Child Care among the Insects

Why do some insect parents risk their lives to care for their young?

by Douglas W. Tallamy

Photographs by Ken Preston-Mafham

RAIN FOREST NURSERY in Brazil features ants attending to a brood of young treehoppers (*Aetalion reticulatum*), while their mothers stand guard over freshly laid batches of eggs. The ants feed on a sweet secretion called honeydew produced by the nymphs and so defend them from predators. As a result, the adult treehoppers look after only their eggs, abandoning the young when they hatch to the ants' capable care.

Throughout the southeastern U.S., lace bugs of the genus *Gargaphia* live on horse-nettle plants. The female usually guards her eggs and, once they hatch, the nymphs that emerge. One fearsome enemy is the damsel bug: it brandishes a sharp, hard beak and, given a chance, will devour every last nymph. The lace bug has no such weapons: she diverts the damsel bug by fanning her wings and climbing on its back.

Meanwhile the nymphs rush to the midrib of the leaf and, using it as a highway, flee up the stem into a young, curled leaf, where they hide. If the mother can get away, she follows them and guards the stem of the leaf. There she can intercept the predator, which is likely to follow. Sometimes the mother may be able to fend off the attacker momentarily; in that case, she scurries to guide the nymphs to an ideal leaf by blocking a branch they might mistakenly follow. All too often, though, she dies in the attack, her sacrifice giving the nymphs time to escape with their lives.

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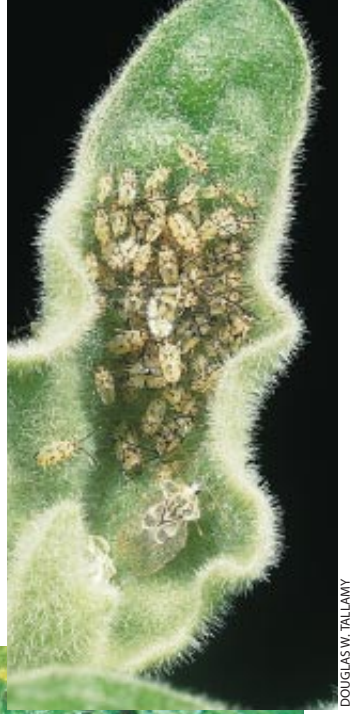

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HIDING IN FOLDS of a young leaf (*right*), nymphal lace bugs of the genus *Gargaphia* seek shelter from predators. The species is common in the southeastern U.S. In another episode (*below*), the mother faces off with the lethal larva of a lacewing, which, despite her efforts, is eating the nymphs.

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POISED TO DEFEND her offspring is a Ugandan assassin bug (*Pisilus tipuliformis*), which watches over her emerging nymphs (*right*). Shield bugs *Cocoteris* (*center*) from New Guinea and *Antiteuchus* (*far right*) from Brazil are quite likely to lose to predators those young they cannot fit under their sheltering shields.

Swedish naturalist Adolph Modeer first described parental care in insects as early as 1764. He noticed that the female European shield bug, *Elasmucha grisea,* remained steadfast over her eggs and tilted her body toward attacking predators rather than taking flight. But as late as 1971 many scientists hotly contested the idea that some insects actively care for their young. Even those who accepted the observations assumed that parental care was an innovation that only the most sophisticated bugs had managed to achieve.

Such behavior is indeed analogous to that of "advanced" life-forms, such as birds and mammals. But caring for offspring is hardly a recent innovation. It is common in invertebrates, including mollusks, worms, rotifers and even jellyfish. Among arthropods, it is the rule for centipedes, spiders, scorpions, sea spiders and the likely closest relatives of insects, the crustaceans. In fact, the relative rarity of "parental" insects—they are scattered, seemingly at random, throughout 13 insect orders—seems to reflect its widespread loss from early lineages.

Still, the ecological penalties for parental care can be so severe for insects that some entomologists wonder why it has persisted at all. The far easier strategy, followed by most insects, is simply to produce an

JOSTLING FOR SAFETY underneath the body of their mother, larvae of the Brazilian tortoise beetle (*Acromis sparsa*) arrange themselves into a symmetrical ring (*left*). At the ends of their bodies are anal hooks on which they wave their feces, repelling incautious predators with a mouthful. The mother guards the offspring from the time they are eggs (*above*) and shepherds the hatchlings to food sources, taking care to round up stragglers.

FORMIDABLE MOTHER, the praying mantis *Oxyophthalmellus somalicus* (*left*) has positioned herself at the base of a twig in a Kenyan desert. There she can intercept predators interested in her nymphs. The *Galepsus* praying mantis (*below*) is also from Kenya; she has hidden her egg sac so that it blends in with the bark surfaces. But she stands guard in case the ruse fails.

abundance of eggs. In his widely acclaimed synthesis, *Sociobiology,* Edward O. Wilson described parental care as a response to unusually favorable or unusually harsh environments. He argued that it should be most prevalent when resources are rich, in which case competition is intense, or when food is difficult to obtain or process, when physical conditions are particularly harsh or when predation is severe.

A Rich, Rough World

Burying beetles and dung beetles around the world have responded to competition for unusually nutritious but ephemeral resources such as carrion and dung by evolving a specific form of child care. Either the female alone or both parents secure the resource in an underground chamber as quickly as possible to protect it from competitors and from drying out. A pair of *Nicrophorus* carrion beetles, for instance, might bury a small dead rodent and then mold it into a cup that will hold and nourish the young. When the larvae hatch, the female—and occasionally the male—supplements their diet with regurgitated liquids. Michelle P. Scott of the University of New Hampshire and Gonzalo Halffter of the Institute of Ecology in Veracruz, Mexico, have shown that the males of such species prevent other males from usurping their prize and from killing their offspring.

Parents can also process food for the young. For example, *Sehirus* burrowing bugs provide their delicate nymphs, hidden within a soil depression, with seeds. *Umbonia* treehoppers expose plant phloem tubes, those that carry nutrients, to tiny nymphs by cutting a series of spiral slits in the bark. Wood eaters face the challenge of converting a tough, indigestible food source that is unusually low in nitrogen into a form that their young can use. *Cryptocercus* wood roaches and passalid bess beetles solve this problem by feeding the offspring directly from the anus with macerated wood fibers or with protozoans (which colonize the intestines and break down cellulose), feces and gut fluids that may be high in nitrogen. Bark beetles, on the other hand, chew tunnels within which they lay eggs and inoculate the excavated wood chips with symbiotic fungi that convert the cellulose to digestible forms for the larvae.

Insect caregivers typically protect only the eggs, but in some species one or both parents will defend the young as well. In that case, the parent and offspring must communicate extensively and coordinate their movement. *Gargaphia* lace bugs, sawflies, tortoise beetles and fungus beetles protect their larvae as they forage for food. A mother can guard only offspring that remain in a single group, so she herds them together by blocking the paths of the wayward ones.

As these examples suggest, mothers are most likely to care for their young. On rare occasions, however, the fathers take over, permitting the species to use habitats that would otherwise be too inhospitable. Water bugs, for instance, have large eggs that are in danger of drying out if laid above water or of drowning if laid within. Somehow, the eggs have to be moistened and aired.

In a primitive group of giant water bugs called *Lethocerus,* the female lays eggs on a stick above the water. The male repeatedly dives into the water and climbs out to drip onto the eggs to keep them moist; he also

HARLEQUIN STINK BUG (*Tectocoris diophthalmus*) from Australia defends her eggs aggressively. Because she lays only one batch, they are her sole chance for reproductive success.

drives off predators. But male *Belostoma* giant water bugs (often seen in swimming pools) instead carry the eggs, which the females glue onto the males' backs. A male has to keep floating to the surface and exposing these to air. He moves his hind legs back and forth or holds on to a twig and does push-ups for hours to keep aerated water flowing over the eggs. Similarly, *Bledius* rove beetles, *Bembidion* ground beetles and *Heterocerus* marsh-loving beetles all prevent their eggs from drowning within tidal mudflats by plugging their narrow-necked brood chambers when the tide is in and removing the plugs when waters recede.

The Cost of Care

Wilson has undoubtedly identified conditions that promote parental behavior in insects. Still, one wonders why some insects meet these challenges by caring for their young, whereas other species—even close relatives—reproduce under the same conditions using other strategies. One approach to this question is a simple cost-benefit analysis.

Both males and females can pay severe penalties for confronting, rather than fleeing from, predators. Such risks are difficult to quantify, and data are scarce. But when I measured the chances of *Gargaphia* lace bugs surviving the predation of jumping spiders, the mothers guarding nymphs were three times less likely to survive than females without such responsibilities.

Care is costly also because—with rare exceptions—it restricts parents to the site of the nest. Eggs are outstandingly expensive to produce, and mothers standing guard over their first clutch cannot forage for the nutrients that a new batch of eggs would require. This trade-off in fecundity can be substantial: *Gargaphia* females that are experimentally restricted from caring for eggs lay more than twice as many eggs as females that guard their young.

Such high costs have on occasion prompted alternative behaviors even within the same species. Some *Gargaphia* lace bugs and *Polyglypta* treehoppers dodge the risks and losses of guarding their young by laying eggs in the egg masses of other females of their species whenever possible. If they succeed, these "egg dumpers" are free to lay a second clutch almost immediately, whereas the recipients cannot resume laying until their first eggs hatch (in *Polyglypta*) or until their nymphs reach adulthood (in *Gargaphia*). If a *Gargaphia* female has no opportunity to dump her eggs, she reduces the risk by defending her young aggressively only when she is old and has little to lose or when her nymphs are in the final stages of development and have a good chance of reaching maturity.

Catherine M. Bristow of Michigan State University has found that *Pubilia* treehoppers limit maternal costs in a different way. A mother remains with her young until ants discover the group and begin to eat the sugary secretion, called honeydew, produced by the nymphs. Then the mother abandons them, transferring care of her young to the very capable ants, which defend the nymphs from predators.

As substantial as parental costs are for females, they are typically prohibitive for males. Physiologically, sperm are cheap. So although baby-sitting means less time for foraging, the reduction in nutrients should not hinder a male's ability to manufacture sperm. The trade-off is instead in the loss of promiscuity: when committed to guarding one batch of offspring, a male is no longer free to roam for additional females and to father many more young.

Exacerbating this loss is the inability of most insect males to guarantee their paternity. Females usually can store sperm and can even choose that of one male over another within their bodies. Such uncertainty about who fathered the eggs makes paternal care a dubious investment for most males.

Not surprisingly, exclusive paternal care is extremely rare in insects, occurring only in three families of true bugs. In a few species of assassin bugs, in even fewer leaf-footed bugs and in all giant water bugs, males manage to avoid the costs of care.

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MALE GIANT WATER BUG (*Abedus herberti*) from Sycamore Canyon in Arizona carries around the eggs he has fertilized, which are glued onto his back by the female. The male—one of very few paternal insects—goes to great lengths to keep the eggs moist and aerated.

Rhinocoris assassin bugs, for instance, make a display of their attention to an egg mass. Neighboring females seem to assume that a male that is already attending to eggs has a commitment to such behavior and seek him out for matings. Because females refuse to mate with males that are not guarding (except early in the season, when few eggs have been laid), males will fight over egg masses to protect. Such behavior pays off because the females lay eggs right after they mate, or even while mating, so that the male is accepting care for ones he more certainly fathered.

Moreover, in both water bugs and paternal assassin bugs, the density of females seeking males is high. Lisa Thomas, then at the University of Cambridge, has found that *Rhinocoris tristis,* a paternal assassin bug from Kenya, lives only on *Stylosanthes* plants; it drinks nectar from the flowers and hunts insect prey around them. Because the bugs concentrate on a particular host, and females can easily find males for guard duty, the latter do not suffer reduced promiscuity. Robert L. Smith of the University of Arizona offers similar arguments concerning the relatively dense populations of giant water bugs confined to ponds: the male does not need to roam, for the females come to him.

The Last Resort

Notwithstanding all these instances, the vast majority of insects avoid the costs of parental care by resorting to a variety of mechanisms by which eggs can survive. Piercing ovipositors (swordlike appendages used for laying eggs) or hard, impenetrable egg coatings allow many insects to hide their eggs in plant tissue or seal them out of harm's way in natural cracks and crevices. At the core of all such innovations is the development of iteroparous reproduction. Rather than laying all their eggs at one time—called semelparous reproduction—and then guarding them well, most insects have acquired the ability to lay them in many small clutches, thus spreading their eggs over time and space.

This strategy alone is a very effective way of cutting losses: if a predator discovers one clutch, it has access to only a small fraction of the total number of eggs laid by the mother. If *Gargaphia* lace bugs are, for instance, prevented from guarding their large clutches—typically well over 100 eggs—56 percent of those eggs are destroyed by predators before they hatch. In contrast, *Corythucha ciliata,* the sycamore lace bug, lays 33 small clutches rather than one large clutch and distributes them on many different leaves throughout its host. By this means, these bugs lose only 16 percent of their eggs to predators.

So then why have all insects not abandoned caregiving? Let us reconsider the cost analysis. A parent pays a substantial cost for caring only if it implies a loss in fecundity. Thus, if advancing winter or resources that are otherwise limited somehow prohibit future production of eggs, such costs do not enter the equation. Care may consequently become an effective option.

For example, females of the Japanese burrowing bug, *Parastrachia japonensis,* rear young only on fallen fruits of *Schoepfia* trees and must confine reproduction to the brief period when fruits are abundant. A female has food enough to produce only one large clutch, which she guards and provisions for weeks without sacrificing subsequent opportunities for reproduction.

Almost all parental species are thus constrained to no more than one clutch by seasonal change, ephemeral or scarce resources, or some other ecological limitation. If parental care in insects is viewed in terms of iteroparity and semelparity, the lack of pattern that has puzzled scientists for so long becomes easier to explain. For most insects, the opportunity to spread reproduction over time and space has made child care both prohibitively expensive and unnecessary. But for those with fewer chances to breed, it can be the only way to ensure that their offspring live on after them. SA

The Author

DOUGLAS W. TALLAMY studies the evolution of maternal and paternal care in arthropods, as well as the chemical interactions between insects and plants. He obtained his Ph.D. in entomology from the University of Maryland in 1980, served as a postdoctoral associate at the University of Iowa and is now a professor at the University of Delaware. Many of Tallamy's studies feature the *Gargaphia* lace bug, whose behavior he is able to observe in his backyard.

Further Reading

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