Seashore Players Most Successful When They're *In Their Zone*

By Jan Holmes

From the high tide line to the subtidal, one feature shared by all shorelines is the phenomenon of grouping or banding of benthic (bottom dwelling) species referred to as **zonation**. It is most obvious on steep or rock-faced beaches where the horizontal tide range is small and the bands are narrow. It is less obvious (and sometimes almost undistinguishable) on flat beaches were the horizontal tide range can stretch for hundreds of feet. Why does zonation occur? The answer lies partly in the local tidal regime, but ultimately we have to look at the evolutionary and ecological make-up of individual plants and animals for the answer.

In general, quality of life in the upper tide zones depends upon an animal's ability to manage *physical* factors such as desiccation, temperature changes, fresh water, wave action etc. In the lower tide zones *biological* factors such as predation and competition for space and food determine the community.

Marine biology texts and shoreline guides commonly divide the intertidal into three or four zones. Zone one, which extends from the splash or spray zone (that area which only gets wet from breaking waves) down to about +7 feet above 0.0 tide, is referred to as the high tide zone or the supralittoral fringe (from littoralis or littoral meaning seashore*)*. Zone two or the upper midlittoral zone extends from +7 feet to about +4 feet. Zone three, the lower midlittoral zone, extends from +4 feet to the zero (0.0) foot tide level. Finally zone four, the infralittoral fringe, extends from about the zero tide level to the lowest exposed portion of the shoreline (-3.5 to -4.0 feet during extreme low tides).

To illustrate zonation and the factors that blur the borders between zones, we only need to look at the interactions of five animals common to the intertidal zones of our area: two barnacles, a bivalve, a snail and a seastar. *Chthamalus* (kah-tham-ah-lus) *dali* is a tiny barnacle found high in the intertidal. Its cousin *Balanus glandula*, the common acorn barnacle, is found a bit lower in the intertidal. Lower still dwells *Mytilus*, the blue mussel. The whelk snail *Nucella lamellosa* can often be found mixed in with *Balanus* and *Mytilus*, and during low tides we can find *Pisaster* the seastar at the lower edge of this mix.

The barnacles *Chthamalus* and *Balanus* are surrounded by thick outer plates and two inner beak-like plates which clamp tightly shut during the time they are exposed, preventing desiccation. *Chthamalus* is better at controlling its internal temperature and moisture content than *Balanus*, so it can live higher and dryer than *Balanus.* Both barnacles are filter feeders. The only time they can eat is when they are totally submerged.

At the tide heights where *both* barnacles are capable of surviving, *Balanus* is the dominant barnacle. Three to four times as large as *Chthamalus*, *Balanus* crushes and crowds out its little cousin. So what we see on the "textbook" shoreline is a higher band of *Chthamalus* followed by a lower band of *Balanus*. *Chthamalus* would prefer to live in a less exposed portion of the intertidal so it could have more time to eat, but it must trade away part of its eating time so it can avoid the lethal actions of *Balanus*.

Mytilus, the blue mussel, cannot tolerate desiccation as well as the barnacles and prefers a lower intertidal location. At the upper edge of its range where it encounters *Balanus*, the thick mussel mats grow over and smother the acorn barnacle preventing *Balanus* from taking advantage of its entire habitat range (though sometimes Balanus prevails by settling on top of mussel shells). The *Mytilus* story will continue later.

The *Nucella* snail and *Pisaster* the seastar LOVE to eat barnacles and mussels. *Nucella* drills a hole into its prey (which can take many hours), then sucks out the juices. *Pisaster* uses its numerous powerful tube feet to pry open shells, then inserts its stomach into the shell to eat.

Nucella has a thick outer shell and when exposed during low tide, withdraws tightly into its shell, holding on to the rock surface with its powerful foot. *Nucella*, however, cannot tolerate the same exposure times as the two barnacles, so it is limited in how high up it will be able to travel for a barnacle meal. *Pisaster* is quite vulnerable to desiccation, only able to withstand a fraction of the exposure time that *Nucella* can. This gives *Nucella* an advantage at the barnacle banquet because *Nucella* can stay higher and dryer than *Pisaster* can. But *Nucella* feeds only on *Balanus*, ***not*** the smaller barnacle *Chthamalus*. *Chthamalus* is *too* high and dry for *Nucella* thanks to the influence of *Balanus* which indirectly has spared *Chthamalus* from predation by *Nucella.*

Mytilus the mussel (a filter feeder like the barnacles) is capable of living totally submerged in the subtidal but we rarely see it there. Why? Because *Pisaster* the seastar, who also prefers to stay submerged, consumes all the lower mussels first before risking feeding in areas that become exposed during low tide. Remember that *Nucella* also likes to eat mussels but ! here!s another twist to the story ! *Nucella* also *gets eaten* by *Pisaster* if it moves too low down into the water column. So we have Nucella feeding on *Mytilus* from above and *Pisaster* feeding on it from below. *Pisaster* makes short work of mussel meals whereas Nucella takes hours to eat just one animal. The result is that *Mytilus* can grow and reproduce faster in the !snail zone! than in the !seastar zone!. Consequently we see a neat band of mussels just below the acorn barnacle band. The mussel band upper limit is set by the mussel!s exposure tolerance; the lower limit is set by the exposure tolerance of its predator *Pisaster*.

Above is just one example of the hundreds of ecological interactions taking place in the intertidal, not just among animals, but between seaweeds and animals and among different species of seaweeds which also have to make choices between a place to live, availability of resources (mainly sunlight), and avoidance of predation (grazing) and desiccation. The result of all of this is a series of zones (or ecological niches) in which the inhabitants of each zone have worked out a harmonious living arrangement that allows them to meet their physical and biological needs for growth and reproduction.

On an evolutionary time scale there continue to be subtle shifts in zone community structure as organisms decide to !jump zones! and try out new niches. Some, like the high intertidal Littorine snails, have moved so high and dry they are thought to be heading toward a terrestrial existence (if they only knew what was waiting for them)! Other organisms evolve toward lower habitats.

Among other factors that can blur zone boundaries are: storm events which might scour rock surfaces opening up space for opportunistic colonizers; population explosions (causing a temporary encroachment of one species into another zone) or the disappearance of species (from disease or over harvesting) which might provide an opportunity for others to move into the vacated niche; and microhabitats, i.e., crevasses, tide pools and other havens of protection. The biggest blur occurs on flat or gently sloping beaches where a one foot drop in tidal elevation can be spread out over hundreds of feet horizontally.

And so it goes, this intertidal aquatic opera, held not in acts but ZONES. The concept of intertidal zonation is not the final word when trying to pin point the habitats of intertidal organisms, but it is a valuable and fun tool to help us understand the complex ecological relationships that abound in the intertidal.