckoo queens will miss their window of opportunity when the host nests are the perfect size, and be unable to reproduce. Not to mention, the cuckoo queens are now trapped in an arms race, constantly having to evolve new ways to thwart the host bumblebees' defences. Failing to keep up would also spell extinction. With all of these threats to contend with, perhaps working harder was the smarter strategy after all.

References

- Alford, D. (1969) "A Study of the Hibernation of Bumblebees (Hymenoptera:Bombidae) in Southern England". *Journal of Animal Ecology*, 38(1), pp.149-170. DOI:10.2307/2743
- Antonovics, J. and Edwards, M. (2011) "Spatio-temporal dynamics of bumblebee nest parasites (*Bombus* subgenus *Psithyrus* spp.) and their hosts (*Bombus* spp.)". *Journal of Animal Ecology*, 80(5), pp.999-1011. DOI:10.1111/j.1365-2656.2011.01846.x.
- Fijen, T. (2020) "Mass-migrating bumblebees: An overlooked phenomenon with potential far-reaching implications for bumblebee conservation". *Journal of Applied Ecology*, pp.1–7. DOI:10.1111/1365-2664.13768
- Higginson, A.D. (2017) "Conflict over non-partitioned resources may explain between-species differences in declines: the anthropogenic competition hypothesis". *Behavioural Ecology and Sociobiology*. 71, 99. DOI:10.1007/s00265-017-2327-z
- Kreuter, K., Bunk, E., Lückemeyer, A., Twele, R., Francke, W. and Ayasse, M. (2012) "How the social parasitic bumblebee *Bombus bohemicus* sneaks into power of reproduction". *Behavioral Ecology and Sociobiology*, 66(3), pp.475-486. DOI: 10.1007/s00265-011-1294-z
- Lhomme, P. and Hines, H. (2019) "Ecology and Evolution of Cuckoo Bumble Bees". *Annals of the Entomological Society of America*, 112(3), pp.122–140. DOI:10.1093/aesa/say031
- Sladen, F. (1912) *The Humble-Bee*. 1st ed. Cambridge: Cambridge University Press.
- Sramkova, A. and Ayasse, M. (2009) "Chemical ecology involved in invasion success of the cuckoo bumblebee *Psithyrus vestalis* and in survival of workers of its host *Bombus terrestris*". *Chemoecology*, 19, pp.55-62. DOI:10.1007/s00049-009-0009-7
- Suhonen, J., Rannikko, J. and Sorvari, J. (2015) "The Rarity of Host Species Affects the Co-Extinction Risk in Socially Parasitic Bumblebee *Bombus*(*Psithyrus*) Species". *Annales Zoologici Fennici*, 52(4), pp.236-242. DOI: 10.5735/086.052.0402
- Yun, S., Lee, J. and Yoo, J. (2020) "Host-parasite interaction augments climate change effect in an avian brood parasite, the lesser cuckoo *Cuculus poliocephalus*". *Global Ecology and Conservation*, 22, pp.00976. DOI: 10.1016/j.gecco.2020.e00976