Nature's Game of Thrones:

Cuckoos, Hosts and the Battle for the Nest

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animals.fandom.com/wiki/African_Cuckoo

If someone switched your baby at birth, would you be able to notice? Believe it or not this does happen in the animal world and usually has one common culprit: the Cuckoo. Cuckoos are essentially con artists who will remove eggs from other birds' nests and replace them with their own eggs, having evolved the ability to mimic the appearance of other birds' eggs. Bringing a whole new meaning to the term absentee parent, Cuckoos force the host birds to raise offspring that aren't their own. But some birds are fighting back. We see rejection of the Cuckoo copycat eggs in some species of birds. The major questions are: how are they doing this? Why have they become able to do it? and how can they tell the baby isn't theirs when it looks just like the others?

Over the last few centuries many researchers have looked into brood parasitism in cuckoos and new research form Jess Lund and her team aims to expand on how host birds have evolved to detect copycat eggs when the cuckoo has essentially mastered its disguise[1]. This is an important topic of interest as these hosts and cuckoos coevolve new ways to con the host that become harder and harder to detect. In this case it was unclear to the researchers how fork tailed drongos were able to reject cuckoo eggs that were nearly identical to their own eggs so they decided to look into it[1] .

Research into the concept of brood parasitism can be traced back to a biologist named Edward Blyth who researched cuckoos brood parasitism during the mid 19th century[2]. Edgar Layard also made significant contributions to the research into egg mimicry in the late 19th century and early 20th century[3]. As these animals coevolve over generations and they find new more creative ways to mimic or detect eggs.

What is Brood Parasitism?

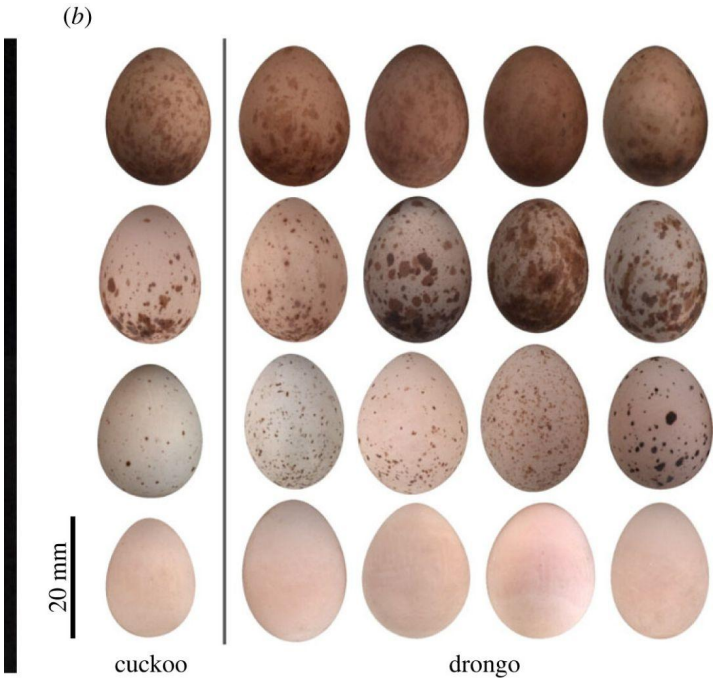
The term brood parasitism can be broken down and explained by its two parts. The word brood refers to the progeny of a bird and the process of brooding which is essentially looking

https://www.africancuckoos.com/study-systems/

after the egg. A parasite we know is an organism that finds a way to benefit from using the already present systems of another organism. Thus a brood parasite exploits another organism's brooding behaviours.

Mimicry and Rejection

Mimicry has evolved vastly across Cuckoo species. Studies conducted have determined a high level of accuracy in the colour mimicry amongst common cuckoos[4]. In host birds this manipulation of their senses needed to be overcome to ensure their own children's survival. One feature of their eggs that assisted them in rejecting the copycats was the egg's pattern. This rejection of the eggs becomes a barrier for the cuckoo's that they need to overcome so they improve their mimicry. So although the host birds find a way to detect it, in turn the cuckoo's find a better way to disguise it. In the study by Lund and her team, they researched the rejection by drongos of cuckoo eggs that had extremely accurate pattern mimicry[1]. They suggest that host birds are using specific markers to distinguish their eggs from the more random patterns produced by the cuckoos[1].



https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10369021/

Does this cycle ever end?

In short, no, host and parasite species participate in what is referred to as an "evolutionary arms race" to ensure their own survival. This arms race occurs in pretty much every ecosystem on the planet. It can be best described using the Red Queen hypothesis. This hypothesis states that to survive extinction on a planet of evolving species one must constantly evolve to ensure it keeps its place in the ecosystem and to not fall behind and be overtaken by another species. This explains the dynamic between cuckoos and hosts as they both must evolve and remain in this constant battle or risk extinction of their lineage.

Jess Lund's Study

Lund's team headed to Southern Zambia to research fork-tailed drongos to try to understand the potential reasons for their higher rates of rejection[1]. They surveyed 196 fork-tailed drongo nests over the course of 4 years and simulated 1000 parasitism events[1]. They analysed a single egg from each female drongo and cuckoo and assessed the eggshell colour, eggshell pattern, and egg size and shape[1]. As well as other quantifiable features such as pattern coverage, pattern variation, PC energy and number of features[1].

PC Energy?

PC energy is the strength or intensity of a pattern. The higher the PC Energy, the more dominant or pronounced the pattern

They developed two main models. The first model was used to determine which traits were consistently used by drongos to reject copycat eggs and to find out if any individual traits are good predictors of rejection[1]. The second model was used to determine differences in pattern traits between the host eggs and experimental eggs (eggs made to simulate cuckoo parasitism[1]. Providings a more comprehensive evaluation of overall trait differences to determine how they inform rejection choices. They measure something called the Euclidean distance which is the distance between two plotted points to determine a single value that tells you the magnitude of the pattern difference between the two types of eggs[1].

These experimental models helped researchers understand the mechanism of mimicry and explain the rejection behaviours of the fork-tailed drongo. Ultimately they decided model 2 was the best model for basing their predictions of rejection[1].

What did they find?

Firstly they discuss colour mimicry which is an important foundation to a good copycat egg. More often in other studies of egg mimicry quantify the colour accuracy using human vision which does not account for birds tetrachromatic vision[4]. In this experiment they were able to approximately replicate the bird's vision, to assess the colour differences the way the bird would see it[1]. Through doing this they found that the average colour of a cuckoo egg and drongo egg is virtually indistinguishable from the drongo's perspective[1].

When it came to the patterns on the eggs there was no substantial difference in PC energy or feature size or number[1]. However, there was evidence that indicated the coverage of the pattern was more concentrated in the cuckoo's eggs[1]. This is the first sign that indicated there are imperfections in the cuckoos disguise that may be an indication of how the drongo's are detecting the copies. The researchers conclude the pattern mimicry was only near-perfect because of this.

https://www.sabisabi.com/discover/wild-facts/fork-tailed-drongo

Based on model 2, if both the drongo and cuckoos were to make monomorphic eggs - eggs that all looked the same - the Euclidean distance between species would be around 0.75, which means there would be minimal differences[1]. Indicating cuckoo's mimicking skills are very fine tuned. In these hypothetical monomorphic populations the cuckoo eggs would be rejected less often, only around 35% of the time[1].

This is the basis these researches used to support the hypothesis that the drongo's are using what they refer to as 'signatures' to inform their rejections and vastly increase rejection rate to their current 93% success rate[1].

However, they found little evidence to suggest that the drongo's were using any specific trait to consistently reject imposter eggs[1]. So how can we be sure there are these supposed 'signatures'? The researchers suggest the 'signatures' are unique to the drongo's own eggs and they evaluate several cues of the egg's appearance to distinguish the fraudulent egg[1]. Asserting the idea that it may not be individual traits but overall composition of the egg[1].

What does it all mean?

Although there may not have been specific or consistent markers the researchers concluded that diversification of phenotypes - essentially personalising their eggs - by the drongo's is what has gotten them the leg up in this evolutionary race[1].

In terms of the cuckoos mimicry they need to step up their game if they want to beat these clever drongo's. This is afterall an arms race. It's hard to know exactly how the cuckoo would combat this issue but we can assume without a shadow of a doubt that they will find a way.

Impact on the Field

The high level of mimicry by the African Cuckoo to the Fork Tailed Drongo is quite unique and magnificent as most other brood parasite interactions have varying levels of mimicry. Most cuckoos and cowbirds that mimic host eggs do so with regular inconsistencies in size, colour and pattern. Making this analysis of high fidelity mimicry a substantial step in understanding how a host may go about rejecting eggs with near perfect mimicry. An incredible feat by both the cuckoos and drongos in their intense arms race that deserves recognition and opens the field to many new and exciting questions.

It has been proposed that mimicry and host egg appearance evolve in what is called 'chase-away' selection[4]. This type of selection is based on the idea that if cuckoo imposter eggs are based on the model egg of the host, the host would gain the upperhand if it changed the appearance of their eggs to make the cuckoo's mimicry even less accurate[4]. As this cycle continues the host stays one step ahead making changes to their eggs before the cuckoo has a chance to learn how to copy it.

https://www.snexplores.org/article/bird-fish-insect-parenting-cuckoo-brood-parasite

In the context of the findings of Lund's team this may be a potential reason for these so called 'signatures' that are enabling the rejection of fakes. However, the chase-away is noted to help maintain low fidelity mimicry so it appears as though the coevolving African Cuckoo and Fork-Tailed Drongo may have been in this race for quite some time.

In this long battle the cuckoo has been able to catch up to the drongo's chase away in terms of the detectable appearance however the drongo's are taking it a step further in personalising their eggs. The cuckoo mimics what most host eggs look like in the hopes it will be enough to trick them; however, research into the differences between the individual female drongo's eggs could tell us if they truly are customised signatures . If two drongos could tell their eggs apart from one another because they have a specific appearance then it should go without saying that they can identify the cuckoo's more basic egg copy.

What was missing?

One factor Lund's paper did not touch on was other potential motivators that rouse the host bird's suspicions. Many researchers have suggested that seeing or sensing the presence of a cuckoo near their nest can set off alarm bells for the host. Perhaps this phenomenon contributes to the high rate of rejection by drongos but was not assessed in the scope of this research paper.

So much more to explore

The field of bird brood parasitism is vast and intricate. Mimicry fidelity is not the only mechanism used by cuckoos, and cuckoos are not the only birds that exploit others this way.

Some cuckoos take their scheme to an entirely different level, the chicks. For most avian brood parasite systems the host bird for some reason does not notice the hatched chick that is almost entirely different looking from her chicks[6]. Perhaps not a common issue for the drongo's with their masterful observation and high rejection rate but what about the few that do make it past them? Does the drongo's keen observation only go as far as egg shells? And does the cuckoos' deception go beyond those shells?

https://www.researchgate.net/figure/Newborn-Bronze-cuckoo-chicks-left-are-visual-mimics-of-their-hosts-right-Top-Little_fig9_274173610

It would be interesting to see if they did reject chicks if it would in turn cause cuckoos to start being extra sneaky. Research has shown that some species of cuckoos - specifically the bronze-cuckoo - go as far as to make their chicks appearance mimic the way the host chicks are meant to look. It would be interesting to see if African cuckoos would take up this strategy to ensure the few chicks that made it past the drongo's close inspection would not be rejected after hatching.

How Far are They Willing to Take this Competition?

There is a clear arms race between these bird species. There are many different species of cuckoos each to parasitize their own host species. These species evolve so they can become really good at parasitizing their specific host, but could this go further in the case of African cuckoos?

https://www.theguardian.com/science/2023/jul/26/spot-the-difference-why-drongos-are-likely-to-clock-african-cuckoo-eggs-94-of-the-time

Could this competition become so specialised that the cuckoo's parasitise a specific family? Would they become differentiated to mimic the signatures of a particular drongo? More research would need to be conducted to understand what exactly these African cuckoos are looking for in nests they wish to parasitise. Although unlikely in the context of the chase-away theory it is an interesting thought of the potential extremes this arms race could reach.

All in All

Jess Lund's team was able to concretely analyse just how amazing the cuckoo's have become at disguising their eggs. These undetectable eggs are an interesting phenomenon in light of chase-away and its role in reducing the accuracy of mimicry.

They also concluded that drongo's have become masters at detecting imposter eggs based on a series of visual cues. With this phenomenal contribution to research there are many new paths of discovery to explore!

Further Readings

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