

SEARCHING SEA HABITATS



The Rocky Shore



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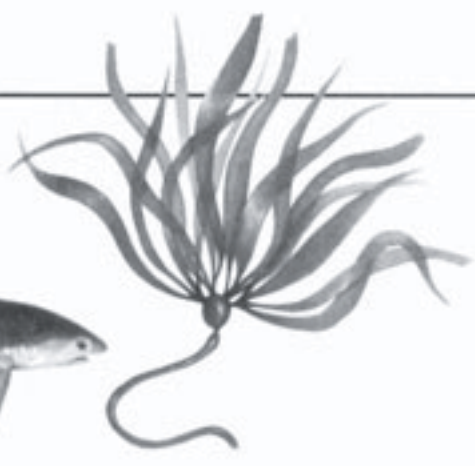
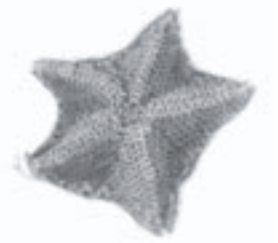
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THE ROCKY SHORE

FIELD NOTES

What Is the Rocky Shore?

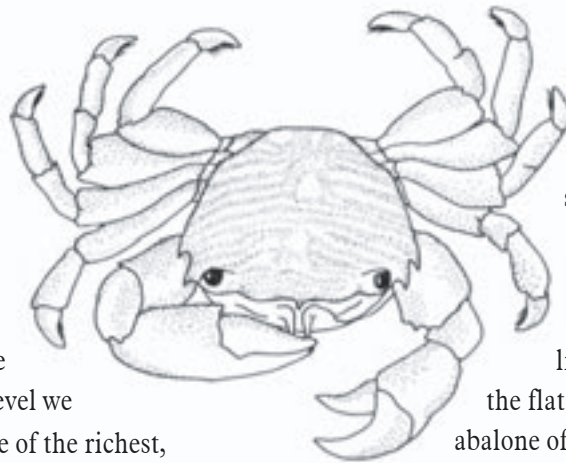
The rocky seashore is an ideal place to investigate the mysteries of the sea. The regular rise and fall of sea level we call the tides has created one of the richest, most variable environments in the ocean.

The narrow fringe of land and sea between the lowest and highest tidemarks is called the intertidal. During low tide, you can explore the seafloor; no other marine habitat is as accessible. Because of this, the rocky intertidal is the most thoroughly studied, best-known ocean area.

Wave force

Waves batter the rocky intertidal. During storms, a wave can hit the shore with the force of a car going 90 miles per hour. To protect themselves from being smashed by waves or torn from rocks, plants and animals here hold on, lie flat, bend with the waves or hide.

Many intertidal animals hold on tight to avoid being swept away. Snails and chitons have a strong, muscular foot. Sea stars have thousands of tiny tube feet with suction-cup ends. Mussels anchor themselves by gluing threads to the rocks; seaweeds have strong, rootlike holdfasts that cling to the rocks.



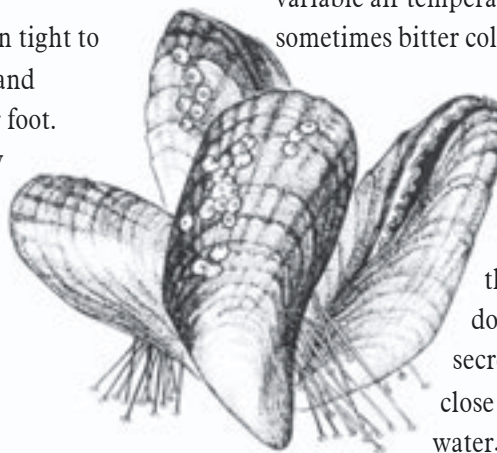
Lined shore crab

Body shape and structure help plants and animals survive crashing waves. The Chinese-hat shape of limpets and barnacles and the flat shape of chitons and abalone offer little resistance to the water rushing past. Snails, crabs, barnacles and mussels have strong shells to protect them. Flexible anemones bend rather than break; seaweeds, too, are smooth, strong and flexible.

Many animals escape the waves by hiding under plants, among other animals or between and under rocks. Crabs crawl into rock crevices and small, delicate animals like brittle stars hide under rocks or in mussel beds and kelp holdfasts.

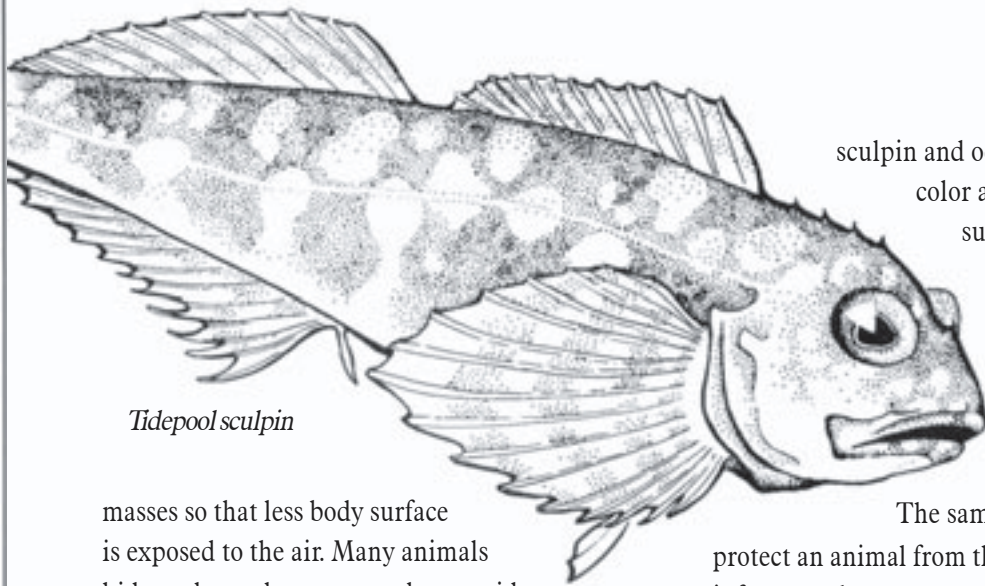
Air exposure

Air exposure also creates problems for intertidal creatures. Falling tides expose them to highly variable air temperatures: sometimes hot, sometimes bitter cold.



California mussels

Plants and animals left out of water must find ways to keep from drying out. To cope, some snails draw into their shells and seal them with doorlike operculums; some also secrete a mucous seal. Mussels close their shells tightly to retain water, and anemones gather in



Tidepool sculpin

masses so that less body surface is exposed to the air. Many animals hide under rocks or seaweeds to avoid drying out.

Seaweed are layered on rocks with upper layers shielding the lower layers so only a few plants are exposed. Some seaweeds can dry out completely, rehydrating when the tide returns.

At low tide, creatures submerged in tide pools may face low oxygen levels and widely fluctuating salinity. On warm days, evaporation raises salt concentrations, on rainy days, salt concentrations are lowered.

Competition and defense

To survive in the crowded intertidal, plants and animals must compete for space. Animals also need strategies to avoid being eaten. While the armorlike shells of crabs, barnacles and snails help protect them from predators, sea urchins and some intertidal fishes have spines. Other animals here are camouflaged like rocks and seaweeds; they're practically invisible. The tidepool

sculpin and octopus can change color and pattern to match their surroundings. And the decorator crab plants a garden of seaweeds, sponges and other sessile (attached) creatures on its back to escape detection.

The same refuges that help protect an animal from the waves also protect it from predators.

People and the rocky shore

Intertidal creatures can survive harsh conditions, but not human carelessness. In the past, people collected animals by the bucketful. Now, strict laws govern the collecting of plants and animals in the intertidal. If you visit, do your part to preserve the community: turn each rock back, and leave everything as you find it.



Red octopus

Zonation

The intertidal can be divided into horizontal bands based on the length of time each is exposed to the air.

The **spray zone** is out of the water almost all the time, covered completely only during the highest of high tides. Few plants and animals can survive such harsh conditions. The plants and animals that do live here need the saltwater spray that wets this zone, but most of them couldn't survive long being submerged.



The **high-tide zone** is out of the water most of the time and completely covered only during high tides. Creatures here also tolerate long air exposure. Some of them would prefer living the lower-stress life in the lower intertidal, but they'd either get eaten or couldn't compete for space.



The **mid-tide zone** is usually covered and uncovered twice each day. The great variety of plants and animals living here spend more time under water than exposed.



The **low-tide zone** is exposed to the air only for a few hours each month during minus tides. Many plants and animals can't live in a higher tide zone because they can't tolerate much exposure.



The Tides of History

Tides, the regular rise and fall of the water along the ocean's shores, have intrigued people for a long time. Early Greeks noticed that the tidal cycle was tied to the phases of the moon. However, it wasn't until 1687, when Isaac Newton stated the laws of gravity, that a cause was discovered for this effect: the moon's gravity reaches out and pulls the ocean's water toward itself.

Forces creating the tides

Three major forces shape the tides. The moon pulls out a tidal bulge of water on the moonward side of the Earth. On the other side of the Earth, an equal and opposite bulge is created as the moon's gravity is less on the water than it is on the Earth (Figure 1). The sun's gravity also affects the tides, but because the sun is so far away, it pulls with only about half the moon's force.



Figure 1

The two bulges on opposite sides of the Earth are like two giant waves of water that travel across our seas. The bulges cause the world's high tides; the low-water troughs between them cause low tides. A viewer in space would notice that the bulges remain fixed in their relationship to the

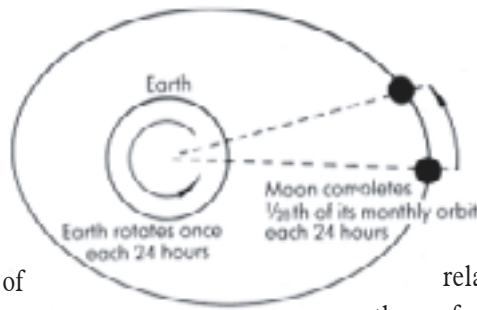


Figure 2

moon, but the Earth rotates beneath them. Because the earth moves relative to the bulges of water, those of us on dry land see the high water come and go as tides.

Tidal patterns

A given point on the Earth rotates beneath two tidal bulges each day. In theory, this causes two high and two low tides each day, but things aren't really so simple. As the Earth rotates, the moon is also traveling in its 28-day orbit of the Earth (Figure 2). Each day the Earth's rotation lags behind the moon's by about 50 minutes. For this reason, both moonrise and the tidal cycle start 50 minutes later each day. Tides cycle in a lunar day instead of our familiar solar day.

Tides vary in their height from day to day, due in part to the sun's influence (Figure 3). When the sun and moon line up (during a full or new moon) their gravitational pulls combine. This

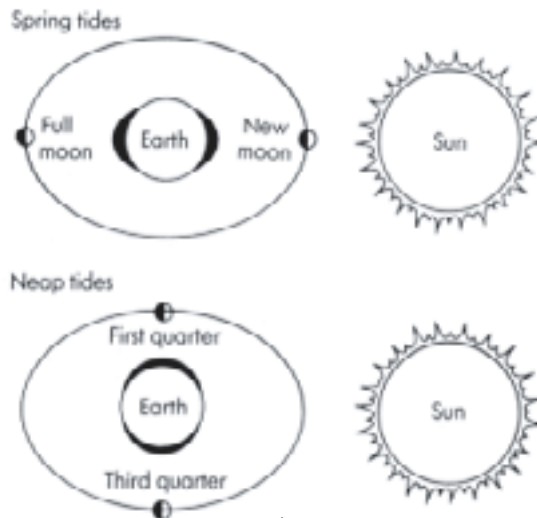


Figure 3

THE ROCKY SHORE FIELD NOTES



creates extreme high and low tides called spring tides (as in water that “springs up”).

Figure 5

(call it Monterey) will pass beneath the deepest part of the first tidal bulge, but just catch the edge of the second one.

When the sun and moon are at right angles to each other, during first and third quarters of the moon, their pulls tend to cancel each other. This produces neap tides, where the range between high and low tides is the slightest.

In all, about 400 different factors combine to determine our tides. Local tide tables, available in bait shops and marine supply stores, use all these factors to predict tidal times and heights.

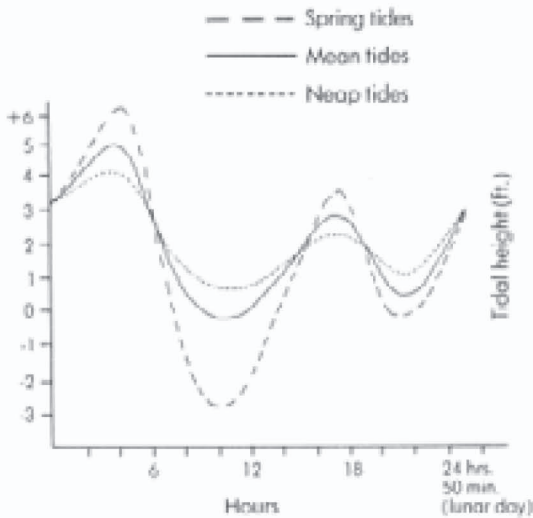


Figure 4

Tidal patterns also depend on where you are in the world. Along the western coast there are two tides daily, one more extreme than the other—a “mixed semi-diurnal” pattern. Another orbital oddity accounts for this pattern: the moon doesn’t circle directly above our equator.

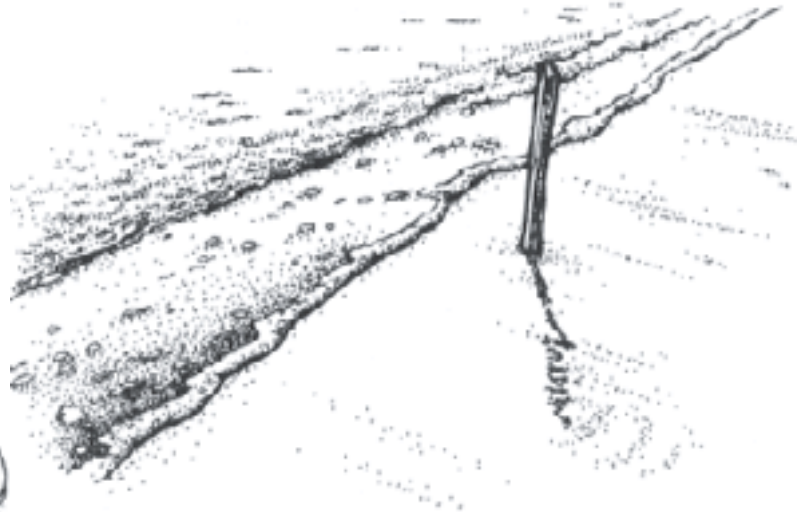
The illustration (Figure 5) shows how this affects our tides. In the course of the day shown, Point A

Marine life and the tides

Marine plants and animals that live close to the intertidal shore must cope as the tide comes and goes. Some species can stand exposure to air better than others; they commonly live higher along the shore than do more sensitive species. Such distribution patterns have led biologists to break the intertidal into zones, with predictable types of plants and animals living in each. Local biologist Ed Ricketts (“Doc” of John Steinbeck’s *Cannery Row*) proposed such a system for this coast in his 1939 book, *Between Pacific Tides*. He called the highest, driest zone, which is wetted only by sea spray and occasional wave splash, Zone I. Tides regularly cover and uncover Zones II and III, while Zone IV is exposed to the air only during the lowest of tides.

The ability of a plant or animal to withstand the force of crashing waves or avoid predators also plays a part in where it settles. But the ebb and flow of the tides, more than anything else, sets the pattern of life along our coast.

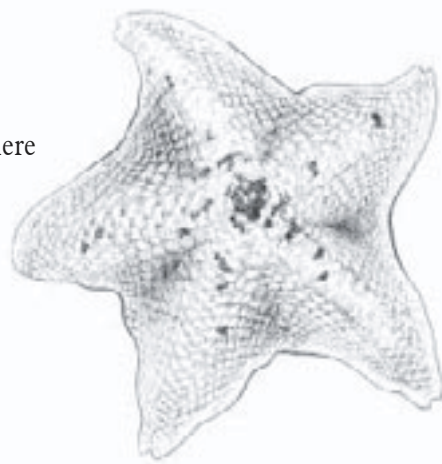
A Trip to the Sea



If you're planning a trip to the sea, make a rocky shore journal to bring with you. Before you go, record with words and drawings what you expect to find at the seashore and what you'd like to see while you're there. Then when you're at the seashore, record what you do find. How do your lists compare?

Hold on tight!

At the seashore, find an animal where the waves splash. Did you get splashed? Watch the animal closely. How does it hold on when the waves crash on it? How do other tide pool animals hold on?



When the tide turns

Count the number of seconds between waves. Does the number change? Count seven waves, then put a stick in the sand to mark the wave's furthest point. Play for awhile at the beach, then return later to see where your stick is. Is it under water? Do the waves reach it? What happened?



YOUR TRIP
TO THE
SEASHORE
is a visit to the
home of many,
many plants and
animals. Treat them
gently, with kindness
and respect; and
leave them in their
homes as you find
them.

Living with the Tides



MATERIALS

- Papier-mâché and chicken wire or large chunks of foam
- Paint and paint brushes
- Pictures or drawings of tide pool plants and animals

Turn one corner of your room into a tide pool (or you can use a large cardboard box, if you'd like). Build rocks out of papier-mâché or foam and paint them. (Or you can make rocks from pillows, rolled-up towels and small cardboard boxes.)

Hang pictures of your favorite animals in the

habitat. Then invite others to visit your tide pool. On the first visit, tell them they can collect animals; on the second visit, they can't. Compare how the tide pool looks each time. Which tide pool would you like to visit again? Why? What happens to your tide pool when you move rocks? What happens when you leave litter?



Sometimes Wet, Sometimes Hot!



MATERIALS

- Tide table (from a local bait shop, sporting goods store or dive shop)
- Several sheets of graph paper
- Pencil

Learn to read the tide table by using the directions in the table. Graph the tides (horizontal X-axis = time of day, vertical Y-axis = height of tide) for either a week or a month. On each sheet of paper, graph a different day.

Now check your tide table or look in your newspaper to see the different moon phases.

Record on each graph the moon's phase for that day. Tape the graphs together around the wall of

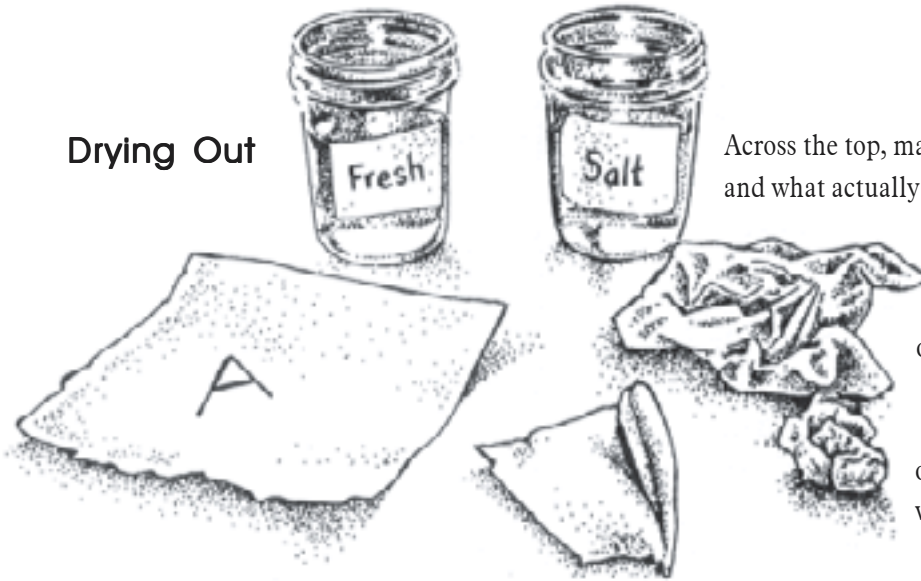
your room for a continuous record. How does the moon's phase relate to the tide? What is the best time and date to go tide pooling?

At low tide, animals are exposed to the drying air and warming sun.

THE ROCKY SHORE

SEARCHING FOR MORE

Drying Out



Across the top, make two columns: your guess and what actually happens.

Now leave your pieces for one hour, six hours and one day. Compare the different pieces to the shapes of tide pool animals. Are any of your pieces similar to the way an animal finds cover at the seashore? Which of your

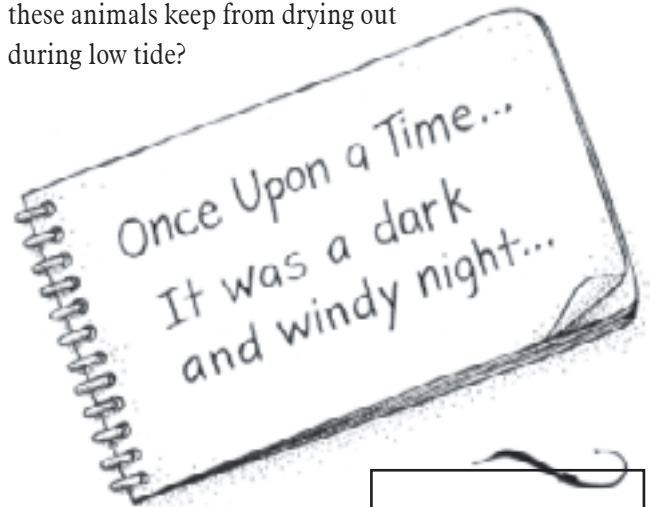
towel pieces is like a seaweed? Which one is like a barnacle, a sear star, a mussel? How do these animals keep from drying out during low tide?

MATERIALS

- One cup of fresh water
- One cup of salt water (one tablespoon of salt in one cup of water)
- Several sheets of paper towels
- Two or three sandwich-size plastic bags
- Crayon or pencil

Tear each sheet of paper towel into four pieces. Using the crayon or pencil, give each piece a different number or letter. Now experiment with folding the pieces into different sizes and dipping them in the fresh or salt water. Wad up some pieces into tight balls, fold some once, fold some a few times and fold some not at all. Dip

some in the fresh water and some in the salt water. Place some in the plastic bags and leave some exposed to the air. Leave some in a sunny spot and some in the shade. Now, take a guess. . . what do you think will happen? Which ones will dry the fastest? Which will dry the slowest? Make a chart to record your experiments. Going down the left side of your paper, list what you did to the paper towel.



Pick a rocky shore animal and write a story about its life from the animal's point of view. What happens when a wave comes crashing in? How does it protect itself from waves? How does it keep from drying out? How does it find and catch food? What happens when a predator approaches? Who does it meet when the tide is high? Who does it meet during low tide?

MATERIALS

- Paper
- Pen or pencil

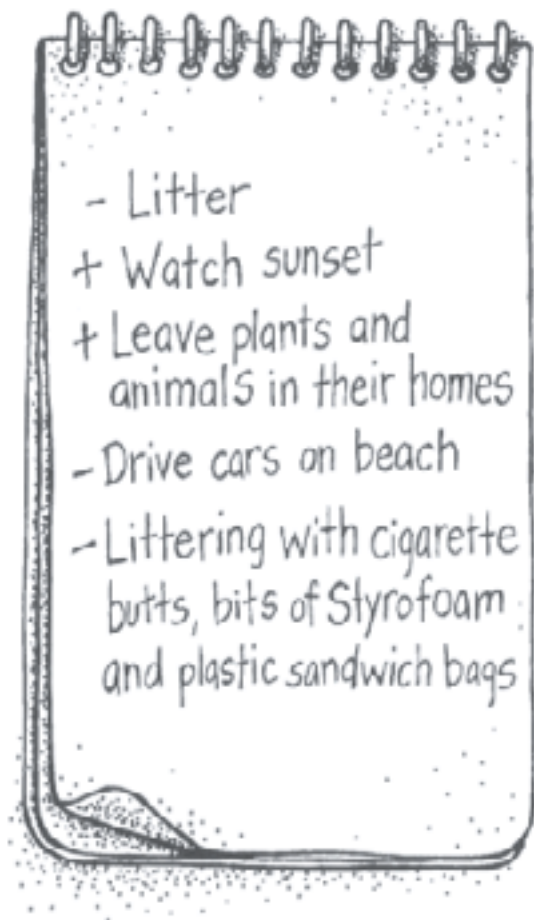
What Do You Think?



MATERIALS

- Paper
- Pen or pencil

Make a list of the different ways people use the shore. Place a (-) by the uses you feel have a negative effect on shoreline communities and a (+) by those you feel have a positive effect. Compare your results. How could negative effects be eliminated? What can you do to help eliminate them?



News Bulletin



MATERIALS

- Bulletin board
- Current magazines and newspapers

Make a bulletin board titled "Shorelines in the News." Post current news articles on storms, fishing, sand castle contests, seaside development, oil spills, surfing and other events or issues.

Tide Pool Coloring Sheet



MATERIALS

- Your favorite coloring tools - markers, colored pencils, watercolors or crayons
- Pen or Pencil

The following page is a coloring sheet. If you'd like, make copies of it first so you can color it many different times - and many different ways. Go nuts!

THE ROCKY SHORE
SEARCHING FOR MORE



Critter Cards - Rocky Shore



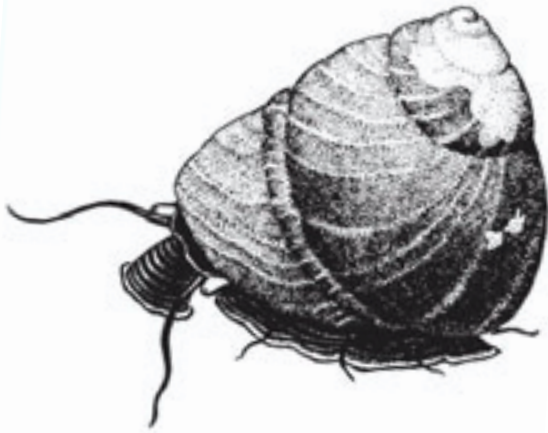
Barnacle

Barnacle

Balanus glandula [size: to 1 in. (2.5 cm)]

A young barnacle cruises at sea during its first weeks. When it's ready to settle down, the barnacle glues its head to a rock. Once attached, it changes into a juvenile barnacle, a miniature of an adult. Then each builds its own fortress—an odd-shaped limestone shell with a trap door in the ceiling. As sea water rushes by, the barnacle's legs kick bits of food down into its mouth.

Its shell closes tight at low tide, so the barnacle stays moist. It makes a juicy meal for a shorebird with a prying beak.



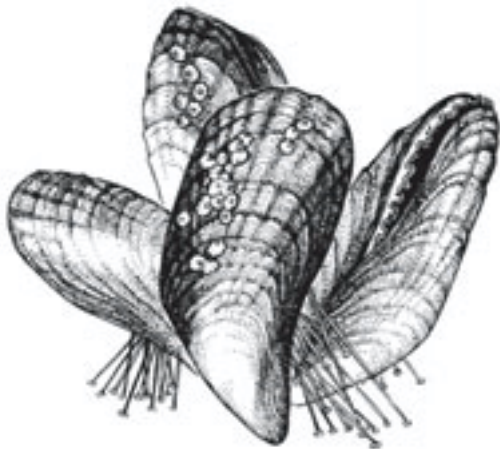
Brown turban snail

Brown turban snail

Tegula brunnea [size: to 1 in. (2.5 cm)]

At low tide, the brown turban snail stays under water or low on the shore. The turban snail scrapes algae with its filelike tongue, or radula. One lick from this snail can leave scrape marks on kelp.

If a wave flips a snail upside-down, it can pick up pebbles with its foot. By rolling with the added weight, the snail can turn right-side-up again.



California mussel

California mussel

Mytilus californianus [size: to 5 in. (13 cm)]

Mussels crowd together on wave-swept rocks. To hang on to the rocks and each other, mussels make strong threads that look like plastic and stick better than superglue.

A mussel eats by filtering tiny plants and animals from the water. To collect enough food to survive, a mussel has to filter two to three quarts of water an hour.

Critter Cards - Rocky Shore



Hermit crab

Hermit crab

Pagurus samuelis [size: to 1 in. (2.5 cm)]

A hermit crab wears an empty snail shell to protect its soft body. The back legs hold the shell on tight. As the crab grows, it needs bigger shells. One hermit crab will even steal a good shell from another crab.

Though a hermit crab threatens and fights with its large claws, it's not a hunter. This crab eats seaweeds and dead animals.



Lined shore crab

Lined shore crab

Pachygrapsus crassipes [size: to 2 in. (5 cm)]

The shore crab dances sideways down to the sea and then back up over the rocks. Using tiny cups on its pincers, the crab scrapes small plants off the rock to eat.

This crab is so flat, it can hide in cracks in the rocks. If a hungry gull grabs the shore crab's leg, the crab can shed the captured limb and dash away. In time, a new leg will grow back.



Ochre star

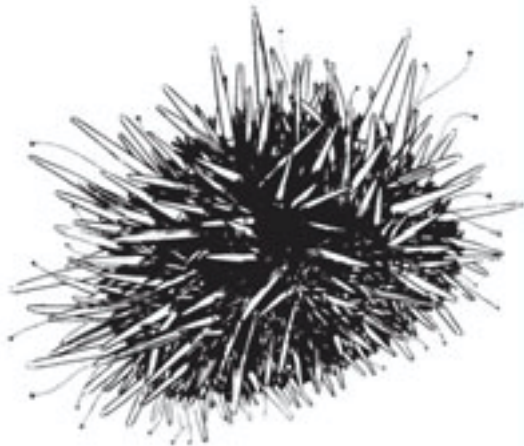
Ochre star

Pisaster ochraceus [size: to 1 ft. (30 cm)]

This sea star has hundreds of tiny suction-cup feet under each arm that help it stick to rocks. The sea star is a real loafer; it clings motionless on a rock for weeks.

Even a hungry sea star isn't hasty. Slow and steady, its feet can pry apart a mussel. When the mussel's two shells open, the sea star slides its stomach between the shells to digest the animal inside.

Critter Cards - Rocky Shore



Purple sea urchin

Purple sea urchin

Strongylocentrotus purpuratus [size: to 4 in. (10 cm)]

Using their spines and teeth, urchins burrow slowly into solid rock. Because they grow as they dig, some end up trapped in holes, too big to leave.

Between the hard spines, an urchin has hundreds of tube feet. Its soft tube feet are always busy: some hold the urchin onto the rock; others move kelp to the urchin's greedy mouth.



Red octopus

Red octopus

Octopus rubescens [size: to 20 in. (50 cm)]

Like magic, this octopus can change its color and shape in a flash. It can also squeeze through small holes to hide in caves or under rocks.

A hiding octopus keeps out of danger. And a quick armful of suckers can surprise a crab or fish. The octopus's body is soft except for a parrotlike beak that's sharp enough to kill and tear up food.



Sea anemone

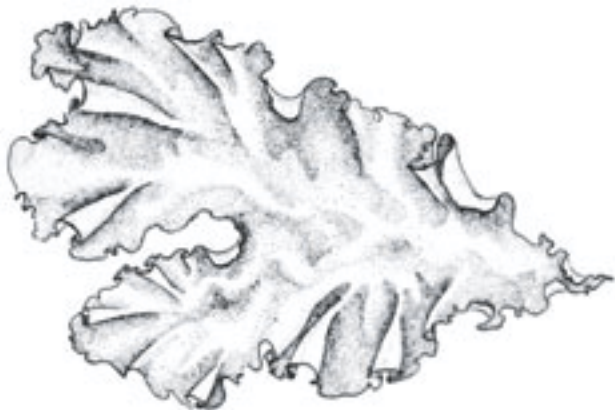
Sea anemone

Anthopleura elegantissima [size: to 10 in. (25 cm)]

The sea anemone looks like a flower on a thick, bumpy stalk, but it's really an animal. The flowery parts are tentacles with stingers. The stingers zap small animals that get too close; then the anemone swallows them whole.

At low tide, the anemone closes up. Bits of shell stuck to the bumpy flesh help keep the sea anemone from drying out.

Critter Cards - Rocky Shore



Sea lettuce

Sea lettuce

Ulva sp. [size: to 8 in. (20 cm)]

Sea lettuce is as green as lettuce from land, but it's only two cell-layers thick. Although it's thin and fragile-looking, sea lettuce can survive pounding waves and drying sun.

These plants quickly overgrow bare rocks. Just as quickly, sea lettuce is gobbled up by snails and crabs.



Sea slug

Sea slug

Phidiana crassicornis [size: to 3 in. (8 cm)]

This blue-and-orange sea slug is a cruel beauty. It tastes terrible and it has stingers. Maybe the bright colors warn other animals, "Don't mess with me!"

This sea slug eats all kinds of animals, some small, some large, some already dead. When two hungry sea slugs meet, they may fight a terrible battle to the death. The loser becomes the breakfast of champions.



Tidepool sculpin

Tidepool sculpin

Oligocottus maculosus [size: to 8 in. (20 cm)]

A tidepool sculpin is hard to see because its colors match the rocks and plants it lives on. A sculpin on sea lettuce won't look like one living on gray rocks.

At high tide, this fish travels about looking for small animals to eat. At low tide, it hurries back to its tide pool. Even if it explores nearby pools, a sculpin can find its way back home.