



CAN YOU SPOT THE
CUCKOO'S EGG?



ACT LIKE A DUNNOCK



BE BIRD - BRAINED

HOW DO YOU LIKE YOUR EGGS IN THE MORNING?



An activity for Key Stage 3 pupils: Using cuckoo behaviour to investigate natural selection through role play.

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“Summer is ycumen in, lhude sing cuccu...”
(the oldest song in English, written around 1250AD)

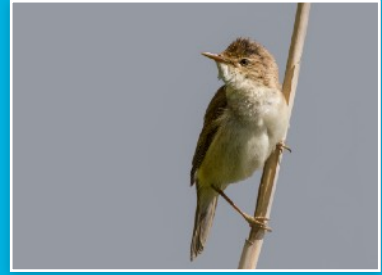
Background notes for teachers

Apart from the distinctive call that gives the species its common name, European cuckoos (*Cuculus canorus*) are best known for their habit of laying eggs in other birds' nests. The female cuckoo then flies away, leaving the host bird to bring up the young cuckoo. This is clearly a good idea for the cuckoo – raising young is energetically costly, dangerous and time consuming, so getting someone else to do all the work makes a lot of sense. For the host bird, however, it's a disaster. If a cuckoo lays an egg in your nest and you do nothing about it, then not only will you have no offspring yourself that year, you will also waste huge amounts of time and energy on the parasite squatting in your nest.

So the cuckoo's behaviour must place enormous selective pressure on the host species – individuals that have defences against being parasitized in this way will have an advantage over other birds, and successful defensive behaviour, if heritable, will spread through the population. That, in turn, places a selective pressure on the cuckoo to evolve a response to the defence. And so on.

This kind of co-evolution is termed an Evolutionary Arms Race.

The teaching resource described here uses the cuckoo/host example of co-evolution to provide an original approach to teaching natural selection, as well as providing opportunities for developing other key scientific skills such as experimental design and research.



The four main host species of cuckoos in the UK are reed warblers, meadow pipits, dunnocks and pied wagtails. Interestingly, an individual female cuckoos will only parasitize one type of host.

Example of host defences/cuckoo adaptations

Cuckoos that lay their eggs in reed warbler nests produce an egg that is remarkably similar to that of the reed warbler. In the picture, the cuckoo egg is the slightly larger one on the right.



Why do they do this?

The obvious suggestion is that the female cuckoo is camouflaging her egg. But why does she need to camouflage it? Is it just because it makes these eggs safer from predation? Or does it suggest something about the reed warblers. Have reed warblers evolved the ability to recognise and reject eggs that do not match their own? Is this why cuckoos have evolved the ability to lay mimetic eggs? Experimental evidence confirms this idea – if a non-matching egg is added to a reed warbler clutch, it is thrown out of the nest.

There are other details to this extraordinary parasitic behaviour. When a female cuckoo finds a suitable reed warbler nest (a nest with eggs in it but no

reed warblers in attendance) the first thing she does is remove at least one of the warbler eggs, which she swallows. Perhaps this is just because it makes for an easy and convenient meal. Perhaps it is to make more room for her own egg. It might also suggest, however, that reed warblers are somehow aware of the number of eggs in their nest. How do they react if there are more eggs in their nest than they laid?

The female cuckoo then lays her own egg remarkably quickly (generally less than 10 *seconds* – the record is 4 seconds! – compared to over 20 *minutes* for most other birds). Again, this unusual behaviour raises “why” questions – after all, she must be in a hurry for a reason. Can reed warblers recognise cuckoos? What do they do if they see a cuckoo at their nest? They might well chase her away before she can lay her egg – a leisurely 20 minute lay would be out of the question. It’s also possible that her presence at the nest will make the reed warblers more likely to reject her egg, or even their clutch.

Assuming the cuckoo’s egg is not rejected by the host birds, the cuckoo chick usually hatches a few days before the other eggs – the result of the female cuckoo letting the egg develop further inside her before laying it – and the young cuckoo then proceeds to eject all of the other eggs and/or chicks inside the nest. The cuckoo chick even has a special hollow in its back on which to balance the host bird eggs as it systematically shovels them over the edge.

This behaviour of the cuckoo chick makes perfect sense – though it makes for unsettling viewing – it guarantees that the cuckoo will gain all the food brought to the nest by the host parents. What is utterly baffling is the behaviour of the reed warbler parents, who just watch it happen and do nothing to interfere or prevent the destruction of their own reproductive success. No-one has yet shown why host birds have not evolved a defence against this behaviour.

Having calmly watched their own offspring being so ruthlessly despatched, the host birds settled down to the serious business of feeding a baby cuckoo. The work rate is extraordinary for the 20 days that the chick is in the nest, and for a further 2 weeks after it has fledged. Here, again, natural selection has been at work, the chick's curious call accurately mimicking the sound of an entire reed warbler clutch, and thereby stimulating the parent birds to work even harder.



As a result, the chick grows rapidly and is soon far too big for the nest. The sight of a tiny host bird standing on the head of the cuckoo chick in order to feed it is one that students find fascinating and disturbing in equal measure. Writers through the ages – from Chaucer to Shakespeare to Milton - have commented on this apparent breach in nature.

As Biologists, the question remains – why can't the host birds see what is so blindingly obvious to us? Again, no-one has provided a definitive answer, though there are some intriguing suggestions.



Lesson Overview

INTRODUCTION

Examples of natural selection and evolution in secondary education tend to focus on physical structures or characteristics of organisms, such as the adaptive camouflage of peppered moths. Yet animal behaviour is also shaped by natural selection and provides interesting and varied possibilities for approaching the topic of evolution in lessons.

The following lesson focuses on the evolutionary arms race that has resulted from cuckoos laying their eggs in host birds' nests. It aims to give an alternative perspective on how natural selection can work, squeezing thousands of years of evolution into a 30 minute activity. It also opens up many possibilities for interesting extension work.

LESSON PLAN

The lesson introduces cuckoos and their breeding behaviour. The class is then divided up with some students playing the part of female cuckoos, the others playing the part of host birds. Each cuckoo student will attempt to "lay" an egg in a host bird nest. The host birds, for their part, will try to prevent this happening or respond appropriately if it does.

The following allows for a class of 30 students, made up of 10 pairs of host birds and 10 female cuckoos. This arrangement is flexible – you might prefer to have your students working in trios or all students working as pairs – so a class of 32 would give 8 pairs of host bird and 8 pairs of cuckoo. Larger or smaller classes can be accommodated very easily. The key point is that the number of host bird pairs matches the number of cuckoos. The lesson fits into a single lab/classroom, though you would ideally have access to another, empty lab or corridor.

The introductory powerpoint shows pictures of cuckoos and provides some basic background information on cuckoo breeding behaviour. Suggested questions have been attached to the notes section of the presentation.

After the introduction, your students should appreciate that:

- Cuckoos are specialist brood parasites – i.e. they lay their eggs in other birds' nests
- Cuckoos provide no parental care at all
- This behaviour is evolutionary advantageous to the cuckoo
- Cuckoos do not parasitise all birds – they are very selective
- If a cuckoo lays an egg in your nest, you lose all your offspring, as the young cuckoo chick will eject all of the host bird eggs.

There are also pictures of the host birds. It's worth spending some time discussing what host birds are capable of and why this makes it all the more remarkable that they seem so helpless when faced with an enormous cuckoo chick in their nest. In the case of reed warblers, for example, here is a tiny, 11g bird that can migrate accurately over 4000km between Europe and Africa using the stars to navigate. It can build exquisite nests in the reed beds where they live. It can select exactly the right kind of insect to feed to their young. But given an enormous chick in their nest, 5 times as big as they are, and totally unlike their partner, they happily feed it. This is a very curious observation that needs explaining!

Don't, at this stage, give any detail or hints as to the complexity of the relationship. The idea is that they're going back in time to when cuckoos first started laying eggs in reed warbler nests.

ALLOCATING ROLES

You obviously need to have done this in advance. One way of differentiating is to give brighter students the chance to be cuckoos on their own – they get less guidance and have to really think through the ideas. Or you might prefer to encourage cooperative learning and mix up the abilities in the pairings.



Dunnock



Reed warbler



Pied Wagtail



Meadow pipet

GENERAL OUTLINE

Explain that the pupils will be playing a game. A competitive game. The game will progress over a number of rounds. In each round, a cuckoo will attempt to lay an egg in a host bird nest. If the host birds do nothing about it, the cuckoo wins that round and scores a point. But if the host birds can successfully avoid being parasitized, it is they that win and score the point. Try challenging them to see how many successive rounds they can win!

Becoming a bird...

The single most important point to stress to all the students is that they are *birds*. They are bird-brained, not human-brained. **This means that they cannot think – they cannot reason, they cannot imagine, they cannot count, they cannot remember.**

Instead, they get through life by following very simple rules.

The rule that **host birds** start with is: **look after any eggs in my nest.** You could discuss why this is usually a very good rule for a bird to follow.

Then explain to the host birds that if they can successfully avoid being parasitized by a cuckoo, they score a point and don't have to change anything for the next round. After all, their strategy clearly works! Points are recorded as a running total at the bottom of their tally sheet.

But if a cuckoo succeeds in laying an egg in their nest, and they do nothing about it, then they lose the round and score no points. At this point, they are allowed to choose a defence from the list provided which they can use in the next round. They can only choose one defence at a time, but having chosen it, they keep it for the rest of the game.

Pairs of host birds start the lesson with a nest (perhaps they could make one in preparation?) and six, plain white eggs. These might just be egg shaped outlines that they cut out from card, but they can also be readily purchased (see Appendix). They can place the nest anywhere they like in the lab (within reason!), but they must be able to reach it. They also have a laminated sheet of possible 'defences', their tally sheet and access to a sheet of small coloured round stickers.

Cuckoos, or pairs of cuckoos, start the lesson with one white egg that is significantly bigger than the host bird eggs, their own version of the tally sheet, and access to the same stickers as the host birds.

Controlling the lesson

Start with the host birds at their empty nests and the cuckoos lurking elsewhere. The host birds have made their nest but not yet laid any eggs in it. Explain that birds need to be constantly looking for food, so they will have to briefly abandon their nests to forage. Send the host birds out of the room (it might be fun to hide food items in a neighbouring class which they have to try and find – maybe a rule that they can't return to their nest until they have a food item?).

This is the cuckoos' opportunity! In the time available, they must try to put their egg into a host bird nest. Explain that for future rounds, they must keep using that particular nest.

Once the cuckoos have laid their egg and departed, bring the host birds back in and let them lay their 6 eggs in their nest.

As sentient humans, they will, of course, notice that there is already an egg in their nest. As birds following simple rules, however, they have no choice but to accept it.

So in Round 1, the cuckoos score a point (and don't have to change anything for round 2), while the host birds score zero and get to choose a defence. It's usually worth walking this first round through with the class as a whole – discuss what the best defence is. Get them to choose the rule, "Reject any egg that appears in my nest before I start laying." Discuss why this is a sensible rule for the birds to follow.

Let cuckoos retrieve their giant egg and run the game again. This time, when the host birds return to their nests, they are equipped to reject the alien egg that they find there. For Round 2, the host birds score 1 (and make no changes), and the cuckoos score 0.

So what are the cuckoos going to do? Again, depending on the class, you might want to walk it through, discussing the options, and suggesting an option. Or you could let the cuckoos figure out that they need to wait until there are already eggs in the nest before trying to lay their own.

For each round, the host birds do need to abandon their nest in order to go and feed, and this is something you should control, as they will otherwise sit fiercely protective of their nest and its precious contents.

Run the game over 8 to 9 rounds or until they run out of steam. You will need to be on hand to referee disagreements or interpretations!

Reviewing the lesson

DISCUSSION POINTS

How you structure this will depend greatly on you and your students. The following is just intended as suggestions.

Get them to describe what happened. What defences did the host birds choose? How did the cuckoos respond? Was there a pattern to the points scored? They should see that, in general, they alternated winning the rounds. This is the essence of an arms race – each response provoking a reaction.

Depending on the age of the group (I have successfully used this game with mixed ability Year 7 students and Oxbridge candidates!), you could discuss the nature of the selection pressure, or the heritable nature of the changes.

Compare a cuckoo egg in a reed warbler nest, with a cuckoo egg in a dunnoek nest. What do they notice? How could they explain this?

EXTENSION/HOMEWORK

- Ask the **host birds** to research their bird for a brief presentation in the next lesson.
- **Cuckoos** could be given different brood parasites to research and present on.
- Find out about a different type of evolutionary arms race and prepare a brief presentation
- In English, we describe the call as “cuckoo.” In Turkey it’s “guguk”. In German it’s “kuckuck”. How many other examples can they find? What does this tell us about cuckoo distribution in the world?
- How common is brood parasitism? How many species of cuckoos are there? What other birds have evolved this strategy?
- Studying cuckoo/host behaviour in the wild - How could scientists investigate the ideas behind this game? Ask your students to design simple, controlled experiments (using the CORMS criteria if you are an iGCSE Edexcel school) that test the following questions...

Do cuckoos lay mimetic eggs to try and prevent host birds from rejecting them?

Does the cuckoo chick call stimulate the host birds to work harder when feeding the chick?

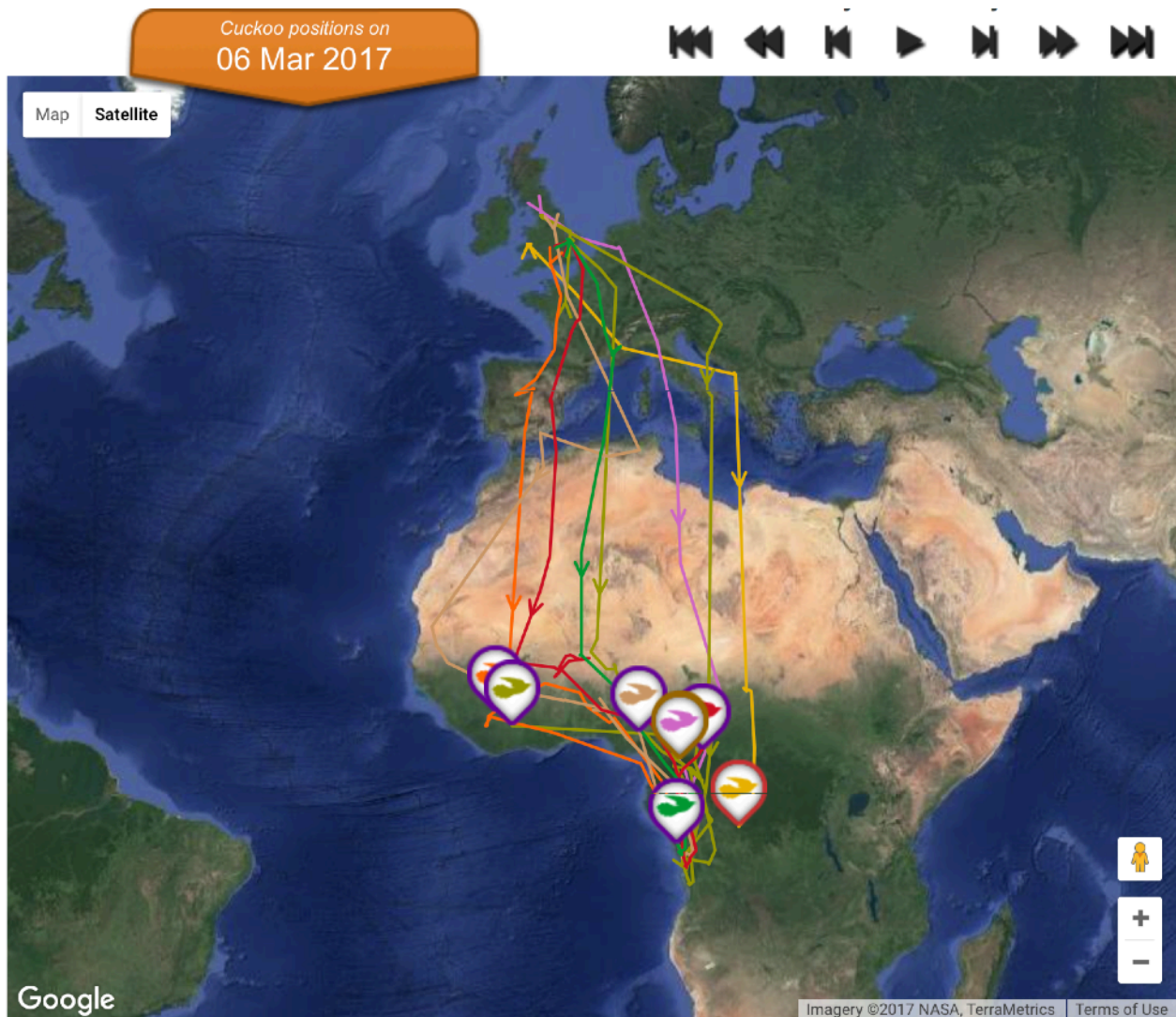
Can host birds count their eggs and respond if there are too many/too few?

Does seeing a cuckoo near its nest increase the chance that a host bird will abandon its eggs?

The main challenge here for the students is thinking of appropriate controls. For example, if you want to put a stuffed cuckoo model near a reed warbler nest to observe the response, the control must have a stuffed model of some other, non-threatening bird near it.

- An on-going project would be to follow the individually tagged cuckoos on the BTO website which gives the location and movement, in real time, of individual cuckoos tagged in the UK, but then tracked throughout their migration by satellite. Students can watch the movements of the cuckoos live from the classroom. They end up very attached to “their” individual cuckoo.

<https://www.bto.org/science/migration/tracking-studies/cuckoo-tracking>



References

CUCKOOS, COWBIRDS AND OTHER CHEATS

Nick Davies

The definitive and comprehensive book on all avian brood parasitism. Superb. The hardback version is a bit pricey, but there's a much more affordable Kindle version.

ISBN: 1408135868, 9781408135860

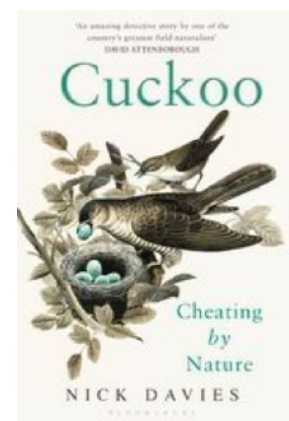


CUCKOO: CHEATING BY NATURE

Nick Davies

This book, available in paperback just focuses on the Common Cuckoo but covers all the background you could possibly want. Immensely readable and crammed with fascinating information, including lots of detail on the experiments that Nick and his colleagues have carried out at Wicken Fen on precisely the type of questions raised in the lesson.

ISBN: 9781408856567



CUCKOOS AND THEIR VICTIMS: AN EVOLUTIONARY ARMS RACE

Lecture by Professor Nick Davies

<https://www.youtube.com/watch?v=noO6S4hDDfE>



CUCKOO HIJACKS WARBLER NEST

Natural World - BBC

<https://www.youtube.com/watch?v=dAU5MTXmAPY>



Appendix

<http://www.arkive.org/cuckoo/cuculus-canorus/video-09c.html>

http://www.bbc.co.uk/nature/life/Common_Cuckoo

<https://www.youtube.com/watch?v=7BmGROmnrUA> (Animal Planet Cuckoo Switcheroo)

Model eggs are widely available from online auction sites and craft shops.

We ended up using coloured stickers as they are easy to remove so the eggs can be recycled.

The David Attenborough Life of Birds DVD has astonishing footage of all the behaviour described above, as well as lots of examples from around the world of other brood parasites. The shot of a duckling head suddenly emerging in a seagull nest is always a popular moment.



Cuddly singing cuckoos available here:

<http://www.britishbirdlovers.co.uk/gift-shop/rspb-singing-soft-toys>

<https://www.amazon.co.uk/Wild-Republic-Birds-13-16cm-Cuckoo/dp/B000N98M30>

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