### Acorn Barnacles

#### Latin names: Balanus glandula; Chthamalus dalli

Description: Hard, sometimes sharp shell-like plates form a little hummock that houses the animal; large settlements often cover rocks in the tidal zone.
Balanus glandula: usually grayish, grows to about ½ inch in diameter; Chthamalus dalli: usually brownish, grows to about ¼ inch.
Habitat: Beach rocks, floats, driftwood, pilings, etc., according to species.

y college marine biology classmates and I were unimpressed with barnacles. Sure, we noted their regular occurrence at the various beaches we visited, identified them by species, and dutifully described them in our notebooks. But compared to the snapping crabs, harpoon-flinging anemones, and neon-tipped nudibranchs we were finding, the barnacles were too dull and stodgy to hold our interest.

Nevertheless, our professor, Pete Taylor, decided that we would observe them during one of our lab sessions. He collected rocks covered with the two species we'd seen most often, the little brown *Chthamalus dalli* and the bigger, grayish *Balanus glandula*. We trained the eyes of our dissecting microscopes on the barnacles, and noted how their shell-like plates overlapped and the characteristic way the four inner plates closed tightly together—those of *C. dalli* in the form of a cross and those of *B. glandula* forming a particular wavy line. It may have been science, but it was not exactly riveting.

Then Pete supplied beakers of fresh seawater and told us to simulate an incoming tide. As we poured the water over the barnacles, they came to life. The inner plates of the submerged fortresses opened, and feathery plumes called cirri extended from each and waved about. Then the cirri abruptly withdrew and the plates once more snapped shut. A moment later, the barnacles opened and again extended the graceful plumes.

We noticed differences between the two species, and scribbled them in our notebooks. The plumes of *B. glandula* curled downward like thin fingers grabbing fistfuls of water; *C. dalli*'s delicate digits spread out and pivoted right and left before dipping back into their shell. Across the broad expanse of the magnified rocks, barnacles repeatedly popped open and shut like tiny jack-in-the-boxes, just as they did with every tide, twice a day. The unexpected animation of the barnacles animated us students too even thrilled us, giving us a glimpse of how much happens in the natural world to which we are oblivious. And that was

> before the first wandering barnacle penis poked out of its shell a sight that further impressed my college class.

Soon more of the surprisingly long, slender probes were reaching into their neighbors' shells in an attempt to release sperm before those plates snapped shut again. Because barnacles are hermaphroditic (having both female and male sex organs), an animal in the process of being impregnated might have its own penis out snaking around the neighborhood. We took copious notes during that lab class.

But you don't need a laboratory or a dissecting microscope to watch the feeding and sexual antics of barnacles. You need only a little patience and a good location where you can observe these little crustaceans underwater—while staying safely away from the waves yourself. The cirri you'll see unfurling act like a net to catch drifting plankton. When they disappear back into the shell, the minuscule food bits are scraped off into the mouth-parts, and the cirri roll out again to grab another bite.

Most barnacles hold their fertilized eggs within their shells until the larvae hatch and are released. The larvae swim away and eventually seek a place to settle. Each little creature has a sophisticated ability to sense and test the substrate in an attempt to find just the right spot. Once it attaches, it cannot relocate, so this decision is crucial to its chance of survival. Having made its choice, the larva secretes a cement from glands at the base of its first antennae and glues its head to the substrate. It then begins building the shell-like walls that will encase and protect it and from which the cirri will extend at feeding time. The nineteenth-century scientist Louis Agassiz compared those cirri with the legs of other crustaceans. He wrote that the barnacle is a shrimplike animal that stands on its head and uses its legs to kick food into its mouth. And there's nothing staid or boring about that.

### Shrimp

Latin names:Archaeomysis spp.; Heptacarpus spp.; Pandalus danae; Callianassa spp. Description: From less than ½ inch to 5 inches in length, depending on species; slender bodies; long antennae; jointed legs; may have pincers. Habitat: Various species can be found in wave wash, sandy mud, estuaries, or tide pools.

any species of shrimp inhabit Pacific Northwest waters, and some of the most common sport lively, descriptive names such as ghost, opossum, broken-back and coonstriped shrimp. The opossums (*Archaeomysis* spp.) are not true shrimp, but they are closely related and are shrimplike. They can be found jetting about the wash zone of the waves, although you might be most apt to spot them, as my family did, after you wade into the cold waves to collect water for sandcastle making. We found many dozen of these tiny, nearly transparent creatures zipping around in my daughter's big blue bucket. They are called "opossum" shrimp because, like those mammals, the females carry their eggs in special pouches on their abdomens.

It's also sometimes possible to find opossums in a rocky tide pool, but the most common shrimp there is the broken-back (*Heptacarpus* spp.). These half-inch to inch-long shrimp can be recognized by the sharp bend in their abdomens for which they're named—if you can manage to spot one at all. Broken-backs tend to hide among strips of seaweed, blending in amazingly well with in their background. They are covered with tiny dots of many colors, and by controlling the size of these dots they can appear tinged green, white, or brown, or covered with speckles and patches of various colors.

The larger coon-stripe shrimp (Pandalus danae) don't change color but

107

### Anemones

#### Latin name: Anthopleura spp.

06

Description: 1 inch to 12 inches in diameter, depending on species; disk fringed with tentacles is attached to substrate by a fleshy column. When tentacles are pulled in at low tide, anemones look like nondescript blobs.

Habitat: Tide pools, surge channels, rock faces, also underwater offshore.

nemones are often described as animals that look like plants. Their circular disks surrounded by petal-like tentacles do resemble exotic hothouse flowers. But make no mistake: the pretty anemone is a carnivore, and it kills its prey with harpoonlike weapons.

The giant green anemone (*Anthopleura xanthogrammica*) grows ten to twelve inches in diameter and is a lovely shade of new-spring green. Its coloration is due both to its own pigmentation and to a large population of one-celled algae that live inside it in a mutually beneficial relationship. In exchange for protection, a place to live, and nutrients from the waste of their host, the algae photosynthesize and produce carbohydrates used by both themselves and the anemone.

Like all anemones, the giant green has stinging cells called nematocysts, which are especially concentrated in the tentacles. These cells fire harpoonlike microscopic threads and discharge a toxin into predator or prey—or into your finger, should you touch a tentacle. (The relative thickness of our skin prevents us from feeling anything but an interesting sticky sensation, although a very few people might have an allergic reaction to the toxin.) As the tentacle gently cleaves to your finger, its harpoons fire, but there's no difficulty pulling it away when you're finished playing Moby Dick. It's a different story, and a different ending, for prey like mussels and small crabs or fish. Once paralyzed by the nematocysts, they are drawn into the anemone's mouth (the bellybutton-looking protuberance in the center of the animal) and swallowed whole. The anemone's powerful digestive juices then dissolve the flesh of the unfortunate prey, and its undigestible bits, like shell fragments, are spit back out.

More numerous than the giant green is an anemone that seems to have no widely agreed on common name. *A. elegantissima* is sometimes called either the "elegant" or the "aggregating" anemone. This indecision almost seems appropriate, since the animal itself comes in two forms, one solitary and one that lives in colonies. The solitary form grows to eight inches in diameter and resembles a giant green anemone, except for the straight,

dark lines radiating from mouth to tentacles. In the aggregating form, more commonly seen, the disk diameter varies from about one to three inches and the tentacles are often tipped a delicate pink or lavender.

Like the giant green anemone, an individual *A. elegantissima* is either male or female and produces either sperm or eggs. These are released via the mouth and mix in the current to produce swimming larvae. But an *A. elegantissima* who finds itself alone on a bare rock has a second reproductive option: cloning. After pulling itself in opposite directions for about two days, the animal tears in half. This is a particularly fast way to fill an open space, and the anemone goes on producing exact replicas of itself (same gender, same coloration) until it runs out of room—or meets up with another *A. elegantissima* colony that has been busily cloning *its*elf.

Such a meeting does not go well. After repeated jostling, war erupts between the two colonies. The anemones on the outskirts of each group prepare for battle. Special structures called *acrorhagi*, located on the upper portion of the anemone's column and loaded with nematocysts, begin to swell. In what looks to us like slow motion, a combatant rears up and clouts an enemy with its knoblike acrorhagi. The attacked anemone may choose to stand its ground and fight back, but usually it contracts as if cringing and gradually shuffles away. But there is only so far an anemone can retreat with its crowded clone family behind it. Eventually the colonies, after attack and counterattack, form a no-anemones land. This is a clearly visible strip between the two communities that was once assumed to be a pathway for snails and limpets.

Characteristics such as these demilitarized zones and the weaponwielding tentacles reveal that, despite appearances, the pretty anemone is really an animal. It may look like a demure plant, but an anemone is no shrinking violet.

### Purple Shore Cral

#### Latin name: Hemigrapsus nudus

 Description: Shell of back up to 2 inches wide; predominantly purple-tinged, but may be reddish brown or green; purple-red spots on claws.
Habitat: Under rocks or scurrying around the upper tidal area; rocky beaches and some estuaries; occasionally ventures onto sandy beach, if nearby.

he right way to pick up a little purple shore crab, should you wish to do so, is to nab it quickly and firmly from behind, catching it between thumb and forefinger. The wrong way to pick up a crab is by a claw clamped onto your finger. I've done it both ways and the first is definitely preferable.

Purple shore crabs are the crabs most often encountered by ocean beachcombers and tide-pool enthusiasts. These crustaceans can spend long periods of time without direct contact with seawater, so they are often found in the higher levels of tide pools. If you don't see any scuttling around, you can often find them by lifting loose rocks (be sure to replace the rocks just as you found them). Purple shore crabs measure at best a mere two inches across their backs, and when they wave their little claws at you menacingly, its a bit like a belligerent tot hollering, "Try it—go on, I dare ya!"

But should your fingers slip when you make your move to pick up the tyke, you'll find its claws surprisingly strong. It seems ridiculous that such a little thing can cause as much pain as it does, but you don't usually laugh about it until the beast has been pried off.

If you grab it the right way, however, you'll have a chance to look it over



### Beach Hopper

Latin name: Megalorchestia californiana Description: About ½ inch long; brownish white, grayish white, or ivory body; antennae as long as or longer than body and bright orange; seven pairs of legs. Habitat: On sandy ocean beaches, buried along high-tide line or on washed-up kelp and other seaweed.

n her 1955 classic *The Edge of the Sea*, Rachel Carson writes that the tiny and seemingly insignificant beach hopper portrays "one of those dramatic moments of evolution, in which a creature abandons an old way of life for a new." She suggests that the beach hopper's ancestors lived in the ocean and that in the distant future its descendants will likely be terrestrial.

But, for now, the beach hopper can live neither too far from the water nor too close to it. The tiny critters still have gills, located on their leg joints, and require moisture to breathe. But many species are poor swimmers and can drown if submerged too long. So they live on the margin, navigating the area between dry sand and lapping tide.

These little creatures are not insects, as might reasonably be supposed. They are crustaceans, relatives of the pillbugs and sowbugs found in backyards and woodpiles, which are a little ahead of the beach hopper on the evolutionary transition to landlubbers.

Beach hopper, beach flea, sand hopper, sand flea—all these names refer to the same type of animal. More confusing than picking a common name is the attempt to identify individuals by specific scientific names—there are many species of beach hoppers, and they can look bafflingly similar, even under magnification. However, *Megalorchestia californiana* is one of the most common species found on Northwest shores.

*M. californiana* prefers open beaches and tends to congregate on washed-up masses of seaweed. If you lift up a pile of kelp, sometimes hundreds of beach hoppers will explode from their refuge, leaping wildly about until they land back on the seaweed or bury themselves safely in the sand. These particular hoppers can be identified by their long orange or pinkish antennae. (Another common species, *Traskorchestia traskiana*, is found on sheltered beaches or bays and has bluish legs.)

If they're not nestled in seaweed, beach hoppers pass the day above the high-tide line, buried headfirst in the sand, and emerge at dusk to feed. The hoppers are scavengers that eat what the tide tosses up, especially seaweed. At night, impressive armies of the leaping little crustaceans storm the beaches, discovering and devouring what the tide has left them.

While foraging, they must watch out for their enemies, especially the inch-long rove beetles that also emerge for nocturnal feeding. Beach hoppers escape their predators with prodigious jumps. (It's this ability alone that earns them comparison to fleas—hoppers don't bite people.) They use their back two pairs of legs for jumping and are propelled by a sudden snap of the abdomen.

The females hold their fertilized eggs in special brood pouches on their legs and carry the young everywhere until they are hatched. Then, at night, they are released onto the sand, miniature versions of their parents that

73

immediately take up the rhythm and routine of feeding and burrowing.



Before dawn, the hoppers make their way back up the beach to dig their dens, reportedly orienting themselves by the moon.

By daylight or high tide, the little beachcombers' work is finished and they are sealed away until the return of darkness and a lowering tide. You can look for the small round holes near the high-tide line, which are their previous night's burrows. (Occupied dens are closed off with sand granules, so you're not likely to see them.)

Beach hoppers avoid the waves yet are still bound to the ocean. Although their gilled legs are tiny, beach hoppers straddle the wide transition zone between salt water and dry land.

### Geoduck

#### Latin name: Panopea abrupta (formerly generosa)

Description: Grayish white shell grows to 8 inches long, with irregular concentric rings; siphon can extend to about 39 inches.

Habitat: From several hundred feet offshore up to the low-tide line; also in bays and estuaries. Prefers sand or mud, but can be found in gravel; typically burrowed 2 to 3 feet down.

y student vote, the geoduck narrowly defeated the banana slug to become the mascot of The Evergreen State College in Olympia, Washington, where I studied marine biology. The rather outrageous clam seems a fitting representative for the rather unorthodox college.

Geoducks (pronounced "gooey-ducks") are outrageous by virtue of size alone. They are the world's largest burrowing clam—giants can weigh ten pounds. More often the adults weigh in at two pounds, but lucky diggers sometimes unearth beefy 'ducks weighing six or seven pounds—as much as a newborn baby.

Their shells are a rounded rectangular shape, partially covered with a thin, brownish "skin" that protects against sand abrasion. Although the shells often grow to seven or eight inches long, they are not nearly large enough to contain the paunchy animals. The geoducks' bodies bulge out of their gaping shells (hence Evergreen's motto: *Omnia exteris*, or "Let it all hang out"). They get away with this obvious flaw in their armor only by being so deeply buried that few predators can reach them.

Various bottom-dwelling fish might nip off siphon tips poking out of the seabed, but the geoduck's most cunning predators are people. Commercial

can also be hard to pick out from their seabed or eelgrass background. They can grow to five inches long and are brightly colored, with brown, red, and white stripes. The stripes earned them comparison with raccoons and led to their common name. Like other shrimp, they are fastidious little crustaceans and use specialized brushes called *setae* on their legs to groom themselves. Also like some other shrimp, coon-stripes start life as males but become females as they mature, passing through an intersexual stage at two to three years old. Because they are females for the last one to two years of their lives, all of the large specimens of this commercially important species are female.

One of the Pacific Northwest's subterranean shrimp is the ghost shrimp (*Callianassa* spp.), which grows to about three inches. It's so ghostly that its organs can be seen inside its transparent pinkish orange or pinkish gray body. This shrimp burrows industriously for two good reasons: shelter and food. It digs with its mouthparts and hauls the loose particles up to the surface in a sort of basket formed by its legs. Both sexes sport one large claw (the male's can be nearly as long as his body), which they use to push the muddy sand out of the way. Their homes can be recognized on mud flats by the small piles outside each hole. Each burrow has at least two openings and a number of side branches, with wider areas that enable the shrimp to turn around.

The ghost digs down two feet or deeper, collecting food bits to eat as it goes. In the course of its excavations, it mixes the organic debris collected on the top level down into the substrate, creating a never-ending food supply. (This dynamic mining can wreak havoc in an oyster farmer's deliberately placed cultures, however, quickly covering and destroying them.)

At the beach, you can find shrimp with big claws, minuscule ones, or none. You can find shrimp that are far-ranging and ones that are homebodies. You can find shrimp with differing habits and habitats, ones with colorful bodies and ones with colorful names. The Pacific Northwest does not scrimp on shrimp.

### Brittle Stars

Latin names: Ophiopholis aculeata (daisy brittle star); Amphipholis occidentalis (burrowing brittle star); A. squamata (small or dwarf brittle star)

Description: Central disk 1/2 to 3 inches in diameter, distinct from arms; five arms relatively long and thin.

Habitat: Crevices and under rocks in rocky tide pools; offshore, on sea bottom and on seaweed holdfasts.

nlike the big, bold sea stars, brittle stars are small and delicate, and more likely to be found hiding under a rock than conspicuously clinging to one. Brittle stars are not considered sea stars, and there are important differences between the closely related groups. Brittle stars lack pedicellariae, the tiny jawed stalks that keep sea stars clean of detritus. And although, like sea stars, they have small tube feet studding their undersides, the dainty



them for locomotion. Instead, they move about by writhing their sinuous arms, two pulling and three pushing in the direction they want to go. The tube feet are used for respiration, as tactile organs, and in feeding.

Brittle stars are also commonly differentiated from another group, the very similar serpent stars, by their mode of defense. At the slightest provocation they will drop arm segments or entire arms—hence the name "brittle." A curious beachcomber who picks up a brittle star can end up holding just the central disk as the startled animal drops arms one after another. (This defense mechanism works better when a hungry fish grabs a single arm and the mostly intact brittle star is able to escape.) The star's arms are later regenerated.

The Pacific Northwest's most common animal of this type is the daisy brittle star, *Ophiopholis aculeata*, which can be found tucked under rocks or crammed into crevices in tide pools. The central disk, less than an inch in diameter, is shaped like a stubby star. It is intricately, often beautifully, mottled with tan and dark or bright red, although markings of grays, white, yellows, oranges, and browns have also been seen. The arms, up to two inches long and covered with stout spines, extend from between the blunt points of the disk and are banded with the two alternating colors.

A star with a more circular disk and much longer arms is the burrowing brittle star, *Amphipholis occidentalis*. These can occasionally be found under rocks in tide pools with sandy bottoms. (Daisy brittle stars prefer tide pools without sand or gravel.) Scuba divers who know to examine muddy sand seafloors and check kelp holdfasts may find them—and may find them in abundance, since they tend to cluster together. Burrowing stars are a mottled gray, and their long arms are strikingly out of proportion with the small disk. The entire animal can measure over a foot across, while its disk is only a half-inch in diameter.

Brittle stars typically burrow down into the sand and then lift their long arms above the sand to capture food. They eat detritus and tiny singlecelled plants called diatoms, snagging them with mucus secreted by their arms. A brittle star's digestive organs, unlike those of sea stars, do not extend into the arms, nor can it extrude its stomach. Instead, fine hairs convey the diatoms down the arms and into the creature's mouth. A brittle star's small disk contains both its digestive and its reproductive organs.

Individuals of most species release either sperm or eggs, which meet and mingle in the water, producing swimming young that can settle far from their parents. The small or dwarf brittle star (*A. squamata*) is an interesting exception; our smallest common brittle star broods its young. The female's eggs are held in openings near the base of her arms. The male's sperm enters these slits, and the resulting embryos develop inside the pockets. The mother may brood as many as twenty-five young, which eventually crawl out and disperse. This species is bioluminescent—able to emit a glowing light. The small brittle star is mostly gray, measures up to three inches across, including a disk diameter of a quarter of an inch, and can be found in shallow, muddy water.

Unlike the brazen sea stars, brittle stars make a tide pool visitor hunt to find them. If you have the good luck to uncover one, remember that it's best admired where it lies. It doesn't take much handling before a brittle star decides it is under attack and starts shedding arms left and right ... and left ... and ....

111

in detail; the reddish purple spots on its claws that identify it, the individual coloration, which might range from brownish red through green and purple with white splotches thrown in. The carapace (back) is shaped like a rounded rectangle, with three jagged "teeth" on the front margin.

While you've got it in hand, note the lack of hairs on its legs—this is what gives it the species name *nudus* and distinguishes it from the similar green crab. The green or mud crab (*H. oregonensis*) is usually found in mud flats, but the two crab territories overlap in gravelly, muddy areas. (In addition to its hairy legs, the green crab is usually grayish green and lacks its relation's purplish dots on the claws.) The crab's first pair of legs end, of course, in its waving pincers, and each of the other eight legs ends in a pointy hook that helps the animal get a grip on slippery rocks.

Purple shore crabs feed mostly on seaweed and other algae but also scavenge any dead animals they may come across. They are in turn eaten mostly by shorebirds and some fish. Crabs are especially vulnerable to predation when molting, which they must do throughout their lifetimes in order to grow.

Female crabs carry their eggs behind a broad flap on their undersides. The spongy egg mass is so large that it pushes the flap open and bulges out the gap. The eggs eventually hatch as larvae into the ocean. These tiny, transparent, fanciful-looking, big-eyed creatures are so unlike their parents that they were originally described as a separate species. But after a succession of molts, each looks like a miniature adult, complete with menacing little claws. Its combative spirit might really grab you.

### Chitons

#### Latin names:Katharina tunicata; Cryptochiton stelleri; Mopalia muscosa

Description: From 1<sup>1</sup>/2 inches to 14 inches long, depending on species; oval or oblong; upper surface hard, eight valves may be visible; lower surface mostly a large fleshy foot, unseen unless the creature is pried off its rock.

Habitat: Tide pools, shallow waters, and below low-tide line on rocky shores.

hitons like the West best. They are bigger and more abundant here, and there are more species along the Pacific Coast than on the Atlantic Coast-or just about anywhere else in the world. Chitons (pronounced "KI-tens") are marine snails characterized by the eight plates or "valves" that make up their shell. (The "butterfly shells" found by beachcombers are actually the valves of dead chitons.) Hard flesh called a girdle surrounds the valves and covers them to a greater or lesser extent, depending on species. This is all that is usually seen of the mollusk: it has no tentacles to extend and is often clamped so tightly to a rock it can't easily be dislodged. Its overlapping valves allow it to conform neatly to uneven surfaces Should it be taken by surprise or by force and removed katy chiton

101

from its rock, the valves even allow the chiton to curl itself up to protect its soft foot. This curling action of the animal earned it the nickname "sea cradle" (a term preferred by John Steinbeck in *Cannery Row*, his classic account of life along the California coast).

No one would accuse a chiton of being rambunctious or even mildly entertaining. You could watch one all day and never see it move an inch, and if you came back the next day you'd be likely to find it in exactly the same place. There are two reasons for this: Most chitons are nocturnal, and most have a "home" spot they return to before the day breaks. Although they lack eyes, many chitons have light-sensitive spots in their shells, and they often spend the daylight hours under stones or in crevices, hiding from the sun.

One of the most common Northwest chitons breaks that rule, however. The Katy or leather chiton, eschewing the customs of chiton society, cruises the rocks any time of the day or night in a shiny, black, leatherlike girdle. One of the most conspicuous chitons on the rocky coast, the Katy is usually one and a half to three inches long but occasionally reaches five inches. Its Latin name, *Katharina tunicata*, honors Lady Katherine Douglas, the naturalist who sent the first specimen of this species to England for study in 1815.

102

The world's largest chiton is also found in the Pacific Northwest. *Cryptochiton stelleri*—the gumboot, moccasin, or giant Pacific chiton grows to fourteen inches and has been described as looking like a wandering meatloaf. The Latin *Crypto* refers to its hidden valves, which are completely covered

so foot scales mossy ehiton by a tough, grainy girdle. The species name *stelleri* honors another early naturalist, Georg Steller (also the eponym of the Steller's jay and Steller's sea lion). The gumboot chiton is brown or reddish brown and is usually found below the low-tide mark.

The mossy chiton (*Mopalia muscosa*) is another relatively common chiton, found under rocks or in crevices. It can grow to nearly four inches, although it's often smaller. Short, stiff hairs on the girdle give this chiton a mossy appearance. The animal is brown, dark olive, or greenish gray, and the eight valves sometimes have a whitish stripe down their centers—as well as small barnacles, algae, or other hitchhikers. Mossy chitons are said to have "teeth of iron," because their radulas, or rasping, file-like tongues, contain magnetite, an oxide of iron. Not only is the radula especially hard, it can be picked up with a magnet.

All chitons use their radulas to scrape food off the rocks. Leaving its home spot, usually under cover of night and/or tide, the animal creeps about, clearing a path as it eats its way through a film of algae. Many chitons are vegetarians, but some also consume minute animals. The rising sun will find most chitons back home, hunkering down for the day. The only time in its life this creature shows a little wanderlust is when it is very young.

Male chitons release sperm, which in most species is then drawn inside the female's mantle cavity (the space between the shell and the soft body) along with the water she draws in for respiration. The fertilized eggs then flow out of the mantle cavity, and the developing young are free-swimming for a brief period before they find a home and begin their sedentary lives.

It's apparently a life that suits them: fossil records show that chitons have remained essentially unchanged for five hundred million to six hundred million years. And, as the variety and abundance of chitons found in the Northwest proves, that life is especially good on the West Coast.

### Common Sea Star

#### Latin name: Pisaster ochraceus

Description: 8 to 10 inches in diameter; usually orange or purple (though it can be yellow or brown); a network of small, white spines shows up against the darker background color; five arms.

Habitat: Rocky tide pools and below the low-tide line.

t's the star of the tide pool: *Pisaster ochraceus*, a.k.a. the common, purple, or ochre sea star. It is the creature everyone can identify, the one we most hope to see. This animal is commonly called a "starfish," but scientists and naturalists prefer the term "sea star" because it is clearly not a fish. It's an echinoderm—a spiny-skinned animal that can be divided into five equal parts. A sea star is more closely related to sea urchins and sand dollars than to fish.

Having neither head nor tail, the sea star moves in any direction that one of its arms points and can reverse direction without turning around. It's true that a sea star can regenerate a lost arm—or two or three; the central disk alone can regenerate all of the arms.

Male and female sea stars look identical, but even the creatures themselves have no real need to differentiate. With the arrival of springtime and warmer water temperatures, the males simply release sperm and the females release eggs to mix in the ocean currents. The fertilized eggs become swimming larvae, which eventually settle on the ocean floor and grow into proper sea stars.

If you look closely at the upper surface of an adult sea star, you'll notice a small round opening—the anus—near the center of the animal. You're less likely to notice the very tiny pincers called *pedicellariae* that cover the animal's entire upper surface. But if you rest a hairy hand or arm briefly against the star, you may feel the tug of these tiny pincers when you pull away. The pedicellariae keep the animal clean by crushing any minute larvae or parasites that happen to land on it.

The star's mouth is located in the center of its underside. When it finds a delectable meal, perhaps a snail or a small crab, the star extrudes its stomach outside its body through its mouth. The stomach looks something like a little plastic bag as it envelops the prey. Juices secreted by the stomach walls dissolve the smaller animal's flesh, and the star absorbs the resulting liquid.

The everted stomach is able to slide into incredibly thin cracks, which is useful when the star pries apart the shell of its favorite food, the mussel. The common sea star's penchant for California mussels gives it a pivotal role along the rocky coast. When scientists removed all the common sea stars from a tidal community, they found that it was soon overgrown with mussels—which eventually crowded out all other species. Thanks to its appetite, the sea star is in large part responsible for the variety of life found along rocky seashores.

Lining the undersides of the star's arms are many slender but amazingly strong tube feet tipped with suction cups. The tube feet use hydraulic pressure to adhere to a mussel's shell and to hold the star in place on rocks in pounding surf. The small feet also enable the animal to travel: a sea star can move at a rate of three inches per minute by reaching out with its tube feet, planting the suckers, and pulling its body along.

The ends of the sea star's arms contain the animal's sensory abilities. Tube feet there have no suction disks but are able to feel and smell, and an eyespot is located at the very tip of each arm. Although the eyespots don't allow vision, they are believed to be sensitive to light.

Ochre star, purple star, or common star. Starfish or sea star. Whatever name you prefer, it's not only one of the most common animals you'll find on the rocky Pacific Coast; it's also one of the most influential.

### Dungeness Cral

Latin name: Cancer magister Description: Shell to about 9 inches at its widest; upper shell purplish or orangish brown, tan or grayish, undersurfaces lighter. Front edge of shell has 10 or so small, sawlike points. Habitat: Estuaries, eelgrass beds, bays, around piers, wharfs, breakwaters, deep water to 600 feet.

n some winters the cast-off, molted shells of Dungeness crab are so numerous and obvious that many people become convinced the animals themselves are washing ashore, dead from pollution or some terrible disease. The confusion is understandable. The Dungeness crab population fluctuates wildly; years can pass with relatively few molts arriving on the beaches, while at other times hundreds of them are cast up to form long embankments on the sand. And because each molted shell is whole (although empty), it can appear that dead crabs are piling up.

All crabs molt in order to grow. Instead of the internal skeletons that soft-bodied animals like ourselves employ, they have hard outer exoskeletons. This shell protects them, but every so often crabs (like other crustaceans, or "crusty-bodied" creatures) must give up the safety of the confining shell so they can grow.

When it's time for the animal to molt, a crack develops along the rear edge of the crab's shell and the animal backs out, leaving the old exoskeleton neatly intact. Now the crab inflates itself by taking in water. It is making room, before its new shell hardens, for more growth to occur. The crab is now in the soft-shell stage, which means both that it is more vulnerable to predators and that if you catch one for your dinner its meat will be rather mushy and watery. Left alone, the shell will harden, and the animal will gradually become heavier and heavier as it grows to fit the new exoskeleton.

It is the synchronized molting of the male Dungeness crabs that sometimes becomes especially noticeable in the late winter months. The males all molt at once for a reason, and naturally that reason is sex. Crabs mate when the female is in the soft-shell stage, and the males need to be back in their hard-shell stage by then. The females' molt is not synchronized, but occurs throughout the spring and summer.

Because the males know when an adult female is preparing to molt, scientists speculate that she releases hormones in her urine. A male who tracks down such a female immediately embraces her. The two may remain for days in the clinch, belly to belly. Should she become restless during this tight courtship, the male soothes her by rubbing her shell with his claws. When the female is ready to molt, she informs the male by nibbling on his eyestalks. This causes him to loosen his grip so she can turn around. Still within the protecting embrace of his arms, she slips out of her old shell and into something more comfortable. After she pumps herself up, and perhaps her shell hardens a bit, the two finally mate. He releases sperm through special appendages into her reproductive openings. She will hold this sperm for several months in an abdominal receptacle until she is ready to lay her eggs. After mating, the male continues to clasp the female until her shell hardens and she is able to defend herself.

In late fall or early winter, the eggs are finally fertilized by the waiting sperm as they emerge. Throughout the winter months, the female carries the eggs with her, tucked up against her abdomen. The female's abdominal flap, which is like a modified tail, is different from the male's, and this is an easy way to determine a crab's sex: his flap is narrower and triangular, while hers is more U-shaped. The broader flap allows her to carry up to a million eggs. These develop into embryos, which are finally released in late winter or early spring.

The young go through a series of molts. By the time they resemble tiny



crabs, about four months later, they seek the refuge of estuaries to continue molting and growing. As they near adulthood, they will have mastered the Dungeness crab lifestyle. They will avoid predators by burrowing backward in the sand so that only their eyes and antennae show. They will feed on small fish, marine worms, and small clams and abalones, chipping open the shells with their pincers. (Crabbers use turkey legs, dead fish, or some other animal flesh for bait.)

Three-year-old Dungeness are prepared to enter the adult crab world, and the males are ready to begin the synchronized late-winter molt in the offshore waters. Another generation of young Dungeness crabs leaves the sheltering estuaries, armed with their knowledge of crab survival skills and drawn back to the ocean by the promise of soft-bodied sex.

### Scallops

Latin name: Hinnites giganteus, Chlamys hastata, Chylamus rubida Description: To 6 inches in diameter, depending on species; shell is fan-shaped with radiating ridges and furrows; two jutting "ears" near hinge; size and color vary according to species.

Habitat: Different species are found in deep water, just offshore, in large beds on seafloor, or attached to rocks in crevices and under boulders.

eople don't expect much from shellfish—except perhaps a tasty meal. But apart from their culinary qualities, scallops, as bivalves go, are surprisingly alert little creatures. Among all the wide ocean's two-shelled animals, only scallops have eyes and can see. Their many eyes have lenses and retinas, and are a lovely shade of deep greenish blue. Although scallops are unable to perceive images, they can detect movement and changes of light and shadow. The eyes are located in a row lining the inside edges of both of the animal's shells, and they alternate



30

### Great Blue Heron

Latin name: Ardea herodias Description: 3 or more feet; bluish gray body; long bill, neck, and legs; long black plumes extend from head.

Habitat: Salt or fresh water, in tideflats, ponds, streams, or lakeside, but also in fields some distance from water or near backyard pools.

hunting great blue heron seems outfitted with only two speeds: slow motion and fast forward. This large bird may stand kneedeep in ponds and rivers, staring intently at the water for long, patient minutes. Or it may wade slowly, drawing one foot from the water and placing it precisely back in, toes closed to a point to avoid creating any warning ripples.

But when a frog or fish cruises into range, the heron suddenly slams into high gear. It makes a lightning jab into the water with its bill, seizes the animal, and swallows it head first and whole. Small fish make up the bulk of its diet, but the heron also nabs crayfish, dragonflies, and insect larvae, and uses its bill to stab larger fish. A heron hunting in a field or meadow is probably after insects and mice.

Native to the Pacific Northwest, the great blue heron has earned many names over time. The Nisqually tribe is said to call it "our grandfather," settlers often called it "big cranky" or "long john," and today birders refer to it by the initials "GBH."

The sight of a wading or flying blue heron is not unusual today, but in the early 1900s, the heron population was severely reduced due to a whim of fashion: the feathers of both herons and egrets adorned women's hats, and thousands of the birds were killed annually to feed the fad. An organization that would later become the National Audubon Society was launched by two prominent Boston women who opposed the slaughter. The public outcry they helped spur resulted in laws that protected these birds and spared the great blue from being wiped out by a fashion craze.

The heron has two ingenious ways to care for those once-coveted feathers. Like other water birds, it uses its bill to "paint" its feathers with a waterproofing oil gathered from a gland at the base of its tail, but an additional tactic helps keep them clean. The tips of special feathers on its breast, called powder down, disintegrate into a dust that the heron uses to clean itself. The fine, waxy powder absorbs fish oil and helps keep feathers water repellent. The bird also grooms by using a serrated section on its middle toe as a comb.

Great blue herons are solitary birds most of the year, but in late February and early March the males and females court with displays that include neck-stretching and the raising and lowering of feathers. Sometimes a pair will groom the feathers of each other's head, neck, and back. Most endearingly, they might grasp the tips of each other's bills and then, in unison, rock their heads back and forth. The birds gather in nesting areas called heronries, usually located near water in remote, secluded woods. (The city of Portland, Oregon, however, boasts two rookeries within its city limits, the larger one located on Ross Island in the Willamette River.) They haul branches up into tall trees to make platform nests or repair old ones. After the female lays three to five eggs, the parents take turns sitting on them. Herons probably nest in a large group to help protect their gangly, helpless young.

In the first few weeks after their offspring hatch, one parent stands guard while the other goes fishing, but as the young birds grow it takes both parents to keep up with their demanding appetites. The constant comings and goings of the adults and the raucous calls of their young make the heronry a noisy, bustling place.

174

When the young herons leave the nest (usually only two or three survive at this point), they must hunt for themselves. The art of two-speed fishing apparently takes some time to learn. Studies have shown that the young birds expend far more energy than adults do in getting a satisfying meal. But each misstep and every miscalculated attempt perfects a young bird's technique. Eventually they master the great blue heron's art of slow, dignified concentration and wicked, fast jabs.

### Belted Kingfisher

Latin name: Ceryle alcyon

Description: 12 inches; large blue-gray head with ragged crest; compact body with white neck and underparts; blue-gray belt across breast; females have an additional ruddy band across belly and rufous flanks.

Habitat: Near water, fresh or salt: streams, ponds, ocean, estuaries.

f you want to see a kingfisher, look to water. It's estimated that these birds were once found patrolling every waterway, small or large, across the country. But the same old sad song of habitat loss and killing of creatures believed to be in competition with people led to a precipitous decline in kingfisher populations.

When you do find one of these birds, it will probably be fishing. The mainstay of a kingfisher's diet is small fish, up to five inches long, although they are known to take crayfish, frogs, newts, mice, butterflies, moths, and other small creatures. The kingfishers I've seen spend a lot of time on a perch—a branch, a pier, or a convenient utility wire—gazing intently at the water below. When a small fish swims by, the kingfisher dives headfirst into the water to claim it. (Later, the bird will upchuck a pellet composed of scales, bones, and other undigestible items.) A kingfisher will also peruse its fishing ground on the wing, hovering briefly over its next meal before plummeting to the water. It takes the still-wriggling prey to a perch and whacks it to death against a branch before swallowing it.

Fishermen once embarked on campaigns to kill the birds, but today kingfishers are protected by federal law. The birds themselves have never been wont to share their fishing rights either. They are intensely territorial and, should another kingfisher dare enter the area, the resident charges full tilt after the intruder, hollering its rattling alarm call, which has been likened to a New Year's Eve noisemaker. The mad dash continues until the

176

### Western and Glaucous~ Winged Gulls

Latin names: Larus glaucescens (glaucous-winged); L. occidentalis (western) Description: About 26 inches; white head, neck, and breast; gray wings and back (breeding plumage); yellow beak with red spot near tip on lower half; pink legs. Habitat: Along coast, in estuaries and bays, also garbage dumps and sewage treatment plants.

lipped smoothly into conversation, the statement "There's no such bird as a seagull" would probably win a lot of barroom bets. Open any bird book and you'll find it's true. Although plenty of gulls live by the sea, they go by names such as herring gull, ring-billed gull, and California gull. Thirteen different species regularly visit the Pacific Northwest, and there's not a single "seagull" among them.

Of those thirteen, the two most commonly seen along the coast are the western gull and the glaucous-winged gull. They're both relatively large gulls with pink legs, and the best way to tell them apart is by the color of their backs; the western is the darker of the two. Glaucous-winged are named for their color ("glaucous" meaning a frosty gray). These two species are most numerous because they both breed along the Pacific Northwest coast. Glaucous-winged tend to nest in Washington and farther north, westerns in Oregon and south. But the two intermingle and sometimes interbreed, creating offspring that look a bit like each of them (and, coincidentally, also like Thayer's gulls). These hybrids are so common they're sometimes given their own unofficial name of "Puget Sound gull."

Identifying gulls is not for the faint of heart. Different species can look maddeningly similar, but serious birders look for subtle clues: the color contrast between the back and the wing tips, and the leg and bill colors. Further complicating matters, each species has different breeding and nonbreeding (winter) plumages, and their juveniles are a variety of browns in their first years, shading into grays and whites as they age. (It may help somewhat to know that the ring-billed and California species are the most common inland gulls.)

The two species that claim the coast breed in large colonies on outer islands and rocky cliffs. Gull couples form long-term, perhaps lifelong, relationships, returning annually to the same territory and sometimes even to the same nest. Their three eggs are held in a bulky cup of grasses, seaweeds, and feathers. Parents take turns incubating the eggs and standing guard. They defend their territorial borders fiercely, and even seize and eat neighboring chicks that stray from their own nests. Glaucous-winged gulls are especially prone to cannibalizing other birds' chicks and are a major cause of mortality in those younger than three weeks.

Both parents feed the chicks, who elicit a regurgitation response by pecking at the red spot on the lower half of the parent's bill. The young are programmed to zero in on this target: they'll peck with equal insistence at a stick with a similar spot painted on it, even though the stick looks nothing like a bill and is not attached to anything that looks like a bird.

Once the young have fledged, they learn all the gull tricks, such as swaggering up to picnickers to beg handouts and breaking open mussels and clams by dropping them from the air onto rocks. They learn the locations of canneries and other hot eating spots, and that following clammers on the beach and fishing boats at sea often reaps rewards.

Primarily scavengers, gulls have long been lauded for their efforts in helping to clean beaches of carcasses and garbage. They also pirate morsels from other birds, and they manage to choke down such huge food items such as sea stars—that it almost makes you gag to watch them. Gulls are so very good at eating nearly anything that they can be found in many places other than the sea. As my husband Tim likes to say, if there are seagulls, then there must also be reservoir gulls, dump gulls, and supermarketparking-lot gulls. You can bet on it.

81

For this reason, the essays segue from ocean and sandy beaches to rocky intertidal areas, blending into those species found in estuaries and leading, finally, to those whose habitat is fresh water.

With apologies to those of you living in the eastern part of Washington and Oregon, the essays in all three books focus to a greater degree on the region west of the Cascade Mountains. Please note I often use the shortcut of "Pacific Northwest region" instead of the more accurate (but too cumbersome) phrase "Pacific Northwest region west of the Cascades."

For many years I had the pleasure of working as a naturalist in Washington and Oregon, discussing with people the plants, animals, and natural events of the Northwest as we walked through woods and beside waterfalls, down into caves and along lakeshores. It's my hope that the *Uncommon Field Guide* series continues that work, acting in the capacity of a friendly naturalist who answers your questions, mentions interesting tidbits you might not think to ask, and helps to further both your understanding and your relationship with the natural world.

# Harlor Seal

Latin name: Phoca vitulina Description: 5 to 6 feet long; males slightly larger than females; mostly pale gray mottled with darker spots and rings, but may have extremely pale markings or may be dark overall.

Habitat: Harbors, beaches, mudflats, low rocks, and offshore waters.

was sitting on the beach, watching my friend Jolyon surf, when a dog poked its head out of the water behind him. It took me a moment to realize that the "dog" was really a seal. Although I yelled and pointed, Jolyon couldn't hear me over the sound of the surf and never did turn around to see the ocean creature that trailed along behind him like a canine companion.

When harbor seals are in their element—water—they tend to be very curious. They check out boaters as well as surfers, and will swim parallel to people walking along the shoreline. But when they "haul out" onto land, seals are wary and vulnerable. Even when lounging like overinflated

1

XII

sausages, they are aware when people come uncomfortably close. If they feel threatened, they hump across the beach to reach the safety of the sea. (Seals can't rotate their back flippers underneath themselves to walk on them as do sea lions.)

But underwater, it's people who are ungainly and awkward in comparison. Harbor seals glide and gambol, using their powerful hind flippers as propulsion and adjusting course with a flick of their front flippers. As the animal dives, it closes off nostrils and earholes, and its heart rate slows down to one-tenth of its capacity. Blood flow remains strong to the brain and heart but dawdles to the extremities. A harbor seal can hold its breath for twenty minutes in dives that reach nearly three hundred feet below the surface. But most of the time the seal is underwater for just three to five minutes before popping its head above the surface for a quick, inquiring look around.

During its dives, a seal might be foraging for crabs, squid, octopus, or fish. Harbor seals, unlike their larger salmon-loving cousins, the sea lions, seem content to feed mostly on noncommercial fish like eelpout and rockfish. But before this was general knowledge, and before the passage of the Marine Mammal Protection Act, fishermen and state authorities attempted to eradicate harbor seals from Northwest waters. An estimated seventeen thousand animals were killed between 1947 and 1960. Today the harbor seal's chief predator is not people but its ancient nemesis, the killer whale.

Despite their ease in the water, seals must come ashore to mate and give birth. Unlike many of their pinniped relations (sea lions, seals, and walruses), harbor seals don't form large breeding colonies overseen by a single male. Instead, both sexes couple promiscuously with whoever strikes their fancy. Pups are born between April and July. When the babies are very young, they are unable to keep up with their foraging mothers. This isn't usually a problem; the mother simply leaves her baby on a convenient beach while she feeds, afterward returning to collect her child. The glitch in the harbor seals' daycare system is that well-meaning, uninformed people

2

"rescue" the pups, delivering them to police officers, vets, or other inappropriate foster mothers.

So, if you should you find a pup on the beach, let it be. If you are concerned that its mother has been gone overly long (keep in mind that she may leave the pup for more than twenty-four hours), contact the state's department of fish and wildlife, a local animal shelter, or a marine mammal stranding network. *Never* take a pup off the beach yourself, despite its adorable looks and its big doelike eyes. Left alone, that baby will grow into an inquisitive adult who bobs up out of the water to watch people walking along the beach or surfing in the ocean.

### Hermit Crals

#### Latin name: Pagurus spp.

Description: Body to about 1½ inches, depending on species; much of body hidden inside an appropriated snail shell; front legs visible; two claws, the right larger than the left; stalked eyes.

Habitat: Rocky shore tide pools, gravel beaches; also offshore to more than 50 feet deep.

f any crab could be called endearing, the hermit crab would be. They just don't seem as irritable or menacing as other crabs—at least toward people. We can pick them up by their shell-houses with impunity.

But if hermits don't seem crabby, it may be because they are not true crabs. Hermits' antennae are positioned differently from those of true crabs, and their abdominal legs are reduced in number and size. For that matter, they're hardly "hermits" either; these little crustaceans are actually rather gregarious.

One of the delightful things about hermit crabs is the surprise of an unexpected resident tucked inside a snail's shell. It was once thought that hermits evicted their shell's original occupant by devouring it, gaining meal and house at once, but studies have shown that they do not eat such large prey. They are, however, particularly sensitive to the scent of dead gastropods, so once someone else has done the evicting, they can track their way to a potential new home.

Finding suitable lodging is a lifelong occupation for hermits, and housing shortages can limit populations. Their soft, coiled abdomens require protection but, as they molt and grow, they must abandon their old, tightfitting shells. A hermit appraises a new place with the scrutiny of a housing inspector. It grabs the shell with its claws, hefts it and repeatedly turns it around, feels deep inside the cavity with antennae, and cleans out any debris found therein. After much ado, if the place is acceptable, the hermit abruptly pulls its vulnerable abdomen out of the old home and slides quickly into the new. Through evolution, hermits have lost some legs, and the final two pairs are modified to hook onto the shell—helping, along with the abdomen's coil, to secure the animal in place.

Safely ensconced in its hand-me-down home, a hermit crab spends its time scavenging plant and animal debris, tussling with other hermit crabs, or looking for a mate. A male hermit crab has only a brief opportunity to mate with a female: he must time it to coincide with her molt. Therefore, when he finds a female during breeding season, the male grasps the open-

ing of her shell with his small left claw and may lug her around for days. If, as he's biding his time and dragging her about, another male dares to approach, the enraged suitor will ward him off with his large claw. (Hermit crabs are often described as pugnacious, and they do seem happy to drop everything to fight over females, food, or furnishings-but most of their brouhaha is carefully choreographed. Signals are given and respected, and for all the uproar no one ever seems to get hurt.) When the female finally molts, their

113

mating is a hasty affair. Both animals pull nearly out of their shells, and the male quickly deposits sperm on the female's abdomen. She later uses this to fertilize her eggs as they are laid. The female retains two degenerated appendages on the left side of her abdomen, and these "swimmerets" are used to carry the eggs. She waves the swimmerets about from time to time, drawing fresh seawater with its oxygen into her shell. Eventually the hatched young leave the protection of their mother's shell and begin their own adventures.

Different species of hermit crabs prefer specific habitats and even particular types of shells. But all spend their days trundling about in their appropriated mobile homes. And all, despite their puckish inclination to fight one another, strike most beachcombers as amusing—even charming—little crabs.

### Rockweed

#### Latin name: Fucus gardneri

Description: To 12 inches long; yellowish green to olive-green when wet; can appear almost black when dry; plant branches at regular intervals of 1 to 2 inches; prominent midrib runs down center of flattened, lobed branches; branch tips may be swollen and warty.

Habitat: Upper areas of tide pools.

e think of most seaweed as living, appropriately, in the sea, but this alga's common name of rockweed says it all. Rather than stretching up from ocean depths, it hangs from tide pool rocks in thick moist curtains. Rockweed is found along the coast and within Puget Sound; it is one of the Northwest's most common and most often seen seaweeds.

Each plant is secured to its rock by a disk-shaped holdfast. Unlike most land plants, which can photosynthesize only through their leaves, rockweed can take in the sun's energy throughout its entire body. It is a hardy seaweed, able to withstand extreme changes in temperature and salinity levels and loss of moisture each day. In fact, it holds in moisture so well that it creates a microhabitat used by small creatures who escape the heat of a sunny day beneath the plant's fronds.

There is evidence, however, that rockweed may wage a quiet sort of war against the creatures that would grow up to graze on it. The seaweed releases tannins that can kill planktonic crustaceans that land in its tide pool. As rockweed ages, its ability to create the tannins used in the chemical

114

orange to gray. The larvae are eventually released into the waves and spend the next four months or more traveling the ocean. The young initially look nothing at all like their parents, but through successive molts they eventually resemble miniature adults.

The offspring can settle as far north as Alaska, but in colder waters they are unable to reproduce. Likewise, the colonies north of the Oregon-California border occasionally die out, and it may be years before another swarm of larvae arrives from warmer waters to repopulate a given beach.

But if the tide and your timing are right, you can watch for tell-tale V ripples the next time you walk along a sandy beach, and carefully unearth a mole crab. And when it reburies itself or scuttles backward across the sand, you'll be able to identify (accurately) which end is the head.

### Limpets

#### Latin name: Class Gastropoda; various genera and species

Description: Most from 1 to 3 inches, but length varies according to species; soft-bodied, two-tentacled animal encased in hard, broadly cone-shaped shell; keyhole limpets have a small hole in the top of shell.

Habitat: Differs according to species, including surf-pounded rocks, eelgrass or surfgrass, shells of other snails, vertical surfaces, crevices, or rocky upper reaches of high tide.

ry to pluck a limpet off a rock and you'll discover this mollusk's main defense strategy: suction. A limpet adheres so tightly to rocks that you could end up breaking its shell before it would loosen its grip. Staying attached to its substrate is important to a creature that has a soft and vulnerable body tucked into a single shell. Bivalves like mussels and scallops can clamp their two shells tightly shut; snails can seal their single shell with a hard door called an operculum; but limpets, like chitons and abalones, rely on suction power to protect them from pounding surf and potential predators.

Many limpets can sense and respond to the approach or touch of a sea star. As the hunter nears, the limpet hikes up its shell like a Southern belle raising her hoop skirt, and glides off in another direction. This is called the "running" escape defense, apparently named by a researcher with a sense of humor. Still, this member of the snail family need not be much of a sprinter to outdistance a creeping sea star. Other limpets respond to the predator's approach by simply letting go of their rock and tumbling to a (hopefully) safer location.

The rough keyhole limpet (Diodora aspera) has another option. This

85

common limpet of Puget Sound and the open coast also lifts its striped skirt at the approach of a sea star, but instead of running, it extends fleshy curtains down over the foot and up over the shell. The common sea star is usually deterred by this defense, perhaps because its tube feet cannot grip the slippery surface. But a disagreeable chemical "taste" may be the real deterrent. Other sea stars are known to prey on the rough keyhole limpet, regardless. But this creature usually has a hidden cohort who springs into action when its host is under attack. Almost every rough keyhole limpet carries a worm, *Arctonoe vittata*, coiled underneath its shell. In this symbiotic you-help-me-and-I'll-help-you relationship, the worm receives protection and access to food. It pays its rent by helping to ward off attacking sea stars, reportedly biting their tube feet and hastening their retreat.

Most limpets are vegetarians who wait until the tide covers them especially the night tide—to creep about in search of algae. They extend their two sensory tentacles and begin foraging. The barest film of new algae feeds a limpet, and it eats by rasping a file-like tongue called a radula over the rocks, both breaking up food particles and conveying them to the mouth. Many limpets cruise a specific home territory, bulldozing or otherwise uprooting potential homesteaders such as barnacle spawn. Some species have a very specific resting spot to which they return with the falling tide. An individual uses the same spot throughout its life, and over time its shell carves an exact outline into the rock. The returning limpet aligns itself precisely in its "home scar" and settles down. As the tide recedes, the animal retains some water, which allows it to breathe until the next tide.

Most limpets also rely on the tides to mix their sperm and eggs. The sexes are separate (although in some species all young limpets are male, becoming female as they mature), and each looses its eggs or sperm to meet in the water. The resulting larvae swim about for a time as they develop, eventually finding habitats that match their particular species requirements.

The dunce cap, or whitecap limpet (Acmaea mitra) prefers rocks that harbor an encrusting pink coralline algae. This knobby pink stuff is the dunce cap's food, but it often finds a hold on the creature's shell and grows there as well, covering and camouflaging the animal. (This helps not only the limpet, but also the lucky algae riding safely on its predator's back.) You'll often find the dunce cap limpet's empty tall, conical, one-inch shell on the beach.

The digit or ribbed limpet (*Lottia digitalis* [formerly *Collisella digitalis*]) prefers vertical rock faces that receive some wave action. Other limpets attach to strands of eelgrass, surfgrass, or kelp, or the shells of black turban snails. Limpets can be found in specific niches from high-tide rocks to grasses, and all have a solid grip on the place where they live.

86

diameter than the animal that made it. As the urchin grows, it can carve itself into a hole that it can't get out of after reaching its full size of up to four inches in diameter. The surrounding rock protects the animal, and the never-ending waves deliver its food.

The red sea urchin (*S. franciscanus*) can be found in both quiet and wilder waters, and may grow to a foot in diameter. Its spines are longer than those of either the green or the purple urchin.

Male and female urchins release their sperm or eggs simultaneously. Females reportedly produce twenty million eggs in one season. The small swimming creatures that develop from the fertilized eggs are bilaterally symmetrical, but eventually they settle in an appropriate place and metamorphose into the radial symmetry of the adults.

An urchin's mouth is located in the center of its underside; its anus is in the center of its top side. The animals eat algae, seaweed, and plankton. In turn, they are eaten by some sea stars, seagulls, and people who consider urchin gonads a delicacy.

These little bundles of spines are some of the most common creatures found along Northwest shorelines. You'll find different sea urchin species on wave-swept ocean rocks than you'll discover in Puget Sound tide pools, but both places boast plenty of the small, spiky beach balls.

## Blue and California Mussels

Latin names: Mytilus trossulus (blue mussel); M. californianus (California mussel) Description: Blue mussels to 4 inches long; California mussels to more than 10 inches. Blue and black shells are a rounded, elongated triangular shape.

Habitat: Blue mussels: tide pools, quieter waters inland and on coast, also associated with California mussels in wave-swept area. California mussels: wave-swept rocks on coast.

mussel larva looking for a place to settle embodies the real estate agent's maxim: the three most important considerations are location, location, and location. If the young mussel lands too high on a rock, it will die of dehydration and exposure; too low on the rock and it enters the territory most frequented by its archenemy, the sea star. Perhaps this difficulty in choosing just the right spot is the reason that the larvae are predisposed to attach themselves to already established mussels. By simply having stayed alive, the elders prove their location is a good one. But even this option has its own inherent danger. Too many mussels attaching to other mussels that are attached to the relatively few who are actually anchored to a rock can pull the whole shebang into the ocean.

But that, of course, would open up a nice patch of prime real estate for the next infant mussel that swims along. During their young and wayfaring stage, larvae are nothing like the adults. They live and feed in surface waters and are dispersed with the currents. Eventually they settle on a substrate and change into their adult form—but they can be quite choosy about where they will live and can delay maturity to continue rambling until they find the site that suits them.

Even after they are established, blue mussels (also called bay mussels and

93

occasionally edible or foolish mussels) have a limited ability to move. Mussels fasten themselves to rocks, pilings, and other mussels by byssal threads, collectively called a byssus ("BISS-us"). These tough elastic threads, produced by the animal's byssal gland, are made of protein, like hair. By touching the gland with its foot, the mussel draws a thread to the substrate, where it attaches. This action is repeated many times until threads radiate outward around the animal like many guy wires steadying a pole. The byssus changes color from brown to white and hardens in the water. Even after the byssus hardens, a blue mussel can move a small distance by throwing threads in the direction it wants to go and then using muscle contraction to slide forward.

Mussels live clumped together, tightly nestled in large beds that may cover several square feet. Blue mussels occasionally live on exposed rocks pummeled by the ocean but are more likely to be found in quiet tide pools, estuaries, and bays. They grow to about three inches in length and have smooth shells outlined with irregular concentric rings. California mussels are the species more likely to be found in areas of heavy surf and wave action. They have stronger byssal threads to anchor them and grow larger than the blue mussel—usually to five inches, but sometimes reaching ten inches or more. Their shells also have concentric rings, but these are rippled instead of smooth.

Mussels feed when the tide covers them, and their shells gape open like the mouths of hungry baby birds. The animals siphon in the water, pulling it over their gills, which have the dual responsibility of breathing and foodgathering. The gills simultaneously extract dissolved oxygen from the water and filter the tiny plankton that mussels eat. (During the summer months mussels, like clams, sometimes ingest a microscopic organism responsible for "red tides," which has a toxin that builds up in the creature's gut. This toxin has been known to paralyze or kill people who eat filter feeders such as mussels. It is imperative to heed posted notices warning of shellfish poisoning.) The sexes are separate in mussels, and their sperm and eggs unite in the water to create swimming larvae. Relatively few of these survive their rambling adolescence. Each young mussel that does escape predation eventually settles down, finds itself a nice home, and puts down some byssus threads.

95



Thinophores

Lemor

Latin names:Hermissenda crassicornis; Anisodoris nobilis Description: Most 1 to 4 inches long; those in deeper water may grow to 10 or 12 inches long; often with striking coloration and variously shaped appendages. Habitat: In tide pools, eelgrass beds, mudflats, estuaries; around floats, docks, pilings; in shallow water near shore.

udibranchs need a good public relations firm. Marine textbooks regularly refer to these mollusks as the most beautiful animals in the sea, yet the little snails-without-shells are unknown or overlooked by most people. The term "sea slug" certainly doesn't help their image.

Nudibranchs (pronounced "nudie-branks") are downright gaudy. They come in many colors, including lemon yellow, orange-red, and rosy pink; they can be sprinkled with black, outlined in frosty white, or streaked with electric blue. They might be striped, spotted, mottled, or all one hue. Some sport color combinations that shriek to be noticed, while others match their background so perfectly as to be nearly invisible. Nudibranchs come in wildly fanciful shapes, too. Sensory tentacles called *rhinophores* that arise from the front or back of the animal can be conical, feathery plumes, or spires. The basic slug-body shape might be adorned with a circular tuft of gills at the back end, or entirely covered with projections called *cerata*. The cerata can be blunt and finger-shaped, wide and spade-shaped, or thin and pointy like thorny branches.

Over one hundred and seventy species of nudibranchs have been described along the Pacific Coast. The most common one in the Northwest is *Hermissenda crassicornis*, sometimes called the opalescent nudibranch. Its body is a translucent white with a bright orange line running down the back. Blue lines (sometimes a brilliant neon blue) run from the tentacles down either side of the orange line and also streak along the margins of the animal. Finger-shaped cerata cover the nudibranch's back, waving in the currents and with the animal's movements; each is usually a deep orange or brown, ending with a ring of bright orange and a white tip.

The cerata perform several functions for the nudibranch. Branches of the liverlike digestive gland run up inside them. They are also used for respiration, taking the place of gills used by other sea creatures (the name "nudibranch" translates to "naked gills"). The cerata are also used in defense. Many nudibranchs feed on animals such as anemones, which are armed with stinging cells called nematocysts. For some reason (perhaps the slime they exude protects them), the sea slugs are not injured or deterred by these harpoonlike cells. They simply gobble down the nematocysts along with the rest of the animal; the stinging cells are then sorted inside the nudibranch's body and migrate up into the cerata. The sea slug thus becomes armed with the weapons of its prey. Some species of nudibranchs can also lose cerata to an enemy, make an escape, and then grow more a few days later. Others employ chemical weapons, releasing sulfuric acid or toxins.

In Anisodoris nobilis, often called the sea lemon (shown on preceding page), the cerata are replaced by a flowery white plume of gills that surrounds

45

the animal's anus on the rear upper side; the rest of the body is covered with tiny bumps. The sea lemon is bright yellow to orange and speckled with black. Like most nudibranchs, it is a fussy eater and feeds exclusively on sponges.

Nudibranchs are hermaphrodites (each individual has both male and female sex organs). Some species are male when young and become female as they grow older, but most species are both genders simultaneously. When two mate, each usually gives and receives sperm. Later, each will lay eggs in coils or rippling curtainlike masses, depending on the species.

With their enticing coloration, varied shapes, and interesting sex life, nudibranchs should be far more popular than they currently are. If they just had the correct packaging (including a catchy slogan—something like "Nudibranchs: the mermaid's lapdog"), pretty little sea slugs could become the darlings of the coast.

# Sea Cucumber

#### Latin name: Parastichopus californicus

Description: To about 16 inches long; about 3 inches in diameter; tubular animal with prominent fleshy warts; usually dark red with orange, also brown above and yellow below. Habitat: Low rocky tide pools or just offshore; also on sandy bottoms in deep ocean.

ot many of the world's animals could be appropriately named after a vegetable, but the sea cucumber's name fits it nicely. A sea cucumber (some smaller species are called "gherkins") looks more like a salad bar offering than like its closest relatives, which are sea stars, sand dollars, and sea urchins.

The giant or California sea cucumber is the most common species in the Northwest, and also the largest. It moves around, when it needs to, by means of three rows of small tube feet lining its flattened underside. Other tube feet have become fleshy pointed bumps on its upper surface, and still others have been modified into feeding tentacles that surround the cucumber's mouth, located at one end of its body. These white tentacles branch and branch again into plumelike structures that are often compared to mop heads.

The mop heads wave about, collecting small organisms on their sticky mucus surfaces, or swab detritus from the sand or mud. When the oral tentacles are coated with food, the cucumber does what any child with sticky fingers would: it inserts the tentacles one by one into its mouth and scrapes off the delectable items.



### Octopus

Latin names: Octopus dofleini; O. rubescens Description: O. dofleini: arm length to 15 feet; usually gray or mottled brown; O. rubescens: arm length to 18 inches; usually red or mottled red and gray, both species can change color.

Habitat: Coastal or ocean waters, sometimes in rocky dens and crevices.

ur ship was dead in the water, floating on the vast Pacific, while the engineers tinkered down in the engine room. When Athel reached into the main sea suction box to clear it of debris, something grabbed his fingers. Snatching back his hand, he yelled, "It's got tentacles!" Indeed it had. The baby octopus he gingerly extracted a few minutes later had eight little tentacles, each just a couple of inches long.

I had spotted full-grown octopuses (not "octopi," according to those who study them) underwater before, crouched in rock crevices, but this soft baby was the first I'd ever touched. Peter, the captain of the *Rainbow Warrior*, and I donned snorkels, masks, and fins and went over the side of the ship to release the little mollusk. We played with it for a bit underwater, watching it swim and peeling its suckered arms off the ship when it grabbed hold. When the octopus had had enough of us, it loosed a tiny cloud of black ink and scooted away. Later I learned that the ink is not only a smoke screen, but also a stink bomb that stuns the olfactory abilities of pursuing predators.

Because my voyages on the *Rainbow Warrior* are long over, these days I hope to encounter another baby octopus in a tide pool. Two species are most likely to be found in Northwest tide pools or seen by divers. The giant

Pacific octopus (*Octopus dofleini*) and the red octopus (*O. rubescens*) can both be found in shallow water; the red octopus is more likely to be encountered. The giant Pacific octopus is the largest in the world; the record-setter weighed more than six hundred pounds and had an armspread of thirty-one feet. But the largest most divers can hope to see is closer to one hundred pounds, with a sixteen-foot armspread.

For many years the octopus was depicted as a fearsome monster liable to grab any passing ship and wrestle it down to the bottom of the ocean. In reality, octopuses are shy, spend a great deal of time hiding, and get into a wrestling match only with the crab they want for dinner.

Octopuses are now widely regarded as the most intelligent invertebrate (animal lacking a backbone). Scientists have taught them to run simple mazes, open jars and small doors, and distinguish shapes, colors, and textures. Captive octopuses recognize specific people (wild ones, too, sometimes become friendly with certain divers) and often endear themselves to their keepers. One clever octopus slithered out of its tank at night, ate fish in a nearby aquarium, and then returned to its own tank, thereby perplexing the scientist who, in the morning light, found an apparently undisturbed yet empty fish aquarium.

The octopus may need its more highly developed brain to coordinate all those arms, operate the thousands of suckers that both taste and touch, and control minuscule muscles that allow thousands of pigment sacs on its skin to change color to replicate its current background. An octopus makes a chameleon look boring by comparison; it can be any combination of red, brown, black, gray, yellow, or orange and can even change the texture of its skin.

Octopuses can flush red when they discover a member of the opposite sex, although the actual mating occurs without much fanfare. One of the male's tentacles has no suckers on its last six inches or so, and this arm is used to transfer a packet of sperm up under the mantle (the part that looks like a head) of the female. After she has laid her eggs in a protected place,

14

the female tends them continuously for the next five or six months until they hatch. She usually takes no nourishment during this time, and dies shortly after the young struggle out of their eggs.

Whenever I peek into a tide pool, I hope to see a baby octopus. Who knows? I may have already looked at one without ever seeing it. Even very young octopuses are so adept at camouflage that, like our ship's engineer, I may have to be grabbed by its tentacles before noticing it.

Spiny Dogfish

Latin name: Squalus acanthias

Description: 3 to 4 feet long, rarely 5 feet; adults gray, sometimes brownish above and whitish below, juveniles have white spots; jutting spine just in front of each of two dorsal fins. Habitat: From just offshore to 1,200 feet deep.

he spiny dogfish, by far the Pacific Northwest's most common shark, is more annoying than dangerous. Although dogfish may swim alongside divers and have an unnerving habit of sometimes veering abruptly toward them, they do not attack people. They eat fish, not the seals and sea lions that a larger shark might occasionally mistake a human for.

Dogfish are much more trouble to people who fish than to those who dive, surf, or swim. Because these sharks are attracted by the same bait that appeals to salmon, dogfish strike on fishing lines. And because they sometimes travel in schools, once one dogfish is hauled aboard via net or line, many more may follow. (The school has also probably run off the desired fish, and a new fishing location will have to be found.) A dogfish aboard a boat can be difficult to subdue and must be handled cautiously. In addition to its sharp teeth, it has two slightly venomous spines on its back, one in front of each fin. If one of the spines punctures flesh, a gland releases venom into a shallow groove along the spine. From there the poison flows into the victim's skin, resulting in a painful wound.

Although dogfish are eaten in Europe and other parts of the world, they have never caught on in North America as a culinary treat. At one time,

16

are conveyed via mucus and cilia to the creature's mouth.

Another cirrus plume has been modified to a funnel shape that is often compared to a golf tee. If the tube worm senses danger, it snaps back into its shell and this golf tee is the last cirrus to retract. The tee is an operculum, or lid, that seals the worm inside. The operculum is as red as the rest of the cirri, so each closed tube-worm home seems to be sealed off with a little bright-red door.

Relatives called feather-duster or plume worms (*Eudistylia vancouveri* and *Schizobranchia insignis*) live in leathery or parchmentlike tubes. These live in much the same way as do fan worms, but they can grow much larger. The tube of *E. vancouveri* can be twenty inches long, sprouting flowerlike cirri that measure two inches across. Their cirri can be white to green to deep maroon or purple.

Another worm, known as *Spirorbis*, is less impressive, but only because of its small size. These worms are more easily overlooked, although they are quite common. They build their homes in tiny, tight spirals about a tenth of an inch or less in diameter, and they favor out-of-the-way places like the undersides of rocks or seaweed. Like the other tube worms, *Spirorbis* has brightly colored red cirri. One of the ways in which it differs from other tube worms is in its sex life. Most tube worms are either male or female and, in season, send out sperm or eggs to mingle and fertilize in the water (although some species brood the young in the female's tube). But *Spirorbis* is both male and female simultaneously. Curiously, the front part of its abdomen is female, while its posterior end is male. In some species, the operculum has a special cavity that serves as a brood pouch for larvae.

The beaches and waters of the Pacific Northwest are squirming with all kinds of worms. The Northwest hosts so many species that guidebooks dedicated to worms alone could be written. But of all the worms you're likely to run into, surely some of the loveliest and most graceful are the tube worms who daily perform their food-gathering fan dances.

# Black Oystercatcher

Latin name: Haematopus bachmani

Description: To 18 inches; long orange-red beak; yellow eye surrounded by red ring; dark plumage; pinkish legs.

Habitat: On rocky shores and islands; rarely on sandy and cobble beaches.

irds that dine on shellfish have developed a variety of ways to get to the encased meaty bits. Scoters simply swallow a mussel whole and let their muscular gizzards do the work; gulls take a clam up into the air and drop it on a rock to crack it open. Black oystercatchers rely on sneak attacks.

The long-beaked shorebird strolls along the rocky coast, or sometimes wades in water up to its belly, looking for any mussel that has opened its shell slightly to breathe and feed. Finding a mussel in this vulnerable position, the oystercatcher abruptly thrusts its bright, chisel-like beak between the mollusk's shells. It was long thought that the bird severed the strong muscles that clamp the mollusk's two shells shut, but apparently the swift stroke of the oystercatcher's bill paralyzes the mussel's nervous system instead.

A similar fate awaits unlucky crabs. Finding one of these, the oystercatcher flips it onto its back and kills it with a blow to the center of the nervous system. Despite its name, the oystercatcher of the Pacific Coast doesn't catch many oysters. (The region's small native oyster, *Ostrea lurida*, is not usually found in large numbers.) The Northwest bird gained its name through the activities of the American oystercatcher, found in other regions. The black oystercatcher is more apt to eat limpets, chitons, and

118

barnacles, in addition to mussels and crabs. On its rare forays to sandy beaches, it also probes about for worms.

In spring the oystercatcher's attention turns to courtship. An enamored couple can put on quite a display: the two bow to one another and take off in noisy flying chases, their loud calls ringing out over the sound of the surf. Pair bonds are long-term, and the couple often uses the same nest site year after year. The female lays two eggs in late May or June, usually in a shallow depression or on beach gravel above the high-tide line.

Because they are ground nesters, oystercatchers are especially vulnerable to beachcombers and their dogs, and to boaters who visit outcroppings and small islands. The birds are sensitive to disturbance and may abandon their nest, although they would probably attempt another clutch.

The parents take turns incubating the eggs. The returning adult, as if being thoughtful, relieves its hungry mate during low tide, when meals are easiest to find. The eggs hatch after twenty-four to twenty-nine days, and the young are able to run at three days old. Only two days later they begin feeding themselves, catching insects in their bills. Although they get off to a fast start, it will take many months before the young are truly able to take care of themselves. The oystercatcher's sneak-attack method of drilling into an animal's nervous system takes some time to properly learn. The young sometimes stay with their parents for nearly a year, ensuring that they get enough food while they're studying the proper technique.

Eventually the young oystercatchers are able to fend for themselves and leave the sheltering care of their parents. Having survived the ravens, crows, and gulls that like to snatch eggs, bumbling beachcombers, and an extended adolescence, the newly emancipated oystercatchers may live for more than thirty years. They never stray far from their birthing areas, however. Instead of migrating, oystercatchers form small flocks in winter and usually stay within thirty miles of their breeding grounds. Their redrimmed eyes may give them the look of wild party-goers, but black oystercatchers are really monogamous homebodies.

# Tidepool Sculpin

Latin name: Oligocottus maculosus Description: To about 3½ inches long; large head and front fins, body tapers to tail; not scaly; usually a mottled gray, but variable. Habitat: Rocky tide pools, exposed or protected.

mongst all the curious creatures found in a typical tide pool, there is liable to be only one that has a backbone: the tidepool sculpin, or tidepool johnny. This little fish is easy to overlook, however. At a maximum length of three and a half inches and cleverly camouflaged, it blends in splendidly with its background.

There are other sculpins and other small fish that inhabit the rocky pools, but one of the most commonly found is the tidepool sculpin. It is generally described as "ugly" because of its large head and mouth and disproportionately tapering body. Its pectoral fins (the two front ones) are relatively large and shaped like fans. The fish not only uses these to scuttle around on the bottom of the pool but can also stretch them up and sideways to make itself look more imposing or threatening. In about twenty minutes, this sculpin can change its color to blend in with a new background, becoming various shades of red, brown, green, or gray. The only

121

dark lines radiating from mouth to tentacles. In the aggregating form, more commonly seen, the disk diameter varies from about one to three inches and the tentacles are often tipped a delicate pink or lavender.

Like the giant green anemone, an individual *A. elegantissima* is either male or female and produces either sperm or eggs. These are released via the mouth and mix in the current to produce swimming larvae. But an *A. elegantissima* who finds itself alone on a bare rock has a second reproductive option: cloning. After pulling itself in opposite directions for about two days, the animal tears in half. This is a particularly fast way to fill an open space, and the anemone goes on producing exact replicas of itself (same gender, same coloration) until it runs out of room—or meets up with another *A. elegantissima* colony that has been busily cloning *it*self.

Such a meeting does not go well. After repeated jostling, war erupts between the two colonies. The anemones on the outskirts of each group prepare for battle. Special structures called *acrorhagi*, located on the upper portion of the anemone's column and loaded with nematocysts, begin to swell. In what looks to us like slow motion, a combatant rears up and clouts an enemy with its knoblike acrorhagi. The attacked anemone may choose to stand its ground and fight back, but usually it contracts as if cringing and gradually shuffles away. But there is only so far an anemone can retreat with its crowded clone family behind it. Eventually the colonies, after attack and counterattack, form a no-anemones land. This is a clearly visible strip between the two communities that was once assumed to be a pathway for snails and limpets.

Characteristics such as these demilitarized zones and the weaponwielding tentacles reveal that, despite appearances, the pretty anemone is really an animal. It may look like a demure plant, but an anemone is no shrinking violet.

### Purple Shore Crab

#### Latin name: Hemigrapsus nudus

Description: Shell of back up to 2 inches wide; predominantly purple-tinged, but may be reddish brown or green; purple-red spots on claws.
Habitat: Under rocks or scurrying around the upper tidal area; rocky beaches and some estuaries; occasionally ventures onto sandy beach, if nearby.

he right way to pick up a little purple shore crab, should you wish to do so, is to nab it quickly and firmly from behind, catching it between thumb and forefinger. The wrong way to pick up a crab is by a claw clamped onto your finger. I've done it both ways and the first is definitely preferable.

Purple shore crabs are the crabs most often encountered by ocean beachcombers and tide-pool enthusiasts. These crustaceans can spend long periods of time without direct contact with seawater, so they are often found in the higher levels of tide pools. If you don't see any scuttling around, you can often find them by lifting loose rocks (be sure to replace the rocks just as you found them). Purple shore crabs measure at best a mere two inches across their backs, and when they wave their little claws at you menacingly, its a bit like a belligerent tot hollering, "Try it—go on, I dare ya!"

But should your fingers slip when you make your move to pick up the tyke, you'll find its claws surprisingly strong. It seems ridiculous that such a little thing can cause as much pain as it does, but you don't usually laugh about it until the beast has been pried off.

If you grab it the right way, however, you'll have a chance to look it over

00

in detail; the reddish purple spots on its claws that identify it, the individual coloration, which might range from brownish red through green and purple with white splotches thrown in. The carapace (back) is shaped like a rounded rectangle, with three jagged "teeth" on the front margin.

While you've got it in hand, note the lack of hairs on its legs—this is what gives it the species name *nudus* and distinguishes it from the similar green crab. The green or mud crab (*H. oregonensis*) is usually found in mud flats, but the two crab territories overlap in gravelly, muddy areas. (In addition to its hairy legs, the green crab is usually grayish green and lacks its relation's purplish dots on the claws.) The crab's first pair of legs end, of course, in its waving pincers, and each of the other eight legs ends in a pointy hook that helps the animal get a grip on slippery rocks.

Purple shore crabs feed mostly on seaweed and other algae but also scavenge any dead animals they may come across. They are in turn eaten mostly by shorebirds and some fish. Crabs are especially vulnerable to predation when molting, which they must do throughout their lifetimes in order to grow.

Female crabs carry their eggs behind a broad flap on their undersides. The spongy egg mass is so large that it pushes the flap open and bulges out the gap. The eggs eventually hatch as larvae into the ocean. These tiny, transparent, fanciful-looking, big-eyed creatures are so unlike their parents that they were originally described as a separate species. But after a succession of molts, each looks like a miniature adult, complete with menacing little claws. Its combative spirit might really grab you.

### Chitons

#### Latin names:Katharina tunicata; Cryptochiton stelleri; Mopalia muscosa

**Description:** From 1½ inches to 14 inches long, depending on species; oval or oblong; upper surface hard, eight valves may be visible; lower surface mostly a large fleshy foot, unseen unless the creature is pried off its rock.

Habitat: Tide pools, shallow waters, and below low-tide line on rocky shores.

hitons like the West best. They are bigger and more abundant here, and there are more species along the Pacific Coast than on the Atlantic Coast-or just about anywhere else in the world. Chitons (pronounced "KI-tens") are marine snails characterized by the eight plates or "valves" that make up their shell. (The "butterfly shells" found by beachcombers are actually the valves of dead chitons.) Hard flesh called a girdle surrounds the valves and covers them to a greater or lesser extent, depending on species. This is all that is usually seen of the mollusk: it has no tentacles to extend and is often clamped so tightly to a rock it can't easily be dislodged. Its overlapping valves allow it to conform neatly to uneven surfaces. Should it be taken by surprise or by force and removed katy chiton

101

mating is a hasty affair. Both animals pull nearly out of their shells, and the male quickly deposits sperm on the female's abdomen. She later uses this to fertilize her eggs as they are laid. The female retains two degenerated appendages on the left side of her abdomen, and these "swimmerets" are used to carry the eggs. She waves the swimmerets about from time to time, drawing fresh seawater with its oxygen into her shell. Eventually the hatched young leave the protection of their mother's shell and begin their own adventures.

Different species of hermit crabs prefer specific habitats and even particular types of shells. But all spend their days trundling about in their appropriated mobile homes. And all, despite their puckish inclination to fight one another, strike most beachcombers as amusing—even charming—little crabs.

### Rockweed

#### Latin name: Fucus gardneri

Description: To 12 inches long; yellowish green to olive-green when wet; can appear almost black when dry; plant branches at regular intervals of 1 to 2 inches; prominent midrib runs down center of flattened, lobed branches; branch tips may be swollen and warty.

Habitat: Upper areas of tide pools.

e think of most seaweed as living, appropriately, in the sea, but this alga's common name of rockweed says it all. Rather than stretching up from ocean depths, it hangs from tide pool rocks in thick moist curtains. Rockweed is found along the coast and within Puget Sound; it is one of the Northwest's most common and most often seen seaweeds.

Each plant is secured to its rock by a disk-shaped holdfast. Unlike most land plants, which can photosynthesize only through their leaves, rockweed can take in the sun's energy throughout its entire body. It is a hardy seaweed, able to withstand extreme changes in temperature and salinity levels and loss of moisture each day. In fact, it holds in moisture so well that it creates a microhabitat used by small creatures who escape the heat of a sunny day beneath the plant's fronds.

There is evidence, however, that rockweed may wage a quiet sort of war against the creatures that would grow up to graze on it. The seaweed releases tannins that can kill planktonic crustaceans that land in its tide pool. As rockweed ages, its ability to create the tannins used in the chemical

114

warfare diminishes. This may allow grazers such as sea urchins to clear away the older plants, making way for a new generation of pioneer seaweed.

Rockweed doesn't share the complicated reproduction scheme of bull kelp and most other seaweeds. Its simplified version bypasses the asexual generation with its intermediate microscopic stage, and its fertilized eggs develop directly into young plants. When rockweed is mature and ready to reproduce, the tips of its fronds inflate into bulbs. These give the plant its other two common names, bladder wrack and popping wrack (when squeezed, the bulbs make a popping sound, squirting water through tiny pores). The bulbs develop small bumps, where the gametes (sex cells) are stored. Female organs each hold eight eggs, while male organs produce sperm packets, each of which contains sixty-four sperms.

As the appropriate time nears for their release, the bulbs dry and begin to shrink. The plant doesn't simply jettison the gametes into any old wavebashing tide, however. Incredibly, it waits for the daytime low tide, when the water is relatively calm. Rockweed might "recognize" daylight via its photosynthetic cells, but how it determines low tide is not yet understood. At any rate, the plant shoots its gametes into the water through tiny holes. After the gametes are released, the floating eggs secrete a pheromone that attracts the swimming sperm. These gather around the much larger egg, attach themselves, and begin to spin their way in. When one sperm manages to fertilize the egg, the rest take off in hot pursuit of another available egg. As it is carried off by the waves, the fertilized egg begins developing immediately. If it is to survive, the resulting tiny young plant must eventually be thrust up onto an appropriate spot by the waves. There it develops a holdfast and, if it escapes grazing by snails, sea urchins, chitons, and limpets, can grow to be a foot or more long.

The abundance of this alga on the Northwest Coast proves the success both of its reproductive strategy and of its coastline lifestyle. Like all seaweeds, rockweed lives its life associated with salt water—but demands it on the rocks.

### Tube Worms

Latin names: Serpula vermicularis (fan worm); Eudistylia vancouveri and Schizobranchia insignis (feather-duster or plume worms); Spirorbis spp.

Description: To 20 inches long, depending on species; visible parts of worm feathery, colorful tentacles extending from head; hard white tube or leathery tube encloses rest of body.

Habitat: Coastal shorelines; depending on species, on floats, pilings, floating docks, on shells and seaweed, on sides and undersides of rocks; in tide pools, estuaries, and offshore.

e don't usually think of worms as pretty creatures, but fan worms and feather-duster worms certainly are. Or at least the delicate, feathery portions of them that we can see are lovely. The worm sometimes called the calcareous tube worm or fan worm (*Serpula vermicularis*) builds its home from lime that it somehow extracts from seawater, creating a hard white tube that protects its soft body. The tube grows longer as the worm ages (fine rings on the shell show the gradual additions). The homes may be nearly straight or may curl or meander over rock (or whatever the animal has attached itself to). Although the tube may be as long as four inches, the worm inside maxes out

at two and one-half inches long.

117

Like its relative the common earthworm, the fan worm is pinkish or reddish-orange and segmented. Unlike the earthworm, it unfurls two gorgeous feathery tentacles, or cirri, in order to eat and breathe. The spiraling cirri, which can be brilliant red or orange and often have white bands, wave about, taking in food and oxygen. Tiny hairlike cilia on the cirri set up a rhythmic pulse that helps to pull in minute particles of food. Once the particles have contacted the cirri, they

higher or lower in the sky, with its bulge of water faithfully following it.

Our sun also exerts a gravitational tug on the tides. Although the moon is puny compared to the sun (which is millions of times larger), it has more than twice the sun's gravitational pull because it is so much closer to Earth. Twice a month (during the full and new moons), the sun, the Earth, and the moon are arrayed in a straight line in space. Then the gravitational pulls of moon and sun are also aligned, resulting in a greater difference than usual between high and low tides. These are called spring tides. And twice a month (during the moon's first and third quarters), the sun and moon form a ninety-degree angle with Earth. Now the pull of the sun somewhat negates that of the moon, resulting in less of a difference than usual between high and low tides. These are called neap tides.

That's the basic outline, but other competing influences also determine the timing and levels of a particular area's tides. These include the shape of the shoreline, the slope of the beach, the depth of the water, winds, currents, and coastal storms. In addition, inertia and friction contribute to lag time, so that spring tides generally occur two or three days after a full or new moon; likewise, there is a lag of several hours between the time the moon passes overhead and the maximum tidal effect results.

Happily, beachcombers don't have to figure out all these variables themselves. Tide tables, usually adjusted for local conditions, are available at bait-and-tackle shops, sporting goods stores, dive shops, and marinas. Tidal information is also supplied in coastal newspapers.

Although observing beach life can be enjoyable at any time, you'll see more organisms if you time your visit to match low tides, especially the low spring tides. Just remember to watch out for the inevitable return of the waves, as the enthralled bulge rolls back in your direction.

## Sand Dollar

Latin name: Dendraster excentricus

Description: About 3 inches across; nearly circular, flattened body; living animal is gray, black, brown, or purplish and covered with tiny spines; dead ones bleach white. Habitat: Coastal beaches, in sandy beds running parallel to shoreline.

hen my friend Diane visited from Ohio, she wanted to see the ocean. But when we arrived on the sandy beach that early spring day, it was a miserable place. Clammy fog and shrill wind had driven most other visitors from the beach. We gamely removed our shoes anyway and immersed our toes in the frigid water so Diane could say she'd waded in the Pacific. That accomplished, we were ready to go somewhere warm—when we spotted the sand dollars.

There were five of them, in faded shades of green and lavender. The bridesmaids' hues surprised us, especially Diane, who had seen only dead white ones. A recent storm must have carried the living sand dollars up onto the beach from their beds beyond the breakers. Diane and I picked them up for a closer look. Holding them on our open palms, we could feel their slight movement. Their undersides were covered with slowly moving short spines that looked like animated terrycloth. Using these spines, sand dollars are able to travel about and to bury themselves under sand. My landlocked friend's excitement over our unexpected find was contagious. The beach suddenly didn't feel quite so cold, and, fortified, we returned the circular animals to sand and turned into the wind for a long stroll down the beach.

The five-petaled design on the top of the sand dollar reveals its kinship to sea stars and sea urchins; all can be divided into five equal parts. Sand dollars breathe via tube feet, which they extend through holes along the

65

margins of the petals. Though its gender is not obvious to the beachcomber, a sand dollar is either a male or a female. Sex cells are released from five pores located where the five petals come together. The spawning of one sand dollar in a colony triggers the others to release clouds of sperm and eggs. A fertilized egg develops into a swimming larva, which eventually settles when it finds just the right spot and develops into an adult.

A sand dollar's mouth is on its underside, near the center. The living animal has five triangular jaws, whose tips can just be seen. If you break open the white test (exoskeleton) of a dead animal, you'll see the five little V-shaped pieces, which some people say resemble flying birds. Sand dollars eat minute particles such as diatoms and bits of detritus. They may plow through the sand, ingesting as they go, or dig partially down into the sand until they stand upright on edge. (Young sand dollars sometimes selectively ingest the heaviest sand particles to act as a sort of weight belt and help anchor them in place.) Regiments of upright sand dollars parallel the shoreline, all leaning at the same angle, in the direction of the current.

On the underside of the animal, small beating hairs on the terryclothlike spines create a slight current that draws in food particles. The particles catch on mucus exuded by the spines and flow toward the mouth via grooves. Like streams joining larger rivers, these branching grooves join larger channels that lead directly to the central mouth. These can be clearly seen on the bottom side of sand dollar tests, as can the small hole of the anus, located near the margin.

Sand dollars can sense the presence of certain sea stars and react to the enemy by burying themselves in the sand. They also do this in response to ocean storms, but as Diane and I discovered, they are sometimes washed ashore regardless. The surprising bridesmaids' colors we saw probably indicated that the animals were dying. As we walked the length of the beach, we found many more sand dollars, living and dead. When we left that day, Diane and I each carried a few of the white ones home with us, as souvenirs of a warming walk on a cold Pacific beach.

# Lewis's Moon Snail

#### Latin name: Polinices lewisii

Description: Large, rotund shell to 5 inches high, with one large whorl at base and smaller whorls making a spiral; yellowish white to brownish gray; body when extruded covers lower part of shell.

Habitat: Protected beaches, bays, mud flats, and salt marshes, especially where sand is mixed with mud; to 160 feet offshore.

or many years naturalists were puzzled by the sand-encrusted rubbery "collars" they found on the beaches. Even Jack Calvin, one of the authors of the classic seashore guide *Between Pacific Tides*, admitted to having been confounded by them. As the book points out, moon snail egg cases look like "discarded rubber plungers of the type plumbers use to open clogged drains."

Lewis's moon snails and their odd egg cases appear on sheltered Pacific Northwest beaches between April and September, especially during May and June. The sexes are separate, and fertilization occurs during copulation. The female later lays her egg case just offshore or on the intertidal

66

divers, using high-pressure hoses, can blast the animals loose from their homes at the rate of two or three per minute. Clam diggers on the beach, however, must be knowledgeable, persistent, and properly equipped to reach one of these trophies. When its siphon blasts a load of cold seawater and disappears beneath the sand, a 'duck might appear to be digging. But adult geoducks do not dig at all. The well-endowed geoduck simply contracts—and contracts, and contracts—that extravagant siphon as far as it can. Only a digger's most dogged determination will eventually reveal the meaty bivalve waiting at the bottom of up to four feet of densely packed sand and mud.

Given that, the creature's original name of *gweduc*, bestowed by the Nisqually people, is entirely logical. Before it was corrupted into nonsensical English, this favored clam was named "dig deep." Still, the ludicrous name is part of the oversized animal's charm.

Geoducks make more 'ducks without ever having to leave their deep, cozy burrows or even meet a member of the opposite sex. They simply release either eggs or sperm from their siphons and allow the current to make introductions. It's been estimated that one female geoduck produces up to fifty million eggs per year. The relatively few lucky fertilized eggs develop into swimming larvae, which metamorphose into miniature adults.

These young geoducks burrow into the substrate, digging deeper as their siphons grow longer. If they survive to the end of their second year, they are probably deep enough to be safe from most predators. As they mature and grow heavier, the size of their foot does not keep pace, and eventually the animals are as deep down as they are ever going to get. The geoducks settle in, inhaling oxygen and plankton through their snorkellike siphons, and exhaling waste as well as sperm or eggs. These outlandish animals live for one hundred and forty years—or perhaps more. Unless, of course, they are unearthed by someone intending to savor the sublime taste of my alma mater's mascot.

### Sandpipers

#### Latin name: Calidris spp.

**Description:** From 4<sup>3</sup>/4 inches to 7 inches, depending on species; different species of sandpipers share these characteristics: slender bills; winter and summer plumages differ, but colors include grays, browns, and whites and may be streaked or mottled.

Habitat: Annual visitors to Pacific Northwest sand or gravel beaches, coastal mudflats, flooded fields, marshes. Migration generally peaks mid-April to mid-May.

f you regularly walk on sandy beaches, you have already made acquaintance with little birds called sandpipers that do the same. Instead of traveling the length of the beach, however, these shorebirds tend to move up and down the slope of it, following the tidesand the food. They're Dunlin not out for a casual stroll; the sandpipers are loading up on calories during one of their stops on a marathon migration. Sanderling Sandpipers can be a bewildering lot. There are many different kinds, and Least Sandpipe they wear different feathers

76

depending on the time of year and whether they are juveniles or adults. The group contains not only birds that are *called* sandpipers, like the western and least sandpipers (*C. mauri* and *C. minutilla*), but also birds like dunlins and sanderlings (*C. alpina* and *C. alba*). An astute observer can sometimes distinguish the birds by niceties including leg color, slight curving of bills, and an inch more or less in body length. But when sandpipers are running, flying, or a bit too far away for details, it's hard to say who's who. Which is probably why birders coined the generic (and energetic) term "peep" to mean any small *Calidris* species.

The peeps sort themselves out when feeding according to slight differences in the length of their bills. Sanderlings scurry ahead of and chase after lapping waves as if they don't want to get their feet wet. They nab newly deposited or newly revealed prey off the sand or from just below the surface. The western sandpiper also goes after surface food but is willing to wade right into the water, sometimes submerging its head to feed. Dunlins are more likely to probe deeper into the sand or mud. And the tiny least sandpipers prefer foraging at the high-tide line. All these birds feed on marine invertebrates such as beach hoppers, tiny shrimp, and insects. Their differentiation in feeding strategies explains how so many similar birds can feed on the same kinds of prey without being in competition.

Marine invertebrates are offered in bulk on the Pacific Coast, and the sandpipers stop here on their transcontinental travels to load up. (Many overwinter too.) In spring the birds are all adults and sport their breeding plumage, so they are usually easier to identify. The migration time is relatively brief, but huge numbers of birds stop over in Washington and Oregon on their way from South or Central America to their Arctic nesting areas.

They fly these long distances to take advantage of insect hatches and relatively few predatory mammals on the tundra of Siberia and northern Alaska. Many sandpipers lay four eggs, which are brooded by both parents. In some cases the family remains together until the young are ready to fly. In others, like the dunlins and least sandpipers, the females leave the young

78

in the care of the father long before they fledge.

Upon the shorebirds' return to the Northwest from June onward, some are still in breeding plumage, while others have assumed their duller nonbreeding feathers. Juveniles also show up to further confuse matters. Dunlins generally don't return until late October, but they tend to stick around and are the Pacific Northwest's most common overwintering shorebird, roosting on sandy beaches throughout the winter, biding their time until low tide. During this season, you can safely assume that any large flying, flashing flocks you see are dunlins.

Sandpipers attempting to elude predators take to the air in stunning synchronized displays. A merlin or peregrine falcon will try to zero in on one single bird, so the birds' best defense is to remain solidly together as they elude capture. The flock wheels and dives, rises, spreads apart or pulls back together. Their plumage appears to blink white and dark as the birds turn their bodies from front to back. Slow-motion studies have revealed what our eyes cannot detect: rather than all the birds turning at the exact same time, the edge of the flock leads the way. Each following bird catches "the wave" in turn, quickly enough that the action appears simultaneous. Using this choreographed flight, the sandpipers manage to confound some of their predators as readily as they do many of the birders who try to identify them.

the animal's anus on the rear upper side; the rest of the body is covered with tiny bumps. The sea lemon is bright yellow to orange and speckled with black. Like most nudibranchs, it is a fussy eater and feeds exclusively on sponges.

Nudibranchs are hermaphrodites (each individual has both male and female sex organs). Some species are male when young and become female as they grow older, but most species are both genders simultaneously. When two mate, each usually gives and receives sperm. Later, each will lay eggs in coils or rippling curtainlike masses, depending on the species.

With their enticing coloration, varied shapes, and interesting sex life, nudibranchs should be far more popular than they currently are. If they just had the correct packaging (including a catchy slogan—something like "Nudibranchs: the mermaid's lapdog"), pretty little sea slugs could become the darlings of the coast.

# Sea Cucumber

#### Latin name: Parastichopus californicus

**Description:** To about 16 inches long; about 3 inches in diameter; tubular animal with prominent fleshy warts; usually dark red with orange, also brown above and yellow below. **Habitat:** Low rocky tide pools or just offshore; also on sandy bottoms in deep ocean.

ot many of the world's animals could be appropriately named after a vegetable, but the sea cucumber's name fits it nicely. A sea cucumber (some smaller species are called "gherkins") looks more like a salad bar offering than like its closest relatives, which are sea stars, sand dollars, and sea urchins.

The giant or California sea cucumber is the most common species in the Northwest, and also the largest. It moves around, when it needs to, by means of three rows of small tube feet lining its flattened underside. Other tube feet have become fleshy pointed bumps on its upper surface, and still others have been modified into feeding tentacles that surround the cucumber's mouth, located at one end of its body. These white tentacles branch and branch again into plumelike structures that are often compared to mop heads.

The mop heads wave about, collecting small organisms on their sticky mucus surfaces, or swab detritus from the sand or mud. When the oral tentacles are coated with food, the cucumber does what any child with sticky fingers would: it inserts the tentacles one by one into its mouth and scrapes off the delectable items.



These tentacles, when extended, also reveal which end of the cucumber is the front end. If the oral tentacles aren't visible, it's still possible for an attentive observer to tell which way the animal is facing because it breathes through its anus, regularly taking in big gulps of water that circulate throughout its body. The anus opens into a chamber called the cloaca, which divides into branches that reach throughout the creature. This "respiratory tree" carries oxygenated water throughout the body. A short time after sucking in the water, the cucumber forcibly expels the deoxygenated water and takes in another refreshing gulp.

The cloaca often becomes a rooming house for small creatures that enter through the sea cucumber's anus and, apparently liking the accommodations, take up residence. Various flatworms, small crabs, and snails are said to take refuge from the harsh outside world, protected from their predators and collecting their own food as it is drawn into the cucumber with each breath. Some are commensals, which do no harm to the host, while others are parasites, which in some way live off the energy of the cucumber.

Freeloaders are routinely evicted, however. For any number of reasons, a sea cucumber will eviscerate, or eject its own internal organs out of its body, usually through the anus. By contracting, the animal squeezes the water inside itself, exerting pressure that forces out the organs, including the intestine and respiratory tree. The cucumber does this in response to danger, perhaps in an attempt to entice the predator with its offal while the rest of the animal makes its getaway. But it also appears to do this seasonally, in the fall, perhaps to rid itself of internal parasites. This is also the cucumber's standard response to changes in water temperature or fouled water. The lack of internal workings doesn't seem to hinder the creature, and it regrows them within a few months.

The giant sea cucumber, like most sea cucumbers, has separate sexes. Ova or sperm are released from the mouth in large quantities. The animals probably gather together in groups to ensure a better fertilization rate. Although the swimming young are fair game for any number of hungry creatures, adult sea cucumbers seem to have few enemies. The multi-armed sunflower star might take some, and gulls have been seen eating beached cucumbers. But the animal's skin reportedly contains holothurin, a badtasting toxin that deters most potential predators.

Human palates are undeterred, however. The sea cucumber's internal muscles are considered a delicacy, especially in China and the South Seas. In meeting the demand abroad, there is concern that these creatures may be overfished in the Pacific Northwest and elsewhere. There can be no doubt that the human appetite is voracious, when it extends even to the warty, uninviting sea cucumber.

49

sea urchin mouth located on animal's underside

### Sea Urchins

Latin name: Strongylocentrotus spp.

**Description:** From 3 inches to 12 inches in diameter, depending on species; spine-covered, ball-shaped or slightly flattened animals; purple, red, or green, depending on species.

Habitat: Coastal shorelines, from exposed, wave-pounded rocks to quiet shores; different species prefer different habitats.

ea urchins, with their rounded bodies and stiffly moving spines, are more often compared to pincushions than to other animals. Even their closest relatives, sea stars and sand dollars, don't look much like them, though they share certain characteristics.

All three types of animals have many tube feet—slender appendages used for locomotion, respiration, and grabbing any food tidbits that float by. In sea urchins, the tube feet protrude randomly among the spines, over the entire body of the animal. The three cousins also have similar fivejawed chewing mechanisms used for eating, and all three have tiny, jawed pedicellariae on stalks, which are used for defense and to keep the animals clean. The pedicellariae are scattered across the sea urchins' bodies, like their tube feet. The three jaws of each pedicellaria grasp and remove the larvae of barnacles and mussels that are looking for a place they can call home. The biting pedicellariae also defend the urchin against attack from predators like sea stars. Both tube feet and pedicellariae can be regrown if they are detached.

The three relatives all have five-part radial symmetry, meaning that their internal structures are arranged around the central point of their mouths and the animal could be divided into five equal parts. This symmetry is

more obvious in five-armed sea stars and in the fivepetaled design on the tops of sand dollars than in the many-spined sea urchin.

Those spines—which can point toward an enemy or away from it, so that the pedicellariae can better rise to the attack—also get the sea urchin from one place to another. The urchin uses the spines to "walk" as if it were tippy-toeing or stilt-walking.

The Northwest's three common urchins are sensibly named according to their coloration. The green sea urchin (*S. droebachiensis*) grows to about three inches across and is usually found in calm waters from Washington northward. When the purple sea urchin (*S. purpuratus*) is young, it could be mistaken for a green urchin except that its habitat choice can give it away. Purple urchins are almost never found in quiet tide pools. Preferring strong wave action, they actually burrow into rock to help them hold on. The purples accomplish this by rasping their spines against the rock, and perhaps by using their sharp-tipped jaws as well. Because they begin this process when they are small, the opening of the resulting hole is smaller in

90

diameter than the animal that made it. As the urchin grows, it can carve itself into a hole that it can't get out of after reaching its full size of up to four inches in diameter. The surrounding rock protects the animal, and the never-ending waves deliver its food:

The red sea urchin (*S. franciscanus*) can be found in both quiet and wilder waters, and may grow to a foot in diameter. Its spines are longer than those of either the green or the purple urchin.

Male and female urchins release their sperm or eggs simultaneously. Females reportedly produce twenty million eggs in one season. The small swimming creatures that develop from the fertilized eggs are bilaterally symmetrical, but eventually they settle in an appropriate place and metamorphose into the radial symmetry of the adults.

An urchin's mouth is located in the center of its underside; its anus is in the center of its top side. The animals eat algae, seaweed, and plankton. In turn, they are eaten by some sea stars, seagulls, and people who consider urchin gonads a delicacy.

These little bundles of spines are some of the most common creatures found along Northwest shorelines. You'll find different sea urchin species on wave-swept ocean rocks than you'll discover in Puget Sound tide pools, but both places boast plenty of the small, spiky beach balls.

# Blue and California Mussels

Latin names: Mytilus trossulus (blue mussel); M. californianus (California mussel) Description: Blue mussels to 4 inches long; California mussels to more than 10 inches. Blue and black shells are a rounded, elongated triangular shape. Habitat: Blue mussels: tide pools, quieter waters inland and on coast, also associated with California mussels in wave-swept area. California mussels: wave-swept rocks on coast.

mussel larva looking for a place to settle embodies the real estate agent's maxim: the three most important considerations are location, location, and location. If the young mussel lands too high on a rock, it will die of dehydration and exposure; too low on the rock and it enters the territory most frequented by its archenemy, the sea star. Perhaps this difficulty in choosing just the right spot is the reason that the larvae are predisposed to attach themselves to already established mussels. By simply having stayed alive, the elders prove their location is a good one. But even this option has its own inherent danger. Too many mussels attaching to other mussels that are attached to the relatively few who are actually anchored to a rock can pull the whole shebang into the ocean.

But that, of course, would open up a nice patch of prime real estate for the next infant mussel that swims along. During their young and wayfaring stage, larvae are nothing like the adults. They live and feed in surface waters and are dispersed with the currents. Eventually they settle on a substrate and change into their adult form—but they can be quite choosy about where they will live and can delay maturity to continue rambling until they find the site that suits them.

Even after they are established, blue mussels (also called bay mussels and

92

Soon more of the surprisingly long, slender probes were reaching into their neighbors' shells in an attempt to release sperm before those plates snapped shut again. Because barnacles are hermaphroditic (having both female and male sex organs), an animal in the process of being impregnated might have its own penis out snaking around the neighborhood. We took copious notes during that lab class.

But you don't need a laboratory or a dissecting microscope to watch the feeding and sexual antics of barnacles. You need only a little patience and a good location where you can observe these little crustaceans underwater—while staying safely away from the waves yourself. The cirri you'll see unfurling act like a net to catch drifting plankton. When they disappear back into the shell, the minuscule food bits are scraped off into the mouth-parts, and the cirri roll out again to grab another bite.

Most barnacles hold their fertilized eggs within their shells until the larvae hatch and are released. The larvae swim away and eventually seek a place to settle. Each little creature has a sophisticated ability to sense and test the substrate in an attempt to find just the right spot. Once it attaches, it cannot relocate, so this decision is crucial to its chance of survival. Having made its choice, the larva secretes a cement from glands at the base of its first antennae and glues its head to the substrate. It then begins building the shell-like walls that will encase and protect it and from which the cirri will extend at feeding time. The nineteenth-century scientist Louis Agassiz compared those cirri with the legs of other crustaceans. He wrote that the barnacle is a shrimplike animal that stands on its head and uses its legs to kick food into its mouth. And there's nothing staid or boring about that.

### Shrimp

Latin names:Archaeomysis spp.; Heptacarpus spp.; Pandalus danae; Callianassa spp. Description: From less than ½ inch to 5 inches in length, depending on species; slender bodies; long antennae; jointed legs; may have pincers.

Habitat: Various species can be found in wave wash, sandy mud, estuaries, or tide pools.

any species of shrimp inhabit Pacific Northwest waters, and some of the most common sport lively, descriptive names such as ghost, opossum, broken-back and coonstriped shrimp. The opossums (*Archaeomysis* spp.) are not true shrimp, but they are closely related and are shrimplike. They can be found jetting about the wash zone of the waves, although you might be most apt to spot them, as my family did, after you wade into the cold waves to collect water for sandcastle making. We found many dozen of these tiny, nearly transparent creatures zipping around in my daughter's big blue bucket. They are called "opossum" shrimp because, like those mammals, the females carry their eggs in special pouches on their abdomens.

It's also sometimes possible to find opossums in a rocky tide pool, but the most common shrimp there is the broken-back (*Heptacarpus* spp.). These half-inch to inch-long shrimp can be recognized by the sharp bend in their abdomens for which they're named—if you can manage to spot one at all. Broken-backs tend to hide among strips of seaweed, blending in amazingly well with in their background. They are covered with tiny dots of many colors, and by controlling the size of these dots they can appear tinged green, white, or brown, or covered with speckles and patches of various colors. The larger coon-stripe shrimp (*Pandalus danae*) don't change color but

106

can also be hard to pick out from their seabed or eelgrass background. They can grow to five inches long and are brightly colored, with brown, red, and white stripes. The stripes earned them comparison with raccoons and led to their common name. Like other shrimp, they are fastidious little crustaceans and use specialized brushes called *setae* on their legs to groom themselves. Also like some other shrimp, coon-stripes start life as males but become females as they mature, passing through an intersexual stage at two to three years old. Because they are females for the last one to two years of their lives, all of the large specimens of this commercially important species are female.

One of the Pacific Northwest's subterranean shrimp is the ghost shrimp (*Callianassa* spp.), which grows to about three inches. It's so ghostly that its organs can be seen inside its transparent pinkish orange or pinkish gray body. This shrimp burrows industriously for two good reasons: shelter and food. It digs with its mouthparts and hauls the loose particles up to the surface in a sort of basket formed by its legs. Both sexes sport one large claw (the male's can be nearly as long as his body), which they use to push the muddy sand out of the way. Their homes can be recognized on mud flats by the small piles outside each hole. Each burrow has at least two openings and a number of side branches, with wider areas that enable the shrimp to turn around.

The ghost digs down two feet or deeper, collecting food bits to eat as it goes. In the course of its excavations, it mixes the organic debris collected on the top level down into the substrate, creating a never-ending food supply. (This dynamic mining can wreak havoc in an oyster farmer's deliberately placed cultures, however, quickly covering and destroying them.)

At the beach, you can find shrimp with big claws, minuscule ones, or none. You can find shrimp that are far-ranging and ones that are homebodies. You can find shrimp with differing habits and habitats, ones with colorful bodies and ones with colorful names. The Pacific Northwest does not scrimp on shrimp.

### Brittle Stars

Latin names: Ophiopholis aculeata (daisy brittle star); Amphipholis occidentalis (burrowing brittle star); A. squamata (small or dwarf brittle star)

Description: Central disk ½ to 3 inches in diameter, distinct from arms; five arms relatively long and thin.

Habitat: Crevices and under rocks in rocky tide pools; offshore, on sea bottom and on seaweed holdfasts.

nlike the big, bold sea stars, brittle stars are small and delicate, and more likely to be found hiding under a rock than conspicuously clinging to one. Brittle stars are not considered sea stars, and there are important differences between the closely related groups. Brittle stars lack pedicellariae, the tiny jawed stalks that keep sea stars clean of detritus. And although, like sea stars, they have small tube feet studding their undersides, the dainty brittle stars do not use



barnacles, in addition to mussels and crabs. On its rare forays to sandy beaches, it also probes about for worms.

In spring the oystercatcher's attention turns to courtship. An enamored couple can put on quite a display: the two bow to one another and take off in noisy flying chases, their loud calls ringing out over the sound of the surf. Pair bonds are long-term, and the couple often uses the same nest site year after year. The female lays two eggs in late May or June, usually in a shallow depression or on beach gravel above the high-tide line.

Because they are ground nesters, oystercatchers are especially vulnerable to beachcombers and their dogs, and to boaters who visit outcroppings and small islands. The birds are sensitive to disturbance and may abandon their nest, although they would probably attempt another clutch.

The parents take turns incubating the eggs. The returning adult, as if being thoughtful, relieves its hungry mate during low tide, when meals are easiest to find. The eggs hatch after twenty-four to twenty-nine days, and the young are able to run at three days old. Only two days later they begin feeding themselves, catching insects in their bills. Although they get off to a fast start, it will take many months before the young are truly able to take care of themselves. The oystercatcher's sneak-attack method of drilling into an animal's nervous system takes some time to properly learn. The young sometimes stay with their parents for nearly a year, ensuring that they get enough food while they're studying the proper technique.

Eventually the young oystercatchers are able to fend for themselves and leave the sheltering care of their parents. Having survived the ravens, crows, and gulls that like to snatch eggs, bumbling beachcombers, and an extended adolescence, the newly emancipated oystercatchers may live for more than thirty years. They never stray far from their birthing areas, however. Instead of migrating, oystercatchers form small flocks in winter and usually stay within thirty miles of their breeding grounds. Their redrimmed eyes may give them the look of wild party-goers, but black oystercatchers are really monogamous homebodies.

# Tidepool Sculpin

Latin name: Oligocottus maculosus Description: To about 3<sup>1/2</sup> inches long; large head and front fins, body tapers to tail; not scaly; usually a mottled gray, but variable. Habitat: Rocky tide pools, exposed or protected.

mongst all the curious creatures found in a typical tide pool, there is liable to be only one that has a backbone: the tidepool sculpin, or tidepool johnny. This little fish is easy to overlook, however. At a maximum length of three and a half inches and cleverly camouflaged, it blends in splendidly with its background.

There are other sculpins and other small fish that inhabit the rocky pools, but one of the most commonly found is the tidepool sculpin. It is generally described as "ugly" because of its large head and mouth and disproportionately tapering body. Its pectoral fins (the two front ones) are relatively large and shaped like fans. The fish not only uses these to scuttle around on the bottom of the pool but can also stretch them up and sideways to make itself look more imposing or threatening. In about twenty minutes, this sculpin can change its color to blend in with a new background, becoming various shades of red, brown, green, or gray. The only

121

constant in its coloration seems to be a small spot of white near the base of the tail, although there are also often dark or whitish saddles on its back.

Like all tide pool creatures, the sculpin is extremely tolerant of changes in the temperature, salinity, and oxygen content of its pool. The sun not only heats up a small pool, it also evaporates some water, making the remaining water saltier. Rain, on the other hand, dilutes the seawater. Despite a tide pool's apparent peaceful stability, the conditions within it can change dramatically between tidal visits.

When the tide is up, the sculpin usually leaves its home pool on feeding excursions, especially in summer. It tours around the vicinity, seeking shrimp, smaller fish, and crabs, which it captures with a short burst of speed and a quick gulp of its large mouth. By low tide, the wayfaring sculpin has returned to its home pool or a nearby one. Scientists curious about this homing behavior have determined that the fish finds its way back by smell. Sculpins high in the upper intertidal zone can be homebodies, however, rarely venturing out but simply waiting for edible goodies to be washed into their pools.

One good reason to leave home is for reproduction, which occurs from November through May. Some kind of copulation may be involved in their spawning, and a male of this type of sculpin is amply endowed with a papilla or "fish penis." The females deposit small clusters of adhesive eggs. These are green or maroon and are sometimes scattered in beds of mussels or barnacles.

In addition to sculpins, you may find two other types of fish in a tide pool. One type is blenny eels—a term that refers collectively to the pricklebacks and gunnels. These fish look like little eels and are from three to five inches long. They can sometimes be found by lifting tide pool rocks. (Whenever you move a seashore rock, whether in a pool or on the beach, it is important to the creatures surrounding it that you replace it in exactly the same position you found it.) When flushed from its hiding place, a blenny eel slithers about like a snake. The aptly named clingfish, like the blenny eels, can be found underneath rocks, especially ones with smooth undersides. The clingfish grows to about six inches and is tadpole-shaped, with a wide body and tapering tail. It attaches itself to rocks (or even your hand) with a surprisingly strong suction created by its pelvic and pectoral fins.

Looking into a tide pool, a little fish will be the sole fellow vertebrate that you're liable to find. When it comes to seashore life, invertebrates rule the pool.

123

noodles, the kelp is eaten by beach hoppers and other small scavengers. These little herbivores are not the only creatures who enjoy the taste of kelp; people sometimes gather the fresh hollow stipe of the seaweed to make pickles, and these reportedly taste excellent. The life of a bull kelp may be short, but the plant manages to get a tremendous amount of growth, reproduction, sheltering, and feeding of small animals into its one year.

### Tides

he moon does more than cast a lovely, romantic glow on the ocean. As it travels in its orbit, that hypnotic eye pulls the water toward itself, raising and lowering the pulse of tides around the world.

It's the gravitational pull of the moon that holds the ocean in sway. (That same pull also exerts its influence on the land and on other objects on the Earth's surface, including people.) As the moon passes overhead, objects are drawn toward it, and the larger and less solid the object, the more obvious this is. The immense and utterly fluid ocean responds by rising up in a massive bulge beneath the moon. As the moon travels, the location of the bulge shifts to follow it. This heaping of water is undistinguishable in the open ocean, but reveals itself as high tide at the shoreline.

So far, so good. But consider that there are *two* high tides a day (as well as two low tides). As the moon pulls the water on one side of the Earth, a similar bulge occurs on the opposite side (scientific explanations for that second bulge differ, but have to do with the Earth's centrifugal force or the Earth's own attraction to the moon). At any rate, as the planet rotates on its axis, the coast experiences both of the high tides as well as the low tides situated between them (the extra water that goes into the high tide bulges has to come from somewhere—it is drawn from the areas of low tide).

But not all tides are created equal. One high tide is higher than the other, and one low tide lower than the other. The levels of the tides also vary from day to day because the tilt of the Earth's axis results in the moon traveling

63

higher or lower in the sky, with its bulge of water faithfully following it.

Our sun also exerts a gravitational tug on the tides. Although the moon is puny compared to the sun (which is millions of times larger), it has more than twice the sun's gravitational pull because it is so much closer to Earth. Twice a month (during the full and new moons), the sun, the Earth, and the moon are arrayed in a straight line in space. Then the gravitational pulls of moon and sun are also aligned, resulting in a greater difference than usual between high and low tides. These are called spring tides. And twice a month (during the moon's first and third quarters), the sun and moon form a ninety-degree angle with Earth. Now the pull of the sun somewhat negates that of the moon, resulting in less of a difference than usual between high and low tides. These are called neap tides.

That's the basic outline, but other competing influences also determine the timing and levels of a particular area's tides. These include the shape of the shoreline, the slope of the beach, the depth of the water, winds, currents, and coastal storms. In addition, inertia and friction contribute to lag time, so that spring tides generally occur two or three days after a full or new moon; likewise, there is a lag of several hours between the time the moon passes overhead and the maximum tidal effect results.

Happily, beachcombers don't have to figure out all these variables themselves. Tide tables, usually adjusted for local conditions, are available at bait-and-tackle shops, sporting goods stores, dive shops, and marinas. Tidal information is also supplied in coastal newspapers.

Although observing beach life can be enjoyable at any time, you'll see more organisms if you time your visit to match low tides, especially the low spring tides. Just remember to watch out for the inevitable return of the waves, as the enthralled bulge rolls back in your direction.

# Sand Dollar

#### Latin name: Dendraster excentricus

Description: About 3 inches across; nearly circular, flattened body; living animal is gray, black, brown, or purplish and covered with tiny spines; dead ones bleach white. Habitat: Coastal beaches, in sandy beds running parallel to shoreline.

hen my friend Diane visited from Ohio, she wanted to see the ocean. But when we arrived on the sandy beach that early spring day, it was a miserable place. Clammy fog and shrill wind had driven most other visitors from the beach. We gamely removed our shoes anyway and immersed our toes in the frigid water so Diane could say she'd waded in the Pacific. That accomplished, we were ready to go somewhere warm—when we spotted the sand dollars.

There were five of them, in faded shades of green and lavender. The bridesmaids' hues surprised us, especially Diane, who had seen only dead white ones. A recent storm must have carried the living sand dollars up onto the beach from their beds beyond the breakers. Diane and I picked them up for a closer look. Holding them on our open palms, we could feel their slight movement. Their undersides were covered with slowly moving short spines that looked like animated terrycloth. Using these spines, sand dollars are able to travel about and to bury themselves under sand. My landlocked friend's excitement over our unexpected find was contagious. The beach suddenly didn't feel quite so cold, and, fortified, we returned the circular animals to sand and turned into the wind for a long stroll down the beach.

The five-petaled design on the top of the sand dollar reveals its kinship to sea stars and sea urchins; all can be divided into five equal parts. Sand dollars breathe via tube feet, which they extend through holes along the



### Waves

wenty-four hours a day, every day of the year, waves relentlessly march toward the shore to die. They are such an expected phenomenon that, even as you watch row after row stomping in and throwing themselves against the rocks or onto the beach, it might never occur to you to wonder where they come from.

Ocean winds generate these regimented waves, and the waves are unceasing because the winds are unceasing. Small waves will dissipate before ever meeting land, but larger waves brewed by storm winds can travel thousands of miles before reaching shore. The harder the winds blow and the longer the distance they blow over, the larger are the waves they generate. Because the Pacific Ocean is larger than the Atlantic, with wider stretches of open water, its wavés are generally larger than those of the Atlantic.

Unless a wave is breaking, it doesn't actually move much water. Once you swim out past the breakers, an incoming swell will lift you up and down rather than bearing you directly back to the shore. This is because the motion within a swell on open water is more of a circular movement than a forward one. Although the wind begins to push the surface water forward, as the resulting swell gains height, gravity forces it back down. The water of the swell plunges below the surface, where it is shoved upward by water pressure—and so completes its circular route.

But a wave near shore encounters friction from the sea bottom. As the base of the wave drags against the sea bottom, the top of the wave contin-

ues to hurtle forward and begins to crest and break—it's almost as if the wave trips on the sea bottom in its rush toward shore. The wave breaks when the depth of the water it enters is about one and one-third times the height of the wave. A four-foot wave will break where the water is about five and a quarter feet deep. A large wave can break far offshore, creating smaller waves that break again as they near the shore. Noting where waves break can tell you the topography of the sea bottom just offshore. Waves consistently breaking at a particular spot offshore indicate a reef or some other raised area. An area lower than the surrounding seabed is revealed where waves are able to rush closer to shore before breaking.

The highest wave ever measured off the Northwest coast was ninety-five feet high, but circumstantial evidence suggests that the Pacific has delivered even higher waves here. During a winter storm that battered the Tillamook Rock lighthouse near the mouth of the Columbia River, a rock weighing more than a hundred pounds was hurtled through the roof of the lightkeeper's house, located one hundred feet above the water. The wave that threw the rock may have been one hundred and twelve feet high.

In addition to being created by ocean winds, huge waves can be generated by earthquakes or volcanic eruptions that shake the water and generate tsunamis ("soo-NAH-mees"), also known as "tidal waves" (a misnomer, since they are not associated with tides). A tsunami can pass unnoticed under a ship at sea yet rear up one hundred feet when it eventually reaches shallow water.

But the vast majority of the waves that reach the Pacific Northwest coastline are simple swells created by storms at sea. And they'll keep right on dashing themselves against our shores for as long as the winds do blow.

6

warfare diminishes. This may allow grazers such as sea urchins to clear away the older plants, making way for a new generation of pioneer seaweed.

Rockweed doesn't share the complicated reproduction scheme of bull kelp and most other seaweeds. Its simplified version bypasses the asexual generation with its intermediate microscopic stage, and its fertilized eggs develop directly into young plants. When rockweed is mature and ready to reproduce, the tips of its fronds inflate into bulbs. These give the plant its other two common names, bladder wrack and popping wrack (when squeezed, the bulbs make a popping sound, squirting water through tiny pores). The bulbs develop small bumps, where the gametes (sex cells) are stored. Female organs each hold eight eggs, while male organs produce sperm packets, each of which contains sixty-four sperms.

As the appropriate time nears for their release, the bulbs dry and begin to shrink. The plant doesn't simply jettison the gametes into any old wavebashing tide, however. Incredibly, it waits for the daytime low tide, when the water is relatively calm. Rockweed might "recognize" daylight via its photosynthetic cells, but how it determines low tide is not yet understood. At any rate, the plant shoots its gametes into the water through tiny holes. After the gametes are released, the floating eggs secrete a pheromone that attracts the swimming sperm. These gather around the much larger egg, attach themselves, and begin to spin their way in. When one sperm manages to fertilize the egg, the rest take off in hot pursuit of another available egg. As it is carried off by the waves, the fertilized egg begins developing immediately. If it is to survive, the resulting tiny young plant must eventually be thrust up onto an appropriate spot by the waves. There it develops a holdfast and, if it escapes grazing by snails, sea urchins, chitons, and limpets, can grow to be a foot or more long.

The abundance of this alga on the Northwest Coast proves the success both of its reproductive strategy and of its coastline lifestyle. Like all seaweeds, rockweed lives its life associated with salt water—but demands it on the rocks.

### Tube Worms

Latin names: Serpula vermicularis (fan worm); Eudistylia vancouveri and Schizobranchia insignis (feather-duster or plume worms); Spirorbis spp.

Description: To 20 inches long, depending on species; visible parts of worm feathery, colorful tentacles extending from head; hard white tube or leathery tube encloses rest of body.

Habitat: Coastal shorelines; depending on species, on floats, pilings, floating docks, on shells and seaweed, on sides and undersides of rocks; in tide pools, estuaries, and offshore.

e don't usually think of worms as pretty creatures, but fan worms and feather-duster worms certainly are. Or at least the delicate, feathery portions of them that we can see are lovely.

The worm sometimes called the calcareous tube worm or fan worm (*Serpula vermicularis*) builds its home from lime that it somehow extracts from seawater, creating a hard white tube that protects its soft body. The tube grows longer as the worm ages (fine rings on the shell show the gradual additions). The homes may be nearly straight or may curl or meander over rock (or whatever the animal has attached itself to). Although the

117

tube may be as long as four inches, the worm inside maxes out at two and one-half inches long.

Like its relative the common earthworm, the fan worm is pinkish or reddish-orange and segmented. Unlike the earthworm, it unfurls two gorgeous feathery tentacles, or cirri, in order to eat and breathe. The spiraling cirri, which can be brilliant red or orange and often have white bands, wave about, taking in food and oxygen. Tiny hairlike cilia on the cirri set up a rhythmic pulse that helps to pull in minute particles of food. Once the particles have contacted the cirri, they

are conveyed via mucus and cilia to the creature's mouth.

Another cirrus plume has been modified to a funnel shape that is often compared to a golf tee. If the tube worm senses danger, it snaps back into its shell and this golf tee is the last cirrus to retract. The tee is an operculum, or lid, that seals the worm inside. The operculum is as red as the rest of the cirri, so each closed tube-worm home seems to be sealed off with a little bright-red door.

Relatives called feather-duster or plume worms (*Eudistylia vancouveri* and *Schizobranchia insignis*) live in leathery or parchmentlike tubes. These live in much the same way as do fan worms, but they can grow much larger. The tube of *E. vancouveri* can be twenty inches long, sprouting flowerlike cirri that measure two inches across. Their cirri can be white to green to deep maroon or purple.

Another worm, known as *Spirorbis*, is less impressive, but only because of its small size. These worms are more easily overlooked, although they are quite common. They build their homes in tiny, tight spirals about a tenth of an inch or less in diameter, and they favor out-of-the-way places like the undersides of rocks or seaweed. Like the other tube worms, *Spirorbis* has brightly colored red cirri. One of the ways in which it differs from other tube worms is in its sex life. Most tube worms are either male or female and, in season, send out sperm or eggs to mingle and fertilize in the water (although some species brood the young in the female's tube). But *Spirorbis* is both male and female simultaneously. Curiously, the front part of its abdomen is female, while its posterior end is male. In some species, the operculum has a special cavity that serves as a brood pouch for larvae.

The beaches and waters of the Pacific Northwest are squirming with all kinds of worms. The Northwest hosts so many species that guidebooks dedicated to worms alone could be written. But of all the worms you're likely to run into, surely some of the loveliest and most graceful are the tube worms who daily perform their food-gathering fan dances.

## Black Oystercatcher

Latin name: Haematopus bachmani

Description: To 18 inches; long orange-red beak; yellow eye surrounded by red ring; dark plumage; pinkish legs.

Habitat: On rocky shores and islands; rarely on sandy and cobble beaches.

irds that dine on shellfish have developed a variety of ways to get to the encased meaty bits. Scoters simply swallow a mussel whole and let their muscular gizzards do the work; gulls take a clam up into the air and drop it on a rock to crack it open. Black oystercatchers rely on sneak attacks.

The long-beaked shorebird strolls along the rocky coast, or sometimes wades in water up to its belly, looking for any mussel that has opened its shell slightly to breathe and feed. Finding a mussel in this vulnerable position, the oystercatcher abruptly thrusts its bright, chisel-like beak between the mollusk's shells. It was long thought that the bird severed the strong muscles that clamp the mollusk's two shells shut, but apparently the swift stroke of the oystercatcher's bill paralyzes the mussel's nervous system instead.

A similar fate awaits unlucky crabs. Finding one of these, the oystercatcher flips it onto its back and kills it with a blow to the center of the nervous system. Despite its name, the oystercatcher of the Pacific Coast doesn't catch many oysters. (The region's small native oyster, *Ostrea lurida*, is not usually found in large numbers.) The Northwest bird gained its name through the activities of the American oystercatcher, found in other regions. The black oystercatcher is more apt to eat limpets, chitons, and

118