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The Decorated Defenders

Insect Strategies of Disguise and Survival

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Introduction

Insects are found in a wide range of environments and are continuously exposed to extreme biotic and abiotic factors. To cope with these challenges and to escape or reduce the adverse effects of their surroundings, insects have evolved a wide variety of adaptations and survival strategies.

Survival adaptation

Survival adaptation is any special feature or behaviour that helps an insect survive in its environment, protect itself from enemies, tolerate harsh conditions, find food and reproduce. These adaptations are commonly grouped into three categories:

1) Behavioral adaptations deals with an insect action, either solitarily or as a group.

2) Physiological adaptation is an internal body process or chemical change inside an organism that helps it survive in its environment.

3) Morphological adaptations are structural features that enhance survival and mainly include mimicry, camouflage and decoration (Sheikh *et al*., 2017).

Decoration in insects

Decoration is the process in which insects actively collect and attach materials from their surroundings onto their bodies. By doing this, they completely transform their appearance to get protection against their natural enemies and to ambush prey. Decoration in insects is described by using various synonyms like covering, masking, ornamenting, trash-carrying, shield-carrying and hatting (Ruxton and Stevens, 2015).

How do insects attach decorative materials to their bodies?

Decoration in insects is a complex, multi-step process in which insects first actively select suitable materials based on predator type, habitat and camouflage needs. The selected material is then trimmed or processed, carefully positioned on the dorsal surface and anchored using specialised body structures such as hooked setae and dorsal bumps etc. Attachment is also strengthened by silk, adhesive secretions, or faecal matter, forming a stable protective covering. Finally, the decoration is continuously maintained and repaired. This entire process demonstrates that insect decoration is an actively controlled and highly coordinated defensive mechanism rather than a random or accidental covering.

Examples:

Green lacewing larvae, often called “trash bugs,” decorate their backs with lichen, sand, plant fibres, shed insect skins and prey remains, forming a portable camouflage cloak held in place by hooked bristles. Before becoming an adult, the larva spins a silken cocoon and leaves behind its debris-carrying stage (Tauber *et al*., 2014).

Ant-backpack reduviid bug (*Acanthaspis* spp.) nymphs hunt ants and decorate their backs with their dead bodies using sticky secretions. This provides visual and chemical camouflage, making it look and smell like an ant cluster and protecting them from predators such as jumping spiders. After hatching **Bagworm moth caterpillars** build a portable silk case mixed with twigs, leaves and bark that serves as both home and armour. The same case is enlarged during growth and reused in the pupal stage, providing lifelong protection. **Tortoise beetle larvae** live openly on leaf surfaces and protect themselves by carrying a faecal shield made of their own excreta and shed skins, held on a forked anal process. This movable shield provides both physical armour and visual camouflage, while chemicals from host plants in the faeces add chemical defence. **Reduviid nymphs** cover themselves with dust, lint, soil and fibres trapped on sticky body hairs, making it look like a moving dust particle. This provides excellent camouflage, helping them to avoid predators and ambush prey such as bedbugs and cockroaches (Udikeri and Gaddanakeri, 2024).

Cased caddisfly larvae live underwater and protect their soft bodies by building a tubular silk case, which they strengthen with sand, pebbles, shells and plant debris. The case acts as movable armour, protecting them from predators and helping them remain stable in flowing water (Tasker and bilton, 2024).

Case studies

- Brandt and Mahsberg (2002) found that survival time differed between the three types of nymphs (backpack+ dust coat, dust coat and naked nymph) this means camouflage level strongly influenced survival, with backpack + dust coat showed the highest survival rate against selenopidae spider and geckos, and in interactions with centipedes and ants revealed that nymph with backpack + dust coat and dust coat only were mostly ignored, while naked nymphs were frequently attacked, confirming effective chemical and tactile disruption.
- Nakahira and Arakawa (2006) reported that the trash-package of the green lacewing, *Mallada desjardinsi* reduced both attack (55%) and capture (20%) by the intraguild predator, *Harmonia axyridis* compared to naked larvae. Trash-carrying larvae also required many more contacts before capture, demonstrating protection at both recognition (primary defence) and subjugation (secondary defence) stages of predation.
- Jackson and Pollard (2007) found that across all tests with both live bugs and motionless lures, masked individuals of *Acanthaspis petax* were consistently attacked far less often than naked individuals by all three salticid spiders (*Hyllus*, *Thyene* and *Plexippus*), regardless of whether the masked bug was larger or smaller than the naked bug. This proves that the reduction in attack is not due to body size, but due to the ant-corpse backpack itself.
- Hayashi and Nomura (2011) reported that carrying dead aphids greatly increased the survival of the lacewing larva *Mallada desjardinsi* against the ant *Tetramorium tsushimae*. Decorated larvae experienced fewer ant attacks, remained longer on ant-tended plants and captured significantly more aphids than larvae without dead aphids. Thus, dead-aphid decoration acted as a combined shield, deterrent and foraging enhancer, ensuring survival in ant-defended habitats.
- Ferry *et al.* (2013) experimentally demonstrated that the presence of a case itself is the key defensive factor in caddisfly larvae, rather than the specific material used. Against the predator *Anax junius*, larvae without a case suffered the highest attack and capture rate, longest handling time and lowest survival (20%), whereas larvae with leaf, stick, or rock cases showed very high survival (80-90%).
- Sugiura (2016) reported that the portable bag of *Eumeta minuscula* provided complete physical protection against predation by the carabid beetle, *Calosoma maximoviczi*. All control and bag-replaced larvae survived (100% defence), whereas all bag-removed larvae were immediately attacked and killed. This proved that the presence of the bag itself,

regardless of material, acted as an effective portable armour against invertebrate predators.

- Khan *et al*. (2020) conducted a field experiment and recorded that bag-bearing caterpillars of *Eumeta crameri* experienced very low kill rates, whereas bag-removed larvae suffered frequent attacks and near complete mortality when exposed to the weaver ant, *Oecophylla smaragdina*. Although both forms are equally touched by ants, only naked larvae were bitten and killed. This confirms that the bag functions as a highly effective anti-predatory shield under natural field conditions.
- Huang *et al*. (2023) found that the faecal shield of *Ophrida xanthospilota* larvae significantly repelled the ant *Camponotus japonicus* due to hexane-soluble chemical compounds. In contrast, the same shield attracted the predatory stinkbug, *Arma custos via,* DCM-soluble compounds. Thus, the faecal shield acted as a chemically mediated double-edged defence, protective against ants but risky against stinkbugs.

Conclusion

Insects under intense biotic stress have evolved decorating behavior, the active attachment of environmental materials to enhance survival alongside other behavioral, physiological and morphological defenses. Decoration works through multiple mechanisms *viz.* visual masquerade, mechanical shielding and chemically mediated signaling, each exploiting different predator sensory systems. Experimental studies show visual masquerade (e.g., ant-corpse backpacks) can result in detection without recognition, sharply reducing attack initiation by visually guided predators. For mandibulate predators, portable cases and bags act as mechanical armour, producing near-complete survival when intact and high mortality when removed. Debris and faecal shields frequently operate as primary deterrents and secondary physical barriers, lowering both attack frequency and capture success in controlled assays. Chemical cues from faecal shield can repel some enemies yet attract others, creating community-level trade-offs that alter net fitness outcomes. Thus, insect decoration is a context-dependent, multimodal defense and versatile adaptive strategy that enhances insect survival in natural environments.

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