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BIODIVERSITY
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EGG REJECTION: GETTING RID OF A PARASITE IN THE NEST

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YOUNG REVIEWERS:


ANVIKA
AGE: 12


ARIA
AGE: 10


SEBASTIAN
AGE: 13


SHRIYA
AGE: 12


TITILADEO-LUWA
AGE: 13

Some species of birds, called brood parasites, lay their eggs in the nests of other species (called the hosts). Male and female hosts take care of the parasitic offspring. In most cases, the hosts raise only the parasitic chicks, which reduces the breeding success of the host birds. However, hosts can defend themselves from brood parasitism by developing the ability to recognize and reject parasitic eggs from their nests. In this article, we explore how host age influences the ability to reject foreign eggs. We show that female magpies improve their ability to reject foreign eggs added to their nests as they age, and we discuss what this might mean for both the magpies and cuckoos. Our results might ultimately help us to better understand how animals and humans defend themselves against the disease-causing parasites that infect them.

NOT ALL BIRDS TAKE CARE OF THEIR CHICKS

Breeding is a lot of work for birds and takes up much of their time. They must build a comfortable nest, incubate the eggs, and provide the chicks with food. But a few bird species skip all these duties! These species are called **brood parasites**. How do brood parasites breed without all the hard work? Cuckoos, cowbirds, and other brood parasites sneak their eggs into the nests of other bird species, which are called the **hosts**. Hosts, fooled by brood parasites, end up rearing chicks that are not their own. Brood parasites are real masters of trickery! Hosts often seem to be unaware of the deception and take care of the foreign eggs in their nests for the entire breeding season [1].

BROOD PARASITE

Bird species that avoid the duties of parenting by laying their eggs in the nests of other bird species, which then raise chicks that are not their own.

HOST

An organism that is infected or otherwise used by a parasite. In this case, magpies are hosts to the cuckoos, which are brood parasites.

HOSTS ARE NOT DEFENSELESS AGAINST CUCKOO INTRUDERS

Are not hosts able to spot the strange eggs in their nests? Yes, sometimes they can. The features that allow some birds to avoid brood parasites are favored by **natural selection**. How does this work? Well, those hosts that are targeted by brood parasites do not raise their own chicks, but those of the brood parasites. But imagine that some hosts could spot an egg that is somehow different from their own eggs. And now imagine that they could pick up the odd egg and get rid of it. Birds that can do this can focus their attention on their own eggs, so they are more successful at raising their own chicks. Since their chicks can inherit this foreign egg-spotting ability, over time, more and more birds in the population will have the egg-identifying skill. This is how natural selection has resulted in individuals able to spot and remove foreign eggs from their nests in many host species [1].

NATURAL SELECTION

The evolutionary change in the characteristics of populations and species over time, due to variations in the breeding success of individuals with specific traits.

WHY IS IT THAT SOME FEMALE MAGPIES CANNOT GET RID OF BROOD PARASITE EGGS?

Magpies are the hosts of brood parasites called great spotted cuckoos (Figure 1). Female magpies can often reject foreign eggs from their nests... but not every female magpie can do this. Why not?

There may be several reasons but, in our work, we tested a particular idea [2]. We thought that the age of the female might explain why some females can reject cuckoo eggs while others cannot. We got this idea because of another species we heard of, in which younger females were less likely to reject foreign eggs. So, we came up with the **hypothesis** that female magpies improve their ability to reject foreign eggs as they age, meaning that younger females would be less likely to reject foreign eggs than older females are.

HYPOTHESIS

An idea that is proposed to explain something, and that needs testing to be accepted. Scientists pose hypotheses as they attempt to explain the natural world.

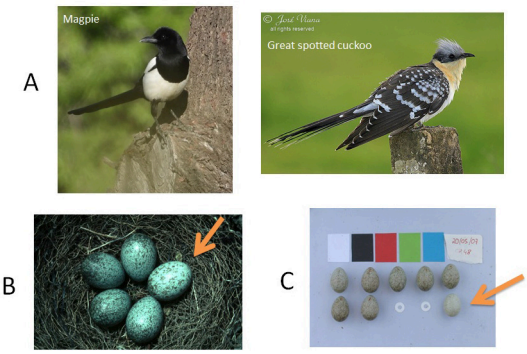

Figure 1

(A) Magpie (left) and great spotted cuckoo (right). **(B)** A magpie clutch with a great spotted cuckoo egg (arrow). **(C)** A magpie clutch with an experimental model egg [arrow; photo credits: Candela Gonzalez (magpie), Jose Viana (cuckoo), and Juan Gabriel Martinez **(B,C)**].

OUR MAGPIE STUDY

We study magpies near a little village in southern Spain called La Calahorra (Granada). Magpies build their nests in almond trees. The area is also home to great spotted cuckoos—brood parasites that use magpies as hosts. The cuckoos lay one to several eggs in magpie nests. The great majority of parasitized nests produce only cuckoo chicks—it is uncommon for parasitized magpies to rear both magpies and cuckoos. Up to half of all magpie nests in this area can be parasitized each year. The magpies we study are fitted with color rings. We place the rings on the legs of nestlings when they are about to leave the nest. Each individual magpie has a different combination of colors; this way, we can identify the magpies when we see them from afar using powerful binoculars. We also know their ages because we ring them when they are still in the nest. Every spring, we search the area for nests, and we observe each nest to see which magpies are using it. Later, we climb the trees to check whether the nests contain cuckoo eggs, and we count how many chicks (magpies or cuckoos) survive to leave the nest.

PLASTER OF PARIS

A powder made of calcium that can be mixed with water and molded into specific shapes (for example, an egg) before becoming solid.

CAST

A latex mold made from a real cuckoo egg. When plaster of Paris solidifies inside, an artificial egg is created that can be painted to resemble a real cuckoo egg.

EXPERIMENTS WITH PLASTER OF PARIS

It is very difficult to know if a magpie rejects a cuckoo egg. It is hard to find a parasitized nest right before the magpies remove the cuckoo egg, because egg removal happens very quickly. So, if we find a nest with no cuckoo eggs, it could be that the magpies just removed them already. How do we know if magpies can spot foreign eggs in their nests? We use artificial eggs, made of **plaster of Paris** molded in **casts** of real cuckoo eggs. These model eggs are painted to look like real cuckoo eggs. When we find a magpie nest with a few magpie eggs, we place a model cuckoo egg inside it, together with the magpie's own eggs. This way, we are certain that magpies have foreign eggs in their nests, because we planted them. Then we check to see whether the model eggs are still there a few days later.

CLUTCH

The batch of eggs that a female bird lays.

Using model eggs, we "parasitized" the **clutches** of 70 female magpies. We did this for each female every year, from her first breeding until she died. Magpies may live up to 11 years, although they live 3–4 years, on average. We carried out 176 model egg experiments between 2007 and 2018. Some females could only be tested once or twice. For many others, we managed to repeat the experiment until they were 3, 4, 5, and even 9 years old.

OLDER FEMALES ARE SMARTER WHEN IT COMES TO SPOTTING FOREIGN EGGS

We found that older females were more likely to spot and reject the model eggs! Young females (1–2 years old) rarely rejected model eggs, but the chances of females rejecting model eggs increased as they aged (Figure 2). In fact, more than 50% of the females aged 5 years or older were able to spot and reject model eggs. So, it seems that most female magpies become "smarter" and can more easily spot foreign eggs as they get older. On average, it took 5 years before the females could spot and reject model eggs. Our results proved the prediction of our hypothesis: age explains why some females reject the eggs of brood parasites while others do not.

Figure 2

Bars show the percentage of nests in which the model egg was rejected, graphed by age of female magpies. Age 5 includes females aged 5 years old or older. You can see that, as female magpies get older, they are more likely to spot and reject foreign eggs.

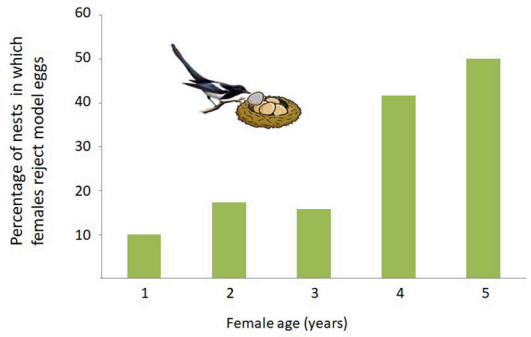

Figure 2

WHY IS THIS IMPORTANT?

Our results help us to understand the puzzle of acceptance or rejection of eggs from brood parasites. First, it seems that female magpies need a few years to learn to identify foreign eggs in their nests. Female magpies do not know what their eggs look like until they lay them, so maybe they cannot tell their own eggs apart from others until they have laid many eggs over several years. Perhaps their **visual sharpness** improves as they get older.

VISUAL SHARPNESS

The ability to tell similar objects apart or to identify small details using vision.

Second, most magpie females do not survive long enough to become very old. Most females we studied did not even live 4 years. Thus, when cuckoos are looking for magpie nests to lay their eggs in, they

will find a lot of nests owned by young female magpies. This helps cuckoos succeed in their cheating strategy because most magpie females are too young to discover the trick. That is good news for cuckoos! Although we now have a better understanding of why some magpies accept cuckoo eggs, we still are not sure why young magpies cannot spot the strangers in their nests. We are now trying to answer this question.

In the bigger picture, understanding why some individuals are unable to defend themselves against parasites is also useful for biologists and doctors who study other types of parasites, such as those that produce illness in humans and other animals. Maybe parasitized individuals are unable to get rid of pathogens because they are too young to have all the necessary mechanisms, similar to the situation with magpies and cuckoos! Future research might give us the answer!

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CONFLICT OF INTEREST: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

YOUNG REVIEWERS

ANVIKA, AGE: 12
My favorite subject in school is science and I think a particular field I want to study in the future is neuroscience. In my free time you would most likely catch me playing the violin or reading a book. I love music, books, and plants!

ARIA, AGE: 10
Aria loves playing with her two guinea pigs and feeding birds and squirrels in her backyard. She gave each squirrel a unique name and lots of peanuts. Aria is always curious about science and she has a lot of questions about nature, animals, and the universe. She also likes singing and drawing in her spare time.

SEBASTIAN, AGE: 13
I am Sebastian. In my free time I enjoy soccer, playing video games, and coding. My favorite field of science is either neuroscience or chemistry.

SHRIYA, AGE: 12
I love learning, running, and reading! My favorite subject in science is biology.

TITILADEOLUWA, AGE: 13
Hi, my name is Titiladeoluwa, but I go by Titi. I am 13 and I enjoy all types of science.

AUTHORS

JUAN GABRIEL MARTINEZ
I am very interested in the way animals behave and reproduce. I have spent many years studying the relationships between magpies and cuckoos, and I enjoy looking for explanations of the variability in animal behavior. I teach zoology and evolutionary biology at the University of Granada in Spain. *jgmartin@ugr.es

MERCEDES MOLINA-MORALES
I earned my Ph.D. studying the interactions between magpies and cuckoos, and I still work trying to better understand their relationships. I am also interested in other ecological interactions, such as seed dispersal by birds. I am currently a researcher at the University of Granada (Spain).

MARTA PRECIOSO
I have just finished my Ph.D. at the University of Granada (Spain), working on the interactions of magpies and cuckoos. I am very keen on nature and birds, and I have very much enjoyed doing fieldwork with magpies.

JESÚS MIGUEL AVILÉS
I work as a scientist at the Spanish Council for Scientific Research, in Almería (Spain). I have been passionate about birds ever since I was a child, and now I am lucky enough to work studying how birds like scops owls, rollers, and magpies interact with other birds and the environment during reproduction, and how birds use colors to communicate.