Journal of Avian Biology

JAV-00410
Mikami, O. K., Sato, N. J., Ueda, K. and Tanaka, K. D. 2014. Egg removal by cuckoos forces hosts to accept parasite eggs. – J. Avian Biol. doi: 10.1111/jav.00410

Supplementary material

Appendix 1

If hosts are parasitised by more than one cuckoo, w_e and Δw are described as follows:

$$w_e = (1-p)tN + prs(N-1-\alpha) + (1-p)(1-t)(N-1-\alpha)$$

$$w_a = (1-p)N$$

$$\Delta w = w_e - w_a = prs(N-1-\alpha) - (1-p)(1-t)(1+\alpha)$$

where '−α' represents an additional reduction of host eggs due to multiple parasitism. In this case, the conclusions are the same because Δw decreases as N increases. However, the situation may be more complex if multiple parasitism frequently occurs. First, if it is difficult for the hosts to successfully remove multiple parasite eggs, they should accept eggs more frequently. Second, in the situation where multiple parasitism frequently occurs, the probability of being parasitised must be high because multiple parasitism is the result of a high probability of being parasitised. Thus, hosts may choose trying-to-eject more frequently. Third, if multiple parasitism frequently occurs, cuckoos should have evolved to selectively remove rival cuckoo eggs. Fourth, our previously proposed model (Sato et al. 2010b) shows that if multiple parasitism frequently occurs, it is beneficial for the host to accept cuckoo eggs even if they are capable of discriminating cuckoo eggs from their own. This is because the parasitic cuckoo eggs laid by the first cuckoo serve to ensure host egg survival by protecting against parasitism by the second cuckoo. Thus, a different model would be needed to correctly examine the effects of multiple parasitism on egg removal by the host.

Appendix 2

If the host chick and parasite chick grow up together, the payoffs for a host that selects trying-to-eject (w'_e) and for a host that selects acceptance (w'_a) are as follows:

$$w'_e = prs(N-1) + pr(1-s)\{N-2-f(N-2)\}$$
$$+ p(1-r)\beta\{N-1-f(N-1)\} + (1-p)tN + (1-p)(1-t)(N-1)$$

$$= N - p\{1 + f(N - 1)\} + prs\{1 + f(N - 2)\} + pr\{f(N - 1) - f(N - 2)\} - pr - (1 - t)(1 - p)$$

$$w'_a = p\{N - 1 - f(N - 1)\} + (1 - p)N = N - p\{1 + f(N - 1)\}$$

where $f(x)$ represents the degree of fitness lost (i.e. a negative effect due to competition among host chicks and a parasite chick) by the host because of the presence of one parasite chick when there are x host chicks in the nest. The difference between the two cases ($\Delta w'$) is as follows:

$$\Delta w' = w'_r - w'_e = prs\{1 + f(N - 2)\} + pr\{f(N - 1) - f(N - 2)\} - pr - (1 - t)(1 - p)$$

where $f(N - 2)$ and $f(N - 1) - f(N - 2)$ decrease with the value of N because there is less competition among the host chicks and parasite chick as N becomes smaller. For example, if there is one host and one parasite chick, the host parent can feed them sufficient food, whereas this is not the case when there are five host chicks and one parasite chick. Thus, the negative effect would be smaller as N declines. As N decreases, $\Delta w'$ declines and it may eventually become negative. Therefore, the payoff for a host that selects trying-to-eject still decreases with the value of N. This is the same conclusion as that described in the main text.