



Candy stripe shrimp a.k.a. clown shrimp (*Lebbeus grandimanus*) are often found on rocky bottoms in association with anemones, remaining on the base of the column or foraging around on the oral disk picking up scraps. The shrimp seems immune to the anemone's nematocysts.

Symbiosis

— *Partnership Between Species*

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Marine ecosystems are complex and dynamic places in which species interact in a myriad of ways: they both compete and cooperate for protection, shelter, food and various other resources. On individual species these interactions may have negative—such as competition or predation—or positive effects in the form of symbiotic relationships.

The term "symbiotic" has long since made its way into everyday parlance; we use it, often in a casual way, to loosely describe all sorts of mutually beneficial relationships in our lives including business, social and personal matters, but what does it actually mean?

The word symbiosis literally means "living together," and in biology, it refers to a close and usually obligatory association of two organisms of different species. While it is often assumed that this relationship is mutually beneficial, it is, however, not always the case. Symbiotic relationships include mutualism, commensalism and parasitism. In mutualism, different species have a cooperative or mutually dependent relationship where both organisms benefit. In commensalism, one benefits and the other is unaffected. In parasitism, one benefits at the expense of the other.

Mutualism
Two organisms of different species are said to exist in a mutualistic relationship when each individual benefits from the activity of the other. This relationship can be either external or endosymbiotic, whereby an organism resides in another's body or cells such as the photosynthetic algae harbored in corals.
Examples that will be well

known to divers include the relationship between sea anemones and anemonefish. The sting of the anemone's tentacles provide the fish with protection from predators, while the fish defend the anemone against butterflyfish, which feed of anemones.
Meanwhile, but less obviously, waste ammonia from the fish also nourish the algae residing in the anemone's tentacles. Since these algae are also in an endosymbiotic relationship with their host coral—they provide photosynthates and get protection and supply of inorganic nutrients in return—it goes to show that there is often more than one aspect to symbiosis, and many relationships can exist concurrently, often in an intermeshed manner.

Commensalism
Commensalism is a symbiotic state in which one organism benefits from the other without affecting it. The term stems from Latin *commensalis*, meaning "sharing a table". In biology, it describes the relation between



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Like other cleaner wrasses, the blues-treak cleaner wrasse, *Labroides dimidiatus*, eats parasites and dead tissue off larger fishes' skin—in this case a parrot fish—in a mutualistic relationship that provides food and protection for the wrasse, and considerable health benefits for the other fishes.

An example of metabiosis are hermit crabs (left) using gastropod shells to protect their bodies—this case seemingly a whelk. The shell is adorned by anemones. Anemones are predators, which catch small organisms floating past in the current. By being carried about by the crab, they get further exposure as well as catching drifting scraps from the crabs meals. The anemones stinging tentacles helps protect the crab while mobility probably also helps the anemone—i.e. there are reports of the sea anemone itself being eaten by the sea slug *Aeolidia papillosa*.

This sponge crab (below) is wearing a "hat" that consists of a living sponge colony; the brown sponge is itself covered by a colony of yellow ascidians. The sponge and ascidians gain mobility that they do not normally have, while the crab gains a disguise, and is further protected by toxic chemicals produced by the sponge. Unlike decorator crabs, the sponge is not actually growing on the crab's shell; the crab uses its back legs to hold the sponge in place.



individuals of two species in which one species obtains food or other benefits from the other without either harming or benefiting the latter. The benefitting species, the commensal, may obtain nutrients, shelter, support, or locomotion from the host species, which is usually significantly larger and mostly unaffected. However, commensalism is often a tricky case to argue. As any close interaction between two organisms is unlikely to be completely neutral for either party, relationships identified as commensal may in

fact be subtly mutualistic or parasitic.

Phoresy—an association in which one animal is attached to another exclusively for transport—may hinder the host by making movements more difficult or cause it to expend extra energy. Barnacles on whales and remoras attached to sharks or algae growing on turtles' shells are examples of such commensal relationships. Other forms of commensal relationships that are less direct include one organism using another for housing

(*inquilinism*) or using something another created, after its death (*metabiosis*) such as is the case with hermit crabs, which use shells from gastropods to protect their bodies, as shown on the image on the left.

Parasitism

An interaction between species wherein one, the parasite, benefits at the expense of the other and will often live in or on its host for an extended period of time. Although parasitism applies unambiguously to many cases,

it is part of a continuum of types of interactions between species, and in many cases, it is difficult to demonstrate that the host is harmed. Parasites that live on the outside of the host, either on the skin or the outgrowths of the skin, are called ectoparasites (e.g. lice, fleas and some mites) while those that live inside the host are called endoparasites (e.g. parasitic worms).

Community

How do symbiotic relationships affect the ecosystem? An eco-



An *inquiline relation* is said to exist when an animal lives commensally in the nest, burrow or dwelling place of an animal of another species. The yellow shrimp goby (above) shares a burrow with a commensal alpheid shrimp such as a pistol shrimp. The shrimp has notoriously poor eyesight, digs and cleans up a burrow in the sand in which both the shrimp and the goby live. The goby, meanwhile, has particularly good vision, but is less adept at creating burrows which, of course, offer valuable protection on the reef. The shrimp maintains almost constant contact with the fish with an antenna and is alarmed by touch when the fish retracts to the burrow for safety.



system is the interaction between living and nonliving things in a particular environment. Ecosystems can be likened to complex marketplaces through which resources flow, are

traded and passed on between entities in a multidimensional web.

Whether the currency of this market should rather be viewed as energy,



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Anemonefish (left) are fiercely protective of their host anemone warding off anemone-eating fish. In turn, the stinging tentacles of the anemone protect the clownfish from its predators. A special mucus on the anemone fish protects it from the stinging tentacles.

Benthic ctenophores have taken up residence on a sea star (center). These colorful invertebrates that look like flatworms are related to the comb jellies and cast their feeding tentacles into the current.

information or entropy, is the subject of a never-ending scientific discourse. Suffice it to say, all organisms and parts within this place are interacting all the time, and adjustments must occur if the organism is to survive. Since cooperation is fundamental to achieve integral participation, good results and ultimately, survival, symbiosis has been key in natural evolution.

Competition, predation and symbiosis are three processes that organise ecological communities. All these interactions vary in strength and duration from intimate, long-lived symbioses to brief, weak interactions through intermediaries.

While competition and predation *controls the abundance and diversity of species* in a community, symbiosis links species and serves to *increase community organization*, and with it, complexity and specialization in an ongoing process, until resources get limited or a structural collapse occurs, i.e., due to catastrophic events. ■



These cryptic teardrop crabs have attached bits of red sponge to themselves, and the sponge has grown and spread to completely cover the crabs' shells. The sponges not only disguise the crab, but also contain chemicals that make them distasteful to potential predators.