Supporting Online Material for

Reduced Egg Investment Can Conceal Helper Effects in Cooperatively Breeding Birds

A. F. Russell,* N. E. Langmore, A. Cockburn, L. B. Astheimer, R. M. Kilner

*To whom correspondence should be addressed. E-mail: a.f.russell@sheffield.ac.uk

Published 17 August 2007, Science 317, 941 (2007)
DOI: 10.1126/science.1146037

This PDF file includes:

Materials and Methods
References
Supporting online Material for Russell et al. MS 1146037

1. Our study was conducted from September-January in 1999 and 2003-2005 in Campbell Park (a 128ha area of semi-managed eucalypt woodland in north-eastern Canberra, ACT, Australia), and August-March in 1988-2007 in the Canberra Botanic Gardens (a 60ha area 9 km west of the Campbell Park population) (S1-4). In both populations, females lay clutches of 2-5 eggs (mean±s.e = 3.5±0.08). Nestling starvation is negligible during the 11-day long period in the nest, but high rates of nest destruction by predators (up to 66%) mean that few females produce more than one or two successful broods/season. Supernumerary birds are virtually always: present before egg-laying; philopatric males that contribute substantially to chick-provisioning; and related to either one or other of the breeders in ca. 60% of occasions. No effect of helpers has been detected previously on any of the following: lay-date; clutch size; incubation/nestling period durations; nestling mass; fledging probability/success; or recruitment rates (S1-4). In Campbell Park, helpers were present at 38% of nests (N = 104 female-years), with 68%, 27% and 5% containing 1, 2, and 3 helpers respectively. Nests were generally categorized as unhelped or helped because the number of nests with greater than one helper was prohibitively low for statistical analysis. In the Botanic Gardens, 43% of nests had helpers, with 63%, 28% and 9% containing 1, 2 and 3 or more helpers respectively (N = 908 female-years). Statistical analyses were conducted in GENSTAT 9 (Rothamsted Experimental Station, Harpendon, UK), details of which are provided in the figure legends. Covariates mentioned in figure legends were fitted into model as potential confounds, but only retained if significant.
2. Helper effects on the rate at which chicks were provisioned was determined in Campbell Park using hour-long nest observations from a hide (N=20 nests, 12 without helpers and 8 with 1-3 helpers) during October-December of 2003 and 2004. Chicks were 6-8 days into their 11-day nestling period and mothers had ceased brooding. Time of day in which observations were conducted was randomized with respect to helper presence. Mass and tarsus lengths were measured in chicks after the end of hour-long provisioning observations at 15 nests and averaged within broods (N = 15 broods of chicks each aged 6-8 days).

3. Egg dimensions were measured in Campbell Park using vernier callipers (±0.1mm) in 1999 and 2003-2005, and egg volumes were calculated using Hoyt’s formula 0.51 x length x breadth x breadth (S5). Only the first clutch of eggs laid by a female was used, such that each female was represented only once (N = 96 females). Volumes were averaged within a clutch.

4. In Campbell Park (2003), all eggs save one (N=2-3/clutch) were removed from first clutches laid by 18 different females (N=6 with helpers, 12 without) on the day that incubation commenced. Nests were protected from predators using wire mesh and removed eggs were replaced with dummies until the day of hatching. Collected eggs were measured and placed in plastic bags to minimize water loss and frozen (-20°C). Yolks were removed, cleaned of albumen and weighed to determine wet-mass and then oven dried (38°C) to determine dry-mass. Lipid content was determined gravimetrically following lipid removal by Soxhlet extraction of oven dried yolks using petroleum ether, and nitrogen content of the dry lipid-free extract was determined using the Dumas method and protein estimated using a 6.25 conversion factor (S6). All masses were measured on a
calibrated analytical scale to 0.0001g. Measures were then averaged within each clutch to provide one value per female.

5. In Campbell Park (2005), complete clutches of eggs (N=40) were cross-fostered between nests and protected using wire mesh. Clutches were matched as closely in lay-date as possible (mean ± SEM: 2.6 ± 0.4 days). Clutches were removed, temporarily replaced with model eggs, measured and then carried in the hand to a foster nest, exchanged with the host clutch, which was then measured and transported back to the original nest, whereupon the models were replaced by the new clutch. All eggs hatched and no clutches were abandoned, although some were depredated by snakes that could penetrate the cages. Of the 40 clutches, 8 were swapped from a group to a pair (0 depredated), 8 were swapped from a pair to a group (2 depredated) and 24 were swapped between nests assisted by the same number of adults (11 depredated). Chicks were measured (mass, tarsus) on day 5, and averaged within broods to give one measure per female. Provisioning rates were determined using hour-long nest observations on day 6.

6. To determine whether females were constrained from investment in territories with helpers we conducted temporary reciprocal cross-fostering experiments involving the transfer of 1-3 chicks per nest. Female provisioning rates were measured using hour-long nest observations (in randomized order) when females were provisioning natural brood sizes, as well as experimentally reduced and experimentally enlarged broods. Overall, we observed 578 maternal chick feeds from our 60 nest observations (20 nests, each with 3 observations corresponding to the three brood size treatments). If mothers in groups are constrained by the presence of helpers, they should react differently to brood-size manipulation from those mothers in pairs only. This was not the case. In a two-way ANOVA in
which maternal feeds per hour was fitted as the response term, helper presence and treatment were fitted as fixed effects and maternal ID was fitted as a blocking function, mothers responded to changes in brood size in a similar way irrespective whether they were in a pair only or in a pair plus helpers (helper presence x brood-size treatment interaction term: $F_{2,36} = 0.27, P = 0.75$).

7. The probability that a breeding female would survive from the end of one breeding season to the start of the next was modelled for a sample of 424 females sampled over 855 female-seasons using 19-years of data from the un-manipulated Botanic Garden population (SI). The data were analysed using a Generalised Linear Mixed Model with binomial error and a logit link function with helper presence/absence fitted as the fixed term of interest, spring rainfall and helper age fitted as covariates, and maternal identity was fitted as a random term to correct for the use of repeated measures of females ($N = 1-7$).

References


