



Species Spotlight

Acorn Barnacle

Semibalanus balanoides

Ever feel stuck in place? Like you're just one lost in a crowd? Overwhelmed by the rising tide? Hung out to dry? In too deep? Metaphorically limitless as they may be, barnacles usually get a bum rap in poems and literature. They are often compared to something that slogs down progress or sticks to you like a parasite. And while they do cause hardships for ocean-going vessels, barnacles are much more complicated and interesting life-forms than mere clingers-on.

You've Just Crossed Over into the Barnacle Zone

Truly, barnacles are among the hardiest of hardy creatures. Baked by a blazing, shadeless sun for hours on end, only to be inundated with near-freezing ocean water for an equal time span - they are able to tolerate a wide ranging set of conditions over the course of a year. Barnacles are often the only creatures that can consistently survive in the highest part of the intertidal band (the area of marine shoreline exposed to air at low tide, and covered with seawater at high tide), precisely the reason this area is dubbed the "barnacle zone". Situated where they are, these barnacle fields are able to survive temperatures ranging from -4F to about as high as 90F, and also must be able to take a pounding from the incoming surf like a champ. But how did they end up on those rocks in the first place?

The Wanderings of Youth

Barnacles are actually tiny crustaceans that share more in common with lobsters and crabs than mussels, snails, or clams. After hatching from eggs, barnacle larvae spend about the next 6 months adrift in ocean water in what is known as the "nauplius" larval stage. Much like our own species, these adolescent barnacles spend this portion of their lives floating about, with no attachments. They feed on plankton, growing and moulting six times until they reach their next life stage. Once they reach this "cyprid" stage, it's time to settle down and raise up a family. This lilliputian larvae's single-minded mission is to find an appropriate surface to permanently settle on and build its cone-shell home around. So mission driven is it that it does not feed during this stage, which can sometimes last for weeks, though more typically a few days or so. The longer the hunt goes, the less picky the larvae becomes for it's new homestead as its finite energy reserves become depleted.

Don't be such a Drag

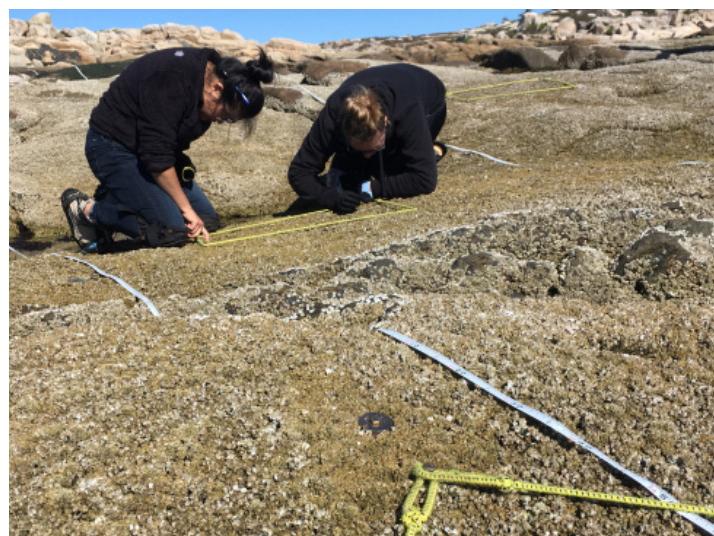
Barnacle larvae will attach themselves to almost any surface that is periodically immersed in ocean waters. Everything from rocks and docks, boats and ships, clams and mussels, and even whales may find these crafty crustaceans glued to them. This can be a problem for large vessels as literally tons of barnacles can attach to them (10 tons for a typical tanker over 2 years if not treated), slowing the ship considerably

and wasting hundreds of gallons of fuel. One Navy study claims that barnacle "biofouling" reduces vessel speed by up to 10 percent and the added weight and drag can increase fuel consumption by as much 40 percent. This is no small deal for the Navy, and it needs to spend about \$1 billion annually in extra fuel costs as well as maintenance to keep its ships' hulls clean of barnacles and other debris.

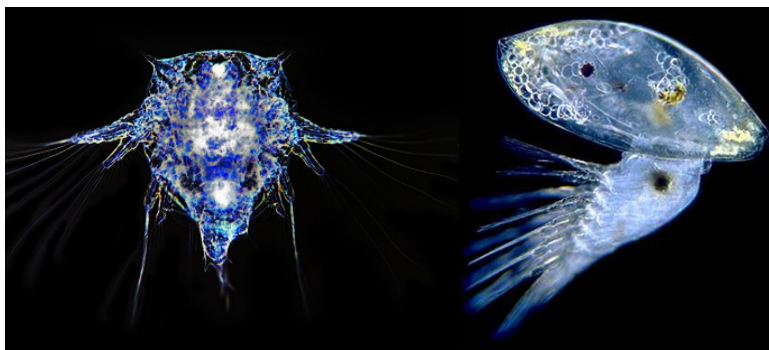
Survival of the Fit-test.

Adult barnacles secrete compounds into the water that attract other larvae to settle nearby, which serves to create densely populated clusters. This "swamping" strategy discourages other competitors for space (mussels, seaweeds, etc.) from settling there and makes for easier fertilization of each other's eggs. When a barnacle larvae has found a suitable homestead it attaches to it using a particularly strong natural glue. At this point it begins to build the familiar six-plated shell, or more technically - "test", around itself. When not submerged by seawater, the top two plates close up like a trapdoor over the animal, sealing in water and sealing out most predators. Eventually it will grow to adulthood and brood (warm and protect until they hatch) the next generation of fertilized eggs within its shell.

The whole process of barnacle reproduction so fascinated renown naturalist Charles Darwin that he intimately studied them, practically on a daily basis, from 1846 to 1854. Ultimately, Darwin's deep and focused research on barnacles resulted in the publication of a 4-volume study about them. His fascination and fondness for the less-than-effervescent



Volunteers from the Maine Maritime Academy and the Schoodic Institute search for snails in study plots of a large barnacle "swamp" in Acadia National Park. The study is part of a larger NETN rocky intertidal monitoring program in the park. NPS photo.



The two larval stages of a barnacle. The Nauplius on the left free floats and feeds in the open ocean going through six moults over the course of about 2-weeks, eventually morphing into a Cypris larvae (right). At this point it ceases to feed, and sets out on a mission to find a place to permanently attach for the rest of the barnacle's life.



Acorn barnacles seal themselves in water-tight calcareous plates when exposed to the air and drying sunlight (left). When under seawater (right), the feet of the barnacle pop out of its shell and filter plankton out of the water.



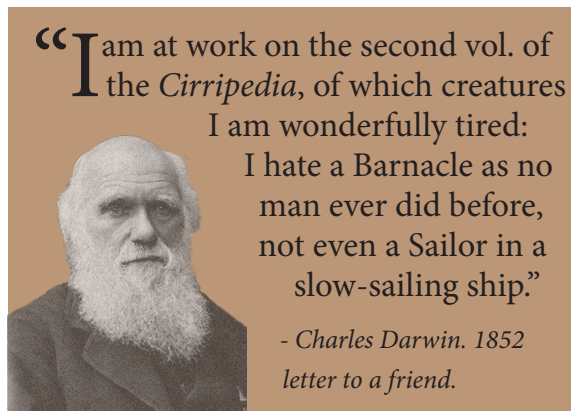
personalities of these crusty critters appears to have waned over his years of research (see quote), but many historians credit this work on barnacles as a key component to his formulation of the theory of speciation he wrote about in 1859's *On the Origin of Species*.

As Darwin learned, barnacles are hermaphroditic (having both male and female reproductive organs) which helps to maximize chances of successfully producing the next generation. This is a big advantage for an animal that spends its adult life stuck in one place. That very immobility is likely the reason barnacles hold another, semi-salacious superlative claim to fame: their male appendage, yes that one, is proportionally the longest (8 times their body length) for any species on Earth. They use it to search for other nearby barnacles that have eggs in need of fertilization.

Now that's using your Head. And Feet.

A Darwinian contemporary, 19th century geologist and biologist Louis Agassiz, once dismissed barnacles as "nothing more than a little shrimp-like animal, standing on its head in a limestone house and kicking food into its mouth." While not a completely inaccurate description - what they do is actually a pretty impressive feat, er feat, when you think about it (I'd like to see him try it):

Using a super-glue shaming natural adhesive, a barnacle larvae glues itself, headfirst, to just about any surface. When the tide washes over, it feeds by opening the trap door to the bone-hard shelter that it made *out of it's own spit* and thrusts it's "legs" and "feet" into the water. They rhythmically beat, combing through seawater and capturing plankton which it directs towards it's mouth. A winning party trick if I've ever seen one.



The Latin for barnacles - *Cirripedia*, means "feather-foot" in reference to their feathery feeding appendages. This strategy of gripping with its head and feeding with its feet has a practical advantage. If a predator were to snip off all or part of its feet before they could be withdrawn back safely into the shell, the barnacle can actually regrow them. The same can't be said if it lost its head.

A Very Sticky Subject

The incredibly strong natural glue barnacles create biochemically baffled Darwin, and all succeeding scientists for nearly century and half. It is still far superior to any yet-created synthetic adhesive, and will stick to near any surface and under any conditions. How can it have such strong holding power under seawater? Scientists only a few years ago cracked this viscous

vexation. Using specialized techniques worthy of being name-dropped in any Marvel Universe film, scientists observed the barnacle gluing process with 2-photon atomic force microscopy and mass spectrometry. One surprise they found is that an enzyme in the glue was remarkably similar to Factor XIII (c'mon - how superhero does that sound?), an essential blood clotting agent in human blood. But the key step to the success of the super sticky cement is that prior to applying it, the larvae first emits a miniscule drop of oil to the selected surface. The oil repels water and enables the larvae to lay down the adhesive directly to the surface.

For more information

- Learn more about [NETN's longterm rocky intertidal study](#) in Acadia National Park and the Boston Harbor Islands.

- [Watch this video](#) to see how barnacles use their feathery feet to filter plankton out of the seawater.