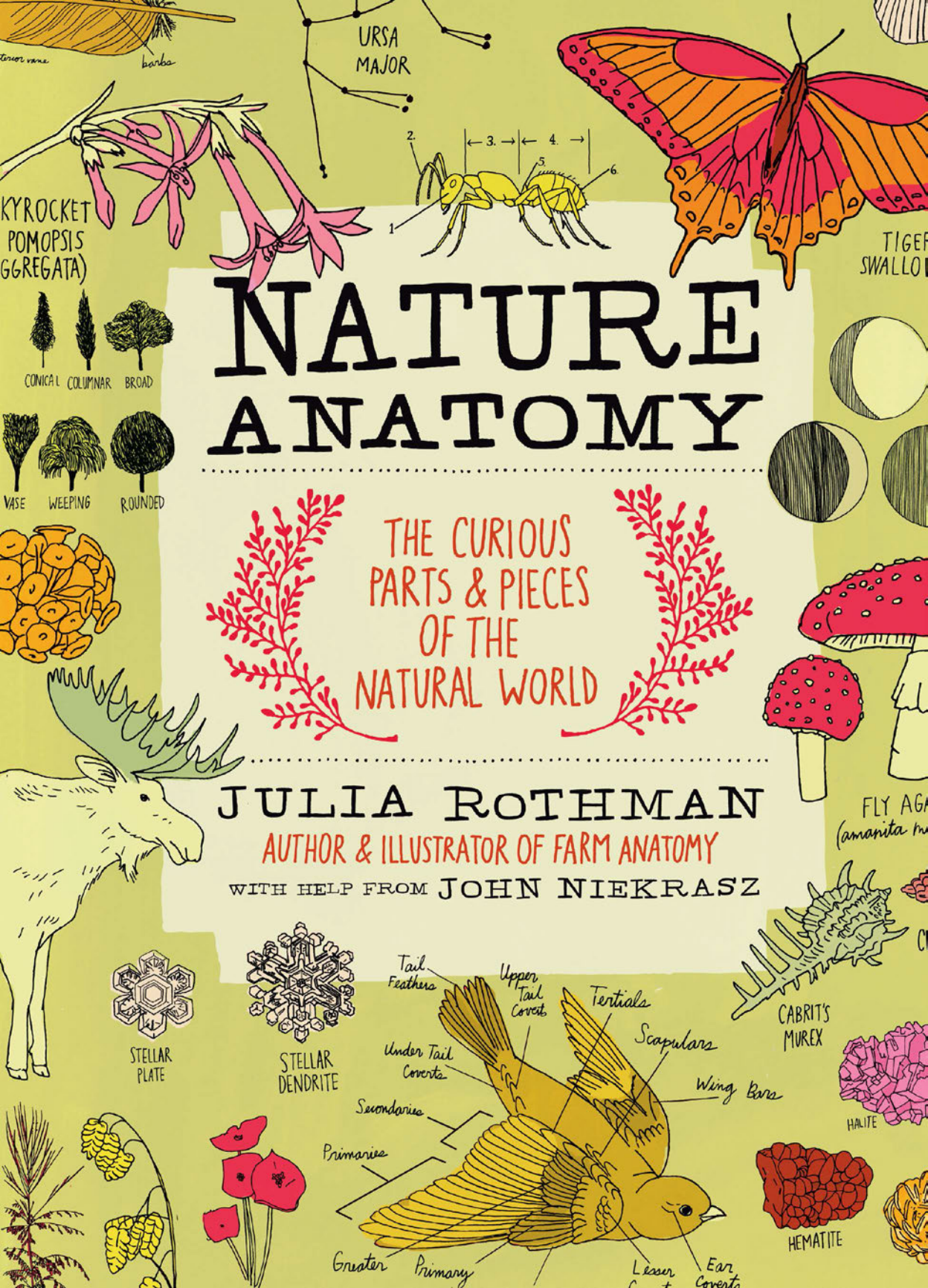

NATURE ANATOMY

THE CURIOUS PARTS & PIECES OF THE NATURAL WORLD

JULIA ROTHMAN
AUTHOR & ILLUSTRATOR OF FARM ANATOMY
WITH HELP FROM JOHN NIEKRASZ

NATURE ANATOMY



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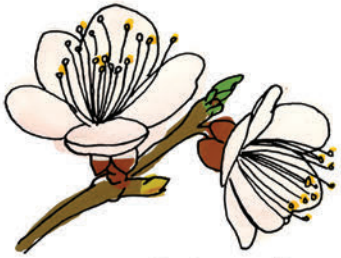
Storey Publishing
210 MASS MoCA Way
North Adams, MA 01247
www.storey.com

Printed in China by Toppan Leefung Printing Ltd.
10 9 8 7 6 5 4 3 2 1

Library of Congress Cataloging-in-Publication Data on file



for my sister, Jess,
who reminds me there's
a whole world outside
the city



CONTENTS

INTRODUCTION 6

CHAPTER 1

Common Ground 11

Really Moving • Layers of the Earth • Minerals • The Rock Cycle • Fossils • Landforms • Mountains • North American Landscapes • Field Succession • Loose Landscape Painting

CHAPTER 2

What's Up? 41

Up in the Atmosphere • Predicting Weather • The Water Cycle • Storms • Why Are All Snowflakes Different? • Rainbows • Sunsets • Phases of the Moon • Constellations

CHAPTER 3

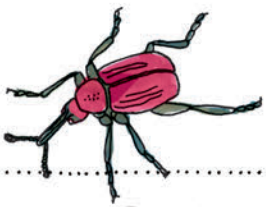
Come Close 61

Anatomy of a Flower • Anatomy of a Bee • Anatomy of a Butterfly • Metamorphosis • Plants That Attract Butterflies • Beautiful Butterflies • Colorful Moths • Sedges, Rushes, Grasses • Grazing Edibles • Incredible Insects and Bugs Abounding • Spectacular Spiders • Anatomy of an Ant

CHAPTER 4

Take a Hike 97

Anatomy of a Deciduous Tree • Anatomy of a Trunk • Leaf Identification • North American Trees • Beautiful Bark • Some Flowers, Cones, Seeds, and Fruits







of Trees • Printing Patterns • Anatomy of a Fern • Pretty, Pretty Lichen
Mysterious Mosses • Waterbears • Mycelium • Anatomy of a Mushroom •
Marvelous Mushrooms • Rotting Log • Foraging in the Forest

CHAPTER 5

Creature Feature 131

Animals in the Neighborhood • Anatomy of a Bat • Common North American Bats •
Tree Squirrels • Ground Squirrels • The Lyme Bacteria Cycle • Grizzly Bear vs.
Black Bear • The Animal Underground • Snakes • Lizards • Wild Cats • Wild Dogs •
Animals with Antlers . . . and Horns • Aquatic Mammals • Outstanding
Adaptations • Marine Mammals



CHAPTER 6

A Little Bird Told Me 161

Anatomy of a Bird • A Bevy of Birds • Kinds of Feathers • Birdcalls • A Variety
of Nests • Extraordinary Eggs • Intriguing Bird Behavior • Birds of Prey • Owls •
Big Birds • A Variety of Beaks • Water Birds

CHAPTER 7

Head above Water 189

Water Bodies • Ecosystem of a Pond • A Few Freshwater Fish • Life Cycle of
a Salmon • Water Bugs • Toad vs. Frog • Life Cycle of a Frog • Tidal Zone
Ecosystem • Fantastic Saltwater Fish • Anatomy of a Jellyfish • On the Sand •
Seashells by the Seashore • Some Seaweed • Harvesting, Processing, and
Eating Seaweed





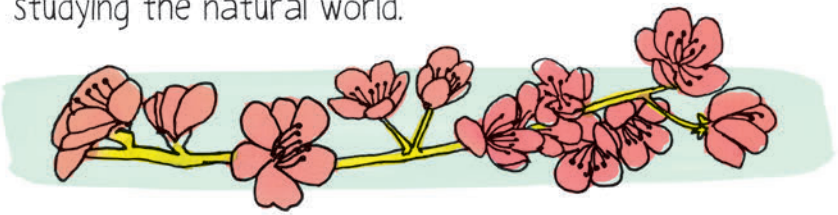
A Note about Conservation 218

Bibliography 220



INTRODUCTION

A couple of years ago, after finishing my last book, *Farm Anatomy*, and learning so many incredible things about growing and preserving food, identifying animals, and the way harvesting works, my hunger for more "green" knowledge grew. I wanted to continue my journey as a city dweller studying the natural world.



I grew up on City Island in the Bronx, in New York City, on a block that ends with a beach, as most of the streets on the island do. Collecting and categorizing shells, studying horseshoe crabs' undersides, and swallowing salt water were part of my childhood, even though we could see iconic skyscrapers glowing across the water. My sister and I spent summers at camp, hiking in the woods in upstate New York, and sleeping in tents outfitted with lots of bug spray to satisfy my over-protective mother.

I really loved nature as a kid and looked forward to outdoor adventures at every opportunity, whether it was a family vacation to Maine or a weekend trip to a neighbor's log cabin. But as I got older, I became a city girl at heart. My teenage years were spent sneaking out to nightclubs downtown and hanging out on the sidewalks of the Lower East Side. That child who loved collecting live bugs and growing crystals (encouraged by my dad, a science teacher) was replaced by a rebellious adolescent who wore black and white checkered stockings with denim skirts and chased skateboarders in Union Square.

While I live in the middle of the city, in Park Slope, Brooklyn, I am only a few buildings away from the entrance to Prospect Park, which I visit on a daily basis, most often for a dog walk or a long run. While it seems a far leap to call these tiny

journeys "nature walks." I cherish being surrounded by greenery for just a small period of time each day. It keeps me sane to be able to smell some grass after being squished like a sardine in a subway car. I really look around the park, wanting to know more. What is that tree with the beautiful leaves called? When will those flowers I saw last year show up again? Are those really bats flitting above our heads? How funny to see so many dragonflies attached, making love!

My curiosity continues to grow, and that's how the idea for this book took shape. I am glad my work has taken me back to a nostalgic place where I can begin to appreciate the things I was intrigued with as a kid.

It's about as fair to call this a "nature book" as it is to call my little walks "nature hikes." There is no way to include even a small portion of the enormous world around us in a book of any size. Where does it end? There is an infinite amount to learn about, from the constellations to the core of the earth. I guess I think of this project as MY nature book. It's the information I was interested in learning about, the things I wanted to draw and paint. While it is only a teeny scratch on the surface, it gave me a chance to become acquainted with plants, animals, trees, grasses, bugs, precipitation, land masses, and bodies of water that I wanted to be able to name when I walked by.

My friend John has always been an influential green voice, telling me about what he cooks from his plentiful gardens, how he saved some infested fruit trees in a neighbor's yard, and how he finds ingredients in his backyard. For this project, I asked John to literally guide me on my path and show me some cool stuff I might not have found myself.



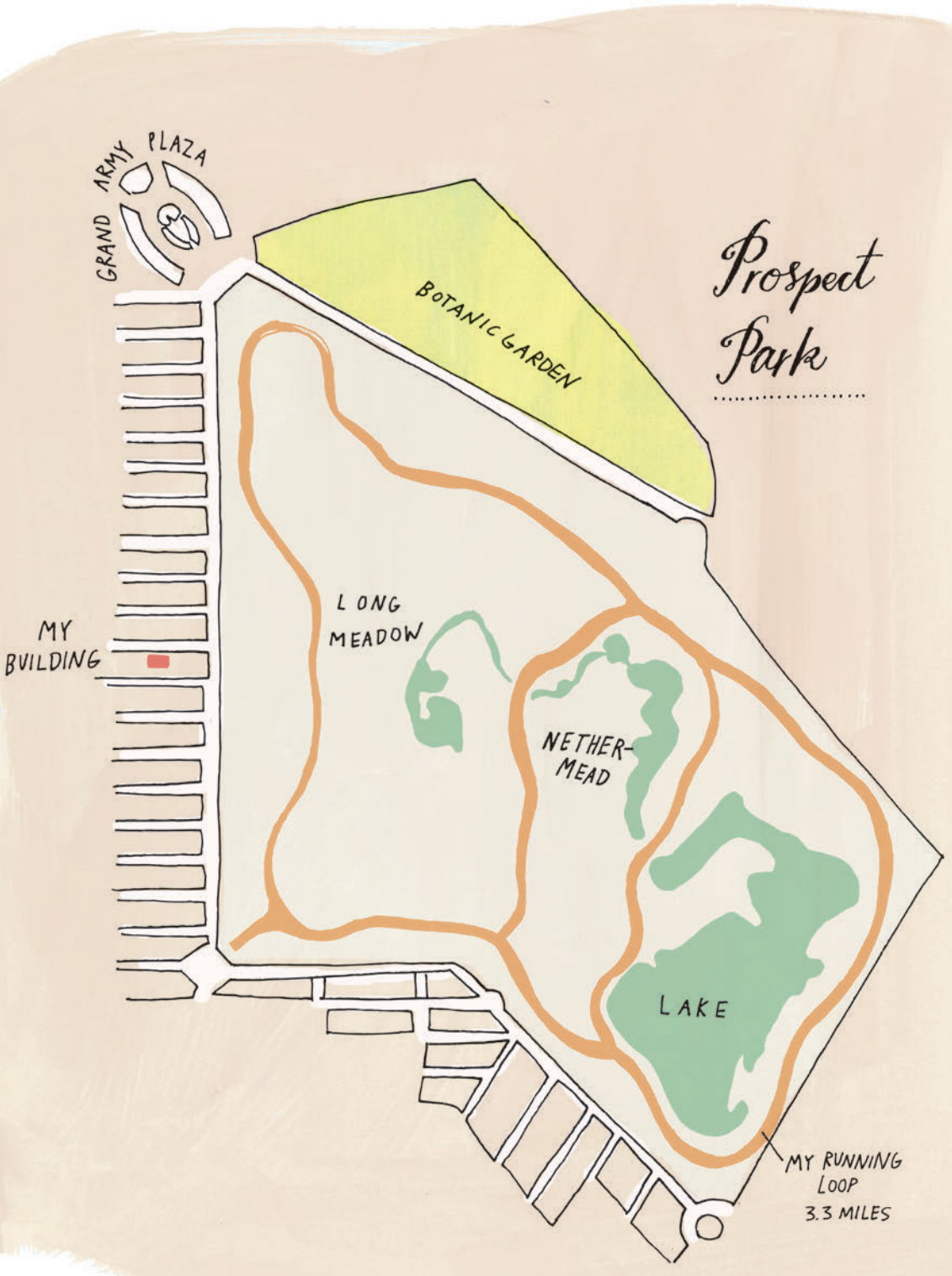
As we walked through Prospect Park one afternoon, John picked some leaves and encouraged me to eat them. I was a bit worried about what dog may have relieved himself on the plant but eventually obliged, chewing while he laughed at my reaction to the flavor. We walked through the park picking and tasting and critiquing the bitterness, sweetness, and texture of all of the edibles right under our noses. I had no idea I could make such a colorful salad from my Brooklyn park. And if this park could give us this much, I could only imagine what we could forage from actual deep woods.

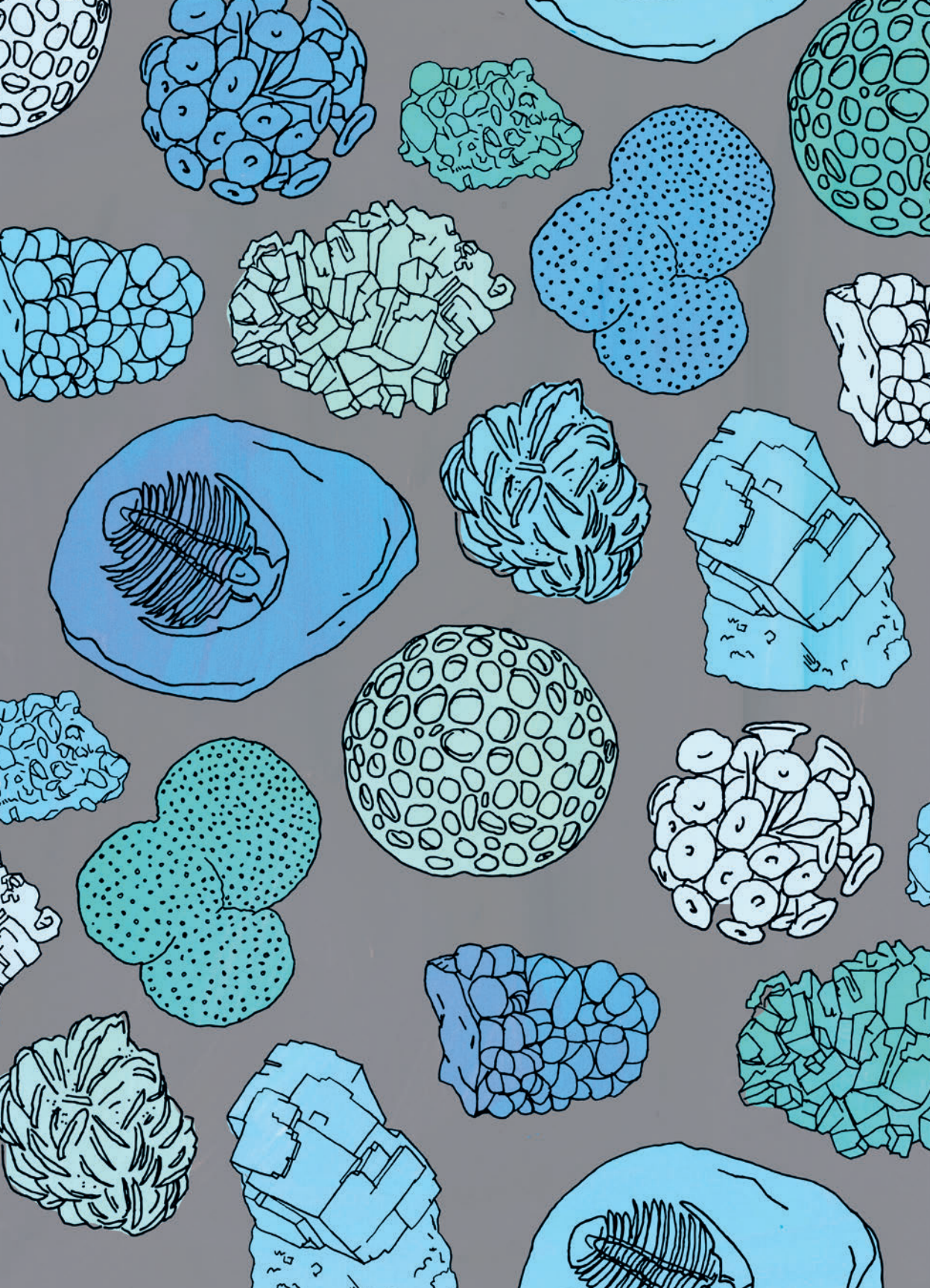
If it weren't for John, this book wouldn't have become what it is, as he was my teacher and I was his student. He wrote and edited and helped me formulate ideas for the project, and I followed his lead. And while I ultimately decided what I wanted this book to be, you can find his voice on every page.

This book is now an object, a finished piece of work that we are both proud to hold in our hands. But I won't stop drawing flowers or looking up birds that I see in the park in my Sibley guide. John will continue telling me about his vegetable garden plans for next year and about the trips he takes to visit specific natural phenomena. It's a continuous lifelong project for us to appreciate our surroundings, whatever they may be, and this book is just a tiny piece of evidence of that. I hope our book inspires you to be curious about your own backyard, too, whether it's rolling hills or a flower box on a fire escape.

Julia Rothman

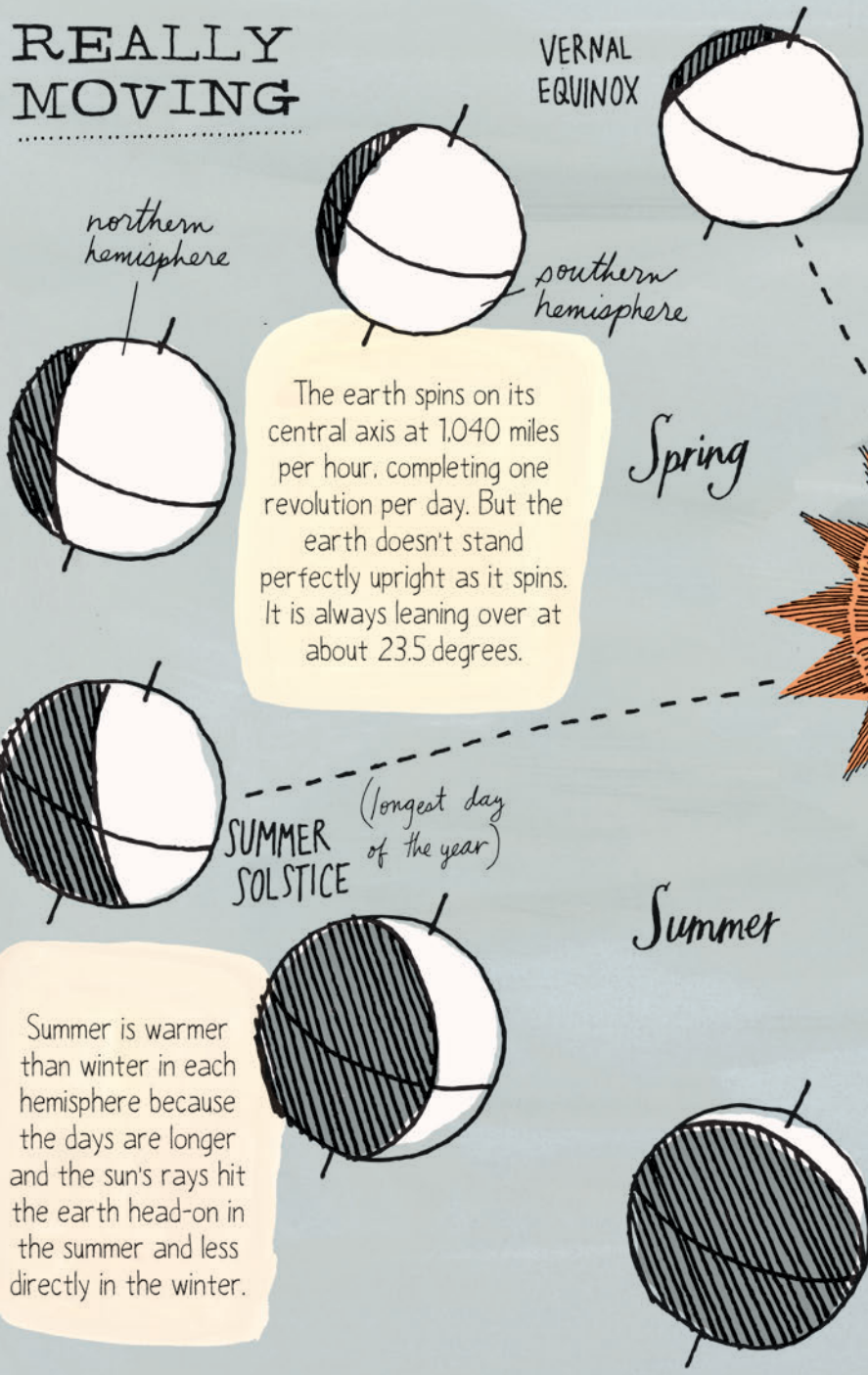



GRAND ARMY PLAZA
BOTANIC GARDEN
Prospect Park
MY BUILDING
LONG MEADOW
NETHER-MEAD
LAKE
MY RUNNING LOOP
3.3 MILES



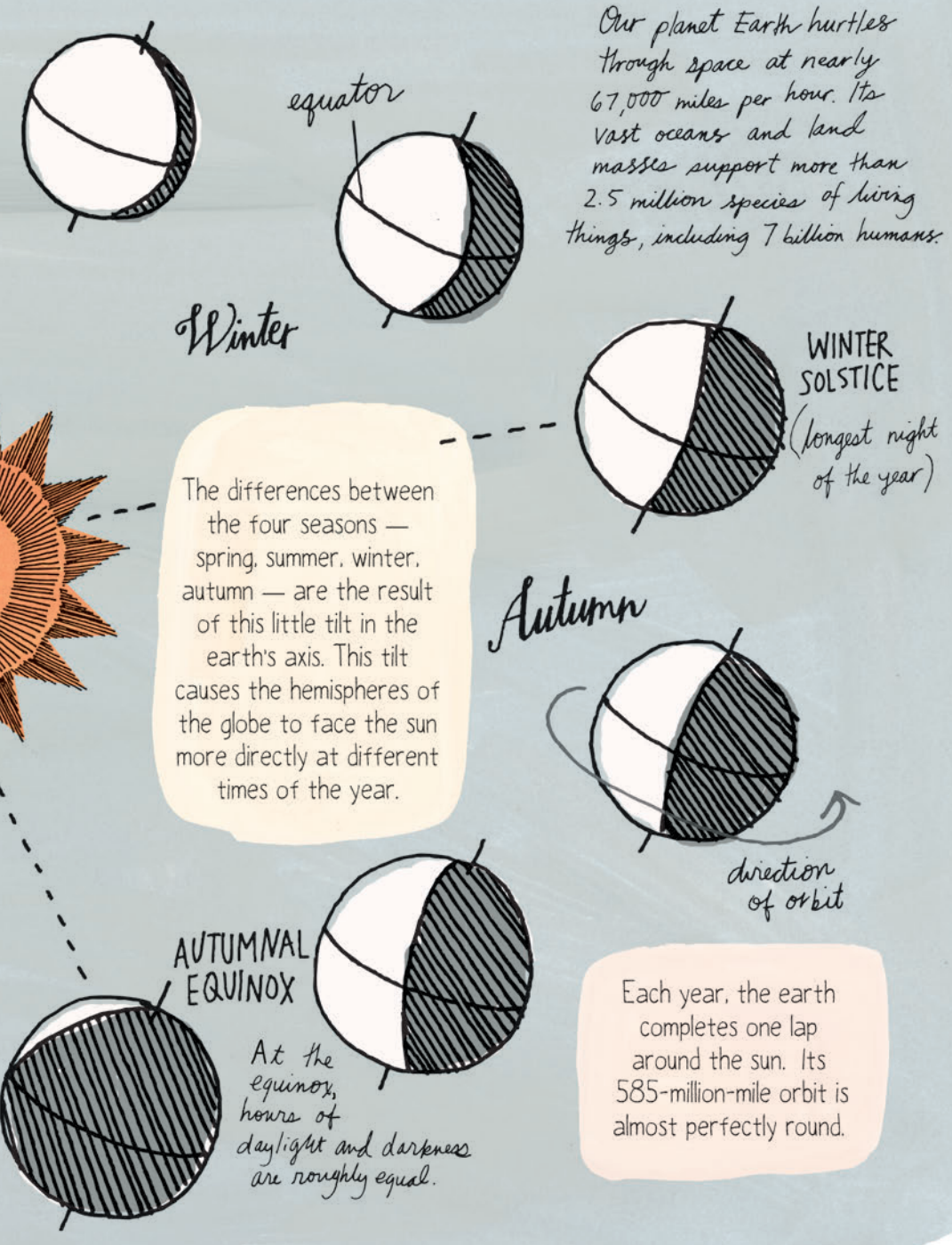

CHAPTER 1
Common Ground

REALLY MOVING



The earth spins on its central axis at 1,040 miles per hour, completing one revolution per day. But the earth doesn't stand perfectly upright as it spins. It is always leaning over at about 23.5 degrees.

Summer is warmer than winter in each hemisphere because the days are longer and the sun's rays hit the earth head-on in the summer and less directly in the winter.



Our planet Earth hurtles through space at nearly 67,000 miles per hour. Its vast oceans and land masses support more than 2.5 million species of living things, including 7 billion humans.

The differences between the four seasons — spring, summer, winter, autumn — are the result of this little tilt in the earth's axis. This tilt causes the hemispheres of the globe to face the sun more directly at different times of the year.

At the equinox, hours of daylight and darkness are roughly equal.

Each year, the earth completes one lap around the sun. Its 585-million-mile orbit is almost perfectly round.

Layers of the Earth

Planet Earth was formed 4.54 billion years ago. Most of what we know about the structure of Earth comes from studying the seismic waves that pass through the planet during earthquakes. Earth is distinctly layered and each layer has its own unique characteristics.

CRUST

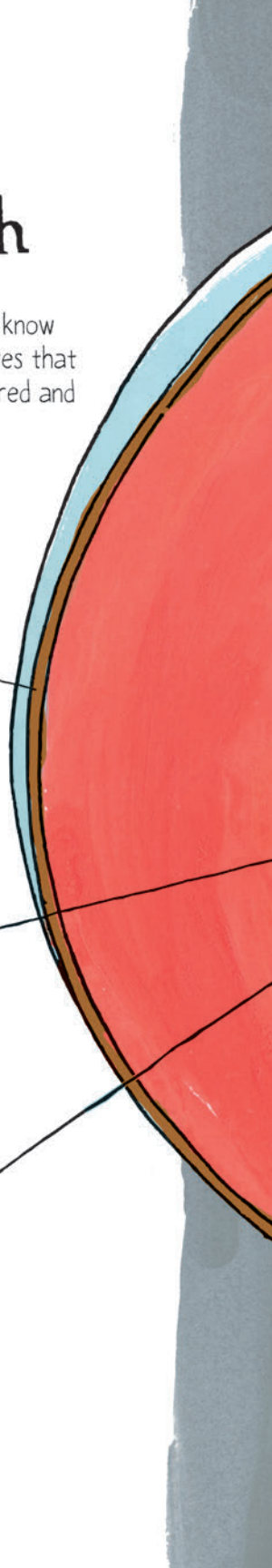
The earth's crust is between 3 and 44 miles thick, being thickest where there are land masses and thinnest beneath the oceans. It makes up less than 1% of the planet's total volume.

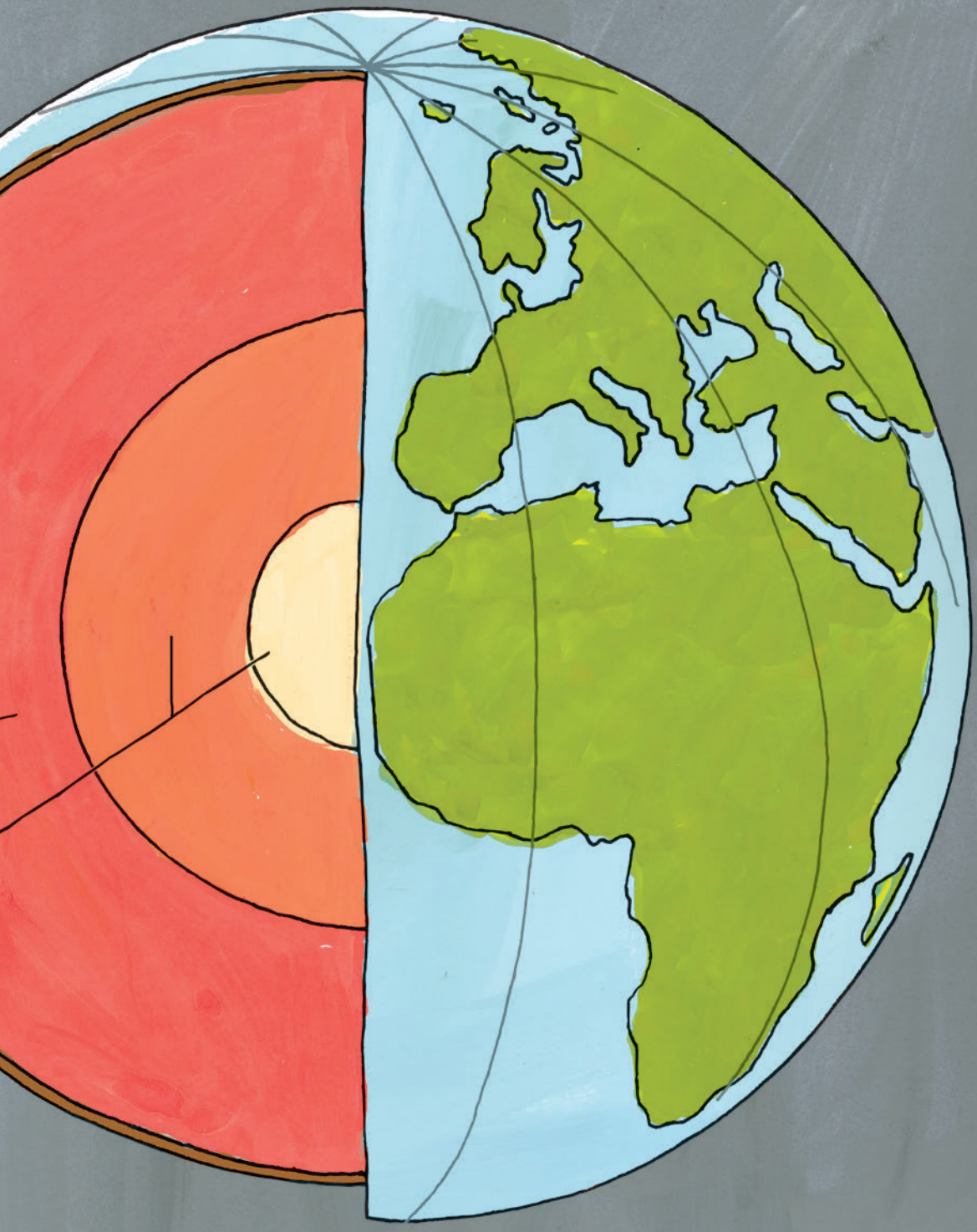
MANTLE

This layer of iron- and magnesium-rich silicate rock is hot enough (between 930° and 7,200°F) that it flows very slowly, causing earthquakes as the surface plates shift atop it. The mantle composes 84% of earth's volume.

OUTER + CENTRAL CORE

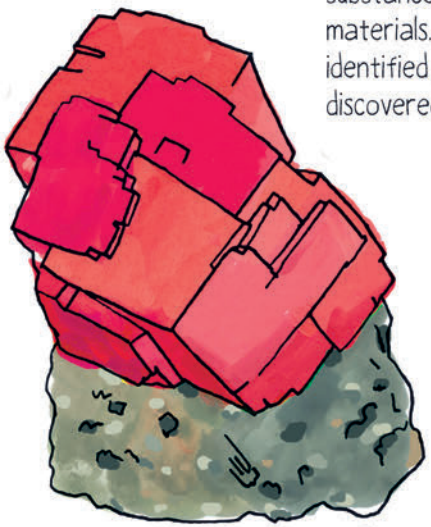
The core has two parts: The outer core is primarily molten iron. The central core – an alloy of iron and nickel – is under so much pressure that it has crystallized into a solid even though it is hotter than the surface of the sun.



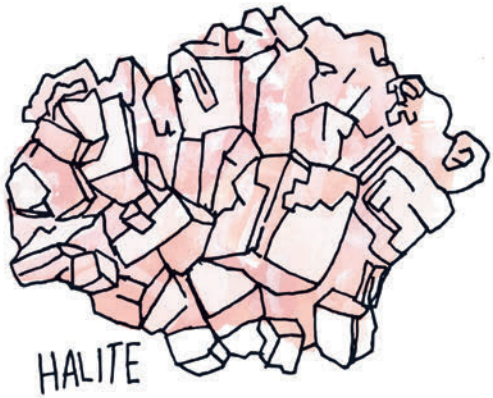


Minerals

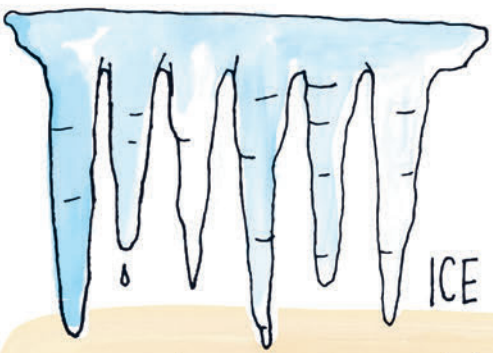
Minerals are naturally occurring solid substances consisting of inorganic materials. There are more than 4,000 identified minerals, with more being discovered every year.



RHODOCHROSITE



HALITE



ICE

TURQUOISE



Liquid water is not a mineral, but naturally formed ice is one of the most common minerals on Earth.



COPPER



GYPSUM
DESERT
ROSE

Minerals form through crystallization:

- through evaporation of a solution (like salt water evaporating into salt)
- through cooling (natural water freezing, magma solidifying)
- through changes in surrounding pressure and temperature (often found at faults and other tectonically active zones)

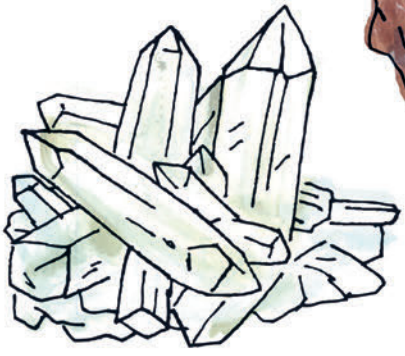


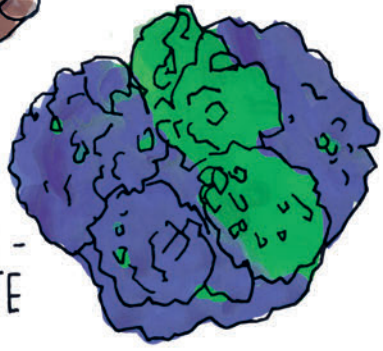
JEREMEJEVITE



HEMATITE

QUARTZ

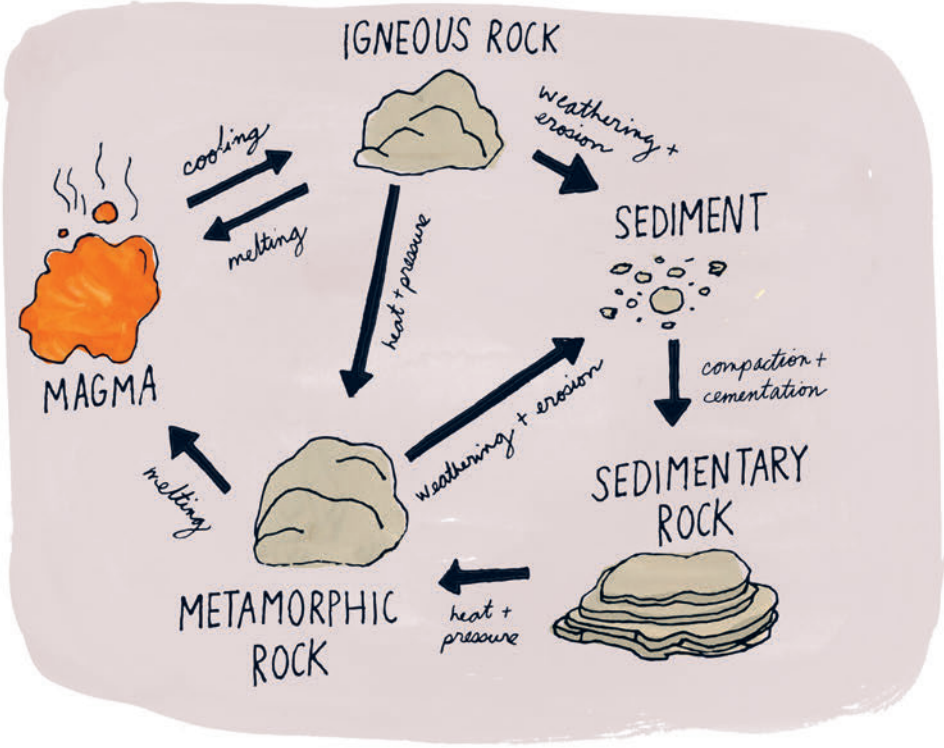




AZURITE -
MALACHITE

The Rock Cycle

Dynamic transitions take place among different types of rocks over long periods of time.

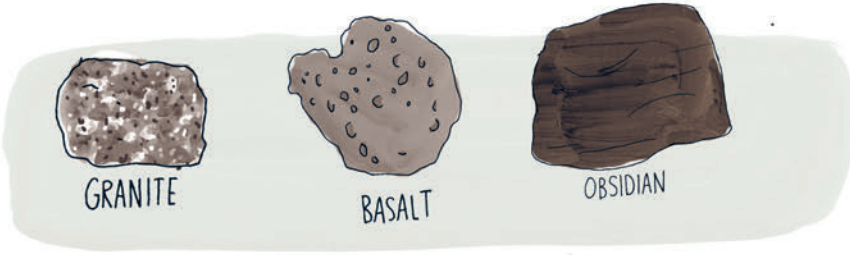


Rocks are altered or destroyed by natural forces: heat, pressure, friction, and weathering.

Based on how they are formed, rocks are classified into types:

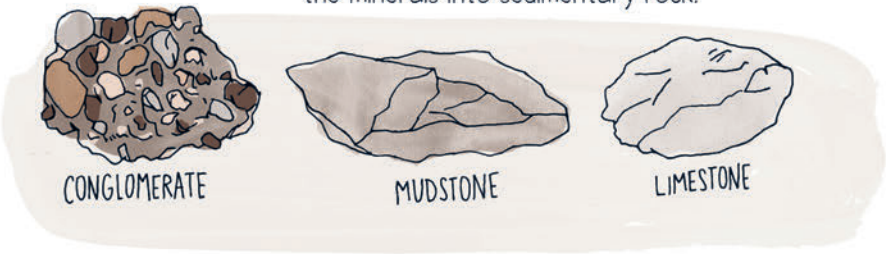
Igneous

Magma is molten rock beneath the surface of the earth. When magma cools and solidifies at or near the surface, it creates igneous rock.



Sedimentary

As bits of minerals settle into layers over thousands of years, the weight of water and the layers of sediment above press down and cement the minerals into sedimentary rock.



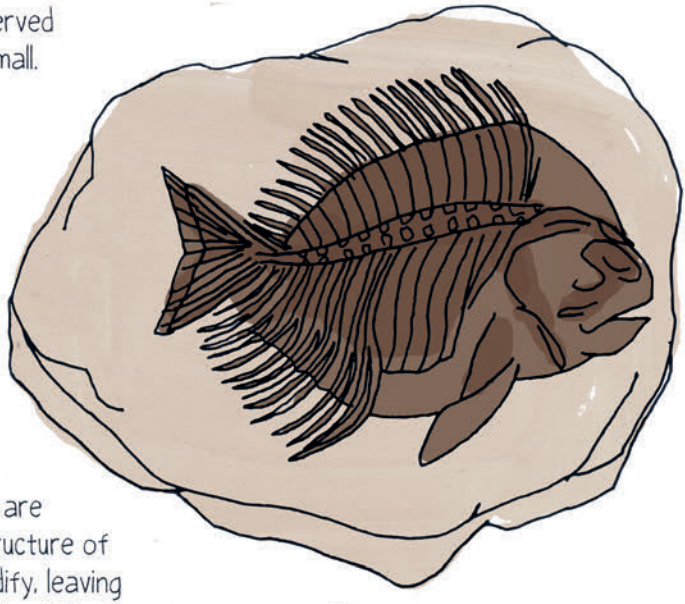
Metamorphic

When sedimentary or igneous rocks are subjected to extreme pressure and heat, their mineral structures transform, resulting in metamorphic rock.

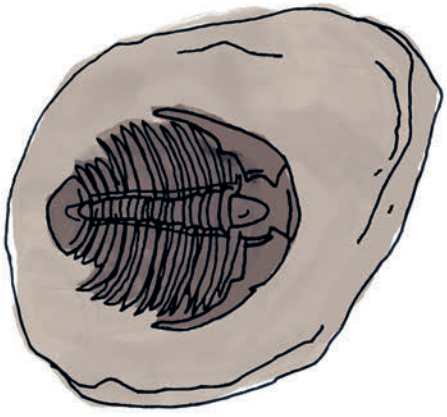


Fossils

The chances of an organism's being preserved as a fossil are very small. For a fossil to form, the organism must be covered in sediment shortly after its death. Then, water with high mineral content enters the small pores and cavities of the organism. With time and pressure, the minerals in the water are deposited into the structure of the organism and solidify, leaving behind a three-dimensional fossil.



Perch from Green River Formation of southwest Wyoming



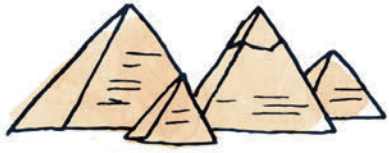
Trilobite from Marjum Formation in Millard County, Utah

Not all parts of a creature become fossilized. Soft parts of the anatomy, like skin and internal organs, often decompose before fossilization.

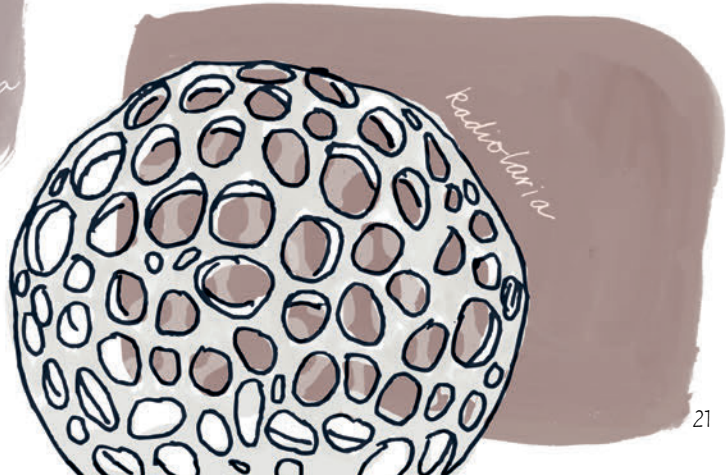


Microfossils

The fossils displayed in museums are macrofossils, that is, larger than 1 millimeter and visible to the naked eye. Vastly more numerous are microfossils, the tiny preserved remains of bacteria, diatoms, fungi, protists, invertebrate shells or skeletons, pollen, and bits of bones and teeth of vertebrates. Microfossils usually occur in large numbers in all kinds of sedimentary rocks.



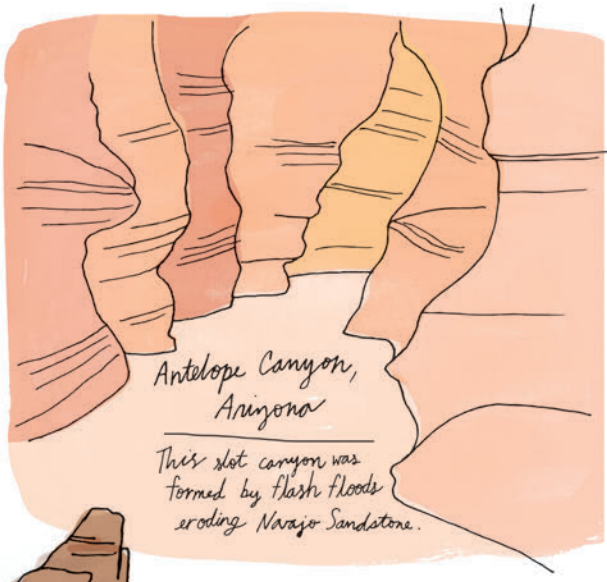
The Egyptian pyramids were built with sedimentary rocks made up of shells of foraminifera, a major microfossil group.



LANDFORMS

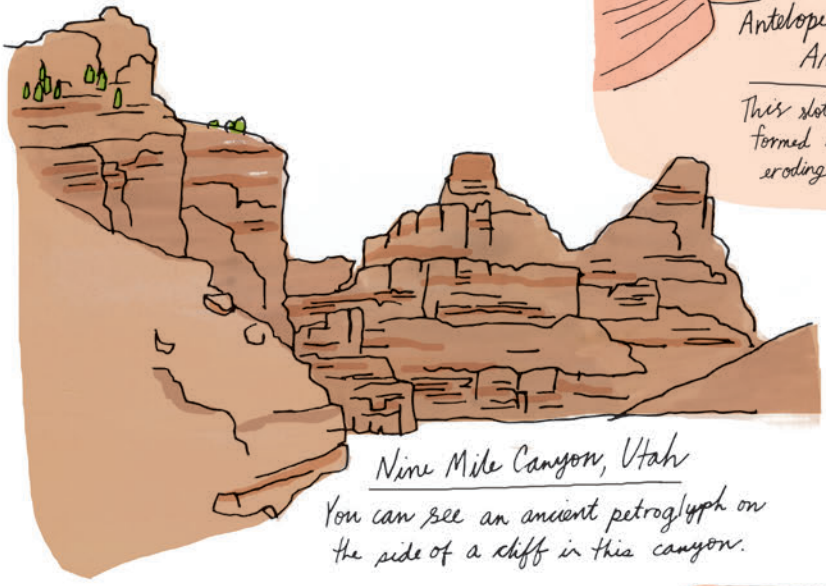
Canyon

a deep river valley with very steep sides, carved into the land by rivers over long periods of time



Antelope Canyon, Arizona

This slot canyon was formed by flash floods eroding Navajo Sandstone.

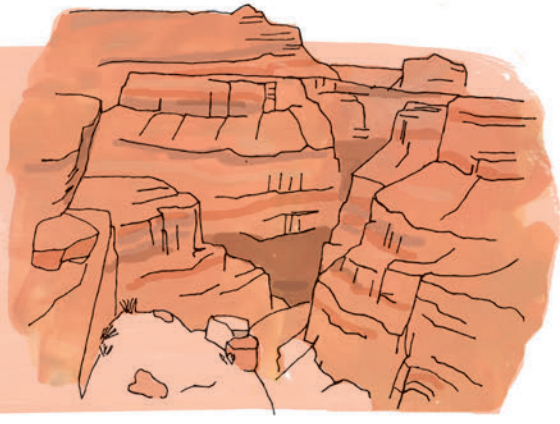


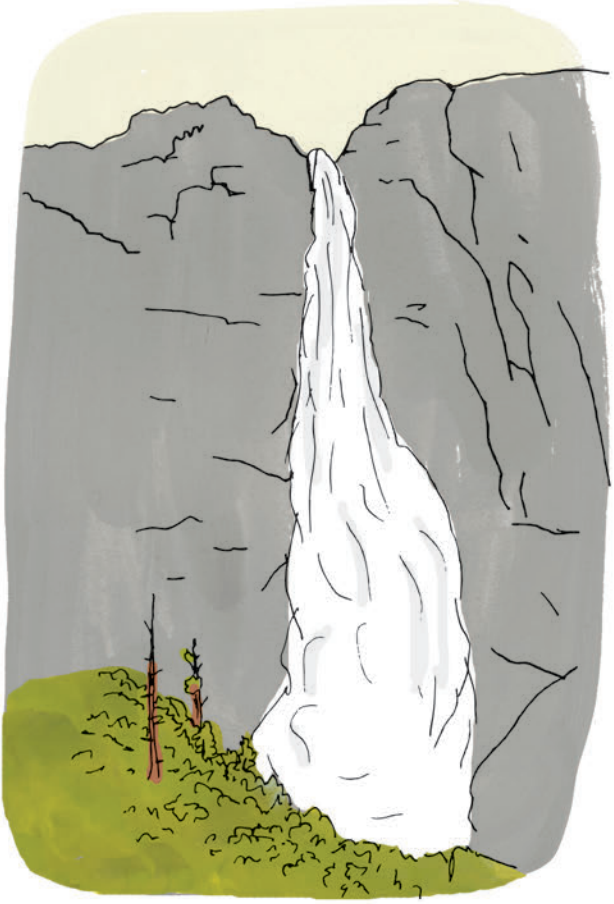
Nine Mile Canyon, Utah

You can see an ancient petroglyph on the side of a cliff in this canyon.

The Grand Canyon, Arizona

The canyon is 277 miles long, 18 miles wide, and over a mile deep.



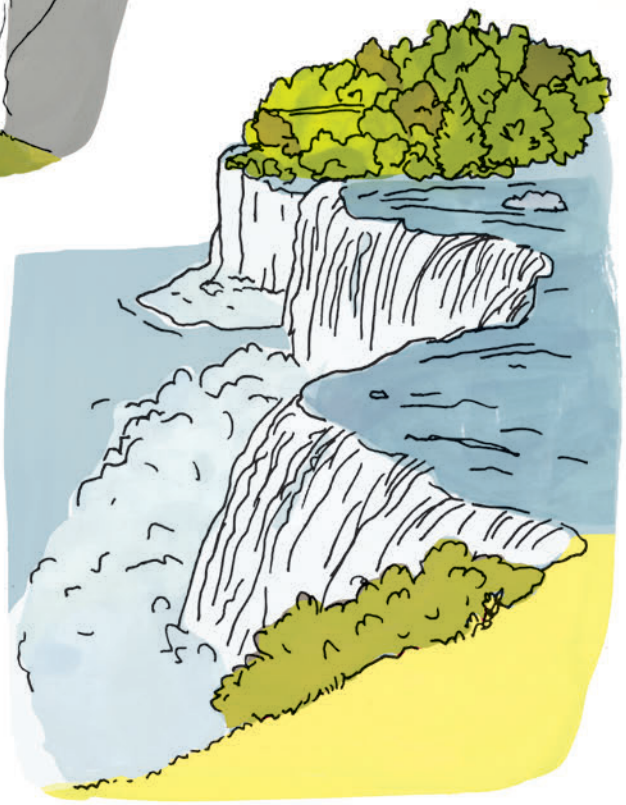


Cataract

a large and powerful waterfall

Yosemite Falls, California

This is the highest waterfall in North America.

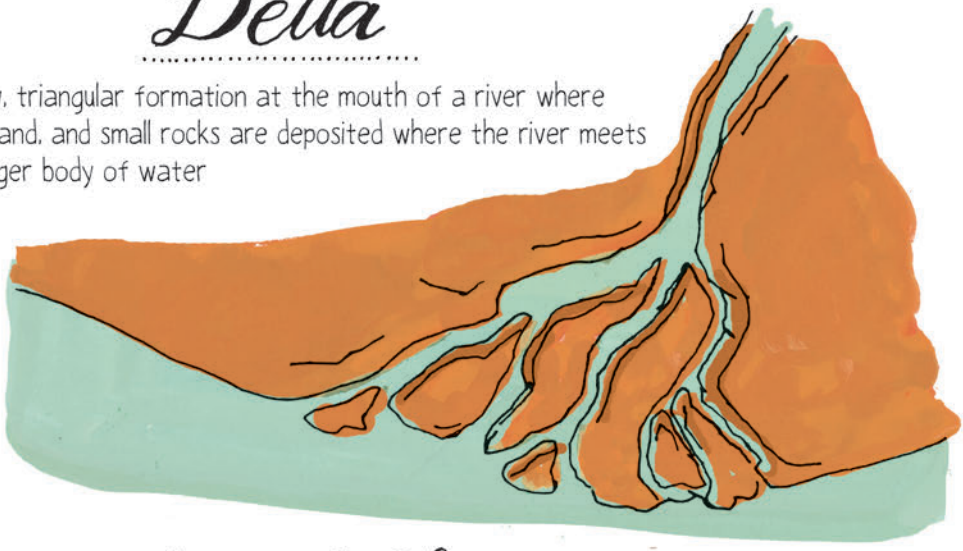


Niagara Falls, border of Ontario, Canada, and New York

It has the highest flow rate of any waterfall in the world.

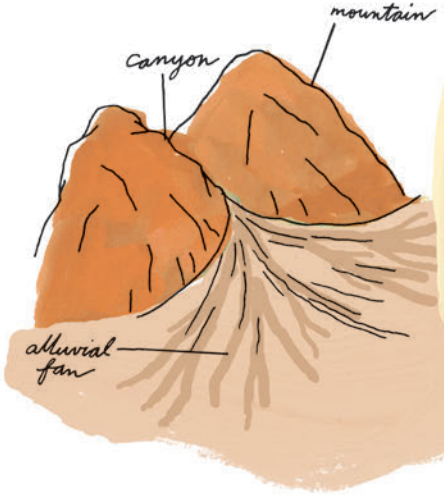
Delta

a low, triangular formation at the mouth of a river where silt, sand, and small rocks are deposited where the river meets a larger body of water



Alluvial Fan

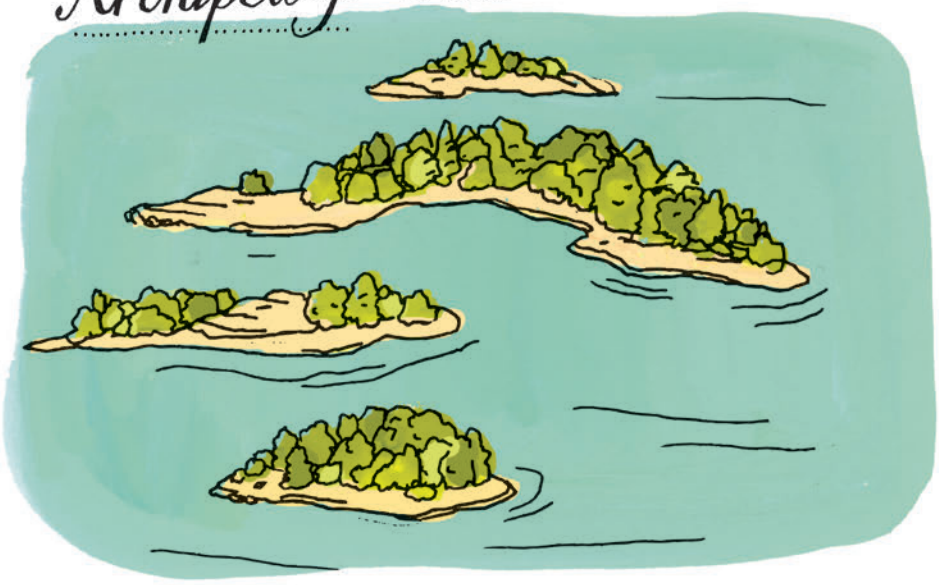
made of large amounts of sediment deposited by streams and rivers in a fan shape, most frequently where a canyon drains from mountains and spreads out over a flat plain



On July 15, 1982, Lawn Lake Dam in Rocky Mountain National Park, Colorado, failed. Thirty million cubic feet of water carried tons of debris to an alluvial fan that is still prominent decades later.

Archipelago

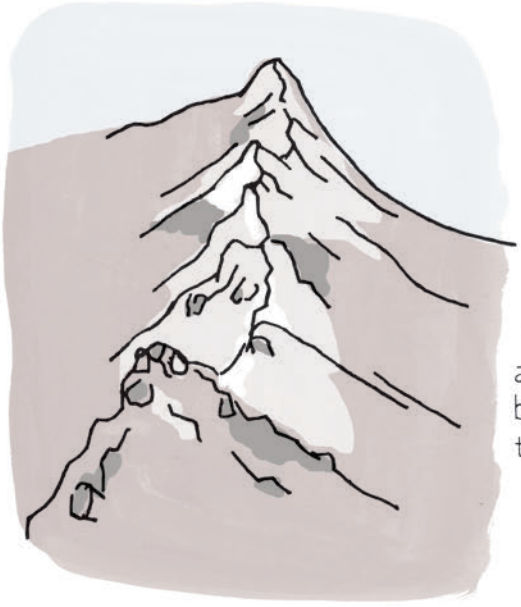
a cluster or chain of islands found in a sea or ocean



Isthmus

a narrow bridge of land connecting two larger land masses across a body of water





Arête

a thin ridge of rock left between the erosion paths of two parallel glaciers

Col

the lowest point on a mountain ridge between two peaks, also called a gap, notch, or saddle



Plateau

a massive area of flat terrain that is higher than the surrounding area



Mesa

a smaller area of elevated arid land with a flat top and sides that are usually steep cliffs



Butte

an even smaller area of raised land with steep sides. Most buttes were once larger mesas.

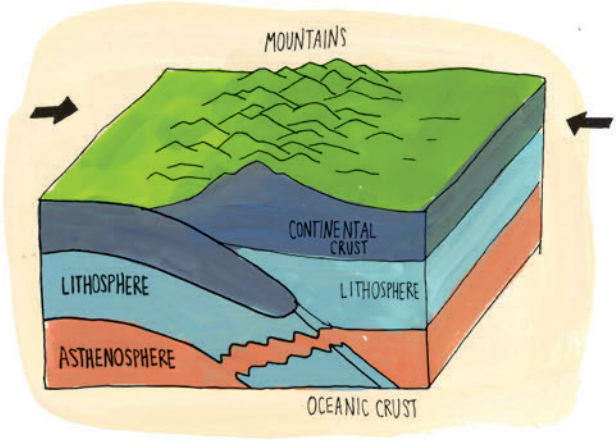
MOUNTAINS

Mountains are formed over long periods of time by plate tectonics, the process by which large pieces of the earth's crust shift, collide, crumple, and slide. With their varying climate zones, altitude, and steepness, mountains are home to unique flora and fauna.

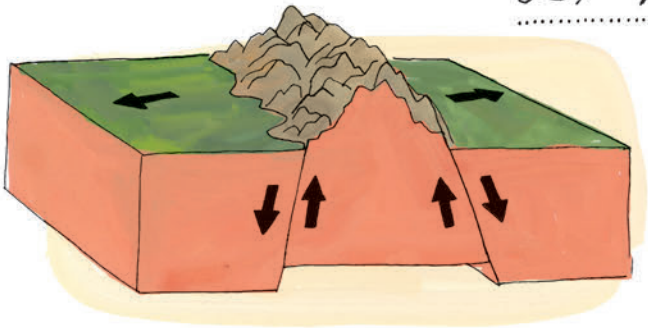
There are three primary types of mountain: fold, block, and volcanic.

Fold Mountains

As the earth's plates collide or ride one over another, the crust tends to buckle and fold upward. Most of the Appalachian and Rocky Mountain ranges are associated with this type of movement.



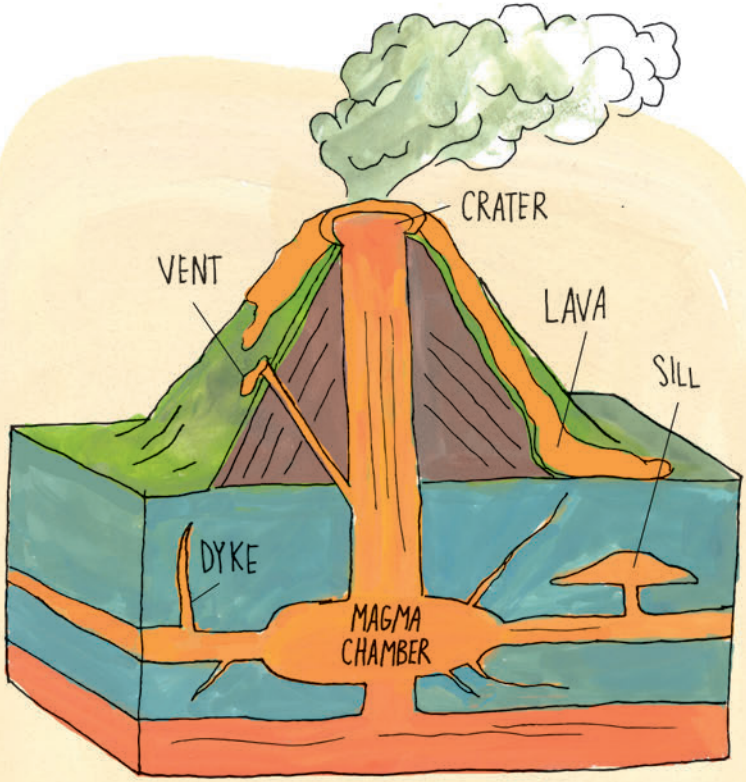
Block Mountains



Block, or fault-block, mountains, are distinguished by enormous sheer rock faces like those found in the Sierra Nevada range in California. Block mountains form when tectonic pressure forces a huge rock mass to break apart. This line of separation is called a fault. The rocks rise on one side of the fault and sink down on the other side, creating dramatic cliffs.

Volcanic Mountains

Volcanic mountains form where two plates of the earth's crust move together or apart, rather than sliding past each other. The magma that volcanic mountains emit often comes from crust material that melts as it is pushed down into the hot mantle below an advancing tectonic plate.

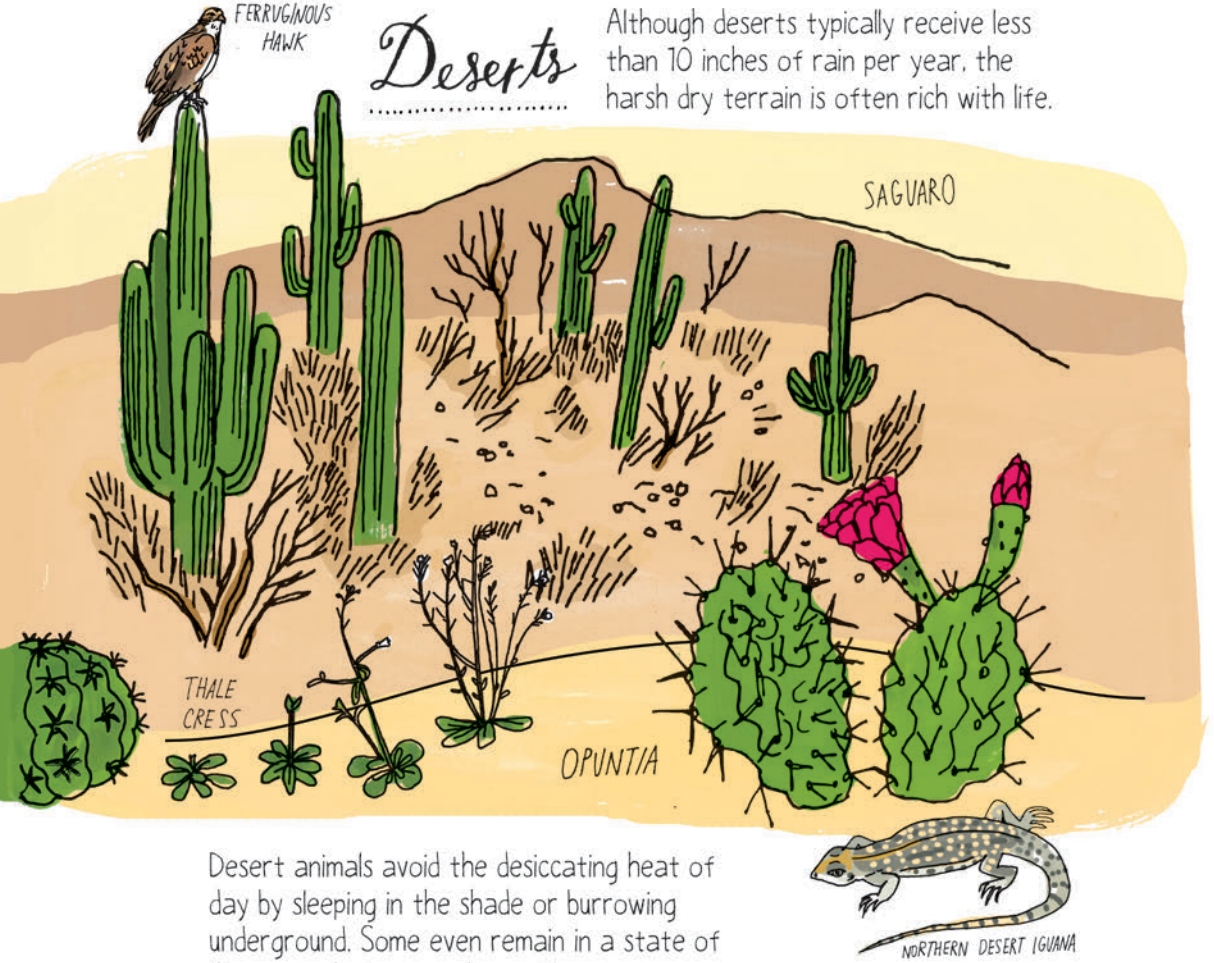


There are about 1,500 volcanoes that are known to have been active in the last 10,000 years.

NORTH AMERICAN LANDSCAPES

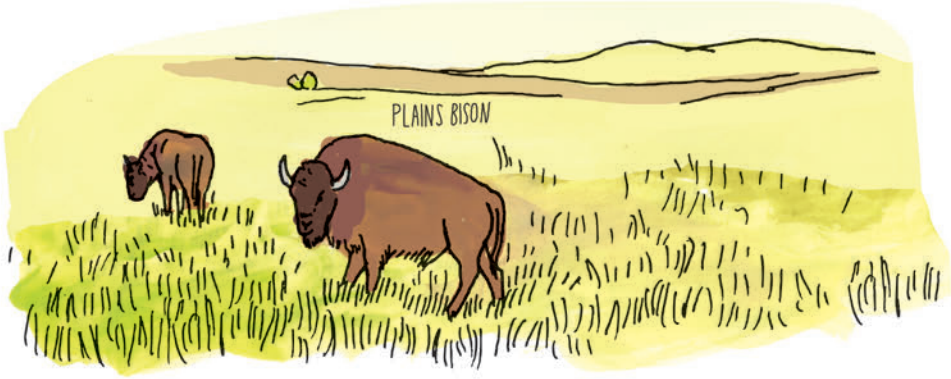
Deserts

Although deserts typically receive less than 10 inches of rain per year, the harsh dry terrain is often rich with life.



Desert animals avoid the desiccating heat of day by sleeping in the shade or burrowing underground. Some even remain in a state of dormancy during very dry spells.

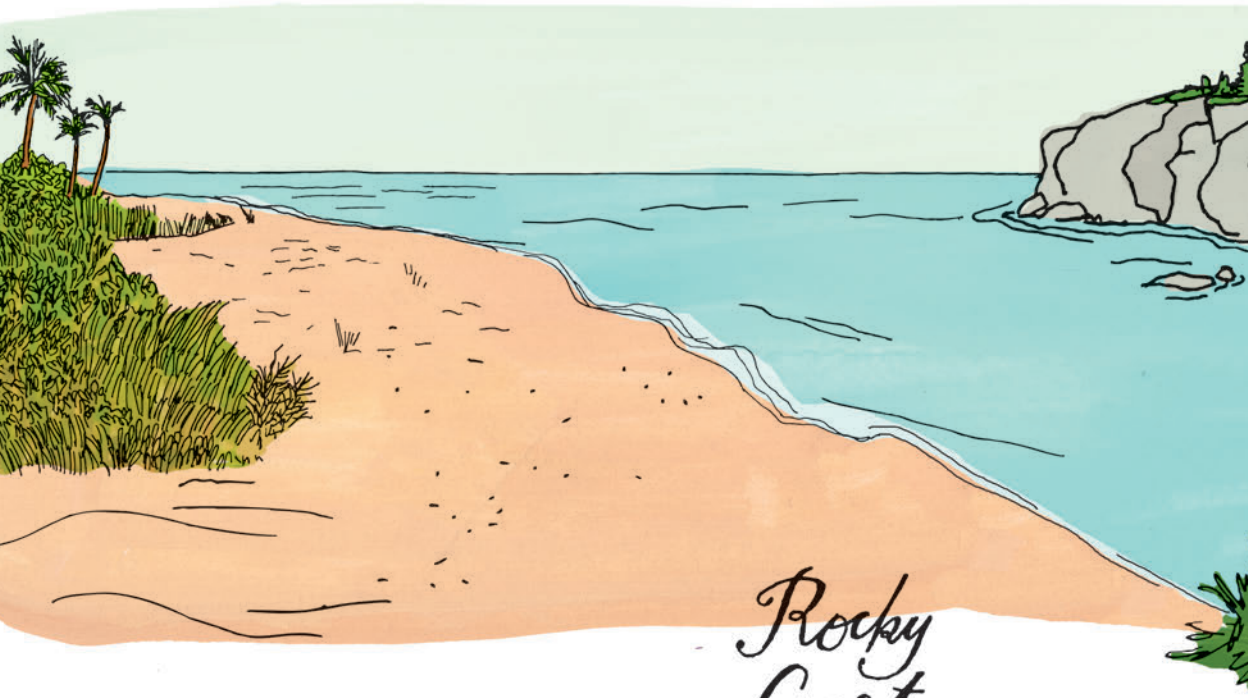
Desert plants can store water for long periods and often have protective spines or needles to keep thirsty animals at bay. Some species germinate and bloom as if in fast-forward, living out their entire lives in the few short weeks after a rare rainfall.



Grasslands

Wide-open treeless areas dominated by grasses, sedges, and rushes occur naturally in most regions of the earth. Grasslands have the deepest soil base of any landscape. Rich soils in an undisturbed grassland can extend as deep as 20 feet.



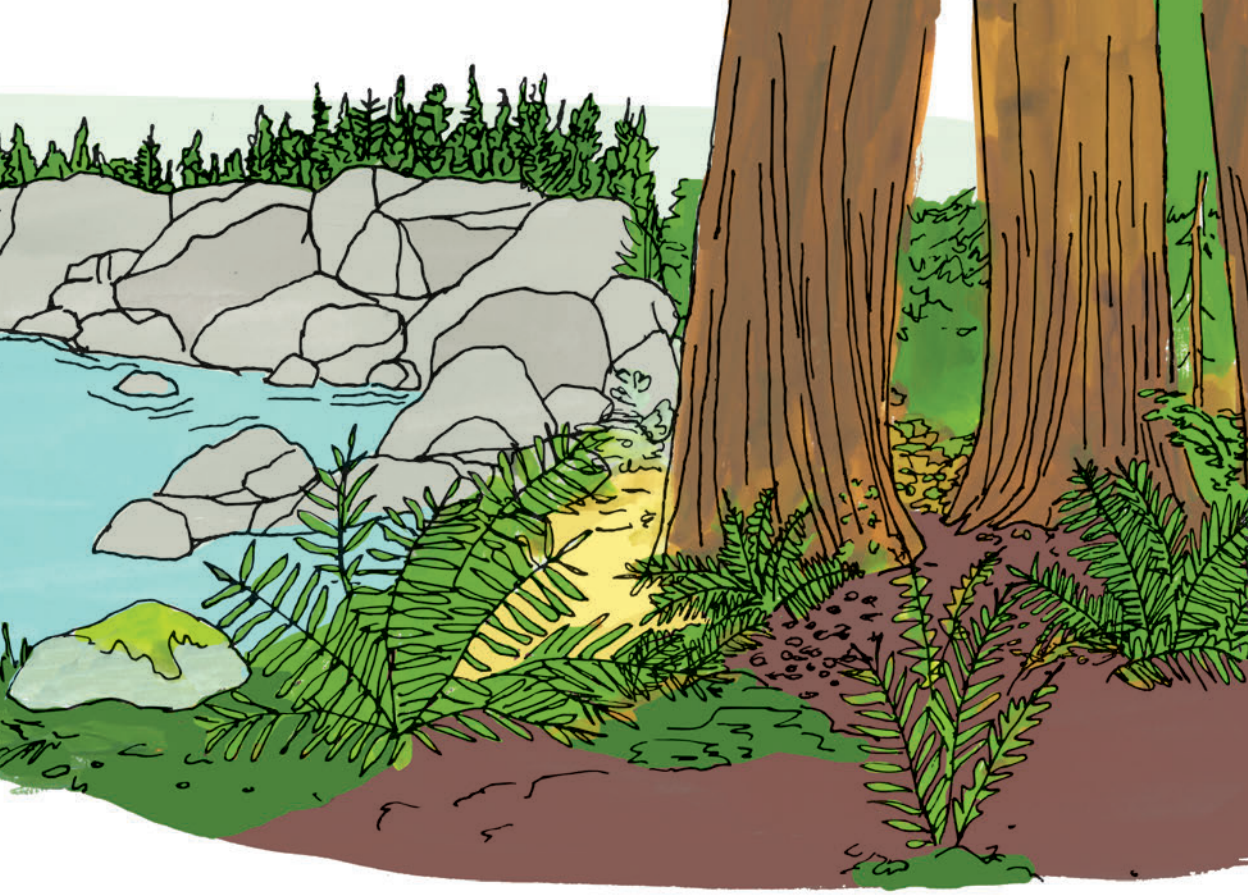


Sandy Shore

Where land meets the open ocean, the eternal beating of waves breaks down rocks and shells into fine sand. Wind and waves constantly move and reshape the shoreline. Salt-tolerant beach grasses, rushes, heathers, and roses hold the dunes and sandy shoreline together.

Rocky Coast

Along the rugged shorelines of inlets, islands, and promontories, the sea's power carves arches and caves into the rocky cliffs. Well above the surface, seabirds nest on protected crags, wind-dwarfed conifers cling to the rocks, and blue-green algae and lichens live amidst the ocean spray. In areas submerged for part of the day, tawny rockweeds and mussels thrive. Limpets, barnacles, and kelp extend from just below the surface out to sea.



Moist Coastal Forest

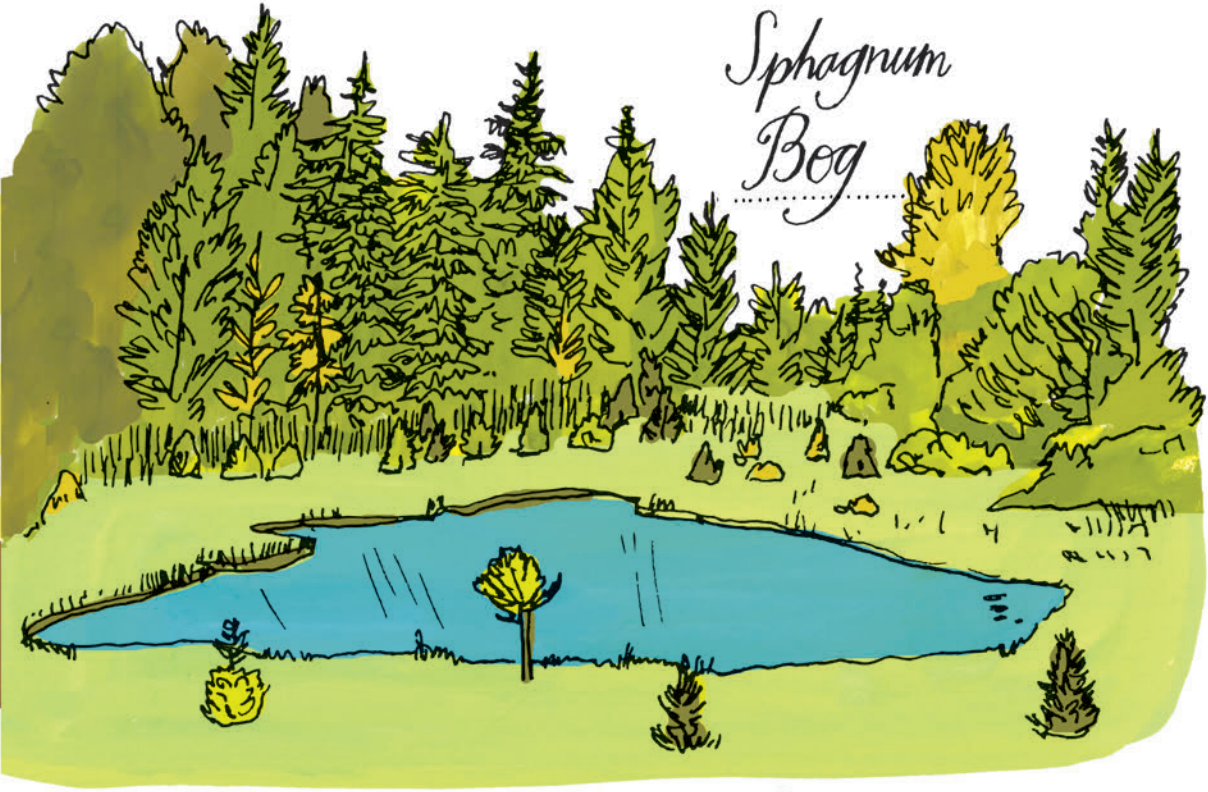
Large ferns, thick blankets of moss, and massive trees give the moist coastal forest the impression of a timeless land. Rain and fog provide consistent moisture, and the mild oceanic climate allows plants to reach great size since they can grow much of the year.



Swamps

In these forested wetlands, birdlife is often spectacularly diverse. Many amphibians, fish, and mammals also thrive in these lush environments. Duckweed and water lilies spread across the surface of the slow-moving water. Alligators, turtles, and venomous cottonmouth snakes can be found basking in warm southern swamps.





Most bogs transition from open water to forested land over many years.

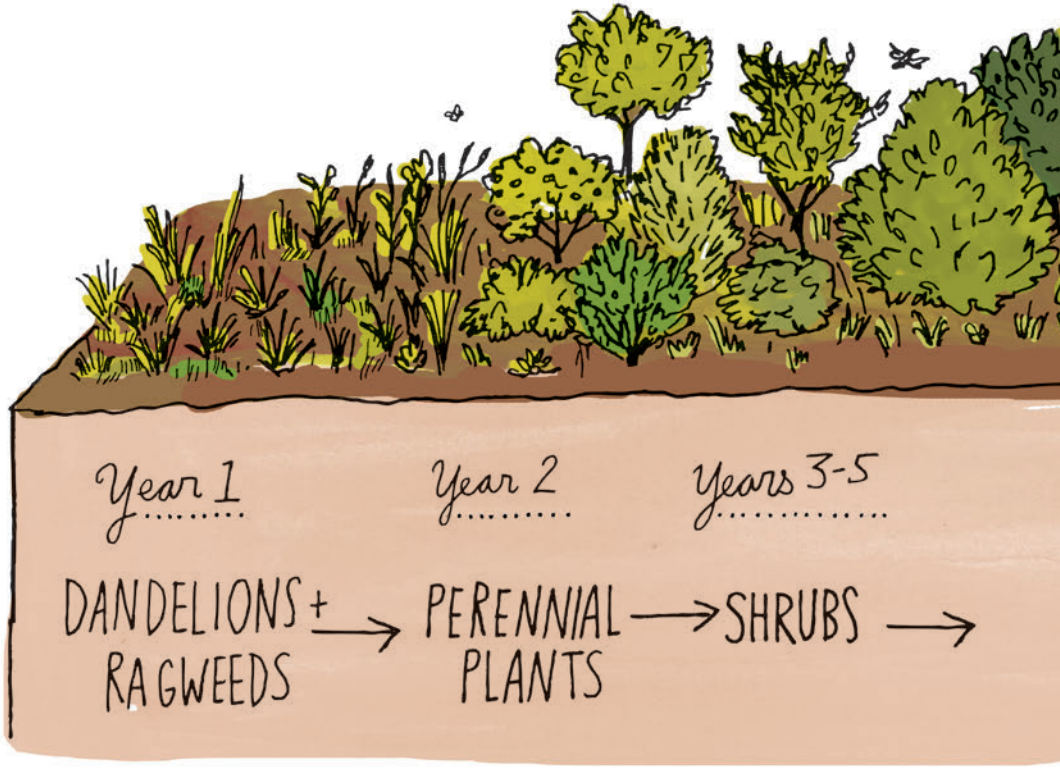
Sphagnum mosses are northern wetland plants that help create unique bog habitats in glacial depressions. The mosses decay extremely slowly, accumulating into thick layers of peat. Sedges, orchids, labrador tea, and even carnivorous plants are found in the cold microclimate of the sphagnum bog. Wetlands deplete available oxygen and peat acidifies its surroundings, so fish and many other aquatic organisms are generally scarce.



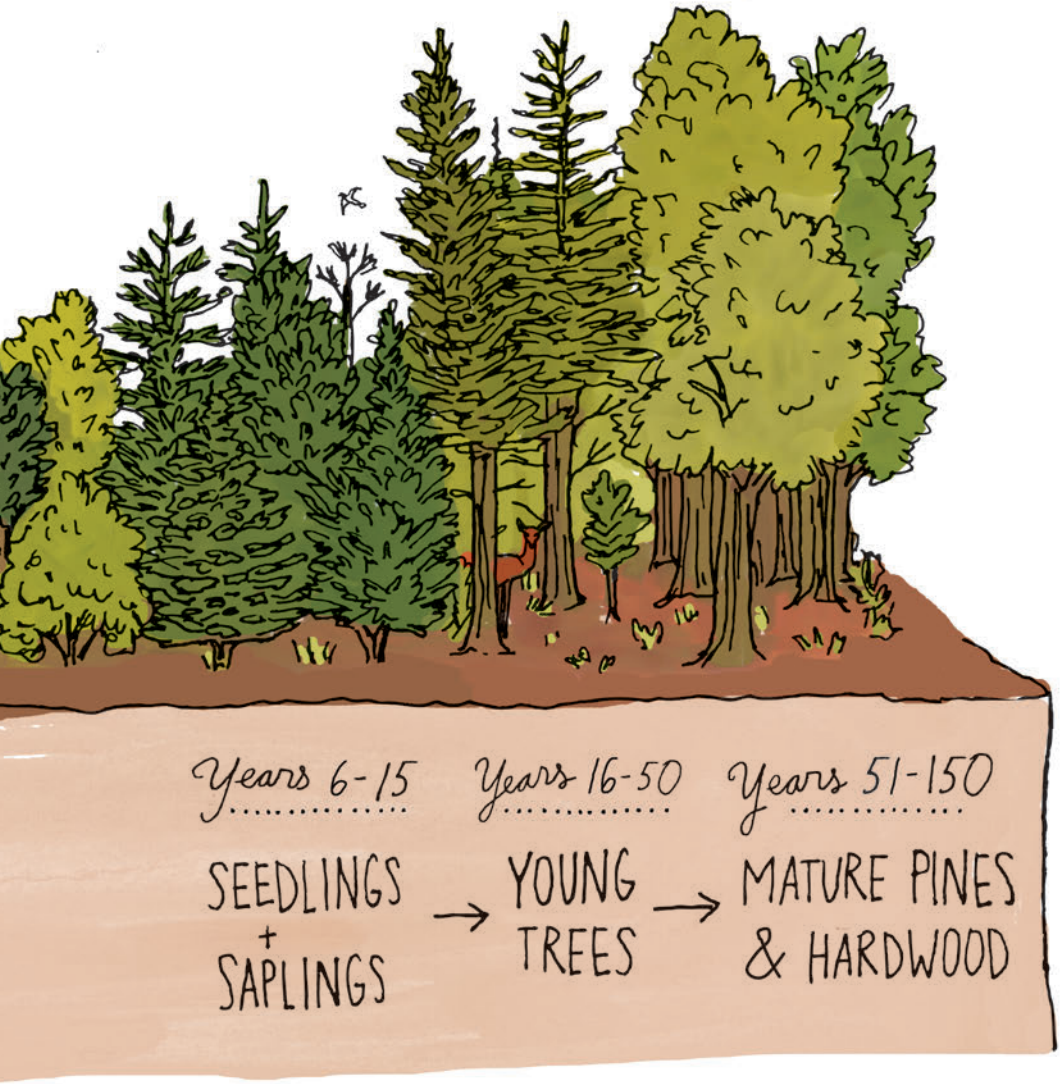
Bog lemmings have bright green droppings!

Field Succession

If a piece of land previously used for agriculture or logging is left alone, it slowly begins to revert to its wild state. Succession is the process by which a field transitions to woodland.

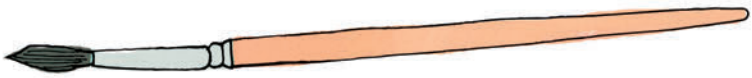


In temperate zones, early species include hardy, sun-tolerant plants like dandelions, ragweed, and lamb's-quarters. Gradually, plants such as thistles, Queen Anne's lace, and milkweed take hold.



As the vegetation matures, animals and insects are attracted by the increased cover and forage. Woodchucks, cottontail rabbits, foxes, and deer can be found, as well as butterflies, sparrows, meadowlark, and quail. Birds and squirrels deposit the seeds of trees such as black cherry, oak, mulberry, and staghorn sumac.

Loose Landscape Painting



TOOLS

- Pigment of your choice: watercolor, gouache (my favorite — it's what this book was painted with), crayon, colored pencil
- Thick paper or small canvas
- Medium to large paintbrush

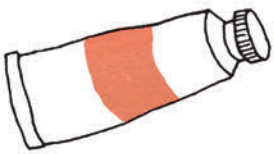
INSTRUCTIONS

Find an intriguing landscape and sit in a quiet, comfortable spot with an ideal view of your subject. Squint your eyes to see the scene out of focus. Look at the area as chunks of color without any close details.

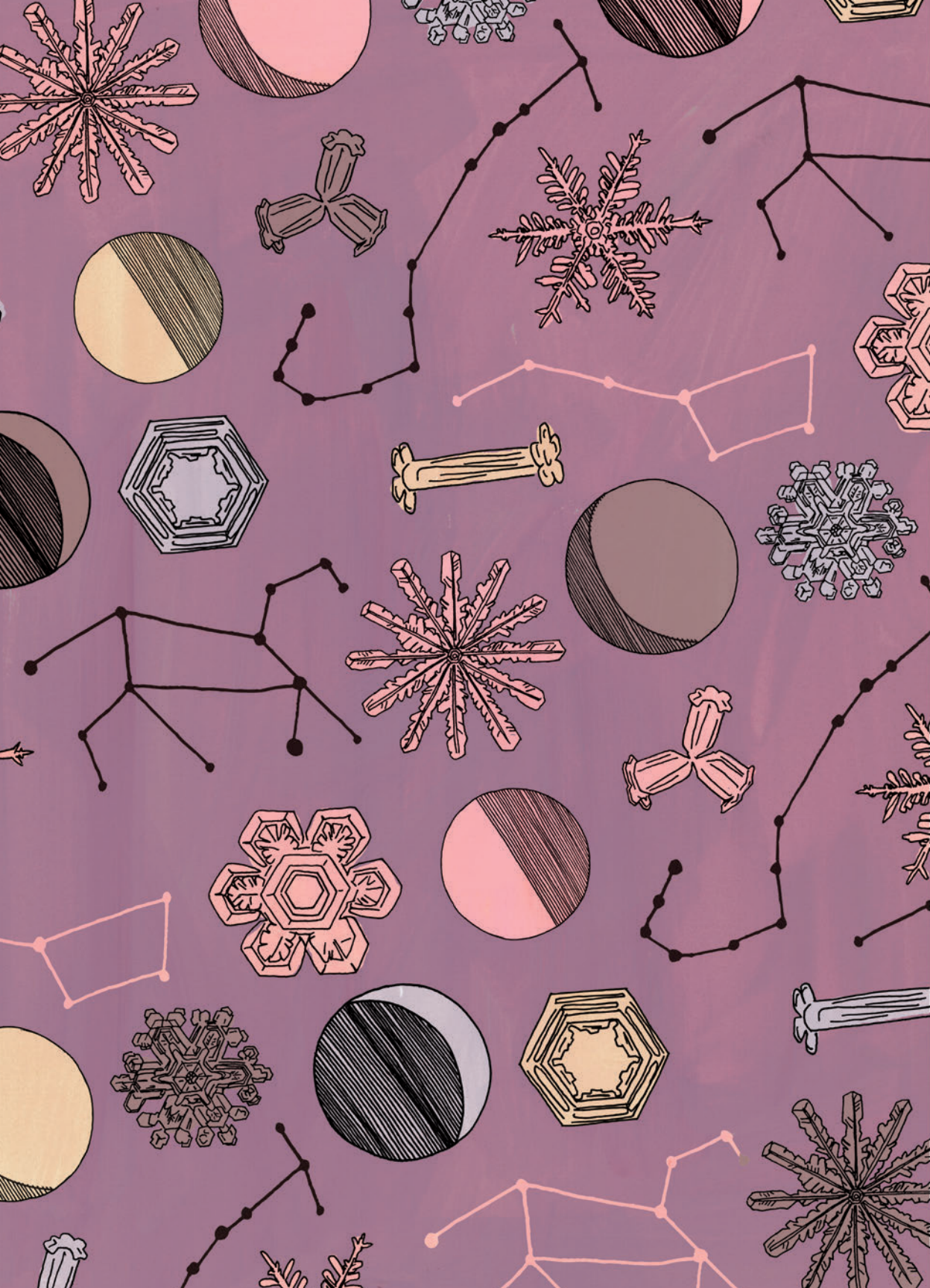
Block in the color in large strokes. Think about using colors that complement each other even if they aren't exactly accurate. Keep adding color shapes until the entire page is full. Try not to leave white paper. If you want to have white, paint it rather than leaving the paper blank.

TIPS

Hold your paintbrush near the tip, not the brush, so it's a bit looser in your hand and harder to control. Do lots of paintings of the same scene, switching the colors slightly to see how much it changes the image.

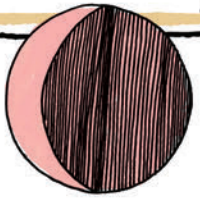






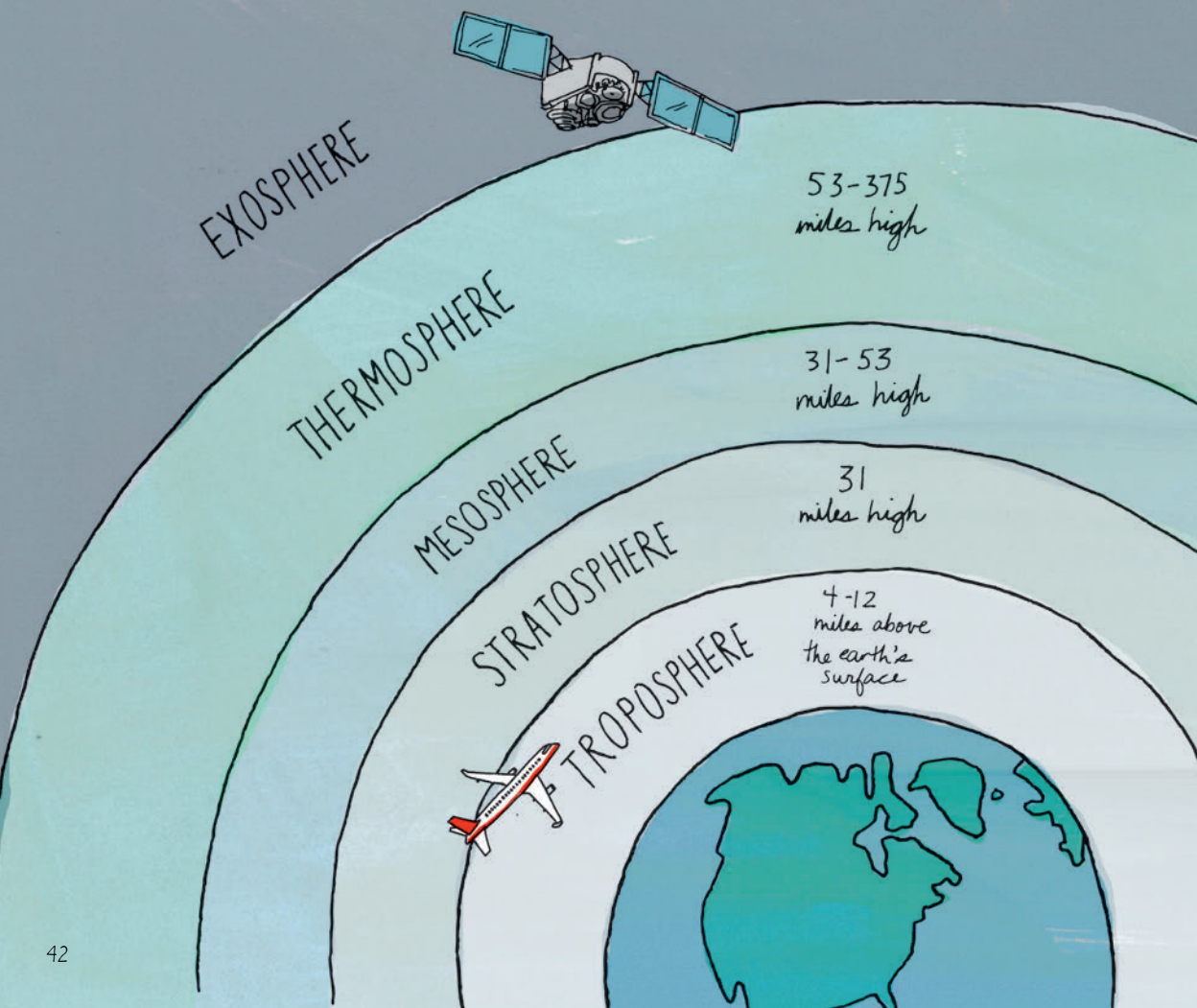
CHAPTER 2

What's Up?



UP IN THE ATMOSPHERE

The atmosphere encompasses all of the layers of gaseous masses that surround the earth.



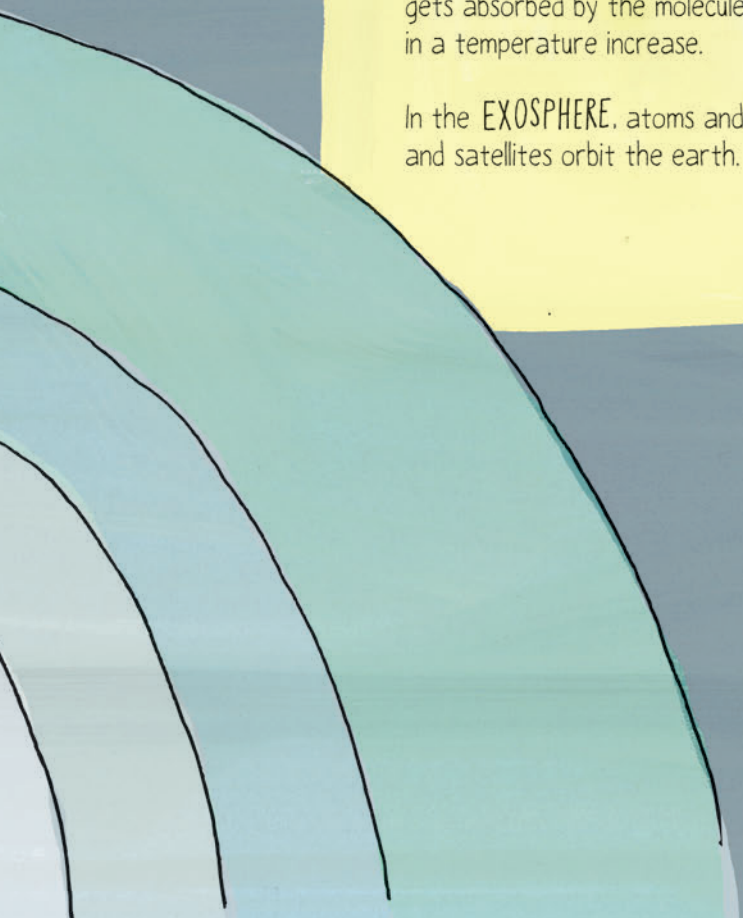
The TROPOSPHERE is the lowest atmospheric level and almost all weather occurs in this region. The troposphere begins at the earth's surface and extends from 4 to 12 miles high.

The STRATOSPHERE holds 19 percent of the atmosphere's gases but very little water vapor.

The gases, including oxygen molecules, continue to become less dense as one ascends the MESOSPHERE.

The THERMOSPHERE is also known as the upper atmosphere. Ultraviolet and x-ray radiation from the sun gets absorbed by the molecules in this layer, which results in a temperature increase.

In the EXOSPHERE, atoms and molecules escape into space and satellites orbit the earth.



Predicting Weather

Here are some ways to predict weather so you're not caught off guard on a hike:

CLOUD FORMATION

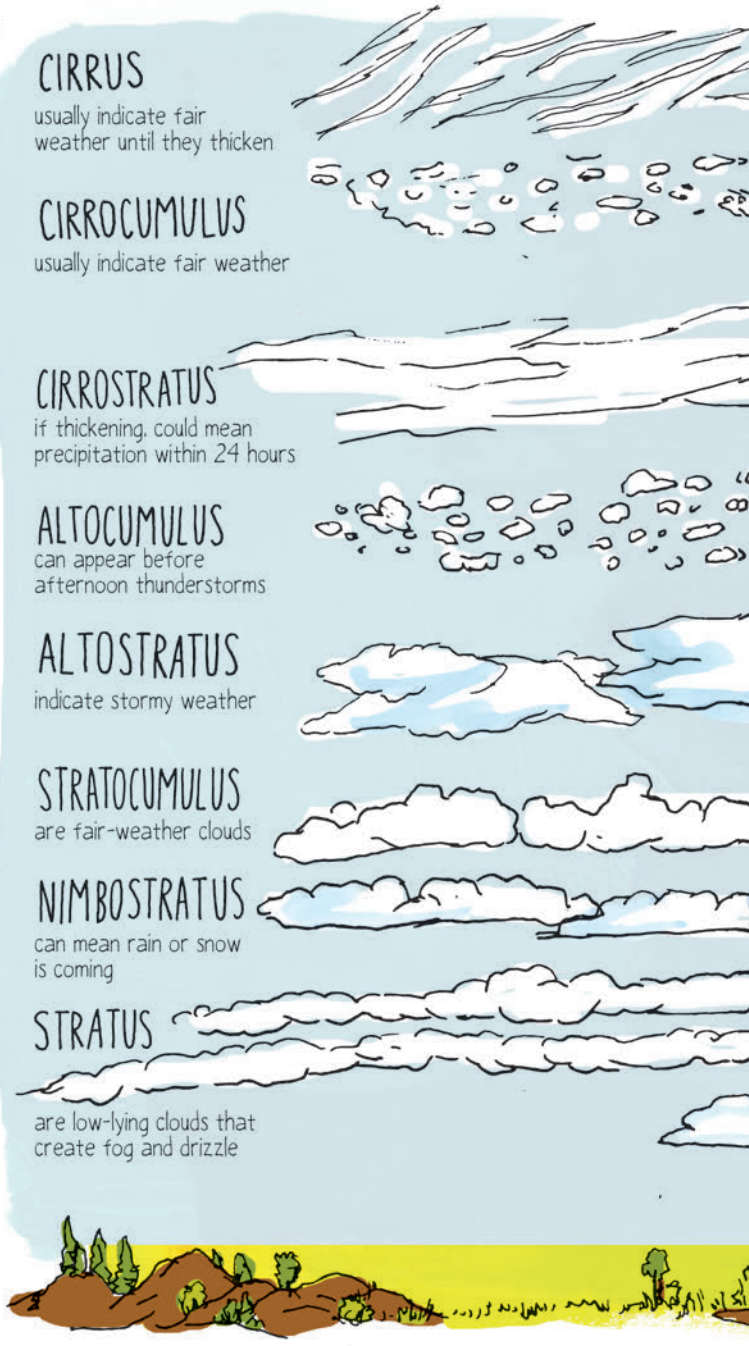
Certain types of clouds are good indicators of precipitation or storms.

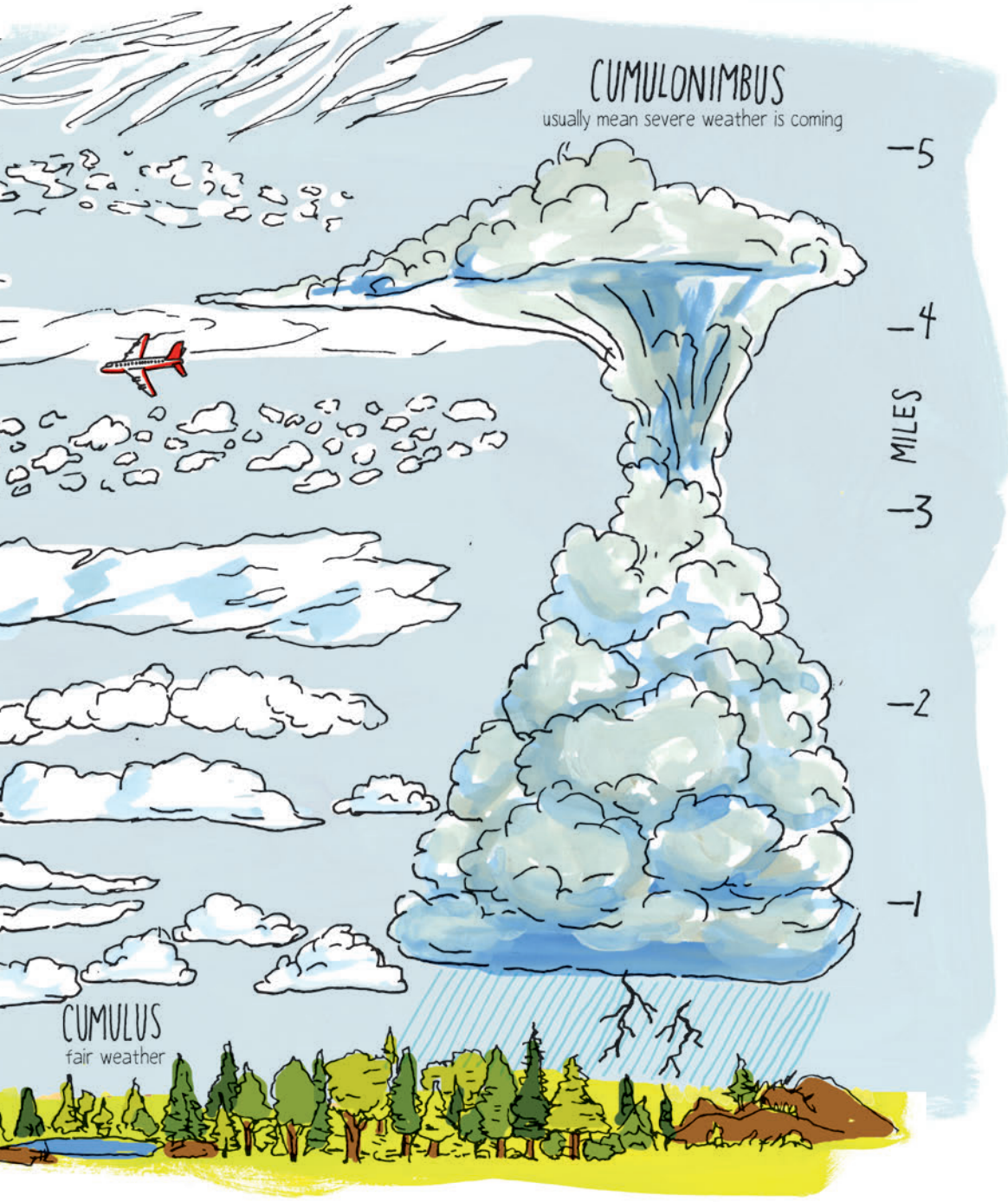
MORNING DEW

Heavy dew means there aren't strong winds to dry it off. That usually forecasts fair weather.

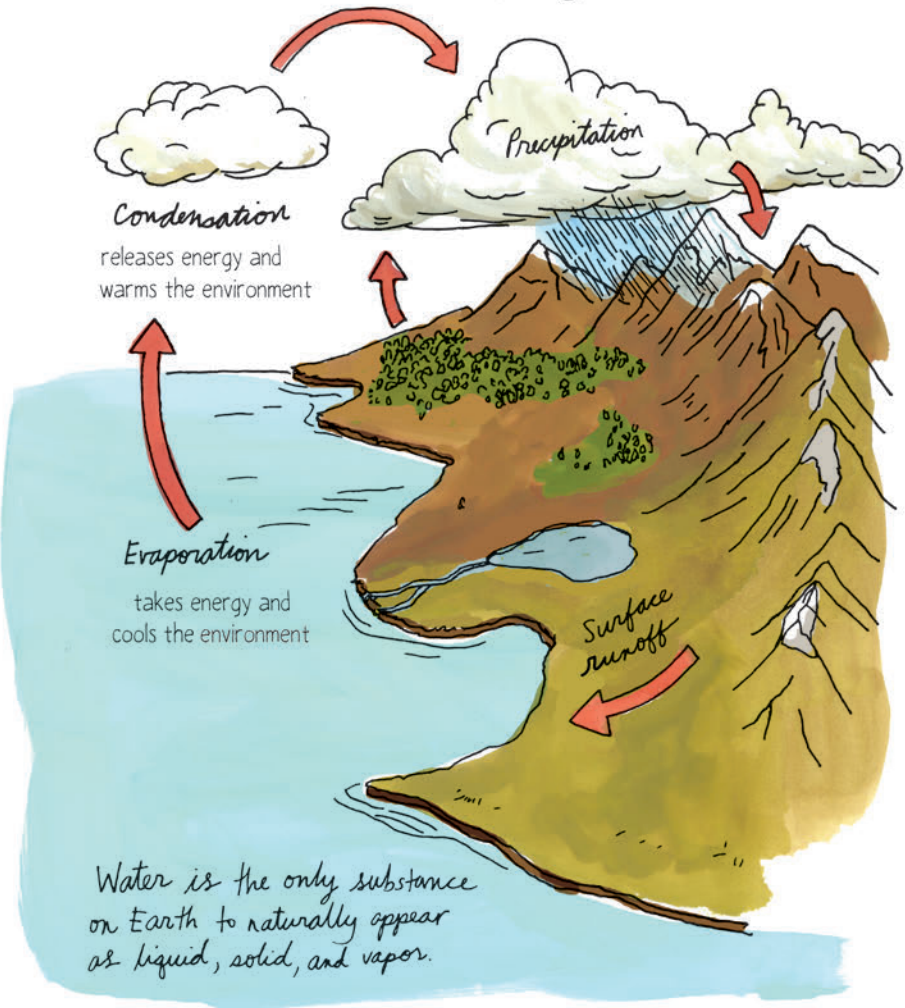
FLIGHT PATTERNS

Birds fly lower to the ground when a storm is coming because the air pressure hurts their ears.




CUMULONIMBUS
usually mean severe weather is coming
5
4
MILES
3
2
1
CUMULUS
fair weather

The Water Cycle



In the natural world, water is always moving and changing its form. It travels from streams to rivers to oceans, from lakes and oceans to the atmosphere, and from the atmosphere back to land. This cycle slowly purifies water and replenishes the land with fresh water.

Fog vs. Mist

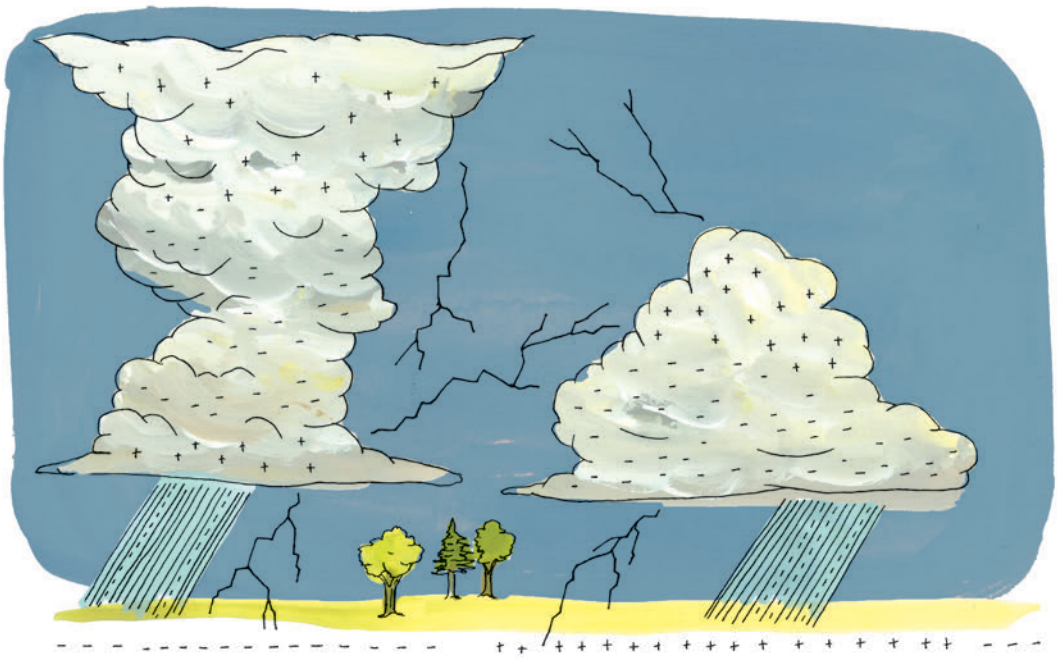
Fog is a stratus cloud formation located close to the surface of the earth. Mist is made of tiny water droplets suspended in the air. Both can form when there is a significant temperature difference between the air and the ground. Bodies of water or moist ground in the immediate area provide the water vapor that becomes mist or fog.

The main difference is that fog reduces visibility to less than 1 kilometer; you can see farther in mist.



Thunderstorm

Storms develop when masses of very cold air collide with masses of very warm air. As the warm air rises, surface air pressure drops, creating a vacuum effect. Cold air rushes in, forcing more warm air upward in a turbulent cycle that can produce strong winds, rain, and hail.



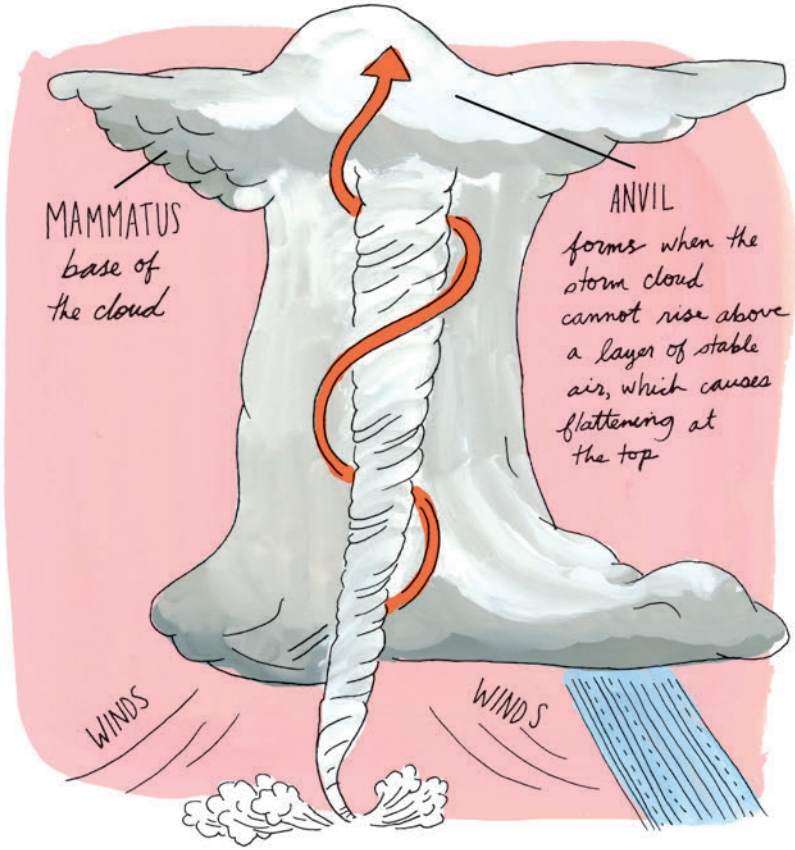
Lightning

The air is full of ions (atoms or molecules with an electrical charge). In a thundercloud, positive ions are grouped near the top of the cloud and negative ones at the bottom. When the difference in voltage becomes great enough, a bolt of lightning balances out the charge. Lightning can bridge the top and bottom of a cloud or strike from the cloud to the ground. Claps of thunder result from sound waves created by the lightning.

Tornado

The collision of hot and cold air can produce mammoth rotating thunderstorms called supercells. A tornado is a violently rotating column of air that stretches between the cumulonimbus clouds of a supercell and the ground.

Tornadoes are classified by wind speed and destructive power on the Enhanced Fujita Scale between EF0 and EF5.



Tornado Alley in the central United States has the highest occurrence of tornadoes in the world.

WHY ARE ALL SNOWFLAKES DIFFERENT?

A snowflake's shape is determined by temperature and humidity. At low temperatures inside a cloud, water vapor crystallizes directly into solid ice through a process called deposition. These tiny ice crystals keep growing until they are heavy enough to fall from the cloud as snowflakes.

As a crystal grows, the molecules do not stack together with perfect regularity. Each falling snowflake travels a unique path through many different microclimates, resulting in a different shaped arrangement of crystals.



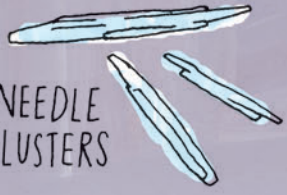
CAPPED COLUMN



BULLET ROSETTES



HOLLOWED COLUMNS



NEEDLE CLUSTERS

SOME SNOWFLAKE SHAPES



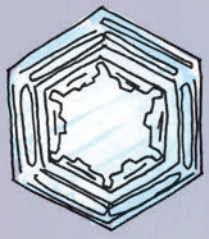
RIMED CRYSTAL



TRIANGULAR FORMS



ARROWHEAD



SIMPLE PRISM



STELLAR PLATE



STELLAR DENDRITE



12-SIDED SNOWFLAKE



FERNLIKE STELLAR DENDRITE

RAINBOWS

The familiar multicolored arc of a rainbow is one of nature's most striking phenomena. Rainbows are formed by light refracting and reflecting through tiny water droplets in the air. Light from the sun may look white or yellow, but it is actually a combination of many colors.

A rainbow always appears directly opposite the sun, but the observer's location determines its apparent position.




Black and white photos of rainbows show no bands, only a regular gradation of light.
The appearance of distinct bands of color is just a result of the way human color vision works.

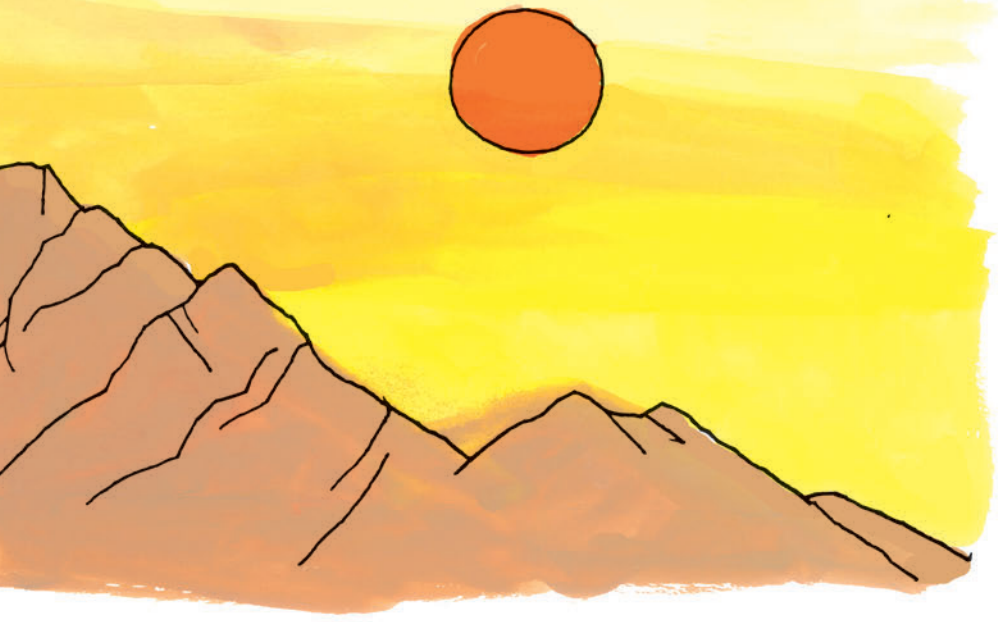
SUNSETS

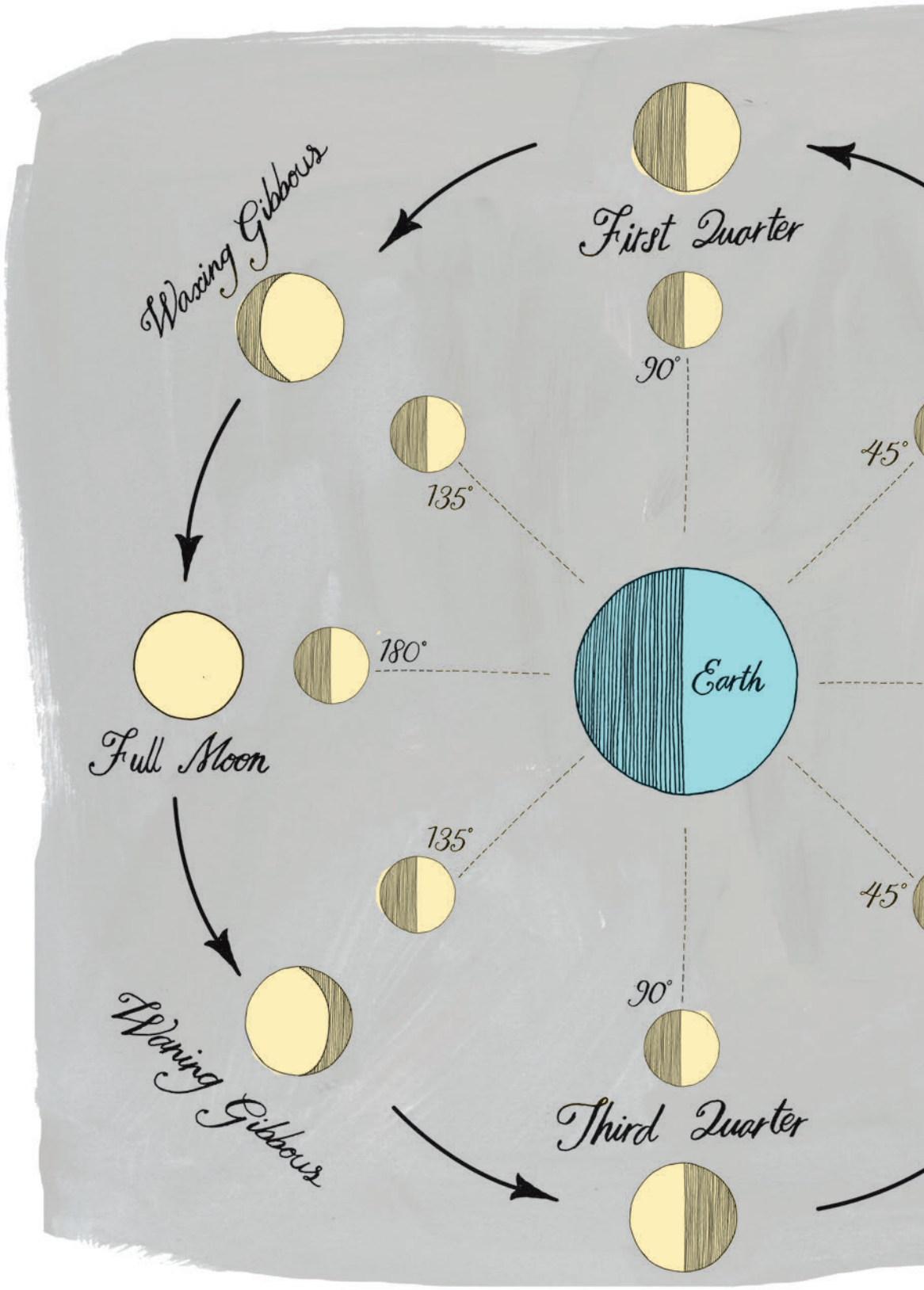
Sunlight is made up of many different wavelengths and colors of light. When sunlight strikes particles in the atmosphere (such as water and air molecules, dust, pollen, or pollution), certain wavelengths are deflected and refracted more than others.

Because of the indirect angle of the sunlight striking the earth at sunset, the light has to travel through more atmospheric particles, so more of it is scattered. Blue and green wavelengths are largely filtered out, leaving the longer-wavelength orange and red hues.



The colors of sunsets are often more dramatic than sunrise colors because evening air is warmer and holds more particles aloft than morning air.




First Quarter
Waxing Gibbous
90°
45°
135°
180°
Earth
Full Moon
135°
45°
90°
Waning Gibbous
Third Quarter

Phases of the Moon





CONSTELLATIONS



For thousands of years, humans have sought and found meaning in the patterns of the stars. Constellations, or asterisms, are images formed by groups of prominent stars in the night sky. Though the stars of a single constellation appear to be close to each other, they may in fact be many light years apart.

The images and meanings ascribed to constellations have varied between cultures and eras, but the International Astronomical Union currently recognizes 88 constellations in the northern and southern skies. Many constellation names we use today are Latin and from the time of the Roman empire, though the particular meanings and images are often much older than that.

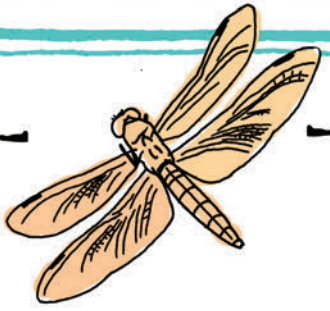




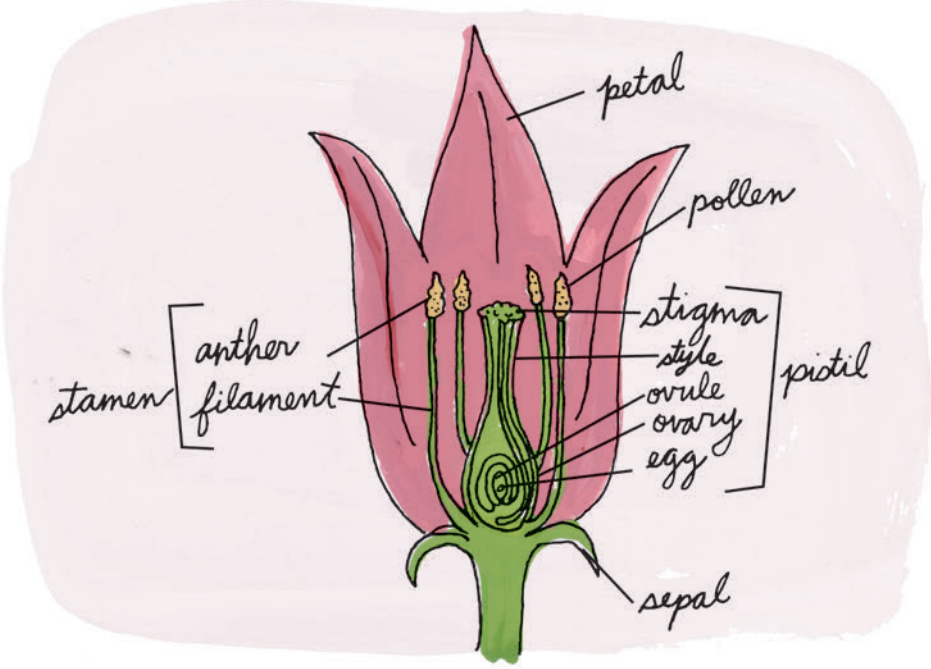


CHAPTER 3

Come Close



ANATOMY OF A FLOWER



anther - male reproductive cell that contains pollen
filament - supports the anther
sepal - modified leaf beneath the flower
stamen - includes the male parts of the flower
pistil - includes the female parts of the flower
ovary - female reproductive organ
ovule - reproductive cell; forms the seed when fertilized with pollen
stigma - structure atop the ovary that receives pollen
style - stalk that connects the stigma and the ovary

WILD-FLOWERS



SMALL CAMAS (CAMASSIA QUAMASH)



MOSS PINK (PHLOX SUBULATA)



BABY BLUE EYES (NEMOPHILA MENZIESII)



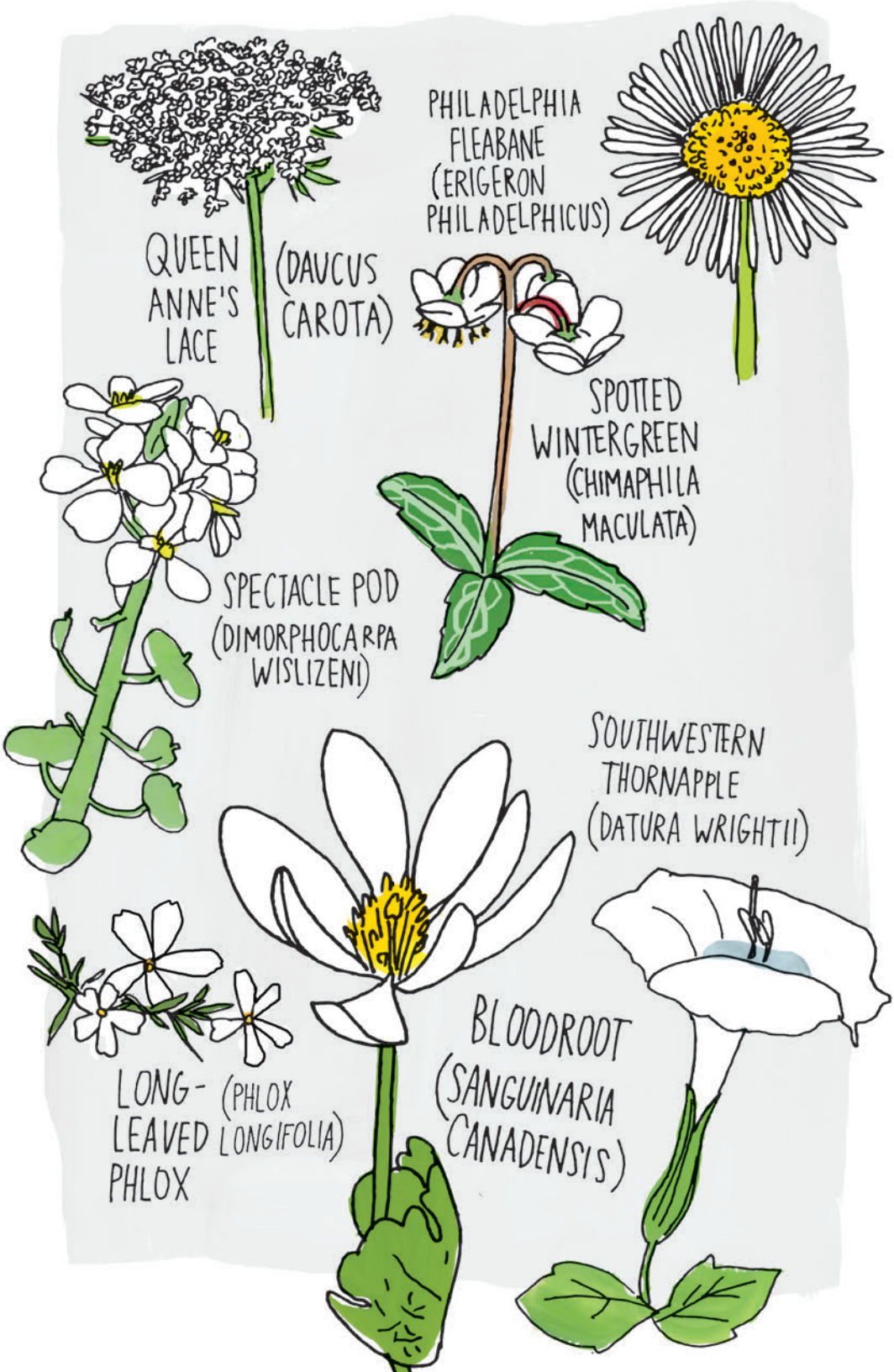
CHICORY (CICHORIUM INTYBUS)

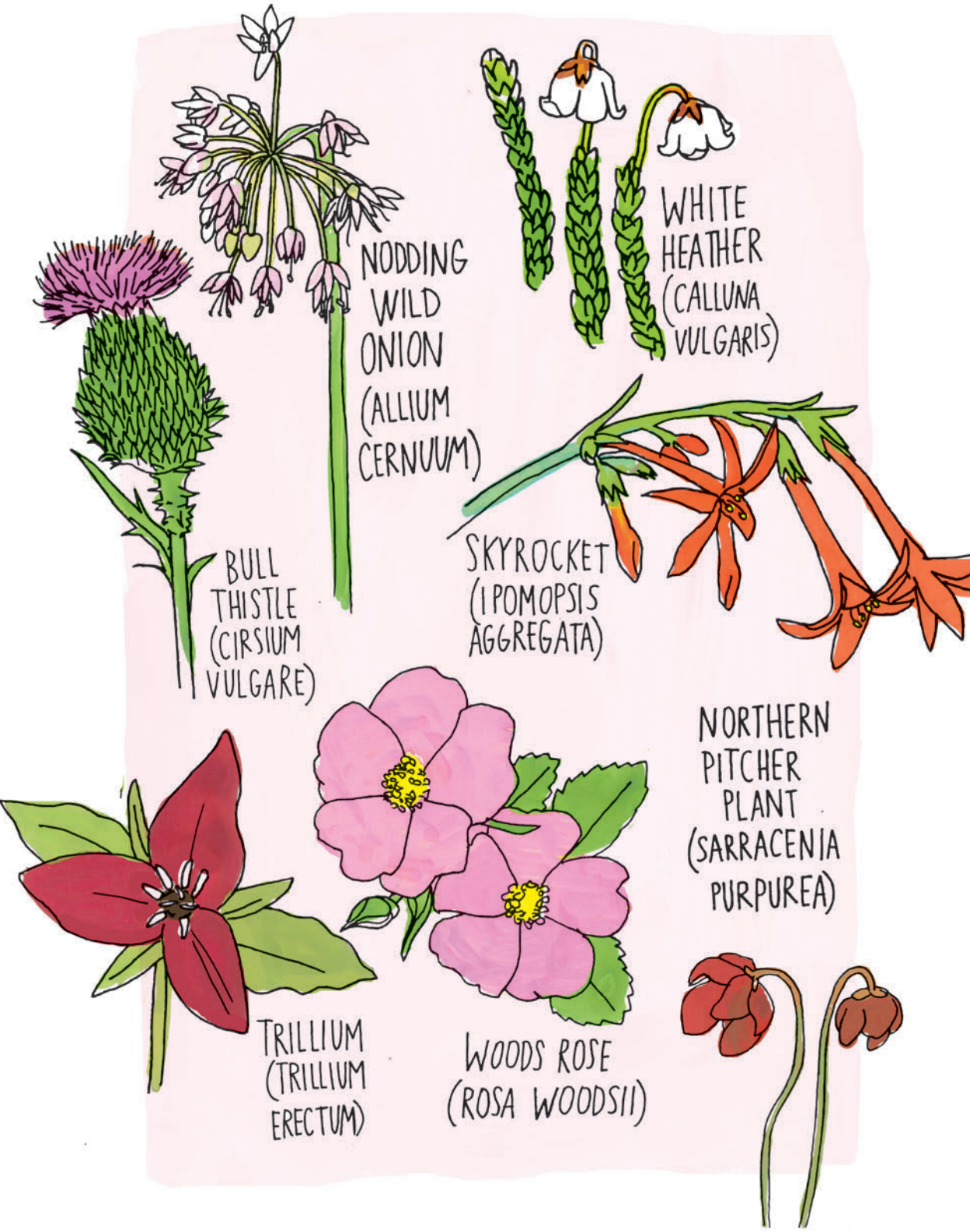
COLUMBIA VIRGIN'S BOWER (CLEMATIS COLUMBIANA)

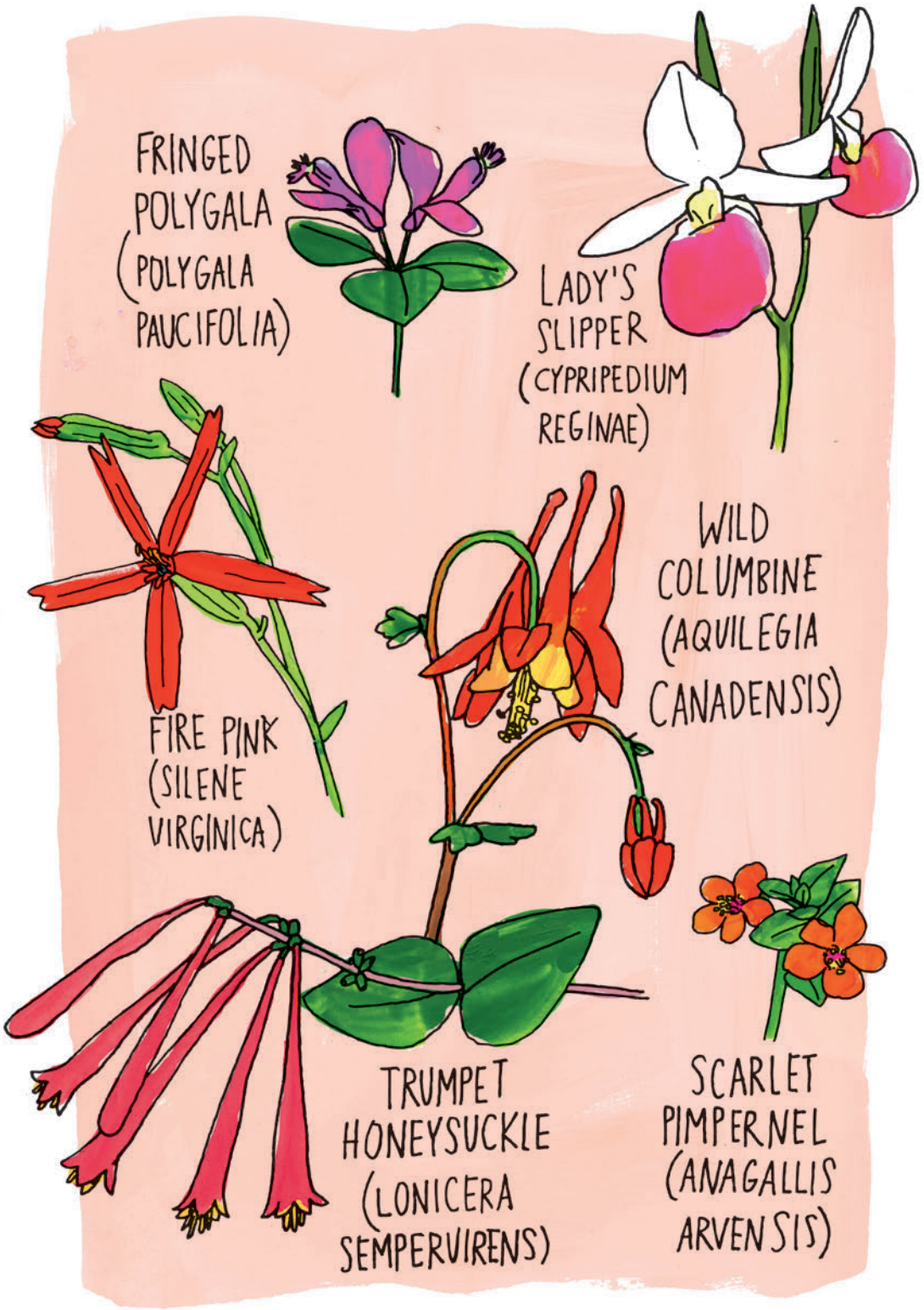


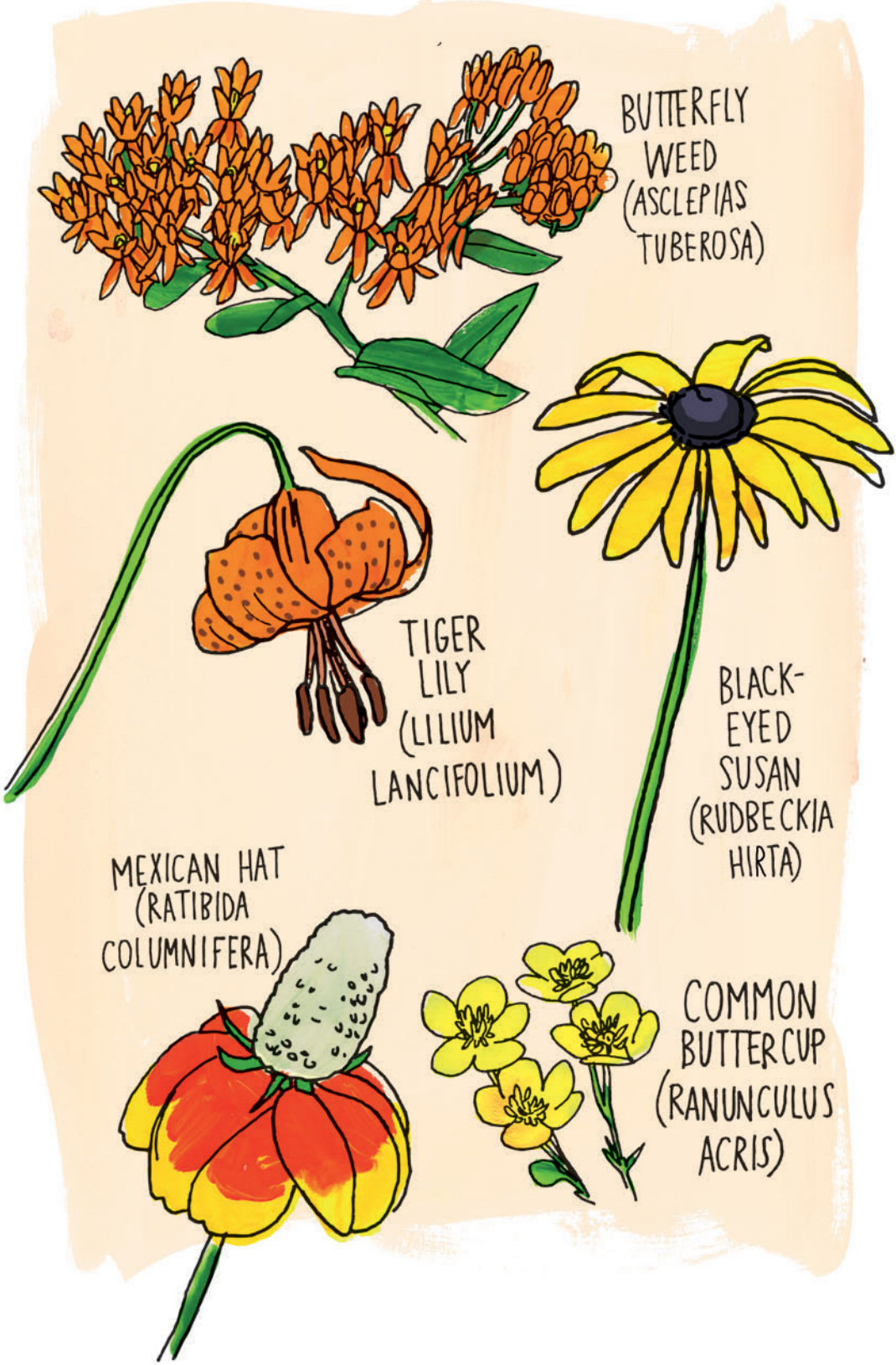
FRINGED GENTIAN (GENTIANOPSIS CRINITA)



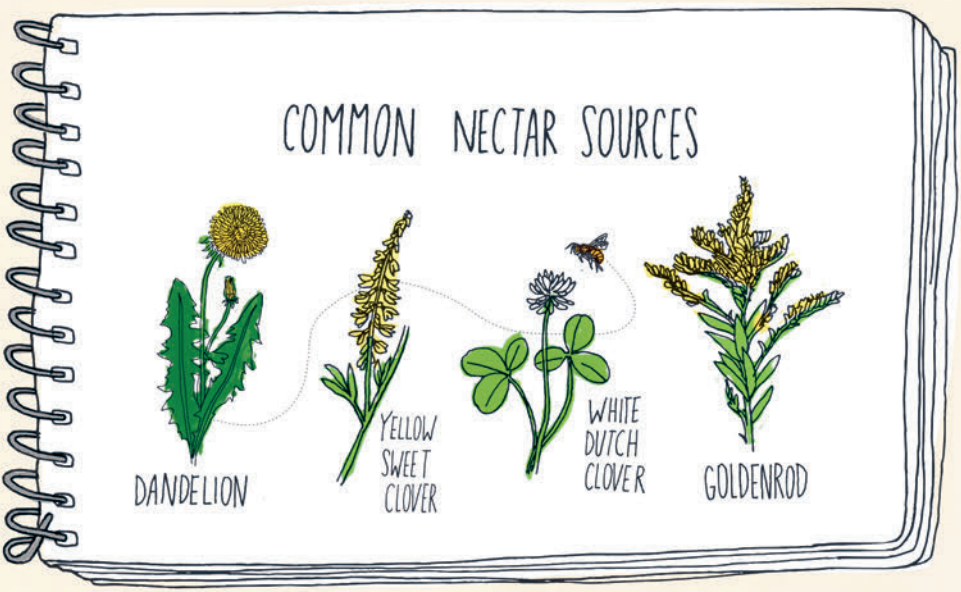

QUEEN ANNE'S LACE
(DAUCUS CAROTA)
PHILADELPHIA FLEABANE (ERIGERON PHILADELPHICUS)
SPOTTED WINTERGREEN (CHIMAPHILA MACULATA)
SPECTACLE POD (DIMORPHOCARPA WISLIZENI)
SOUTHWESTERN THORNAPPLE (DATURA WRIGHTII)
LONG-LEAVED PHLOX
(PHLOX LONGIFOLIA)
BLOODROOT (SANGUINARIA CANADENSIS)


NODDING WILD ONION (ALLIUM CERNUUM)
WHITE HEATHER (CALLUNA VULGARIS)
BULL THISTLE (CIRSIUM VULGARE)
SKYROCKET (IPOMOPSIS AGGREGATA)
NORTHERN PITCHER PLANT (SARRACENIA PURPUREA)
TRILLIUM (TRILLIUM ERECTUM)
WOODS ROSE (ROSA WOODSII)


FRINGED POLYGALA (POLYGALA PAUCIFOLIA)
LADY'S SLIPPER (CYPRIPEDIUM REGINAE)
WILD COLUMBINE (AQUILEGIA CANADENSIS)
FIRE PINK (SILENE VIRGINICA)
TRUMPET HONEYSUCKLE (LONICERA SEMPERVIRENS)
SCARLET PIMPERNEL (ANAGALLIS ARVENSIS)


BUTTERFLY WEED (ASCLEPIAS TUBEROSA)
TIGER LILY (LILIUM LANCIFOLIUM)
BLACK-EYED SUSAN (RUDBECKIA HIRTA)
MEXICAN HAT (RATIBIDA COLUMNIFERA)
COMMON BUTTERCUP (RANUNCULUS ACRIS)

COMMON NECTAR SOURCES





HONEY

North America has some 4,000 species of native bees, but our familiar honey bee came over from Europe with the settlers.



LEAF CUTTER



CARPENTER



BUMBLE

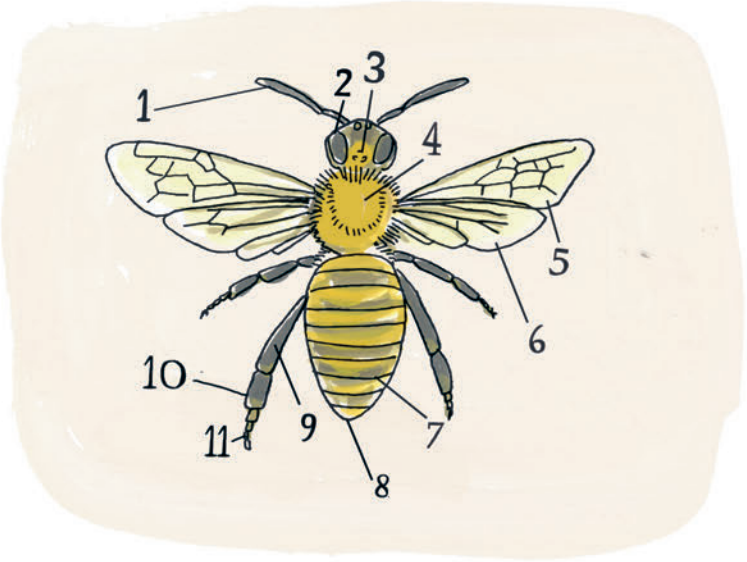


SWEAT



MASON

ANATOMY OF A BEE



1. **antenna** - contains thousands of tiny sensors that detect smell
2. **compound eye** - for general distance sight
3. **ocellus** - three simple eyes used for low light conditions in the hive
4. **thorax** - segment between head and abdomen where wings attach
5. **forewing**
6. **hindwing**

   — 2-part wings hook together in flight but separate at rest
7. **abdomen** - contains all the organs, wax glands, and stinger
8. **stinger** - only present on worker and queen bees
9. **femur**
10. **tibia**
11. **tarsal claw**

    — three pairs of legs with six segments each; used for walking and packing pollen

BUTTERFLY FAMILIES OF NORTH AMERICA

TRUE BUTTERFLIES



swallowtails (FAMILY PAPILIONIDAE)
medium to large, tail-like appendages on hindwings, colorful



brush-footed (FAMILY NYMPHALIDAE)
largest family, two shorter legs used for tasting food



whites + sulphurs (FAMILY PIERIDAE)
mostly white or yellow wings with black or orange marks



gossamer-winged (FAMILY LYCAENIDAE)
sheer wings, smaller sized, includes hairstreaks, blues and copper

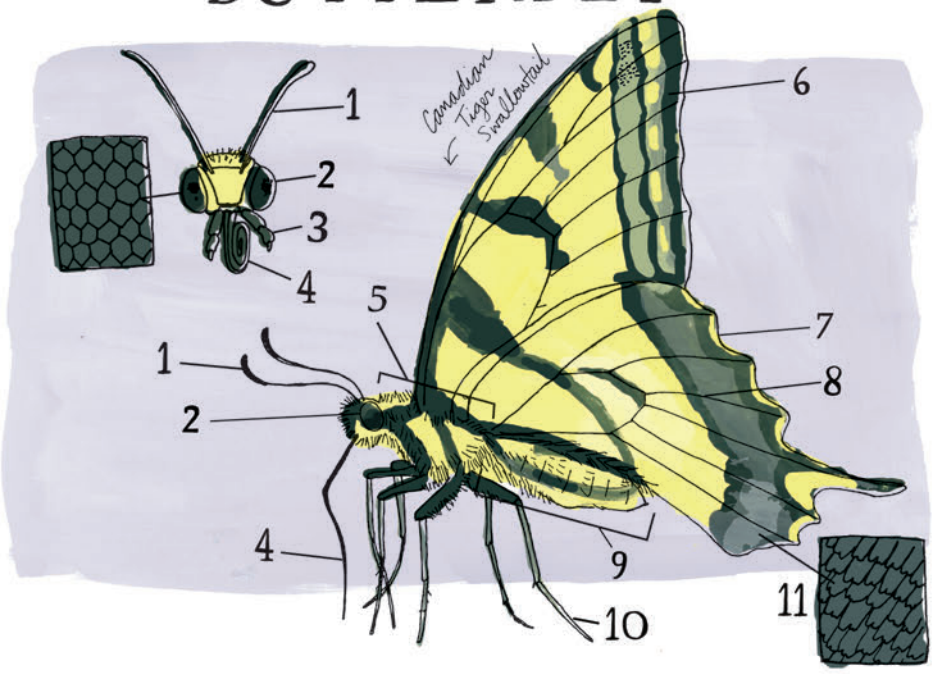


metalmarks (FAMILY RIODINIDAE)
small to medium, mostly tropical, metallic marks



skippers (FAMILY HESPERIIDAE)
wide thoraxes, small wings, hooked antennae, brown and gray with white and orange marks

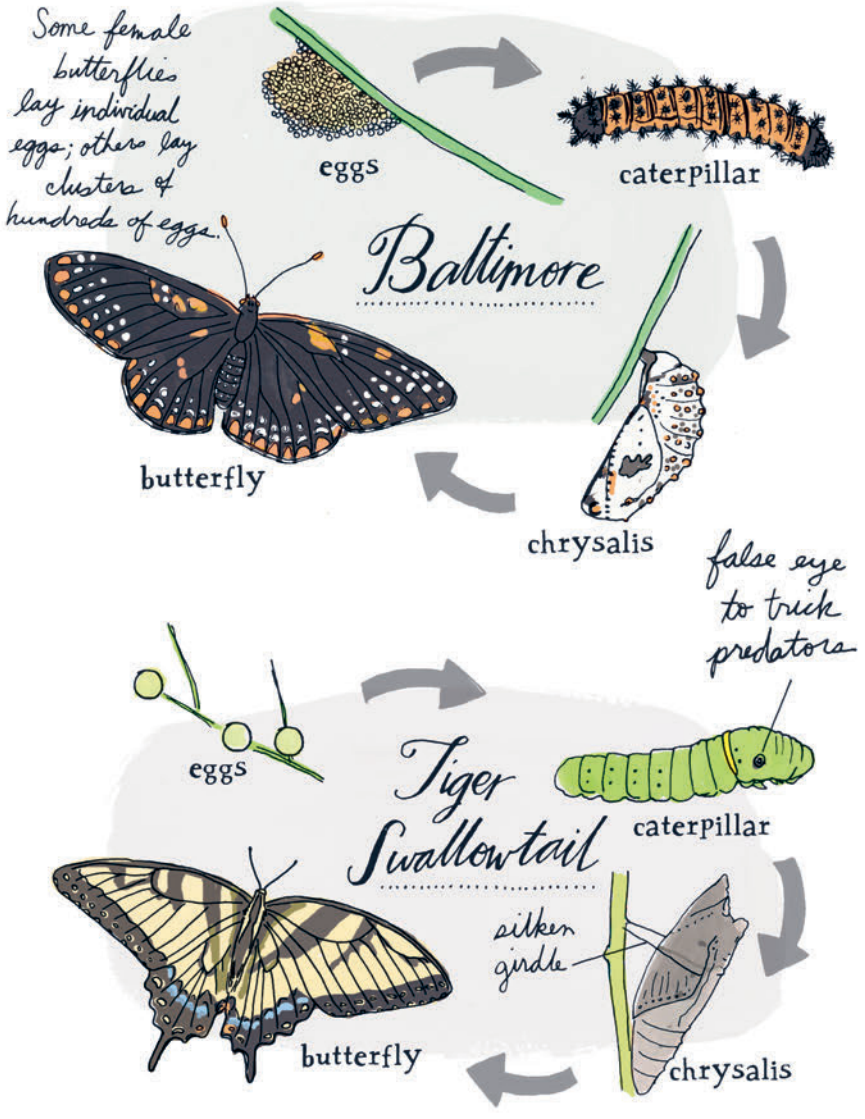
ANATOMY OF A BUTTERFLY

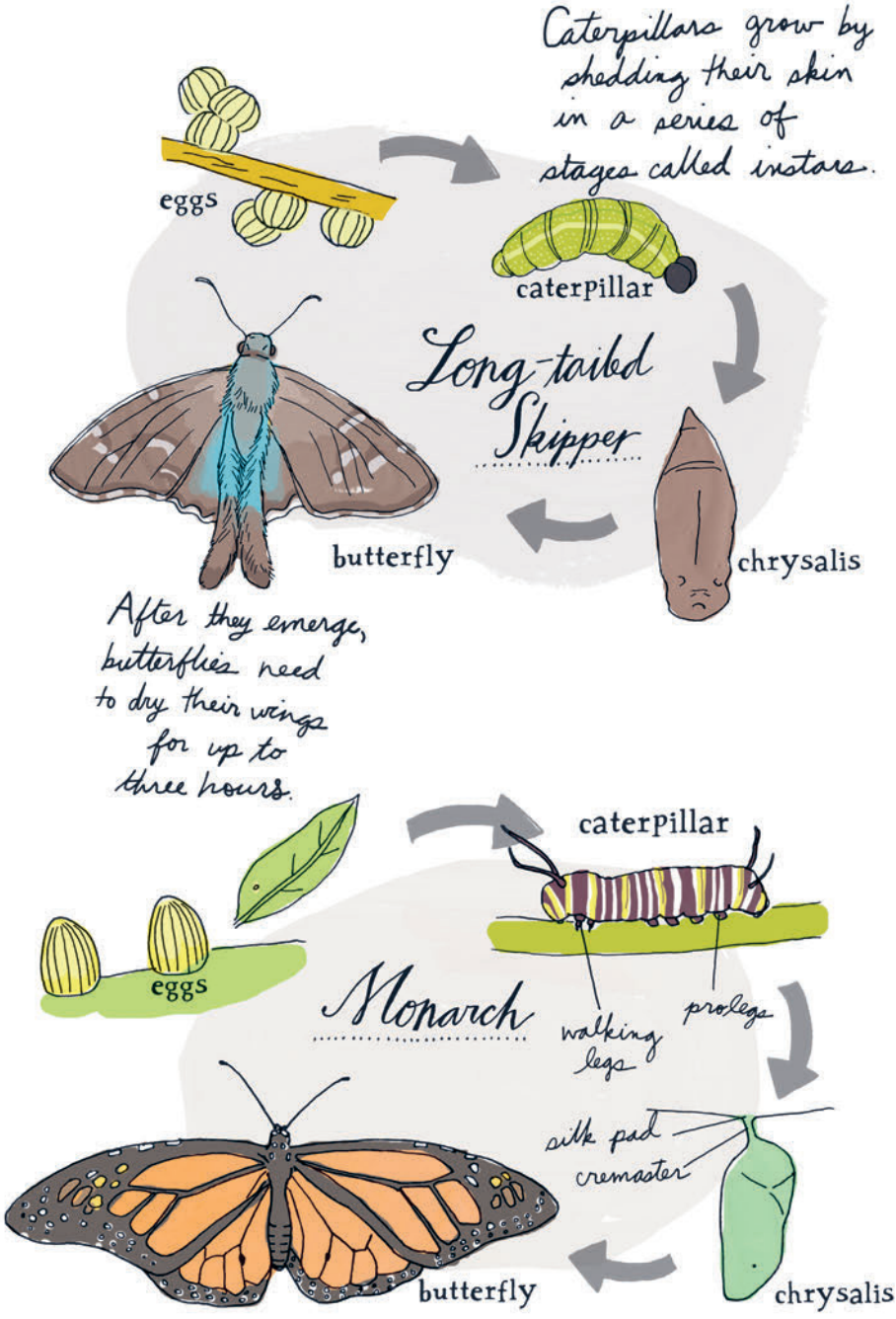


1. **antenna** - used as a form of radar and pheromone detection
2. **compound eye** - has up to 1,700 individual ommatidia (light receptors and lenses)
3. **palpus** - shields the eye from dust, covered in scent-detecting sensors
4. **proboscis** - like a long straw for feeding and drinking
5. **thorax** - three body segments that contain the flight muscles
6. **forewing**
7. **hindwing** — two pairs of overlapping wings that flap and sometimes glide
8. **wing veins** - vary between each genus of butterfly, used in classification
9. **abdomen** - contains the digestive system, respiratory equipment, heart, and sex organs
10. **legs** - butterflies have three pairs except in the Nymphalidae family
11. **scales** - wings are covered in tiny dust-like colored scales

Metamorphosis

The life cycle of a butterfly has four stages: 1. egg, 2. larva (caterpillar), 3. pupa (chrysalis), 4. adult (butterfly).




Caterpillars grow by shedding their skin in a series of stages called instars.
eggs
caterpillar
Long-tailed Skipper
butterfly
chrysalis
After they emerge, butterflies need to dry their wings for up to three hours.
caterpillar
eggs
Monarch
walking legs
prolegs
silk pad
cremaster
butterfly
chrysalis



Monarch Migration

Monarchs travel south in the winter and north in the summer, just like birds. Because of the butterflies' short lifespan, each migration consists of an entirely new generation.



PLANTS THAT ATTRACT BUTTERFLIES



Anise Hyssop

attracts Red Admiral, Monarch, Painted Lady, Buckeye, Milbert's Tortoiseshell, Pipevine Swallowtail, Sulphur

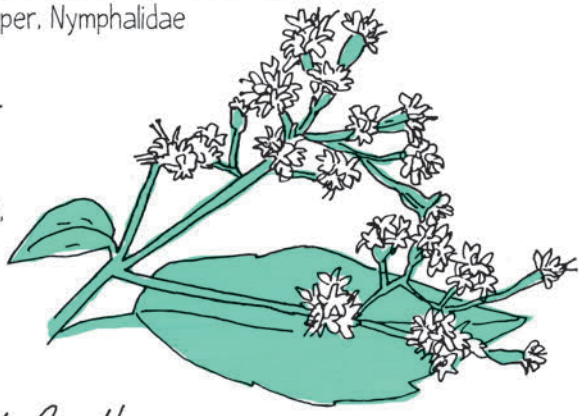


Butterfly Bush

attracts Monarch, Buckeye, Black Swallowtail, Pipevine Swallowtail, Snout Butterfly, Great Spangled Fritillary, Pearl Crescent, Red Admiral, Painted Lady, Common Checkered Skipper, Nymphalidae

New Jersey Tea

attracts Spring Azure, Coral Hairstreak, Striped Hairstreak, Edward's Hairstreak, Acadian Hairstreak





Cut-Leaf Coneflower

attracts Great Spangled Fritillary, Pearl Crescent, Viceroy, Monarch, Blues

Pink Turtlehead

attracts Silver-Spotted Skippers, Spicebush Swallowtail, Tiger Swallowtail



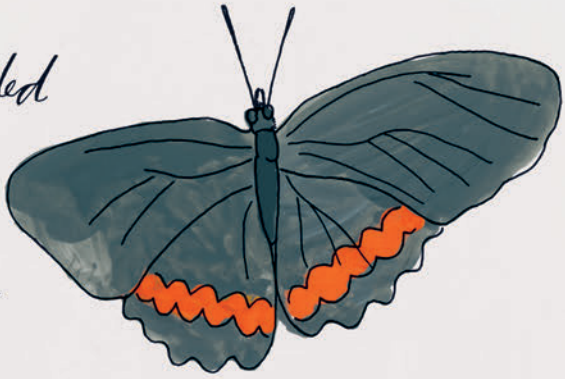
BEAUTIFUL BUTTERFLIES

Crimson-banded Black

(BIBLIS HYPERIA)

Mexico to Panama and South Texas

2 - 2 1/8"





Tawny Emperor

(ASTEROCAMPA CLYTON)

S. Ontario, Nebraska, Wisconsin, Massachusetts south to east Texas and south Georgia

1 5/8 - 2 3/4"

Theona Checkerspot

(CHLOSYNE THEONA)

east central Texas, southern New Mexico, and central Arizona

1 1/4 - 1 3/4"





Eastern Tailed-Blue

(EVERES COMYNTAS)

Southern Canada to Central America; entire area east of the Rockies

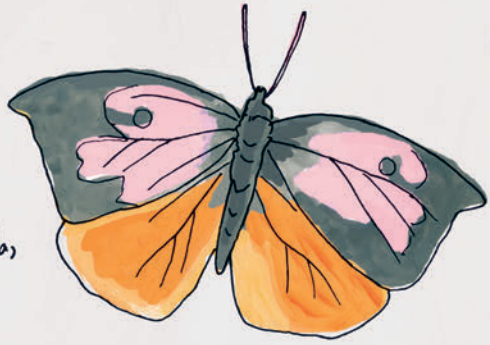
3/4 – 1"

California Dogface

(ZERENE EURYDICE)

California coast ranges, lower western Sierra Nevada, and western Arizona

1 5/8 – 2 1/2"





Spicebush Swallowtail

(PTEROURUS TROILUS)

eastern North America

3 1/2 – 4 1/2"

Zebra Longwing

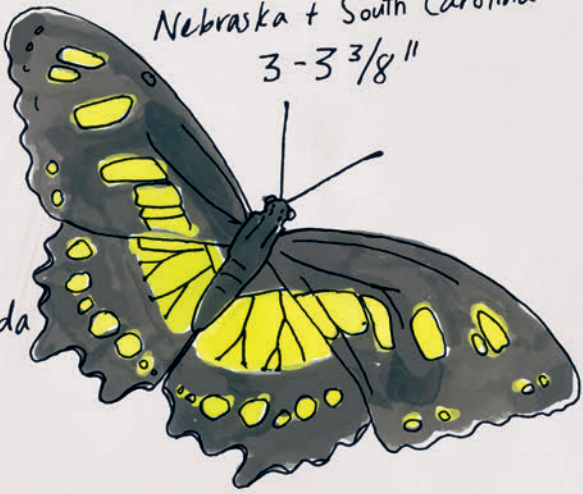


(HELICONIUS CHARITONIUS)

South America through Central America, southern Texas, peninsular Florida, sometimes New Mexico, Nebraska + South Carolina

3 - 3 3/8"

Malachite



(SIPROETA STELENES)

Central America, Mexico to southern Florida and south Texas

3 1/3 - 3 7/8"

White Checkered Skipper



(PYRGUS ALBESCENS)

Southern California, Southern Arizona, Southern New Mexico, west + south Texas, Florida, Mexico

1 - 1 1/2"

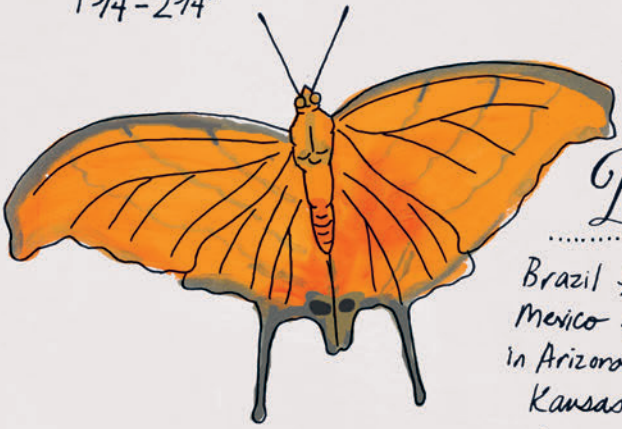
Buckeye

(JUNONIA COENIA)

southern Manitoba, Ontario, Quebec, Nova Scotia - all over US except northwest

1 3/4 - 2 3/4"





Ruddy Daggerwing

Brazil through Central America; Mexico to south Florida. Rarely in Arizona, Colorado, Nebraska, Kansas, south Texas

(MARPESIA PETREUS)

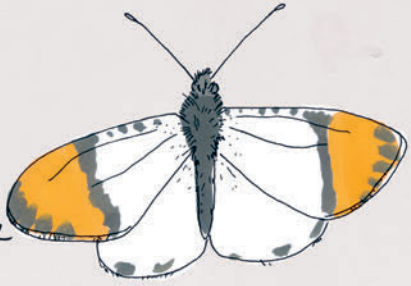
2 5/8 - 2 7/8"

Sara Orangetip

(ANTHOCHARIS SARA)

Alaska coast south to Baja, CA - west of Pacific Divide

1 - 1 1/2"



COLORFUL MOTHS



Hummingbird Clearwing

(HEMARIS THYSBE)
1½-2"



Rosy Maple

(DRYOCAMPA RUBICUNDA)
1⅛-2"



Colona

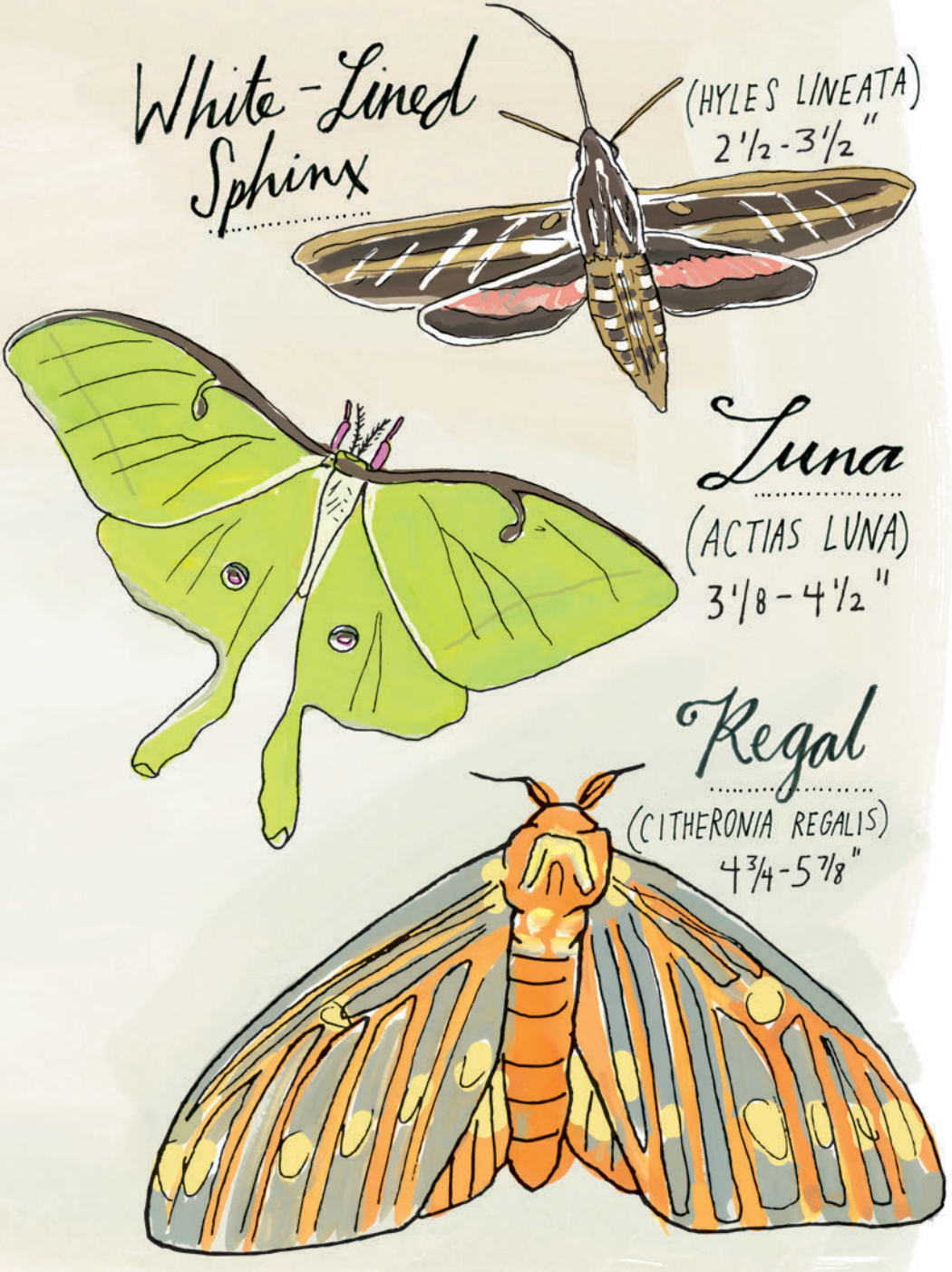
(HAPLOA COLONA) 1½-2¼"

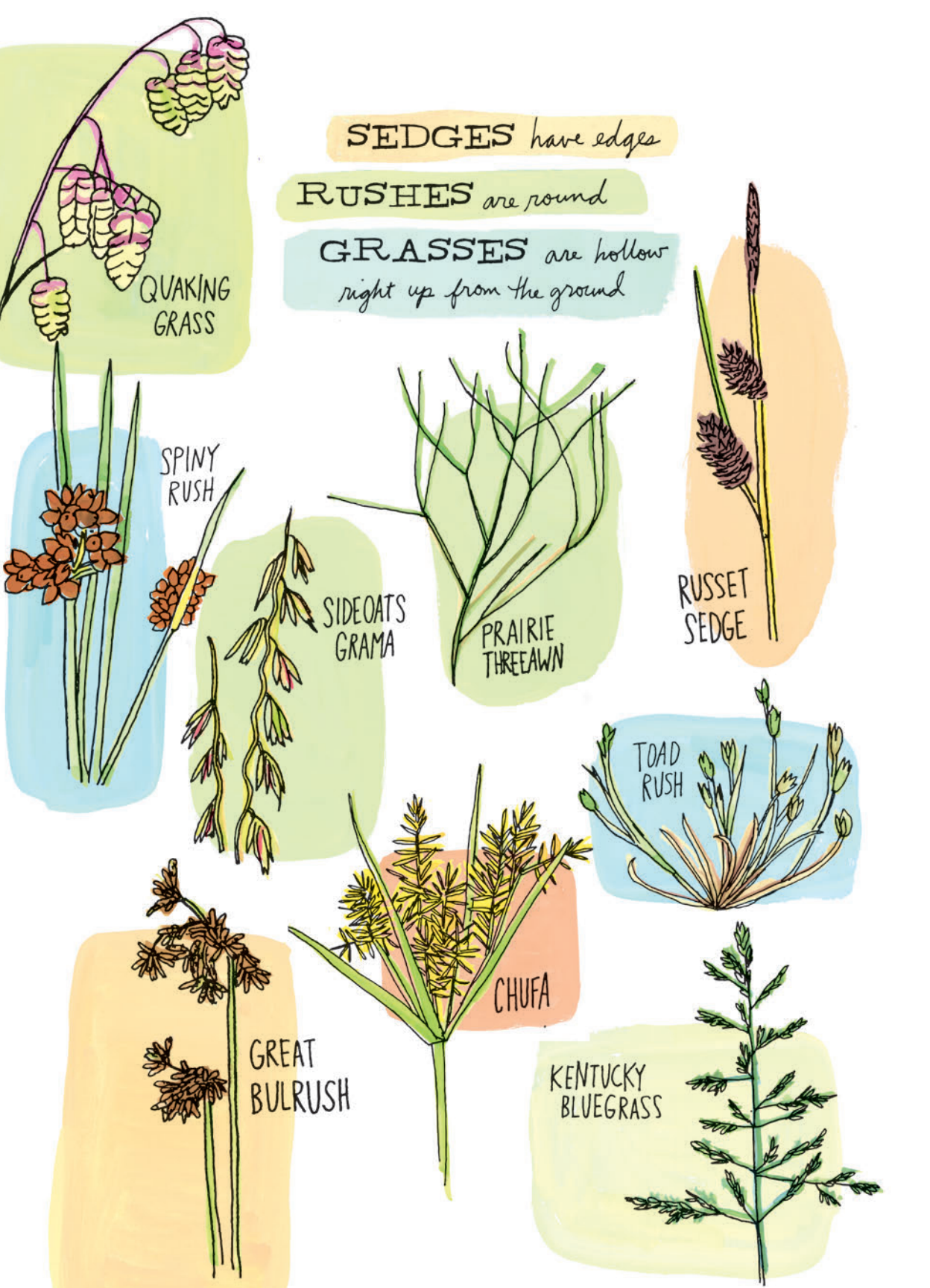
IO (AUTOMERIS IO)

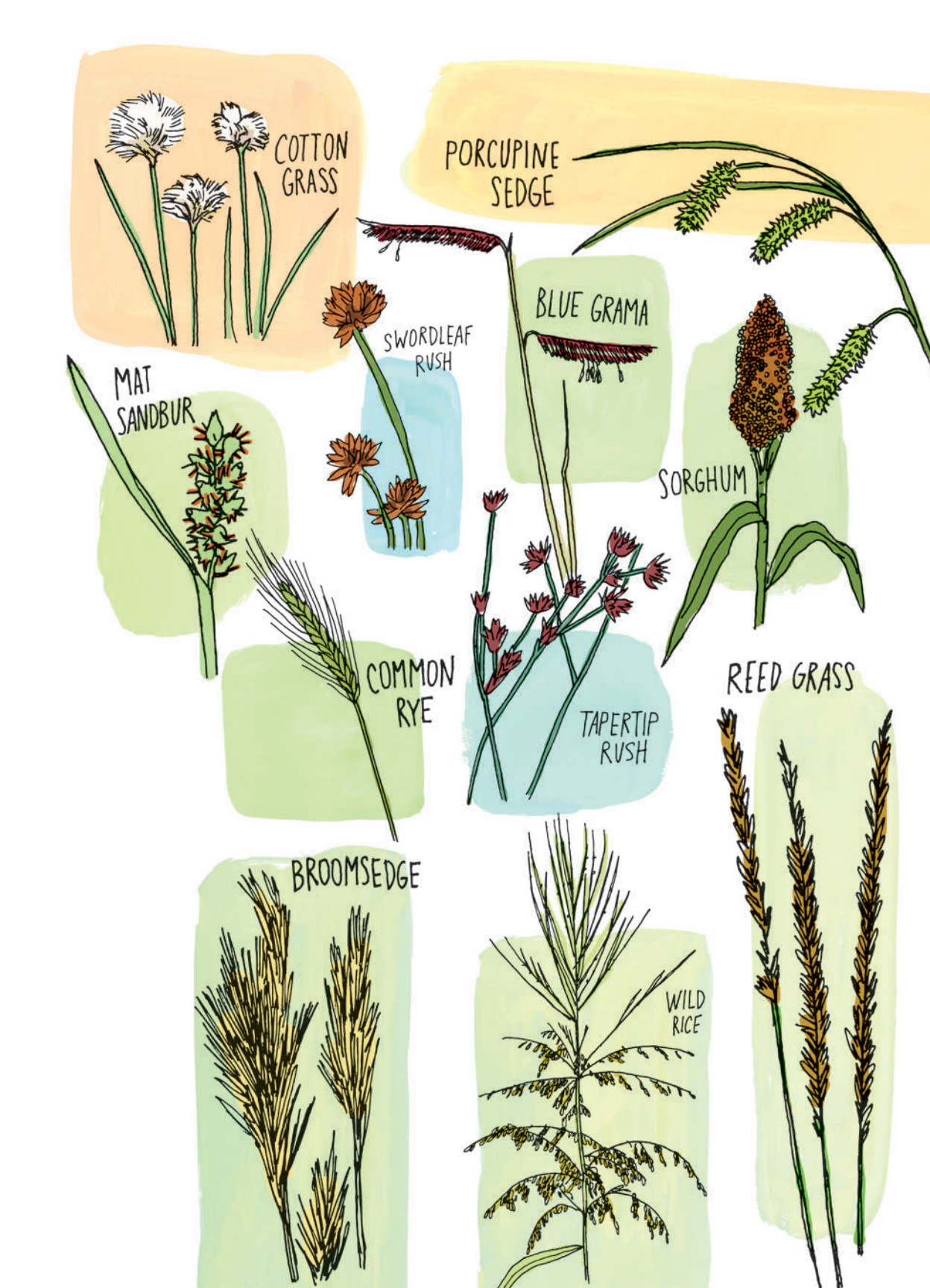
2-3"



BUTTERFLY	VS.	MOTH
· active during the day		· nocturnal
· uses sight to find mate		· uses smell to find mate
· can't hear		· has ears
· uses sun for warmth		· flies for warmth
· makes hanging chrysalis		· makes a cocoon


White-Lined Sphinx
(HYLES LINEATA)
2 1/2 - 3 1/2"
Luna
(ACTIAS LUNA)
3 1/8 - 4 1/2"
Regal
(CITHERONIA REGALIS)
4 3/4 - 5 7/8"


SEDGES have edges
RUSHES are round
GRASSES are hollow right up from the ground
QUAKING GRASS
SPINY RUSH
SIDEOATS GRAMA
PRAIRIE THREEAWN
RUSSET SEDGE
TOAD RUSH
CHUFA
GREAT BULRUSH
KENTUCKY BLUEGRASS


COTTON GRASS
PORCUPINE SEDGE
BLUE GRAMA
SWORDLEAF RUSH
MAT SANDBUR
SORGHUM
COMMON RYE
TAPERTIP RUSH
REED GRASS
BROOMSEDGE
WILD RICE

GRAZING EDIBLES



Young Chicory

Early spring shoots are good raw and the roots can be roasted for a coffee substitute.



Miner's Lettuce

The nutritious, succulent leaves are delicious in raw salads.



Violet

Young leaves are tasty and the pretty flowers can be candied or eaten raw.



Lamb's-Quarters

Packed with nutrients. Use this prolific wild plant just like spinach.



Young Dandelion

Use small leaves from the center of the whorl and serve raw or lightly steamed.



Red Clover

High in protein, the leaves are good as a cooked green and the flowers make a nice tea.



Mullein

Tea from the flowers and leaves is good for coughs and other lung problems.



Plantain

Blanch the young leaves. Seeds can be ground into a nutritious meal and added to breads.



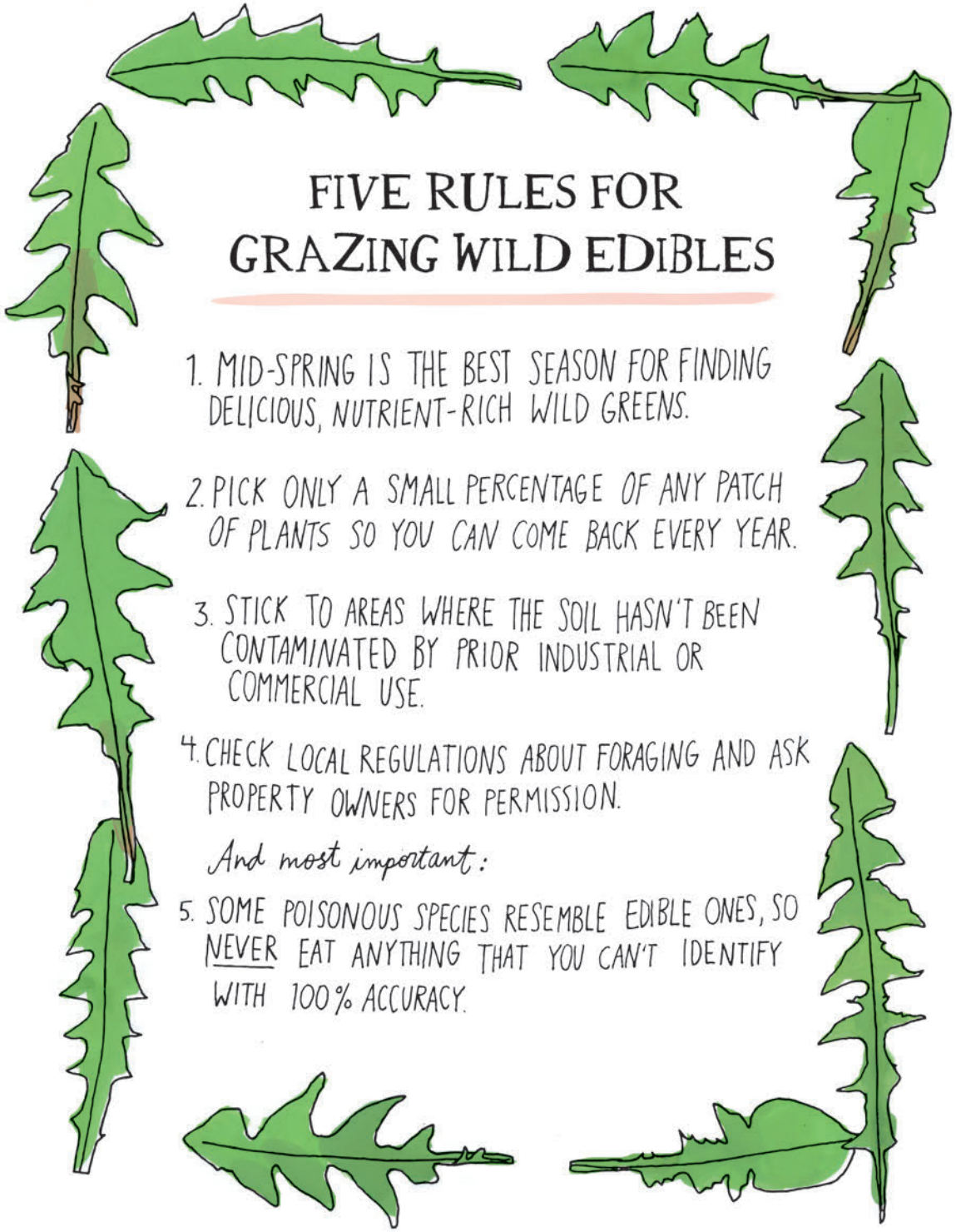
Yarrow

Flowers make an aromatic tea. Leaves can be used in place of hops for beer making.



Wood Sorrel

Flowers, fruits, and leaves are great as a sweet-sour trailside nibble.



FIVE RULES FOR GRAZING WILD EDIBLES

1. MID-SPRING IS THE BEST SEASON FOR FINDING DELICIOUS, NUTRIENT-RICH WILD GREENS.

2. PICK ONLY A SMALL PERCENTAGE OF ANY PATCH OF PLANTS SO YOU CAN COME BACK EVERY YEAR.

3. STICK TO AREAS WHERE THE SOIL HASN'T BEEN CONTAMINATED BY PRIOR INDUSTRIAL OR COMMERCIAL USE.

4. CHECK LOCAL REGULATIONS ABOUT FORAGING AND ASK PROPERTY OWNERS FOR PERMISSION.

And most important:

5. SOME POISONOUS SPECIES RESEMBLE EDIBLE ONES, SO NEVER EAT ANYTHING THAT YOU CAN'T IDENTIFY WITH 100% ACCURACY.

Jenny Kendler's Gorgonzola-Stuffed Daylily Buds

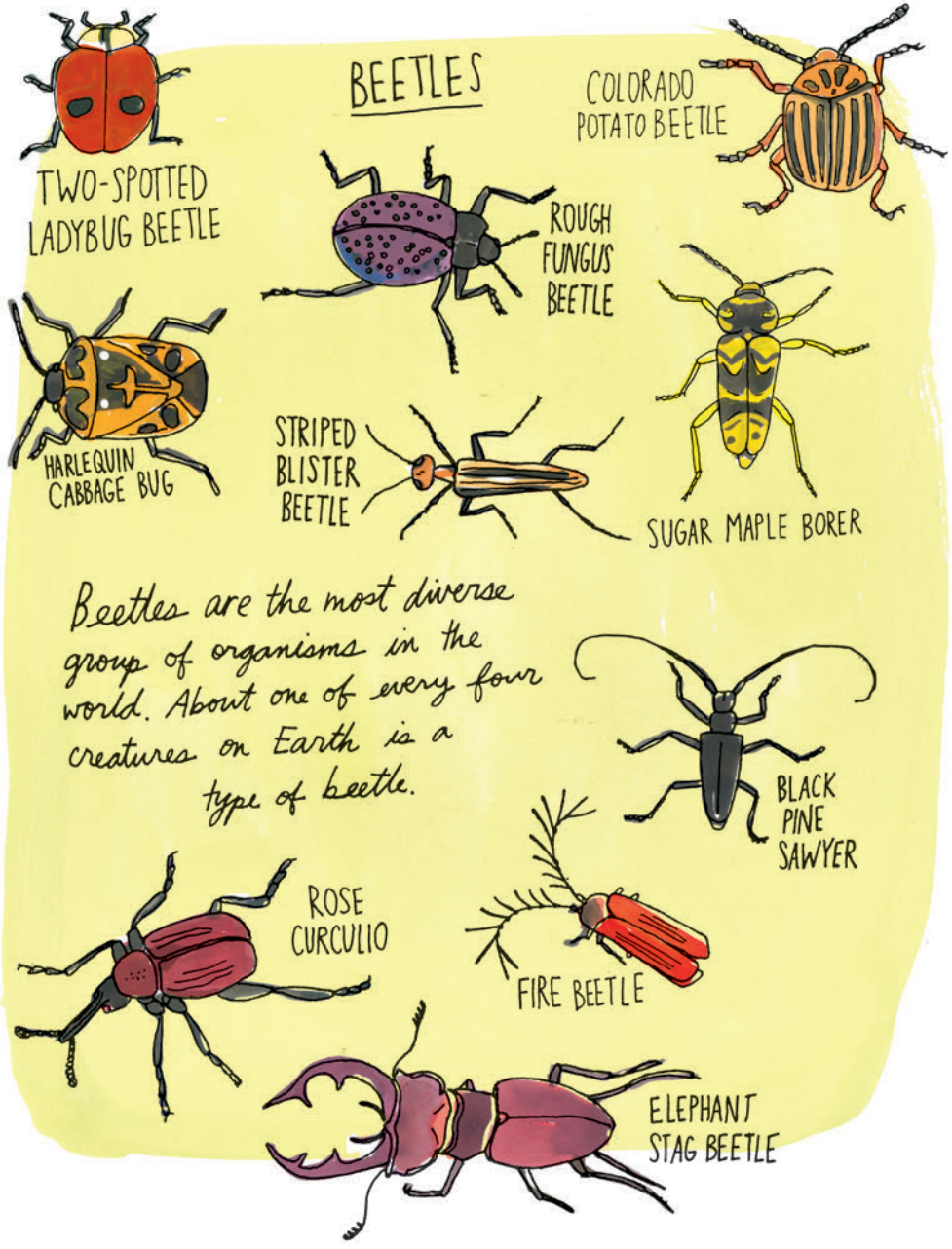
DAYLILY BUDS (CHOOSE UNOPENED BUT MATURE BUDS, 2½-3½" LONG)
OLIVE OIL
GORGONZOLA CHEESE, OR A BLUE CHEESE OF YOUR CHOICE (CHOOSE A LOCAL CHEESE IF POSSIBLE)
FRESH CRACKED PEPPER

Preheat oven/toaster oven to 400°F. Arrange buds on a baking sheet that has been lightly coated with olive oil. Gently open each daylily bud and stuff with cheese, closing the petals back up as best as possible. Brush the stuffed lilies with a touch more olive oil, cracking fresh pepper generously over the tops. Bake until cheese begins to brown and bubble out. Serve hot, and enjoy this elegant, wild-harvested treat with friends.





INCREDIBLE INSECTS AND BUGS ABOUNDING





TACHINA FLY

The larvae are parasitoids that develop inside the body of other insects, eventually killing their hosts.

ALUTACEA BIRD GRASSHOPPER



It can jump up to 20 times the length of its body—the equivalent of a 6-foot-tall man jumping 120 feet.

SCARLET-AND-GREEN LEAFHOPPER



They are covered with tiny hairs and secrete a liquid over their bodies that acts as a water repellent and contains pheromones.

PRAYING MANTIS



The female mantis sometimes bites the head off her mate during copulation.

TRUE KATYDID



Katydids get their name from how their song sounds: "Katy did Katy didn't." Katydids lay their eggs in the fall on plants or in the soil, but they don't hatch until spring.

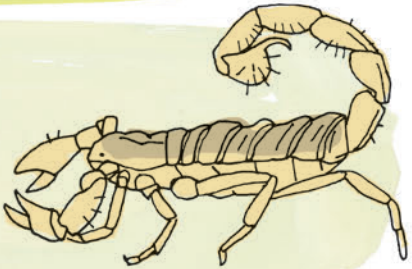
17-YEAR CICADA

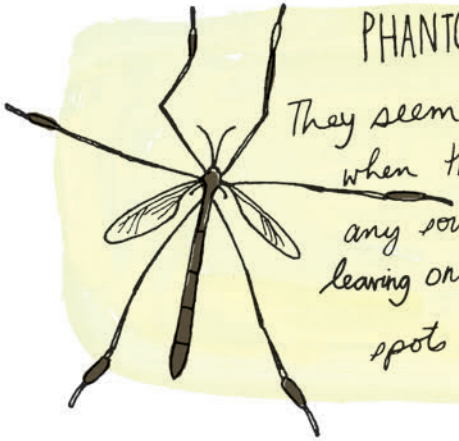
Some species of cicadas live underground, feeding on tree roots and emerging in great numbers in 13-17 year cycles. The famously loud mating call made by large groups of males can go over 120 decibels (breaking local noise laws in some areas) and is thought to repel predatory birds.



GIANT DESERT SCORPION

The largest scorpion in North America — attaining a growth of 5.5 inches in length — feeds on lizards and snakes.





PHANTOM CRANE FLY

They seem to disappear when they fly out of any source of light, leaving only their white spots visible.

THORN-MIMIC TREEHOPPER

It camouflages itself as a thorn when sitting on a stem.

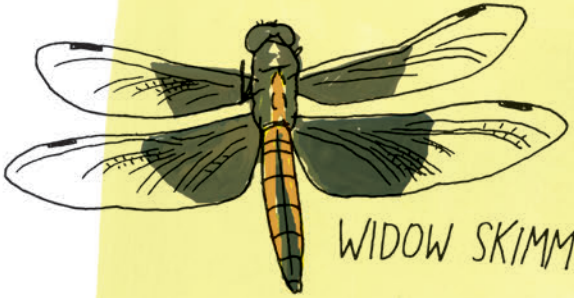




SNOW FLEA

This type of springtail has a unique jumping organ that folds beneath the abdomen and can fling the insect 4 inches into the air.

DRAGONFLIES



WIDOW SKIMMER

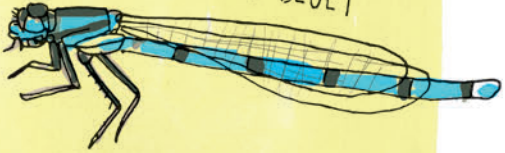


WHITE TAIL

LOW FLYING AMBER WING



DOUBLEDAY'S BLUET





Dragonflies and damselflies often mate in flight. This position is called a wheel formation because the dragonfly couple forms a closed circle with their joined bodies.

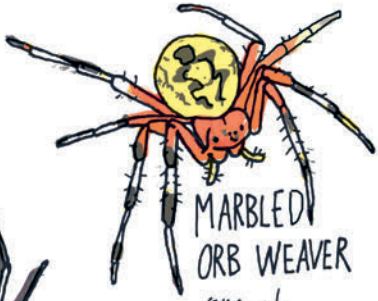
SPECTACULAR SPIDERS

Spiders have been around for at least 500 times longer than humans. They belong to the class Arachnida along with scorpions, ticks, and mites. Unlike insects, spiders have only two major body sections and no antennae.



GOLDENROD SPIDER

changes from white to yellow to hide among flowers



MARBLED ORB WEAVER

one of the prettiest orb weavers



BLACK WIDOW

female eats the male after mating, hence the name "widow"



BANDED GARDEN SPIDER

prefers open fields and prairies



ARROW-SHAPED MICRATHENA

has spikes on the abdomen as armor against predators like birds, lizards, and other insects



WOLF SPIDER

carries its eggs in a sac on its abdomen



SPIRAL ORB WEB

mainly made by spiders from the family Araneidae, "orb weavers"



COBWEBS

used to describe old abandoned webs of any spider and also the tangled webs of the Theridiidae family

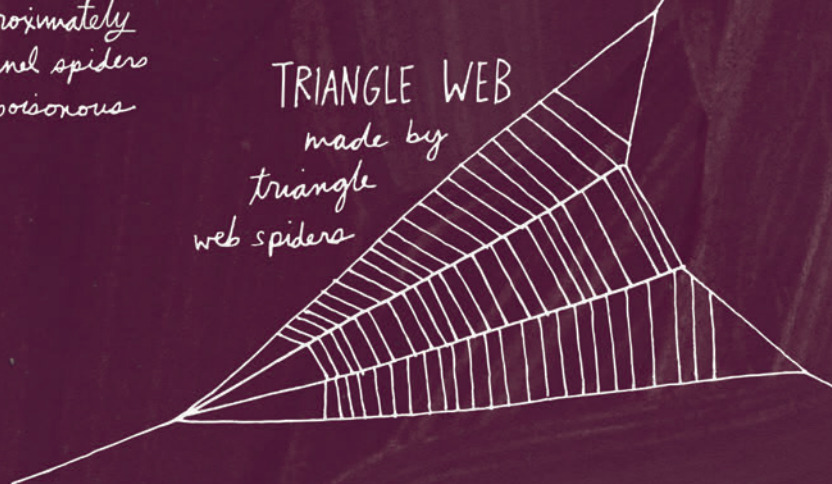


FUNNEL-SHAPED WEB

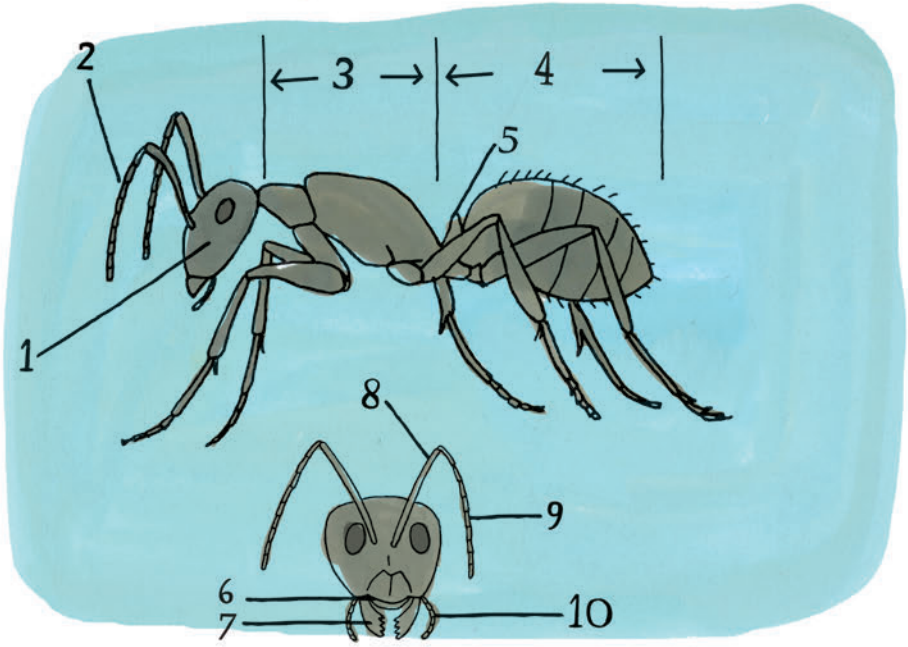
most of the approximately 700 species of funnel spiders (Agelenidae) are poisonous

TRIANGLE WEB

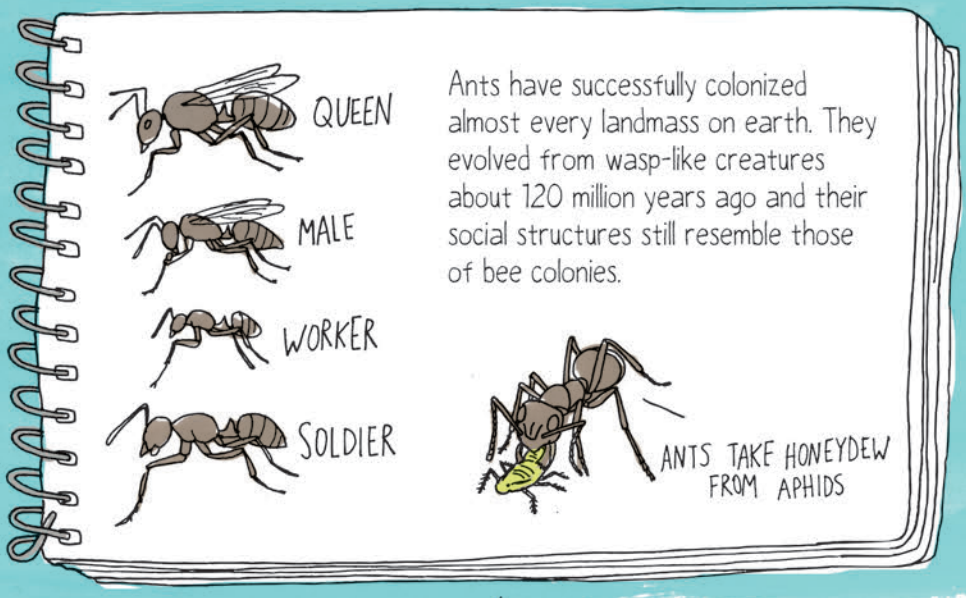
made by triangle web spiders



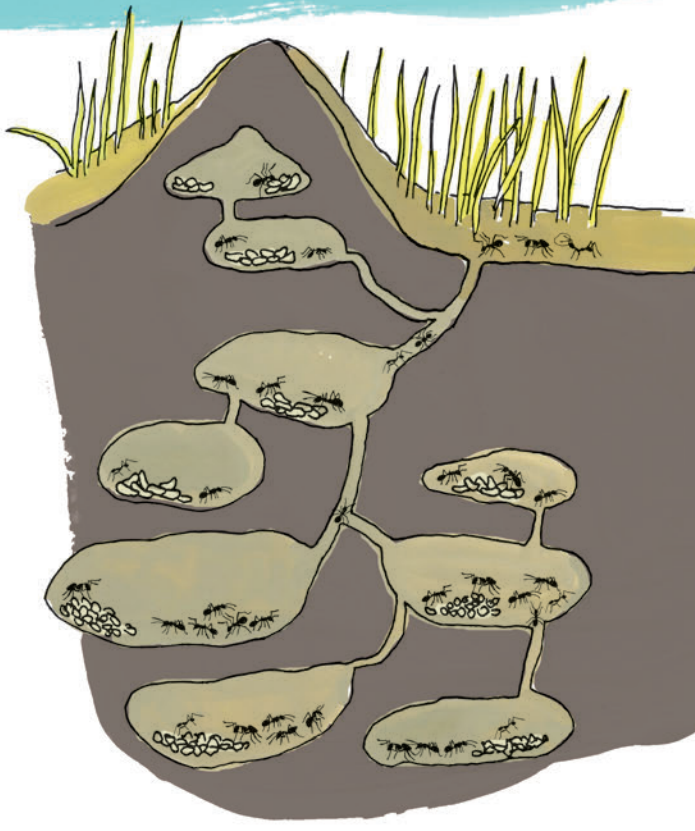
ANATOMY OF AN ANT



1. **head** - contains the mouth, mandibles, eyes, and antenna
2. **antenna** - used to smell, recognize nest mates, and detect enemies
3. **thorax** - middle region where the three pairs of legs are connected
4. **abdomen or gaster** - contains the vital organs and reproductive parts
5. **petiole** - connects the thorax to the abdomen
6. **labrum** - floor of the mouth
7. **mandible** - used for digging, carrying, and collecting food and building nests
8. **shaft** - base of the antenna
9. **lash** - segmented top of the antenna used for smell
10. **labial palp** - serves the function of a lower lip



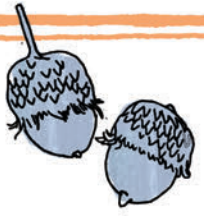
At first glance, ants seem to treat their dead in the same way as humans – the carcass is untouched for two days before it is moved because the ants don't recognize the ant as dead until it starts emitting a chemical called oleic acid. Once they pick up that scent, the decaying ant, which now smells foreign, is carted off to the dump pile. The entomologist Edward O. Wilson found that if you put oleic acid on a live ant, the other ants will think it's dead and carry it away.





CHAPTER 4

Take a Hike



Tree Shapes



PYRAMIDAL



CONICAL



COLUMNAR



BROAD



VASE



WEEPING



ROUNDED

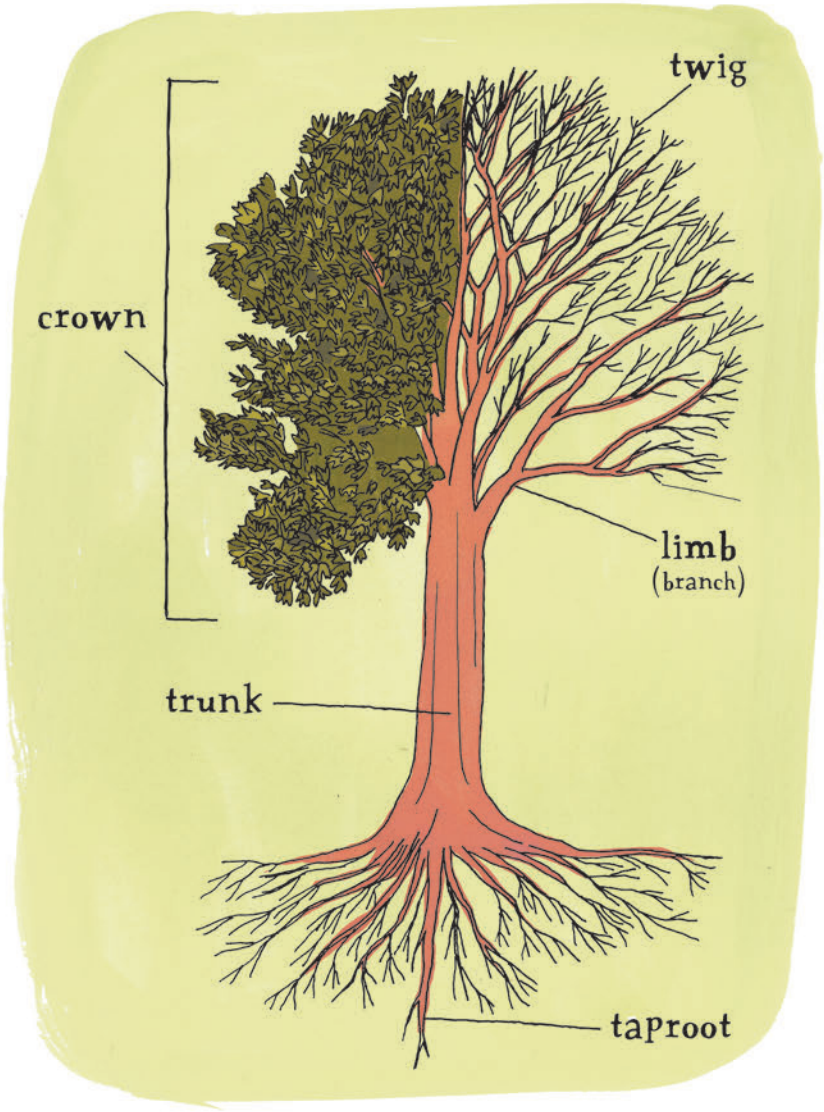


OPEN

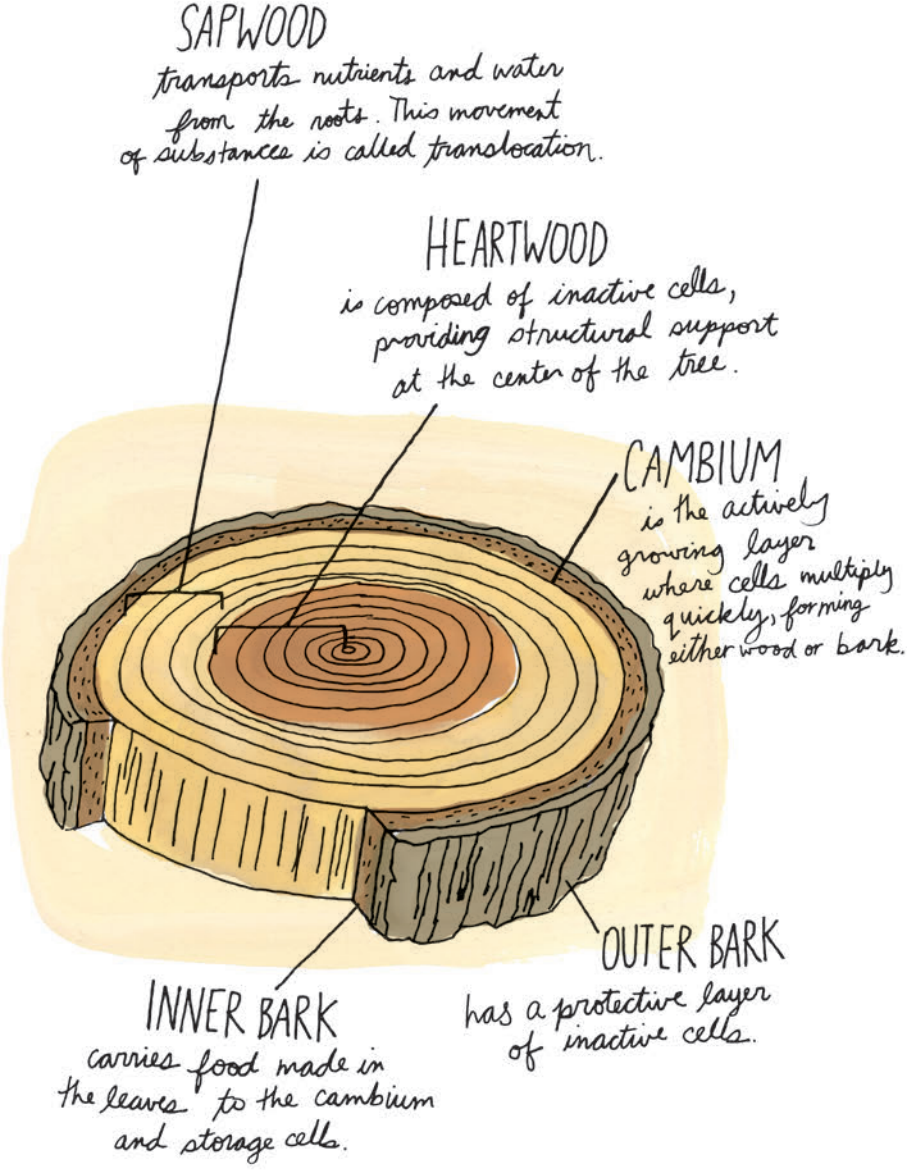


IRREGULAR

ANATOMY OF A DECIDUOUS TREE



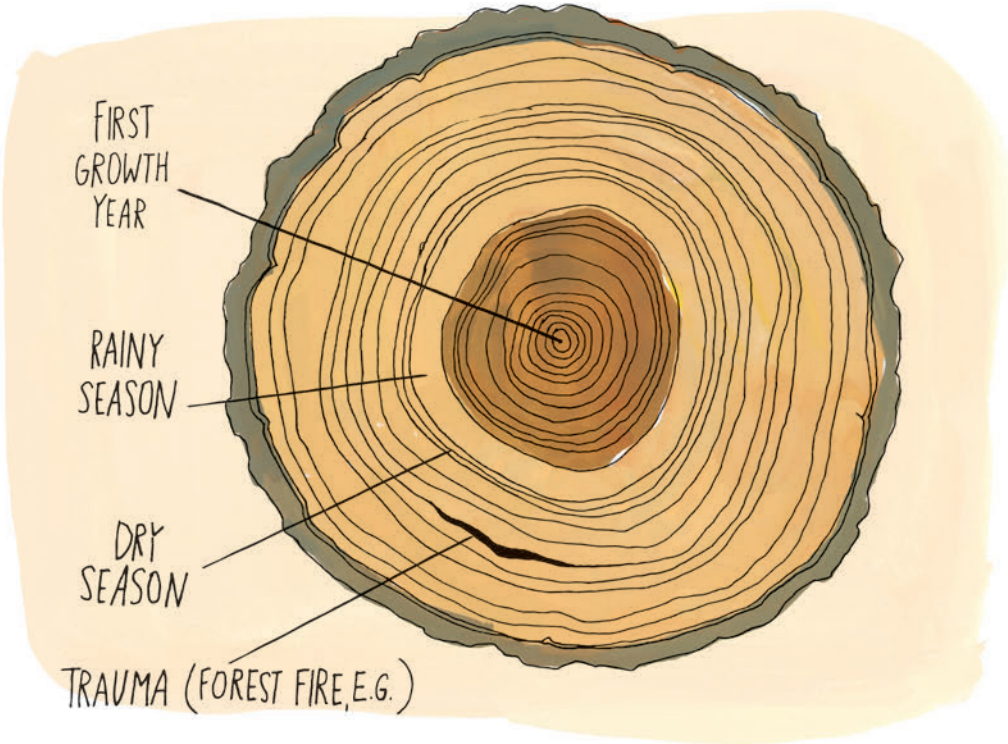
ANATOMY OF A TRUNK



Dendrochronology

(DETERMINING THE AGE OF A TREE BY COUNTING THE GROWTH RINGS IN A CROSS-SECTION OF ITS TRUNK)

New growth appears as rings in cross-sections of a tree's cambium layer, where one ring usually marks the passage of one year. Trees growing in temperate zones with distinct summers and winters develop the clearest rings. A long, wet growing season will result in trees having wider rings. Dry years create very thin rings.

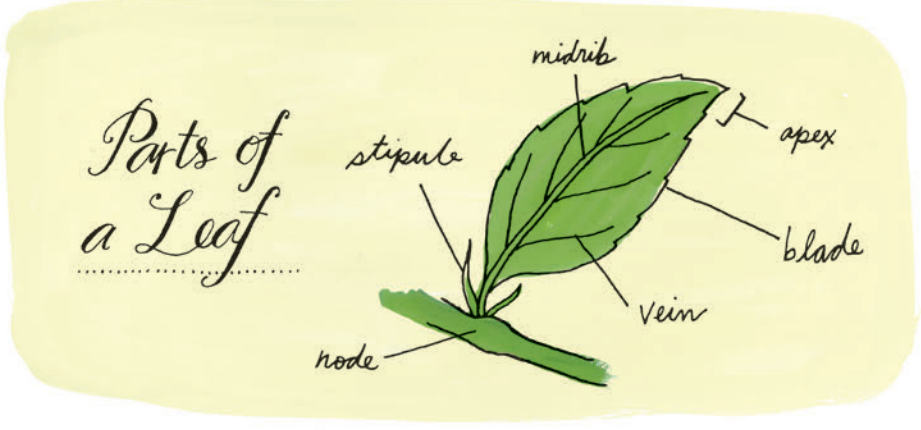


The oldest living tree recorded is named "The Hatch Tree." It was cored to reveal 5,063 rings. It's a Great Basin bristlecone pine located in the White Mountains of California.

LEAF IDENTIFICATION




INDIAN BEAN
CORDATE
ROUGHLEAF DOGWOOD
ARCUATE
LACEBARK ELM
OVATE
CRENATE
SWEET GUM
PALMATELY LOBED
SERRATE
GAMBEL OAK
PINNATELY LOBED


Parts of a Leaf
midrib
apex
stipule
blade
vein
node

NORTH AMERICAN TREES





Giant Sequoia

(SEQUOIADENDRON GIGANTEUM)

Sequoias have the widest trunks and a mature tree's 11,000 cones may produce up to 400,000 seeds per year.

Coast Redwood

(SEQUOIA SEMPERVIRENS)

This species has the tallest living trees with heights that reach 379 feet.

Bristlecone Pine

(PINUS ARISTATA)

This pine lives longer than any other known organism — up to 5,000 years!







American Elm (ULMUS AMERICANA)

These elms are becoming more rare due to the fungal Dutch elm disease.

Sweetgum (LIQUIDAMBAR STYRACIFLUA)

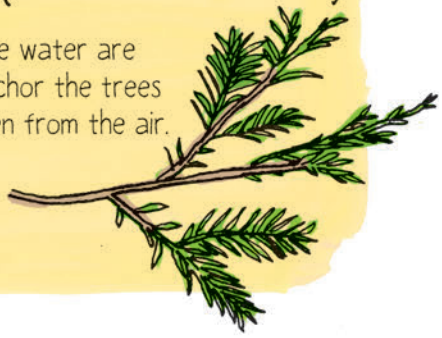
Sweetgums are one of the last trees to leaf out in spring and one of the last to drop their leaves in the fall.

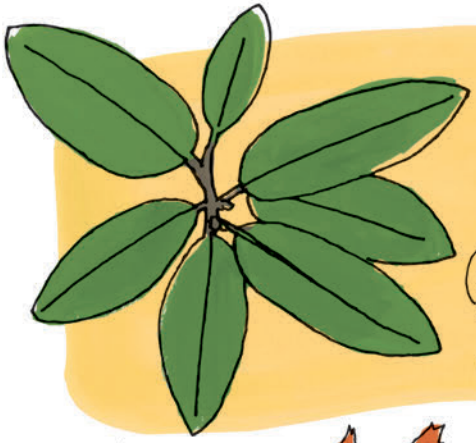




Swamp Cypress (TAXODIUM DISTICHUM)

The "knees" sticking up out of the water are actually root structures that anchor the trees and may help them acquire oxygen from the air.





Southern Live Oak



(QUERCUS VIRGINIANA)

This is one of the few oaks regularly wider than it is tall.



Northern Red Oak

(QUERCUS RUBRA)

Individual trees can live up to 500 years in optimal conditions.



Weeping Willow

(SALIX BABYLONICA)

A staple of Native American medicine, the sap contains salicylic acid, the active ingredient in aspirin.

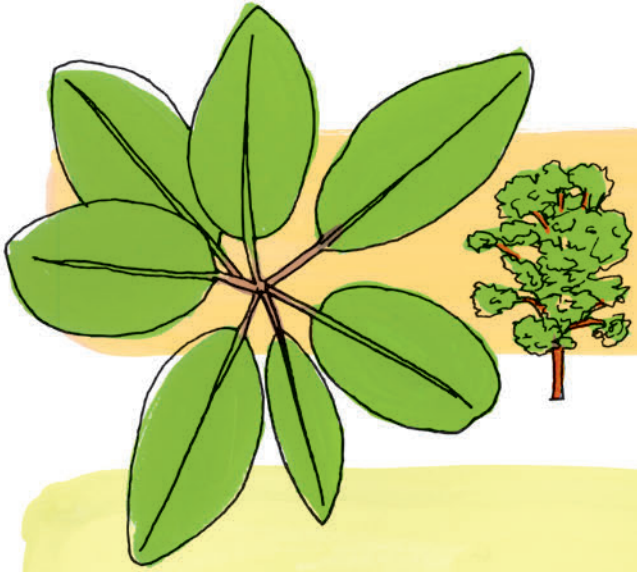




Paper Birch

(BETULA PAPYRIFERA)

This tree provides birch syrup, a sweetener made by boiling down the sap.



Madrone

(ARBUTUS MENZIESII)

The bark of this western coastal evergreen curls off in thin sheets.



Sugar Maple

(ACER SACCHARUM)

Of the 124 species in the genus *Acer*, 13 can be tapped for sugar. The sugar maple and the black maple produce the most concentrated sap.



Staghorn Sumac

(RHUS TYPHINA)

The fruit has a pleasant citrus-like sourness that, when soaked and sweetened, makes a delicious late-summer drink.



Black Cherry
(PRUNUS SEROTINA)

New growth has an almond-like smell when scratched or broken.





Southern Magnolia
(MAGNOLIA GRANDIFLORA)

The fragrant white flowers can be as big as 12 inches in diameter.



Ginkgo
(GINKGO BILOBA)



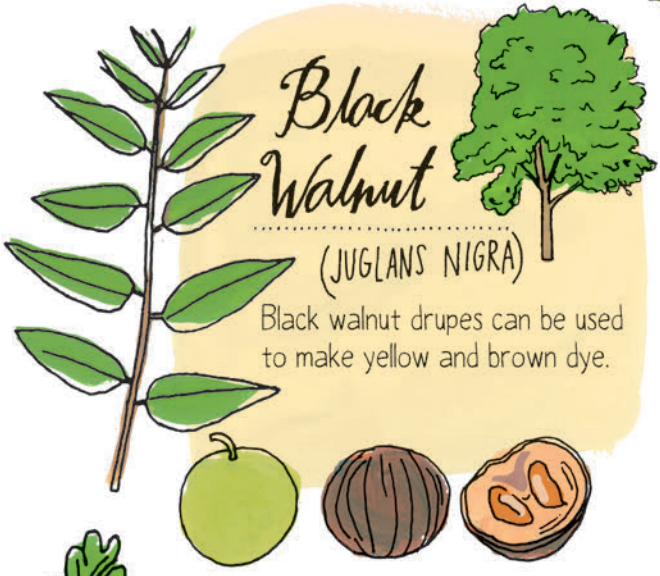
The ginkgo is truly unique in that it is the only species of its kind.





Ponderosa Pine
(PINUS PONDEROSA)

This pine tree has evolved to survive brush fires. Bark from furrows in the trunk is said to smell like vanilla.



Black Walnut

(JUGLANS NIGRA)

Black walnut drupes can be used to make yellow and brown dye.



Tamarack

(LARIX LARICINA)

Though it has needles and looks like an evergreen, this tree sheds its yellowing needles in the autumn.

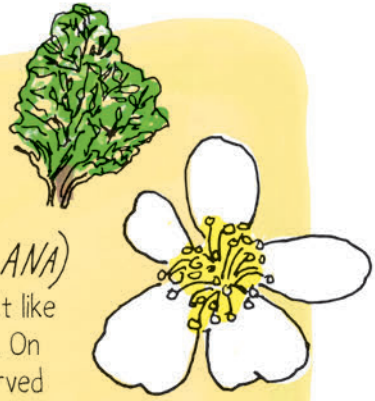


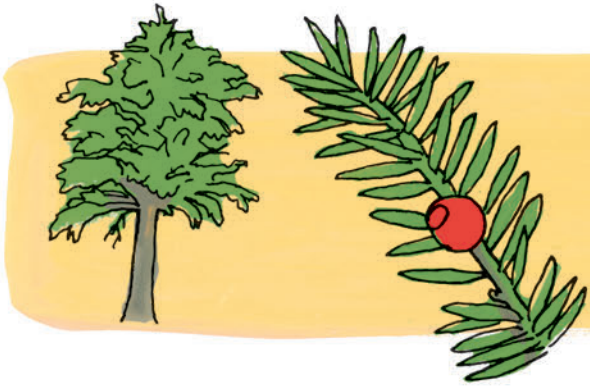


Cliffrose

(COWANIA MEXICANA)

The seeds have long hairs that act like tiny parachutes, aiding in dispersal. On the ground, the wind turns the curved hair into a drill to drive the seed into the soil.





Pacific Yew

(TAXUS BREVIFOLIA)

The chemotherapy drug Taxol is derived from this species.



Eastern Cottonwood

(POPULUS DELTOIDES)

These are one of the largest hardwood trees in North America and typically live to be 70-100 years old.

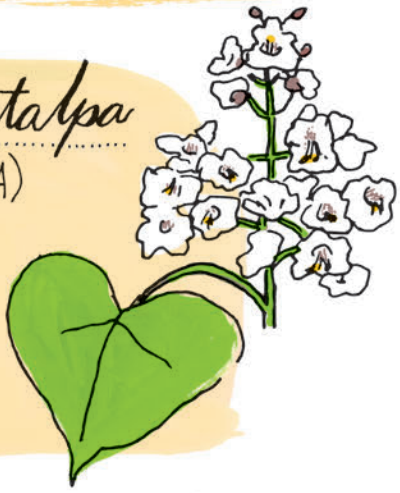


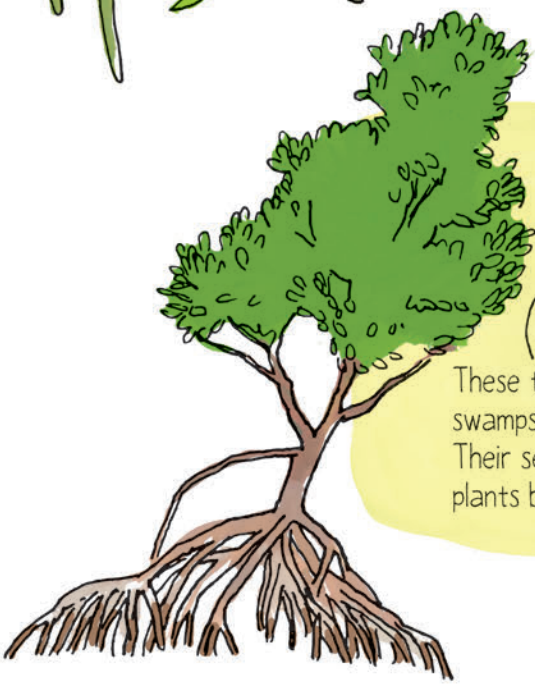
Northern Catalpa

(CATALPA SPECIOSA)

A midwestern native, this medium-sized tree is often planted ornamentally.



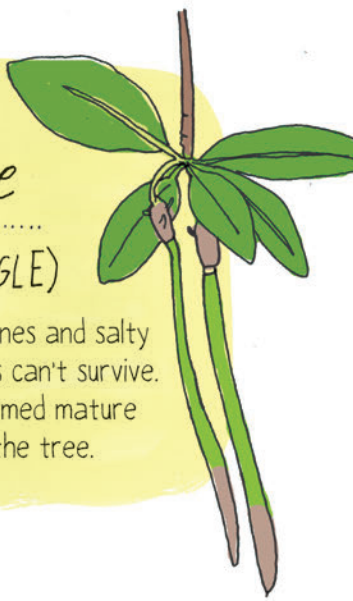


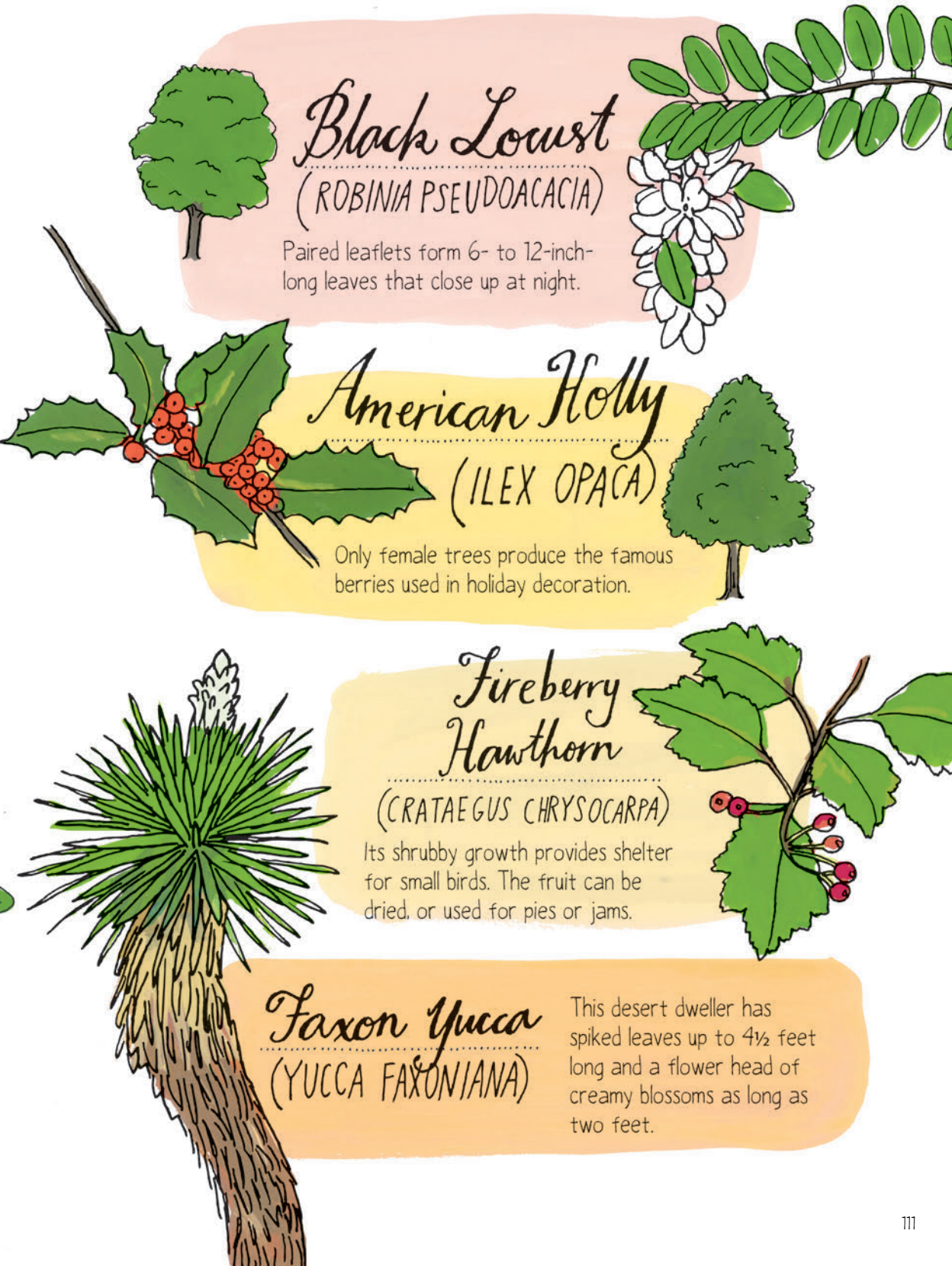


Red Mangrove

(RHIZOPHORA MANGLE)

These trees thrive in coastlines and salty swamps where other species can't survive. Their seeds become fully formed mature plants before dropping off the tree.





Black Locust
(ROBINIA PSEUDOACACIA)

Paired leaflets form 6- to 12-inch-long leaves that close up at night.

American Holly
(ILEX OPACA)

Only female trees produce the famous berries used in holiday decoration.

Fireberry Hawthorn
(CRATAEGUS CHRYSOCARPA)

Its shrubby growth provides shelter for small birds. The fruit can be dried, or used for pies or jams.

Faxon Yucca
(YUCCA FAXONIANA)

This desert dweller has spiked leaves up to 4½ feet long and a flower head of creamy blossoms as long as two feet.

BEAUTIFUL BARK



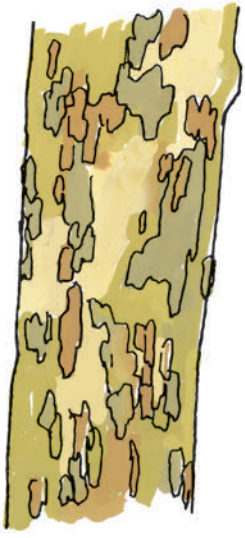
Shagbark Hickory
(CARYA OVATA)



Flowering Dogwood
(CORNUS FLORIDA)



Northern White Cedar
(THUJA OCCIDENTALIS)



Sycamore
(PLATANUS OCCIDENTALIS)



Hercules' Club

(ZANTHOXYLUM CLAVA-HERCULIS)



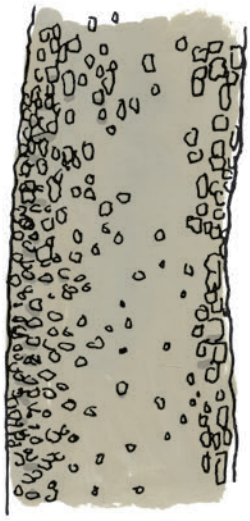
White Poplar

(POPULUS ALBA)



Winged Elm

(ULMUS ALATA)



Hackberry

(CELTIS OCCIDENTALIS)



American plum
(PRUNUS AMERICANA)



Slippery Elm
(ULMUS RUBRA)

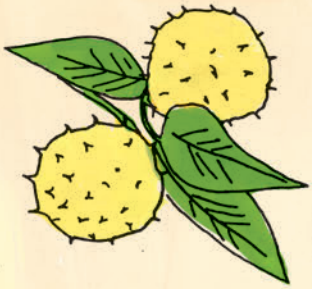
SOME FLOWERS, CONES, SEEDS + FRUITS OF TREES



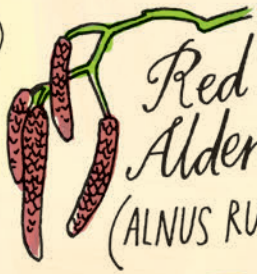
Pussy willow
(SALIX DISCOLOR)



Box Elder
(ACER NEGUNDO)



Ohio Buckeye
(AESCULUS GLABRA)



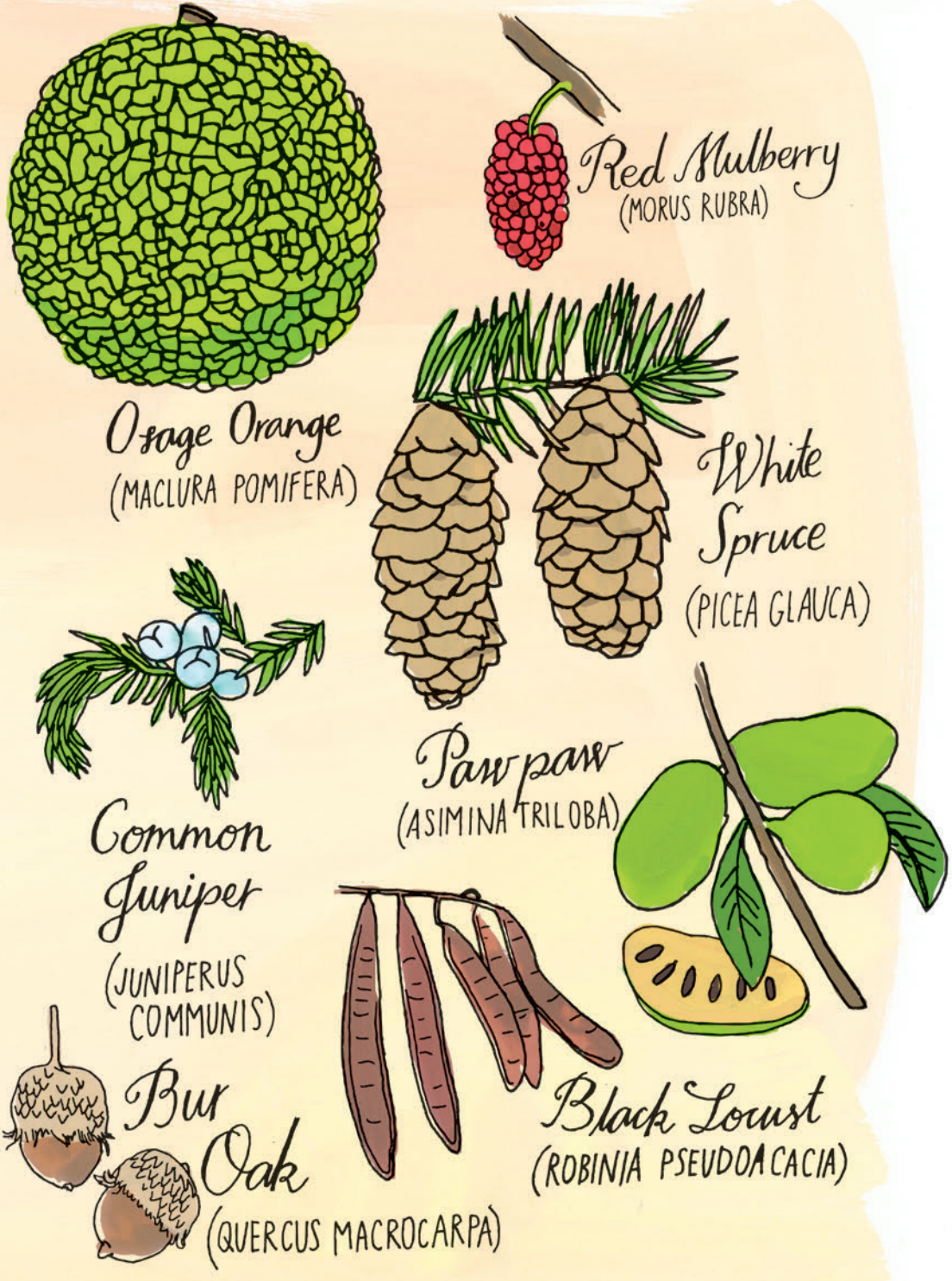
Red Alder
(ALNUS RUBRA)

Sweetbay
(MAGNOLIA VIRGINIANA)



Pecan
(CARYA ILLINOENSIS)

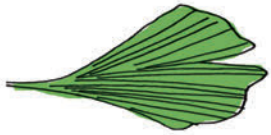



Red Mulberry
(MORUS RUBRA)
Osage Orange
(MACLURA POMIFERA)
White Spruce
(PICEA GLAUCA)
Pawpaw
(ASIMINA TRILOBA)
Common Juniper
(JUNIPERUS COMMUNIS)
Black Locust
(ROBINIA PSEUDOACACIA)
Bur Oak
(QUERCUS MACROCARPA)

Printing Patterns

TOOLS

- Brayer
- Printing ink
- Palette
- Paper or fabric to print on
- Scratch paper



INSTRUCTIONS

Collect interesting leaves, twigs, plants, flowers. Make sure not to pick endangered species or take too much of one plant.

Pour some ink on your palette, then roll the roller back and forth through the ink until it's evenly covered. It should make a sticky noise.

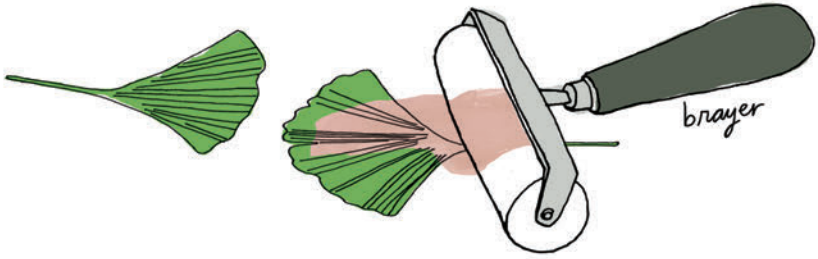
Place your leaf on a piece of scratch paper and directly roll over it with the brayer. Cover the entire surface as evenly as you can.

Press the ink-covered object onto the paper or fabric, pressing down on the entire surface to ensure it transfers. Peel it back slowly to reveal your print.

TIPS

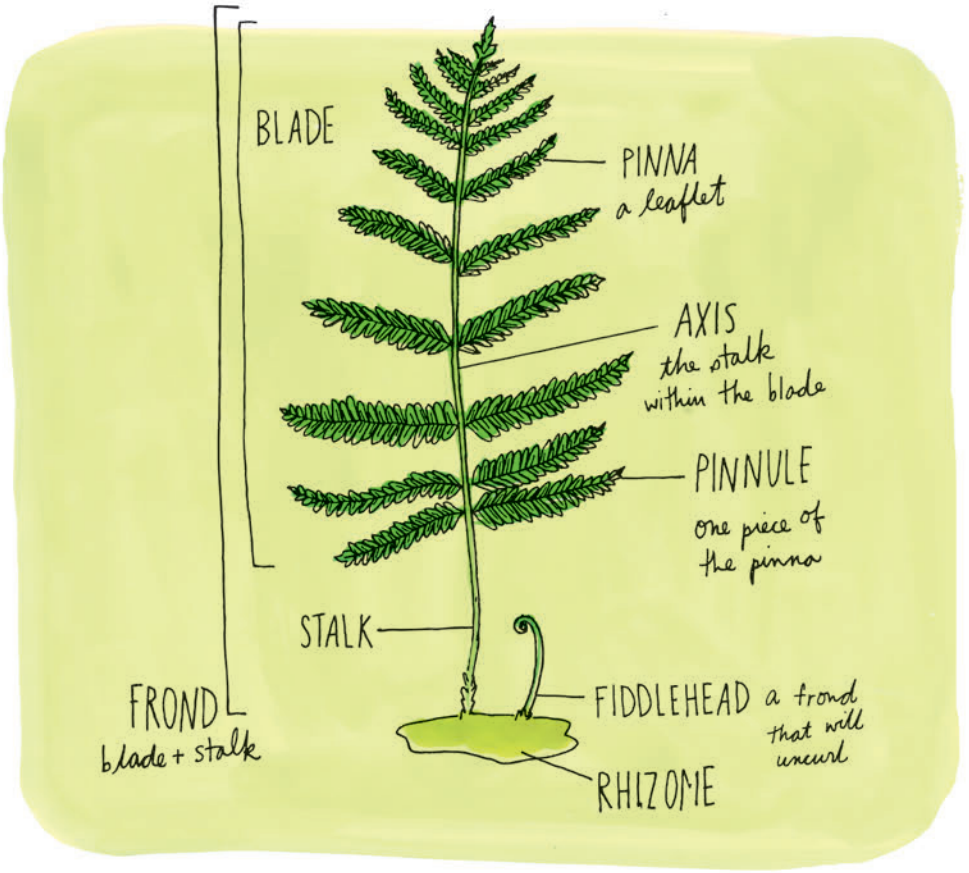
Experiment with pressure. Sometimes it's nicer to have a very faint print than a mushy thick one. Try pressing the paper on to the inked objects instead and see if the result differs.

Play with the design: use lots of objects in the same color or one object in several different colors, or create a repeating pattern.





ANATOMY OF A FERN

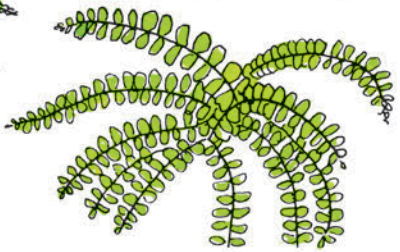




NETTED CHAIN FERN (Woodwardia areolata)

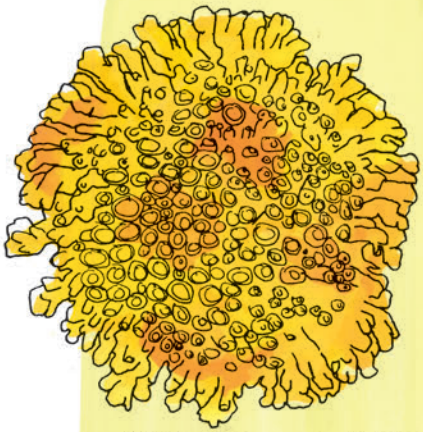


NEW YORK FERN (Thelypteris noveboracensis)



MAIDENHAIR SPLEENWORT (Asplenium trichomanes)

PRETTY, PRETTY LICHEN

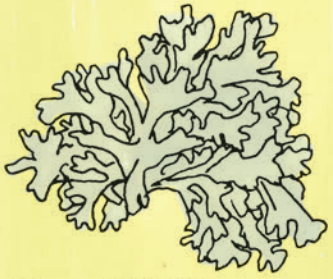


ELEGANT SUNBURST LICHEN
(Xanthoria elegans)

Lichens are a fascinating union of fungus and algae living as one organism. Lichens are not bright green like mosses and lack a leafy structure.

Though they grow all over the world under extreme natural environments like deserts, arctic tundra, and sea-battered coasts, lichens are also good pollution indicators, often refusing to grow in areas with congested urban air.

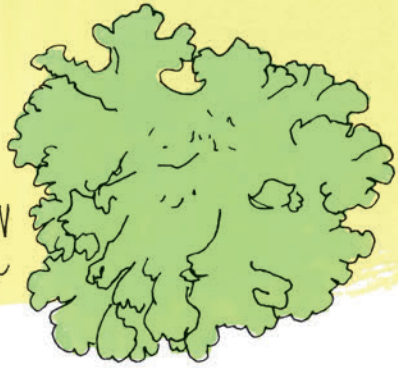
It's estimated that lichen covers up to 6 percent of the earth's land surface.



TUMBLEWEED SHIELD LICHEN
(Xanthoparmelia chlorochroa)

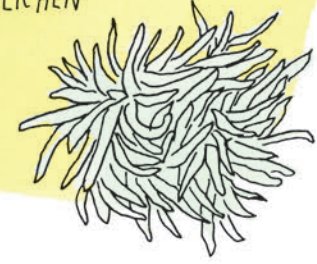
COMMON ORANGE LICHEN
(Xanthoria parietina)





CAPERAT LICHEN
(Flavoparmelia caperata)

WHITE-WORM LICHEN
(Thamnolia vermicularis)



MYSTERIOUS MOSSES

Mosses are small, spore-producing plants with simple leaves and no flowers or seeds. They don't even have proper roots to collect moisture and nutrients. Mosses grow in clumps in shady and moist locations. You can often find them on the north-facing sides of trees.

Tiny insects like mites and springtails are drawn to the scent of moss and help spread its spores.

Tons of sphagnum moss were used in World War I to treat wounds as surgical dressing. Sphagnum can absorb up to 20 times its dry weight in moisture.



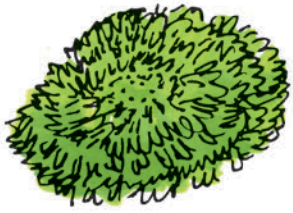
STAR MOSS
(Atrichum angustatum)



TREE MOSS
(Climacium americanum)



SPOON-LEAVED MOSS
(Bryoandersonia illecebra)



PINCUSHION MOSS
(Leucobryum glaucum)



WHITE-TIPPED MOSS
(Hedwigia ciliata)



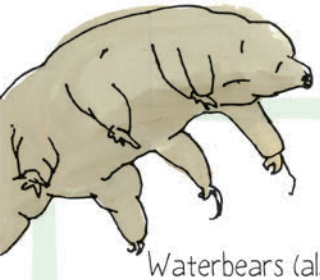
HAIRCAP MOSS
(Polytrichum commune)



ROSE MOSS
(Rhodobryum roseum)



BROOM MOSS
(Dicranum scoparium)

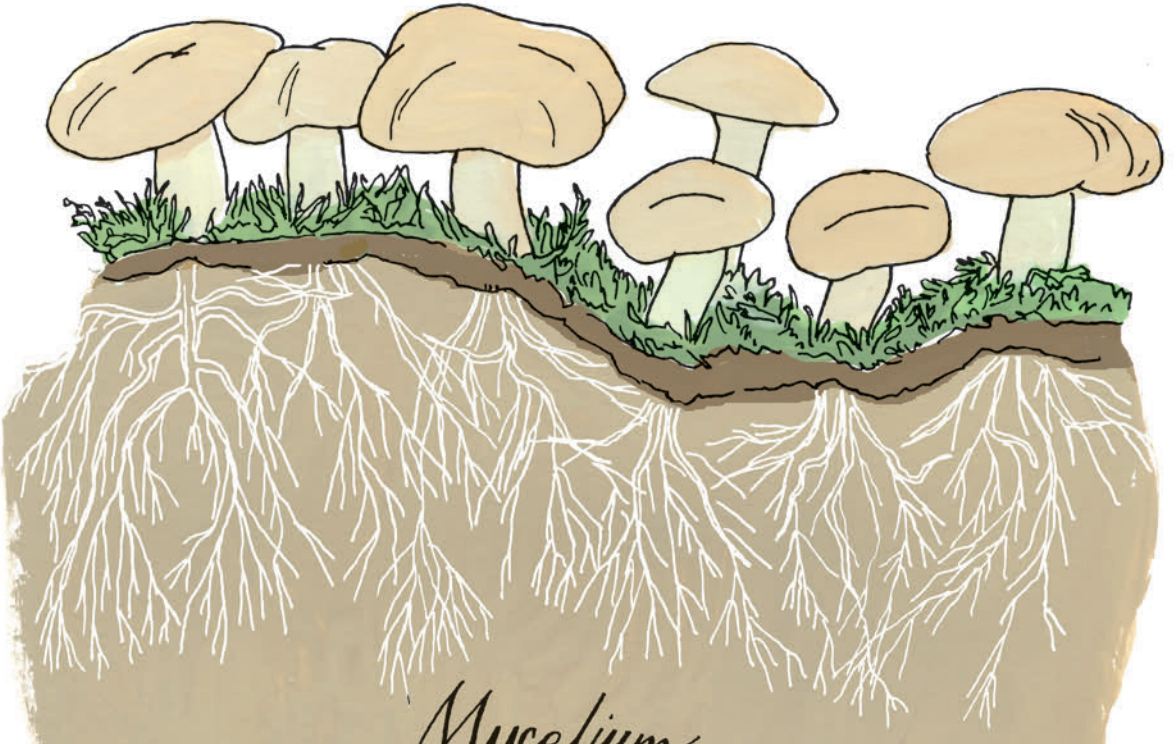


WATERBEARS

Waterbears (also called tardigrades) are eight-legged micro-animals that often live and feed on mosses and lichens. Waterbears may be the most adaptable animals in the world. They can live within a temperature range of -300°F to 300°F, can be dried out to three percent water, survive 6,000 atmospheres of pressure, withstand radiation bombardment at levels that would kill any other animal, and survive the harsh environment of outer space. Plus they're kind of cute!







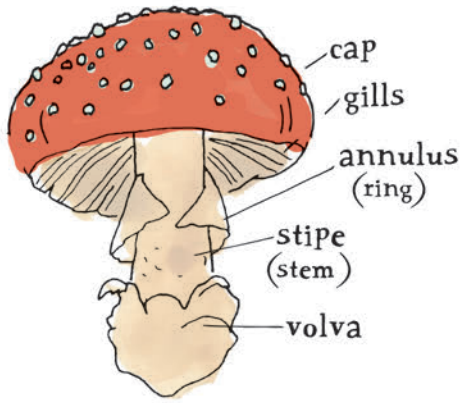
Mycelium

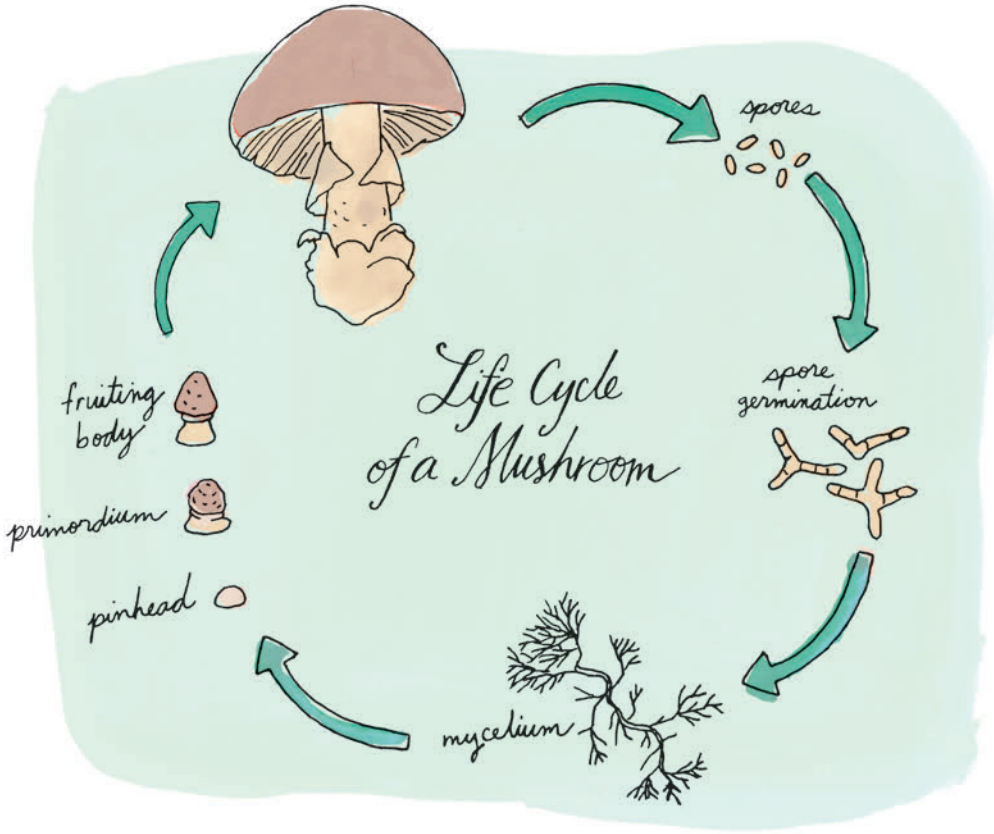
Fungi absorb nutrients through vast underground networks of white branching threads called mycelium. Though hidden in the soil and sometimes mistaken for roots, mycelium is actually the proper body of a fungus. Mushrooms are the fruit, appearing only when conditions for spreading their spores are just right.

Mycelium plays a vital role in the decomposition of plant material but also can form a symbiotic relationship, called mycorrhiza, with the roots of a plant. Most plants depend on mycorrhiza to absorb phosphorus and other nutrients. In exchange, fungi gain constant access to the plants' carbohydrates.

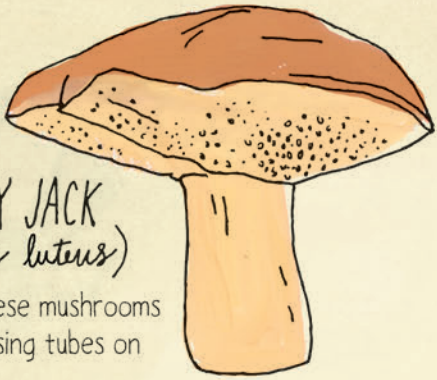
A patch of mycelium in eastern Oregon estimated to be the size of 1,665 football fields and 2,200 years old, is a contender for the title of world's largest and oldest organism.

ANATOMY OF A MUSHROOM





MARVELOUS MUSHROOMS



SLIPPERY JACK
(Suillus luteus)

Instead of gills, these mushrooms have spore-dispersing tubes on their undersides.



FLY AGARIC
(Amanita muscaria)

Luckily, this is one of the most easily recognizable fungi because it's fatally poisonous if eaten.



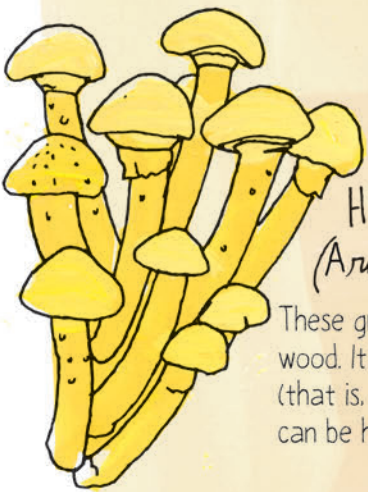
SAFFRON MILK CAP
(Lactarius deliciosus)

This orange edible becomes a dull green when bruised or old.



OYSTER MUSHROOM
(Pleurotus ostreatus)

This choice edible mushroom grows in clusters, attached to trees like ears.



HONEY MUSHROOMS
(Armillaria mellea)

These grow in clusters on decaying wood. Its mycelia are bioluminescent (that is, they glow in the dark) and can be harmful to living trees.



VIOLET CORT
(Cortinarius violaceus)

Edible, but not choice, this one is more admired for its beautiful color.



RAVENEL'S STINKHORN
(Phallus ravenelii)

It emits a slime that smells of rotting meat to attract flies and beetles for spore dispersal.



WITCH'S BUTTER
(Tremella mesenterica)

Edible but not very appealing, it can appear greasy and slimy and is sometimes called "yellow brain."



SHAGGY CHANTERELLE
(Gomphus floccosus)

This one can be toxic.

HEN OF THE WOODS
(Grifola frondosa)

This tasty species grows in clumps at the base of oaks. Also called maitake.





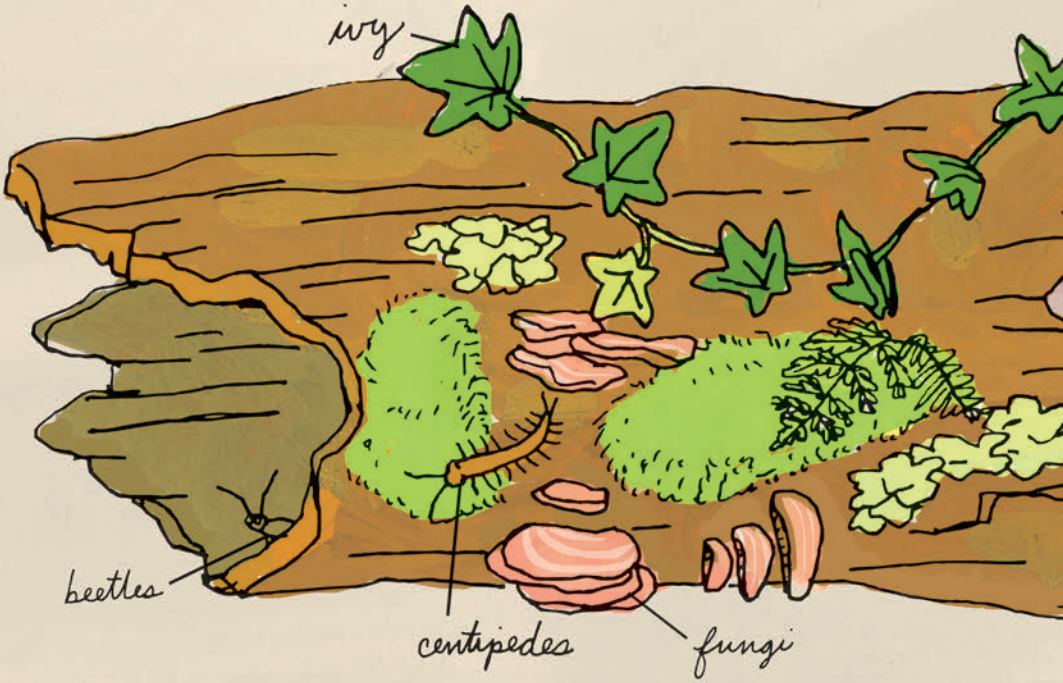
INKY CAP
(Coprinopsis atramentaria)

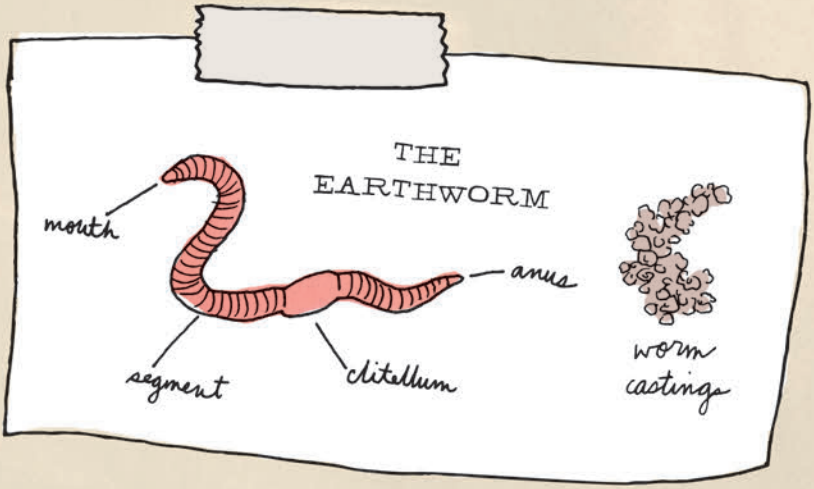
It releases a liquid that can be used as ink. Edible but causes acute sensitivity to alcohol..

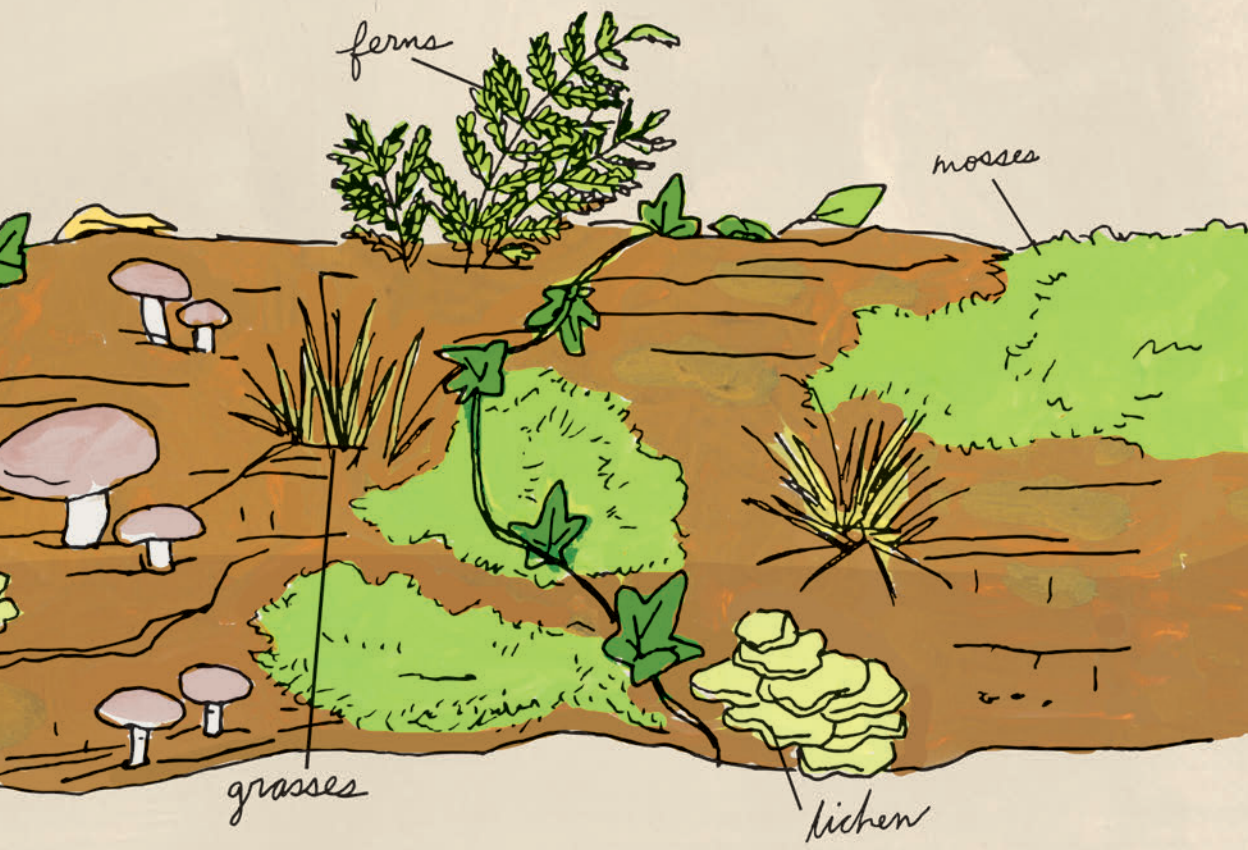


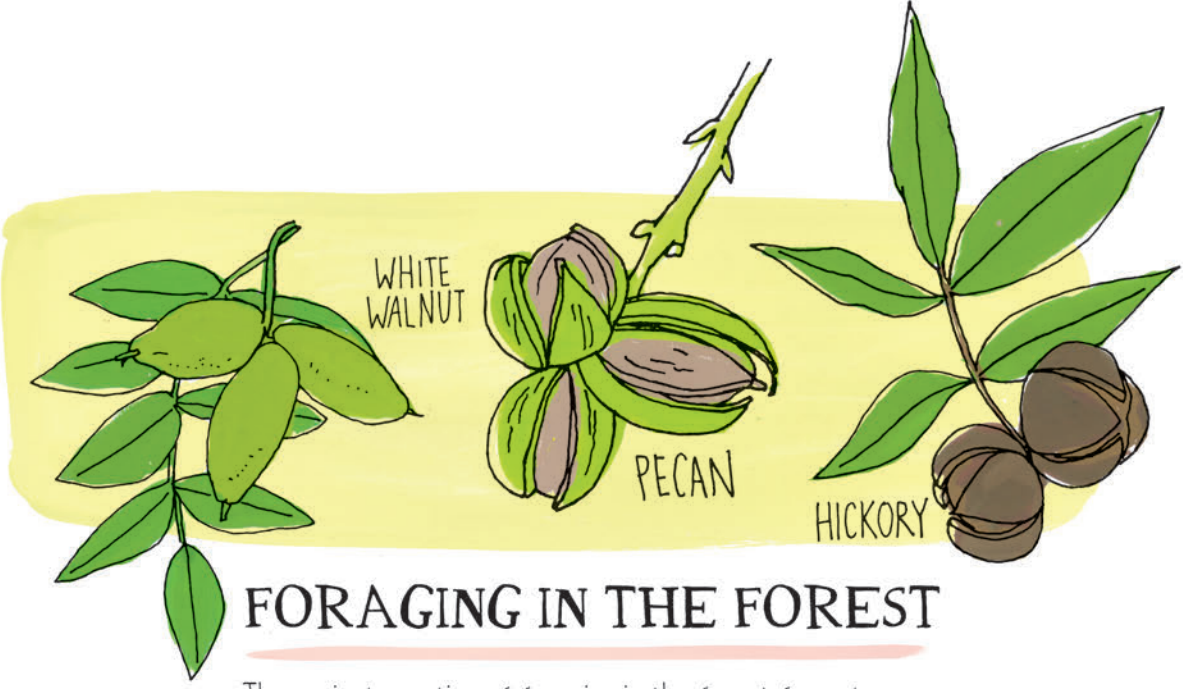
ROTTING LOG

A dead tree on the forest floor may not look like much, but the decomposing wood hosts a party of plant and animal life. Many kinds of insect larvae burrow into decaying wood to take shelter from the winter. Snails and slugs delight in the debris and fungi growing from rotting logs. Earthworms digest vast quantities of rotting organic matter, leaving behind nutrient-rich casts. Moist decomposing wood is a perfect nutrient nursery from which lichens, mosses, flowers, and even other trees can set root and thrive.



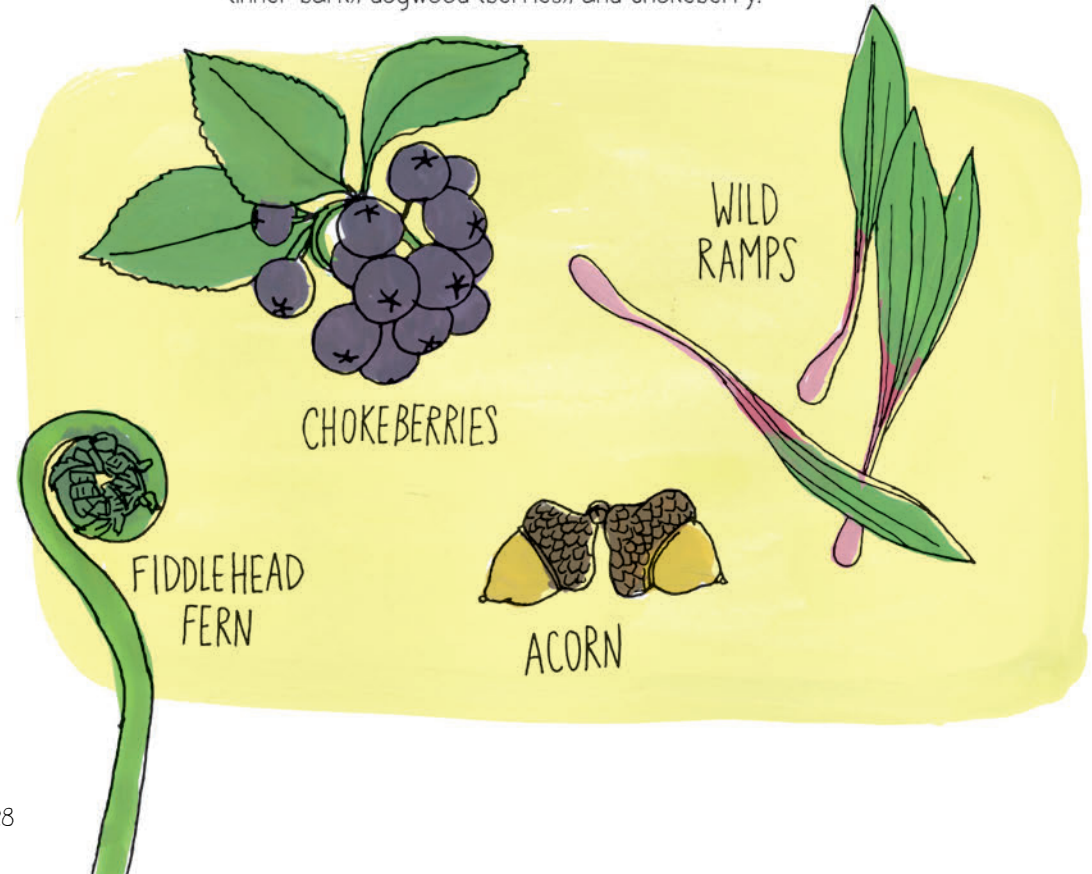

THE
EARTHWORM
mouth
anus
segment
clitellum
worm
castings


ferns
mosses
grasses
lichen



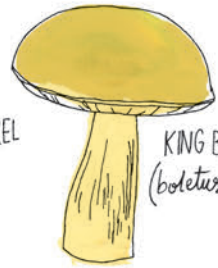
FORAGING IN THE FOREST

The ancient practice of foraging in the forest for nuts, berries, and mushrooms is enjoying a resurgence, and fiddlehead ferns and wild ramps can now be found in many farmers' markets. Other forest edibles include acorns, balsam and spruce (inner bark), dogwood (berries), and chokeberry.



Dry-Sautéed Bolete with Yellow Wood Sorrel and Thyme

- 1 POUND FRESH KING BOLETE MUSHROOMS
- 2 TABLESPOONS BUTTER
- 1 OUNCE WHITE WINE
- 1 SPRIG CHOPPED THYME
- LEAVES AND FLOWERS OF WILD YELLOW WOOD SORREL
- SALT AND PEPPER



KING BOLETE
(boletus edulis)

Fresh mushrooms can become mushy when cooked. Dry-sautéeing leaves them beautifully browned and brings out their natural flavor and texture. It couldn't be simpler:

Gently clean dirt from the fungi with a soft pastry brush. Do not wash them unless absolutely necessary, and then only in a bit of cold water or with a damp cloth.

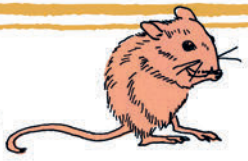
Slice the mushrooms 1/3" thick and place the pieces flat on a completely dry frying pan at medium-high heat. Stir occasionally to avoid sticking. Once the mushrooms are browned and most of the juices have evaporated, add the butter, wine, and thyme to the pan. Stir and cook for another couple of minutes as the mushrooms absorb the liquid.

Remove from heat and top with tangy flowers and leaves of yellow wood sorrel (there's probably some growing in your yard!). Salt and pepper to taste. Serve atop risotto or pasta.



CHAPTER 5

Creature Feature



ANIMALS IN THE NEIGHBORHOOD

Woodchuck

Woodchucks (or groundhogs) can climb trees if they need to escape.





Raccoon

Raccoons have 5 fingers but no thumbs on their highly sensitive paws. They are excellent swimmers.



Opossum

North America's only marsupial rears its young in a pouch, just like a kangaroo.



Striped Skunk

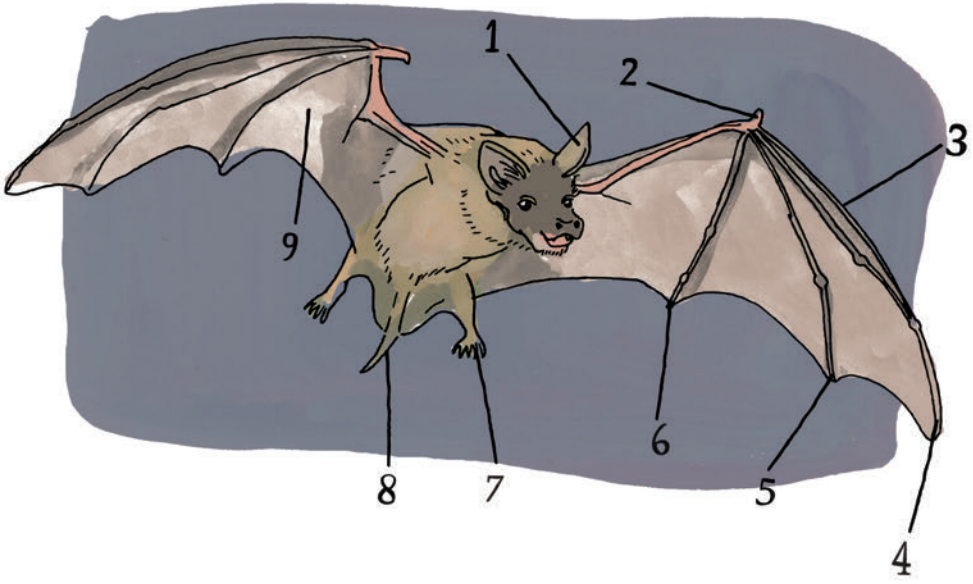
This nocturnal omnivore's primary predator, the great horned owl, lacks a sense of smell.



Eastern Mole

These solitary underground creatures eat worms and grubs. Though nearly blind, they have acute hearing.

ANATOMY OF A BAT



1. ear
2. thumb
3. second finger
4. third finger
5. fourth finger
6. fifth finger
7. foot
8. tail
9. membrane

Bats are the only mammals capable of true flight.

COMMON NORTH AMERICAN BATS

Twenty percent of all classified mammals are bats, with over 1,000 species identified. Insect-eating bats emit ultrasonic sounds to pinpoint with astonishing accuracy the location of their prey. Most larger bats consume fruit, helping to disperse seeds and pollen. There are three species of vampire bats that feed on the blood of animals, but they are rare.



BIG BROWN BAT

It eats mainly beetles and can fly as high as 10,000 feet.



LITTLE BROWN BAT

Although it sleeps almost 20 hours per day, when it's awake, it can catch between 600 and 1,200 insects in an hour.



BRAZILIAN FREE-TAILED BAT

One of the most widespread mammals in the Western Hemisphere, it roosts in colonies of up to several million animals.



SILVER-HAIRED BAT

This solitary, cavity-roosting species flies relatively slowly.



TREE SQUIRRELS

Eastern Gray Squirrel

These squirrels are one of the very few mammals that can descend a tree headfirst.

American Red Squirrel

Though their primary diet is pine and spruce cones, they also eat mushrooms, buds and flowers, and even bird eggs.





Northern Flying Squirrel

Not true fliers, these nocturnal squirrels glide downward between trees, gaining lift from flaps of skin on their sides. Most "flights" are 30 feet or less, but some flying squirrels have been observed gliding nearly 300 feet!

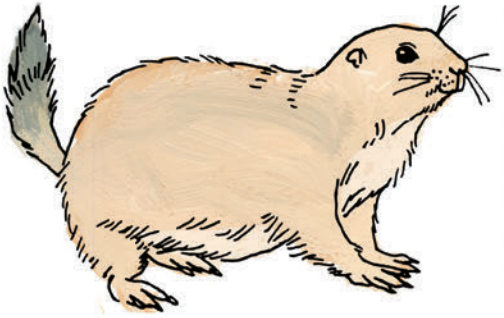
GROUND SQUIRRELS

Yellow-Bellied Marmot



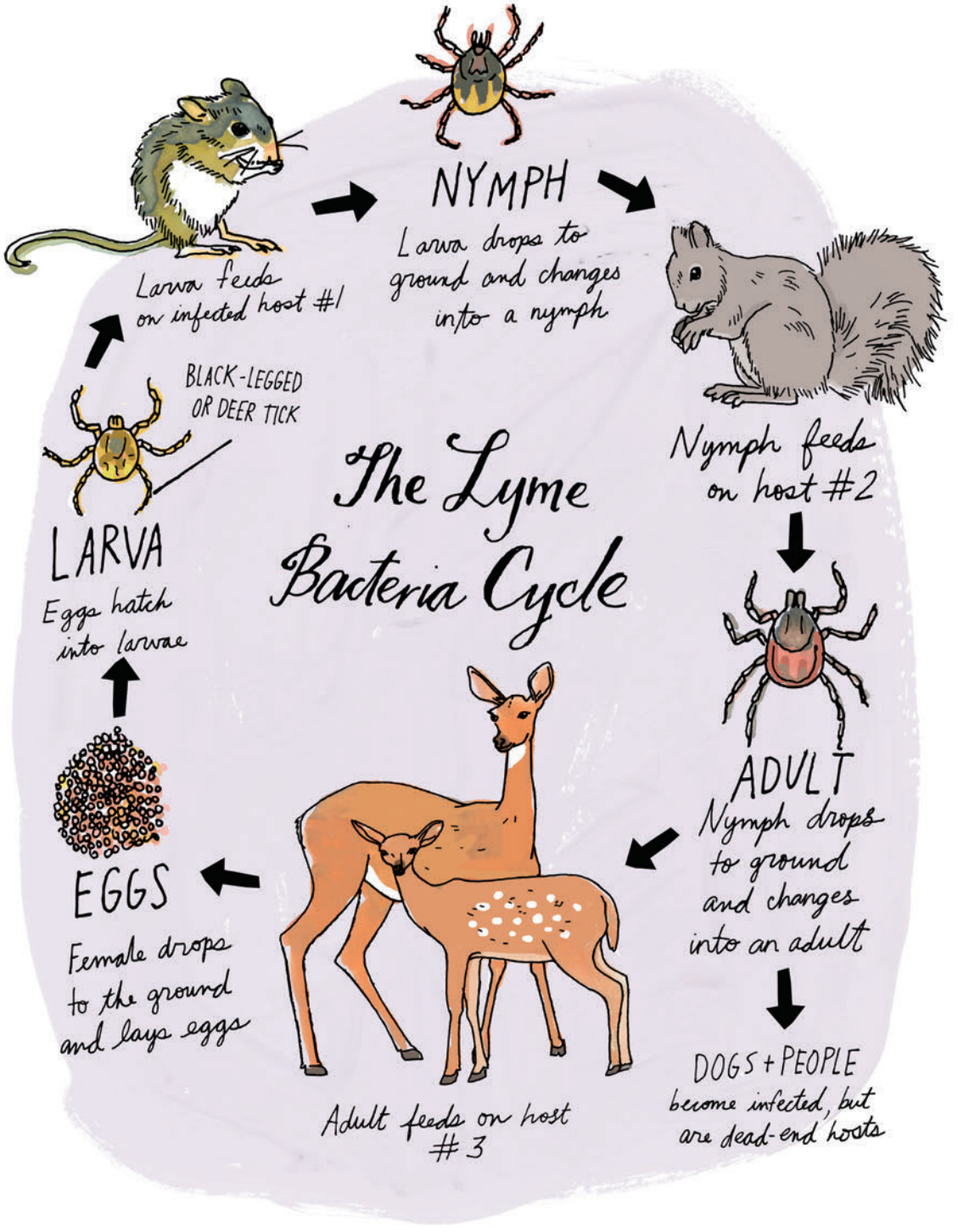
Rather than dig burrows, marmots live in rocky piles in mountainous areas.

Prairie dogs and marmots post sentinels by their burrows to spot predators. Warning calls and whistles identify whether a snake or a hawk is approaching.



These extremely social animals live in elaborate underground "towns" that may house several hundred individuals divided into small family groups.

Black-Tailed Prairie Dog


NYMPH
Larva drops to ground and changes into a nymph
Nymph feeds on host #2
ADULT
Nymph drops to ground and changes into an adult
DOGS + PEOPLE become infected, but are dead-end hosts
Adult feeds on host #3
EGGS
Female drops to the ground and lays eggs
LARVA
Eggs hatch into larvae
BLACK-LEGGED OR DEER TICK
Larva feeds on infected host #1
The Lyme Bacteria Cycle



Black Bear

- weighs between 100 and 600 pounds
- upright ears
- flat shoulder
- rump higher than shoulder
- rounded (convex) profile

VS.

Grizzly Bear

- weighs between 300 and 800 pounds
- rounder, shorter ears
- shoulder hump
- sloping rump
- dished (concave) profile



THE ANIMAL UNDERGROUND



Bushy-Tailed Woodrat

With a fondness for shiny objects, these woodrats sometimes pick up a bottle cap, coin, or bit of foil over food.

Plains Pocket Gopher

This subterranean dweller has large cheek pouches for carrying food and long teeth that are visible even when its mouth is closed.





Badger

Badgers are such strong burrowers that they can dig themselves into underground hiding within moments of any threat.



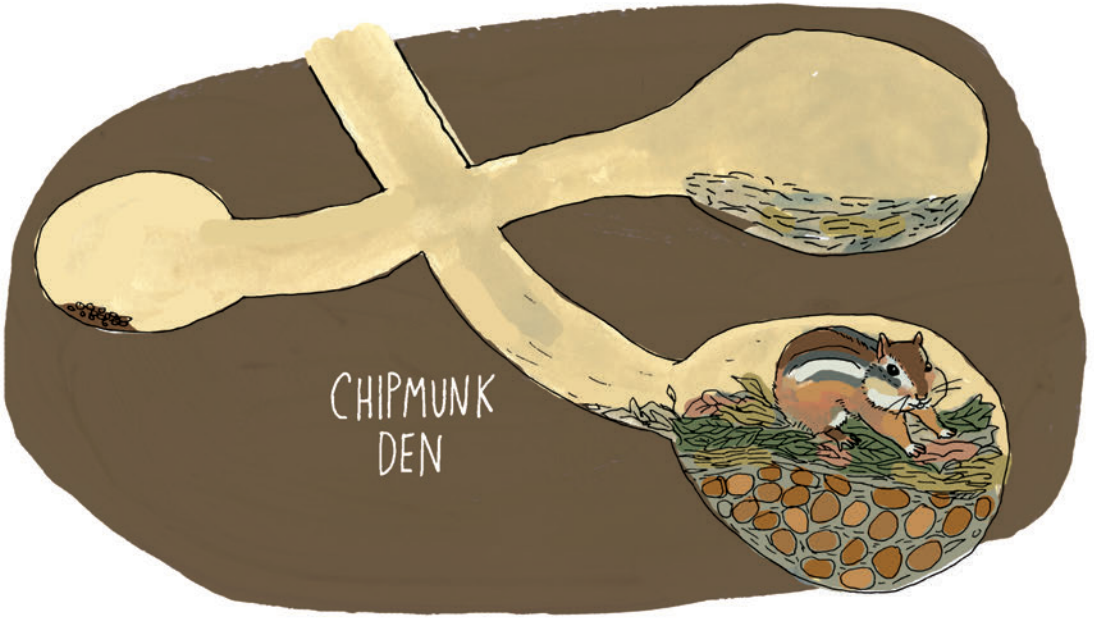
Chipmunks pack food into their expandable cheek pouches and carry it back to their lairs. They dig extensive burrows with "rooms" separated by function: bedroom, pantry, latrine, nursery.

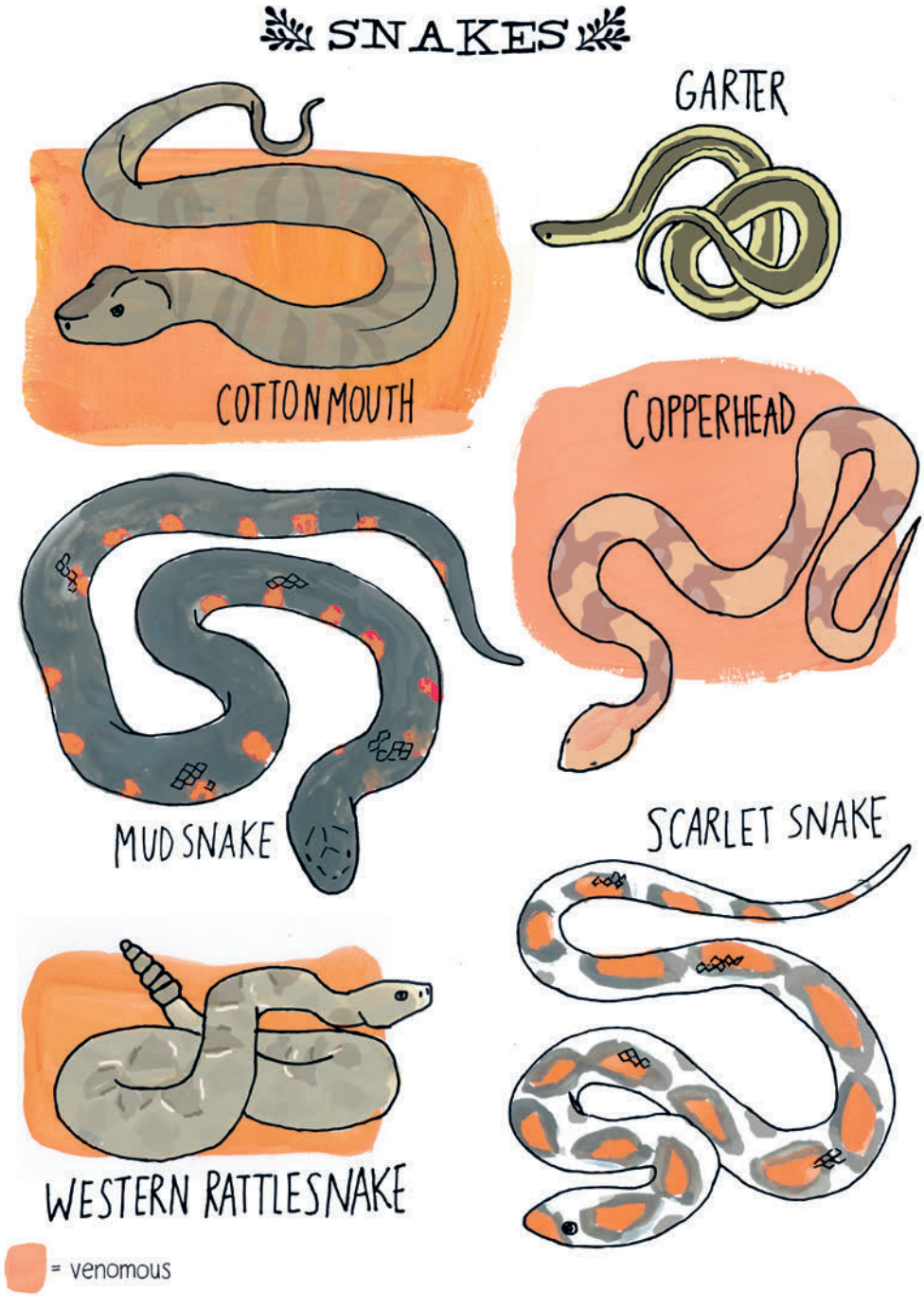
Eastern Chipmunk

Least Chipmunk

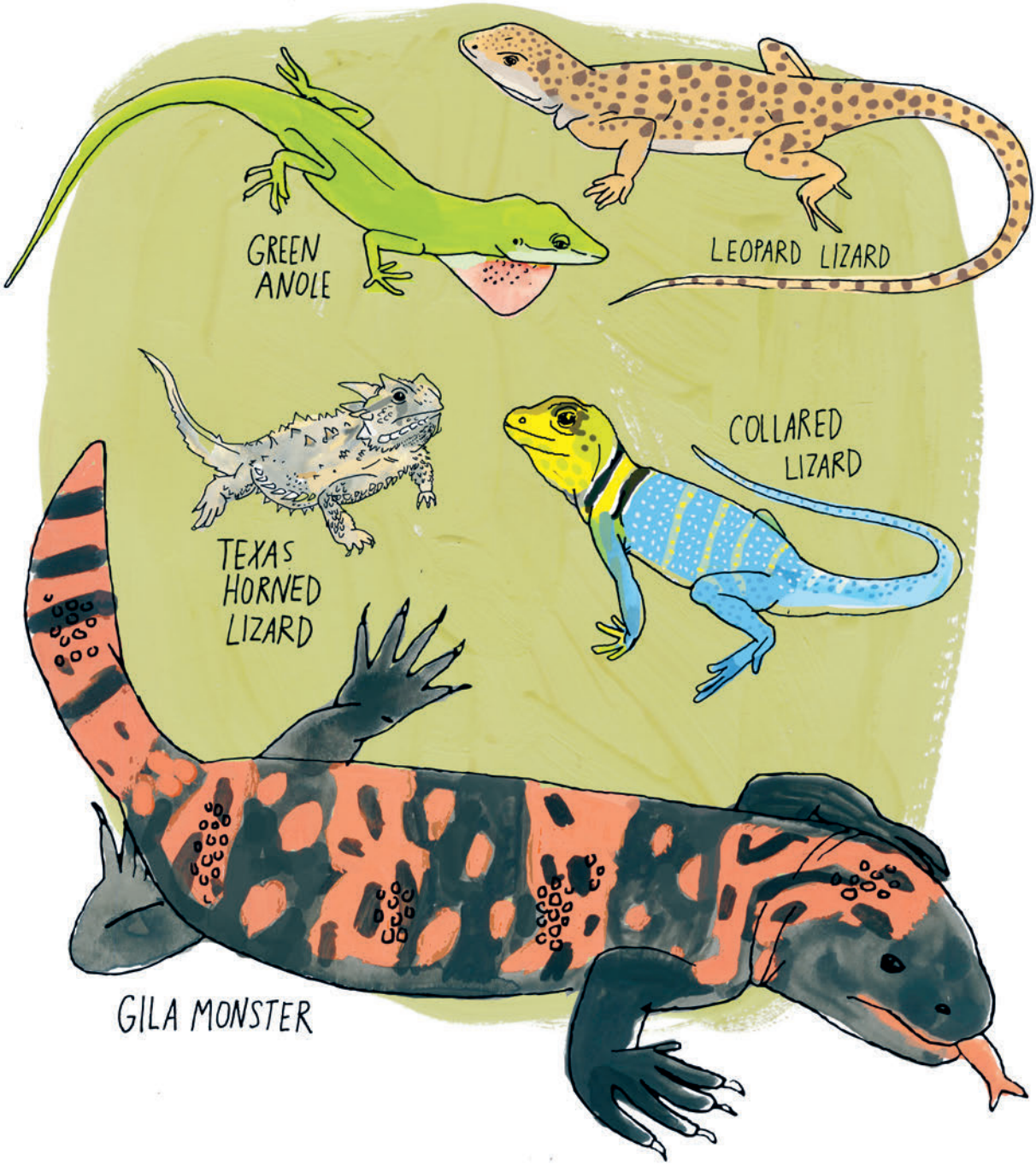


This is the smallest and also the most widespread North American chipmunk. They don't hibernate but go into a state of torpor, or decreased physiological activity, for extended periods of time.




SNAKES
GARTER
COTTON MOUTH
COPPERHEAD
MUD SNAKE
SCARLET SNAKE
WESTERN RATTLESNAKE
= venomous

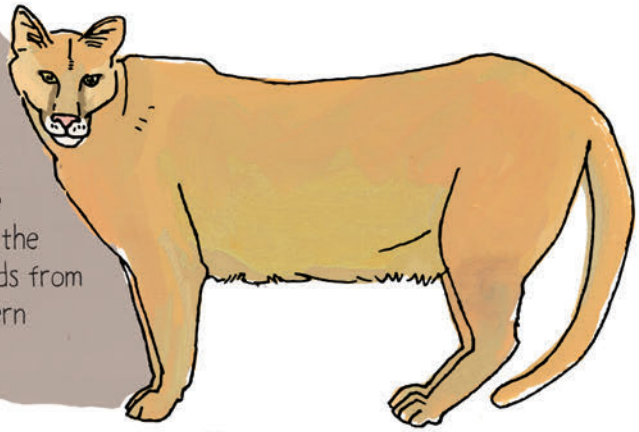
LIZARDS


GREEN ANOLE
LEOPARD LIZARD
TEXAS HORNED LIZARD
COLLARED LIZARD
GILA MONSTER

WILD CATS

Mountain Lion

More closely related to the domestic cat than the lion, the mountain lion's range extends from northern Canada to southern South America.



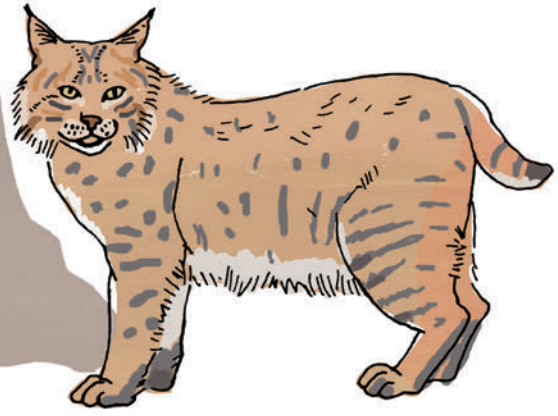


Lynx

In the snowy north, a lynx's paw may be larger than a human's hand.

Bobcat

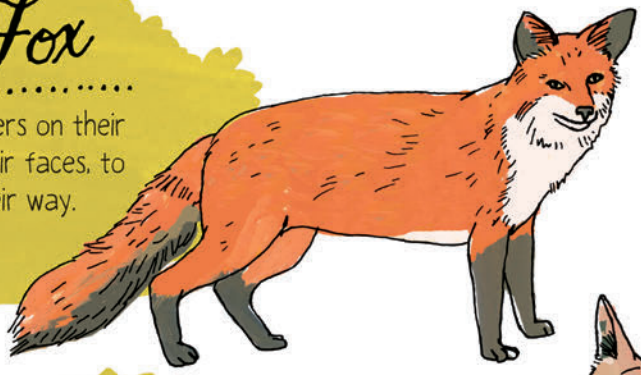
Named for its stubby tail, the bobcat is smaller than its northern lynx cousin and lacks the distinctive ear tufts.



WILD DOGS

Red Fox

Foxes have whiskers on their legs as well as their faces, to help them find their way.



Coyote

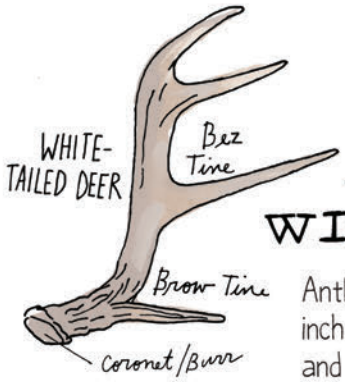
Coyotes communicate with a wide variety of sounds: howls, barks, growls, high-pitched crying, wails, and even squeals.





Gray Wolf

The entire pack cares for the pups produced by the alpha male and female.

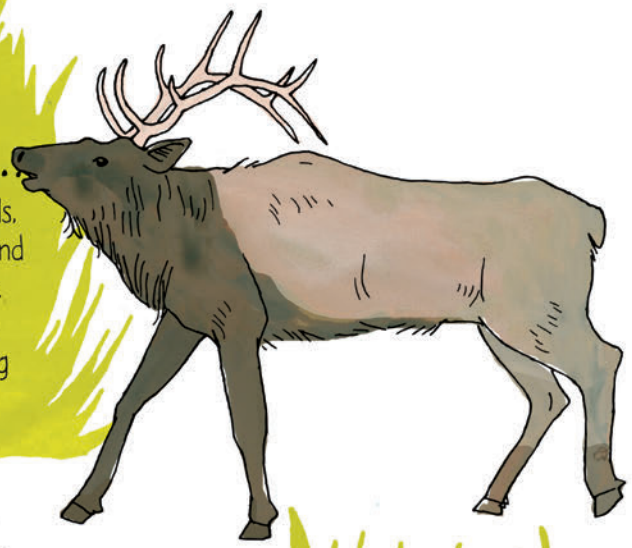


ANIMALS WITH ANTLERS

Antlers are layers of cartilage that can grow up to an inch a day before hardening into bone. They are grown and shed annually, usually by males only.

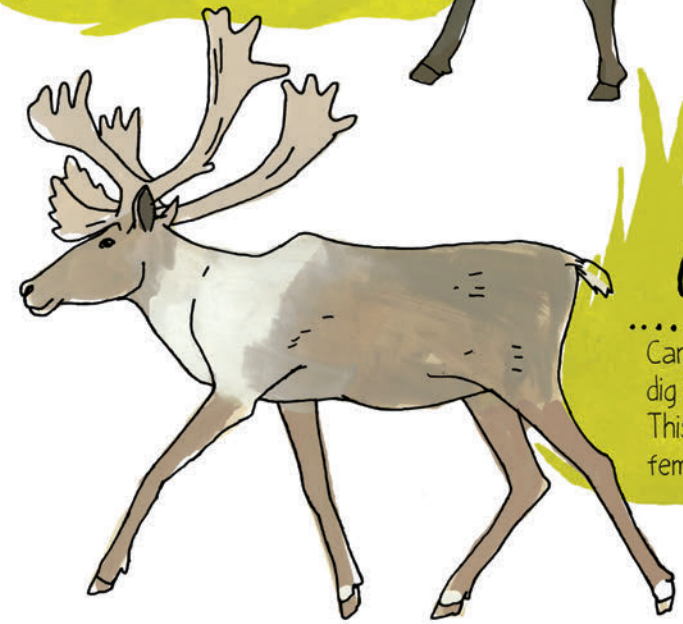
Elk

Elk use a variety of calls, including barks, chirps, and squeals to communicate. Bulls make a distinctive, high-pitched bugle during rut (mating season).



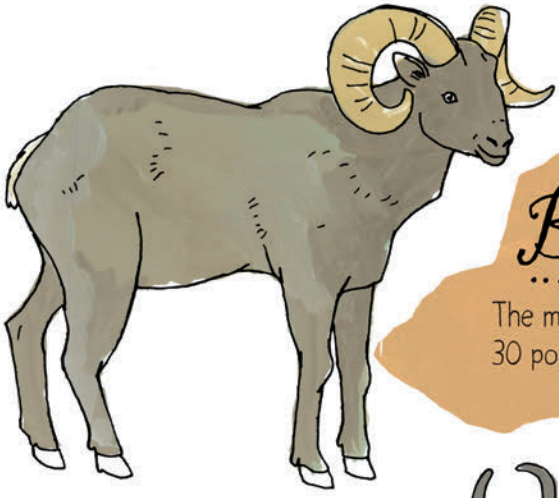
Caribou

Caribou have been known to dig in snow with their antlers. This may be why some females also have antlers.



. . . AND HORNS

Horns are permanent appendages with a bony core covered by keratin. They are typically grown by both males and females and have rings that show the animal's age.



Bighorn Sheep

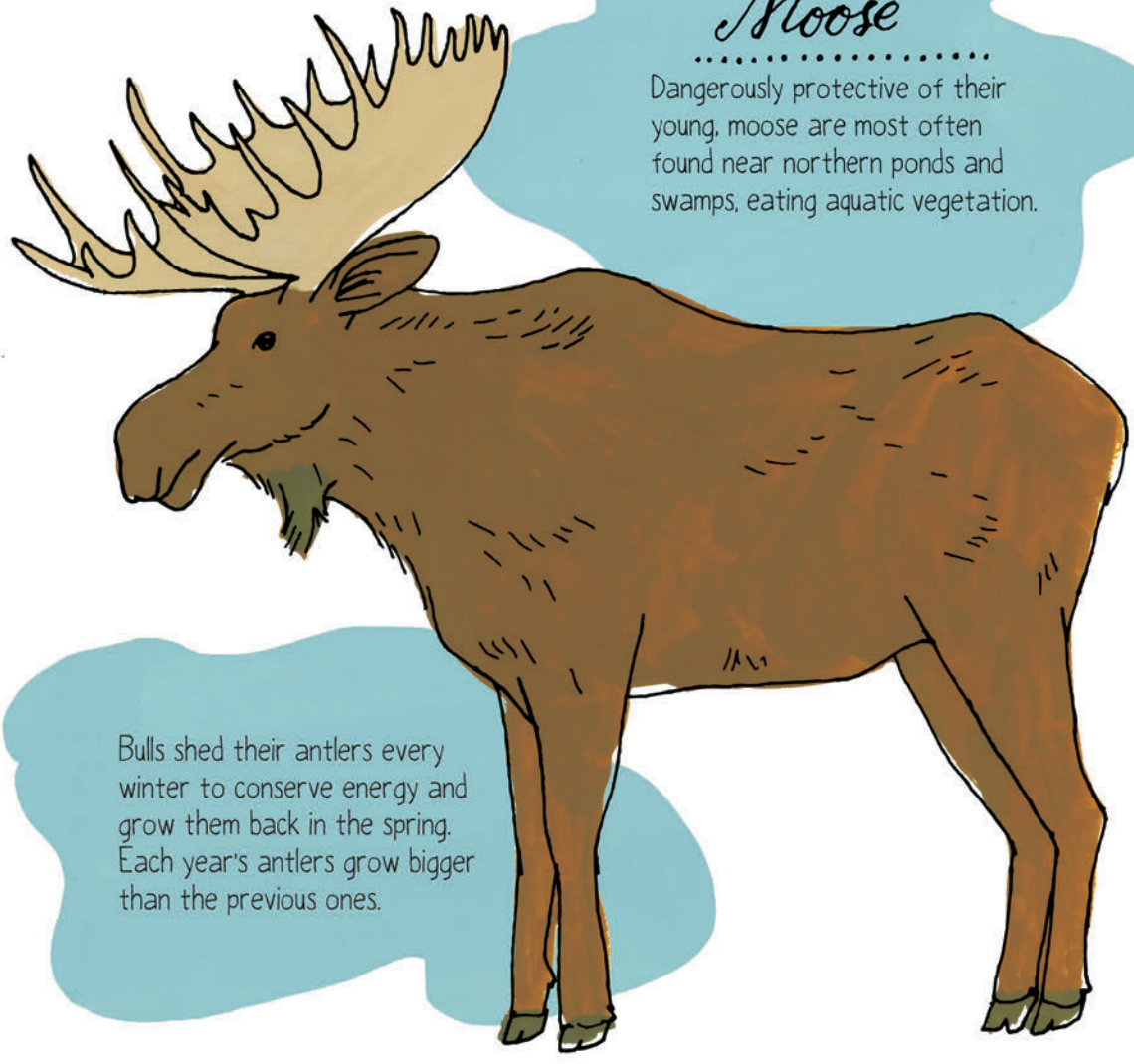
The massive curling horns can weigh 30 pounds.



Pronghorn Antelope

With sprints clocking in at over 55 mph, pronghorns are the fastest land mammal in the Americas.

AQUATIC MAMMALS



Moose

Dangerously protective of their young, moose are most often found near northern ponds and swamps, eating aquatic vegetation.

Bulls shed their antlers every winter to conserve energy and grow them back in the spring. Each year's antlers grow bigger than the previous ones.



Muskrat

The tail of a muskrat is covered in scales, not hair, to aid in swimming.

River Otter

Playful, water-loving otters close their ears when submerged and hunting for fish.



Mink

Comfortable on land or in the water, mink eat fish, rabbits, muskrats, and reptiles. They can spray a foul-smelling fluid when provoked.





Beaver Dam

Beavers transform their surroundings by building dams and massive lodges in streams and rivers. These large, nocturnal rodents can cut down sizable trees with their powerful teeth and jaws, drag them to the water, and position them permanently in place. Beaver dams form ponds that can flood many acres of surrounding land, altering entire ecosystems.

Beavers are second only to humans in the impact they have on the natural environment.



Beaver Lodge

Beaver lodges are made of many tons of mud and sticks and provide a moat-protected, insulated home for surviving the winter, breeding, and raising young.

When threatened, beavers slap the water's surface with their wide tails, producing a distinct alarm that alerts all creatures in the vicinity.



SALAMANDERS

"Salamander" is the name for a group of amphibians that have tails as adults, including newts and sirens. Most adult salamanders have neither lungs nor gills. They breathe through their skins and permeable membranes in their mouths.



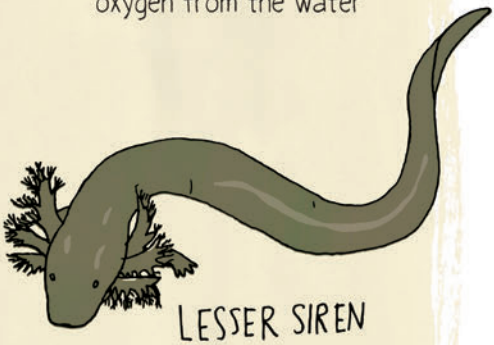
HELLBENDER

wrinkly skin provides more surface area for absorbing oxygen from the water



TIGER SALAMANDER

is striped like a tiger and has two protruding tubercles on the soles of its feet



LESSER SIREN

has visible gills its entire life

SLIMY SALAMANDER

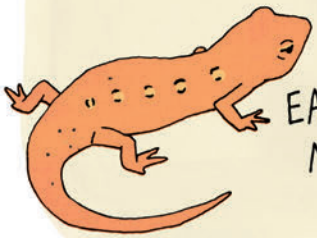
excretes a foul-tasting liquid to deter predators



RED SALAMANDER

the brilliant red of their youth fades as they age

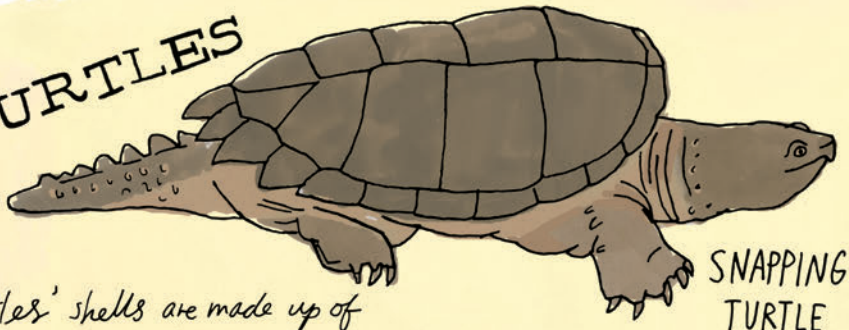




EASTERN NEWT

can regenerate lost or damaged limbs, eyes, jaws, and some internal organs

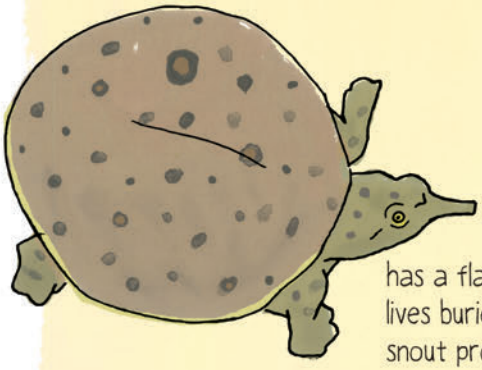
TURTLES



Turtles' shells are made up of dozens of bones, including outgrowths of the spine and ribs.

SNAPPING TURTLE

cannot withdraw completely into its shell



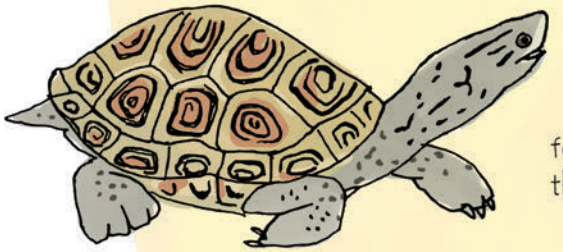
SPINY SOFT TURTLE

has a flat, leathery shell and lives buried in mud with its pointy snout protruding



WOOD TURTLE

feeds on mollusks, small animals, and plants

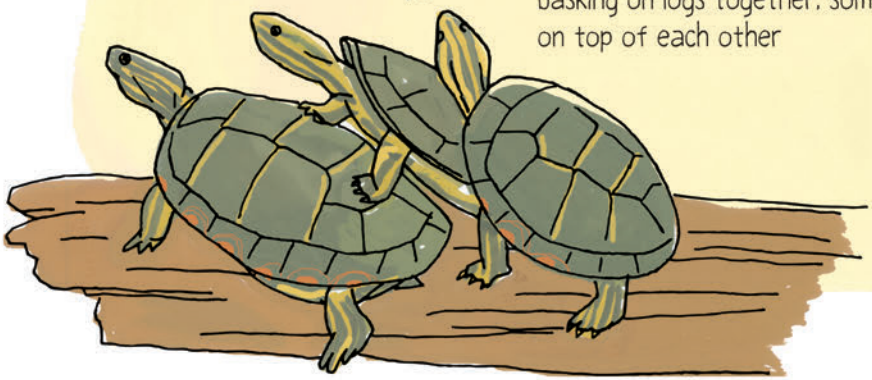


DIAMONDBACK TERRAPIN

females sometimes twice the size of males

PAINTED TURTLE

social and gregarious, often seen basking on logs together, sometimes on top of each other



OUTSTANDING ADAPTATIONS



Short-tailed Shrew

Shrews are among the smallest mammals in the world. This species has venomous saliva for protection and for subduing prey.

Snowshoe Hare

This seasonal chameleon has a stark white winter coat and a brown summer coat. Its name comes from the pads of matted hair on its feet for warmth and mobility on snow.





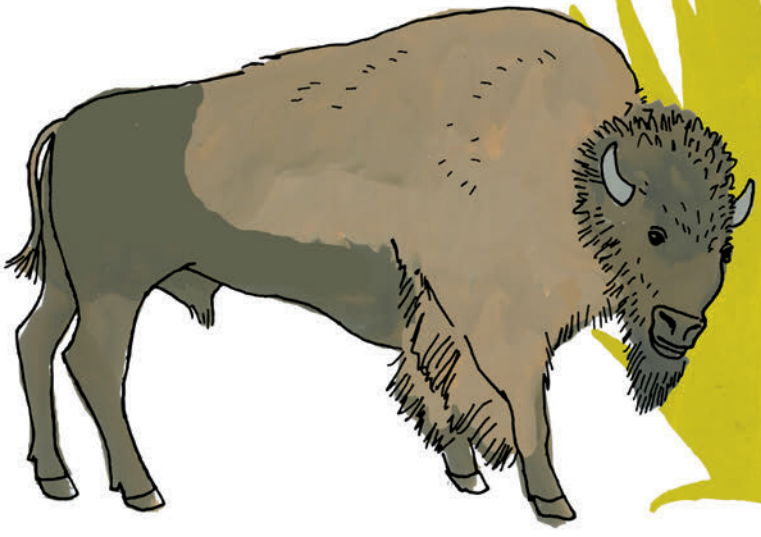
Porcupine

The porcupine's 30,000 sharp quills are actually modified hairs with barbed tips.

Wolverine

The largest member of the weasel family, the wolverine is strong enough to take down animals much larger than itself. Native to the far north, they can comfortably travel long distances on rough, snow-covered terrain.





Bison

When under attack, bison form a circle around vulnerable calves, presenting their formidable horns and well-protected shoulders to predators.

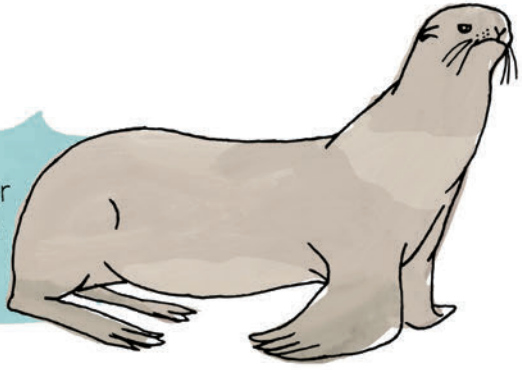
MARINE MAMMALS

Northern Elephant Seal



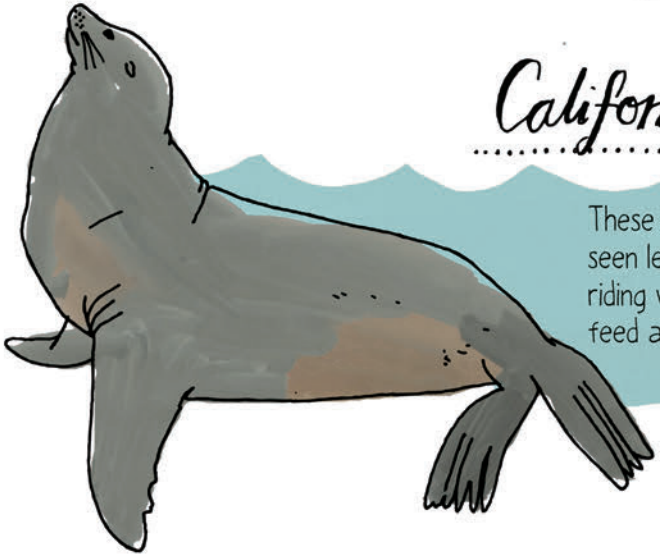
Excellent deep-sea divers, they can remain underwater for up to 2 hours. Males grow to 20 feet long and are fiercely protective of their harems. They roar and bellow through their long noses during the mating season.

Northern Fur Seal



Dense, luxurious fur keeps these seals insulated in the cold north. Males fight for breeding grounds, and once they've won a space they stay put, fasting through the entire breeding season.

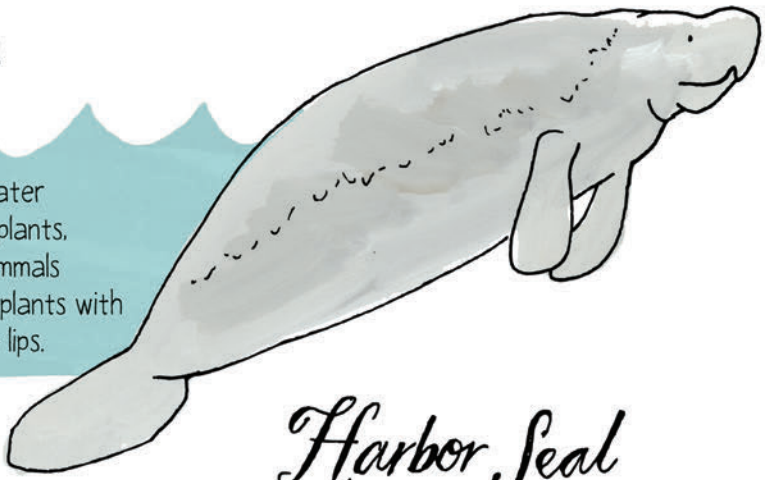
California Sea Lion



These playful swimmers can be seen leaping from the water and riding waves like surfers. They feed at night on fish and mollusks.

Manatee

Fond of the warm water flowing out of power plants, these slow-moving mammals graze on sea-bottom plants with their nimble, prehensile lips.



Harbor Seal

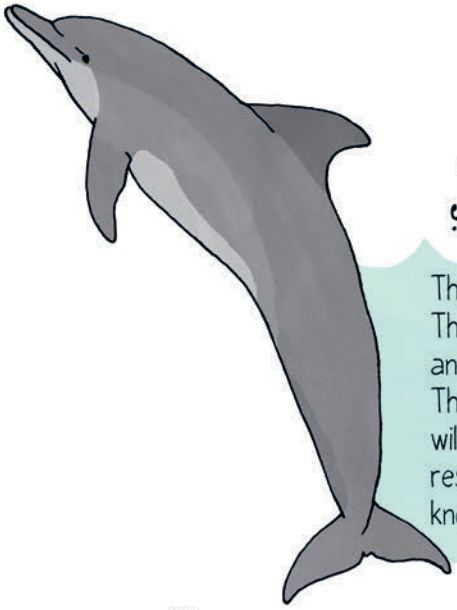


These seals spend a lot of time on shore and are comfortable mating on land or at sea. They've been known to give birth in the water.

Sea Otter

The smallest marine mammal spends almost all of its time in the water. To crack mollusks open, an otter floats on its back and smashes shells against rocks it holds on its belly.



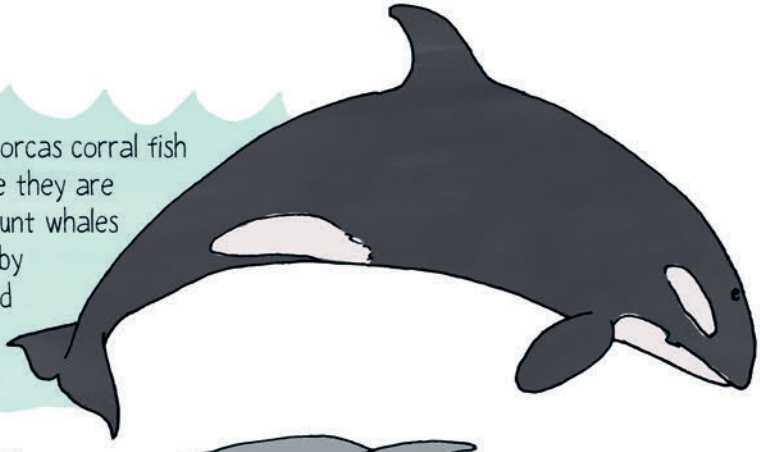


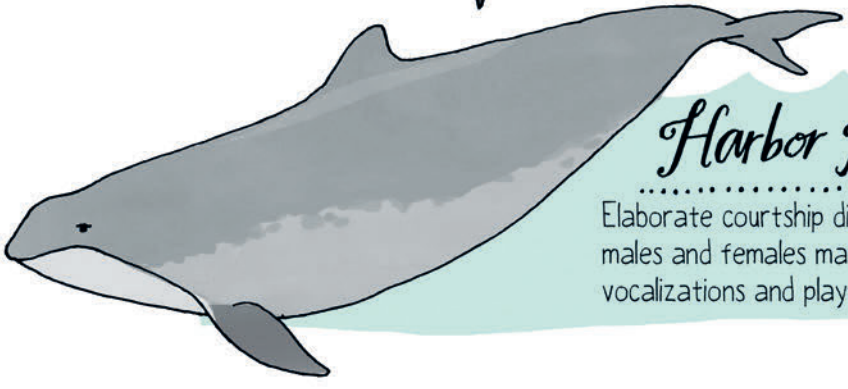
Bottlenose Dolphin

These social creatures use echolocation to hunt. They communicate with body language and clicks and squeaks from their mouths and blowholes. They are known for their intelligence and willingness to interact with humans and recent research suggests that dolphins transmit cultural knowledge across generations.

Orca

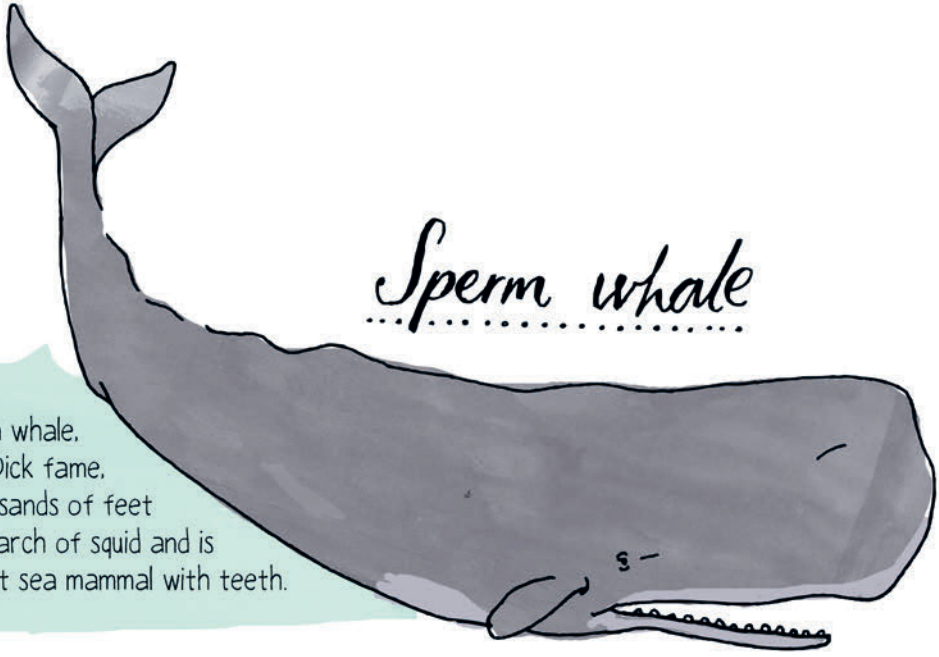
Master pack hunters, orcas corral fish into tight coves where they are easy to catch. They hunt whales many times their size by chasing them down and taking bites until the whale succumbs.





Harbor Porpoise

Elaborate courtship displays between males and females may involve intense vocalizations and playful touching.



Sperm whale

The sperm whale, of Moby-Dick fame, dives thousands of feet deep in search of squid and is the largest sea mammal with teeth.

Gray whale

Calves weigh half a ton and are 15 feet long at birth. A nursing gray whale calf consumes 200 to 300 gallons of high-fat milk every day.

Humpback whale

These whales migrate 15,000 miles per year between polar feeding areas and warm-water mating grounds. They fast all winter, surviving on their reserves of blubber.

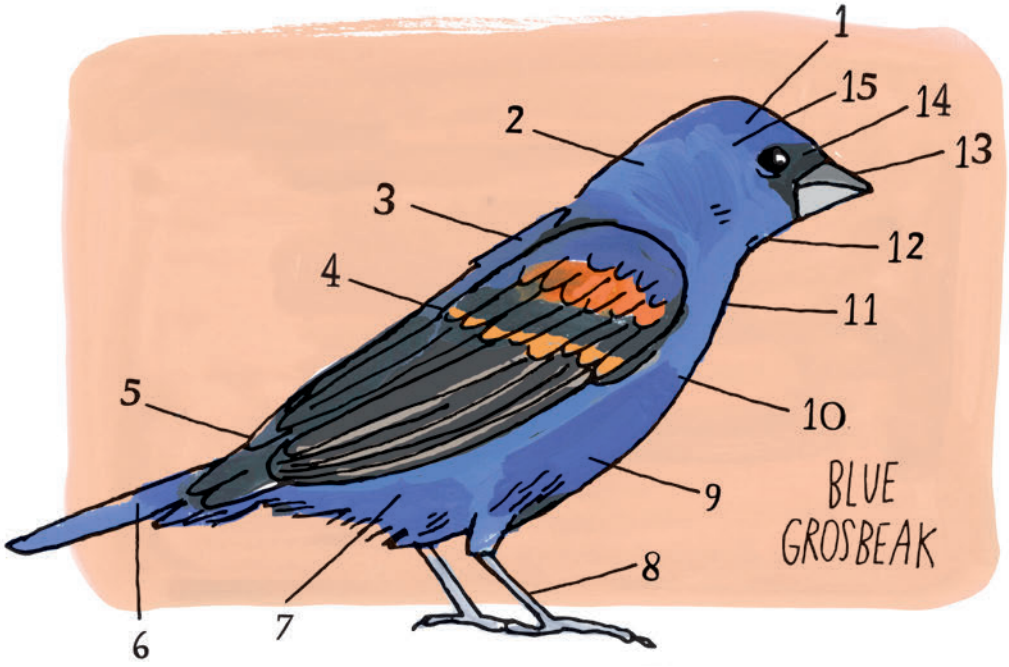




CHAPTER 6

A Little Bird Told Me

ANATOMY OF A BIRD



1. crown
2. nape
3. back
4. wing bar
5. rump
6. tail
7. flank
8. tarsus
9. side
10. breast
11. throat
12. chin
13. bill
14. lore (area between eye and bill)
15. ear patch

A BEVY OF BIRDS



RED-WINGED BLACKBIRD

Only the males have the flashy burst of color on the top of their wings.



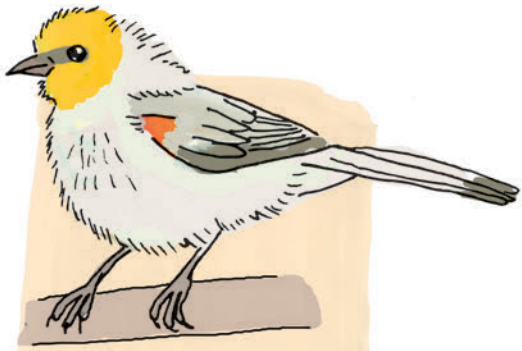
YELLOW-BELLIED SAPSUCKER

One-fifth of their diet comes from the sap collected from drilling tiny holes in trees.



SAY'S PHOEBE

Look for their cup-shaped nests attached to bridges, canyon walls, and wells.



VERDIN

These desert dwellers build round nests covered with thorns.



RUBY-THROATED HUMMINGBIRD

During its winter migrations to Central America, it may fly over the entire Gulf of Mexico nonstop.



YELLOW-THROATED WARBLER

Although it nests high in the canopy of swamp or pine forests, this lovely bird isn't shy of humans.



SCARLET TANAGER

They provide an important service to the oaks they call home by eating damaging caterpillars and beetles.



CANADA WARBLER

This small songbird nests near the ground in decaying logs.



MOUNTAIN CHICKADEE

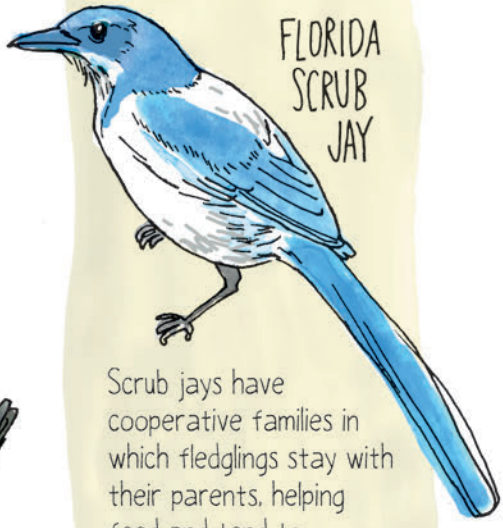
Mated pairs of chickadees may join forest flocks containing several different species of small birds.



CEDAR WAXWING

Flocks have been known to line up on a branch and pass berries down the line beak to beak until every bird has been fed.

FLORIDA SCRUB JAY



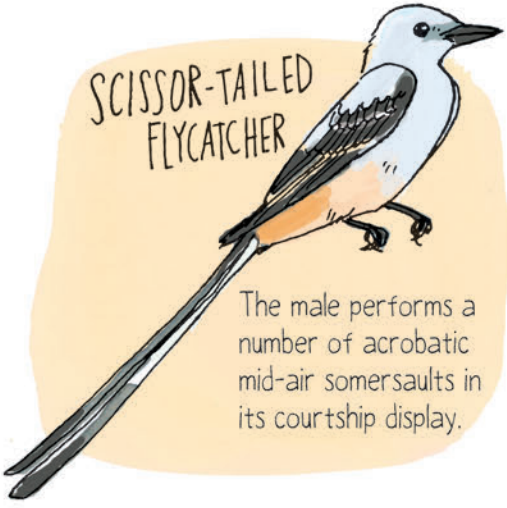
Scrub jays have cooperative families in which fledglings stay with their parents, helping feed and tend to subsequent hatchlings.

WHITE-BREASTED NUTHATCH

This is one of the only birds to descend trees headfirst.

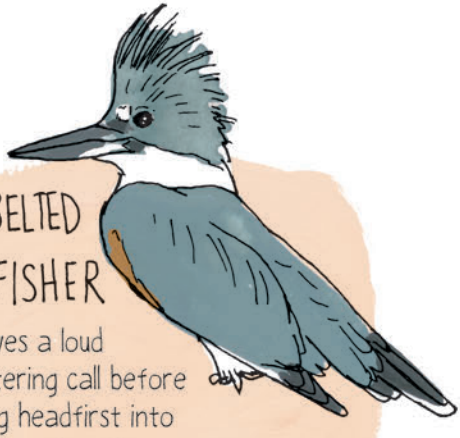


SCISSOR-TAILED FLYCATCHER



The male performs a number of acrobatic mid-air somersaults in its courtship display.

BELTED KINGFISHER



It gives a loud clattering call before diving headfirst into lakes or rivers to snatch fish.



CLARK'S NUTCRACKER

This bird has a pouch beneath its tongue that can hold up to 150 pine seeds, its primary food.



BROWN-CAPPED ROSY FINCH

Finches have a "bouncing" flight with bouts of flapping interspersed with swooping glides with closed wings.



HOODED ORIOLE

Orioles weave distinctive nests shaped like deep purses hanging from branches.



GREAT CRESTED FLYCATCHER

Flycatchers prefer to include snake skins in nest linings but may substitute strips of plastic bags.



BLACK-AND-WHITE WARBLER

During the breeding season, male warblers have much more ostentatious plumage than females, but they revert to drab colors in the fall.



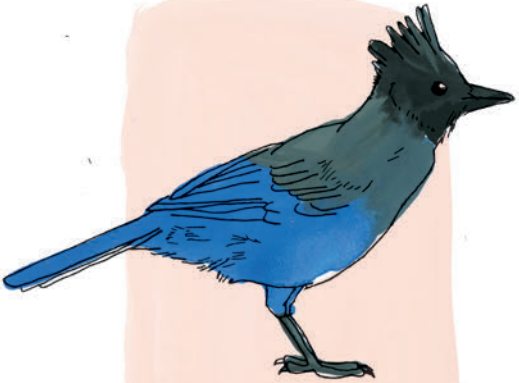
MOUNTAIN BLUEBIRD

Fiercely protective, a bluebird may hunker down in its nest even when approached by humans.



CACTUS WREN

This wren obtains all the liquid it needs from its diet of insects, with some seeds, fruit, and small reptiles.



STELLER'S JAY

North America's largest jay is also the noisiest, with an energetic common call: "Shaack! Shaack! Shaack!"



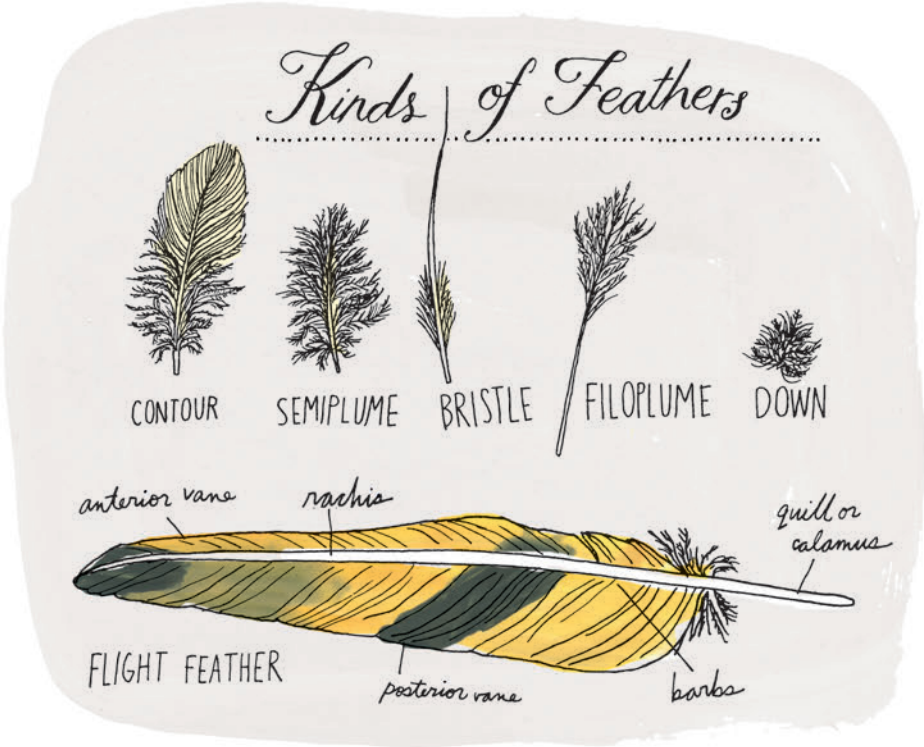
GILA WOODPECKER

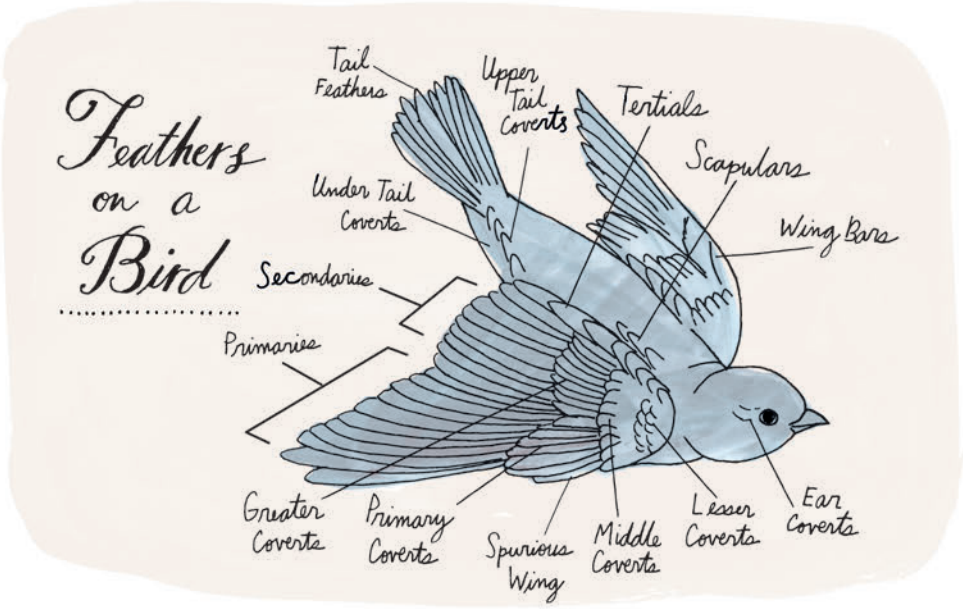
Abandoned nest cavities in saguaro cacti become home to rats, snakes, and other animals.



BRIDLED TITMOUSE

Titmice tend to perform acrobatics while feeding: flipping, swinging, and hanging upside down.


Kinds of Feathers
CONTOUR
SEMIPLUME
BRISTLE
FILOPLUME
DOWN
anterior vane
rachis
quill or calamus
FLIGHT FEATHER
posterior vane
barbs


Feathers on a Bird
Tail Feathers
Upper Tail Coverts
Tertials
Scapulars
Under Tail Coverts
Wing Bars
Secondaries
Primaries
Greater Coverts
Primary Coverts
Spurious Wing
Middle Coverts
Lesser Coverts
Ear Coverts


SOME BEAUTIFUL FEATHERS
NORTHERN HARRIER
SNOWY OWL
AMERICAN KESTREL
NORTHERN FLICKER
YELLOW WARBLER
RING-NECKED PHEASANT
WESTERN BLUEBIRD

BIRDCALLS



Songbirds of the same species don't all sing the same song. Geographically isolated populations often develop distinct vocal repertories that, in time, can form different "dialects" within a species.



"Germany-Germany-Germany"



Songbirds learn their songs rather than inherit them. They make an innate array of sounds, but young birds learn to sing by listening to the older birds around them.

"witchity-witchity-witchity"



Youngsters spend their first winter dreaming about those songs (literally: studies have found that they "practice" in their sleep). In the spring they begin to sing them aloud. And since most songbirds return each year to the same area, little pockets of geographically distinct songs develop.

"cheer-up; cheer-a-lee; cheer-ee-o; whinny"



A VARIETY OF NESTS



SNOWY EGRET

nests in trees, built with woven sticks and twigs, thin lining

HOUSE WREN

a cavity of plant matter lined with a variety of materials: feathers, hair, wool, cocoons, moss



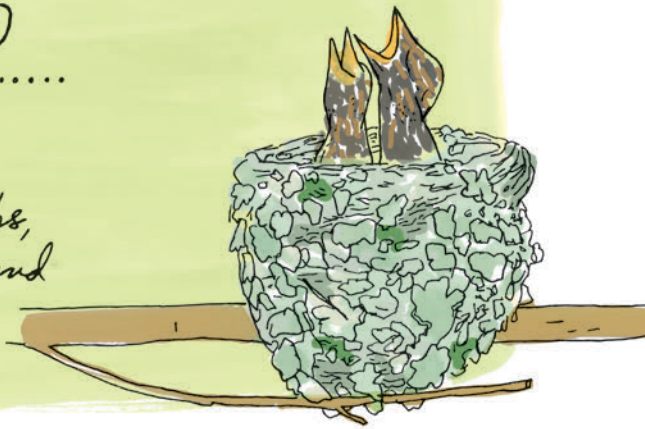


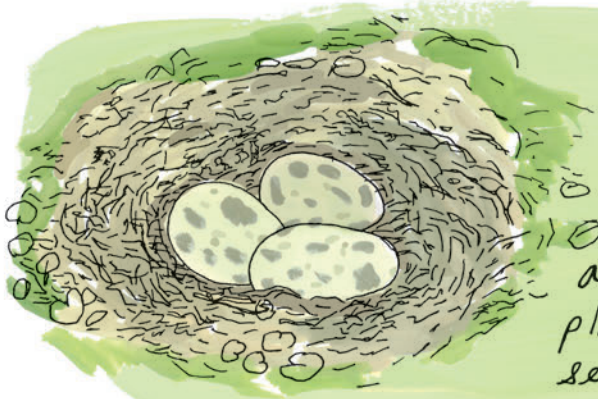
SONG SPARROW

a cup of dead grasses, weeds, and bark pieces, lined with thin grasses

ANNA'S HUMMINGBIRD

a cup made of stems and plant down, held together with spider webs, lined with plant down and feathers, decorated with lichen and moss





GREATER BLACK-BACKED GULL

a scrape of dead plant matter, mosses, seaweed, feathers

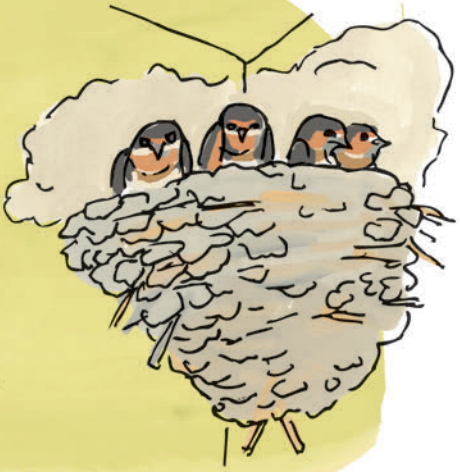


MALLARD DUCK

a hollow of down, plant debris, grasses, and leaves

BARN SWALLOW

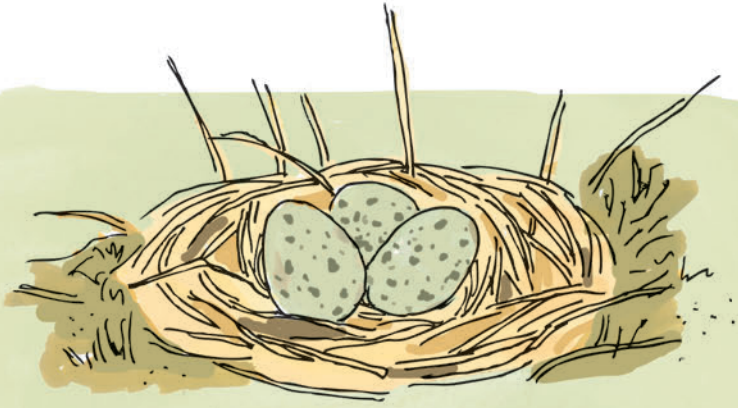
a cup of mud pellets and fibers, lined with feathers; built in caves or rafters of buildings





VERDIN

a spherical insulated nest of sticks with thorns all around them, lined with spider webs and fine grasses, and then a thick layer of feathers and plant down

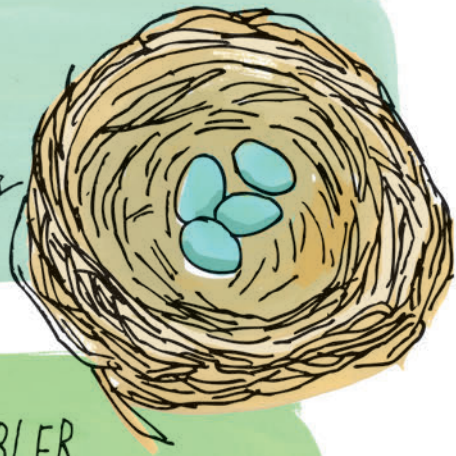


LAUGHING GULL

arranged in beach grass or found in a shallow hole in the sand, lined with grasses and sticks

ROBIN

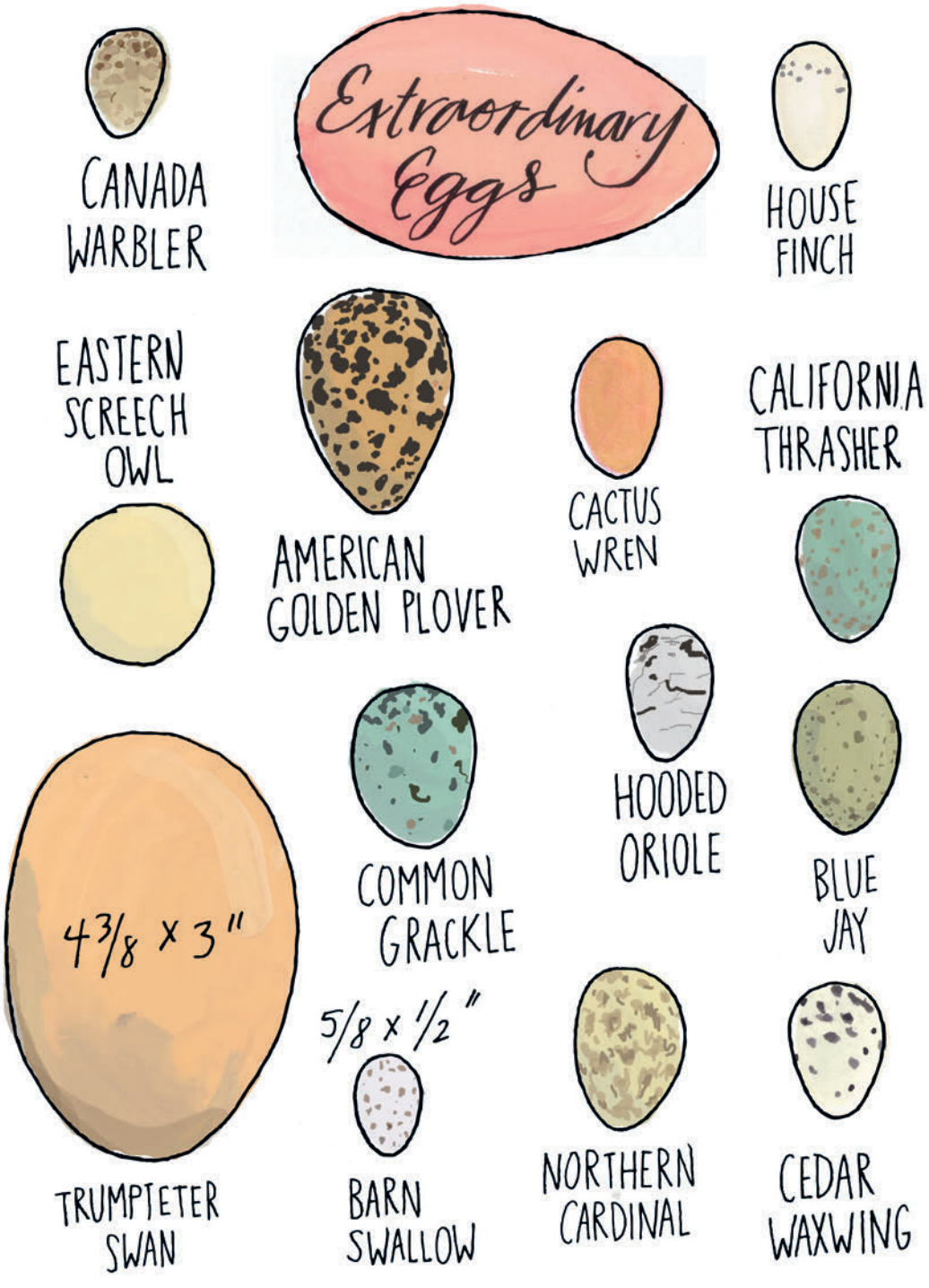
made of twigs, weeds, grass and string, rags and debris. lined with mud and grasses





YELLOW WARBLER

a cup of stems, wool, and plant down, lined with fibers, cotton, and feathers, found in a branch fork


Extraordinary Eggs
CANADA WARBLER
HOUSE FINCH
EASTERN SCREECH OWL
AMERICAN GOLDEN PLOVER
CACTUS WREN
CALIFORNIA THRASHER
HOODED ORIOLE
COMMON GRACKLE
BLUE JAY
4 3/8 x 3"
5/8 x 1/2"
TRUMPTETER SWAN
BARN SWALLOW
NORTHERN CARDINAL
CEDAR WAXWING


CAPE MAY WARBLER
SCISSOR-TAILED FLYCATCHER
GLOSSY IBIS
DICKCISSEL
RED-TAILED HAWK
BLACK-BELLIED PLOVER
ROSEATE SPOONBILL
BLACK SKIMMER
COMMON LOON
OSPREY

INTRIGUING BIRD BEHAVIOR

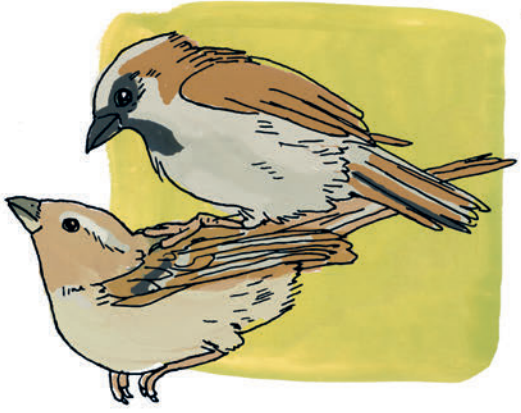
Courting



Most bird species breed in the spring, with males displaying courtship behavior such as specialized songs, dances, or acrobatic flights. Females select males that demonstrate their health and vigor in these displays, thereby ensuring healthy offspring.

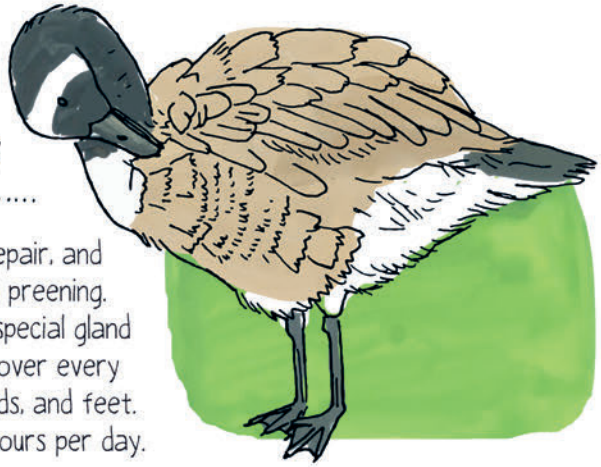
Mating





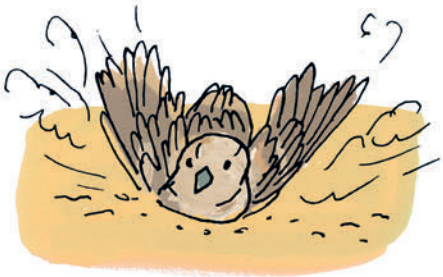
Both male and female birds have a single opening called a cloaca that is used for both waste excretion and reproduction. Males store sperm in their cloaca until a female becomes receptive. When mating occurs, the male typically balances on the back of the hunching female and arches his body so his cloaca can rub against hers. Mating may take only a second or two but is often repeated.

Preening



Birds clean, realign, protect, repair, and waterproof their feathers by preening. Most birds gather oil from a special gland near their tails and spread it over every feather with their beaks, heads, and feet. Birds may preen for several hours per day.

Bathing

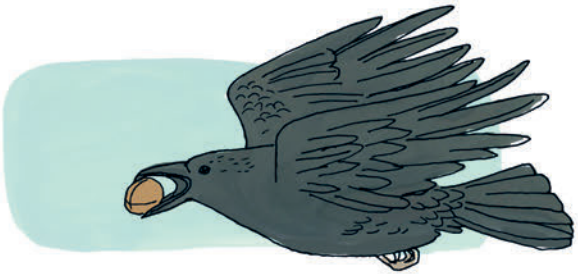


Birds clean their feathers and dislodge parasites by bathing in either pools of water or shallow depressions of dust.

Anting

Several species of birds will lie near anthills with their wings spread, allowing the ants to infiltrate their feathers. The ants leave traces of formic acid, which repels parasites.





Using Tools

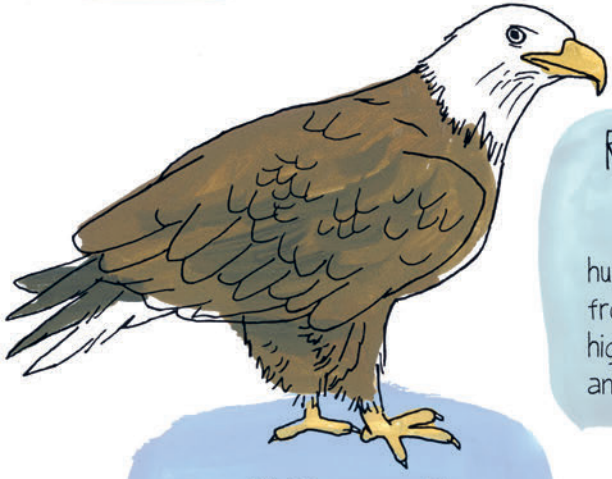
Some species of finch use twigs to gather insects from holes in logs or tree trunks. Crows also do this, and some have learned to open nuts by dropping them in front of moving cars. Herons have been observed using bread, left by humans feeding ducks, as bait for fish.

BIRDS OF PREY



SHARP-SHINNED HAWK

feeds on birds and small mammals



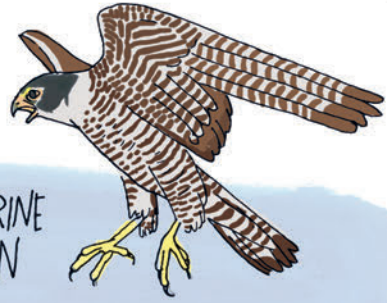
BALD EAGLE

builds massive nests made of sticks, often found near water where it hunts for fish



RED-TAILED HAWK

hunts small mammals from the air or from high perches like trees and highway signs



PEREGRINE FALCON

has been recorded diving at over 250 miles per hour



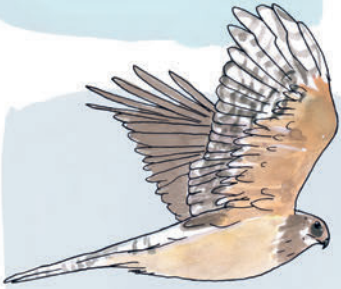
SWAINSON'S HAWK

hunts from the ground for gophers, mice, and even grasshoppers



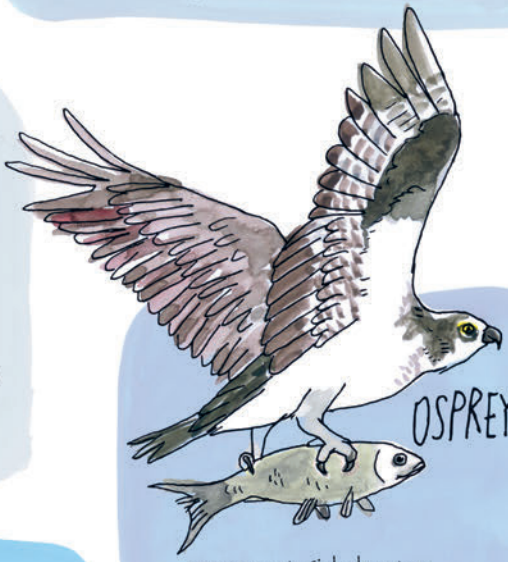
GOLDEN EAGLE

powerful enough to hunt young deer and other large mammals



NORTHERN HARRIER

also called the marsh hawk, builds nests on the ground



OSPREY

an expert fish hunter



AMERICAN KESTREL

hovers above small mammals before quickly diving for the kill

OWLS

Owls have very large eyes that cannot move. Instead, they can turn their heads around almost 270 degrees, much more than most other animals. The faces of most owls are concave discs, ideal for focusing the sounds of night-scurrying prey.



PYGMY OWL

only 6 inches in length, nests in holes in evergreens



BURROWING OWL

lives in large underground burrows lined with feathers and plant matter



COMMON BARN OWL

can locate prey in complete darkness by sound alone



EASTERN SCREECH OWL

a small owl with pronounced ear tufts



GREAT HORNED OWL

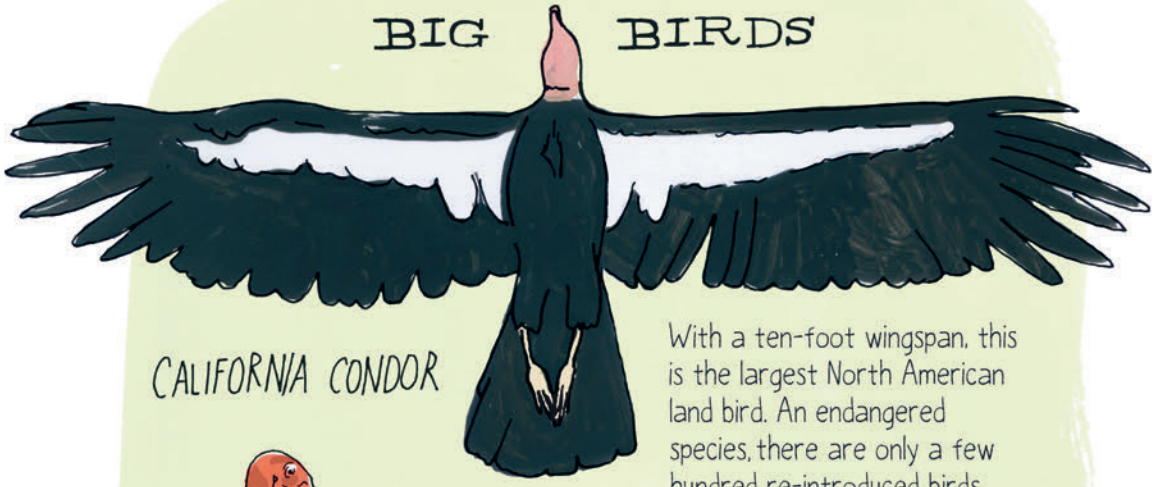
only predator known to feed on skunks; calls of mating pairs may harmonize.



SNOWY OWL

active in daylight hours and often unafraid of humans

BIG BIRDS



CALIFORNIA CONDOR

With a ten-foot wingspan, this is the largest North American land bird. An endangered species, there are only a few hundred re-introduced birds living in the wild.



TURKEY VULTURE

A master of gliding with a six-foot wingspan, vultures use a keen sense of smell to find their primary food: rotting carcasses.

WHOOPING CRANE

The tallest North American bird, the whooping crane is named for its unique call. Fewer than 500 remain in the wild.

AMERICAN FLAMINGO

These birds can live up to forty years. Their pink color comes from pigments in the brine shrimp they eat.





A Variety of Beaks



WHITE-THROATED SPARROW

great for crushing seeds and picking at bark to uncover hiding insects



RINGED KINGFISHER

wedge shape creates no splash when entering the water



MALLARD DUCK

used for skimming in shallow waters



BALD EAGLE

hooked for tearing up prey



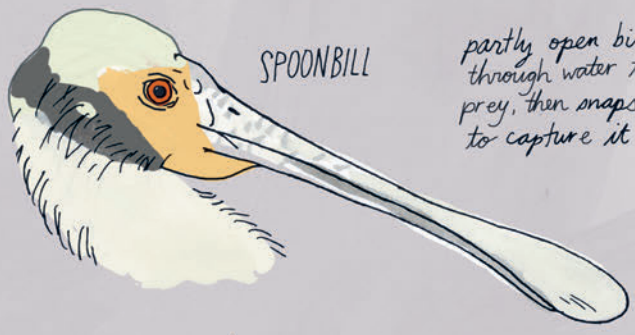
RED CROSSBILL

helps with prying apart scales of a pinecone

RUBY-THROATED HUMMINGBIRD



long, to probe into flowers



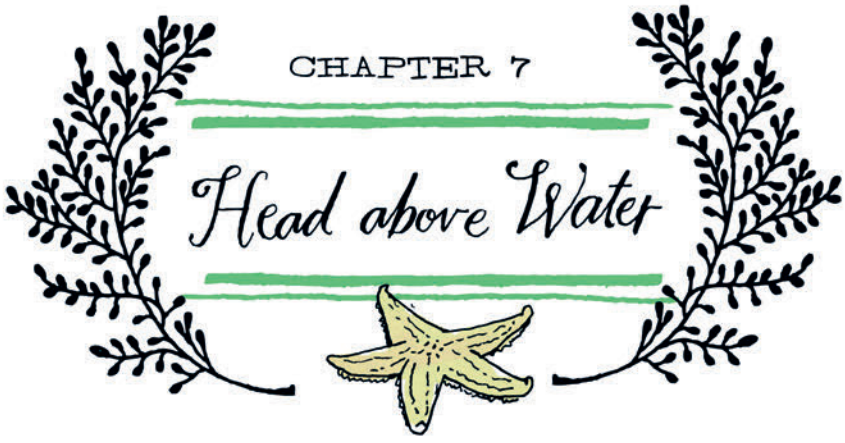
SPOONBILL

partly open bill sweeps through water to find prey, then snaps shut to capture it

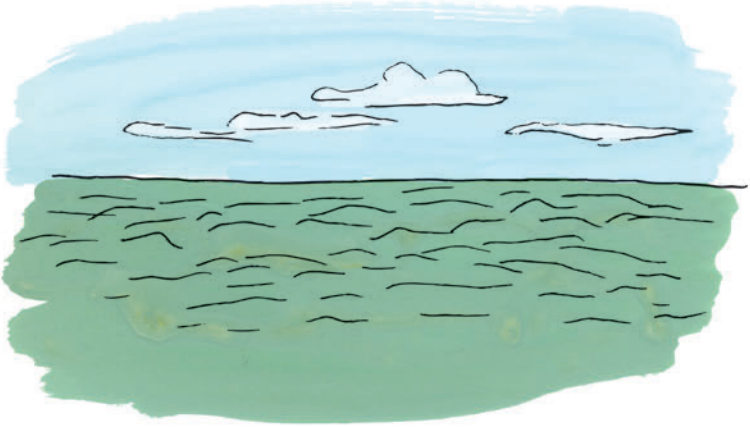

WATER BIRDS
CANADA GOOSE
BELTED KINGFISHER
BROWN PELICAN
LONG-BILLED CURLEW
PLOVER
OYSTERCATCHER


ROSEATE SPOONBILL
GREAT BLUE HERON
CANVASBACK
MUTE SWAN
CORMORANT
BITTERN



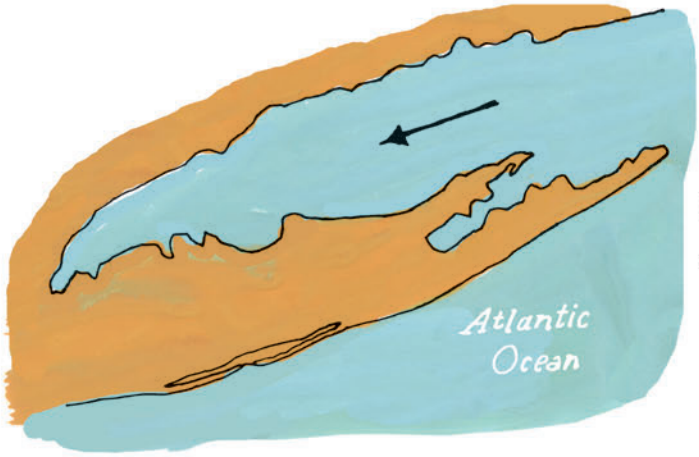

CHAPTER 7
Head above Water

WATER BODIES



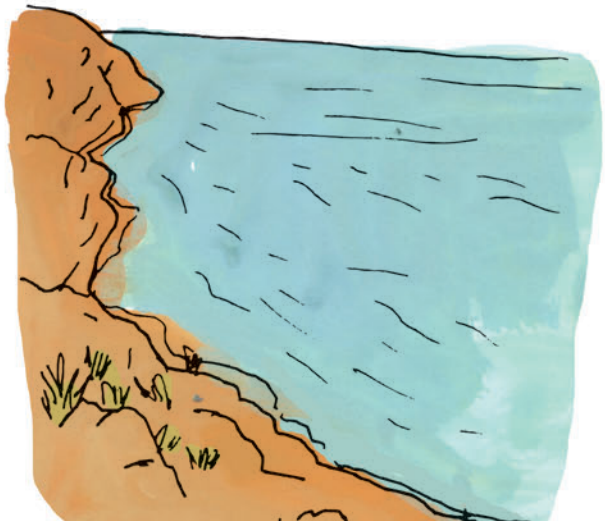
Ocean

massive bodies of salt water that cover nearly two-thirds of the earth's surface



Sound

a large ocean inlet

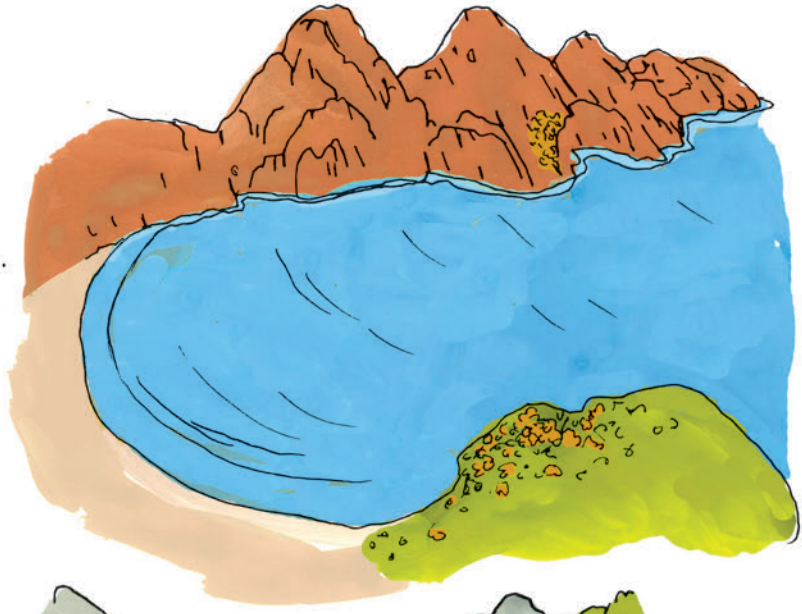


Sea

a large body of salt water that is smaller than an ocean and sometimes bordered by land

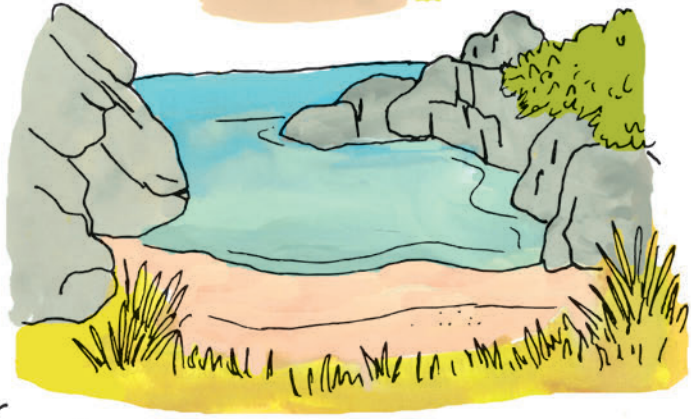
Bay

a broad sea inlet partially surrounded by land



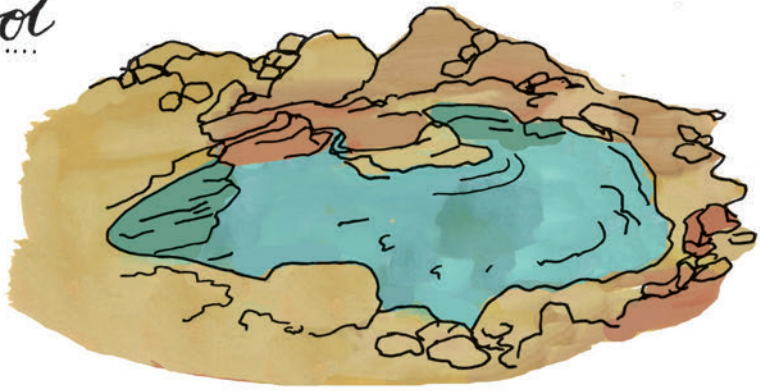
Cove

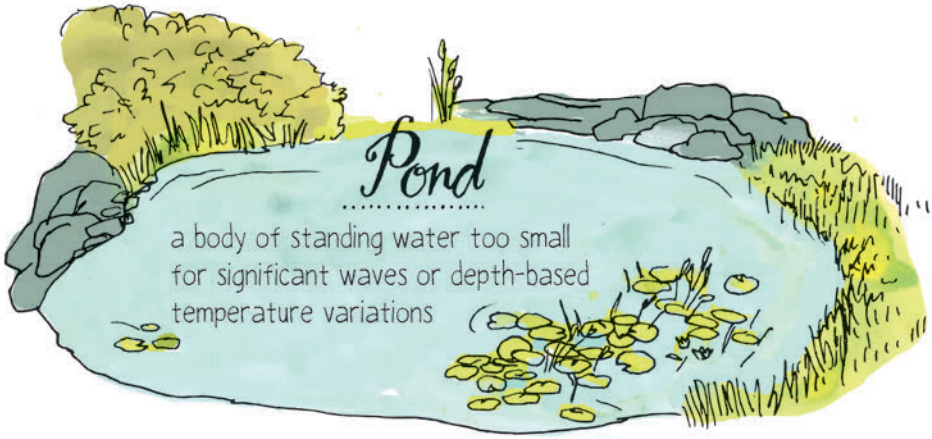
a small bay

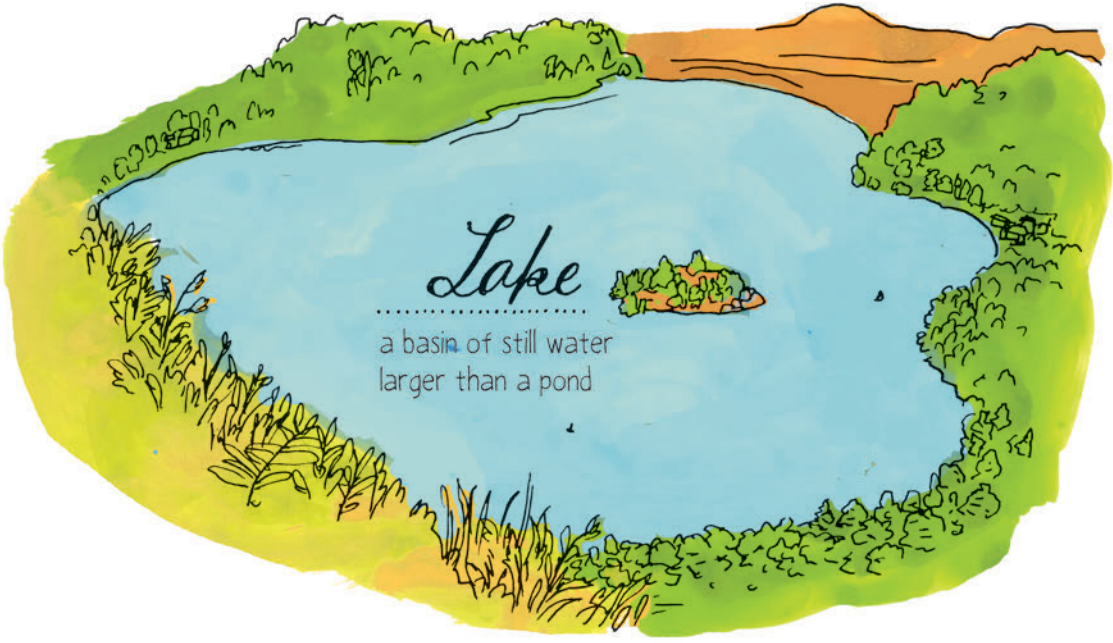


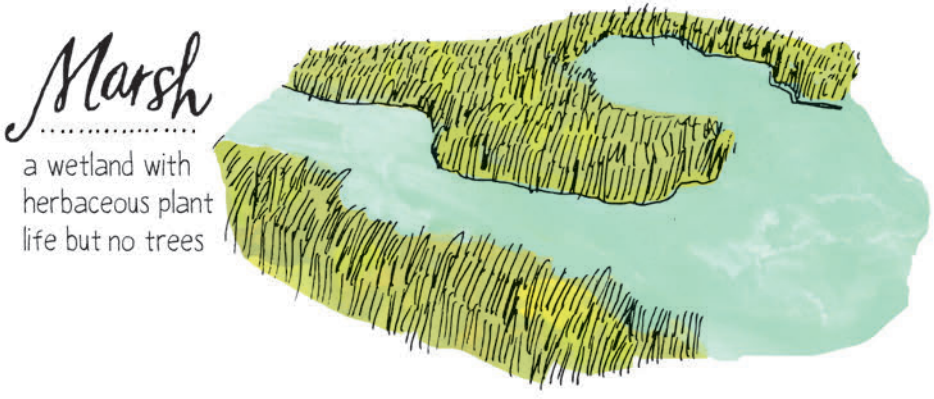
Tidal Pool

rocky saltwater shore pools that become separate from the ocean during low tide




Pond
a body of standing water too small
for significant waves or depth-based
temperature variations


Lake
a basin of still water
larger than a pond


Marsh
a wetland with
herbaceous plant
life but no trees

River

a natural waterway that flows toward another body of water





Stream

a small to medium body of flowing water held between banks



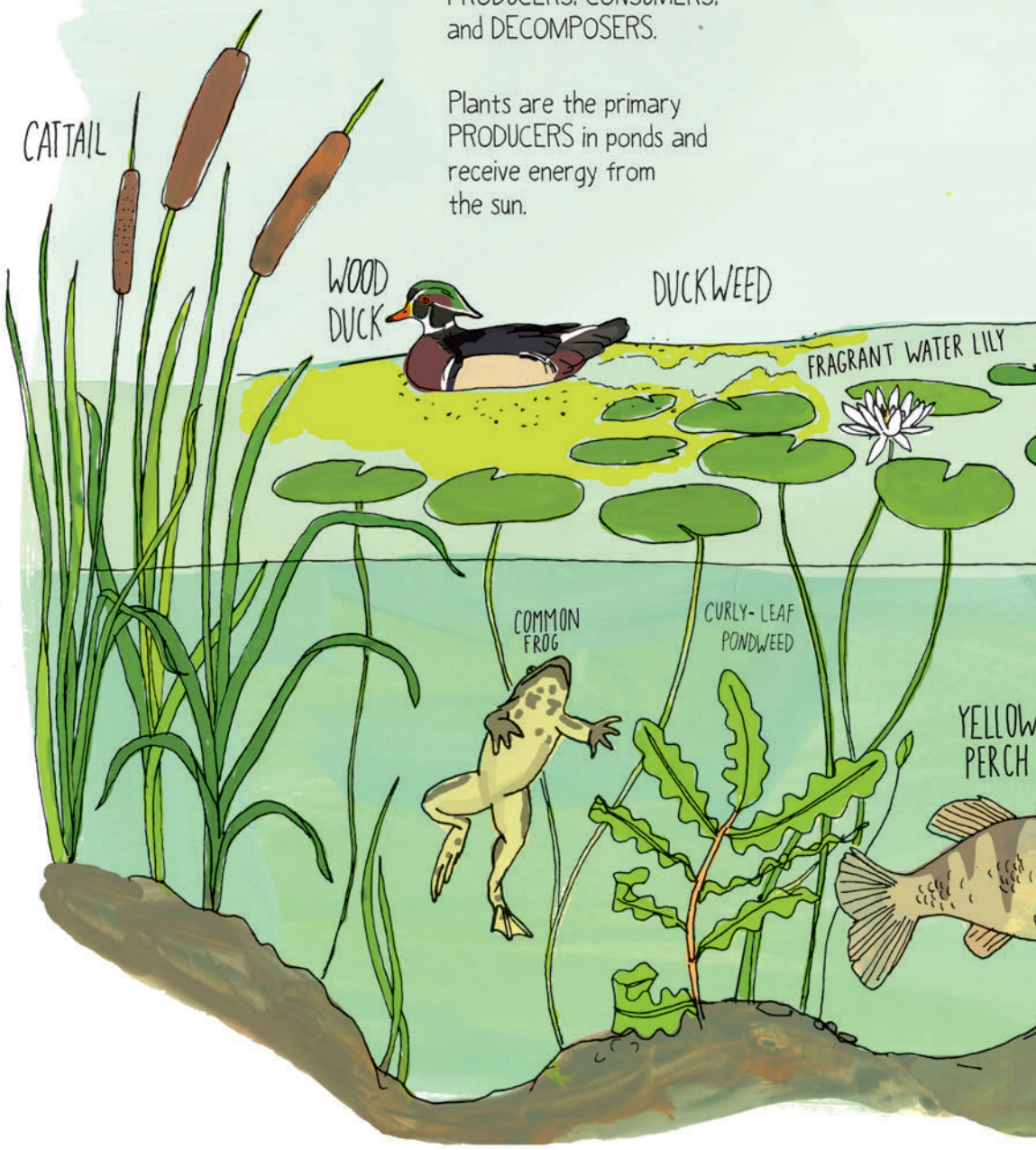
Brook

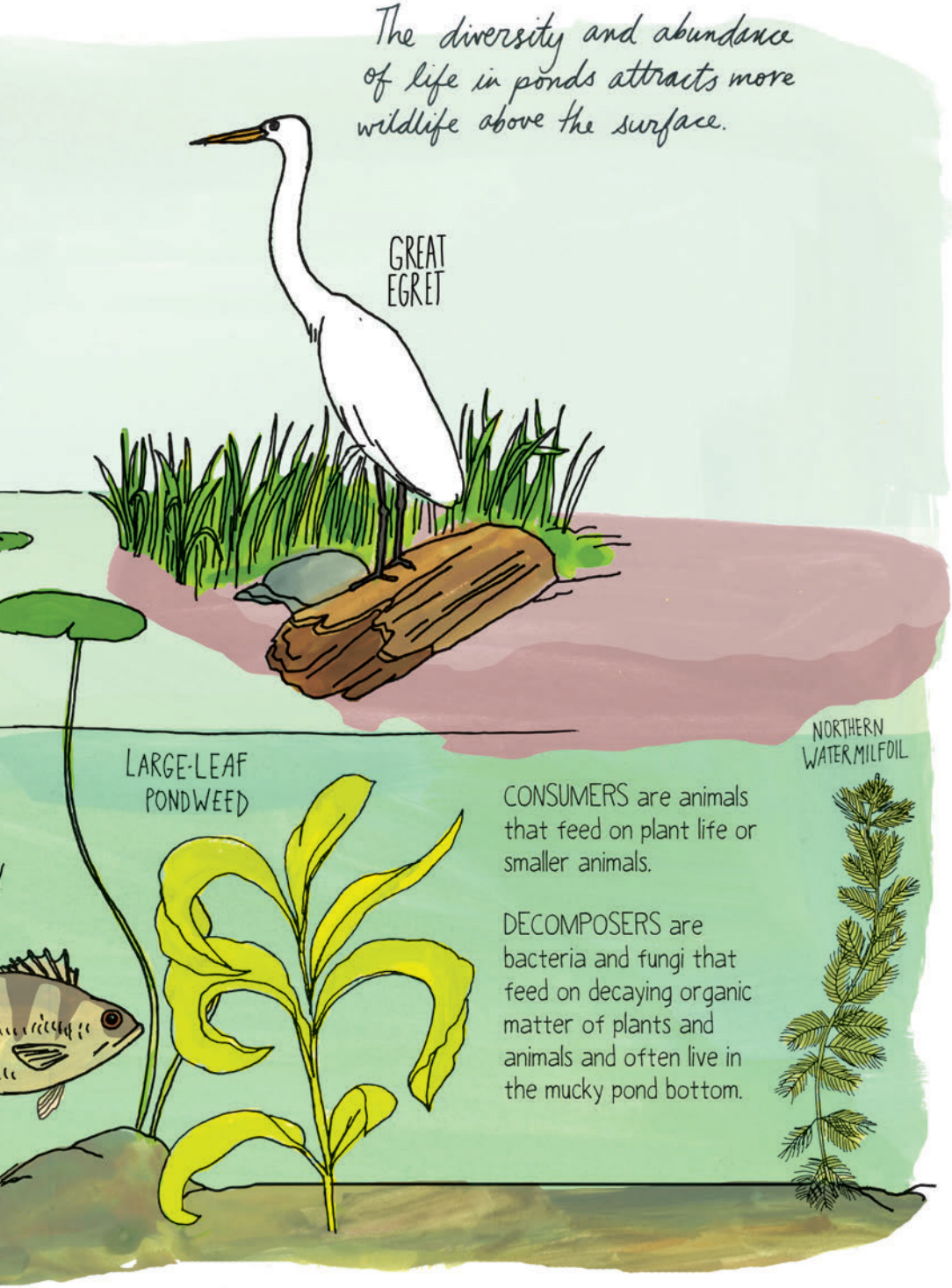
a small stream

ECOSYSTEM OF A POND

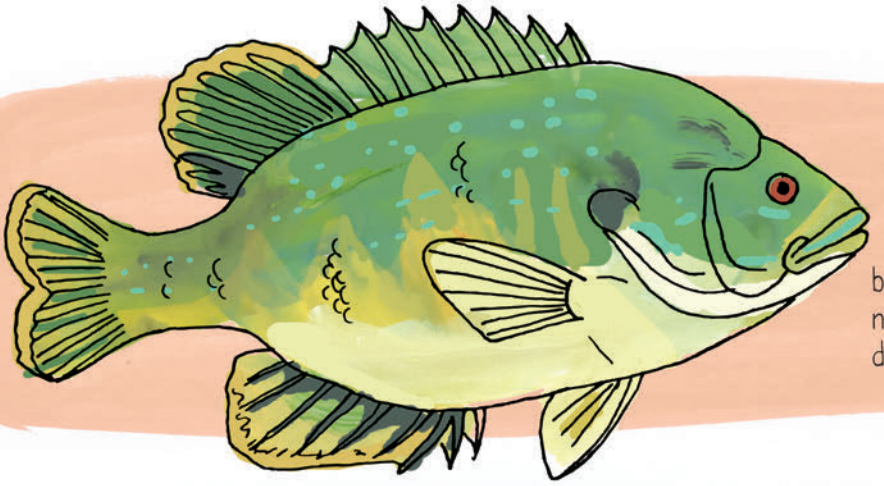
The rich array of life in a pond ecosystem can be classified into three groups: PRODUCERS, CONSUMERS, and DECOMPOSERS.

Plants are the primary PRODUCERS in ponds and receive energy from the sun.




The diversity and abundance of life in ponds attracts more wildlife above the surface.
GREAT EGRET
LARGE-LEAF PONDWEED
NORTHERN WATER MILFOIL
CONSUMERS are animals that feed on plant life or smaller animals.
DECOMPOSERS are bacteria and fungi that feed on decaying organic matter of plants and animals and often live in the mucky pond bottom.

A FEW FRESHWATER FISH

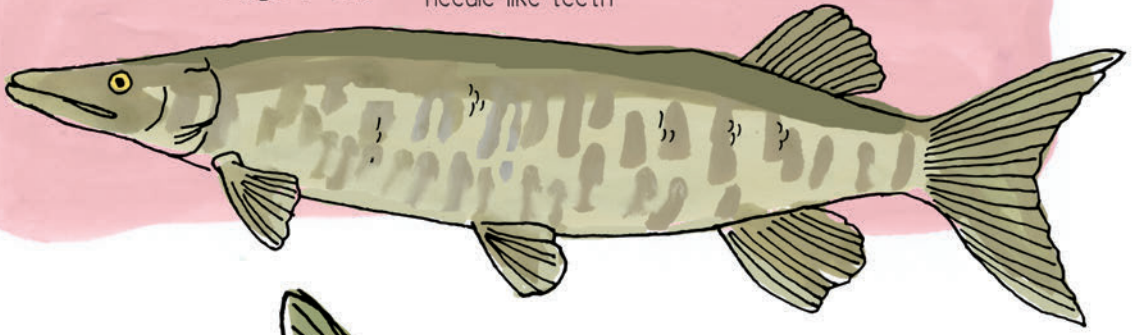


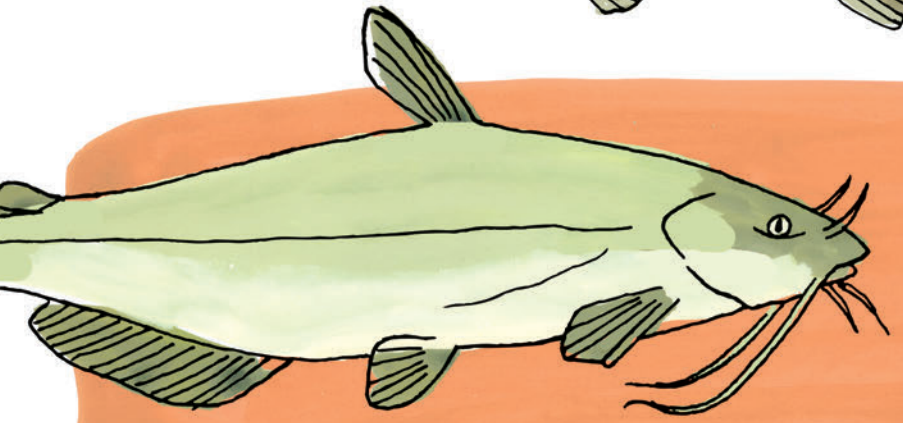
GREEN SUNFISH

build spawning nests that they defend fiercely

MUSKELLUNGE

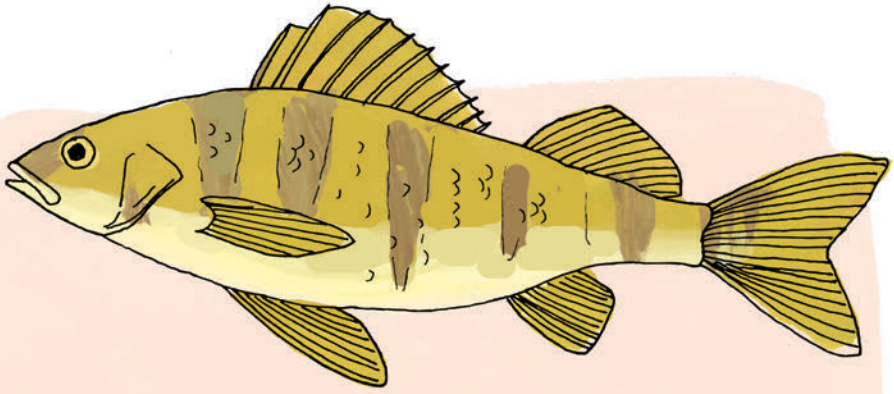
have large mouths with needle-like teeth





CHANNEL CATFISH

have tastebuds all over their bodies to help find food in the murky waters



YELLOW PERCH

live near shore in weedy areas, feed on insects and small fish, and are cannabalistic

LAKE TROUT

are slow-growing and like cold water

LARGEMOUTH BASS

can consume prey that is up to half its size

Life Cycle of a Salmon



EGGS

In freshwater rivers in the autumn, female salmon dig holes, or redds, with their tails in gravelly river beds to lay eggs. Male salmon deposit their sperm, called milt, over the eggs.



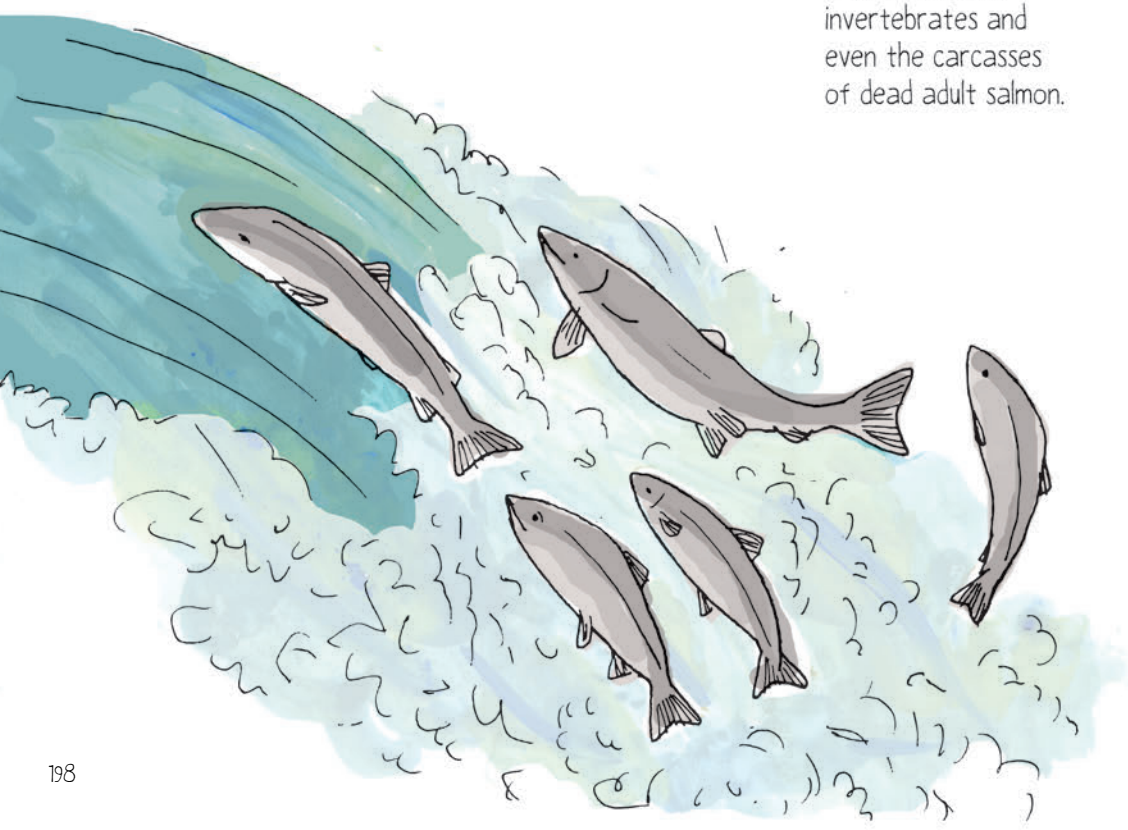
ALEVIN

6 to 12 weeks later, the eggs hatch and tiny salmon, called alevin, emerge. Alevin hide in the gravel and feed from attached yolk sacs for some weeks.



FRY

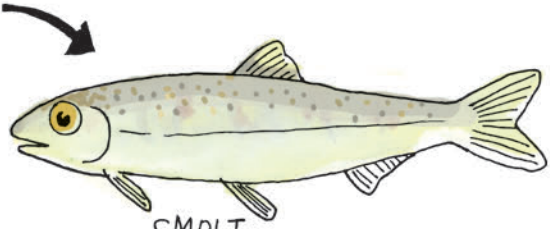
Once the yolk sacs are consumed, young salmon, now called fry, emerge and begin eating tiny invertebrates and even the carcasses of dead adult salmon.





PARR

Parr are salmon over 1 year old but not yet adult. They stay in fresh water for 1 to 3 years feeding on insects.

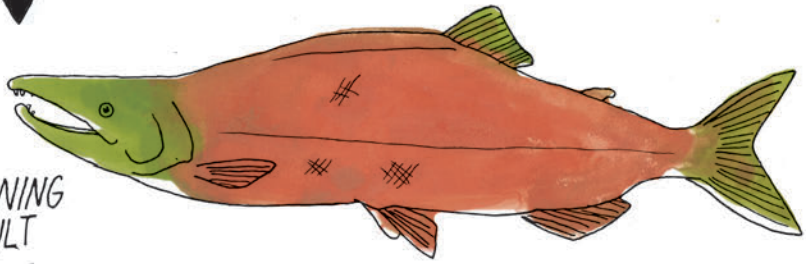


SMOLT

Salmon undergo a developmental transition called smolting that allows them to live in salt water. Smolt then leave the rivers for the open ocean.



ADULT In the open ocean, adult salmon feed on fish and grow in size for 1 to 4 years before returning to their native rivers.



SPAWNING ADULT

Adults return to the site of their birth to spawn, undergoing physical transformation to readapt to fresh water. Their silvery bodies darken as they expend energy to produce eggs and milt. Soon after spawning, adult salmon die, creating a rich source of food for many other animals, including their future offspring.

WATER BUGS



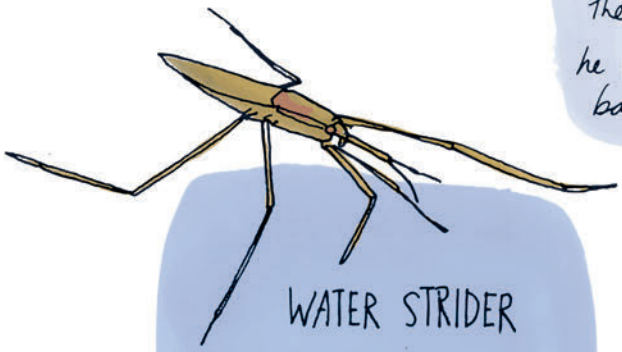
MAYFLY

Because its adult lifespan is so short, the mayfly is called a "one-day" fly in some languages.



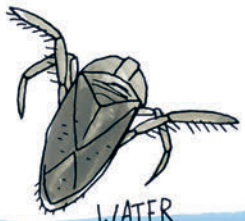
GIANT WATER BUG

The eggs are laid on the male's wings and he carries them on his back until they hatch.



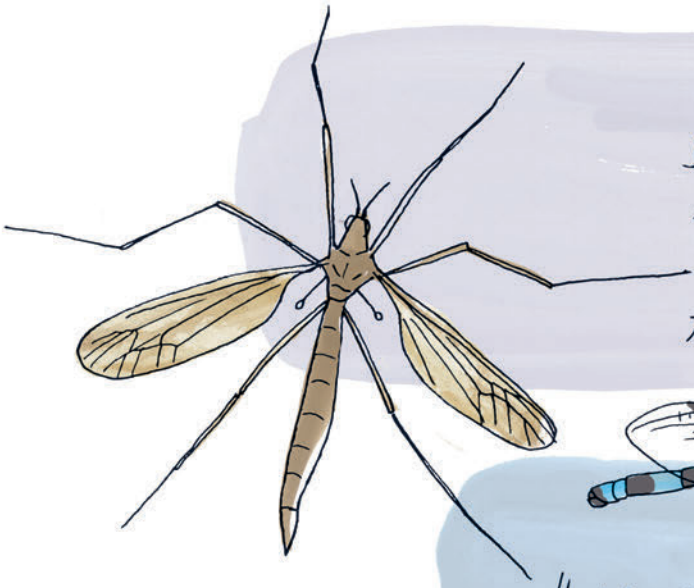
WATER STRIDER

Hairs on their bodies repel water droplets so they can skate on the surface of the water.



WATER BOATMAN

Their long, flat bodies enable them to swim on the bottom of ponds and streams.



CRANEFLY

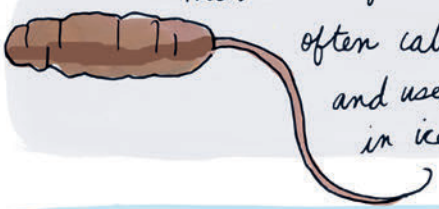
Some adults have such a short life (10-15 days) that they never eat at all.



DAMSELFLY

Unlike dragonflies, they rest their wings together on both sides of their body.

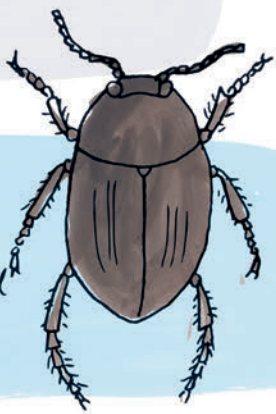
RAT-TAILED MAGGOT



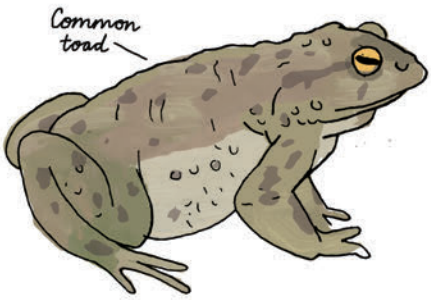
The larvae of the drone fly, they are often called "mousies" and used as bait in ice fishing.

PREDACEOUS DIVING BEETLE

Humans eat large beetles in countries like Mexico, Japan, China, Taiwan, and Thailand.



TOAD VS. FROG



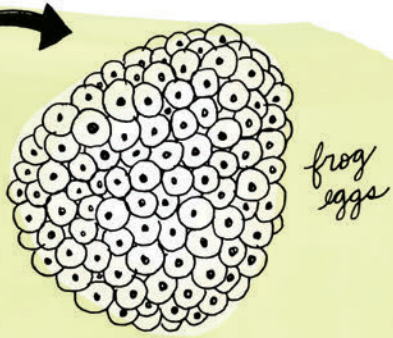


- short legs for walking and hopping
- dry, bumpy skin
- stays mostly on land
- no teeth
- non-bulging eyes
- eats insects, slugs, and worms

- long legs for jumping and swimming
- smooth, wet skin
- stays mostly in water
- tiny, sharp cone teeth on the upper jaw
- bulging eyes
- eats insects, snails, worms, and tiny fish



Following loud and elaborate courtship displays in the spring, frogs mate in the water in an embrace called amplexus that may last several days.



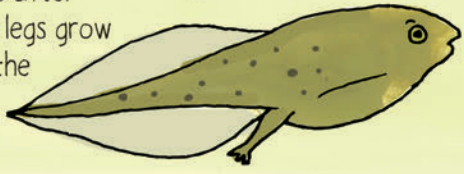
Female frogs lay sticky clusters of eggs in calm water.



Tadpoles emerge after a week or two.



Tadpoles have rudimentary gills. They may stick themselves to plants until they are strong enough to swim and begin eating algae.



From 6 to 9 weeks after hatching, arms and legs grow elbows-first from the tadpole's sides.



By 9 weeks old, they look like tiny frogs with long tails.



At 12 weeks, froglets have absorbed all but a stub of their tails.

Life Cycle of a Frog



TIDAL ZONE ECOSYSTEM

Splash Zone

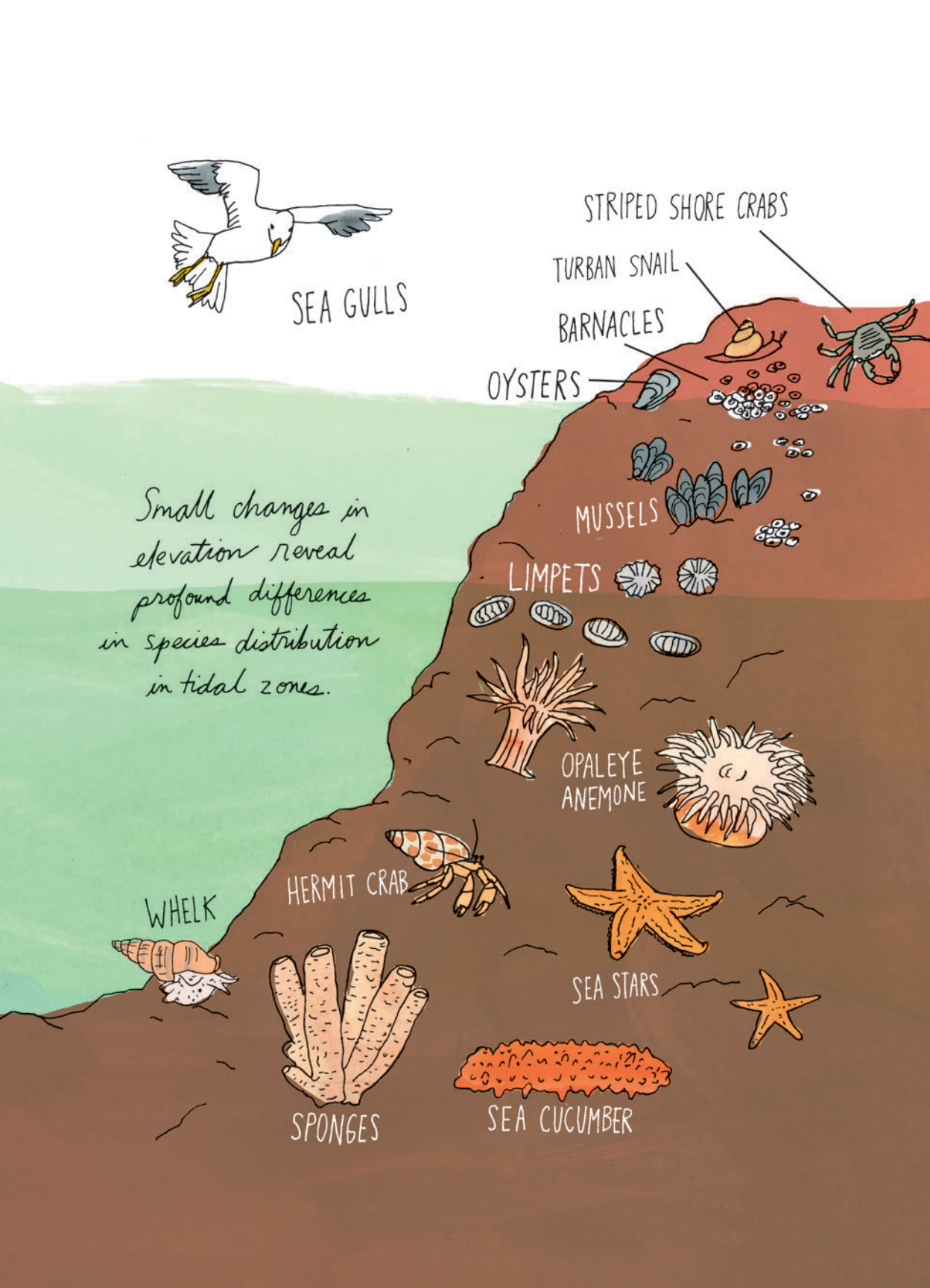
High Tide Zone

Low Tide Zone

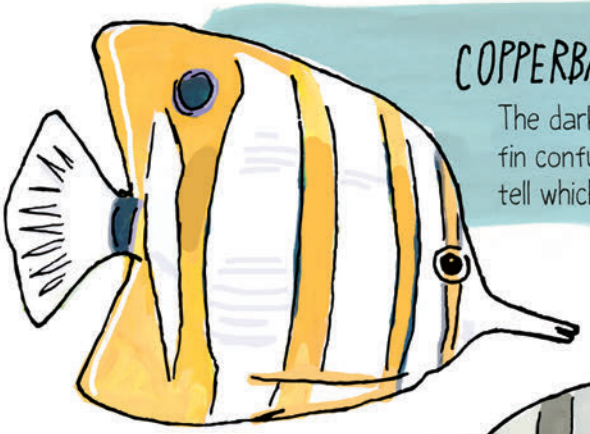
ALGAE

SEA URCHINS

BRITTLE STAR

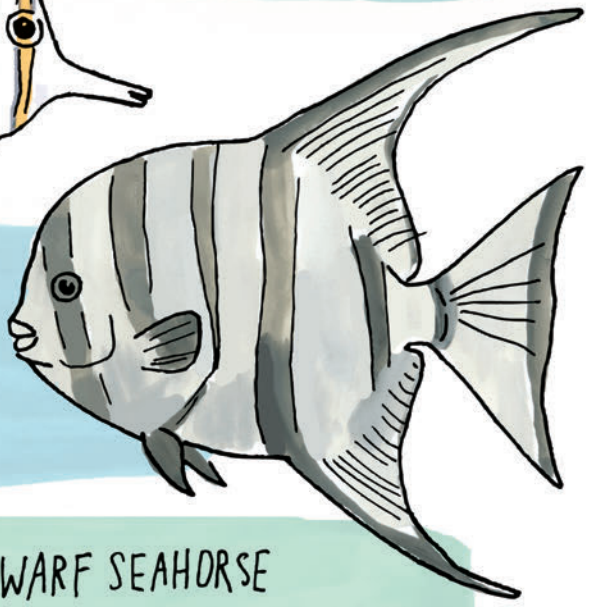

SEA GULLS
STRIPED SHORE CRABS
TURBAN SNAIL
BARNACLES
OYSTERS
Small changes in elevation reveal profound differences in species distribution in tidal zones.
MUSSELS
LIMPETS
OPALEYE ANEMONE
HERMIT CRAB
WHELK
SEA STARS
SPONGES
SEA CUCUMBER

FANTASTIC SALTWATER FISH



COPPERBAND BUTTERFLY FISH

The dark eye-spot on the dorsal fin confuses predators, who can't tell which way the fish will swim.



SPADEFISH

Young fish are all black and sometimes float on their sides to disguise themselves as debris.



DWARF SEAHORSE

These are the slowest moving fish (about five feet per hour). Males carry the developing offspring in a pouch through gestation.

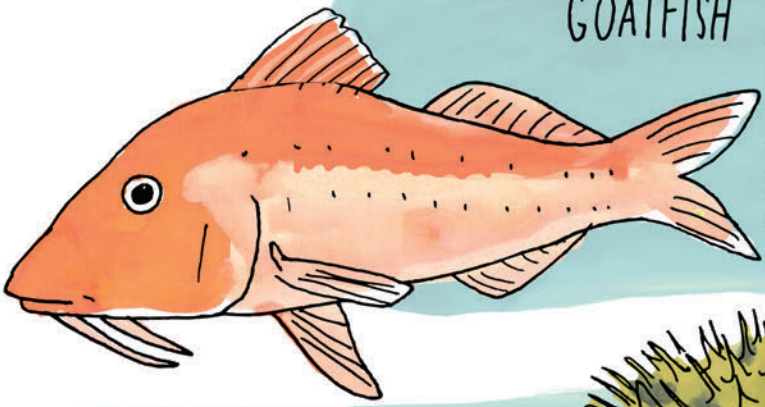


PIPEFISH

Relatives to the seahorse, these are long, slow-moving fish and usually only use their dorsel fin to swim.

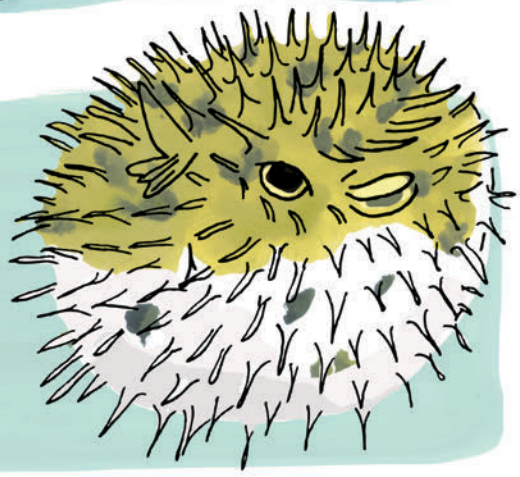
GOATFISH

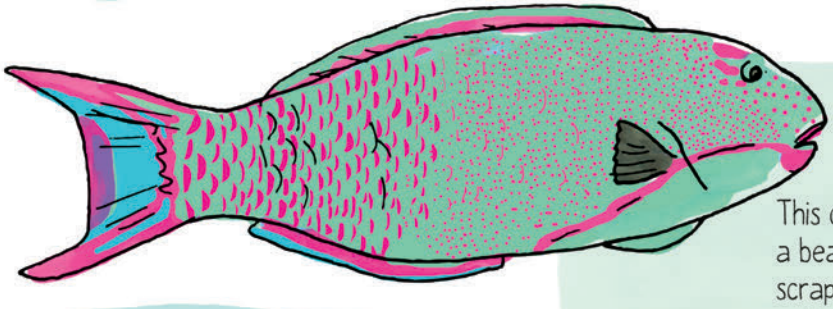
These fish can change color depending on what they are doing: feeding, congregating with other fish, or resting, for example.



PUFFER FISH (INFLATED)

They ingest water to make themselves into a big spiny ball to ward off predators.



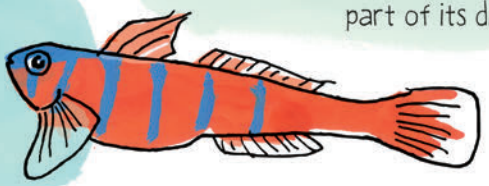


PARROT FISH

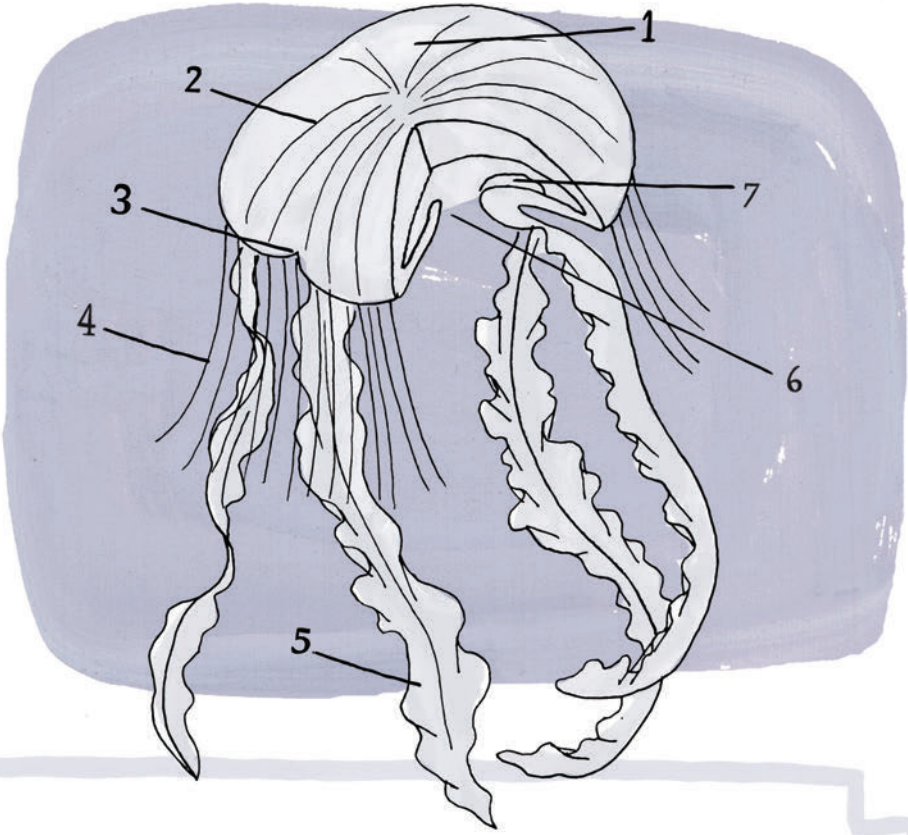
This colorful fish has a beaklike mouth to scrape up the algae and corral that form part of its diet.

BLUEBANDED GOBY

These fish are able to change sex depending on the need within their school.



ANATOMY OF A JELLYFISH

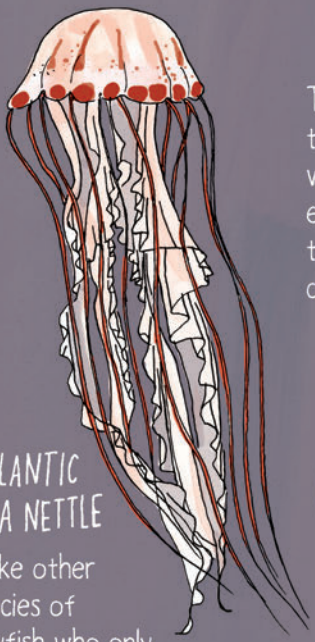


1. **bell** - umbrella-shaped body that contracts and expels water from the cavity underneath to propel the jellyfish
2. **canal** -a series of tubes that run along the bell to distribute nutrients throughout the body in what's called extracellular digestion
3. **eyespot** - light-sensitive spots on the rim of the bell
4. **tentacle** - used for touching
5. **oral arm** - injects the prey with venom
6. **mouth** -- prey goes through here to the gastric cavity
7. **gonad** - reproductive organs that produce sperm and/or egg cells

LION'S MANE

This is the largest known species, with tentacles as long as 100 feet.



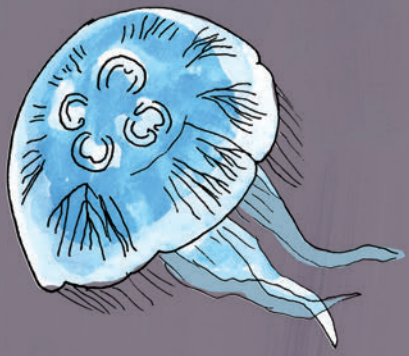


ATLANTIC SEA NETTLE

Unlike other species of jellyfish who only eat plankton, sea nettles have been known to prey on minnows, worms, and mosquito larvae by stinging them with their powerful venom.

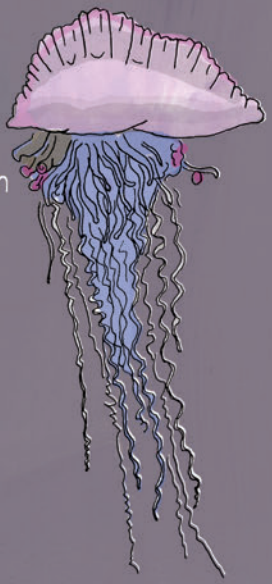
MOON JELLYFISH

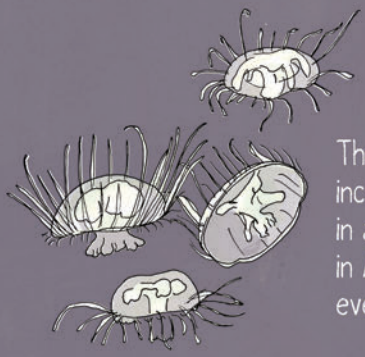
They tend to stay close to the surface of the water, making them easy prey for large fish, turtles, and the occasional marine bird.



PORTUGUESE MAN-OF-WAR

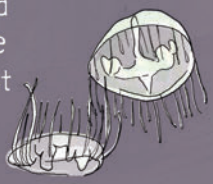
This is not a jellyfish but a siphonophone, an organism made up of many highly specialized minute individuals called zooids.



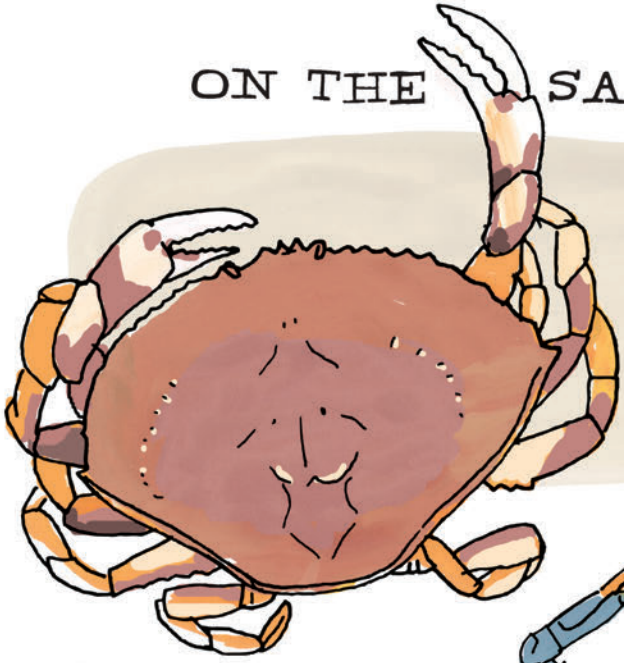


FRESHWATER

These tiny jellyfish (1 inch big) can be found in almost every state in America and almost every continent.



ON THE SAND



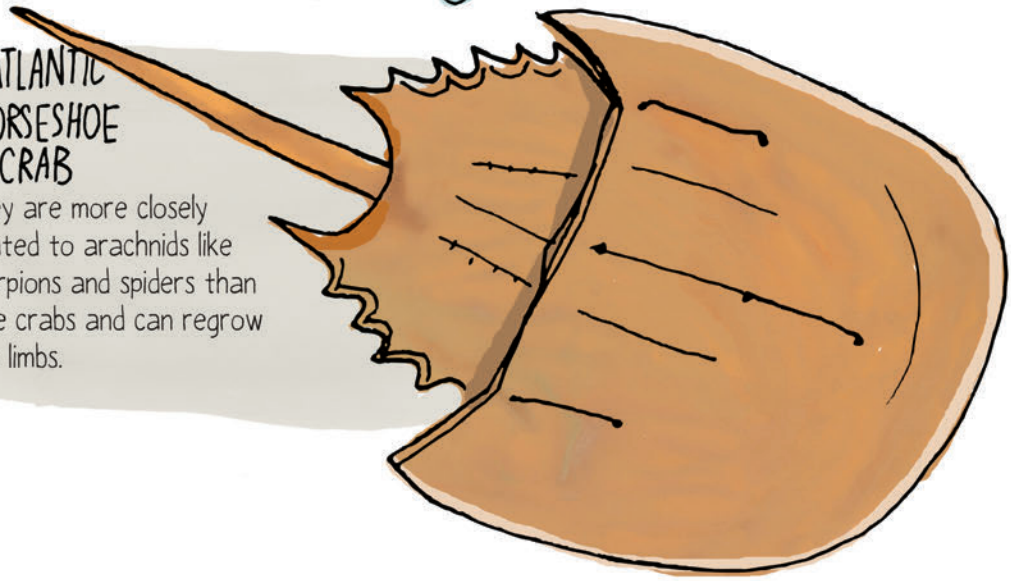
DUNGENESS CRAB

After locating mates with the help of pheromones, males attach themselves to females for several days before mating.



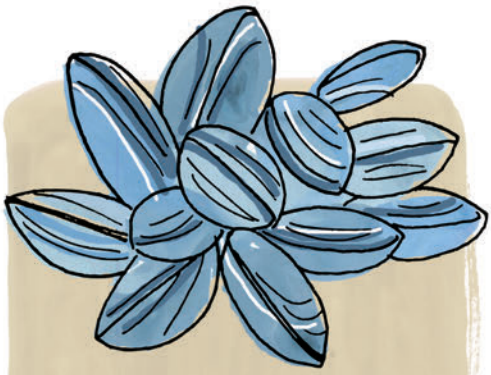
ATLANTIC BLUE CRAB

Females only mate once in their lifetimes, storing sperm for several subsequent broods of up to two million eggs each.



ATLANTIC HORSESHOE CRAB

They are more closely related to arachnids like scorpions and spiders than true crabs and can regrow lost limbs.



MUSSELS

They attach themselves to underwater rocks with strong byssal threads. These gluey threads are being researched for surgical and industrial applications.

HERMIT CRAB



They must find a new shell as they grow and often take the shell of a bigger hermit crab that has vacated its shell for another.



GEODUCK

The largest burrowing clam in the world can be longer than three feet and weigh more than two pounds. It can live hundreds of years.

OYSTER

Of the many different species of oysters, only a few produce commercial-grade pearls.





SKATE EGG CASE

These often wash up on the shore after the fish has hatched out.

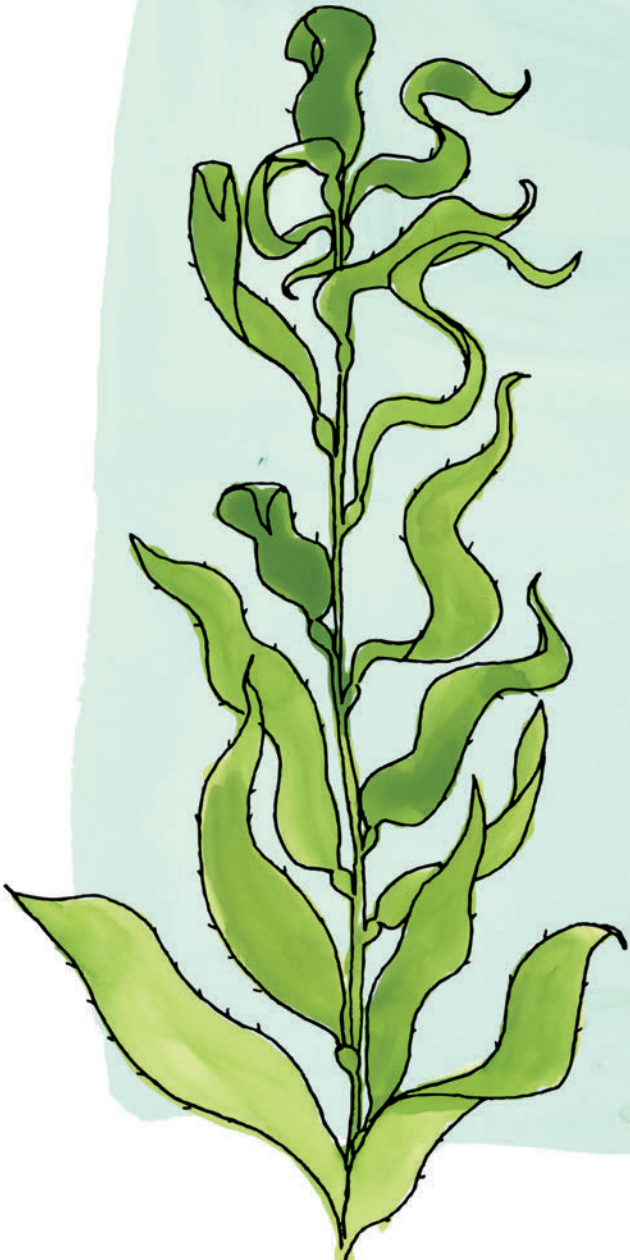

SEASHELLS BY THE SEASHORE
PACIFIC PINK SCALLOP
RED NORTHERN CHITON
FLORIDA CONE
JUNONIA
SCALY WORM SHELL
CABRIT'S MUREX
CLATHRATE TROPHON
RINGED TOP SHELL
GLOSSY DOVE SHELL
SCOTCH BONNET


ANTILLEAN TUSK
TURBONILLE
HAWK-WING CONCH
ROSE PETAL TELLIN
STRIATE MARGARITE
ATLANTIC YELLOW COWRY
GIANT PACIFIC OYSTER
HOOKED MUSSEL
MASK LIMPET
ATLANTIC JACKKNIFE CLAM
YELLOW COCKLE

SOME SEAWEED

GIANT KELP

can grow up to a couple of feet per day until it is more than 100 feet long

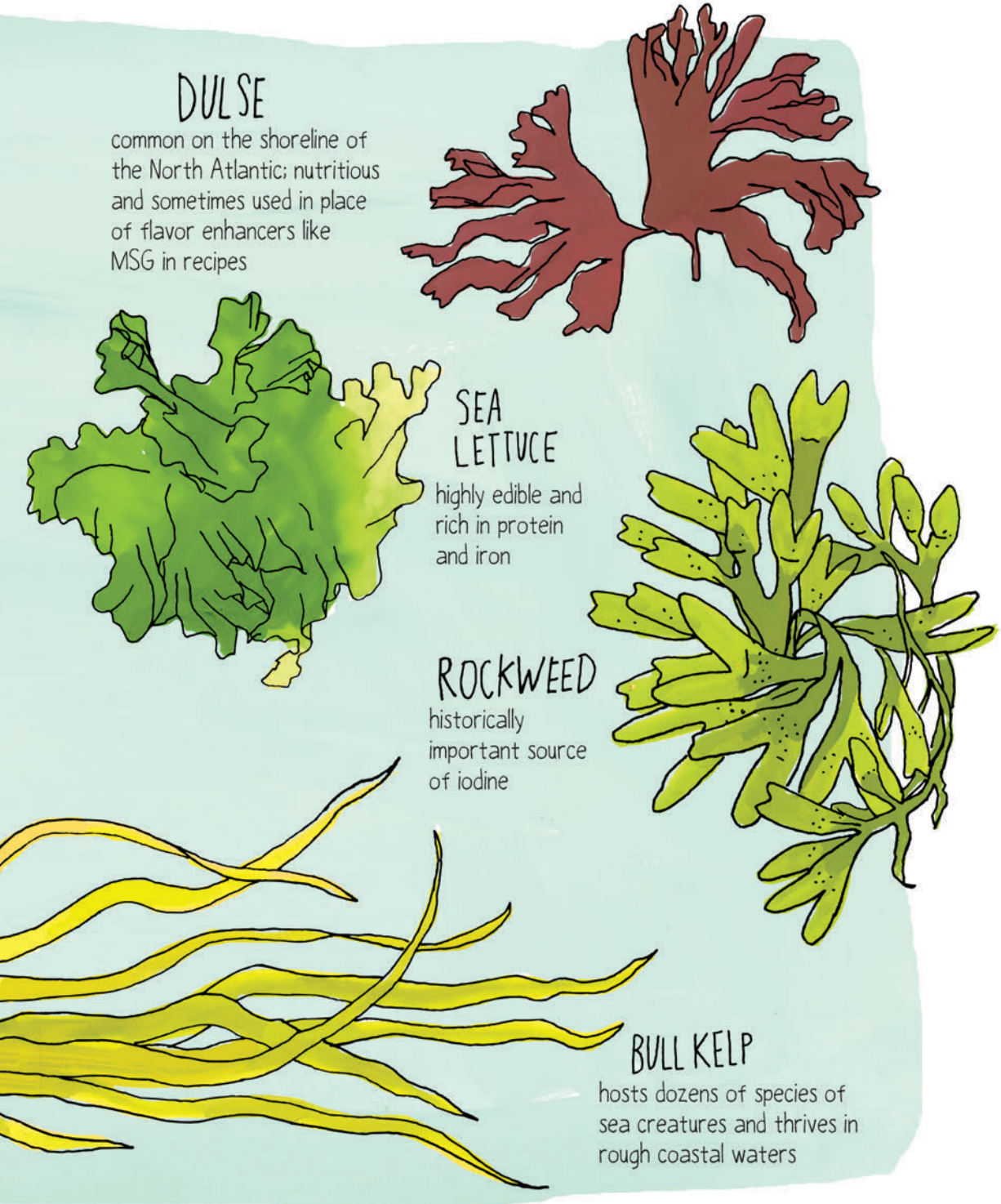




SUGAR WRACK

prefers habitats protected from heavy surf




DULSE
common on the shoreline of the North Atlantic; nutritious and sometimes used in place of flavor enhancers like MSG in recipes
SEA LETTUCE
highly edible and rich in protein and iron
ROCKWEED
historically important source of iodine
BULL KELP
hosts dozens of species of sea creatures and thrives in rough coastal waters



HARVESTING, PROCESSING, AND EATING SEAWEED

Seaweed is a superfood. It contains calcium, potassium, vitamins A and C, and large amounts of beneficial iodine. In some places, seaweed harvesting is limited by law to certain times of year and you may need a permit or license. Learn how to positively identify useful species and only collect from places with clean water.

Harvesting seaweed is far easier during low tide. Consult official tide tables for your area.



Cut a few seaweed leaves from each main stalk with heavy-duty scissors, without pulling the entire plant out of its mooring. Only harvest actively growing seaweed and avoid seaweed that has been washed up on shore since it can be hard to tell how old it is (though old seaweed is a great soil amendment for your vegetable or flower garden).

Dry seaweed for a few hours on clean, flat surfaces in full sun. A food dehydrator also works well. Store in airtight jars or bags.

Fresh seaweed is delicious with cucumbers, sesame seeds, and rice vinegar. Add dried seaweed to soups, salads, and even trail mix.

Seaweed Facial Mask



4 LEAVES DRIED KELP
WARM WATER
1 TBSP ALOE VERA GEL
1/4 RIPE BANANA

Grind kelp leaves into a fine powder with your mortar and pestle or coffee grinder. With a fork, mix 1 tbsp. kelp powder, a bit of warm water, and 1 tbsp. aloe vera gel in a bowl. Add the soft banana and mash with a fork. Add warm water as necessary to achieve silky texture.

Apply a thin layer of the seaweed mask to your face and relax for 15-20 minutes. Rinse off with warm water. You can use this natural facial mask every week as part of your beauty routine.



A NOTE ABOUT CONSERVATION

All parts of the natural world are intimately connected. Small changes to any part of an ecosystem can have profound effects on the health and biodiversity of an entire region.

Though nature is incredibly resilient and adaptable, it is clear that we are in the midst of a period of widespread extinction of species. Most of our natural habitats are threatened by human encroachment. The conservation of expanses of pristine forests, oceans, wetlands, and grasslands is crucial for the survival of threatened species and the future health of our planet.



Your personal commitments to protect wilderness and limit wasteful consumption can make a difference. Help protect the earth's biodiversity and learn more by checking out your local conservation organizations or the Wildlife Conservation Society, the Center for Biological Diversity, the Conservation Fund, Earthworks, the Sierra Club Foundation, and the League of Conservation Voters Education Fund.

No matter where you live, connect with the nature near you in a conscientious way.



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Much of the type in this book was handwritten or uses fonts created from my handwriting. The lettering for titles was based on typefaces Palatino, Archive Antique Extended, Bellevue, and Nelly Script.



Thank You!

This project took me a very long time, and I feel like I have many people to thank for their help. First and foremost I need to thank my editor, Lisa Hiley, who is amazingly patient, thoughtful, and consistently a pleasure to work with. Thanks to Deborah Balmuth for always believing in my endeavors and being an encouraging voice. Alethea Morrison for her continued design expertise, and the rest of the very kind Storey team. Also special thanks to Pam Thompson for all the initial brainstorming sessions.

Thank you to my friend and partner on the book, John, who provided such great ideas and intriguing facts. He raised the bar with his knowledge, research, and well-crafted words.

This book created a little unexpected collaboration with my mom, who helped paint some of the pages (all of the perfectly detailed ones) when I was running over my deadline, and my dad, who scanned pages for me – it became a family team effort! I feel so grateful to have such continued support from my parents.

My sister is doing incredible projects in Africa, studying primates and educating the community about conservation. Visiting her this year in Uganda has been the most inspiring thing I've done and opened my eyes to see the larger picture. I am in awe of her devotion to such a great cause. You can learn more about her research at nycep.org/rothman

Thank you to my assistant painter and aspiring talent Sarah Green. I wouldn't have finished without her quick hands and uplifting whistling.

Lastly thanks to forever collaborators Jenny and Matt for their consistently spot-on advice on both design and life. And hugs to my friends, Santtu and Rudy!

