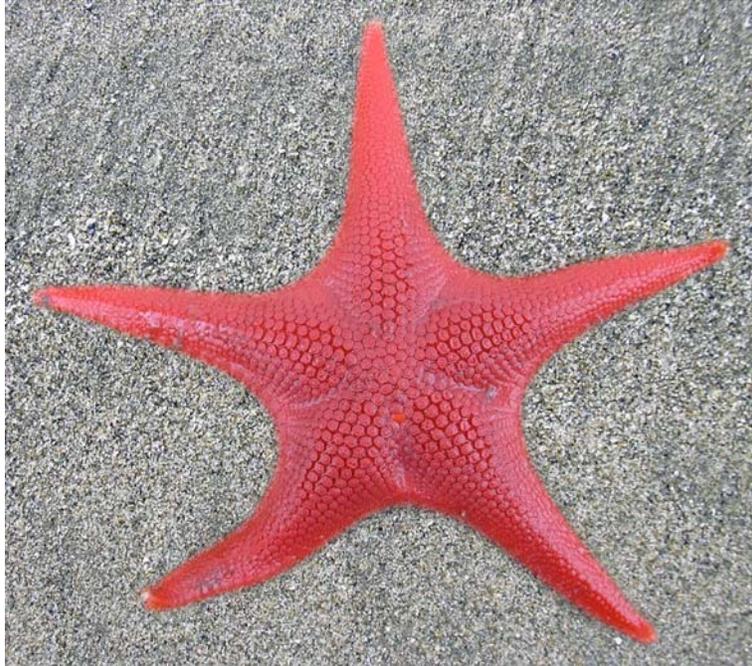


**Some Creatures of
Clayoquot and Barkley Sounds:
A Life History Manual**



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Sponsored by the Ucluelet Aquarium Society
the Clayoquot Biosphere Trust,
and the Biohumanities Project

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Introduction

All of us bring different eyes to the ocean and its inhabitants. Some enjoy food from the sea. Some admire the self-renewing nature of coastal waters. Others marvel in the diversity of colours, shapes and interrelationships among marine creatures. Because we enjoy it, as aquarists, philosophers, fishermen, shore walkers or the merely curious, we ought to care about its well being. To this end, this manual hopes to reveal an unexpected richness of ideas and information.

This life history manual aims to provide readers with something different from what they'd find in a typical species manual for the Pacific Northwest. Instead of broad coverage, we have decided to offer in-depth descriptions of a select handful of species. Our reason for this choice in emphasis is simple: most local marine species lead fascinating lives. The details of how these organisms hunt for prey, avoid predators, select mates and reproduce are a mystery to most visitors and many long-time residents of our coast. Our hope is that this manual will deepen your appreciation of these organisms, and to help you see the natural world in new ways.

Two general themes connect all of the organisms on our coast. The first theme is evolution by natural selection. All of the organisms described in this manual possess interesting adaptations, traits that have been gradually modified over the millions of years that they have interacted with their environment. Seeing the traits of these organisms as adaptations to selective pressures will provide the reader with a deeper understanding of the processes that shape biological systems. The second theme is that “everything is connected” – plants and animals depend on and influence on another in numerous, often subtle ways. Human activities are but one component in this immense network of biological interactions.

We are living in an age of reconciliation with our surroundings, a realization that business as usual has unacceptable consequences. Each person faces a different set of challenges when trying to adopt new ways of relating to nature. By encouraging people to think about their interactions with the marine environment, and how those interactions have cascading effects through the marine ecosystem, we also hope to encourage people to make wise and responsible choices. Finally, we at the Ucluelet Aquarium Society hope that this manual will share some of our passion and fascination with the creatures of our waters.

*- Stefan Linquist,
Philip Bruecker,
& William Morrison.*

Acorn Barnacle (*Balanus glandulus*)



A colony of acorn barnacles.

Any visit to the rocky seashore is sure to reveal hundreds if not thousands of small animals, patiently awaiting the tide's return. An intertidal barnacle's life involves two main activities: feeding and waiting. As we usually encounter them on the shoreline barnacles are sealed up water tight, conserving energy and fending off dehydration. But with the tide's return a barnacle bed bursts into action. Shells open, small fan-like structures start sweeping feverishly for passing food particles. The animals are making the most of their limited time submerged. Observing this daily cycle of feast and famine, you might wonder why barnacles don't spend all their time underwater? Why settle in the intertidal zone where, for extended periods of time, there is no food or fresh water?

To answer this question it helps to know a few things about barnacle ecology and evolution. Barnacles are a type of crustacean. They are more closely related to shrimp and crabs than they are to mussels and clams. Their ancestry is most noticeable when they're newly hatched. Free swimming barnacle larvae look like small shrimp, they have eyes, antennae, a compact brain, and a tail-like structure. These organs allow the larvae to search around for a suitable settling place. Once the location is chosen, be it a rock, a boat, or even another animal, cement-glands in the barnacle's head exude a glue-like substance securing it in place. The barnacle then builds its castle: a conical limestone shell with a door at the peak. At this point the animal no longer needs eyes, or its brain,

or its tail; so it reabsorbs them. The energy from these structures is reinvested in enlarging its feeding fan, which develops out of the animal's legs. The barnacle spends the rest of its life in this position: upside-down, brainless, and glued head-first to whatever it happened to settle on as a juvenile.

Our question remains: why glue yourself to a spot that is partially out of water? One possibility is that barnacles move on land for protection. Under the surface lurks at least one specialist predator. The leafy hornmouth (*Ceratostoma foliatum*) is a snail that uses its radula, a drill-like structure, to bore holes into barnacle shells. Similarly, sea stars can open a barnacle's protective door using their sticky tube feet, giving them access to the animal within. But things on land are not much safer. Several species of shorebirds crack into barnacle shells with their beaks. So, the intertidal zone might actually be less safe than a permanent home under water.

Maybe their intertidal existence has something to do with barnacles living in such large groups? Acorn barnacles find safety in numbers. Having "friends" nearby means that, when a predator is scanning for its next victim, it will be less likely to focus on you. Studies show that barnacles spend more time feeding and less time hiding when in the company of other barnacles than when alone. Barnacles even secrete a chemical attractant into the water as a kind of invitation for new larvae to join them. Another advantage of group-living is that it assists in finding a mate. Acorn barnacles reproduce through sexual contact, but once they become settled in a spot they can't go looking for it. A barnacle's choice of mates is restricted to its neighbors. To make life simpler barnacles have become hermaphroditic, producing both sperm and eggs, so that mate choice is not restricted to just one gender. However, to expand their options even further, barnacles have evolved a special adaptation for long distance fertilization: barnacles have one of the longest penises, for their size, in the animal kingdom. A barnacle's penis can extend over several body lengths, impregnating not only its immediate neighbors, but also the ones living several doors down.

None of this can happen, however, while the barnacle is stuck on dry land. So given the costs of constructing a water-tight shell, the associated loss of feeding and mating opportunities, and the increased exposure to predators, why bother?

Answering this question requires us to think evolutionarily. The ancestors of modern acorn barnacles spent all of their time submerged. These organisms probably had large, imperfectly sealable shells much like the giant barnacles found today (*Balanus nubilus*) that can spend only a short time out of water. Occasionally, some of those ancestors' larvae must have settled on rocks in the intertidal, only to dry up and perish when the tide went out. Eventually, however, one of those barnacles must have evolved a slightly more water tight shell. It could now retain just enough moisture to spend a couple of hours on land. This meant that it could hold its position in the intertidal zone, where there was no competition for space. Not initially, at least. As more and more barnacles acquired this adaptation – a water tight shell—real estate at the bottom of the intertidal zone must have become dearer. This situation placed a selective advantage on barnacles that could hold their moisture for just a little longer, so that they could occupy a slightly higher (and dryer!) position. So our question, “why do barnacles choose to live out of water?” is slightly misleading. It is not a matter of choice. Barnacles have evolved this capacity gradually over successive generations of competing for space. Even a spot high up in the intertidal zone is better than no spot at all.

This competition has driven barnacles to occupy some unusual positions. Take a good look at a gray or a humpback whale and see what's covering its skin. That's right, you guessed it. There is a particular species of barnacle that specializes on riding around on whales. One of the advantages of being a whale specialist is that you never end up on dry land (well, almost never). Another advantage is that your host, the whale, is constantly searching out nutrient-rich waters on which you too can feed. The disadvantage of this lifestyle is that when the whale eventually goes down, you and your fellow colony members go down with it. It has been estimated that upwards of one tonne of a humpback whale's 50 tonne mass consists of just barnacles.

The acorn barnacle is of no direct commercial value. In this respect it differs from its cousin the gooseneck barnacle (*Pollicipes cornucopia*), which is harvested locally for the European barnacle market. However, being a food item is not the only way barnacles can have economic significance. In fact, they can sometimes be quite destructive, especially when they are accidentally introduced to an area as an invasive species. Foreign barnacles are sometimes more effective than local species at competing

for space, they can potentially exclude other valuable species like mussels and oysters. One of the primary means by which barnacles are introduced to an area is by cargo ship. Their larvae are drawn into the ballast tanks along with seawater, transported over great distances, and dumped into foreign waters historically free of the species. Just try to imagine, how many of the items around your home arrived in boats that might have had foreign species stowed away in their ballast. Your car, your lawnmower, your fridge, your T.V- all of these items probably arrived in cargo ships containing unwanted biological cargo. When these invasive species cause harm to local ecosystems and to the local economy, it is a hidden cost to those items around your home.



Giant barnacle (*Balanus nubilus*) retracting its feeding fan

Spiny Pink Sea Star (*Pisaster brevispinus*)



Spiny Pink sea star

Spiny pink sea stars have adapted to a specific feeding niche. They are able to excavate clams that have buried themselves up to 60 cm deep in the sand by means of extensible tube feet that protrude from their mouths. Other sea star species cannot dig so deep. So the spiny pink star has access to a food source that is virtually free from competition. It is no surprise that this species grows so big, with each arm reaching up to seventy centimeters in length. Since its prey is virtually immobile this animal has no need to move quickly. It therefore invests in a thick, calcium-based exoskeleton that offers excellent protection. This contrasts sharply with the soft body and multiple arms of the sunflower sea star which, compared to the spiny pink star, is built for speed.

All sea stars have a **water vascular system**, which is a complex system of canals running through animal's body and ending in its tube feet. Sea stars use connective tissue instead of muscle to inflate or deflate their tube feet. This is an energetically efficient, but relatively slow method of locomotion. The primary advantage of the water vascular system is that it enables the animal to firmly lock onto an object, like when prying open a clam shell, or when resisting the pressure of pounding waves or strong current.

Decorator Crab (*Chorilia longipes*)



Decorator crab with green seaweed on its back.

Camouflage is an essential survival tool for many marine animals. The bay pipefish has evolved a slender green body and an upright swimming style that make it almost indistinguishable from a blade of eelgrass. The green kelp crab has evolved a smooth olive shell that blends perfectly with the kelp fronds on which it hangs. So long as they remain in their home environments, these animals are difficult to spot. They are safe. The problem however is that such specialized mimics are limited to the habitats that they resemble. If a pipefish leaves its eelgrass bed in search of food, that bright green colouring and its awkward swimming style make it stand out as an easy meal. Thus, an obligate (non-modifiable) form of camouflage is not always advantageous.

The ideal form of camouflage is a flexible one. Some animals that forage over a wide range of different habitats have evolved the ability to change colour or texture to match their surroundings. The octopus is the master of this form of disguise. Crabs, however, do not have this option. For protection they can either grow an extra hard carapace like the red rock crab, stay concealed during the day like the dungeness crab, or else lug a thick shell around like the hermit. There is no way for a crab to change the look of its exoskeleton to match its environment; not, at least, from the inside.

One group, the decorator crabs, have managed to overcome their evolutionary limitation. These small spindly animals grow barbs on their shells. They use their long elegant claws to pluck bits of debris from the seafloor — pieces of kelp, clumps of sponge, the odd swatch of algae — which they then hook onto their backs. Those bits and pieces take hold and grow. Eventually the decorator crab's carapace is a microcosm of its surroundings. A well adorned decorator is almost impossible to spot, unless it moves. This disguise permits them to wander cautiously from one micro-habitat to the next, scavenging for food.

What happens when a decorator finds itself in an habitat with which it clashes? Suppose you've spent the last month sticking seaweed on your back, but all the food and mates are over near the coralline algae. Well, like other species of crab the decorator periodically molts. The old shell is discarded for a newer and larger model, also allowing the animal to update its match the surroundings. Occasionally however, a newly-moulted crab will remove artifacts from its old shell and reattach them to its new one. Some attributes are just too good to let go of.

Orange Sea Pen (*Ptilosarcus gurneyii*)



Sea pen.

The sea pen's thousands of stinging polyps are arranged in a feather-shaped plume that is anchored to the sea floor with a small pointed "foot". Looking a bit like a nineteenth century quill, one could almost imagine dipping one of these creatures into an ink well and signing one's name with the pointed tip. The sea pen is actually a colonial animal. Each polyp looks and functions much like an individual sea anemone, with small tentacles poised around a central "mouth" on the end of a tiny stock. However, these polyps are united into a single organism, exhibiting complex behaviors and a high degree of coordination. For example, when threatened by a predator the sea pen pulses with a pale blue-green light, looking much like a neon sign. This display of **bioluminescence** might have evolved as a way of attracting the attention of other fish, as a means of drawing their attention to the animal that is posing the immediate threat.

The sea pen's predators include several species of sea star and sea slugs. One species of sea slug, the *Tritonia nudibranch*, specialises exclusively on this species. This slug has a set of rigid jaws contained inside its soft body that are well adapted for clipping off bits of sea pen tentacle. *Tritonia* have large neurons and a relatively simple nervous system, which has made them one of the most popular research subjects for understanding how nervous systems operate.

Although there is no direct targeted fishery for sea pens, there is significant damage to their habitats by specialized commercial fishing efforts. Bottom trawlers target flat sandy habitats where valuable species such as halibut, flounder, shrimp, and rockfish may be found. The trawl drags along the seafloor, collecting everything in its path. The ratio of bycatch to targeted catch may be quite high and it is not uncommon to find sea pens, octopuses, non-target fish species, sea urchins, and many other species in these nets. In order to minimize habitat damage, many commercial trawlers fish the same areas repeatedly after sufficient time has passed to allow for recovery and recolonisation.

California Sea Cucumber (*Parastichopus californicus*).



California Sea Cucumber

Looking like a chubby brown sausage adorned with soft fleshy spines and growing up to two feet in length, the California sea cucumber bears little superficial resemblance to its cousin the sea star. On closer examination however their ancestry becomes apparent. All members of this family, the Echinoderms, have bodies that radiate in five equal directions from their center. The center of a sea cucumber runs through the length of its body. So if you were to cut one in half and look inside, you'd find a star shaped arrangement of muscles radiating outwards. Like a sea star, the sea cucumber also has several rows of tube feet on its belly and a mop of tentacles in its mouth. These animals are deposit feeders. They use their sticky oral tentacles to sift through seafloor sediments, drawing them individually into their mouth and extracting the collected particles. During this process the cucumber ingests a great deal of sand which it then expels in distinctive long fecal pellets.

Several animals prey on sea cucumbers, most notably the sunflower sea star. With up to 24 arms bearing thousands of tube feet, a sunflower star can easily outrun a more cumbersome cucumber. The California sea cucumber has a few behavioral tricks to

attempt escape. First, it responds to the olfactory signature of its predator by violently stretching and contracting its body. It can be rather amusing to see an otherwise lethargic cucumber suddenly swing into action. Like a determined teenager on a wrestling mat, the cucumber can sometimes wriggle its way out of the predator's grasping tube feet. The cucumber's second mode of defense is even more peculiar. As a last ditch escape effort a cucumber will extrude its entire stomach onto the sea floor, presenting it to the predator as a decoy meal while the animal clambers away to safety. Sea cucumbers also tend to congregate in large groups of several hundred in a small area. This "schooling" behaviour is another way that individual cucumbers minimize the likelihood that they will be consumed.

The sea cucumber is inhabited by several species of parasite. On the underside of a sea cucumber, living amongst the tube feet, one is likely to find a scaleworm. This small worm feeds on dead skin and the detritus which is "kicked up" by the sea cucumber's foraging activity. Some species of sea cucumber even play host to a small fish that resides in their posterior cavity. This fish hides inside the cucumber when threatened and leaves to forage. It was discovered by John Steinbeck and Ed Ricketts who named it *Proctophilus winchelli* after a gossip columnist.

The California sea cucumber has been harvested for food by First Nations communities for millennia. With the relatively recent development of underwater harvesting techniques, these animals now sustain an important commercial fishery. Their muscles and skin are a delicacy in Chinese cuisine and the estimated haul of California sea cucumber in B.C. is worth over \$1 million annually. An experienced fishing crew can land thousands of pounds of sea cucumber each day. Without strict fishing restrictions this species could easily be depleted. Little is known about the life span or reproductive rates of this species (they are impossible to age) so managing their fishery is a challenge. Currently, less than five percent of the estimated California sea cucumber population is harvested each year in British Columbia and scientists are closely monitoring their abundances.

Dungeness crab (*Cancer magister*)



A young adult Dungeness crab.

Dungeness crabs live on sandy bottoms where the soft, nutrient rich substrate affords ample burrowing and scavenging opportunities. As they scurry about on the seafloor, crabs search for prey by probing into the sand with their legs and claws. Live prey such as clams and smaller crustaceans are the crab's preferred food, but they are also drawn to the scent of dead and decaying organisms. This explains why crabs are so easily caught with baited traps. For protection from visual predators like dogfish, sculpins and octopus a crab will sometimes burrow almost entirely into the sand during the day, emerging under the cover of darkness to forage. This activity is especially important shortly after a crab has moulted or discarded its outer shell. In order to grow, a crab must completely shed its shell or exoskeleton. Moulting occurs when a crab absorbs water into its body tissues causing its shell to expand and crack open, which it then discards like an ill fitting suit of armor.

It takes approximately two months for a new shell to harden and this is when the animal is most vulnerable. Interestingly, it is only during this period, shortly after a female has moulted, that she is receptive to mate. Males and females tend to alternate

their moulting cycles so that when a female is still soft the male will be in possession of a fully formed shell. A protective shell is an important asset to a male who must sometimes engage in battle over a mate. During the mating ritual a male crab will clasp the female with their undersides in close contact. Although fertilization only takes a few seconds, the male will continue clasping the female carrying her about for several hours. Once she is released and her eggs have been fertilized, a female crab will deposit up to a million eggs on her abdomen. The eggs are carried for three to five months until they hatch. Her larvae are then deposited into the water column where they will swim freely for several months. It takes between two and three years, or approximately 12 moults, for juvenile crabs to reach sexual maturity. A mature male crab is approximately 160 centimeters across – females are slightly smaller- the size at which it becomes legal to harvest and eat a Dungeness.



Planktonic larval crab.

Clayoquot and Barkley sounds support sizable populations of Dungeness crab. The Nuu-Chah-Nulth have been harvesting these populations for millennia and this fishery is important both as a food resource and as a part of their cultural heritage. Since the 1920s Dungeness crab have also been harvested commercially in British Columbia, the economic value of this fishery is currently between thirty and forty million dollars annually. With such cultural and economic significance it would be utterly devastating if local populations were to suddenly crash, as has happened with this species in other areas.

Perhaps the most famous case occurred in San Francisco Bay in the early 1960s. For the first half of the last century this area supported a thriving Dungeness crab fishery. Between two and five metric tons were being landed annually, about the same amount currently caught in British Columbian waters. But in 1961 this fishery suddenly plummeted. Fishermen's traps kept coming up empty, and the total yield that year was less than a tenth of what it had been previously. It is well known that crab populations fluctuate from year to year, and the San Franciscan crab fishermen must have hoped that the local population would rebound. Alarmingly, this failed to occur. So in 1974 the Department of Fisheries and Game undertook a massive effort to determine the cause of the population decline. The Dungeness Crab Research Program has revealed much of what is currently known about how this species responds to pollution and, more importantly, to changes in ocean temperature.

Initially, industrial and urban pollutants were thought to be the culprit. The runoff of pesticides from our yards and farmlands as well as the heavy metals and hydrocarbons that wash off our streets are known to accumulate in the soft tissues of Dungeness crabs. Crabs collected from areas near pulp mills where pollution levels are particularly high are often far too toxic to be safely consumed by humans. However, scientists concluded that the gradual accumulation of these pollutants in San Francisco Bay could not alone explain the sudden drop in crab populations.

A more likely scenario is that the crash was driven by climactic factors. In the late 1950s the average ocean temperature in San Francisco Bay jumped from 13 to 14 degrees. This meant that during warmer years the ocean temperature would reach as high as 17 degrees, as it did in the winters of 1957 through 1960. But how does temperature increase affect crab populations? To explore this question Dr Paul Wild from the California Department of Fish and Game reared egg brooding females in his lab at three different temperatures. Females reared at the lowest temperature of 10 degrees fared the best, with an average of 69 percent of their eggs hatching successfully. Females reared at the median temperature of 13 degrees were moderately successful, on average 29 percent of their larvae hatched. However, the crabs reared at 17 degrees fared dismally, with less than 1.5 percent of the eggs (14,000 hatchlings per million) hatching successfully. It is now recognized that Dungeness crabs are highly sensitive to even slight increases in

average ocean temperatures and this remains the best explanation for the San Francisco Bay population crash.

These studies were conducted decades before global climate change was considered an important political and environmental concern. Nowadays scientists recognize that global ocean temperatures are increasing due to the release of greenhouse gasses like carbon dioxide into our atmosphere. Measurements taken at the Race Rocks Lighthouse near Victoria BC dating back to 1921 indicate a long term warming trend of 0.9 degrees since 1950. Research using the internal growth rings of gooseneck clam shells, which provide an indirect temperature record dating back to the 1840s, indicate that the 1990s was the warmest decade in over 150 years. Such findings suggest that what happened on a small scale in San Francisco Bay could occur on a much larger scale throughout this region. Often, discussions of global climate change that take place in the popular media focus on rising sea levels and what this will mean for our economic and social infrastructure. It is important to keep in mind, however, that even slight increases in average ocean temperature can impact the fisheries on which we depend as a society.



Chesterman's Beach near Tofino

Boring Sulfur Sponge (*Clinona celata*)



Boring Sulfur sponge “mining” a Giant Scallop shell.

To appreciate the biological significance of sponges we need to place ourselves in the ocean 500 million years ago. There were no multi-cellular animals existing at this time: no sea anemones, no clams, no crustaceans, and certainly no fishes. Yet the oceans were abundant with life. In each drop of seawater lived thousands of micro-organisms (just as one finds today). These early creatures were simple in structure. Some had small tails (or flagella) for propulsion, some could consume other cells by absorption. But these amoeboid creatures lacked proper mouth parts, they had no feet for clasping onto surfaces, no tentacles to waive around for stinging prey. The reason that these first animals were so simple is that they lacked the ability to organize into a unit. When all life functions must be carried out by a single cell, the opportunities for specialization are limited. It must have therefore sent ripples through the biological world when the first multi-cellular animal broke onto the scene. With the evolution of this organism, a type of sponge, cellular specialization suddenly became possible.

Of course, by contemporary standards sponges are one of the simplest animals on the planet. Whereas the modern fish has hundreds of different types of cell (bone cells, skin cells, liver cells, nerve cells, etc.) sponges have about five. One type of cell forms pores or channels through which water can pass. Another cell produces a flagellum for beating the water. These two tissues act in concert: thousands of flagella whipping in unison generates a current pumping water through a sponge’s pores. Meanwhile a third

type of cell extracts nutrients from the water, breaking those nutrients down, and passes the energy back to other cells. The fact that we can decompose the sponge into these few simple cell types leads some experts to think of them not as a single organism, but more as a colony of cooperating cells. Sponges live so close to the edge of multi-cellularity that, even when one has been chopped up in a blender and passed through a cloth, the individual cells can reorganize into a functioning animal.

The boring sponge has a yellowish-brown appearance looking somewhat like a blob of melted banana ice cream. They live below the low tide mark, usually splattered onto the shell of a clam or mussel. This species belongs to a group of sponges that can decompose calcium. They have evolved another specialized cell that works like a boring mechanism, chipping small bits off the backs of bivalves. Some of the calcium extracted this way is used by the sponge for structural support, like an internal scaffold. The boring behavior physically weakens the host's shell, increasing its vulnerability to predators such as birds and crabs. In severe cases, the boring sponge can kill the host mollusk and dissolve its shell entirely. Just one gram of sponge can erode 16 grams of calcium over the course of a year. These creatures are therefore a major pest to oyster farmers. They also cause damage to coral reefs in other parts of the world. However, boring sponges play an essential ecological role. By breaking down shells and corals they recycle calcium into a form that is usable by other organisms. Although they are a threat to mollusks and corals, these animals also depend on the boring sponge's ability to release the calcium they use to grow.

Sponges are impacted by humans in several ways. Commercial trawlers often rake the seafloor where ancient sponges live, destroying them and their habitats in the process. Some sponges are also harvested for the cosmetic industry, with clever marketers over-embellishing the value of natural sponges over their synthetic counterparts. As filter feeders, sponges are sensitive to pollution. The heavy metals and pesticides that run off our streets and farms are absorbed by sponges, interfering with their life functions. As slow growing creatures, sponges have a difficult time recovering from these activities. Yet, sponges are becoming increasingly recognized for their medicinal value. Some sponges produce anti-inflammatory compounds that could be used to fight heart disease. In Britain, the extracts from local sponges have been

discovered to inhibit the growth of cancer cells. Researchers agree that the medicinal values of sponges are just beginning to become understood. Thus, given sponges' evolutionary, ecological, and medicinal significance the conservation of these animals is of great importance.

Moon Snail (*Euspira lewisii*)



The shell of the giant Moon Snail can grow larger than a man's fist.

The largest snail found in British Columbia often goes unnoticed by land dwellers. It spends its days buried underwater in sand, occasionally marking its underground travels with distinctive trails along the bottom. Though rarely seen directly the moon snail leaves two characteristic pieces of evidence in its wake. First, look for clam shells with a precise, countersunk hole on their hinges. These have been drilled by moon snails using a unique mouthpart called a **radula**. The radula is essentially a tooth-covered tongue, which is used to repeatedly lick the same spot on the clam shell until it has been breached. A chemical is then secreted to help weaken the shell. This may take several days, but the clam has no means of escape and the snail has enough patience and determination to finish the job. The snail then inserts an extensible snout with which it slurps up the clam, leaving behind an empty shell with its telltale hole.

A second remnant of the moon snail is something you might mistake for a piece of industrial garbage. The snail's egg case has a distinctive rubbery appearance. With its perfect collar shape and glossy shine this egg case looks more like the neck-seal for a wetsuit than anything found in nature. These collars are actually a sandwich of microscopic eggs and sand held together by mucus. Upon hatching these egg cases release thousands of larval moon snails into the water.

Moon snails play an important role in bioturbation: their subsurface movements stir up sand at the sediment-water interface. This action helps increase the exchange of particles and gases between the sediment and water, much as a plow tilling a field helps aerate the land. Moon snails' movements also disturb settling larvae and perhaps play a role in maintaining densities of certain seafloor invertebrates.

The sheer volume of soft body that a moon snail is able to cram into its shell is staggering. Fully extended, the foot of a moon snail can be 30 centimeters long and reaches all the way up around the top of its shell. Like all snails, when alarmed, a moon snail retracts its entire mass inside the shell and seals the opening with a trap door called an **operculum**.

Moon snails are preyed upon by birds, skates, rays, crabs, and sometimes collected for human consumption. However, no commercial fishery for this species currently exists. Although there are no current conservation concerns for moon snails, they are often treated as pests due to their preference for commercially valuable shellfish. Moon snails are often removed from popular clam collecting beaches and oyster farms where they have the potential to do some damage.

Opalescent Nudibranch (*Hermisenda crassicornis*)



Opalescent nudibranch foraging on a colony of lightbulb tunicates.

The opalescent nudibranch (pronounced Noo-di-brank) is a stunning and colourful species. They are characterized by electric-blue lines running laterally along each side, a bright orange strip down the midline, and a boa of gold-tipped fronds or gill plumes running along their back. These are elegant and gorgeous creatures; but don't let their beauty fool you. Opalescent nudibranchs are aggressive, sometimes fighting one another to the death. When two meet head-to-head, they're likely to engage in battle. From observations in captivity, if one meets the tail of another and gets the first bite, it usually wins the battle and eats the loser.

Have you ever stopped to consider why these animals are so invested in their appearance? More specifically, given the effort that some species put into avoiding detection, why might this little nudibranch be painted up like a neon sign?

In the case of some colourful creatures the answer is sexual selection. Especially in species where males make little or no investment in parental care, females can afford to be choosy. Females will sometimes look for a male who displays a particular colour that is difficult to produce or sustain. For example, female guppies prefer males with orange tails, because synthesizing orange pigment requires a healthy diet. Thus, by

looking at his colour a female can tell how good the male is at foraging, and she decides on this basis whether she wants to mix her genes with his.

However, sexual selection is probably not the explanation for nudibranchs colouration. For one thing, they are hermaphroditic: each individual produces both sperm and eggs. Sex between two nudibranchs is effectively a negotiation process. Neither individual wants to get “stuck” with receiving all the sperm without depositing some of its own. The reason that this would be unfair is that eggs are much more costly to produce, energetically speaking, than sperm. So they engage in a game of give and take. Arranged alongside each other, one nudibranch opens the negotiation with an “offer” of some sperm. The other then responds with a “counter-offer,” and so the process goes. The mating pair leave a spiral trail of eggs in their wake. Since neither individual is making a disproportionate investment in the offspring, there is unlikely to be much benefit in being choosy about who to mate with. And if other nudibranchs aren’t fussy, there’s no reason to invest in your appearance.

A more likely explanation for their bright colours is that nudibranchs are actually advertising to potential predators. Their aim is to be as noticeable as possible. Does this sound like an insane strategy? Well, any fish that has taken a bite out of a nudibranch will have received a mouth full of stinging cells. The combination of vivid colours and a sharp sting ought to leave a lasting impression on any fish’s mind. The next time that fish encounters a slug with bright orange and neon-blue stripes, they’ll know to stay clear.

The story of how the nudibranch acquires its stinging cells is one of the most interesting examples of evolutionary high-jacking in the marine world. The stinging cell, or nematocysts (nem-ah-toe-syst), is a highly evolved structure. It consists of a small trigger that releases a barbed harpoon into its target. Different types of stinging cell have different kinds of harpoons: some are barbed, some inject a painful neurotoxin, some have an especially thick “leash” for holding onto the victim. Looking at an arrangement of these cells under a microscope is like something you’d see lined up along the wall of an old whaling museum.

The nematocyst is the evolutionary pride and joy of the cnidarian family, the taxonomic group that includes jellyfish and sea anemones. Nudibranchs have not evolved the genetic ability to build their own stinging cells. So they steal them from the

cnidarians. Somehow, the nudibranch is able to nibble on the tentacles of an anemone and consume its stinging cells without causing them to discharge. The stinging cell is then transported through the nudibranch's gut to its colourful fronds (which incidentally are its gills) that wave around on its back.

So the opalescent nudibranch's bright colouring is in effect an advertisement of its expert thievery. These animals have high-jacked the stinging cells that other species use for predation and redeployed them as a defensive mechanism. But this strategy doesn't work all the time. One clever fish, the mosshead warbonnet, has been observed bending the body of its opalescent nudibranch prey in half as to prevent its stinger-laden gills from touching its mouth during consumption.

The opalescent nudibranch might not have much to offer in the way of commercial value or even ecological importance. Yet, some of us are just happy to know that they are out there doing their thing, and we are concerned about threats to their existence. Many species of nudibranch are naturally rare and potentially at risk of extinction. Nudibranchs require very clean water. Pollution from agricultural runoff and sediment from land clearing suffocate nudibranch egg cases. Efforts should be made to limit the amount of industrial development close to rocky coastlines, as these are some of the most diverse habitats in Canada.



Mosshead Warbonnett waiting for its next meal.

Moon Jellyfish (*Aurelia labiata*)



Moon jellyfish

Standing on Ucluelet's Whiskey dock on a rainy November morning (and you are almost assured that it *will* be raining) you might see a few thousand semi-transparent moon jellyfish pulsating their way along the surface. This is an annual event. Early winter is when these animals congregate to breed (more on how this works in a moment). Even when they are not congregating however, free swimming moon jellies dwell near the surface. This is the purpose of their characteristic pulsing motion, to keep them topside. Jellyfish cannot travel great distances under their own power; for this they are at the mercy of the prevailing tides.

Can you think of a reason why moon jellies hover near the surface? Why don't they spread themselves throughout the water column?

One reason that some species avoid the surface, especially in winter months, is because of the fresh water that accumulates after rain and river run off. Freshwater runoff forms a layer on the ocean surface (which do you think is warmer?). Not many organisms can tolerate the transition from salt to fresh water and back; but moon jellies do so happily. Not only can they withstand salinity fluctuations, they are okay with dramatic changes in temperature and have a high tolerance for poor water quality.

Clearly, there must be something to be gained from bobbing close to the surface. Why else would moon jellies have evolved such tolerance?

If you guessed that they are attracted to sunlight – perhaps in order to photosynthesize more effectively – you’re wrong. Moon jellies are carnivores and unlike their cousin the green surf anemone, they don’t have small photosynthetic bacteria living in their cells. So sunlight doesn’t benefit them directly. Nor do the animals that jellyfish prey upon rely directly on the sun. Jellyfish eat zooplankton, microscopic animals swimming through the water column with tiny whip-like paddles called flagella. So jellies don’t need sunlight and the things that they like to eat don’t either.

What about the things that zooplankton eat? These animals graze on microscopic plants called phytoplankton that are, it turns out, most common near the surface where sunlight is abundant. In fact the density of phytoplankton is so great near the surface that the majority of the oxygen in our atmosphere is produced by these tiny plants. The oceans’ phytoplankton produce thousands of tons more oxygen each year than the Amazon rainforest.

So maybe the reason that moonjellies are wired to pulsate their way to the top of the water column is to be where all the action is. That is the place where all the yummy zooplankton are found, because they are attracted to the photosynthetic phytoplankton that are, in turn, attracted to sunlight.

Okay so you’re a jellyfish and you’ve managed to get yourself to the right spot where millions of zooplankton are teeming around, competing over who can gobble up the most phytoplankton. Now how do you catch them? If you were a baleen whale you would just open up your huge mouth and suck in a thousand gallons of seawater, then pass it all through filters in your gills that extract the zooplankton. But you’re a jellyfish. That strategy isn’t an option for obvious reasons.

Look at the edges around the perimeter of a moon jellyfish and you’ll see a row of tiny fibers waving about. Covering each fiber is a row of nematocysts, spring-loaded harpoon cells. A second function of the pulsing motion – besides situating the jelly in a productive spot – is to wave those tiny hairs around like so many fishing lines with spring loaded lures. Moonjellies have a second strategy for catching prey. A mucus is secreted on the dorsal and ventral sides (top and bottom) of their bell. The bell is also covered in

tiny hair cells that swish the trapped zooplankton into the direction of the nearest channel leading to the stomach. If you get a moment, look closely at a moonjelly and you'll see translucent vein-like structures spoking out from the center of the bell. Those channels act like tributaries into which food is swept and then washed towards the stomach. These structures are unique to just this species of jellyfish.

While you are looking closely at the moon jelly you might notice four concentric semi-circular organs near the center of its bell. Those are its gonads or sex organs – where the sperm and eggs are stored. Unlike some invertebrates (like sea slugs) jellyfish are not hermaphroditic: they are either one sex or the other. Nor do they undergo a sex change mid way through their lives, as some species of fish do. But jellies have an interesting life in other respects. The organism that you see bobbing along the surface constitutes just one stage in this animal's life cycle. Just as butterflies spend part of their lives as caterpillars, moon jellies spend a significant portion of their lives attached upside down to a wharf or rock, feeding like sea anemone. To get a mental picture, imagine a small white pencil eraser with a collection of tentacles at one end, protruding into the water column, and a stalk at the other end, fixing it to the substrate. The moonjelly spends a year in this state. When October and November roll around, the tentacles are re-absorbed and the eraser breaks off into circular pieces, swimming away as a free floating individual.

Moon jellies are commonly found all around the globe. Recent DNA fingerprinting has revealed some surprising facts about how well they get around. Moon jellies in Australia are more closely related to ones found in Japan than they are to their neighbors in Australasia. Even taking global ocean currents into account, such rapid global movement is difficult to explain as a natural occurrence. How are moon jellies traveling so far?

The prevailing theory is that jellies are hitching a ride – along with many other organisms- in the ballasts of ocean going freighters. One estimate is that 3000 different species of organism are en route from one port to another on any moment of any given day (and that doesn't include microscopic species). Another estimate puts the number of non-indigenous species living in the average international harbour at 23%, and rising. What do you think the impact might be of so much re-introduction of different species?

Is there anything that you do currently to contribute to this process? What changes in your behaviour might curb this process?



Polyorchis jellyfish, a relative of the moon jelly

Bay Pipefish (*Synganthus griseolineatus*)



Bay Pipefish blend in shape, colour and behaviour with eelgrass.

In most fish species a male's contribution to his offspring ends with conception. Generally speaking, it is the female who supplies her eggs with the nutrients required for early development. Usually, it is the female who protects her brood of eggs from predators. However, the Bay Pipefish offers an unusual example of sexual role reversal. In this species, as with all members of the seahorse family, it is the males who become pregnant. During sex a female will court the male and seduce him into accepting a clutch of her eggs, depositing them in a pouch on his belly. The male then fertilizes and cares for the brood, eventually giving birth to live young. Why has such a bizarre sexual practice evolved in just this one family of fishes? Evolutionary biologists have long pondered this mystery. Although no one knows the answer for sure, it is possible that the evolution of male pregnancy is connected to another characteristic feature of these fishes: their impressive capacity for camouflage. Pipefish are so well matched to their eelgrass surroundings that you can be looking right at one without realizing it is an animal and not a plant. They are coloured deep green, thin as a blade of eelgrass, and up to 20 centimeters in length. To maintain their grassy appearance pipefish remain vertical while swimming, which makes them slow movers. These animals spend their entire lives paddling gracefully through the eelgrass beds to which they are so well matched.

But how does the possession of such impressive camouflage lead to the evolution of male pregnancy? Sexual selection theory, a branch of evolutionary biology, offers a possible answer. According to this theory the most important difference between males and females of any species is the amount of time and energy they invest in their offspring. In most species a female's investment far outweighs that of the male. Take rockfish as an example. Each time a female rockfish mates and becomes pregnant she must spend approximately 30 days rearing a clutch of 15 juvenile fish. During this time she must cautiously avoid predators while maximizing her food intake. Meanwhile, her male "partner" is free to search for other mating opportunities. Such discrepancies in parental investment mean that females should be choosy when selecting a mate. If a single copulation commits a female to heavy parental investment, she should select the most biologically fit male she can find. This way her offspring will inherit his traits and have the best chance of surviving when they mature.

However if females are choosy, then males must compete for sexual access. In many species male competition is intense and any trait that offers a slight advantage is favorable. This explains why in so many species it is the male, not the female, who grows large horns for engaging in battle or bright colouration to for attracting mates. The down-side of evolving traits that make males more competitive, however, is that they often make them more noticeable to predators. If you are a pipefish whose only means of avoiding predation is to blend into the eelgrass, bright colouration or cumbersome battle gear is not a viable option.

So at some point in their evolutionary history the male pipefish must have hit upon another strategy to distinguish himself from his competitors, offering to shoulder some of the parental burden. If you were a female pipefish who could select between a male who takes-off after mating or one who helps rear your offspring, which would you choose? Male pregnancy offers a way for males to distinguish themselves competitively while remaining well camouflaged, an achievement rarely found in nature. However, whether sexual selection theory offers the correct explanation for the emergence of this trait is something for future evolutionary biologists to determine.

Aside of their importance as a case study in sexual selection theory, pipefish are an important "indicator species" for determining the health of the eelgrass environment.

Animals who live in eelgrass beds become threatened when oxygen levels drop below a certain level. This happens occasionally when plankton reproduce in large numbers and sap most of the available oxygen out of the water. Plankton blooms occur naturally, but they are encouraged by certain human activities such as the release of fertilizer and other nutrients into the ocean. Therefore, it is important for ecologists to monitor the flow of oxygen through eelgrass beds, and pipefish have proved helpful in this process. Pipefish feed by snapping their jaws open in a rapid sucking motion. This action makes a loud, high-frequency clicking sound that ecologists can easily measure from the surface. It has been demonstrated that as oxygen levels decrease, feeding clicks slow down. So by listening to pipefish feed it is possible to gauge whether an eelgrass bed is suffering as a result of over pollution.

Green Surf Anemone (*Anthopleura xanthogrammica*)



Close up of green surf anemone tentacles

The green, flower-like body of the green surf anemone makes it seem more like a plant than an animal. In fact, their green colour is due to a single-celled plant living inside the anemone's tissue. These algae cells harness energy from the sun which is converted into sugars that the anemone consumes. In turn, the anemone provides the plant cells with a safe environment in the inter-tidal zone where there is plenty of sunlight. Green surf anemones are also carnivores. This species lodges itself firmly within the wave exposed cracks along the rocky coastline close to mussel beds. When mussels are dislodged by wave action, or during predation by the ochre sea star *Pisaster*, they will often fall into the waiting clutches of a green surf anemone.

These anemones reproduce sexually. Eggs and sperm are released in late spring to summer where they meet in the water and fertilize. Larval anemones settle, often near other green anemones, and live out their lives among kin. Although it is difficult to determine a sea anemone's precise age, one British institution had a green surf anemone in their collection for 75 years. These durable animals are also very tolerant of extreme fluctuations in salinity and temperature, a requirement for any inter-tidal species.

It has recently been discovered that the green surf anemone is of considerable potential pharmaceutical value. A drug has been derived from the animal's tissues that is effective in fighting heart disease.

Spot Prawn (*Pandalus platyceros*)



A small catch of spot prawns.

The spot prawn is the largest shrimp on Canada's west coast, reaching sizes up to 25 cm. Spot prawns are eaten by many species of reef-dwelling fishes including rockfish, greenling, cabezon, and others. Since the spot prawn is not able to protect itself with a heavy shell it has developed a novel and effective means of escape. By flicking its tail in a quick downward motion, the spot prawn generates a short but substantial amount of thrust. This quick movement sends the prawn up to a meter backwards, and out of harm's immediate reaches. Some shrimp have the ability to generate a tremendous amount of energy with this quick tail movement. The mantis shrimp creates a mini sonic boom that stuns its would-be predator, and has even been observed cracking the glass of an aquarium in which it was held.

Spot prawns feed on dead and decaying matter, clams, worms, and sponges. Their pincers are relatively weak but precise, and allow the shrimp to meticulously dissect their food. Spot prawns have an interesting life history known as **protandrous hermaphroditism**. All are born male and eventually mature into females. This is beneficial when one considers the energetics of egg and sperm production. In species where it is not necessary for males to fight one another for access to females, there is no selective pressure to attain large sizes. There is, however, great benefit to being large and

female. Since egg production is energy-intensive, a large female has an advantage over a smaller one. The cost of producing and rearing eggs is considerable, and a large female is able to devote more energy to the production of eggs. Sperm production is cheap, and males can afford to do so even when small.

An ingenious technique has evolved to accommodate this methodology. Once males reach a certain size, approximately 10 cm, they metamorphose into females. In areas where females far outnumber males, some male spot prawns will remain male to gain competitive advantage.

Spot prawns are caught with traps which produce minimal bycatch and limit habitat impacts. These traps are baited cages that attract target species and hold them live until fishers return to retrieve the gear. Hauling in a row of traps may drag the cages along the seafloor, causing some habitat damage. This method is far less destructive than trawl fishing, in which a large metal plow is dragged along the seafloor indiscriminately collecting everything in its path. As the demand for spot prawn and shrimp increase, threats to their habitat increase as well.

Even though trap fisheries are efficient and more habitat-friendly, there is a danger known as **ghost fishing**. If a trap is lost at sea due to poor weather or gear destruction, it is possible that the trap will continue to fish for years. To prevent the impacts of ghost fishing, all traps are required by law to include a section of rot cord. This material is designed to break down after a short period in the water, ensuring that any animals trapped inside will be free to escape. Large gillnets and drift nets can be particularly destructive if lost at sea, and pose a particular risk to marine mammals, sea turtles, and birds.

Sea Urchin (*Strongylocentrotus franciscanus*)



Spiny Red sea urchin: one of five species found locally.

“If we ever had to vote for the world’s most unloved animal, the sea urchin would undoubtedly figure in the short list of most people who have met one personally.”

-Martin Wells, Civilization and the Limpet.

Although receiving a puncture wound from one of British Columbia’s three major species of sea urchins is unpleasant, it is not life-threatening. They are not venomous and, really, why should they be? They are as unappetizing-looking as any animal can hope for, with sharp prominent spines, rigid shell, and a set of five pointy teeth arranged in a circle. Sea urchins are members of a large group of marine invertebrates called the *echinodermata* that includes sea stars, sea cucumbers, sand dollars, feather stars, and brittle stars. All urchins have a calcium based exoskeleton which is covered with a layer of skin and, of course, spines. These spines are used for movement, protection, and in some cases for burrowing. Nestled amongst the urchin’s spines are tube feet that are used in food capture, movement, and for attaching to substrate. Sea urchins also have tiny pincers, called pedicellaria, that are used for protection and to prevent the attachment of anything unwanted to their shells.

The mouth is located on the underside and is a complex array of skeletal elements, plates, and teeth arranged in five-part symmetry called **Aristotle's Lantern**. The mouth leads to the digestive tract which empties through the anus on the top of the test. Most prominent inside the test is the roe, a yellowish-colored mass of eggs or testes arranged into five lobes. This material is of great commercial significance and supports a major commercial fishery on Vancouver Island.

Sea urchins are perhaps most famous for their appetite for seaweed. They have such an effect on kelp forests that if their numbers remain unchecked they are capable of eradicating an entire seaweed community. This fact was discovered the hard way during the height of the sea otter fur trade in the nineteenth century when all of the otters on the West Coast of Vancouver Island were driven into extinction. With the extinction of one of their main predators, urchin populations exploded. By the early 1900s an estimated one third of the total kelp forests on the West Coast had been decimated by urchins. The effect that this has had on the innumerable species of fish and invertebrates who rely on kelp forests as a nursery and for grazing is impossible to estimate. Recently, sea otters have returned to Clayoquot and Barkley Sounds and their presence is causing a stir among local crab fishermen. Crab stocks have been low in recent years and some fishermen blame it on the return of the otters. This itself is controversial – crab populations are sensitive to many factors, most notably temperature (see entry in Dungeness crab). But even if it's true that otters are partly responsible for a decline in crab stocks, the long term benefit that otters can have on fish populations, as consumers of kelp eating urchins, makes the otter an ecological asset.

Shiner Perch (*Cymatogaster aggregata*)



A school of shiner perch.

Anybody fishing off a dock in Ucluelet Harbour in the summer is likely to catch at least one shiner perch. There is a 50% chance that a female will be caught, and a very good chance that particular female is pregnant. This is interesting because perch are **viviparous**, or live-bearing. Many fish species lay hundreds or thousands of eggs, with high rates of mortality and very small fish produced. Some fish lay far fewer eggs, each hatching a larger, more developed fish with a greater survival probability. Others, like the Shiner Perch, give birth to a small number of well-developed juveniles who are born with adult features. Newborn male shiner perch are born sexually mature, and some have been observed mating shortly after birth. An agitated pregnant female will often induce birth and it is not uncommon for a surprised angler to find himself with a handful of newborn shiners.

Shiner perch, like all schooling fish, have an interesting set of behaviors. In the interest of appearing as a single large organism, schooling fish have developed a means of moving collectively and in a coordinated fashion. It is fascinating to see a collection of thousands of fish moving in unison with no clear leader or means of communication. A school of silvery-coloured fish moving as one can serve to create a disorienting effect towards their predators. It is thought that schooling fish communicate by means of a lateral line system. The lateral line is a series of sensory organs arranged along the flank

of most bony fish species, providing the fish with information about movement and position in close proximity. Without the information provided by the lateral line, schooling would be chaotic and collisions would be common. Additional protection is garnered by living in a school. A predator will certainly have difficulty targeting a single fish among hundreds, or even thousands, and in large schools the statistical probability of any particular fish being caught decreases with as the school grows.

Although anglers seem to enjoy using shiner perch and their young as bait, it is best to release any clearly pregnant females. This is necessary for the health of the species and to ensure that enough are available for next year's mating season.

Sunflower Sea Star (*Pycnopodia helianthoides*)



Sunflower sea star scavenging on commercial fishing leftovers.

One of the top predators in local waters is the massive sunflower sea star. With up to twenty four arms covered in thousands of tube feet, this animal can travel at the staggering speed of two meters per minute. This is much faster than any clam, scallop, sea star or even some crabs and fish are capable of moving. The sunflower star detects its prey using highly sensitive chemo-receptors or “smell organs” located on the tips of its arms. The animal also has rudimentary light receptors or “eyes” on each arm, but these are probably used more for navigation than for hunting. The sunflower star hunts by smothering its prey and drawing the item into its centrally-located mouth. If a sunflower star manages to gain a solid grip on a prey item, the chances of escape are extremely low. Thus, several species have become sensitive to the sunflower star’s smell. When scallops get a whiff of an approaching sunflower star they mount a feeble retreat, clapping their shells together in attempt to swim away. Cockle clams are too heavy to swim, but when threatened by a sunflower star they use their foot as a sort of pole-vault, pushing themselves out of range. Sea urchins can neither swim nor scurry. These animals are equipped with specialized pinchers that clasp onto a sunflower star’s tentacles and attempt to rip them from their roots. This will sometimes cause the predator to retreat.



Close up of the soft dorsal (top) side of a sunflower star.

Since the sunflower star is at the top of its particular food chain, its pedicellaria serve a less defensive role and more so to prevent the settlement of larvae onto its surface. Have you ever wondered why barnacles can be found growing on most every surface in the shallow subtidal but never on the softest of sea stars? As larvae attempt to settle on sea stars, their pedicellaria detect and remove them with great efficiency. Any unwanted hitchhiker is indiscriminately plucked, crushed, and tossed into the currents.

Feeding and digestion occur in one of two ways. If the food item is small enough, it will be relayed directly into the mouth by a coordinated wave-like movement of its tube feet. The star will position itself over the food item and draw it slowly into its mouth. Within seconds the food is no longer visible. Often the only immediate evidence of the feeding is a prominent swelling of the sunflower's star's soft surface. Larger food items are digested externally, using a novel method of stomach eversion. The sunflower star will bring its stomach out of its mouth, turned inside out, and digest its food as it lies on top of it.

Although sunflower stars have little direct commercial value, their antagonistic effects are well known to crab fisherman of British Columbia's coast. They have proven to be the bane of trap fisherman, effortlessly climbing into crab and prawn traps attracted to the fragrant bait inside. Unlucky Dungeness crabs occasionally become prey when sharing a trap with a sunflower star. The unfortunate crab may be able to clip off an arm or two before being immobilized and slowly digested. Frustrated fisherman would often remove and bisect the offending sunflower star, only to have it slowly and surely regenerate its missing half and return equally hungry.

Squat Lobster (*Munida quadrispina*)



Squat lobster

The only lobster found natively on the Pacific coast of Canada is the squat lobster, and it is a lobster in name only. The squat lobster is in fact a lithode crab, with only three pairs of walking legs instead of the customary true-crab form of four pairs. Despite their formidable-looking pincers, squat lobsters are actually poor predators. The squat lobster is commonly seen extending its long, relatively weak claws into the water column in hopes of catching a piece of food floating past. Often squeezed into rocky crevasses or tucked away inside a sponge, the squat lobster can also wait in ambush for an appropriately-sized prey to appear. Experience caring for squat lobsters in captivity reveals a strong sensitivity to water-borne smells: a small amount of oily fish added to a tank containing squat lobsters elicits a quick “arms extended” response from all lobsters present. The squat lobsters then frantically attempt to collect and sweep even the smallest of particles into their mouths.

Squat lobsters are often found in close association with giant cloud sponges in the deep sea. The lobsters are attracted to the convoluted architecture of the sponge, finding many hiding places within. The lobsters form a mutualistic relationship with their sponge hosts, keeping the sponge's surface free of detritus while receiving shelter from potential predators. Interestingly, the squat lobster is able to survive in areas of extremely low oxygen concentration. This is an important adaptation for animals in the **abyssal** or deep seafloor, regions.

Even though squat lobsters do not reach sizes close to their Atlantic counterparts, there is a small fishery for this crustacean. Squat lobsters are fished in small non-commercial quantities using prawn traps at depths up to 1000 metres. There is little demand for squat lobster meat, although it is used in dishes that call for shrimp or prawns. No official data is currently available on squat lobster fishery yields.

Plumose Anemone (*Metridium farcimen*)



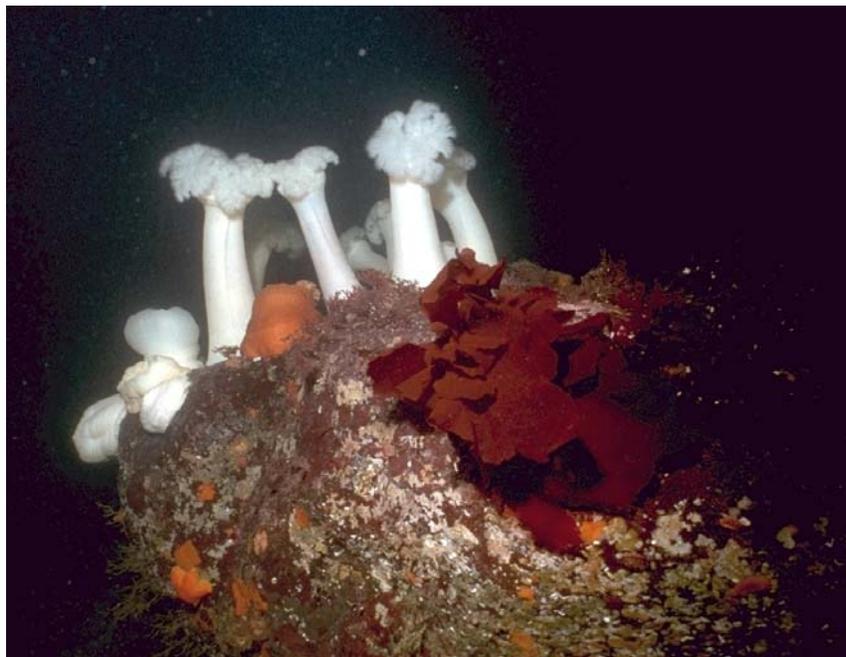
A white Plumose anemone living alongside in sponges and tube worms.

Plumose anemones are members of the *cnidaria* group, characterized by the presence of stinging cells. The plumose anemone bears very fine stingers, arranged on fleshy floral stalks that encircle its mouth. The plumose anemone is **planktivorous**, feeding upon small organisms that float about at the mercy of the currents and tides. As such, the plumose anemone plays an important role in limiting the overabundance of other species. Let us consider the case of the sunflower star and the role it plays in the food chain. The sunflower star can be considered a top predator, feeding on many species but generally not eaten by anything itself. With its generalist diet and no predators, what keeps the sunflower star's population in check? Sea stars are broadcast spawners, haphazardly casting their sperm and eggs into the open sea where they meet and develop into thousands of free-swimming larvae. Without factors controlling these large numbers of offspring, a gregarious species like the sunflower star would be free to outcompete most all other species in the area. It is important to consider the contributions made by planktivorous animals in maintaining balance in the web of life. Much of the plankton consists of larval forms of other species, and these each produce way more than could ever possibly survive. If these were not consumed by animals like

the plumose anemone, there would likely be massive abundances of just a few species, and very little of anything else.

The plumose anemone is commonly observed by divers and often seen attached to docks and pilings in Ucluelet Harbour. A plumose anemone out of water or startled will retract its tentacle crown and resemble a fleshy white blob. It bears little resemblance to the familiar appearance it has when open and feeding.

Plumose anemones have little known commercial or fishery value. However, it might turn out that these species are of pharmaceutical importance, like their cousin the Green Surf Anemone. Although plumose anemones are relatively hearty and tolerant of varying water quality, they do require the same considerations and respect of their more sensitive cousins. Since plumose anemones are commonly found attached to man-made structures in populated harbours they are exposed to pollutants such as heavy metals, diesel fuel, and industrial wastes. As Ucluelet grows and its harbour usage increases it is important to consider the impacts that will certainly be affected on the inhabitants of its harbour.



White and orange plumose anemones

Ochre Star (*Pisaster ochraceus*)



Purple Ochre stars.

Since natural selection favors any species capable of exploiting an available ecological niche, it is no surprise that many marine animals have adapted to the ocean/land boundary. The ochre star serves a model example of this adaptability. Several physical and biological stresses determine which species can and cannot survive exposure at low tide. These stresses include wave action, predation, and exposure to atmospheric elements. Let's consider how the ochre star has adapted to each of these stresses.

Waves: anyone who has tried to remove an ochre star attached to a rock is familiar with the strength exhibited by these animals. This is necessary to remain in place while bombarded by waves. Ochre stars use selectively adhesive tube feet which allow movement during high tide while allowing them to clamp down with great strength when necessary.



Predation: Animals living in the inter-tidal zone are susceptible to predation from not only the sea, but also from land and air. In addition to their tough spiny skin, Ochre stars are covered in thousands of small

needle-like spines or *spicules*. But even these precautions do not make them perfectly unpalatable. Some birds remain undeterred. Seagulls are occasionally seen choking down the odd ochre star.

Weather: most ocean-living creatures are adapted to living in a high salinity environment. One thing that these creatures must do is continually absorb water to compensate for the amount of H₂O that is being leached out of their cells. However, inter-tidal plants and animals (particularly those on the West Coast of Vancouver Island) are regularly drenched with fresh water. Especially during winter months, rainstorms and freshwater runoff dilute tide pools to a fraction of their original salinity. Without a means to prevent excessive absorption of freshwater, dramatic physiological damage could take place. A marine fish placed in freshwater will continue to absorb water until it swells and eventually dies from metabolite imbalance and cellular rupturing. Several methods are commonly used for intertidal animals to negate this effect. Ochre stars and crabs use hard skin or shells to physically prevent the absorption or loss of water. Alternately, some fish have highly efficient kidneys to pass great quantities of dilute urine. This counters the net uptake of water into the body.

Ochre stars play an important role in the structure of the seashore community. They are **keystone predators**, which means that they play an integral role in supporting the inter-tidal community. If you observe a rocky shore at low tide where ochre stars are found you may notice distinct bands of zonation, each defined by the dominant species found there. The uppermost zone is made up of mostly barnacles and the mid zone is primarily mussels, one of the ochre star's preferred foods. The presence of ochre stars in the zone below the mussels limits the areas in which the mussels can colonize. A young mussel settling and growing in the ochre star zone will likely not survive long enough to reproduce. Ochre stars also free muscles from the substrate which Giant Green sea anemones are waiting to consume. The remnants from damaged mussels are also consumed by tidepool sculpins.

Wolf Eel (*Anarrichthys ocellatus*)



Young adult wolf eel.

Although not a true eel, the wolf eel is popular with both divers and aquarium visitors. Its unique, fierce looking head is often seen protruding from its rocky cave. Its reputation as a vicious killer is hardly appropriate, as wolf eels tend to be rather playful with divers. Nonetheless, they are capable of attack if provoked.

Wolf eels are excellent predators, feeding on hard-shelled animals with large teeth and bony mouth plates. When a wolf-eel feeds on a large prey item it bites the prey and flips its own body into a spiral, literally twisting the flesh off the prey. Small prey items such as crabs and sea urchins are simply crunched up with the powerful back teeth. Occasionally a wolf eel will be seen with the spines of a sea urchin protruding from its lips. They are one of the only fishes capable of consuming these living pincushions.

A wolf-eels are also unusual fish in being monogamous. A mating pair often lie side by side with their heads together. They form a bond at about four years old, but do not produce eggs until a few years later. Spawning begins in October and continues through the winter, with the female depositing up to 10,000 eggs in the pair's den. During courtship, the male butts the female in the stomach and then wraps his body around hers. The eggs are fertilized externally as they are extruded from the female. Wolf-eels are very caring parents when compared to other fishes. Both parents participate in egg-guarding duty, with one guarding while the other forages. In the event that one of the

pair dies before the eggs hatch, the remaining parent wraps its body around the egg mass and protects it while neglecting its own feeding needs.

Juveniles live in open water close to the surface for up to two years before settling in a den. A wolf-eel may remain in its chosen spot for the rest of its life unless forced out by another wolf eel or perhaps by an octopus.

Adult wolf eels are rarely preyed upon by other species, but octopuses have occasionally been observed feeding upon them. These two species compete for den access and it is not hard to imagine the victor consuming the loser and taking its home. Wolf eel eggs are eaten by rockfish and greenlings, and young wolf eels are targeted by many fish species as they mature in open water.

Since wolf eels are found among rocky reefs, they are subject to the same fishing pressures as targeted species that live among these reefs, such as rockfish. Wolf eels are known to take baited hooks and their flesh is quite tasty. There is currently no commercial fishery for wolf eel. But as other more endangered species become less common, perhaps the demand for wolf eel will increase.



A mature wolf eel with diver

Sand Dollar (*Dendraster excentricus*)



Sand dollars filter feeding

The sand dollar is one of the most misunderstood creatures on our coast. Most people who encounter this animal find its remains washed up on the beach. The bone-white exoskeleton of the sand dollar provides few clues about how it lives and behaves. Sand dollars are related to sea urchins. Their bodies are covered in thousands of soft purple spines, giving the animal the texture of beard stubble. Sand dollars are expert burrowers. They make their living by burying part-way into the sand with their undersides facing the oncoming current. When in position, the sand dollar looks like a coin that has landed on its side. As water passes over the shell, specialized spines and tube feet collect plankton. Nutrients are then passed into food grooves that channel into the animal's mouth. Sand dollars "breathe" through a flower-shaped organ on their backs called a petaloid. If you do find a sand dollar exoskeleton, you will see that this organ has the shape of a five-arm sea star. While it is alive, it is essential that the animal not bury itself too deep in the sand. If its petaloid becomes clogged, the sand dollar will suffocate.

Sand dollars have been found living at very high densities. At one site on Hornby Island approximately 1,800 sand dollars were found living in a single square meter.

Given that these creatures can live virtually anywhere that there is a sandy bottom to burrow into, why might they choose to live so close to one another?

One possibility is that sand dollars are influencing the flow of water around themselves and their immediate neighbors. Using the contours of its shell and optimizing the distance between itself and its closest neighbors, each sand dollar is able to create a small eddy of current that helps concentrate plankton near its feeding surface. This is an incredible behavioral adaptation which could suggest a form of sociality in these creatures.

Perhaps the greatest threat facing sand dollars in British Columbia's is the beautiful symmetry of their shells. These are attractive to tourists, and many sand dollars are collected, dried and sold as decoration each year. Granted, these shells are lovely, but they do contain a living animal quite content to remain undisturbed in their sandy homes.



Dry sand dollar exoskeleton