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Family life is one long com

Mums and dads all know when their children are hungry—they beg for food. As an evolutionary biologist (not to mention parent) this leads to some questions. We know that begging is a signal telling us that our child needs attention. But how is the signal interpreted? Can children make parents feed more than is necessary? Or do parents decide what is best?

My team and I are studying the burying beetle *Nicrophorus vespilloides*, which has a remarkably complex relationship between parents and children. We are taking advantage of these highly developed interactions to ask how parent and offspring communications evolve.

Offspring of the burying beetle, also known as the undertaker or sexton beetle, beg to their parents and parents respond by regurgitating food. It isn't all that unusual for insect parents to provide or prepare food for their offspring—insect mothers may lay eggs on a host plant, or even dig a hole and bury some food with the egg—but it is very unusual for parents to regurgitate food to their begging offspring. Such highly developed social interactions occur mostly in insects like some bees, ants and wasps. We could study these social insects but there are two great advantages to studying burying beetles: first, unlike social insects, there is no need to maintain a large colony; and second, burying beetles don't sting.

There are over 60 species of burying beetle worldwide; four species live in Britain. We study the most common which lives in forests. It reproduces whenever it finds a vertebrate carcass like a dead mouse on the forest floor, or even a baby chick that has died in its nest. When it finds a food supply, the adult

Family life is complex and there is not one perfect parental strategy.

Feeding time on a mouse carcass. A doting parent responds to the needs of its young.

can I have some more?

promise. Blame evolution, says Allen Moore.

beetle strips off the feathers, scales or fur and covers the carcass in spit-like secretions so the carcass can be rolled into a ball and buried. If a male finds the dead animal, he attracts a female using a pheromone. The two together may then process the carcass and care for the offspring. If the female finds the resource, she can process it and care for the offspring on her own.

We gave female beetles a mouse carcass each. A mouse carcass can support 10 to 30 larvae. The females lay eggs in the soil a small distance from the carcass. The larvae hatch 60 hours after the eggs are laid, and crawl to the top of the carcass where the parents have prepared a crater. Here they sit and beg food from the parents.

Like most children, larvae are demanding. They beg by waving their legs and pushing their mouths against the parent's mouth. With at least ten other siblings vying for food there is considerable competition for access to the parents, and there is a lot of pushing and jostling for position. We have shown that although larvae can feed themselves directly from the carcass, and do so more and more as they get older, they grow faster and larger and are more likely to live to adulthood the more the parents feed the larvae directly. The competition among siblings carries a cost in terms of energy and potentially lost feeding opportunities, but the benefit of winning and being fed directly is that they get more valuable food from their parents.

Why isn't family life more harmonious? Evolutionary biologists know why there is a lot of conflict within families. The rationale is simple: each individual larva is more related to itself than it is to its siblings. The parents, however, are equally related to all their larvae as each parent contributes one half of the genes the larvae possess. Thus, genes that benefit individuals win out over genes that benefit the group when selection acts on larvae, whereas parents should share the resources equally among all the larvae.

Feeding is influenced by the behaviour both of the parents and of the larvae. The larvae only beg if the parents are near the crater and parents only feed larvae that beg. Given the competition for parental attention, who wins? Do parents share resources equally or are some larvae fed more than others? In addition, do all parents do the same thing or are there differences among parents?

We found that there is a strong genetic influence on the

attentiveness of parents and the amount of begging by larvae. By raising offspring with foster parents, we found that the behaviour of both parents and offspring depend on who contributed to their genetic makeup rather than who is caring for them or who they care for. Further, there is a clear genetic link between parent and offspring behaviour. Parents that visit larvae a lot have offspring that beg a lot—even when the larvae were with less attentive parents or the parents were with offspring that begged less than their own. This fits our mathematical predictions of how the signalling and responses of parents and offspring should evolve. The main factor influencing the link between parent and offspring behaviour is which generation controls the allocation of food. When offspring influence parents, behaviour more, as we found for burying beetles, there is a positive association: babies that beg a lot have parents that respond more. When parents

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control the allocation of food more than the offspring, the opposite pattern is seen and there is a negative genetic correlation: parents with babies that beg a lot are less likely to respond.

Our research shows that interactions between parents and offspring evolve to be coordinated, depending on how natural selection has affected each species. This helps explain why there is variation among parents and offspring in the amount of feeding or begging that occurs. There is more than one combination that provides the same benefit. In burying beetles, when the larvae beg more there is also more competition among the young and more costs to begging.

Our work helps explain why families differ. Despite different evolutionary interests of parents and offspring, evolution leads to an integrated system of communication between the two. Future research will address how other conflicts, such as those between parents, are resolved by evolution. Family life is complex and there is not one perfect parental strategy, but it is reassuring to find that parents generally provide what their children need. In complex interactions, such as those between parents and children, there will always be compromises.

Want to know more?

A website covering all things burying beetle is at <http://tolweb.org/tree?group=Silphidae>

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