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Insects as Ecosystem Engineer

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Ecosystem engineers are organisms that significantly alter their surroundings, either by developing new habitats or changing existing ones to better suit their requirements. By creating and preserving microhabitats that would not otherwise exist, ecosystem engineers have a substantial impact on other species. Ecosystem engineers are very frequently, though not always, referred to as keystone species because of the important roles they play in their surroundings and the broader effects they have on other species within the ecosystem. Without a keystone species, ecosystem function and biodiversity would be drastically diminished. Ecosystem engineers are those organisms capable to modify physically the environment in which they live. The engineer organisms do so by producing biogenic structures that impact in some soil processes, and affect the spatial and trophic resources for one or generally more organisms (Jimmenez *et al.*, 2006). Also it has been defined as the organisms that directlty or indirectly modulate the availability of resources to other species by causing physical state changes in biotic or abiotic materials, by doing so they modify, mainatain and/or create habitats (Berke, 2010). Arthropods that manipulate plant leaf to build shelters include spiders, caterpillars, beetles, and ants (Lill & Marquis 2007). Several studies have demonstrated that insect herbivores act as ecosystem engineers through the physical and structural modifications of plants manipulated by insects. Arthropod builders employ these shelters in one or more phases of their lives, and they take on various forms. When left undisturbed, these structures may cling to the plants and serve as a haven for herbivores and predators in the future. Within a species, shelters differ not just across species but also during ontogenetic phases. Many larval insects construct simple structures externally on host plants by covering, tying, folding, cut-and-folding, or rolling plant leaves with silk. Physical and structural modifications of plants by insect herbivores usually occur as the result of feeding and by construction of shelter.

Leaf Shelter Builders

Many larval insects use silk to manipulate parts of leaves, whole leaves, or numerous leaves as they grow to create rudimentary exterior constructions. Depending on how the insects work the leaves, these creations can resemble rolls, webs, ties, folds, or tents. For instance, whereas leaf-tiers and leaf-tent builders bind two or more leaves or a flap of leaf that has already been cut with silk strands, leaf rollers and leaf folders use full leaves or a portion of a leaf to roll or fold them.

Leaf Miners

Leaf miners are roving eaters that produce mines cavities or channels by internally feeding on the soft, living foliar tissue that lies between the upper and lower epidermal layers of leaves without disturbing the leaf surfaces. The construction of a mine represents a distinctive specialization of an endophagous lifestyle that begins with the oviposition of an egg in the leaf tissue, followed by larval consumption, and usually ends in an enlarged terminal chamber used for pupation.

Gall formers

The ability of gall-inducing insects to change host plant tissues and construct a physical structure in which their developing larva grows makes them one of the most astonishing, bizarre, and interesting living things. Additionally, gall-inducing insects are species-specific, which means that, with very few exceptions, each bug species only appears in a single host plant species. Galls usually occur on leaves and stems, but they may also occur on any vegetative and reproductive plant parts. Gallers are able to control gall morphology producing an enormous variety of structures of different types, complexity, colors, hairiness, and tissue type. When different creatures live in abandoned galls, insects that cause galls can be regarded as microhabitat engineers. Galls can affect the distribution and quantity of organisms in a variety of communities when they also offer protection from natural enemies, food resources, and a place to live away from the physical environment.

Leaf tents

Leaf tents ("cut-and-fold") are defined as constructions in which insect larvae use their mandibles to cut a flap of a leaf that is then folded over and usually fastened to the main leaf with silken wires. Larvae reside within the "tent" for a portion of the development and most of them feed upon the leaf portion under the peaked tent, ensuring therefore protection from natural enemies and/or climatic unsuitable conditions. Some species construct and abandon tents as they grow, such as the skipper *Epargyreus clarus* Cramer (Lepidoptera: Hesperiidae), which are obligate-shelter builders and construct five shelters, of four different styles, during ontogeny. Although leaf tiers and leaf rollers resemble each other, these two shelter-building insects can be distinguished by the way they web their leaves. Leaf rollers encompass insects such as caterpillars and beetles that roll entire leaves or a part of them with silken threads and use these rolls as shelters. Lepidoptera larvae, especially Tortricidae and Gelechiidae, can be easily found by unrolling the leaf or the partially folded leaf.

Table 1: Insects and their role in ecosystem engineers

Sr.No	Name of Insects	Role	References
1	Termite	Construct mound	Moore and Picker (1991)
2	Ants	Integrated engineering and trophic roles of species	Wilby et al. (2001)
3	Pseudoltelphusa spp.	Leaf ties	Lill and Marquis (2003)
4	Calacarus flagelliseta	Leaf ties	Fournier, 2003
5	Bees and Moths	Pollination	-
6	Ladybird	Predators	-

Conclusion

Insects belong to the most diverse group of arthropods. There are more than a few million described insect species, and the total number of living insect species is about 5.5 million. When different creatures live in abandoned galls, insects that cause galls can be regarded as microhabitat engineers. Galls can affect the distribution and quantity of organisms in a variety of communities when they also offer protection from natural enemies, food resources, and a place to live away from the physical environment. Despite their broad ecological relevance, very little is understood about the roles that insects play and the environmental services they provide. The absence of complete knowledge is due to the scarcity of adequately designed controlled studies relevant to the many functions provided by insects.

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