



Parental fish change their cannibalistic behaviour in response to the cost-to-benefit ratio of parental care

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Partial filial cannibalism, the act of cannibalizing some offspring, has been explained as a response to the high energetic cost of care. I tested this hypothesis by manipulating the cost-to-benefit ratio of care in the scissortail sergeant, *Abudefduf sexfasciatus*, a tropical damselfish with male care. Background egg mortality was lower than the incidence of cannibalism, confirming that males did not just dispose of dead eggs. Investment in the current brood affected future investment, because males forced to skip a brood cycle put more effort into courtship during the following cycle and obtained larger broods than did unmanipulated males. Any factor influencing the cost-to-benefit ratio of parental care should also affect the incidence of cannibalism. I reduced the cost of care by supplementary feeding and reduced the benefit of care by simulating a decrease in paternity certainty through simulated intrusions by non-nesting males. Supplementary feeding significantly reduced partial filial cannibalism by parental males, a result compatible with the hypothesis that eggs are consumed to cover the energetic costs of parental care. Cannibalism decreased regardless of whether males were fed with conspecific eggs or crabmeat. Cannibalism was only reduced but not fully eliminated by supplementary feeding, and residual levels of cannibalism after feeding were similar to the background rate of egg mortality. Simulated intrusions by non-nesting males led to an increase in filial cannibalism and a decrease in parental effort.

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Filial cannibalism, the act of eating one's own offspring, is found in many taxa (Polis 1981), and it is especially common in fish (Manica 2002c). Filial cannibalism was long interpreted as an abnormal behaviour (Calhoun 1966; Lorenz 1966; Neel 1970; Dolhinow 1977; Ripley 1980). Rohwer (1978) suggested, however, that parents can use offspring as an alternative source of food to increase their current and future reproductive success. According to this adaptive explanation, filial cannibalism should be interpreted as one of the options available to guarding parents, and it is a common behaviour in connection with care of the offspring. The prediction follows that any factor influencing the costs and benefits of parental care should also affect the incidence of cannibalism.

Many factors can affect the costs and benefits of parental care. In teleosts, parental care consists mostly of defending the offspring from potential predators that are not a threat to the adult (Smith & Wootton 1995). This energetically demanding activity often limits foraging

opportunities (Smith & Wootton 1995), leading to a high energetic cost, which is at the heart of the evolutionary explanation of filial cannibalism proposed by Rohwer (1978). The energetic costs should be lower for males in good physical condition, and supplementary feeding should reduce the energetic cost of care and thus the incidence of filial cannibalism (Rohwer 1978; Sargent 1992). The benefit of parental care is proportional to the relatedness to the offspring being cared for (Owens 1993). Sneaking, defined as opportunistic males interfering with a spawning pair in the attempt to fertilize some of the eggs, can reduce certainty of paternity (i.e. perceived relatedness to offspring), and it is a relatively common behaviour in many species of fish (Taborsky 1994). Given that broods of low relatedness are of low value to the father, filial cannibalism is expected to increase with decreasing certainty of paternity (Svensson et al. 1998).

Supplementary feeding could decrease the incidence of cannibalism by decreasing the cost of care (Rohwer 1978; Sargent 1992), but evidence for this relationship is controversial (Sargent 1997). Hoelzer (1992) showed in a field study that, if Cortez damselfish, *Stegastes rectifraenum*, were fed with conspecific eggs, they cannibalized their brood less but still ate some of their own eggs. Kvarnemo

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