ELECTRONIC APPENDIX

Analytical results

The expected fitness of a dominant individual in a peaceful group is equal to

$$(1-p)k\int_0^\infty e^{-2mt} + \int_0^\infty e^{-mt}(1-e^{-mt}) \qquad \text{(A1)}$$

$$= \frac{(1-p)k+1}{2m}$$

The first integral in (A1) gives the dominants output for each time that both she and her subordinate are alive; the second integral gives her output for each time that she is alive but her subordinate is dead. The equivalent expression for the expected direct fitness of a subordinate is

$$pk\int_0^\infty e^{-2mt} + \int_0^\infty e^{-mt}(1-e^{-mt}) \qquad \text{(A2)}$$

$$= \frac{pk+1}{2m}$$

To determine the directional effects of the model parameters on the payoff of fighting, we cancel the common denominator *2m*, substitute (1) and (2) into (3) and differentiate with respect to the parameter in question. This yields the following partial derivatives:

$$\frac{\partial W}{\partial p} = 2fk(r-1) - ck(1+2f(r-1)) \qquad \text{(A3)}$$

$$\frac{\partial W}{\partial k} = f(1-c)(1-2p)(1-r) - c(p(1-r)+r) \qquad \text{(A4)}$$

$$\frac{\partial W}{\partial r} = fk(2p-1)+r(k-1)(f-1+p(1-2fp)) \tag{A5}$$

$$\frac{\partial W}{\partial f} = -k(r-1)(2p-1)(r-1) \tag{A6}$$

Given our assumptions (A4) and (A6) are positive, while (A3) and (A5) are negative. These results also hold for an alternative model in which fights lead to the death of the loser, with one exception: in the fatal fight model the challenger's payoff decreases with increasing *k*. This is because as group productivity increases a subordinate does better to enjoy the benefits of peaceful queueing rather than risk losing everything in a lethal fight. The principle here is the same as in the 'peace incentive' model of Reeve & Ratnieks (1993), which predicts that subordinates in more productive groups will require a smaller fraction of reproduction to deter them from entering into a lethal contest for control of the nest.

Now assume that when one of the breeders dies, the remaining female recruits a replacement subordinate to whom she offers a share $p' = qp$ of reproduction ($q \geq 0$). In this case (A1) and (A2) simplify to

$$\frac{k(1-p)+1-qp}{2m}$$

and

$$\frac{pk+1-qp}{2m}$$

Substituting into expression (3) in the text and differentiating with respect to *p* shows that $\partial W / \partial p < 0$ given the constraint that $p < 0.5$ and $qp < 0.5$, i.e. subordinates always receive the smaller share. The directional effects of the other parameters are identical to those in the basic model above.