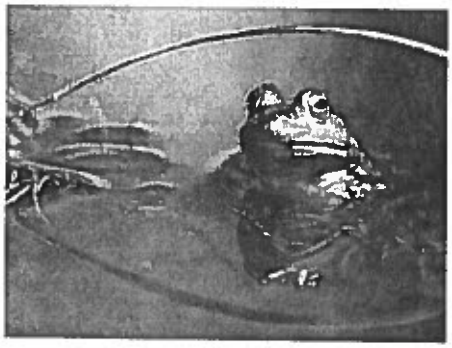
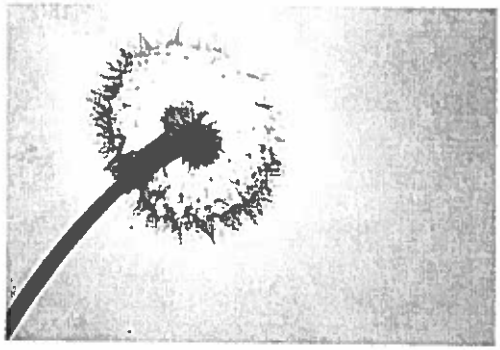
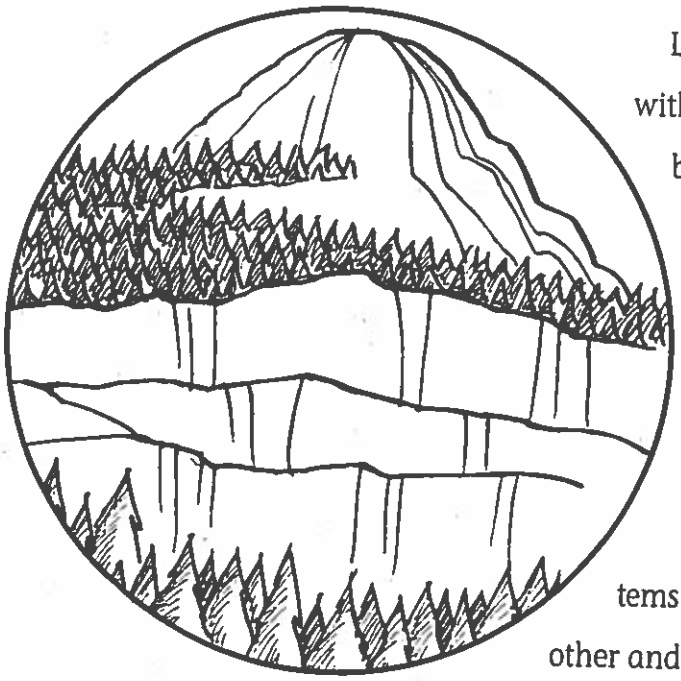
Ecosystems





Ecosystems



Last summer I went to Yellowstone National Park with my family on a vacation. We went on a hike led by the forest ranger. Along the path, I saw some signs reminding us to stay on the path and not to litter. I asked the ranger why they had these signs. He said they want to keep people from polluting the ecosystem in the forest.

"What is an ecosystem?" I asked.

The ranger went on to explain that ecosystems are groups of life forms that interact with each other and the nonliving parts of the environment. He said there are several different ecosystems. Each ecosystem has a particular type of climate and even different types of soil. Some are found where it is hot and dry, others where it is cool and moist, and others can be cold and dry. The types of ecosystems are forest, coastal, desert, grassland, tundra, freshwater, and ocean.

My curiosity was stirred, so I asked, "If there are different ecosystems, does that mean they also have different types of plants and animals that live in each one?"

"Yes, there are!" the ranger answered with excitement. Before I could say anything else, he began to talk more about the ecosystems. He explained that there are three different types of forest ecosystems. They are hardwood, evergreen, and tropical rain forest. Hardwood and evergreen forests are cool and moist. This allows a lot of trees to grow there. Wood, honey, mushrooms, fruit, nuts, and drinking and irrigation water are some of the things the hardwood and evergreen forests give us. He told me the weather was the opposite in the tropical rain forest. It is hot and very wet there. I was shocked when he told me it rains over 100 inches (2.54 m) there every year! He explained that tropical rain forests help clean the air, provide homes for wildlife, and supply us with fruits, nuts, and medicines.

"Boy, this ranger knows a lot!" I thought to myself. So I asked him to describe more to me about the other types of ecosystems. He started with the coastal ecosystems.

"They are mostly marshes and swamps," he said. "They give us fish, shellfish, salt, seaweed, and other resources. They provide a habitat for wildlife and harbors for transporting goods, and they dilute and treat waste." He went on to explain that the oceans cover almost three-fourths of the Earth. There are many different ecosystems in the ocean. Some are in shallow water, and others are in deeper water. The oceans serve as a means of transportation and places for recreation and supply us with lots of fish and shellfish to eat.

He told me how deserts are very dry and hot. "Even though it only rains less than 10 inches (25 cm) a year, the deserts provide homes for some wildlife," he said in a happy voice. "They also provide us with useful things like salt, oil, and minerals."

I continued to learn many new facts as he talked about the grassland ecosystems. The weather is mild and pretty dry there. He said the reason they are called grasslands is because they do not get enough water for many trees to grow and are covered with grasses instead. We receive much of our food from managed grassland ecosystems like the farm. The grasslands also give us animal products like wool and leather.

"You might like to visit the wilderness grasslands in the savanna of Africa someday," he said. "You can see many types of interesting wildlife there! We are almost at the end of our hike so I will quickly finish explaining the rest of the ecosystems." He explained that tundra ecosystems have freezing cold and dry weather. They provide homes for wildlife and many other living things. They also give us oil and minerals. The freshwater ecosystems include ponds, lakes, and rivers. They give us fish and drinking water. They also are a way of transportation and help dilute and carry away waste.

"I sure learned a lot from you," I said to the ranger. "Thank you for teaching me so much! I will be sure to pass the message on to my friends to help keep people from polluting."

Biomes of the World

Grassland Biome: Approximately one-fourth of the earth's land area is covered in grassland.

Temperate Grassland:

Steppes (located in Asia and Europe): area of short grasses found in dry areas; hot summers and cold winters

Examples of flora: tumbleweed, rhubarb, sweet vernal buffalo grass, cacti, sagebrush, spear grass, prairie sagewort, fringed wormwood

Examples of fauna: lynx, foxes, rabbits, mice, squirrels, ferrets, gerbils, horses, antelope, falcons

Prairies (located in the United States and Australia): flat or hilly land covered in tall grasses; hot summers and cold winters; moderate rainfall

Examples of U.S. flora: sunflowers, clovers, wild indigoes, purple needle grass, wild oats, foxtail, ryegrass, buffalo grass, prairie lily, wild rose, milkweed, slough grass, bluestem, Indian grass, switchgrass, wild rye, asters, coneflowers, goldenrod, purplish phlox

Examples of U.S. fauna: bison, coyotes, badgers, foxes, jackrabbits, deer, pronghorns, mice, prairie dogs, blackbirds, grouse, meadowlarks, quail, skunks, praying mantis, black swallowtail butterflies, rattlesnakes, wild turkeys, prairie locusts

Examples of Australian flora: wallaby grass, kangaroo grass, orchids, lilies

Examples of Australian fauna: dingoes, kangaroos, wallabies, wombats, koalas, crocodiles, pygmy blue-tongued lizards, striped legless lizards

Pampas (located in South America): flat, fertile plains; cool to mild winters with humid and warm summers

Examples of flora: pampas grass, cattails, water lilies, reeds, ombum trees

Examples of fauna: finches, rheas, guanacos, Geoffrey's cats, maned wolves, viscachas

Tropical Grassland:

Savanna (located in the tropics between deserts and rain forests: Venezuela, Brazil, Africa, India, and Australia): grassland with widely scattered trees and shrubs; very hot with a dry season and a rainy season

Examples of African flora: baobab trees, acacia trees

Examples of African fauna: lions, rhinoceroses, zebras, gnus, leopards, weaver birds, giraffes, ostriches, elephants, impalas, cheetahs, hyenas, bat-eared foxes, jackals, aardvarks, antelope, gazelle, termites, baboons, storks, secretary birds

Examples of Australian flora: eucalyptus trees, rose mailee, kangaroo paw, orchids, orange banksias, grevilleas, grasses

Examples of Australian fauna: emus, kangaroos, koalas, wallabies, walaroos, dingoes, opossums, crocodiles, cockatoos

Tundra: Tundra covers about one-fifth of the Earth's land area.

Arctic Tundra (located in the Northern Hemisphere): ground covered in permafrost; cold desert-like conditions

Examples of flora: shrubs, sedges, reindeer moss, liverwort, poppy, lichen, sphagnum moss, Kobresia, Labrador tea, arctic willow, blueberry, cranberry, bearberry, crowberry

Examples of fauna: lemmings, voles, caribou, arctic hares, squirrels, Arctic foxes, wolves, polar bears, ravens, snow buntings, falcons, loons, sandpipers, terns, snowbirds, mosquitoes, flies, grasshoppers, arctic bumblebees, cod, flatfish, salmon, trout, wolverines, musk oxen

Alpine Tundra (located in mountains above the tree line): cold, windy, barren place

Examples of flora: tussock grasses, dwarf trees, small-leafed shrubs, heaths, Kobresia

Examples of fauna: pika, marmots, mountain goats, sheep, elk, grouse-like birds, springtail beetles, grasshoppers, butterflies, white-tailed ptarmigan

Biomes of the World (cont.)

Forest: Approximately one-third of the earth's land is covered in forests.

Tropical Rain Forest (located near the equator): one season divided into two parts—wet and dry; warm, wet weather
Examples of flora: mahogany, teak, kapok, mangrove
Examples of fauna: anteaters, jaguars, boas, pythons, anacondas, toucans, parrots, gorillas, spider monkeys, bats, red-eyed frogs, sloths, lemurs, orangutans, leaf-cutter ants

Temperate Forest (located in Eastern United States, Canada, Europe, China, Japan, and parts of Russia): four seasons; cold winters and warm, wet summers
Examples of flora: deciduous trees: oak, hickory, beech, maple, basswood, cottonwood, elm, willow
Examples of fauna: squirrels, chipmunks, rabbits, skunks, raccoon, deer, mountain lions, bobcats, timber wolves, foxes, black bears, warblers, wrens, thrushes, tanagers, hummingbirds, woodpeckers, chickadees, blue jays

Boreal Forest (Taiga) (located in North America, Siberia, Scandinavia, Alaska, and Canada): four seasons; cold winters and cool summers
Examples of flora: coniferous trees: cedar, fir, pine, hemlock, redwood, spruce; lichen, moss
Examples of fauna: woodpeckers, finches, sparrows, wolverines, bobcats, minks, snowshoe hares, red squirrels, red deer, elk, hawks, moose, bears, weasels, lynx, foxes, wolves, chipmunks, shrews, bats

Aquatic: Approximately three-fourths of the earth's surface is covered in water.

Freshwater:

Ponds and Lakes (most lie in the Northern Hemisphere): Lakes are water-filled hollows in the earth's surface. They are usually larger and deeper than ponds.
Examples of flora: pondweed, duckweed, cattail, water lilies
Examples of fauna: earthworms, frogs, mosquitoes, pond skaters, crayfish, dragonflies, tadpoles, catfish, mud turtles, water snakes, muskrats, salamanders, cranes, blue herons

Streams and Rivers (located on every continent except Antarctica): Most rivers begin in the mountains and hills and flow into a larger body of water, such as the ocean, a sea, or a large lake.
Examples of flora: pickerelweed, spatterdock, floating pondweeds, duckweed, reeds, crack willow, arrowhead, cattails, sedges
Examples of fauna: snails, water fleas, freshwater shrimp, mussels, leeches, Mayflies, bluegill, pike, bass, trout, banded water snakes, cottonmouth snakes, bullfrogs, grey herons, mallards, kingfishers, otters, beavers

Wetlands (located throughout the world where lowlands are covered with shallow, and sometimes temporary, water):
Bogs: areas of soggy ground filled with moss and peat
Examples of flora: moss, peat, wild cranberry, Venus flytrap, pitcher plant, butterwort, sundew
Examples of fauna: Insects and amphibians are the only animals that make their permanent homes in a bog.

Marshes: wetlands that do not have peat
Examples of flora: marshmallow flower, marsh grass, cordgrass, spike grass, bulrush
Examples of fauna: blackbirds, crabs, muskrats, turtles, worms, dragonflies, shore flies

Swamps: similar to marshes, but they contain shrubs and trees
Examples of flora: bald cypress, red maple, poison ivy, Spanish moss, water lilies
Examples of fauna: bears, deer, rabbits, alligators, crocodiles, snakes, turtles

Biomes of the World (cont.)

Salt Water (Marine):

Oceans (Pacific, Atlantic, Arctic, Indian): the large bodies of salt water covering three-fourths of the earth
Examples of flora: phytoplankton, kelp
Examples of fauna: barnacles, hermit crabs, squid, tuna, sea lions, sharks, whales, stingrays, swordfish, sea turtles, dolphins, walrus

Coral Reefs (warm, clear, shallow waters of tropical oceans worldwide): Coral is a tiny marine animal that often lives in colonies. Huge colonies of hard corals form coral reefs.
Examples of flora: seagrass, algae, phytoplankton
Examples of fauna: coral, sea urchins, jellyfish, oysters, clams, sponges, sea anemones, octopus, shrimp, crabs, reef sharks, groupers, clown fish, eels, parrotfish, lobsters, sea snakes

Estuaries (found where freshwater streams or rivers merge with the ocean):
Estuaries are often called bays, sounds, or harbors.
Examples of flora: cordgrass, switchgrass, mangrove trees, sea lavender, goldenrod
Examples of fauna: razor clams, horseshoe crabs, diamondback terrapin, oysters, mussels, grunts, mud snails, pinfish, shrimp, scallops, egrets, osprey

Desert: Approximately one-fifth of the earth's land area is covered in deserts.

Hot and Dry Desert (usually at low latitudes in North, South, and Central America; Southern Asia, Africa, and Australia): very little rainfall; when it does rain, large amounts fall in a short period of time
Examples of flora: yucca, ocotillo, turpentine bush, prickly pear, false mesquite, brittlebush
Examples of fauna: kangaroo rats, jackals, coyotes, diamondback rattlesnakes

Semiarid Desert (North America, Newfoundland, Greenland, Russia, Europe, and Northern Asia): moderately long and dry summers; cool nights
Examples of flora: creosote bush, bur sage, white thorn cat claw, mesquite, brittlebush, lyceums, jujube
Examples of fauna: kangaroo rats, rabbits, skunks, grasshoppers, ants, lizards, snakes, burrowing owls, California thrasher

Coastal Desert (Nearctic and Neotropical Realms): cool, short winters; long, warm summers
Examples of flora: buckwheat bush, black bush, rice grass, little-leaf horsebrush, black sage, chrysothamnus
Examples of fauna: nesting sea birds, bighorn sheep, pronghorn antelope, western whip-poor-wills

Cold Desert (Greenland, Antarctica, Nearctic Realm): cold winters with snowfall
Examples of flora: sagebrush
Examples of fauna: jackrabbits, kangaroo rats, kangaroo mice, pocket mice, grasshopper mice, antelope, badgers, kit foxes, coyotes, deer (in the winter)

The Biomes

A Study of Three Major Biomes

by David Chumbley

Deserts

Upon completion of the unit on deserts, the students will be able to:

- Identify and describe a desert
- Know how it differs from their own environment (if they are not located in a desert region)
- Locate and name some major desert regions on a world map
- Explain the problems plants and animals encounter to survive in a desert
- Tell how people use deserts and the effects some of these uses have on desert life

To initiate unit discussion on deserts, ask the students:

- What do you think a desert is, and what does it look like?
- Is there anything in a desert other than sand?
- Are all deserts the same?
- What causes a region to be a desert?

If located in other than a desert region:

- How does a desert differ from where we live?
- What would have to happen for this region to become a desert?

Deserts are characterized by drought because of low rainfall, high evaporation rates, or both. They are dry and barren because rain-bearing air masses are unable to reach them, usually because of neighboring high mountains.

Most deserts are hot and found in tropical or sub-tropical latitudes. Daytime temperatures may reach 120° F or above, while nights are cool because of lack of humidity to hold the day's heat. Some deserts are relatively cool because of high elevation, like the Gobi Desert in Mongolia with an average elevation of 3500 feet.

Deserts vary according to combinations of climate, land forms, native vegetation, water availability, and soil. They can be areas of windblown sand with no vegetation, vast rocky/sandy flatlands with sparse vegetation, or sunbaked basins between barren mountains.

In general there are three types of deserts. One is an extreme desert with only two and a half to four inches of annual rainfall. No plant life is found except in dry river beds, where water accumulates during rainy periods.

For discussion of desert plants and animals, ask:

- If you walked across a desert, what would you see? Would you see big bushy trees?
- Would you have to rake leaves or mow grass? Why not?
- How many kinds of animals could you find?
- Would you see big herds of large animals?
- Where would you find the animals when it's very hot? Why?

A large desert region may blend over distances from one type of desert to another, thereby affecting varieties and diversities of life forms.

Plants and animals depend on water. To survive in deserts, they must adapt to prevent, avoid, or reduce water loss, develop systems for obtaining and storing water, and have a tolerance for dehydration.

Many plants have adapted to life in the desert, each variety evolving its own system for obtaining and holding water. The best-known desert plant, the cacti of the New World deserts, and a similar plant, the euphorbias of the sub-Sahara regions, are succulent plants with spongy stem tissue and thick skins which store water. Other plants (e.g., prickly pear, saltbush, brittlebush) time their life cycles to the availability of water. When rains do come, plants flourish briefly, then become semi-dormant or dormant as the dry conditions and heat become extreme.

The diversity of animal life varies among desert regions according to the plant life available. This is a direct response to the availability of water. Insects, reptiles, amphibians, birds, mammals, and yes, even fish are found in one or all types of deserts. Water and heat are the two most critical components with which they must deal. Most animals are active at night (nocturnal) to prevent water loss through evaporation and to avoid the heat of the day. Small animals burrow under the sand or rocks during the daytime. Their burrows give them relief from the heat and prevent dehydration. Birds tend to stay near water sources, but through flight, they can quickly cover great distances.

For discussion of people's uses of, and effects on deserts, the following questions are suggested:

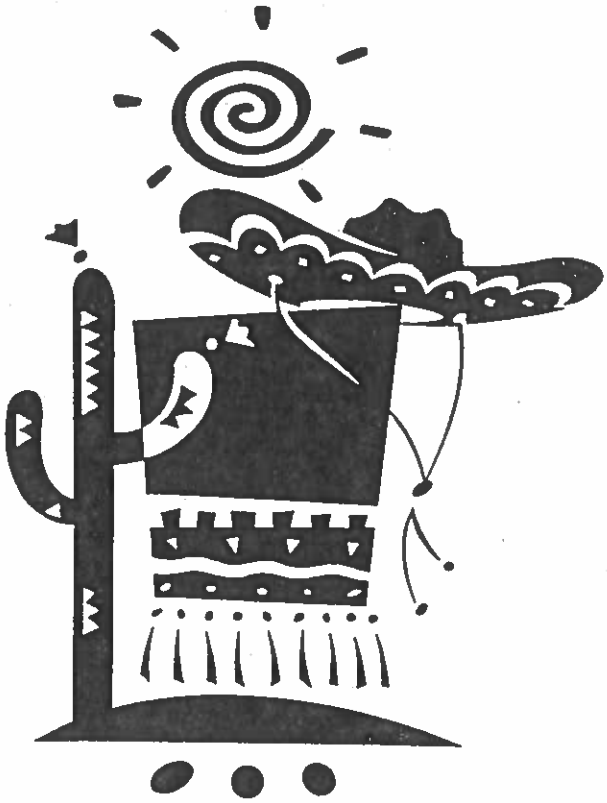
- What would you do with a desert if you owned one?
- How could you make it a more hospitable place to live?
- What would you do to provide water and protection from the heat?
- Would you try to change your desert? How ?
- If you wanted to sell your desert, how could you convince someone else to buy it?

The second is the moderate type of desert with six to ten inches of annual rainfall. This type has a scattered covering of vegetation, mostly grasses and those able to store water (e.g. cacti).

Semi-arid deserts are the third general type. They may have ten to twenty inches of rain per year and support various grasses and shrub vegetation. Where vegetation and water are most plentiful, some farming may occur.

Continue discussion of deserts by using a world map to point out the principal desert regions. Ask the students to:

- Name the continents on which the deserts are found.
- Name the countries (or states) in or near each desert.



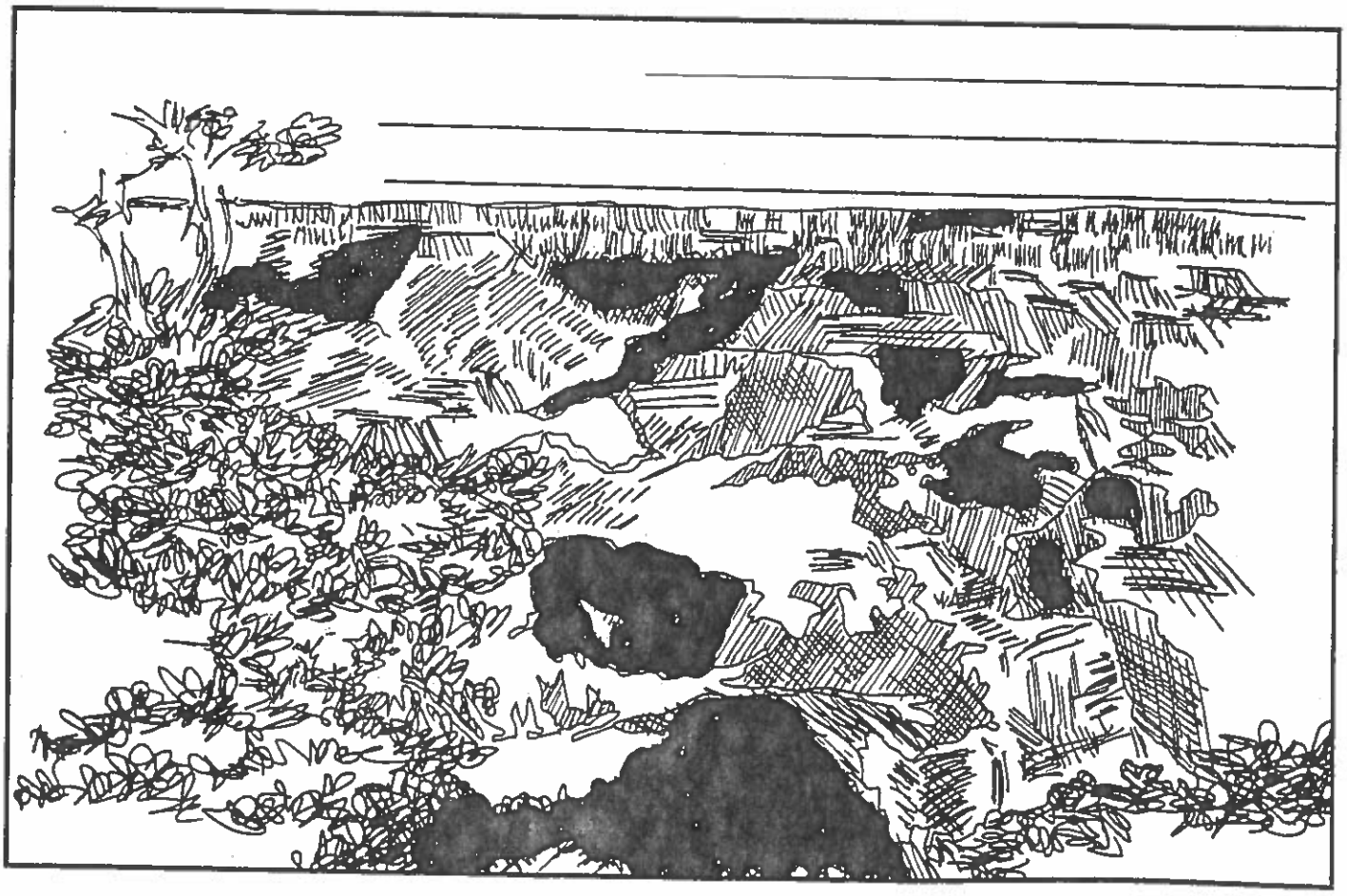
Name	Location	Approximate Sq. Miles
Sahara	across northern Africa	3,300,000
Great Australian (including Great Sandy, Gibson, and Great Victoria)	western and central Australia	1,350,000
Great Arabian	Arabian peninsula	900,000
Turkistan (or Turkestan)	southwestern Asia east of Caspian Sea	750,000
North American (including Mojave, Sonoran, and Chihuahaun)	southwestern United States, central, and northwestern Mexico	500,000
Gobi	Mongolia in central Asia	450,000
Patagonian	southern Argentina in South America	250,000
Thar (or Great Indian)	northwestern India and southeastern Pakistan	230,000
Kalahari	Botswana in southern Africa	200,000
Takla Makan	Sinkiang Province in northwestern China	175,000
Iranian	eastern Iran	150,000
Atacama	coastal plateau of southern Peru and northern Chile in South America	140,000
Namib	coast of Namibia in southern Africa	65,000

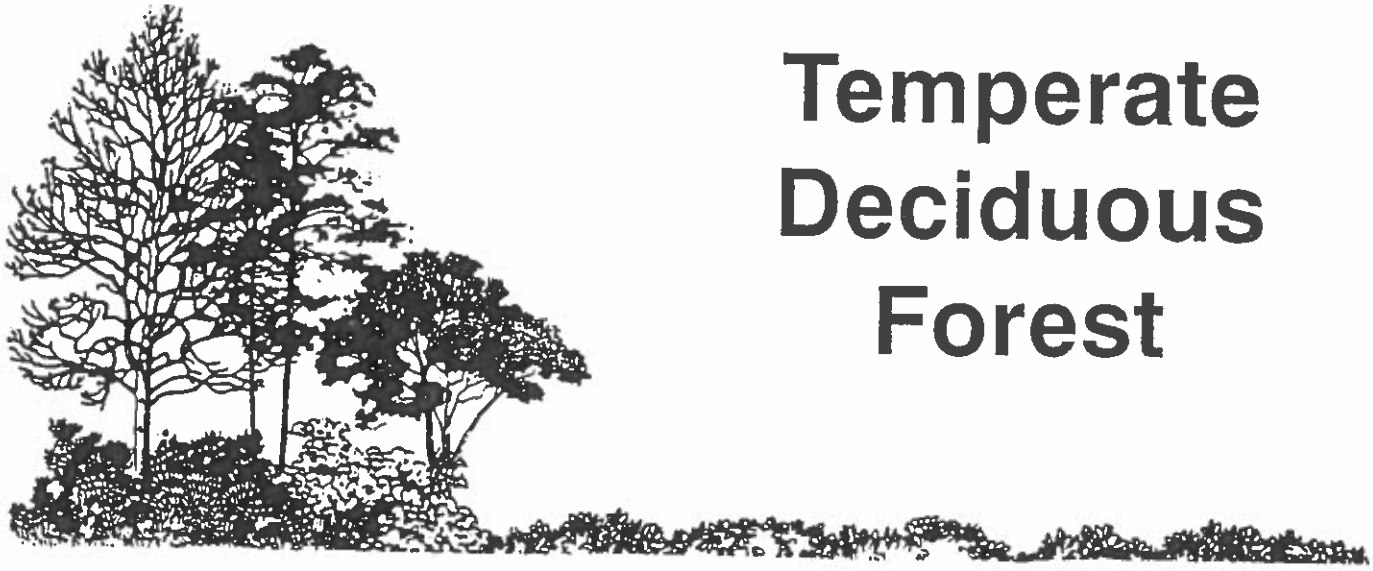
Deserts are harsh and unforgiving environments, and most people consider them to be vast expanses of barren wasteland. Since ancient times, some people have lived in deserts, with the type of desert (extreme, moderate, or semi-arid) having a direct bearing on their life-style. The more extreme the desert, the more likely the people are nomadic, moving with herds of livestock in search of water and grazing areas. Some people have established communities where water is more plentiful, and they have moderate success grazing livestock and growing crops. All of these groups are constantly at the mercy of adequate water.

Today, irrigation (via pipelines, ditches, or deep wells) of once barren land has allowed some desert regions to bloom with highly productive croplands. With good water supplies and plenty of sunshine, some desert soils show their fertility. However, many desert soils have varying contents of salts, and over a period of time this can be a limiting factor. The irrigating waters may concentrate the salts requiring expensive counter measures which can make the farming project unfeasible.

Desert ecosystems are very fragile and easily put out of balance. Lack of water causes desert plants to develop and grow slowly. Once plant life is destroyed, it takes many years for it to become reestablished. Following destruction of plant life is the disappearance of the animal life which ultimately is dependent on it.

People also use the desert for recreation (dune buggies, motorcycles), military training (bombing ranges, tank training), and as a convenient dumping ground for waste. After all, they must think, the desert is a wasteland. These activities scare away the animal life and destroy fragile plants. The results are far more damaging and long-lasting than realized.





Temperate Deciduous Forest

Upon completion of the unit on temperate deciduous forests the students will be able to:

- Understand the term *temperate*
- Know what *deciduous* means and how it is distinctive
- Describe a temperate deciduous forest
- Locate principal temperate deciduous forests in the world
- Explain human uses of temperate deciduous forests
- Discuss damage humans can cause a temperate deciduous forest

Initiate discussion of temperate deciduous forests; ask the students:

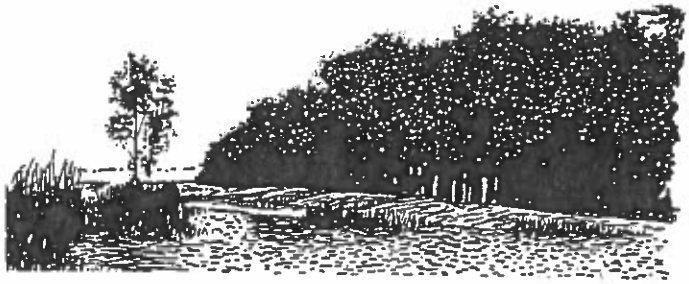
- Would you like to live in a temperate deciduous forest? Why?
- If you do want to live in a temperate deciduous forest, would you want to live in a tent all seasons of the year? Why or why not?
- What causes a region to be a temperate deciduous forest?
- How could you make a temperate deciduous forest into a grassland? a desert? a tropical rain forest? What are the differences?

Deciduous means the falling off or shedding of leaves at a particular stage of growth or season; therefore, deciduous forests are made up of plants which lose their leaves annually.

Temperate deciduous forests are found in temperate latitudes where there is adequate and fairly evenly dispersed annual rainfall (12 to 48 inches) and no prolonged periods of drought. The adequate rainfall supports continuously flowing rivers and streams. Summers are warm and last from four to six months while winters are of about three months' duration and moderately cold.

In temperate deciduous forests the four seasons are distinct in weather and, correspondingly, in plant and animal activity. Spring is the season of awakening and rebirth when plants and animals become rejuvenated. Their activities increase into the summer when growth and most productivity occurs. Fall, then, is a season of harvesting the summer's production and a time of preparation for winter. The season of scarcity is winter when most plants become dormant, and animals either struggle to survive, become dormant or semi-dormant, or migrate to warmer regions. Regardless of the season, each plant and animal species has adapted their life cycles in preparation for it.

Continue the discussion by asking the students to use a map to locate the world's principal temperate deciduous forest regions.



The largest and most important temperate deciduous forests are located in the Northern Hemisphere:

a. Middle and Eastern United States
b. Western Europe from the Alps to Scandinavia.
c. Eastern Asia—primarily China and Japan.

Smaller temperate deciduous forests are found in a few temperate regions of the Southern Hemisphere:

a. New Zealand
b. Chile
c. Argentina

Encourage discussion of temperate deciduous forest plants and animals by posing the following questions:

- If you were standing in a deciduous forest in the middle of summer, could you see very far? How about in the middle of the winter? What's the difference?
- Would you dress differently in the different times of year? How do you think the different times of year effect the plants and animals?
- By standing quietly in a deciduous forest, what could you see and hear as you looked around and listened?

Plants and animals in temperate deciduous forests have developed to time their life cycles to seasonal changes. In general, the sunlight and water are adequate for both plants and animals, but seasonal temperature changes have a direct impact. Both plants and animals have to adapt to carefully using resources when they are available.

Plant life is found in three layers. The first is the top canopy of dominant mature trees from fifty to one hundred feet tall. This layer is somewhat broken, but does create shade for the layers beneath. The second layer is the middle canopy made up of large shrubs and immature trees from 15 to 35 feet in height. This layer receives adequate sunlight and experiences good growth rates.

The first two layers dominate the temperate deciduous forest and cause a deep shade on the forest floor by midsummer. Most of their production is in the growth of wood fibers, and by late fall they prepare for their winter dormancy by shedding their leaves.

The third layer of temperate deciduous forest is the ground cover. It is diverse and well-developed with many annual plants which have a spurt of growth in early spring before the upper canopies block the direct sunlight. They grow quickly, flower, and produce seeds or fruit before the shade overwhelms them. As the shade deepens, other plant species emerge which are better adapted to surviving in the dimmer light. The annual leaf loss of the upper canopies produces a heavy ground litter which protects the annual plants from severe frost. Beginning in the spring and continuing through the summer, this ground litter is decomposed by the actions of microbes and small invertebrates. The result is that the ground cover is on a layer of rich fertile soil which encourages future plant growth.

The dominant trees of temperate deciduous forests produce mostly nuts (oaks, walnut, hickory) and winged seeds (maples) while a few produce fruit (apple, hawthorn, cherry).

Animal life in particular is inclined to be made up of generalists rather than highly specialized species. This is necessary because of the constantly changing seasons and the need to adapt to those changes in order to survive.

Animal life is diverse from the smallest invertebrates (insects, earthworms) to large mammals (deer, bears, wolves). Generally, animal activity begins to build in early spring and accelerates until late fall, or the first heavy frost. The larger animals feed in a frenzy to store fat for the winter. They may need the fat to survive periods of hibernation (e.g., groundhogs) or periods of greatly reduced activity (bears, squirrels). If they remain active all winter (wolves, deer), they need the stores of fat to help survive the period of scarcity. Many birds use the stores of fat as energy for migration to warmer winter regions.

Ask the students to discuss people's uses for, and effects on, temperate deciduous forests.

- What would you do with a deciduous forest if you owned one?
- Would you like to live in a deciduous forest? If so, what would you do there?
- How could you convince someone to be kind in his/her treatment of a forest?
- What could you tell him/her to do to help the forest?
- Imagine someone cut down your forest; what would the land look like?
- Would you try to regrow your forest? How?

In the past, and in the present, temperate deciduous forests have been a source of food, fuel, and building materials. People collect nuts and berries, honey, syrup, and some fruit. Meat is found by taking deer, rabbits, wild pigs, turkeys, and other small animals. As human population has grown and spread, forested areas have been cleared for agricultural uses. The rich soils provide excellent crop and pasture lands.

People also cleared deciduous forests by using the wood as a source of fuel and building materials. Especially in the past, people in our country used wood for fires to heat their homes and cook their meals. This is still common practice in poorer countries. In the 1800s, as the Industrial Revolution progressed, many forested areas were cleared to fuel shelters for the production of metals. Wood is an excellent building material and was once used to construct ships. The fine hardwoods (oak, walnut, hickory) found in temperate deciduous forests continue to be cut for lumber for the construction of homes and furnishings.

Over-cutting the forests for whatever reason has destroyed wide areas of temperate deciduous forests. Once the land is cleared and converted to other uses, there is little chance it will be allowed to regrow. The lumber industry practices clear cutting in some areas and allows the forest to regenerate and mature, but this takes a long time. Often they will plant native hardwoods which grow faster, but are not native to the region. This affects the wildlife which is dependent on certain trees for shelter and food. Another method of lumbering is to do select cutting which takes only the mature trees, leaving the forest somewhat intact and continuing to grow. This too has an impact on wildlife, but not as severe as clear cutting.

When forests are cleared, obviously the habitats of many plants and animals are destroyed. Even when forests are broken with clearing here and there, many large mammals and birds, which need large unbroken spans of forest, cannot survive. In either case the result is the destruction of plant and animal diversity in a region.

People have used temperate deciduous forests since ancient times. They have learned to respect the forest, and with good management the remaining temperate deciduous forests will continue to provide people with many useful products as well as an area sheltering a wide variety of plants and animals.

Temperate Grassland

Upon completion of the unit on temperate grasslands, the students will be able to:

- Understand what "temperate" refers to
- Define, describe, and identify a temperate grassland
- Locate major temperate grasslands on a world map
- Understand the diversity of life on a temperate grassland and how it must adapt
- Explain the damage people and animals can cause to temperate grasslands

To initiate unit discussion on temperate grasslands, ask the students:

- What do you think a temperate grassland looks like... what would you see?
- Where would you find temperate grasslands?
- What causes a region to be a temperate grassland?
- If a storm were coming, could you see it in the distance? Why?

If located in other than a temperate grassland region:

- How does a temperate grassland differ from where you live?
- What would have to happen for a temperate grassland to look like the area in which you live?

Temperate grasslands are vast rolling or flat expanses of fairly uniform and featureless landscapes with only grasses providing a cover. Drier regions are short-grass grasslands where the soil is generally of poor quality. Trees can be found along stream and river valleys where water is more reliably available. Typical of short-grass grasslands are the High Plains of the western United States. Tall-grass grasslands are found in areas with greater annual rainfall to support more growth. These areas typically have deep and fertile topsoil, the result of vegetative decomposition over the ages. The Midwest of the United States once had large tall-grass areas, but almost all have now been converted to high agricultural uses.

On a broad scale, temperate grasslands are found in temperate latitudes between the extremes of humid woodlands and dry desert scrublands. They have hot summers and very cold winters.

Continue the discussion by asking the students to use a map to locate the world's principal temperate deciduous forest regions.

In the Northern Hemisphere, temperate grasslands are generally between 30° and 50° latitude.

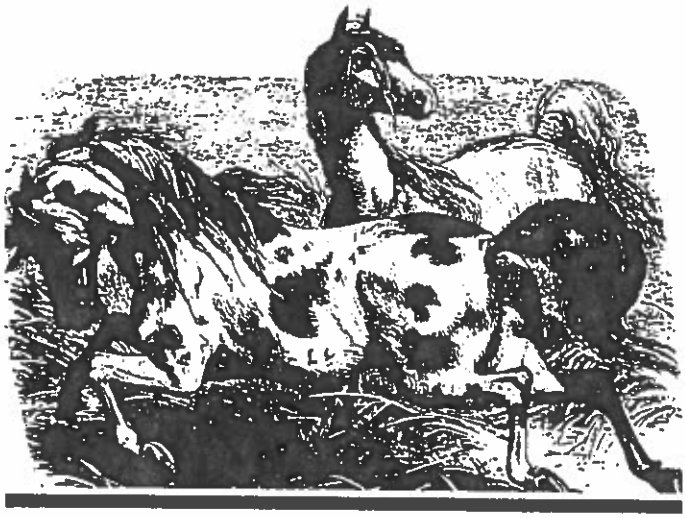
In North America they are principally east of the Rocky Mountains to the Mississippi River and from southern Canada to the Gulf of Mexico. These regions are often called *plains* or *prairies.*

In Asia they cover an area extending from west Asia eastward until it blends into the Gobi Desert. (Accordingly, the annual rainfall ranges from about 16 inches in the west to only two and one-half inches near the Gobi Desert.)

In the Southern Hemisphere, temperate grasslands are not as well defined or nearly as large as in the north.

In South America they are primarily in central Argentina and extending into southern Brazil. These regions are often called the *pampas.*

New Zealand's South Island has a region called the Tussock Grasslands.



Encourage discussion of temperate grassland plants and animals by posing the questions below:

- What kind of plant life would you see?
- Where would you find some shade?
- Do many animals live on the grasslands? What do they eat?
- How can animals hide in grasslands and where do birds build nests?

Temperate grasslands are regions of hardy plants and animals. The climatic extremes and exposure to the elements requires this. They must be tough and adaptive in order to survive.

The dominant vegetation of temperate grasslands are varieties of grasses. The moist springtime is the most productive period. As spring advances into summer, dry conditions begin to prevail in conjunction with higher temperatures, and the grasses better adapted to such conditions become dominant. Trees and large shrubs are usually found close to streams and rivers where water is more plentiful.

Grasslands (including savanna grasslands) have the greatest diversity of herbaceous animals. The limiting factor to animal diversity is the lack of diversity among the plants (e.g., no trees—no tree dwellers). Large grazing animals (e.g., North America—bison, pronghorn; Asia—red deer; South America—pampas deer, guanaco [a relative of the camel]) tend to form large migratory herds. They have to migrate since the quality of grasses changes with the seasons and they consume so much in a given area. Large grazers are fairly easy to see on the open grassland. The gathering together in large herds gives them protection from predators.

Small mammals are also important to grassland (e.g., North America—prairie dogs which form large colonies, ground squirrels; South America—large burrowing rodents; Asia—prairie dog equivalent, ground squirrels). Almost all are burrowing animals and their burrowing helps "churn" or mix the soil, enriching it for future plant life.

Among other animals found are predators (e.g., wolves, foxes, coyotes, weasels, birds of prey) which prey mostly on herbaceous animals, thus keeping a balance among animal life. Because of the lack of trees, most birds build their nests among the grasses; some even use abandoned animal burrows. Insect life is well represented, ants and grasshoppers being plentiful.

Ask the students to discuss the effects people have on temperate grasslands and the impact they have on the land and the plants and animals living there.

- What would you do with a grassland area if you owned it?
- Would you like to live in the middle of a grassland area? If so, what would you do there? If not, why?
- Why would you want other people to be kind to your grassland?
- Imagine it began to rain a lot on your grassland and big trees started growing. Would that be all right? What would or could you do?

People's exploitation of temperate grasslands for agricultural purposes has been extensive with far-reaching results. Much of the grassland has fertile soil and adequate rainfall for many crops as well as good pasturage for livestock. Areas like Iowa and Illinois have grasslands, more commonly called *prairies*, with very fertile soil and good rainfall. These areas have become highly productive farmlands. Further west on the High Plains of Colorado and Wyoming, soil qualities and rainfall are less adequate, but irrigation has produced some good farmland. Most of the prime grassland areas have been converted to agricultural uses. Lands of marginal quality are now being exploited.

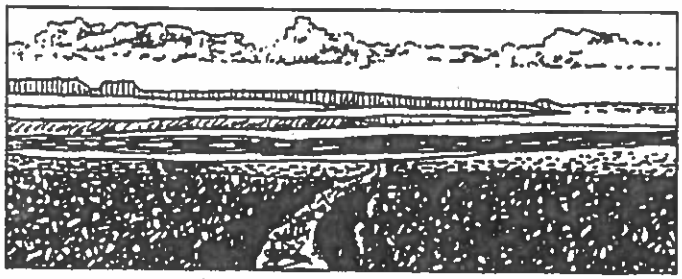
The conversion of temperate grasslands to agricultural uses began a chain of events which forever changed the complex interaction between native plants and animals. Bison in the millions once roamed the American grasslands. They were taken for their meat and hides, and also to allow the conversion of land for what people thought were better purposes. With the big herds gone and domestic agriculture developing, the smaller burrowing herbaceous animals began to flourish. As they flourished, people began eliminating them as pests. This stopped (or reduced) the turning of the soil, weakening the soil's fertility in many areas. Also, with the big herds gone, the larger predators began preying on livestock, so people eliminated them. Smaller predators were reduced as a result of people's drive to eliminate small burrowers. All in all, the chain of events was complex and resulted in irreparable harm to naturally established cycles.

In the drier grassland regions, the vegetation is often shallow and rooted in thin topsoil. The great herds of the past would sometimes graze or trample the ground, leaving it open to wind and rain erosion. Today, overgrazing and trampling by livestock has the same effect, and the plowing for croplands is even more damaging. In the 1930s (the Dust Bowl era) wind erosion showed people their folly in trying to convert land without regard for the consequences.

Irrigation in some dry grasslands can be productive, but some areas have slats in their soil which in time is concentrated by the irrigating waters. This leads to less productive croplands unless expensive counter measures are taken.

Where rainfall is adequate, grasslands converted to cropland suffer more from water erosion. This is a big problem, especially after the ground has been plowed and the soil left exposed to the elements. Since no plants are protecting the soil, the rain water drains faster, carrying bits of soil with it. Slowly but surely the topsoil washes into waterways, clogging and fouling them.

People have interfered in a natural system which was well-balanced. By imposing their will, people have magnified and created problems which damage native plants and animals. Good agricultural management and respect for all life forms can keep the grasslands healthy. Where people will allow, native plants and animals will survive.



Investigating Forest Communities

Background Information

The purpose of this section is to encourage students to appreciate the forest as a rich community of **interrelated organisms** by exploring the **ecological concepts** at work within the forest community.

A forest is a highly complex, constantly changing **environment** made up of a variety of **living** and **non-living** things. Just as each individual part of a tree is vital to the life and growth of a single tree, so all components of the forest community are essential to its health and well-being.

The non-living (**abiotic**) components of a forest include water, nutrients, rocks, sunlight, and air. The living (**biotic**) components of a forest include wildlife, trees, shrubs, wildflowers, ferns, mosses, lichens, fungi, and microscopic soil organisms.

Layers of Life in the Forest

Imagine the forest community as an apartment building, composed of many storeys or living layers stacked one on the other. Each layer is characterized by the types of plants and animals that live there.

On the first floor of the apartment, or the **forest floor**, chipmunks, insects, spiders, earthworms, and mushrooms live and grow amid the decaying logs and leaf litter.

The second storey, or the **herb and shrub layer**, is a home to colourful butterflies, dragonflies, mice, weasels, deer, porcupine, and skunk. These live among the herbaceous plants, tree seedlings, large ferns, and a variety of shrubs.

The next layer of the forest is called the **understorey**. Here the tops of trees, 10 m to 15 m in height, are home to a variety of birds and insects. In the penthouse of the forest, the **forest canopy** formed by the arching upper branches of trees up to 30 m high, you might see a hawk or hear the hoot of an owl.

In addition to the different plants and animals, each forest layer is characterized by its temperature, humidity, and the quality and quantity of light necessary for the survival of the organisms living there.

Habitat

The region where a plant or animal naturally lives and grows is called its **habitat**. A habitat consists of the food, water, shelter, and space required by a particular plant or animal.

All living things have specific and individual habitat needs. For example, beaver require an abundant supply of trees, preferably poplar and birch, near a water supply. Plants need differing amounts and types of light, soil, water, and shelter and a certain amount of space in which to grow. For example, tamarack is often found in cold, wet and poorly drained places. Pines are more commonly found in soils that are sandy or gravelly.

Food Chains and Food Webs

One way of looking at the interactions in forest communities is by examining **food chains** and **food webs**. The dependence of plants and animals on each other for food makes up a food chain. The sun transfers energy in the form of light to green plants. The energy of the food stored in a plant is transferred to a plant-eating animal when it eats the plant and so on.

In most natural situations, the flow of food material is more complicated than in a simple food chain. Many animals eat a number of different foods, depending on their abundance and availability. When many different species of plants and animals are interdependent, we speak of food webs rather than food chains. Nature works to keep a balance within the food web.

Succession

Succession is the gradual and continuous process of change by which one habitat is replaced by another. Even though it may look the same year after year, the natural environment around us is constantly changing.

Imagine a bare stretch of land in the boreal forest. At first glance, it appears lifeless. In reality, the soil is teeming with micro-organisms and earthworms. Gradually, plants and grasses begin to grow and provide shelter for small animals, such as mice. As these plants and animals decay, they provide nutrients for the soil. Shrubs and tree seedlings, usually fast-growing, short-lived species such as birch and poplar, begin to grow and shade out many of the smaller plants. Eventually, more dominant longer-lived species, such as jack pine and black and white spruce, will take over the site.

Agents of Change

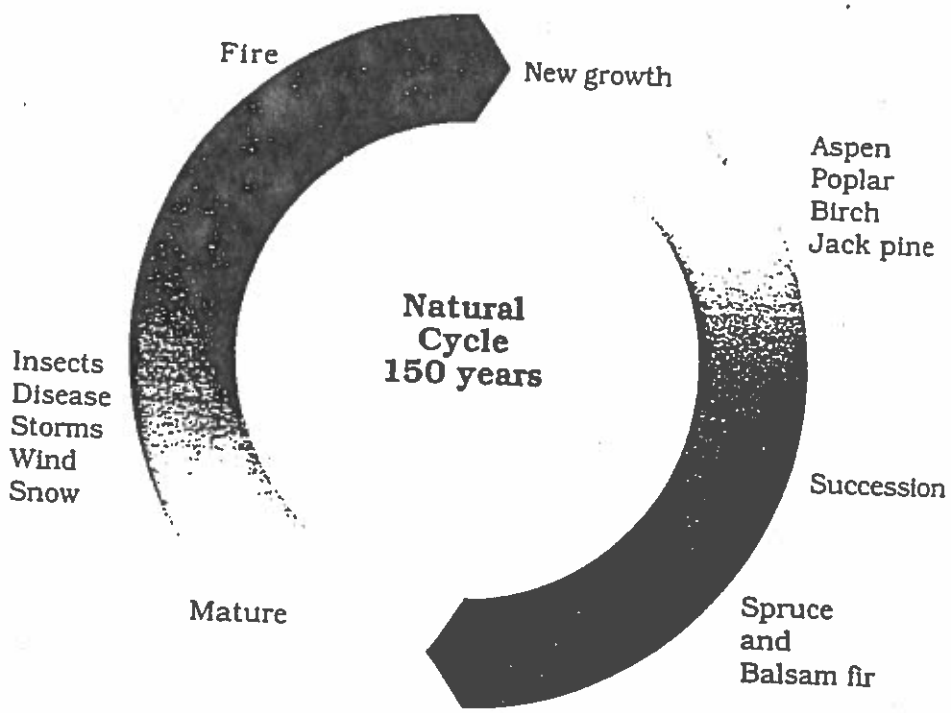
As the forest grows old, it becomes more susceptible to disease and fire. Such disturbances may **seem** quite destructive but new growth quickly returns.

Fire is such a natural part of the ecosystem of the boreal forest that some species of trees, for example the jack pine, have adapted over time to dispense their seeds after fire. By consuming dead leaves, needles, and other debris on the forest floor, fire also puts valuable nutrients back into the soil and encourages new growth.

Despite these benefits, fires may be **suppressed** where they endanger human lives, or property, or the economic value of the timber.

Insects and **disease** are also **natural components** of the forest community. However, in order to protect valuable timber, important wildlife habitat, and recreational areas, it is necessary to **control** serious infestations. If left unchecked, insects, such as the spruce budworm, will defoliate millions of hectares of trees. Once trees have been weakened by insect attacks, disease often sets in.

Some common diseases in Saskatchewan are armillaria root rot and dwarf mistletoe. Dutch elm disease, which attacks American elms, is rapidly making its appearance in the province.

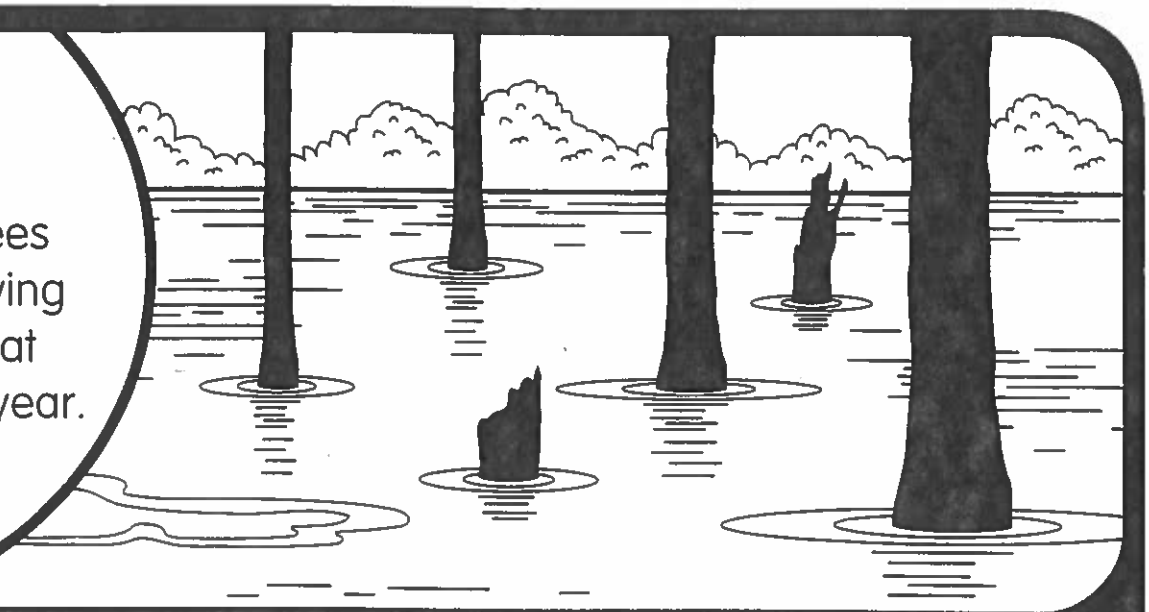


Types of Freshwater Wetlands

There are three main types of freshwater wetlands: swamps, marshes, and bogs. Each has something special about it.

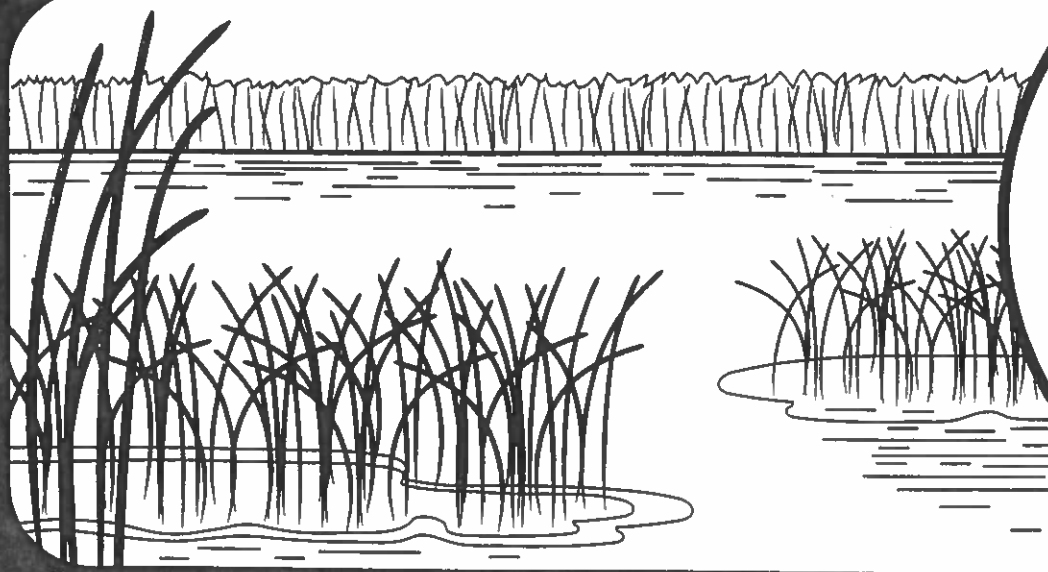
Swamp

A swamp has trees and shrubs growing in it. It is flooded at least part of the year.



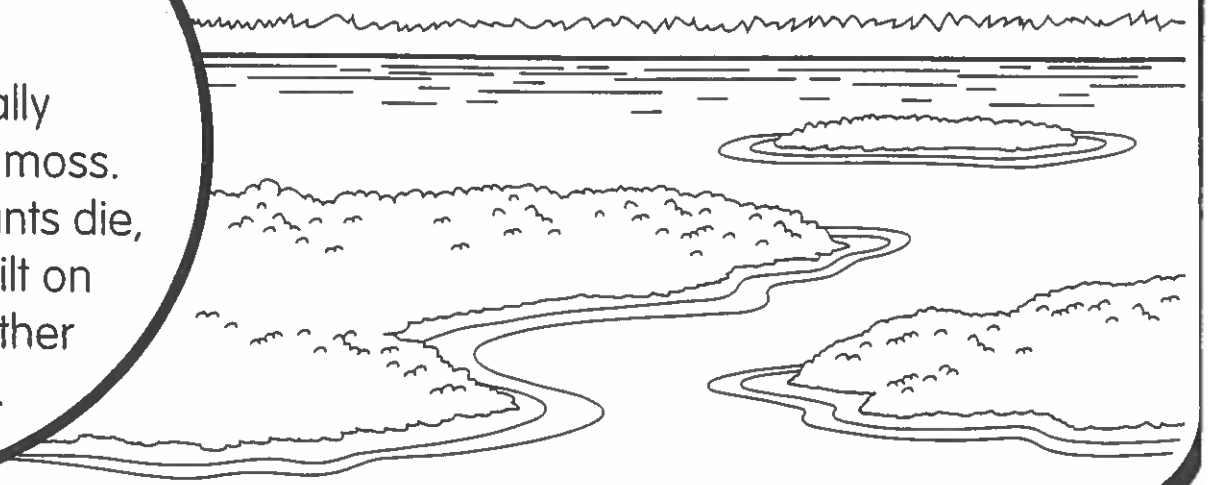
Marsh

A marsh is too wet for trees and shrubs. Grassy plants like cattails and reeds grow in it.

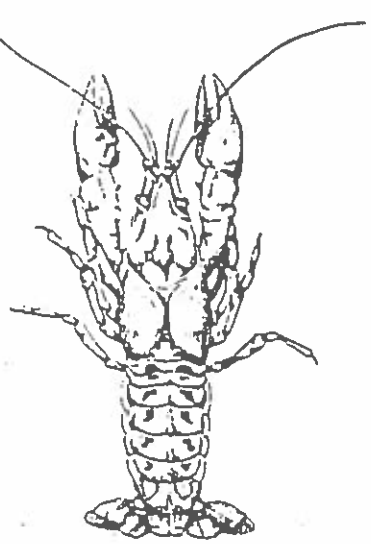


Bog

A bog is usually covered with moss. When the plants die, layers are built on top of each other forming peat.



Aquatic Insects
and Other Invertebrates

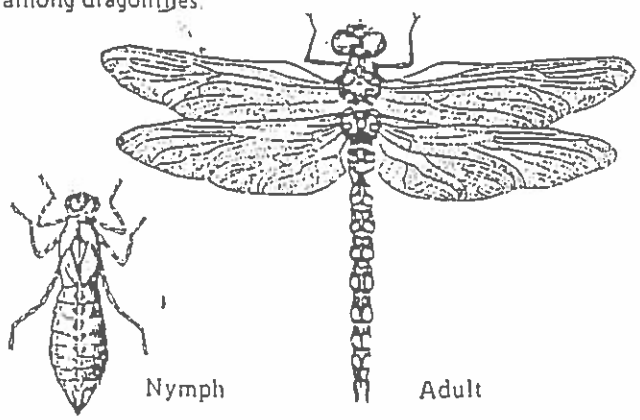


Manitoba has an abundance of running, standing, and ground waters. Here live the myriads of small aquatic invertebrates (animals without a backbone) that comprise an important part of the provincial fauna. Hordes of biting flies come readily to mind, as do the graceful dragonfly and delicate damselfly. Less well known are the vicious water scorpion and giant water bug (both of which can devour small fish), and other groups such as the mites, clams, spiders, striders and snails. The lower animals described in this pamphlet serve as an introduction to this rich and fascinating assemblage of small creatures who spend part or all of their life underwater.

Dragonfly

These active insects are conspicuous and common. Wingspans of 100 mm have been noted and body lengths reach 75 mm. Their large eyes, head, thorax and abdomen are brightly coloured and iridescent. While catching food on the wing, dragonflies dart rapidly back and forth and display great flying ability. During rest, the two pair of wings are held horizontally. Mosquitoes, flies and butterflies are caught and held by the forelegs while the biting and chewing mouthparts go into action.

Mating also occurs in flight and after a period of courtship the female is grasped behind the head by the male's clasper. The female then brings the tip of her abdomen forward and picks up the sperm packet from the second abdominal segment of the male. The eggs are laid on the stem of a sedge below the water's surface and within a month, a robust and predaceous aquatic nymph emerges and starts to feed. Small crustaceans, molluscs, worms, insects and their larvae comprise the dragonfly nymph's diet. The nymphs reach up to 45 mm in length and sometimes four years pass before the nymph climbs out of the water and emerges into the adult. Within an hour the adult can fly and over the next few days it takes on the brilliant colouration. Shortly thereafter breeding takes place and during this period many males die defending their territory against each other. This defense, as well as aggression, migration, and elaborate courtship displays, are common phenomena among dragonflies.

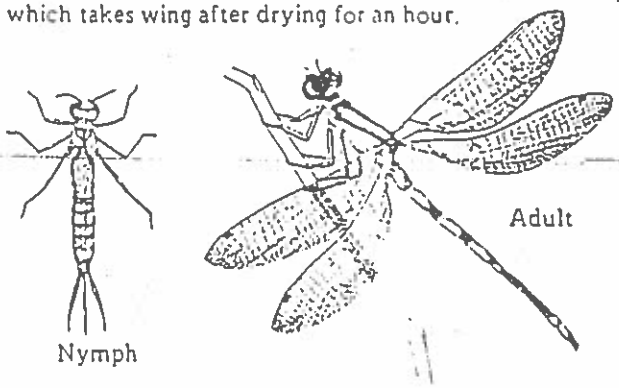


Nymph — 1 cm.

Adult — 1 cm.

Damselfly

The damselfly, unlike the dragonfly, holds its wings together over the body while at rest. They are also slower flyers and more delicate than the dragonfly. They share the same general shape and are among the most beautiful of insects, even exceeding the dragonflies' brilliant iridescence. Mating occurs on the wing after a brief courtship. Eggs are laid underwater and the slender nymphs hatch after about one month. Three flattened leaf-like appendages on the abdomen tip are external gills and are also used as flippers as an aid to locomotion. They overwinter in the nymphal stage and grow by a series of moults. In early summer the nymph crawls from the water and transforms into the adult, which takes wing after drying for an hour.



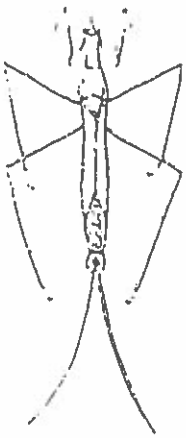
Nymph — 0.5 cm.

Adult — 1 cm.

Water Scorpion

This dark-brown, stick-like insect superficially resembles the praying mantis. It may reach a length of 50 mm, but the long tail makes up about a third of the animal's total length. The tail is not used for stinging, but rather as a breathing tube or snorkel. Water scorpions are predaceous on practically all aquatic organisms of suitable size, such as small crustacea, insects and their larvae, and small fish. Unlike other predatory water bugs, they do not pursue their prey, but rather lie in wait, capturing those animals that pass nearby. The front legs are used to seize and hold their prey while the mid- and hind legs are used for swimming.

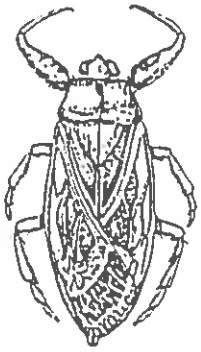
Being stick-like, water scorpions are difficult to discern from the debris in backwater areas. They overwinter as adults buried in the sediments and become active as the ice breaks up in spring. They make a noise (stridulate) to attract mates, and eggs are laid in early summer. Five nymphal moults (instars) follow, with adults appearing in late summer and early fall. Interestingly, water scorpions fly only infrequently, when adverse conditions develop in their habitat.



1 cm.

Giant Water Bug

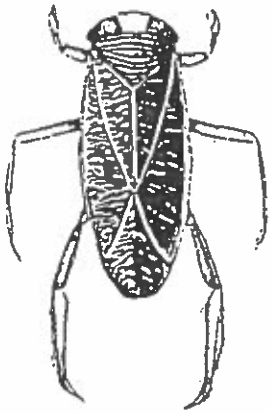
These are large brown bugs measuring up to 60 mm in length, usually found among floating debris in backwater areas. The forelegs are enlarged for grasping prey while the hind legs are fringed with hair for swimming. The water bug sucks the body fluids from insects, larvae, tadpoles and small fish. In spring they lay their eggs in pools and these hatch in about six weeks. The nymph resembles the adult but is smaller and lacks wings and reproductive organs. It develops rapidly and overwinters in the adult stage. At night water bugs are attracted to lights and for this reason they have been called the electric-light bug.



1 cm.

Water Boatman

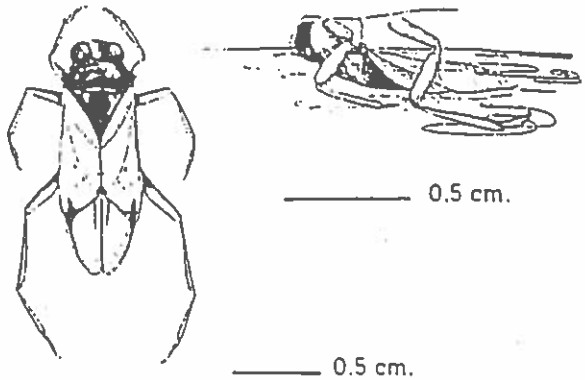
These brownish bugs measure about 10 mm in length, and with a characteristic jerky motion as they row with their long, flattened and fringed hind legs, they feed on algae and small creatures (e.g., protozoans, rotifers) found in the bottom ooze. Food is shovelled up by the flattened forelegs and the bug ingests all sorts of food particles; thus these aquatic bugs differ from others in that they take particulate food rather than liquified food. In spring, stridulation or noise making by the male attracts the female, and shortly after mating, eggs are laid on aquatic debris or vegetation. Within a week the nymph emerges and undergoes five instars, as do all aquatic bugs. Five weeks later the adults appear and these overwinter, remaining quite active under the ice. Water boatmen serve as an important source of food for fish during this time.



0.5 cm.

Backswimmer

Measuring up to 15 mm in length, these bugs are readily recognized by their pale greenish-yellow colouration and prominent reddish eyes. In addition, they swim about upside down on their back, which is shaped like a speed-boat's hull. They progress in quick jerky movements and, if unable to grasp something underwater, they float to the surface when they stop swimming. Since their bite is painful, they must be handled carefully. The adults prey on small insects, snails, crustaceans and even small fish. They remain active under the ice in winter and in spring the males stridulate to attract mates. The eggs are laid on plants and rocks in vegetated areas. Five instars follow hatching and in seven weeks they enter the adult phase.



0.5 cm.

0.5 cm.

Water Strider

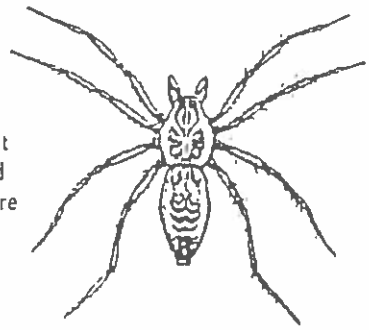
Water striders are thin-bodied, long-legged bugs usually seen in groups along the edge of watercourses, though they occasionally venture far from shore. They dash with great speed after insects on the surface, using their middle legs for propulsion and their fore- and hind legs as balancers. The body is clothed in water-resistant hairs and the legs are specially modified for their mode of travel. Water striders overwinter as adults in protected sites along the shoreline, but sometimes they move further inland and have been found up to 20 m from the water's edge; in spring, they make their way back to the water to mate. Eggs are laid in floating debris or below the water surface on stones and vegetation, and these hatch within a couple of weeks. Five nymphal stages follow and within six weeks the adult stage is reached.

1 cm.

Dock Spider

Dock spiders are among the largest of the true spiders and sometimes reach 25 mm in body length and 75 mm from leg tip to leg tip. They are brown with light-coloured, W-shaped markings on their abdomen. Normally, dock spiders ply the water's surface in search of prey. Once they catch an insect, small fish, or tadpole, they bite and inject venom. The paralyzed victim is dragged from the water, powerful digestive juices are injected into it, and shortly thereafter the spider sucks up the semi-digested, liquified remains. Dock spiders often fall prey to fish. Their appendages may be lost during these attacks, but they soon grow back.

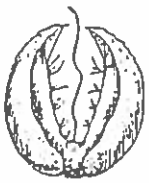
After mating, the female carries the eggs about in a silken cocoon or egg sac. She stands guard over the young spiders, but they grow rapidly and leave her protective care within a few days. After 10 or 13 moults they reach maturity and overwinter as adults in shoreline vegetation. Upon spring break-up, they return to their amphibious way of life.



—— 1 cm.

Unionid Clam

A clam or bivalve has two shell halves joined together by a horny ligament. The foot is shaped like a hatchet and is used for locomotion and digging. Clams live in a variety of habitats, from standing water to riffle areas of streams. Breathing is accomplished by passing a current of water over their gills, and through this means, they also "filter-feed" by sieving small food particles from the water. Clam shells from northern soft waters are somewhat smaller, thinner and lighter in weight than those of harder southern waters. The sexes are separate and in summer the male clam liberates sperm which is taken in through the female's breathing siphons to fertilize her eggs. Small larvae, called glochidia, develop slowly and about a year later, they leave the mother clam in search of a fish to which they attach and begin a parasitic mode of life. Once they develop into juvenile clams, they drop off the host and start a free-living existence on the bottom. Thus, they not only gain nourishment from the fish, but they are also dispersed, sometimes great distances.



—— 0.1 mm.

—— 1 cm.

Fingernail Clam

Fingernail clams are small white bivalves (two shell halves or valves) which measure less than 15 mm across. The interior of the shell may be an iridescent bluish-white, like that of their larger relatives, the unionid clams. Fingernail clams are also filter feeders and breathe by gills, but they differ from unionid clams in that there is no parasitic stage in their life cycle. They are capable of fertilizing themselves, since both sex organs are found within the same animal (hermaphroditic). The young clams pass through the egg stage inside the mother, (oviviparous) and when born, resemble the larger adults. They take up residence on gravelly or rocky bottoms of flowing watercourses, preferably in areas free of thick vegetation. Fish often feed on these small clams.

—— 0.5 cm.

Pond Snail

As representatives of molluscs, the snail shares with the clam: a ventral, muscular foot used for crawling, burrowing and attachment; and an enveloping sheet of tissue called the mantle which secretes a calcareous shell. Unlike the clams, snails have a coiled shell, a well-developed head, and some species breathe by lungs rather than gills. The larger species of snails grow to 50 mm in length. These often have a thin shell with a tall narrow spire and an opening about half as long as the entire shell. Some species are shorter with a more blunt spire and some lack a spire entirely, as they are coiled horizontally. Usually the shell is light brown in colour and the body is black. They are widely distributed throughout ponds, rivers and marshes, wherever there is aquatic vegetation and a sand or rock bottom; they avoid mud, probably because it makes movement difficult.

Certain species live for up to four years, although a simple annual life cycle is the norm for most species. They are omnivorous and feed on higher aquatic plants, algae and dead animals. Since they are hermaphroditic, they may mate with another snail or produce self-fertilized eggs. While in the water column, snails are easy prey for fish such as walleye, while on the bottom they are also taken by frogs and turtles. Snails often carry parasitic organisms which can infect birds and mammals.

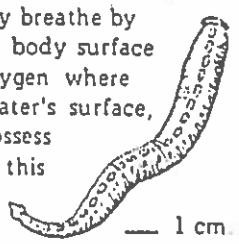
—— 1 cm.

by Dr. W. Brian McKillop
drawings by Margaret Macfarlane

Manitoba Museum of Man and Nature Winnipeg 1981

Leech

Most people consider leeches to be "bloodsuckers", however few species actually suck blood. Some forms prey upon small invertebrates, while others simply scavenge upon dead organisms. They are particularly attracted to disturbances in the water; splashing is known to attract the blood-sucking species. Leeches inhabiting lakes, ponds or rivers are brownish-black or dark olive in colour and reach up to 125 mm in length. They have a flattened appearance, with suckers, used for attachment, at both ends of the body. They are commonly found in shallow water where plants and debris offer some protection. During the winter months they burrow into the bottom mud and become dormant. Leeches can thrive in the soft, calcium-poor waters of the boreal forest, but if the water is particularly soft, both the diversity and abundance of leeches decline. They reach other bodies of water by attaching to birds and fish. Most live about two years, but members of some species live up to three years. They breathe by simple diffusion of gases across the body surface and can survive in areas of low oxygen where they often move about on the water's surface, gaining oxygen from air. Many possess haemoglobin in their blood, and this may help them breathe at low oxygen levels.

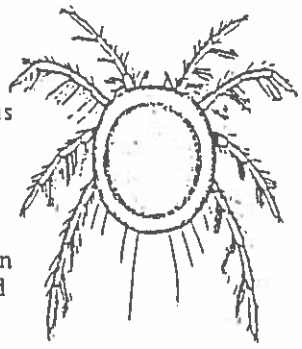


— 1 cm.

Water Mites

In contrast to most freshwater invertebrates, water mites are particularly striking because of their bright colour. The majority are some shade of red or green, mottled with yellow, brown, or blackish markings produced by the colour of internal organs seen through the transparent body wall. They have a globular body, range in size from minute to 8 mm, and could easily be mistaken for tiny aquatic spiders. Some water mites swim by a relatively uncoordinated flailing of the legs. Larger forms remain near the bottom and swim very little. They can be collected throughout the year and even remain active under the ice.

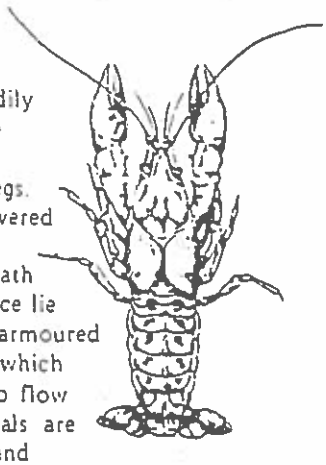
Most water mites are carnivorous or parasitic, their food consisting of small insects, worms, or the host's tissues. Prey is seized and held with the palps and then pierced by the mandibles. An enzyme-rich fluid is then injected and, after some predigestion has taken place, the softened fluid-like material of the prey is sucked up. Mites are in turn eaten by a variety of other invertebrates, principally carnivorous insects and their larvae.



— 1 mm.

Water mites have reddish eggs which are deposited in summer on aquatic vegetation and stones. Within a month the eggs hatch and the larvae seek an aquatic insect to which they attach and assume a parasitic way of life. A free-swimming, nymph-like stage follows, which appears similar to the adult, and within 7 to 10 days it transforms into the adult form.

Crayfish



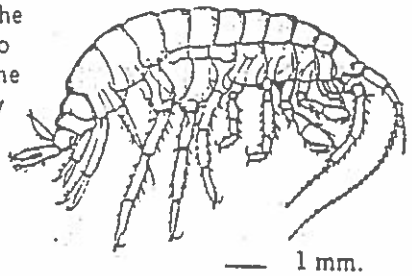
— 1 cm.

Reaching lengths of 100 mm, the crayfish is readily identified by its lobster-like appearance with large claws and four pairs of walking legs. The head and thorax are covered by a horny carapace, usually dark brown. Beneath the thoracic shell or carapace lie the gills. The flexible but armoured abdomen bears appendages which cause a current of water to flow over the gills. These animals are characteristic of streams and rivers with rocky bottoms. Hiding under rocks or in burrows, they venture forth when potential prey appears. These omnivores eat almost anything, and two pairs of antennae and a pair of stalked eyes help locate food. They are, in turn, commonly eaten by fish, birds, and mammals. By rapidly flexing the abdomen the crayfish can jet away from danger in a high-speed retreat. If trapped by a leg, claw, or any other appendage, the crayfish releases or snaps it off; the animal soon regenerates the lost part.

Young crayfish grow for two years before reaching maturity in late fall. Mating takes place and the eggs are carried by the female on the underside of her abdomen until they hatch later in the fall or in early spring. The adults are then three years old and the males die after mating; the females live to the fall but die after bearing their final brood.

Scud or Amphipod

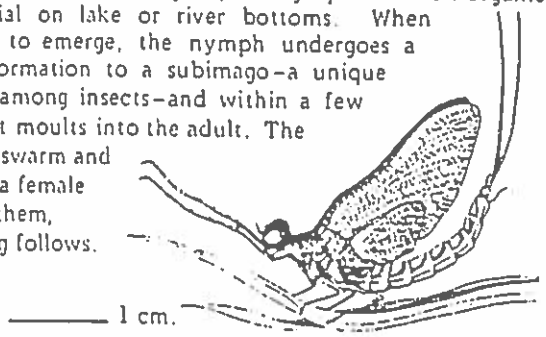
These crustaceans have a shrimp-like appearance and are about 12 mm in length. They usually graze on the small animals associated with aquatic plants, although they will also eat dead animals and autumn-shed leaves, while the very young will feed on the faeces of adults. They are relatively poor swimmers and scuttle along the bottom or jerk clumsily along through the water with their appendages; at this point they are ready prey for trout and perch. They disperse readily and make their way into the headwaters of the smallest streams. During summer, the females give rise to several broods. The young grow rapidly through a series of moults and then quietly overwinter as adults.



— 1 mm.

Mayfly

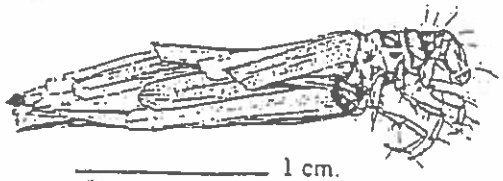
Mayflies often occur in extensive swarms and sometimes large numbers are washed ashore on beaches where they decompose and smell "fishy"– thus the commonly used name "fishflies". Interestingly, they also form an important part of the diet of many fish species. These fragile, soft-bodied insects have a very short adult life and most of their life cycle is spent underwater in the nymphal stage. The adult holds its transparent wings upward and together when at rest. The tip of the abdomen bears two or three long filaments which can account for more than half their overall 25-mm length. The adult does not feed, its sole purpose being to reproduce the species. In contrast to the uniform structure of the adults, the nymphs show considerable variation. Generally they are elongate, with strong legs, large compound eyes, paired abdominal gills, and two or three caudal filaments at the tip of the abdomen. Prior to emergence from the aquatic nymphal stage to the aerial adult stage, up to 40 moults may occur. During this period of almost one year, the nymph feeds on organic material on lake or river bottoms. When ready to emerge, the nymph undergoes a transformation to a subimago–a unique stage among insects–and within a few days it moults into the adult. The males swarm and when a female joins them, mating follows.



1 cm.

Caddisfly

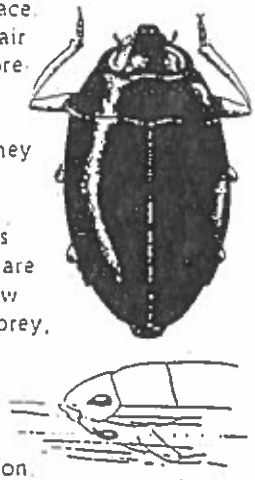
The small moth-like caddisfly (measuring up to 25 mm in length) is nocturnal and readily flies to lights. Sometimes massive accumulations of adults develop along the shores of lakes, but this happens infrequently, as only greatly enriched or heavily polluted lakes produce such vast numbers. Thus these insects can be used as biological indicators of water quality. The larvae build hollow cases for shelter, constructed of shells, pebbles, leaf debris, or twigs. The case also aids in respiration, since the larvae wriggle within the tube, thereby causing a "ducted" current of oxygenated water to flow over the gills. Their biting and chewing mouthparts have evolved along with a diversity of life-styles; carnivores, herbivores, omnivores and detritivores (broken remains of plants and animals) are known. Interestingly, some species even build nets and periodically clean from these the entrapped food particles. The winter is passed under the ice, and in early summer, pupation occurs, followed shortly by emergence into the adult. Mating takes place and the female deposits her eggs in the water. The nymphs soon hatch and begin building their cases.



1 cm.

Whirligig Beetle

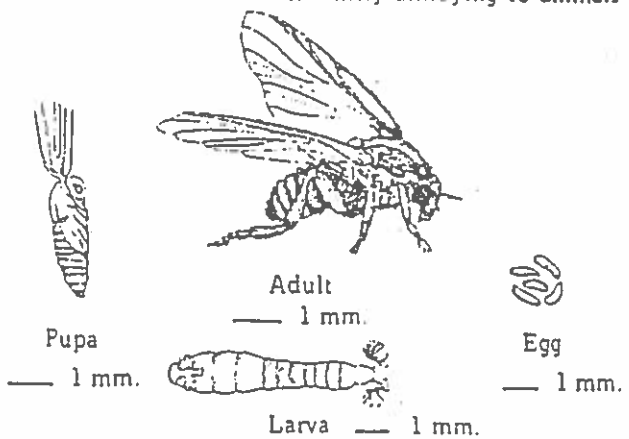
These small, black, gregarious beetles can often be seen swimming rapidly about each other on the water's surface. Although they can fly, they spend most of their time on the water where they detect the presence of insect prey and others of their own kind by pressure waves transmitted along the water's surface. They dive readily and carry their air supply in a bubble beneath the forewings. If they wish to remain submerged, they must grasp hold of underwater objects, otherwise they quickly float back to the surface. While on the surface they can see into both aerial and aquatic worlds at the same time, since their eyes are divided, with parts above and below the waterline. The forelegs hold prey, while the middle and back legs are used for propulsion. They feed on anything they can find, from terrestrial insects which have drowned, to aquatic vegetation. The adults hibernate in the mud bottom and in spring, egg laying commences. Hatching occurs in a couple of weeks and voracious larvae develop. The larvae build pupal cases in late summer and in early autumn the adults emerge.



1 mm.

Black Fly

Waterfalls and rapids are the usual haunts of black flies, since their eggs are laid in fast-flowing water. The larvae require abundant oxygen and cannot survive in stagnant water. Pupation takes place in a larval cocoon and the adults emerge underwater, swim to the surface, and fly away. Like the mosquito, the female black fly requires a blood meal for development of her eggs. These small "hunchbacks" are extremely annoying to animals



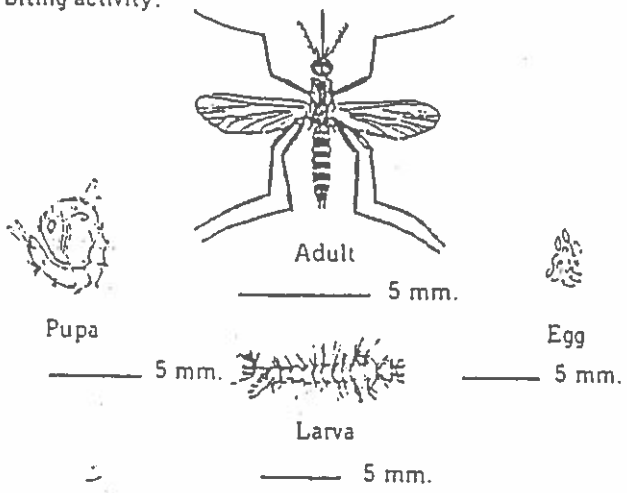
(including man), and although their bites do not attract immediate attention, painful swelling may develop

afterwards. They bite during the day and rarely come indoors, appearing to wait just outside the door for victims. Fortunately, people can gain some protection with insect repellant, but animals have no defence; animals may die from emotional shock, loss of blood, or from inhaling large numbers of these insects.

Mosquitoes

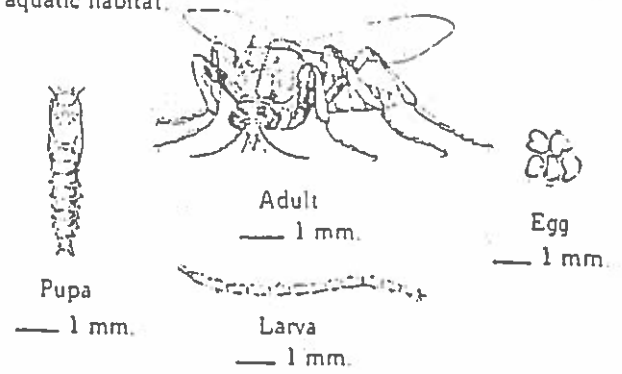
Mosquitoes may be a tremendous annoyance throughout Manitoba, but they are particularly serious in the boreal forest where they are joined by other biting flies–black flies, tabanids and no-see-ums. The group called snow-pool *Aedes* are especially troublesome, as they develop rapidly in the spring and lay several batches of eggs well into the summer. These mosquitoes are active at dawn and dusk, remaining hidden in moist grassy areas during the day unless humidity increases. If disturbed, they rise to attack any intruder. A second group, called the summer *Aedes*, has many generations during the summer, depending upon food availability and high temperatures. The biting period may extend into September.

The adults subsist on plant juices, but the female requires a blood meal for egg production. Once this thirst for blood has been satisfied the female lays her eggs in moist soil or aquatic sites. Mosquito larvae are aquatic filter feeders and both larvae and pupae are easily recognized as they characteristically jerk their way towards the water's surface for air. We recognize the adults by their noisy flight and the female's pestiferous biting activity.



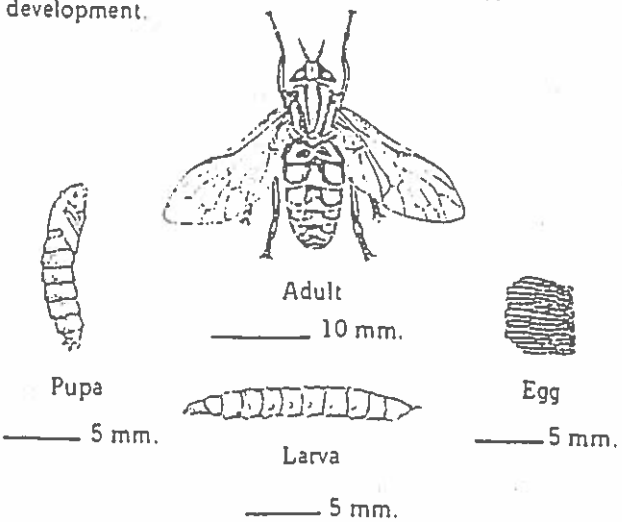
Biting Midge

The biting midges, or no-see-ums, are the lilliputians of the biting flies, measuring less than 4 mm across the wings. Reputed in some areas to be more of a problem than their cousins, the black flies, the biting midges can make life very unpleasant for people active outdoors. In large numbers they are serious pests, particularly since the females of most species actively suck blood. The females attack near sunrise and sunset, or, if the humidity remains high, any time of day. High winds, temperatures less than 10° C, and high rates of evaporation reduce landings and bitings. During periods of high humidity throughout much of June and July, they are particularly troublesome, especially since they are adept at entering screened quarters. They land clumsily and stagger about briefly before attacking their unsuspecting victim. Once the victim is aware of the bite, it is usually a nearby but innocent larger and noisier insect that is blamed for the pain, itching and associated secondary infection which may follow. Eggs are laid in stagnant water or wet soil containing much organic matter. The larvae prey on chironomid insect larvae and may be found in large numbers in nearly any aquatic or semi-aquatic habitat.

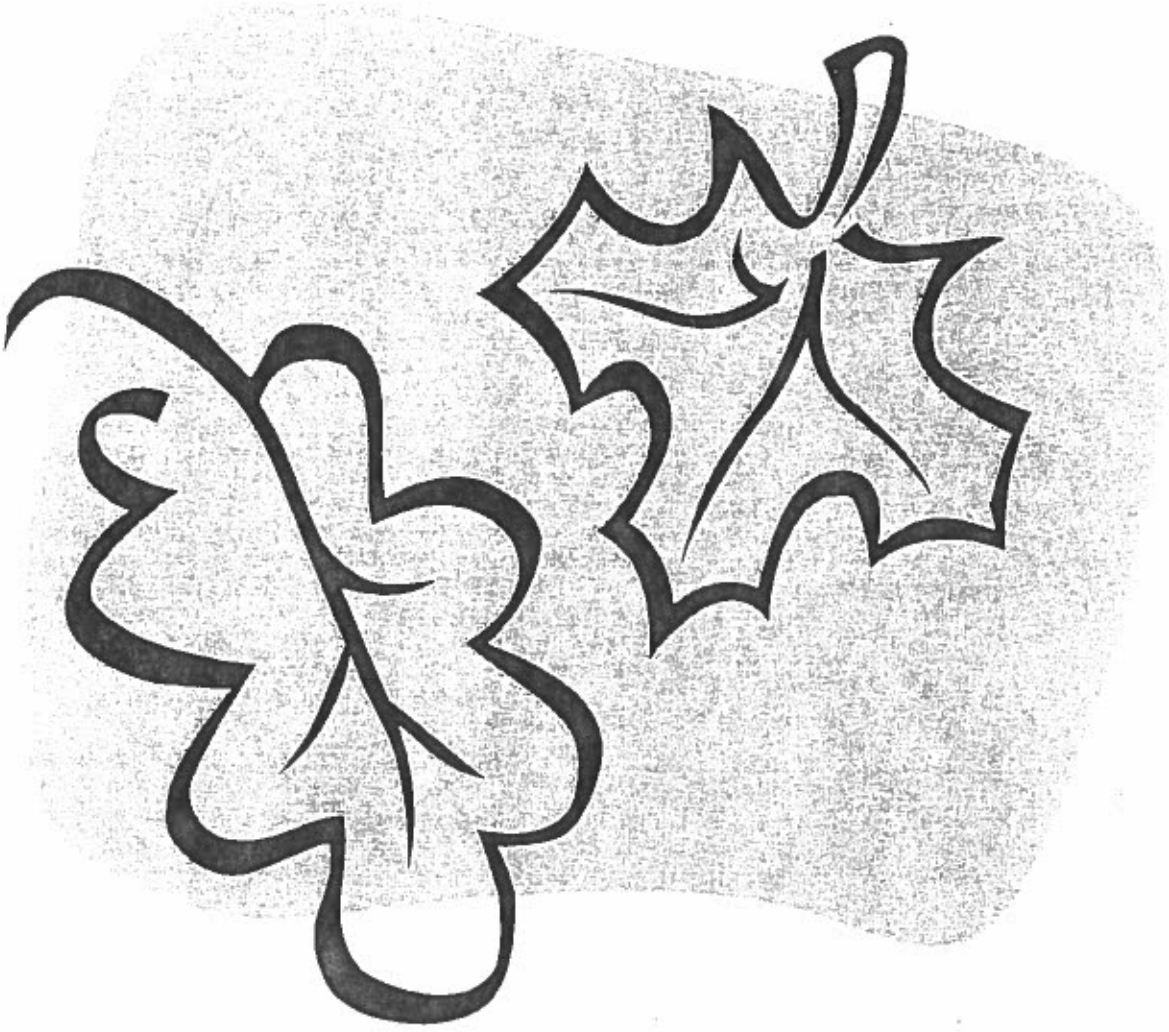


Horse and Deerflies

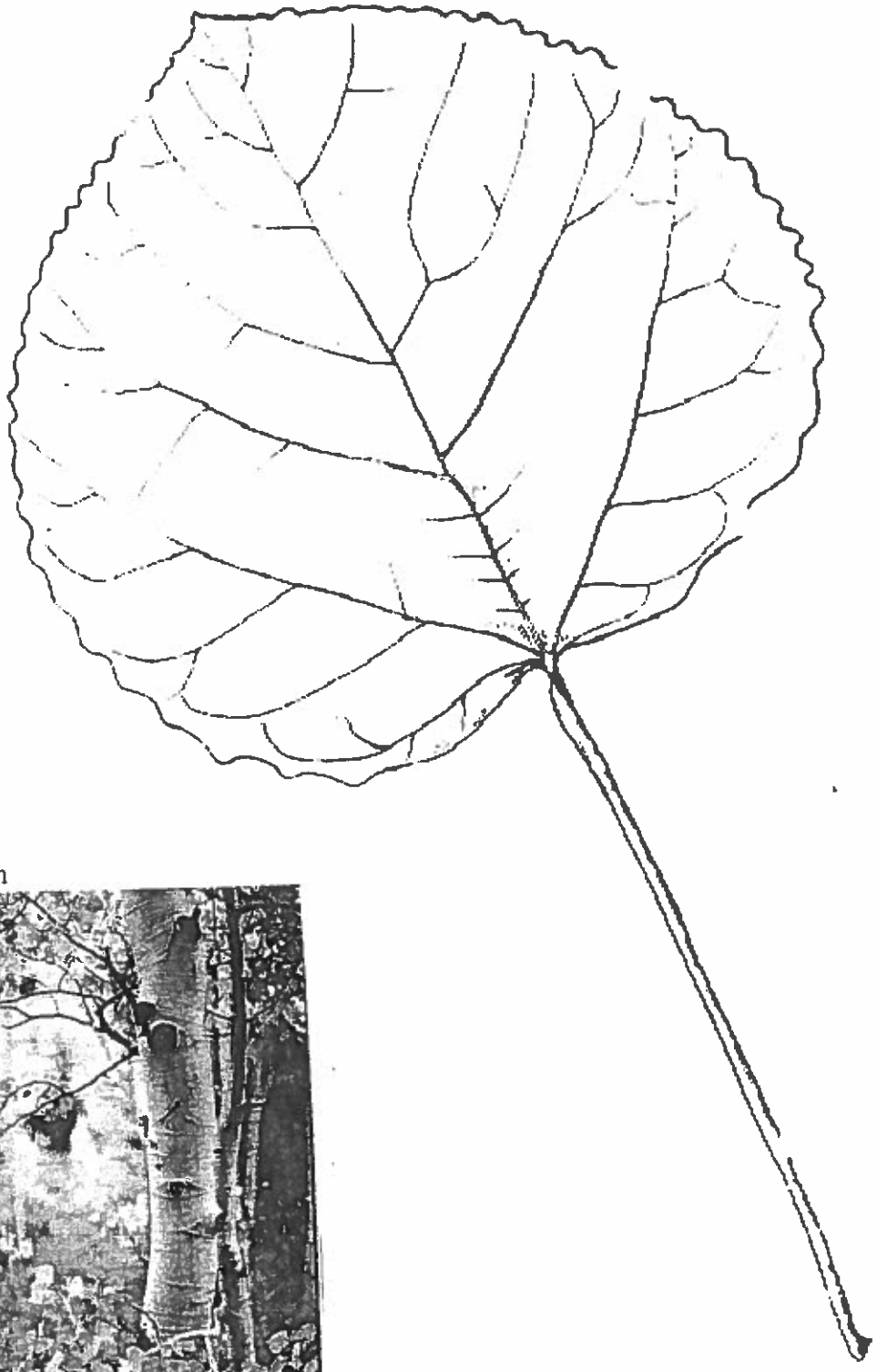
The giants of the biting flies, the horse flies, are often 30 mm long and have a similar-sized wingspread, while their smaller relatives, the deer flies, are about 20 mm long and have wingspans of 15 mm. They are strong fliers and can easily out-distance the swiftest runner. Notorious as pests of warm-blooded animals, including man, they are particularly unnerving as they circle their victim, as if selecting a suitable site on which to land and bite; they are apparently attracted by sweat of humans. Some protection can be gained by standing quietly in an open area where wind deters further or massive attacks. Most horse flies are daylight feeders and prefer animals to humans. In heavily infested areas animals may be seen matted with blood from bites. It is the smaller deer flies that are the more serious pests to people. The larvae of both groups do not require flowing water, and damp soil will suffice for egg and larval development.



Leaf Identification Booklet

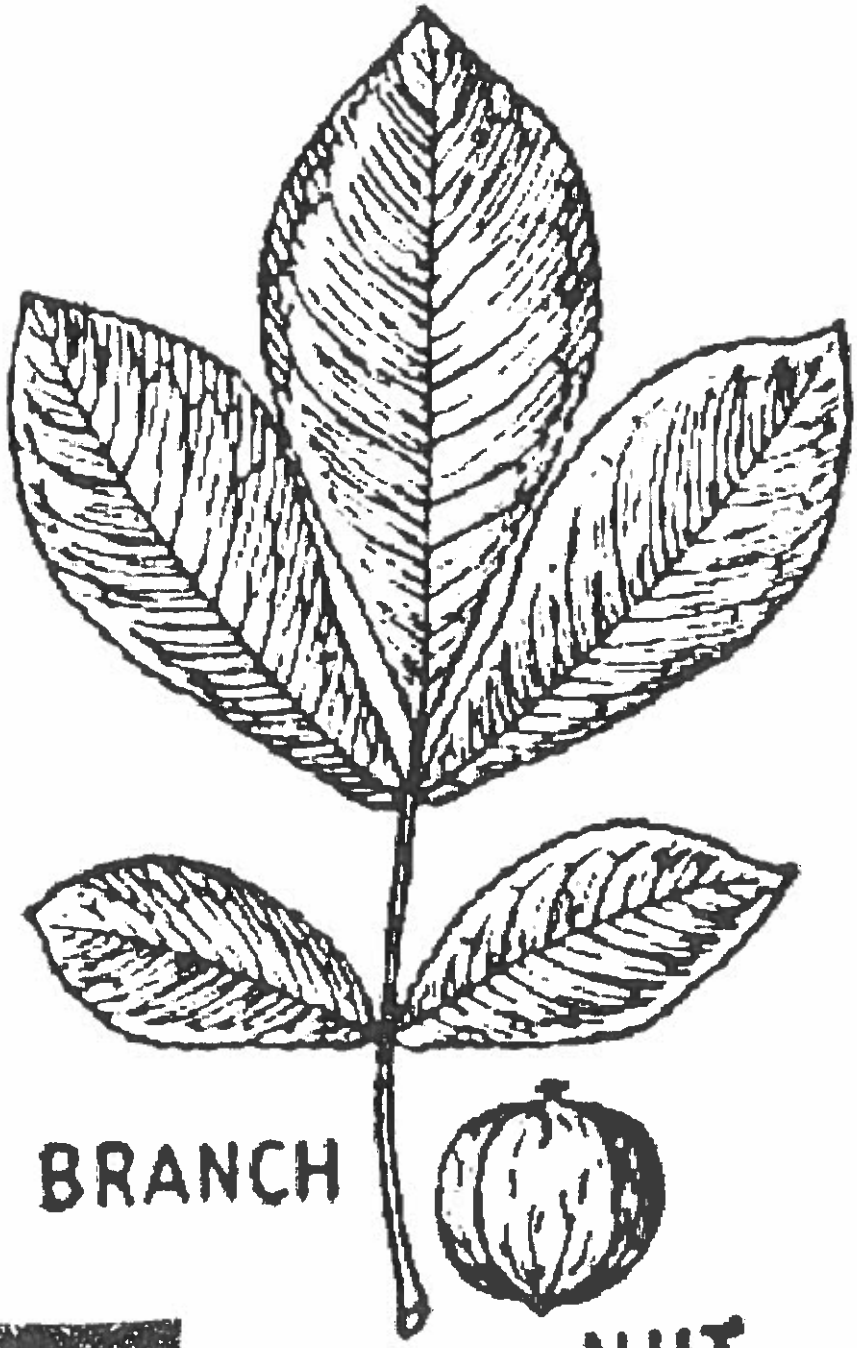


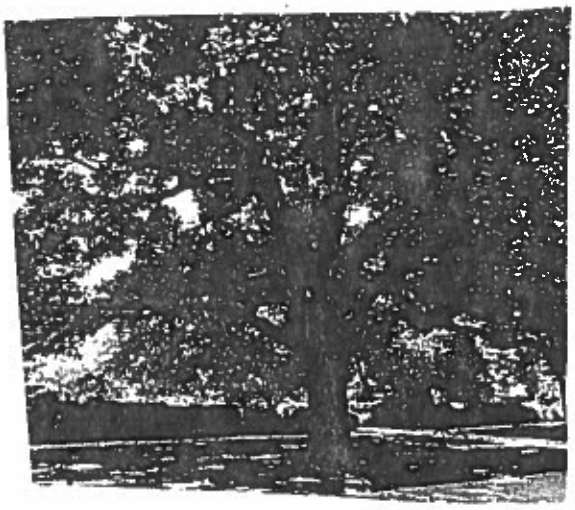
Aspen



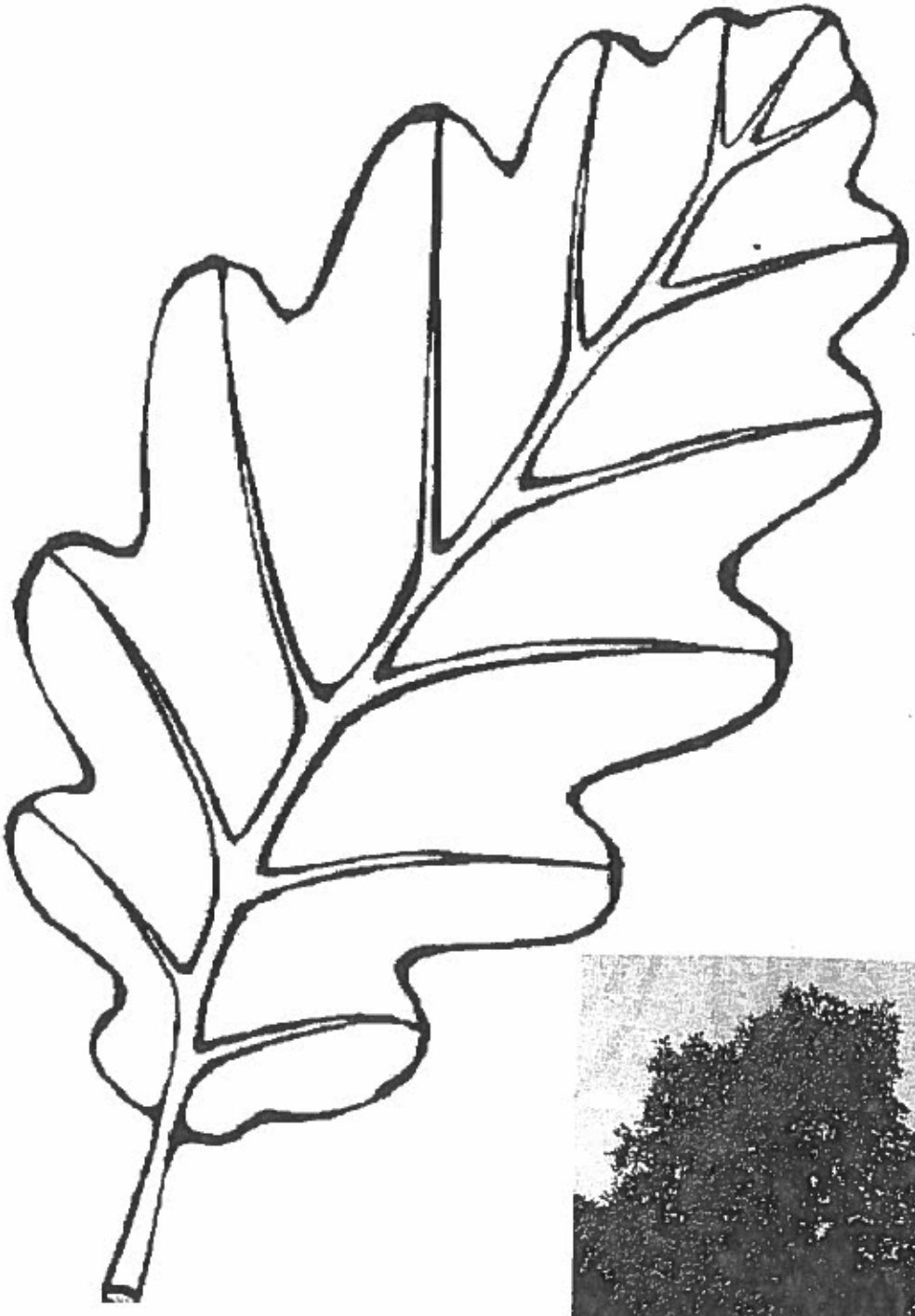
Aspen

Hickory

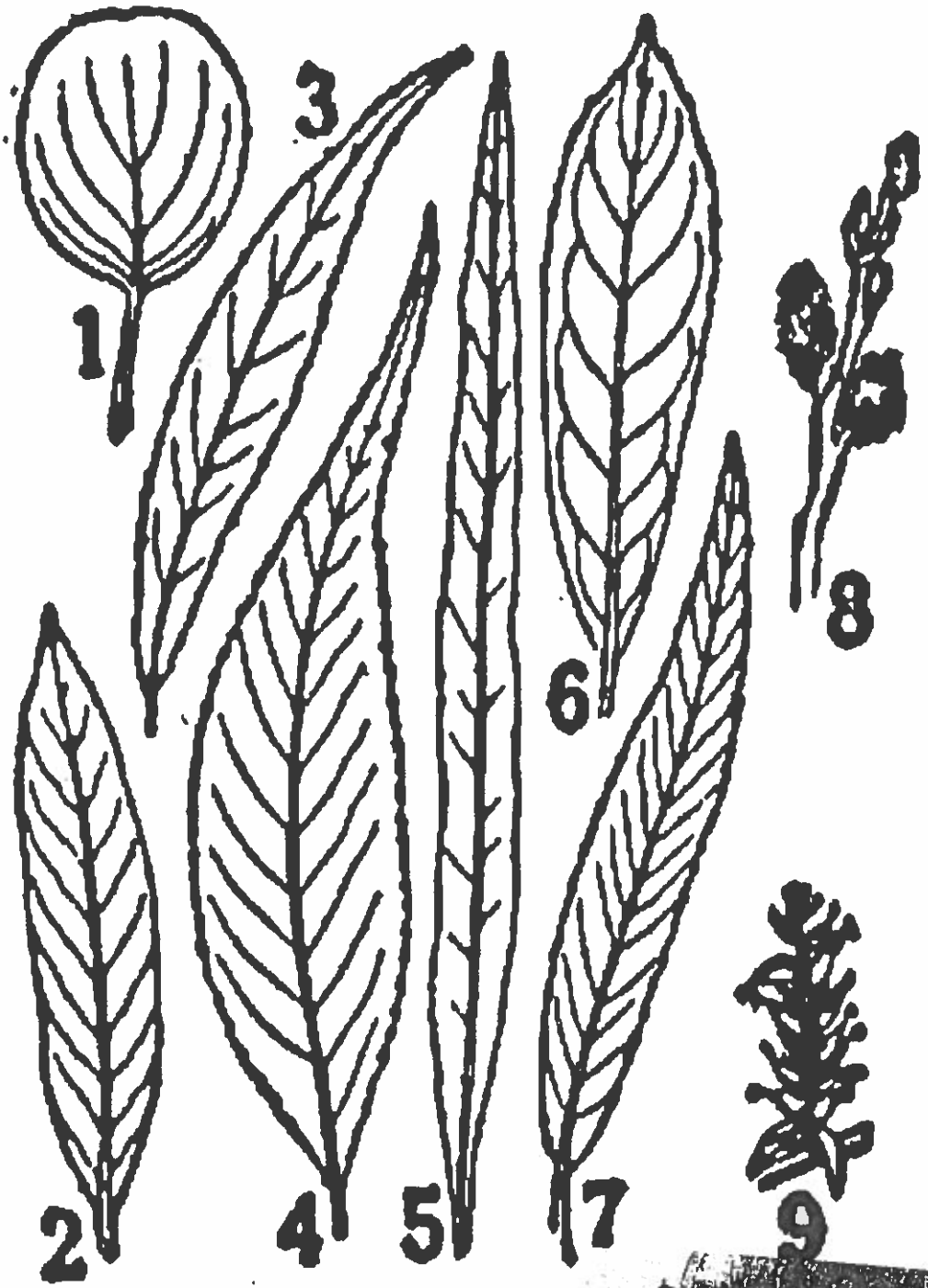


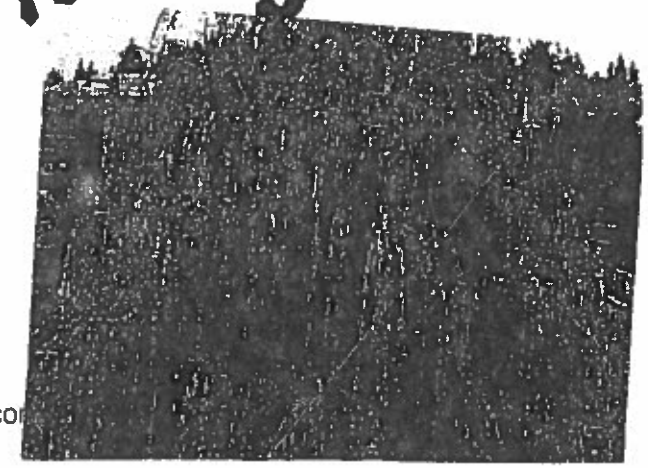


Oak Leaf

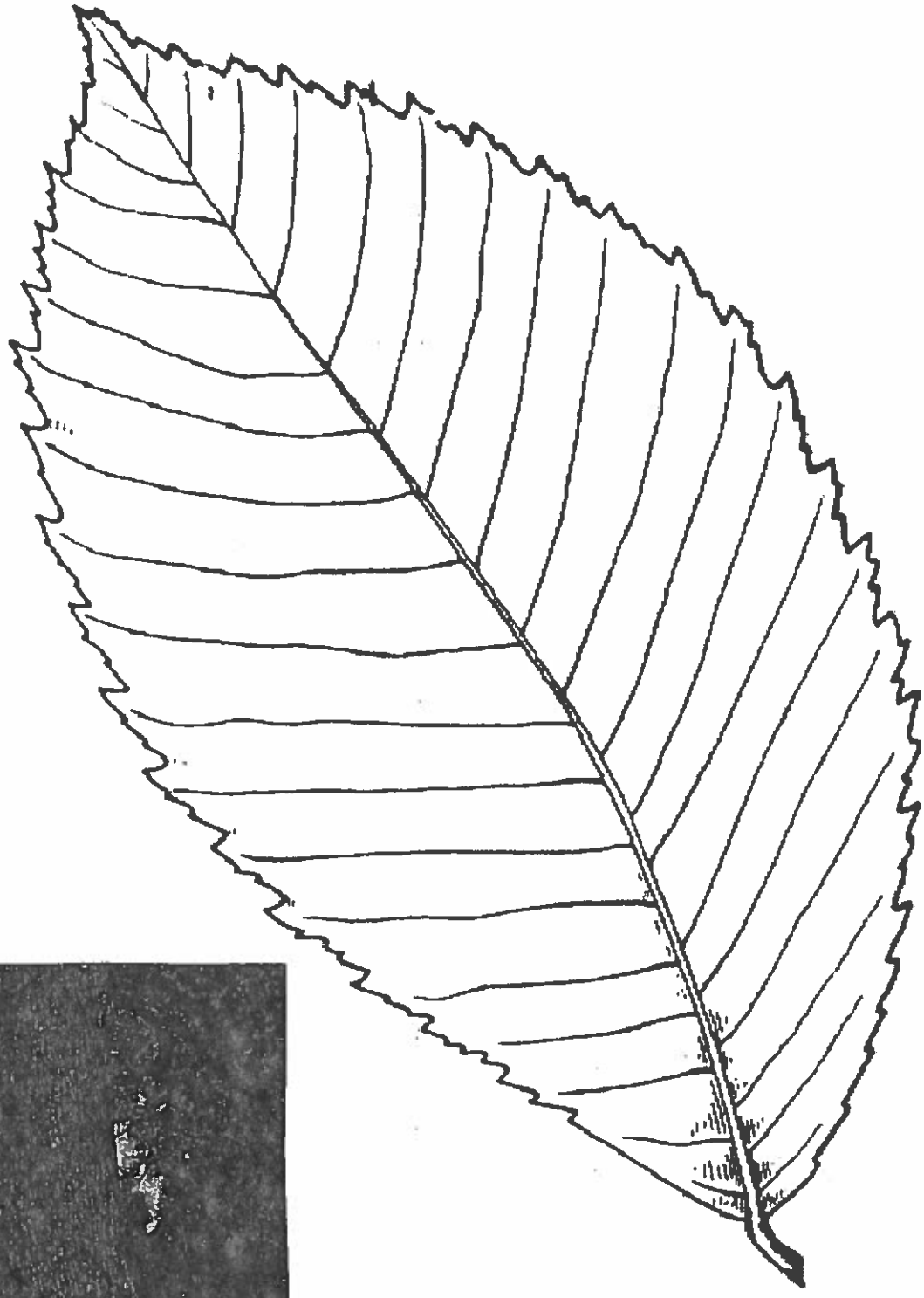


Willows

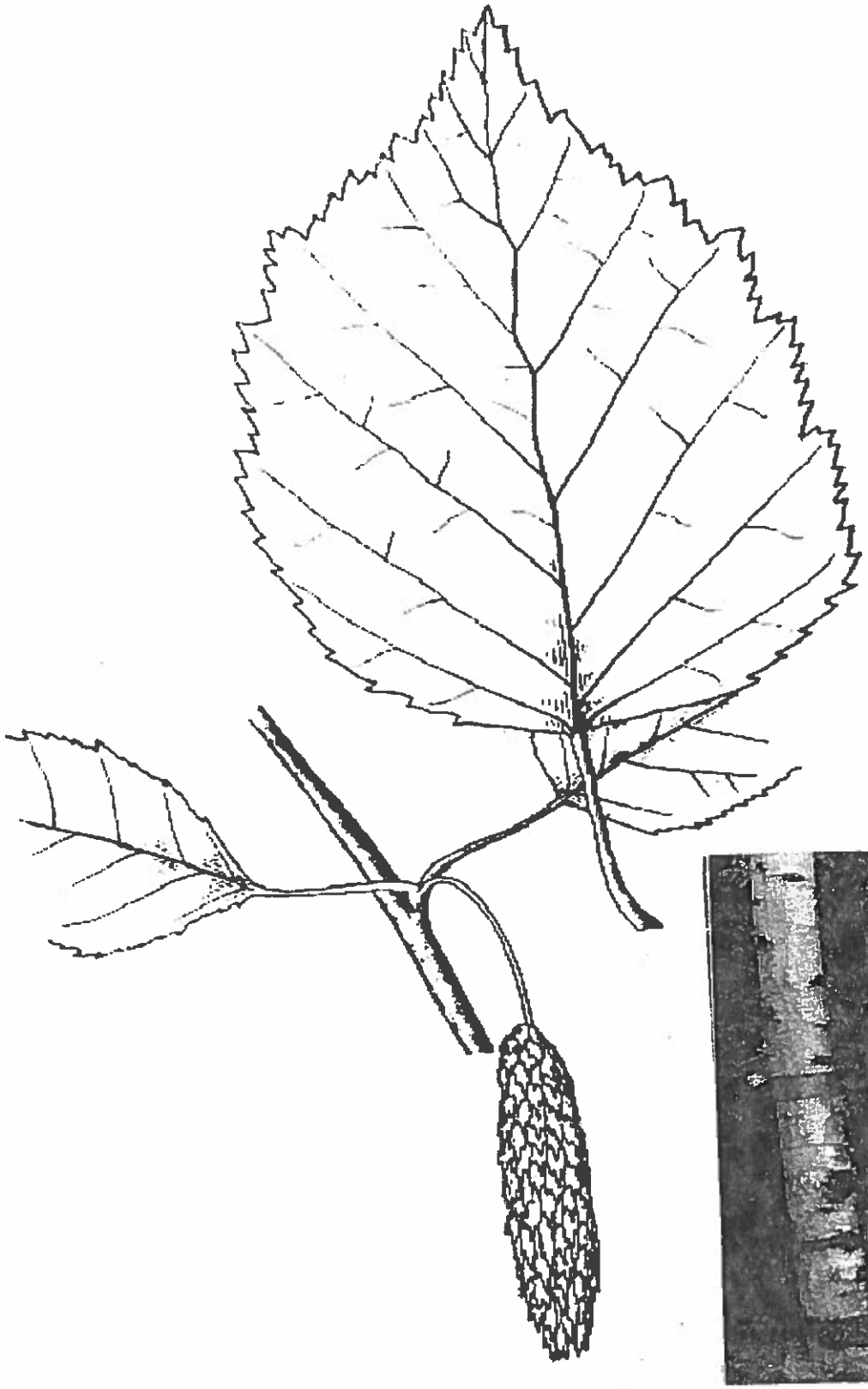




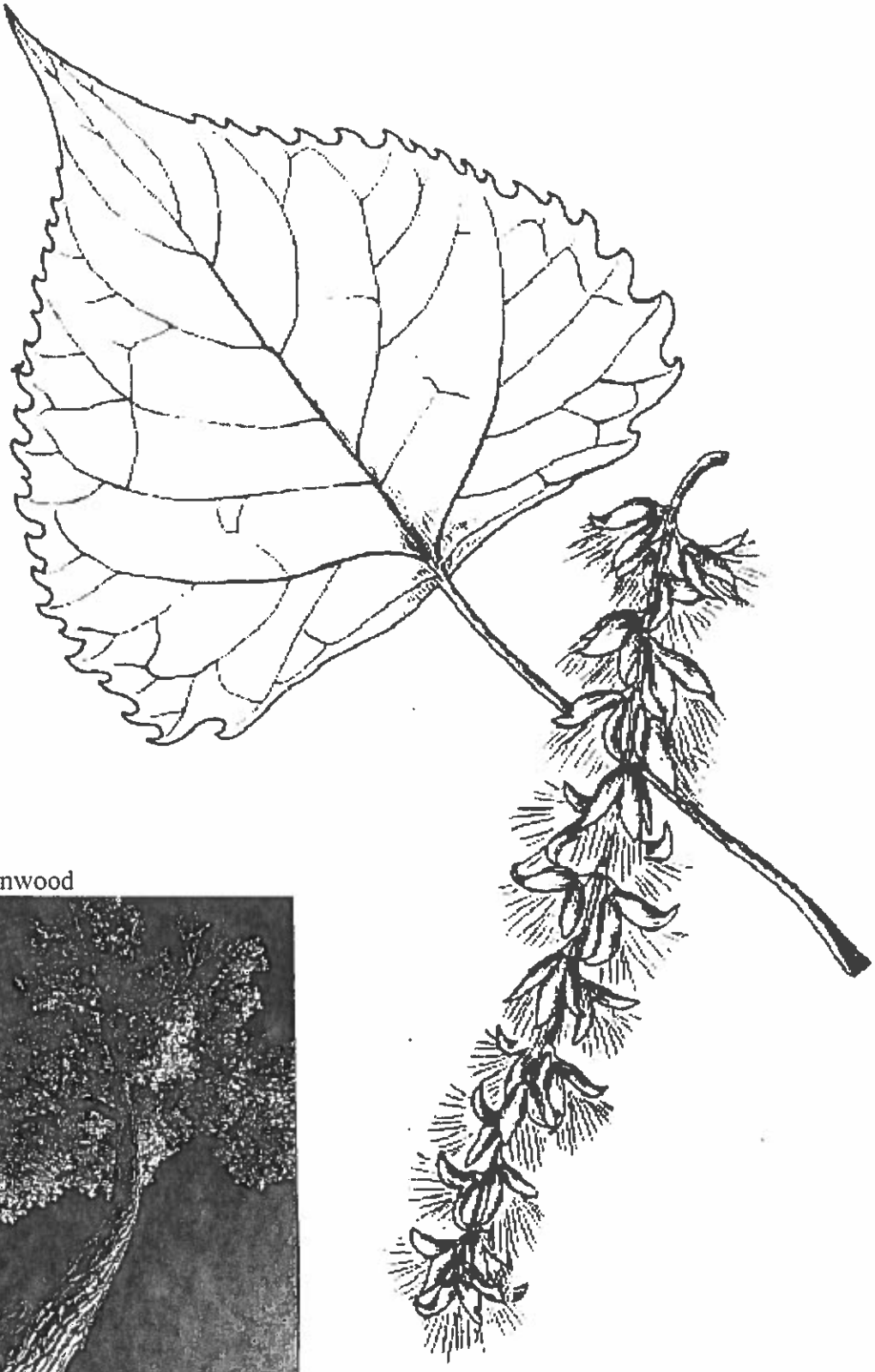
Elm Leaf



White Birch Leaf

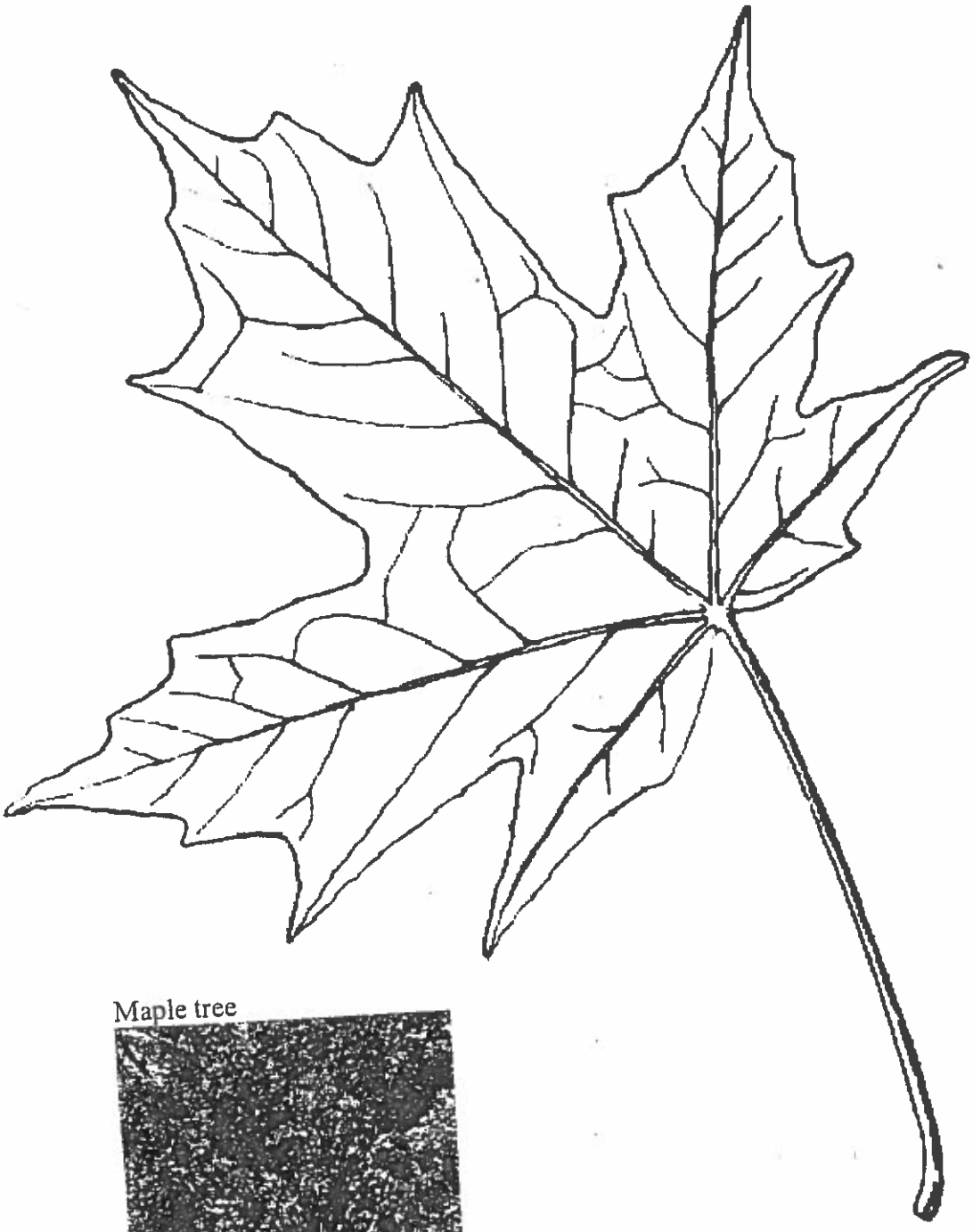


Cottonwood

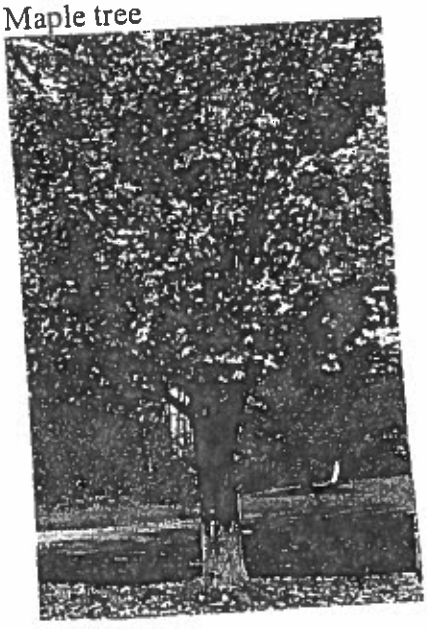


cottonwood

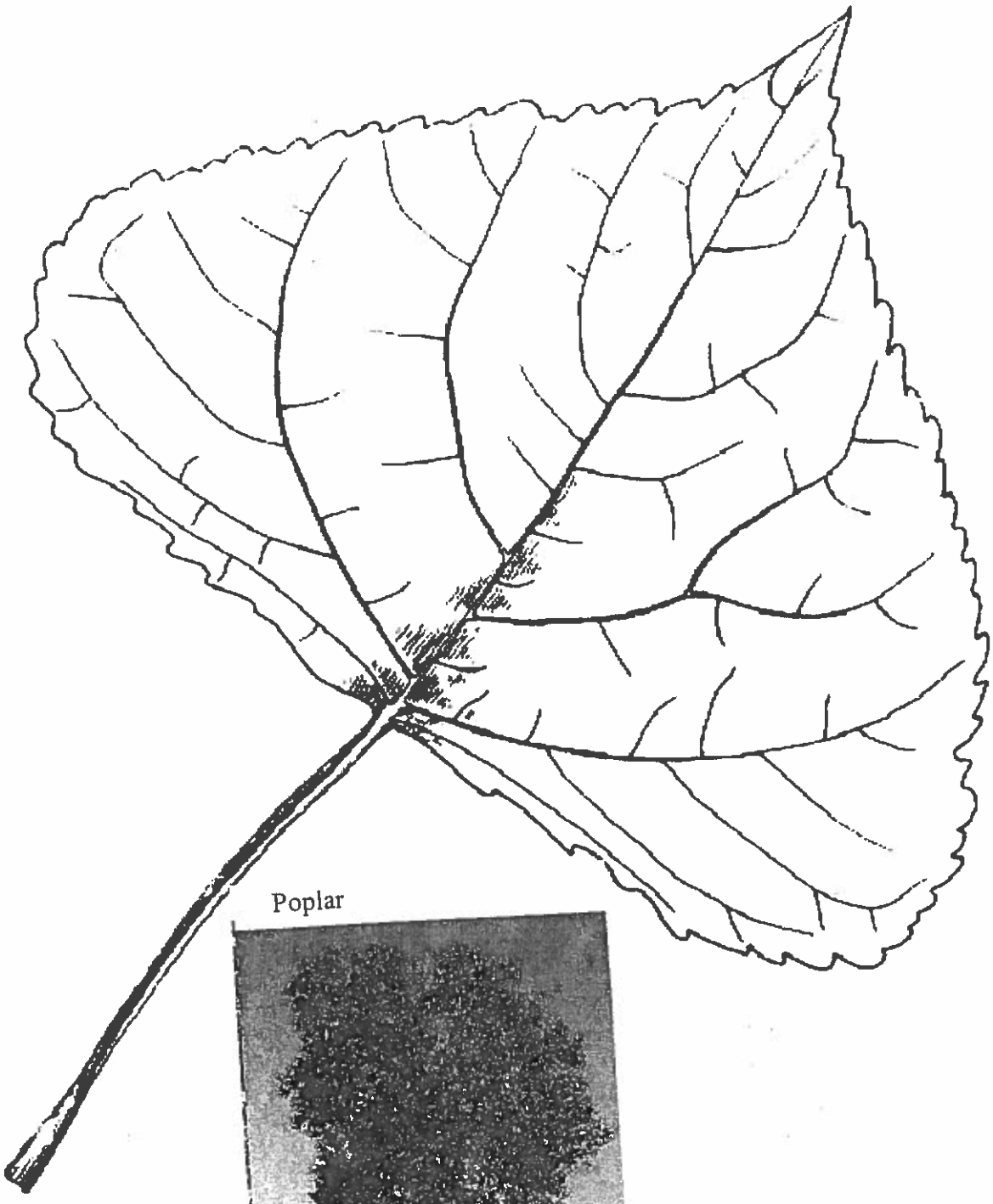
Maple Leaf



Maple tree

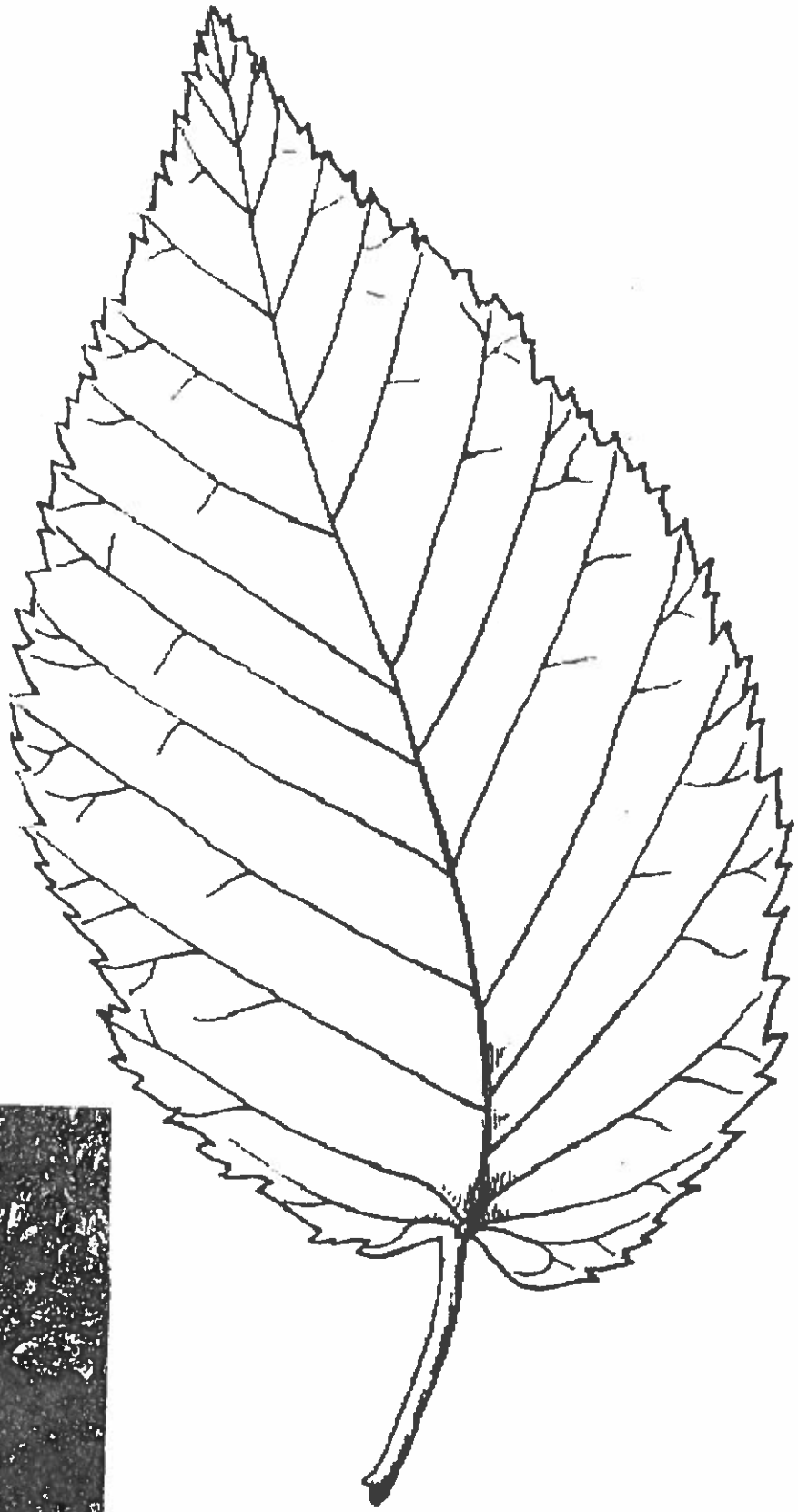


Poplar



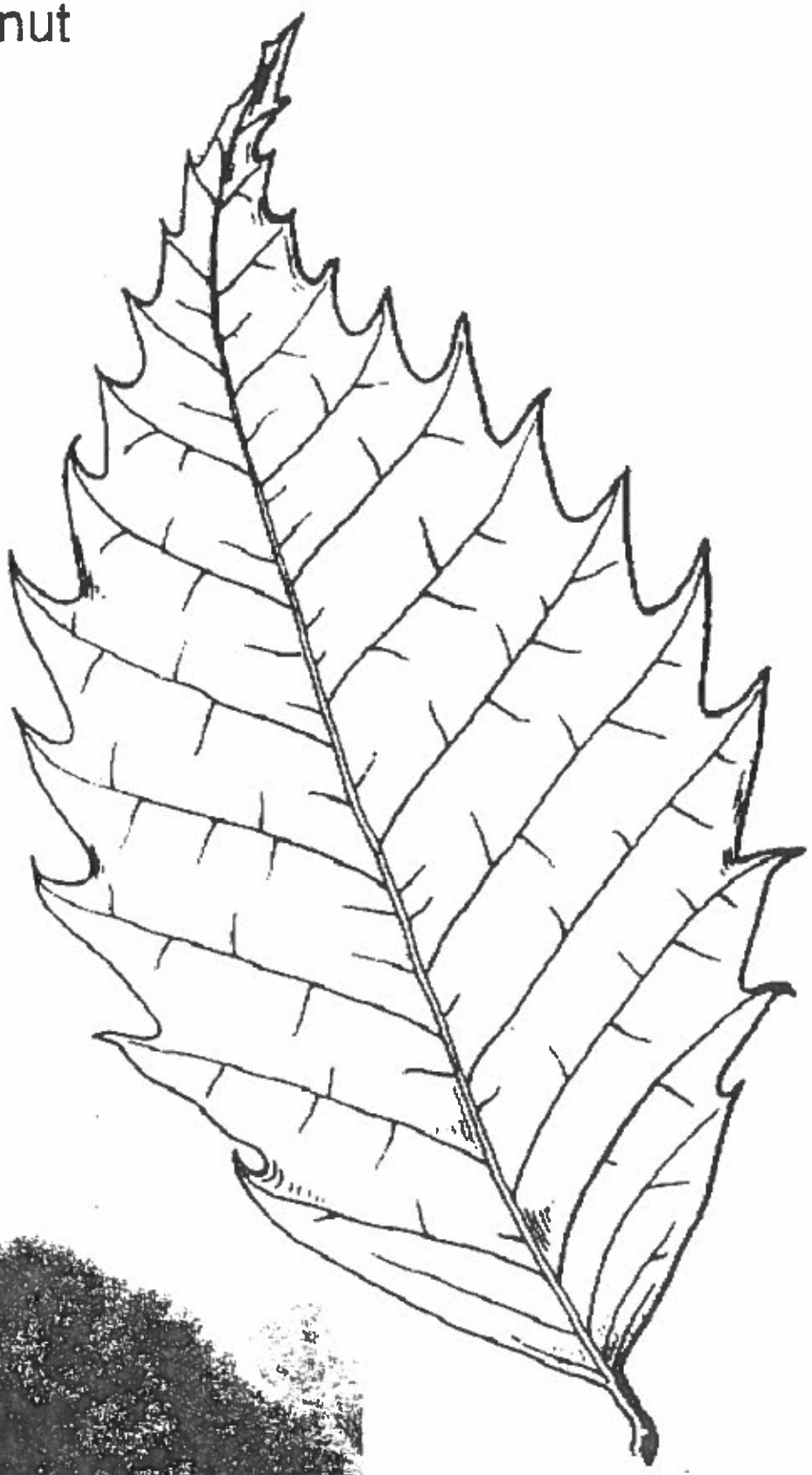
Poplar

Beech

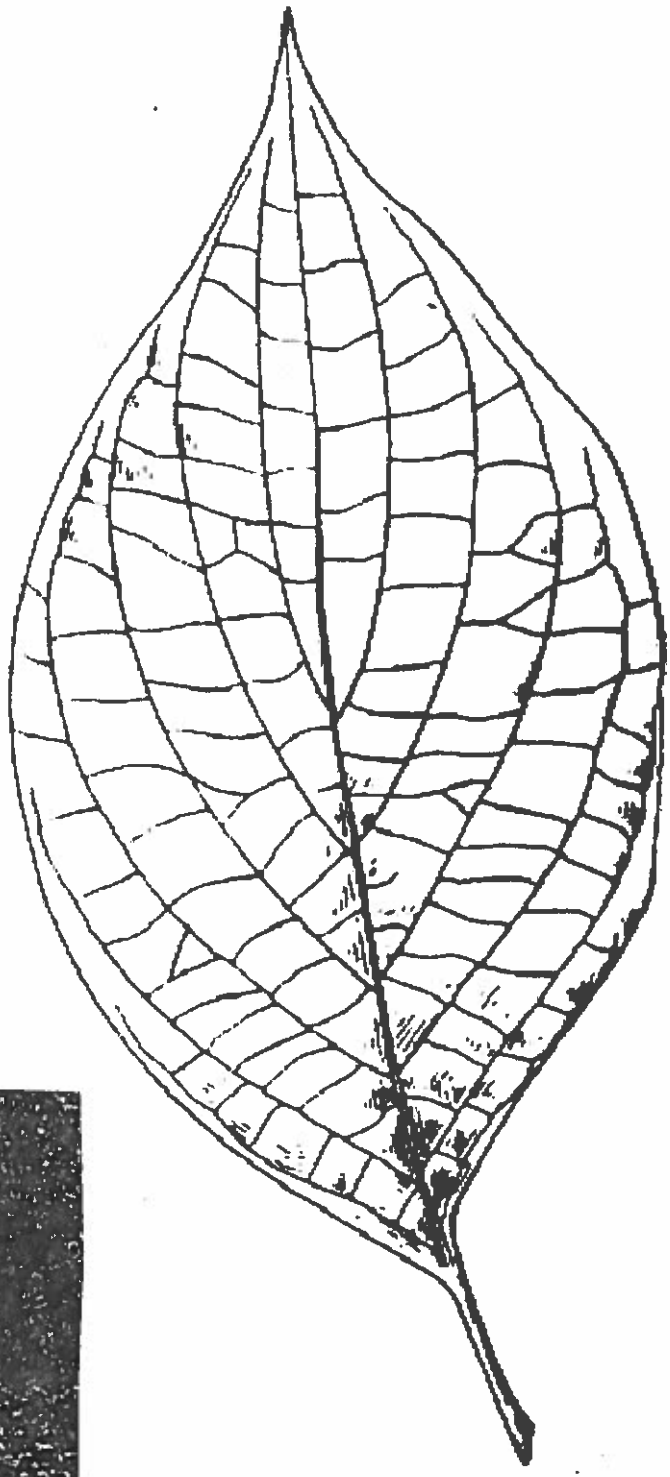


Beech

Chestnut



Dogwood



Dogwood