More Fun Than Fun: The Marvelous World of Outsourcing Parenting Duties

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Common cuckoo (Cuculus canorus), adult female, photographed at Bhondsi, near Gurugram, Haryana. Photo: Satyajit Ganguly.

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This article is part of the 'More Fun Than Fun' column by Prof Raghavendra Gadagkar. He will explore interesting research papers or books and, while placing them in context, make them accessible to a wide readership.

The cuckoo has occupied a prominent place in the collective human imagination for thousands of years in many cultures. But perhaps the cuckoo is unique in that it has stirred our souls for two very different and conflicting reasons. We so admire the male cuckoo for his melodious voice that we have made the song of the cuckoo a metaphor for the sublime in music. It is the song that has conferred on the cuckoo the exalted title 'harbinger of spring'.

On the other hand, the cuckoo is an obligate brood parasite. It never builds its own nest and never cares for its own offspring. Instead, the female cuckoo lays eggs stealthily in the nests of other species and fools them into protecting and incubating her eggs and feeding her chicks – not in addition to, but instead of, their own. People have been so struck by this anomalous substitution of the familiar maternal care with shocking neglect of maternal duties that we have made 'cuckold' a metaphor for cheating.

Evolutionary biologists have brought to bear their own brand of curiosity, both on the song of the male and the deception of the female cuckoo. Let's explore the latter. The female cuckoo has exquisite adaptations for her act of deception. She carefully surveys the available host nests in her territory and keeps track of the progress of egg-laying by the hosts. After the hosts have begun to lay their own eggs and before they have completed laying their species-specific number of eggs, she flies over a host nest, removes and consumes one existing egg, and replaces it with one of her own – all in less than 10 seconds, compared to about 20 minutes that birds generally take to lay an egg.

She carefully chooses to lay her eggs in the afternoon while the hosts lay theirs in the mornings. Parasitic cuckoos have undergone a major physiological adaptation to make their eggs similar in size to their host eggs. This involves a reduction to about one-third of the size of the eggs they might have laid if they were non-parasitic.

Perhaps their most spectacular adaptation is to mimic the colour and unique pattern of spots of the eggs of their hosts. This is especially impressive because different races of cuckoos of the same

species specialise in parasitising and mimicking different host species with unique egg types. All of these adaptations are made even more impressive because they are not adaptations to *static* physical features of their environment. Instead, they are adaptations to living and evolving host birds that can fight back.

Indeed, hosts do fight back and their adaptations to reduce the probability of being parasitised are equally impressive. The result is an evolutionary arms race between host and parasite such that hosts reject a fraction of the parasite eggs and ensure that they don't go extinct. In turn, the parasites get away with enough surviving chicks fostered by the hosts, so that they don't go extinct *either*. This is the exquisite balance of nature.

In a landmark study published in 1988, Nicholas Barry Davies and Michael Brooke of the University of Cambridge, UK, placed each step in this arms race under the scanner of logic and experimentation. They studied natural nests of the reed warblers (*Acrocephalus scirpaceus*), a typical host parasitised by the common cuckoo (*Cuculus canorus*), in a patch of old fenland some 15 km from their university. Their methods of experimentation were as fascinating as their findings. They used the natural nests of the host, but they themselves played the role of the cuckoo. To do so, they prepared artificial model cuckoo eggs and, as stealthily as possible, sneaked them into chosen host nests. Their model eggs were accepted by the reed warblers as often as the real cuckoo eggs. This must have been thrilling.

The critical part of their experiment was to selectively behave like an *inefficient* cuckoo. Sometimes, Davies and Brooke made their model eggs not to resemble the host eggs very well in colour and spots, made the model eggs too large, introduced them before or after the host laying period, in the morning instead of in the afternoon, didn't remove a host egg before introducing the model egg, or so on. Their aim was to see whether such 'mistakes' by the cuckoo would be punished.

To their delight, they found that any deviation from what the real cuckoo did led to significantly greater rejection of the model eggs. They mimicked the parasite but pretended to be somewhat inept, to understand why the cuckoos do what they do – now how cool is that?

Left: three reed warbler eggs and one cuckoo egg (slightly larger) in a reed warbler nest. Right: A 14-day old cuckoo chick in a reed warbler nest. Notice that the cuckoo chick has managed to evict all host eggs and chicks and occupy the whole nest for itself, into which it barely fits. Photos: Nick Davies (Reproduced with permission)

And they needed very little to play this game: no sophisticated laboratory or equipment and funding – just a bicycle, a pair of binoculars, an easily produced model egg and lots of passion for seeking answers to nature's mysteries. My greatest admiration is always for research that anybody could have done.

Thus, they demonstrated that the cuckoo is perfectly adapted to get the maximum numbers of its eggs accepted by the host. But what about the hosts? Why do they not reject all cuckoo eggs, real or fake? The answer is that there is a cost to doing so. If they are too picky about accepting eggs that look ever so slightly different from their own eggs, there is a chance they will end up rejecting their own eggs. Thus, there is a tug of war between host and parasite, in evolutionary time of course, and they seem to have struck a balance that has permitted both of them to survive for millions of years.

I cannot stop marvelling at this.

But there is more mystery. The female cuckoo removes just one host egg because removing more would make the host abandon the nest altogether. So one cuckoo egg and two or three host eggs will hatch into hungry chicks. The drama that ensues now is even more mind-boggling. Within some 24 hours of hatching, the still naked and blind cuckoo chick will perform complicated manoeuvres of its body to summarily eject out of the nest any remaining host eggs or chicks and become the nest's sole occupant. The host will diligently bring food and feed the enormous cuckoo chick even when it has grown to five times *their* size.

Davies and his students have also investigated host-cuckoo chick interactions to understand why the hosts get fooled again. It turns out that the cuckoo chicks use a combination of exaggerated visual and auditory signals, bright and loud enough to mimic four hungry chicks, to fool the host into feeding them. Part of the problem is that it is too late: not feeding the cuckoo chick may not be very helpful in raising their own young. It must also be that the begging cuckoo chick tugs at the maternal instinct of the host parent more irresistibly than passive cuckoo eggs can. Like us, birds also have an elaborate hormonal machinery to turn on caring behaviour at the sight of helpless, crying or begging babies, something that they can't easily switch off.

We must, however, avoid becoming emotional about what we see in nature and refrain from taking sides in any tug of war between different species. It is easy to harbour the sentiment that the host species suffers more because we feel that the parasite is being unfair and ruthless. But the parasite also suffers when the host rejects its eggs. Whether the host populations suffer more from the activities of the parasite or vice versa is hard to predict. It may vary depending on the species and with time and space even for the same species. Neither party will really win or lose unless some external factor disturbs the delicate balance of nature. Conservation of nature is therefore best achieved by identifying the imbalances in nature, especially those caused by us, and helping to restore the balance. This may sometimes mean that we have to shed tears for ruthless parasites!

Indeed, the cuckoo seems to need some help. Davies laments that "the recent decline in cuckoos, our harbinger of spring, is a potent symbol of the diminishing natural world. Since the early 1980s, cuckoo numbers in the UK have declined by 65%, an alarming decrease which has led to them being 'red listed' as of highest conservation concern". I wish we had more information about the status of cuckoos in India.

I recently came across another study conducted near Buenos Aires in Argentina that illustrates the precariousness of nature's balance in striking fashion. What interested me most about this study was that this is a case of a brood parasite being decimated by increased rejection by its hosts, which in turn is caused by an external environmental factor. The brood parasite here is the black-headed duck (*Heteronetta atricapilla*), which is an obligate parasite of two species of coots, the red-gartered coot (*Fulica armillata*) and red-fronted coot (*Fulica rufifrons*).

The black-headed duck is unusual among birds that rely entirely on other species to rear their young. Among many birds, including the cuckoo and the reed warblers, newly hatched chicks are naked, blind and quite helpless, and require much parental care. Such helpless young are called altricial. Most brood parasites produce altricial young. We can see that by outsourcing the responsibility of rearing their young to another species, such mothers can save time and energy to produce more eggs.

A red-gartered coot in Chile, February 2013. Diver Dave/Wikimedia Commons, CC BY-SA 3.0.
Bottom-left: Black-headed ducks in Brazil, November 2009. Cláudio Dias Timm/Wikimedia Commons, CC BY-SA 2.0.
Bottom-right: A red-fronted coot in Chile, December 2009. Cristián Pinto/Flickr, CC BY-NC-SA 2.0

But in other species, such as the domestic hen, for example, the young hatch with eyes open, covered with downy feathers and can immediately move about and feed on their own. Species that produce such precocial young are seldom brood parasites presumably because they gain relatively less by laying eggs in others' nests. But the black-headed duck is an exception in that it has precocial young that is an obligate brood parasite.

John M. Eadie of the department of wildlife, fish and conservation biology at the University of California, Davis, and Bruce E. Lyon of the department of ecology and evolutionary biology at the University of California, Santa Cruz, have been studying this duck-coot host-parasite system for some time now. Like Davies and Brooke did with the cuckoos, Eadie and Lyon have determined the propensity of the coots to reject duck eggs by placing model eggs in the nests of the coots. Since the sizes of the coot eggs, duck eggs and hen eggs are all somewhat similar, they made model eggs by painting domestic hen eggs to look like duck eggs.

The coots normally reject only 35-65% of the duck eggs, which gives the ducks the opportunity to maintain their populations. Eadie and Lyon find that the coots reject as much as 85-95% of duck eggs when there is flooding and loss of vegetation. This is bad news for the ducks. Using simple mathematical models, Eadie and Lyon caution that even at the best of times, black-headed ducks exist rather dangerously. And frequent environmental changes resulting in flooding and vegetation loss may make the chances of their long-term survival bleak. The parasitic species is at much greater risk of extinction and may need conservation efforts while the hosts seem to be doing fine.

In addition implications for conservation, these findings raise interesting scientific questions and provide opportunities for more sleuthing. The increased rate of duck-egg rejection by coots under flooding proves that the coots are quite capable of recognising and rejecting duck eggs. Then why do they not reject more duck eggs when there is *no* flooding? Research by Bruce Lyon's group and by many others is beginning to reveal many unexpected results and show that the ducks and coots are quite different from the cuckoos and reed warblers.

First, the coots don't actively eject duck eggs from their nests at any time, even though they can recognise them. They show a kind of indifference to the duck eggs. Indifference is possible because

the coot parents don't feed the chicks; both coot chicks and duck chicks are precocial and can take care of themselves. Thus, there is not such a big advantage to ejecting duck eggs.

But when there is flooding and vegetation loss, they increase the height of their nests and move only *their* eggs up, and leave the duck eggs behind. It appears that outsourcing parenting duties is not quite suited for species that produce precocial young. It's a bit ironical that outsourcing parenting duties does not seem to work well when the parenting duties are light, as they must be with precocial chicks.

Such findings show that an understanding of the behaviour of animals in the wild is necessary to implement appropriate conservation measures, and have given birth to a the fledgling discipline of conservation behaviour.

There is so much hidden drama in nature and our lives will be that much richer if we pry open nature's secrets. To be able to do so, however, we must preserve the balance of nature. As an enlightened species, I hope we are up to this task, at least with the selfish aim of enriching our own lives.

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