Coral Compatibility

As a reef tank becomes established, coral compatibility will change as corals grow and require more space.

By J. Charles Delbeek

It is my personal opinion that, in general, hobbyists have been mislead about reef tanks from the very beginning. In some — but not necessarily all — cases, the aquariums pictured do not actually exist, at least not in the long term. It is relatively easy to produce a stunning display by simply stocking the aquarium with newly acquired specimens. Thus, many photos are often of newly set-up systems or aquariums that are seldom more than 6 months old at most.

The fact is, it's very difficult to maintain a heavily stocked aquarium for any length of time. This has nothing to do with filtration or water quality, which are important, but rather with a factor that more often than not is ignored or neglected by many authors and hobbyists. If you have overcome the problems of microalgae, water quality, water movement and lighting, you might feel that you have attained the best possible conditions for your animals. Indeed, you may be too successful, for now the animals are growing and migrating throughout the aquarium. As a result, they will come into contact with each other. It is this physical contact that triggers the key factor in maintaining a heavily stocked reef tank: competition for space.

If you observe a shallow coral reef carefully or look at photographs of such an area, it is immediately apparent that space is at a premium. The entire substrate is covered with various life-forms. And yet, no one life-form dominates completely. Obviously, there must be one or more control mechanisms that allow such an extensive diversity of life to exist in a limited area. Failure to recognize this fact can lead to a lot of frustration on the part of the hobbyist, and can result in many expensive losses as a result of the struggle for space. The purpose of this article is to point out the mechanisms that sessile (stationary) marine organisms can use to hold onto their pieces of real estate.

Competition for space, or, more accurately, the lack of space, is one of the most important factors limiting populations on marine hard substrata. This is why sessile colonial marine organisms such as anemones, sponges and soft and hard corals have developed various mechanisms for defending their space and for moving into new ones. There are three primary mechanisms that such organisms can use: rapid growth to "shade-out" competitors, the development of aggressive structures such as mesenterial (gut) filaments, sweeper tentacles and acrorhagi, and the release of toxic compounds into the water. There is no evidence of any species utilizing just one of these mechanisms — generally they use a variety of tactics.

Rapid Growth

The growth rates of hard corals are species dependent, with certain species growing much quicker in shallow waters than others. A rapid rate of growth is a definite advantage, allowing these corals to quickly colonize new areas. A rapid growth rate also permits these species to achieve dominance over other species by "overtopping" them, thereby reducing the amount of light and water flow received. This mechanism has been proposed as an explanation for the dominance of pocilloporid corals in the Pacific and Acropora corals in the Atlantic. Although this mechanism is of limited importance in a closed system with a small number of hard corals, hobbyists should not neglect the possible effects of overtopping and shading caused by large anemones, corals or macroalgae. Such occurrences can be avoided by ensuring that each specimen is receiving adequate lighting and water circulation. Allowances should also be made for rapid growth by allotting sufficient space when first placing a specimen in the aquarium.

Aggressive Structures

Mesenterial Filaments

Mesenterial filaments, a coral's digestive organs, can be used quite effectively as aggressive structures. When two hard corals come into contact (whether the same or different species), one of them, the aggressor, will extrude mesenterial filaments through the mouth cavity or the body wall onto the surface of the other, literally digesting it's tissue. The result is a zone of naked skeleton that can then be overgrown. This zone can be overgrown by the attacking coral itself or it can be colonized by encrusting organisms, thereby creating a "buffer zone" between the two species.

Acrorhagi

Acrorhagi are specialized structures that were first recognized in coldwater species of the anemone family Actiniidae. They consist of inflated sacs that protrude from below the tentacles and are loaded with stinging cells. When these sacs make contact with another anemone, they leave behind a layer of tissue that results in localized tissue death of the intruder. It is not clear whether these structures appear in tropical specimens, but you should at least be aware of the possibility.

Sweeper Tentacles

Sweeper tentacles are specialized tentacles that appear on polyps after several weeks of contact with other organisms. These tentacles are usually much longer and thinner than normal tentacles and have many more stinging cells (nematocysts) than regular tentacles. As a result, the function of normal tentacles — to aid in feeding — changes in these specialized tentacles to one of defense or aggression. The elongated polyps of some corals, such as Goniopora, can also be used as "sweeper polyps" for aggressive purposes.

Although the production of sweeper tentacles is usually associated with hard corals, studies have also shown that they can also develop in soft corals (Octocorallia), such as the encrusting Caribbean gorgonian Erythropodium caribaeorum. These sweeper tentacles were found to lack pinnules (additional branching) on the tentacles and had bulbous tips that were loaded with nematocysts. Such specialized tentacles form only on corals along the edge of a colony that is in contact with another coral or encrusting algae, or by nematocyst discharge. A listing of aggressive hard corals, some of which are regularly kept in aquariums, includes bubble coral (Plerogyra sinuosa), anchor coral (Euphyllia ancora), Favia spp., Favites spp. and Galaxea spp.

Numerous researchers have tried to quantify the aggressive capabilities of corals and rank them in order of aggression. Some found that there is a direct relationship between aggressive proficiency and the number of nematocysts per polyp and/or mesenterial filament. Interestingly, it is the number of nematocysts per structure that is important, not the size or number of the polyps and mesenterial filaments. Combining these findings with those of others, various Indo-Pacific corals can be placed in the following aggressive categories.

Aggressive species include Fungia spp. (mushroom corals), Goniopora spp. (nematocysts concentrated in the polyps not in the mesenterial filaments), Galaxea spp. and Acropora spp. A genus of intermediate aggressiveness is Lobophyllia. Among the non-aggressive or subordinate species are Montipora spp.and Porites spp.

Although Acropora are classified as being aggressive, it is generally believed that they rely more on overtopping and asexual reproduction by fragmentation to compete for space. The small size of Acropora nematocysts supports this hypothesis. As far as Caribbean species are concerned, Isophyllia sinuosa has been classified as very aggressive, Montastrea annularis as moderately aggressive and Porites spp. as weakly aggressive. Interestingly, the initial dominance of Montastrea is due entirely to the action of its mesenterial filaments. However, it has been found that as the duration of an aggressive encounter increased, the subordinate coral was able to develop sweeper tentacles and reverse the interaction in its favor.

Toxic Compounds

It has been well known that many soft corals contain numerous toxic compounds, such as terpenoids and sarcophine (isolated from Sarcophyton glaucum, a commonly imported leather coral). These chemicals have been shown to be very efficient in deterring predators, but recent evidence suggests that they are also released into surrounding waters as a mechanism for maintaining living space. Toxic terpenes have been isolated from seawater surrounding several soft corals, including the common aquarium finger or tree coral, Sinularia spp. The use of chemicals to inhibit the growth of one species by another is called allelopathy and is quite common in terrestrial ecosystems.

In various transplant experiments using the soft corals Lobophytum pauciflorum (devil's hand), Sinularia pavida (tree coral) and Xenia spp. (pulsating polyps), the effects on the hard corals Pavona cactus and Porites andrewsi when the soft corals were brought close to the colonies of hard corals or in direct contact with them have been documented. The researchers concluded that the effects of soft corals on hard corals, and the susceptibility of the hard corals, was entirely species specific.

In some cases, intercolony distances of 30 centimeters resulted in stunted growth and death of the hard coral, whereas another species of soft coral caused damage only when in direct contact with the hard coral. For example, Porites andrewsi was the most sensitive hard coral, reacting to two of the three soft corals used even at distances of 10 centimeters. However, a soft coral that can cause damage by contact cannot necessarily cause damage by releasing compounds into the water. For example, Xenia caused extensive damage to both species of hard corals tested only when in contact with them. On the other hand, if a soft coral (e.g., Lobophytum pauciflorum) could cause damage from a distance, it could also cause damage upon contact.

Through the use of toxic compounds, soft corals are able to compete with hard corals for space by stunting the growth of the hard corals or actually killing portions of a colony and overgrowing it. However, as we have seen, hard corals are not without their own defenses, and serious damage can occur to the soft coral as well.

Planning the Aquarium

I hope you now have a better understanding of some of the mechanisms that are used in the competition for space on a reef. We will now look at how these mechanisms relate to our aquariums. When stocking an aquarium, you must take into account a number of variables, such as lighting and water movement. For better or worse, this article has now given you another variable to take into consideration: Will coral X get along with coral Y next to it? This is not an easy question to answer because it involves mostly trial and error.

The key is to closely watch the inhabitants in an aquarium and their reactions to the introduction of a new specimen. As an example, I offer you a story related to me by John Burleson. It seems that shortly after adding a colony of Xenia to his 150-gallon display tank, he found that his prefilter began clogging at a greater rate than normal. After many weeks of carefully removing selected pieces of coral and then returning them to the tank, he discovered that if he removed either the new Xenia colony or his Tridacna derasa clam, the clogging stopped. Apparently, the clam would produce huge amounts of mucus in response to the presence of the Xenia in the aquarium, which would clog the prefilter material. The Xenia must have been producing a chemical that the clam found objectionable.

The issue of toxic compounds in corals is a relatively new one. As a result, the effects of these compounds in a closed marine system have received relatively little attention in the planning and operation of reef aquariums. Mike Paletta suggests that soft corals not be placed upstream of other specimens in a crowded aquarium, but this is difficult to accomplish.

I am unaware as to whether the toxic compounds produced in an aquarium will accumulate or break down over time. It may be possible to use chemical filtration to remove them. As of now, there is no reliable evidence available to guide aquarists in this matter. However, it was recently pointed out to me (M. Paletta, personal communication) that the chemical nature of these compounds should render them susceptible to destruction by ozone.

The topic of toxic compounds is definitely an area of concern, particularly when it comes to keeping a highly diverse population and/or delicate specimens. The presence of these compounds might explain why certain corals are difficult to keep despite acceptable water quality. For example, Goniopora are generally recognized around the world as difficult to keep alive for more than a year in a closed system. However, they are maintained quite easily in an open system at the Waikiki Aquarium. One possible explanation may be that because they are closely related to the toxin-sensitive Porites spp., they are adversely affected by the toxic effluent of other corals that might build up in a closed system. This would not be a problem in an open system where these compounds would be continuously flushed out.

When placing a coral suspected of belonging to an aggressive genus into a tank, make sure that there is adequate spacing between it and other specimens. Generally, 10 to 15 centimeters should be enough, but don't forget that numerous species can expand to many times their normal size during the course of the day, which should be taken into consideration (do not simply measure only from the base). Also, if the coral develops sweeper tentacles, they may reach much further than normal polyps.

Be aware that many corals change their shape at night too, possibly bringing two species into contact. What may have been a safe distance during the day might not be adequate at night due to expansion or deflation of the coral. This is especially common in soft corals of the genus Sinularia. Do not hesitate to move a coral that you believe is suffering damage. Once damaged, they become more susceptible to disease, parasites and algae.

The final variable to consider is growth. Ensure that the specimen has adequate space to grow. This is particularly true for encrusting forms, such as Xenia spp., Anthelia spp. (waving hand polyps), Clavalaria spp. (star polyps) and zoanthids. It may become necessary to trim and separate specimens that have grown together, especially if they begin to develop aggressive interactions such that one begins to suffer. Separation is an excellent method for propagating your specimens either to help stock another aquarium or to trade for other specimens. Believe me, in a successful reef aquarium, the day will come when trimming and culling your invertebrates will become as necessary as trimming Caulerpa!