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Chapter 14 *Most Parental Sharing of Brood Care*

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Shared brood care or parenting chores are rare behaviors in insects. While a number of species exhibit biparental care, including wood roaches, passalid beetles, and some bark and dung beetles, only burying beetle males (Nicrophorus orbicollis) participate in all activities, remain with the brood throughout development, and can take over all parenting responsibilities if the female disappears. In general, extended parenting by both sexes is linked to insects that use rich but ephemeral resources to provision their young.

Maternal care and protection of offspring have been well documented in insects; some examples include lace bugs, reduviids, and of course, many hymenoptera. More rare is unassisted care of the young by the father, as in belostomatids and the reduviids *Rhinocoris* and *Zelus* (Tallamy & Wood 1986). Among insects, cooperation between the sexes in brood care is very unusual.

Methods

There are risks associated with increased parental care. Defending young from predators could put the adult in jeopardy, aggregations of prey (as a mother with young) may attract predators, and parents must put energy into the care of a few offspring rather than many (Wilson 1975).

Paternal cooperation in offspring rearing has evolved a number of times in divergent groups, most of which feed on carrion, dung, or rotting wood. This convergence of social behaviors associated with dietary constraints is no coincidence. Dung and carrion are rich resources

that decompose rapidly and must be used within a very short time. Many beetles excavate chambers underground to store and protect the resource and the larvae developing within it from predators and desiccation. This intensive processing requires the collaboration of both parents (Halffter & Edmonds 1982). Rotting wood presents a unique resource; while not rich or particularly ephemeral, it requires processing before it can be used as food (Tallamy & Wood 1986). A number of insect species could be nominated as candidates for the most parental sharing in brood care, depending on how one defines "sharing." Below I list several examples.

Cryptocercus roaches pair for life. The adults chew a series of galleries interspersed with large rearing chambers in rotting logs. Young nymphs require the transmission of intestinal flagellates through proctodeal trophallaxis (you don't want to know) from their parents. Nymphal growth is slow (5 yrs.), and the nymphs' diet is supplemented in the early stages with parental hindgut fluids and fecal pellets (Nalepa 1984).

Passalid beetles are also monogamous, and cooperate in construction and defense of interconnected galleries in rotting wood. Larvae of different species have differing abilities to chew and process wood for food; however, all depend on their parents to some extent in this endeavor. Colonies generally have overlapping generations and cooperative brood care. Colonizing adults share galleries with offspring in all stages of development, and with first generation nonreproductive adults. In some cases, young adults assist parents in the construction and repair of sib-

ling pupal cases and other tasks (Schuster & Schuster 1985).

Cooperation in excavation of brood galleries and rearing young is also known in the *Minarthrum* bark beetles (Hubbard 1897), and other scolytids (Tallamy & Wood 1986).

Complex cooperation between the sexes, with division of labor, occurs in many species of scarabaeine dung beetles. Females in the genus *Copris* and many *Ontophagus* species dig tunnels and brood chambers under dung, pushing dirt up to males higher in the tunnel, who in turn push it out. When excavation is complete, males transfer dung from the surface to the female in the tunnel and she constructs the brood ball. Typically the male remains with the female for most of this process, but disappears from the nest soon after eggs are laid in the dung (Hallfater & Edmonds 1982).

Some *Cephalodesmius* dung beetles pair bond for life and cooperate extensively while rearing larvae (Monteith & Storey 1981). The female excavates the brood chamber while the male stands guard at the entrance. The male then forages for detritus (leaves, flowers, and fruits), which he passes to the female. She adds feces and shapes the material into a ball, which is allowed to ferment for a week. The female then divides the ball into smaller sections for each larva. For several weeks, while the larvae are growing, the male continues to provision the nest. When the young approach pupation, both parents seal themselves inside the chamber with the larvae.

Results

The insects with the reputation for the greatest amount of shared responsibility in offspring care are burying beetles (genus *Nicrophorus*) (Featherston et al. 1994). Males and females *Nicrophorus orbicollis* pair off at a carcass, and after defending it from others, bury it. Underground, the carcass is rolled into a ball, fur or feathers are removed, and it is covered with anal

and oral secretions. Eggs are laid in the soil nearby, and hatch into altricial larvae, which are fed regurgitant by both parents. Although larvae may be able to feed themselves relatively quickly, they may still be fed by both parents (Scott & Traniello, 1990). Male and female beetles have identical brood care behaviors; however, in biparental broods, females spend more time provisioning the brood, and males spend more time guarding. Nevertheless, when one member of the pair is removed, the other member compensates by taking over all responsibilities. Furthermore, single males are as successful at raising broods as single females (Featherston et al. 1994).

Discussion

I award burying beetles the prize for most parental sharing in brood rearing. I base this decision on the following reasons: (1) Burying beetles share the same tasks; they do not exhibit absolute division of labor, as do dung beetles; (2) unlike wood roaches and termites, many tasks (defense, nest and food preparation, feeding larvae) are required, (3) males will take over sole responsibility if a female disappears, like many bird species, but unknown in any other insect.

When food resources are patchy and decompose quickly, insect parents are faced with a dilemma in reproduction. Young cannot be abandoned, as in most insect species, but require extended periods of parental assistance. The resource has a short "shelf life", thus the labor-intensive nesting, processing, and, in some species, care and feeding of the larvae, necessitates shared parenting (Wilson 1975).

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