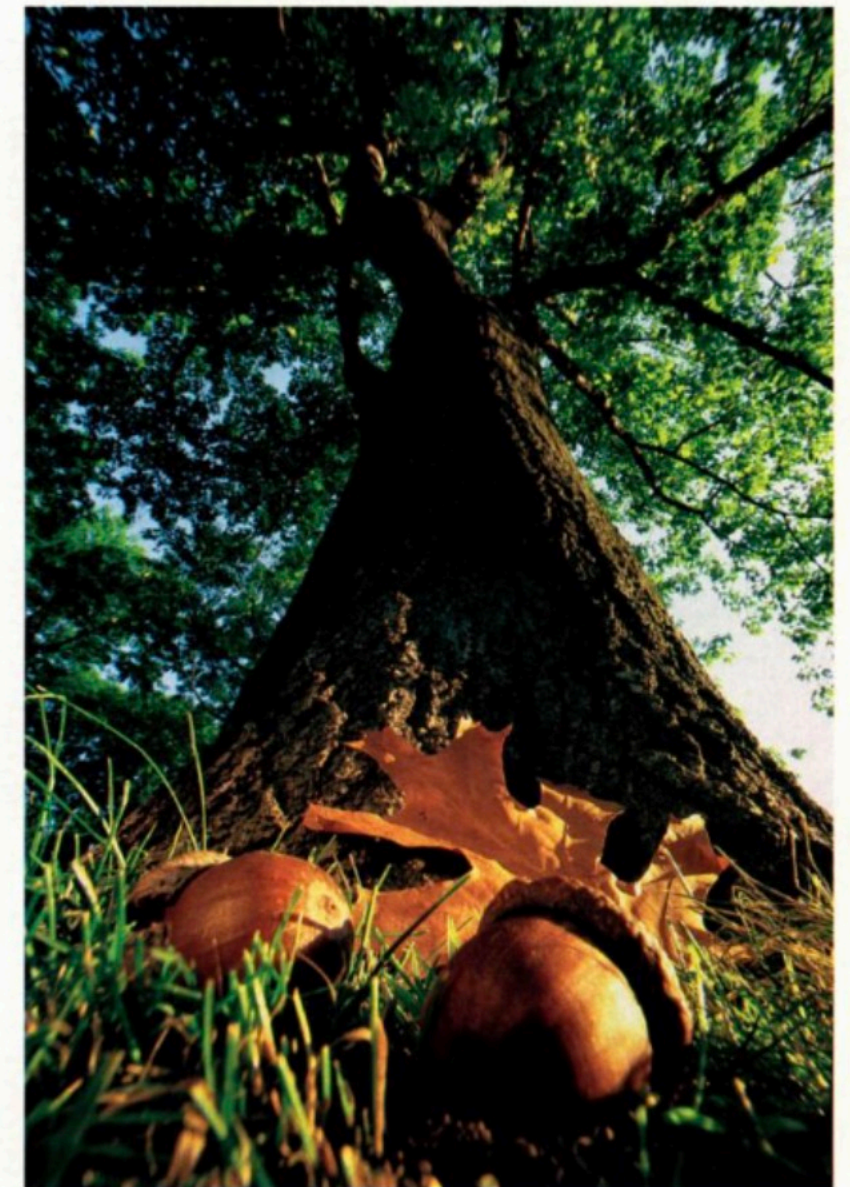




Life in a Nutshell

Article and photographs
by MARK W. MOFFETT

SCURRYING across one nut after another, an acorn weevil searches for a spot to bore into with her snout to feed. Often the first animal to breach an acorn, the weevil strikes while the fruit is still on the tree. As acorns attacked by this and other insects die and decay on the ground, various new animals and plants find their way inside. This community of herbivores, predators, decomposers, and parasites forms a miniature ecosystem in the nutshell. Few acorns escape to become tall oaks.



INTENT on their tasks, scientists tower beside scrub oak trees in the pygmy pine barrens of Long Island, New York (below). The lofty limbs of most oaks put growing acorns out of reach; here, Bob Unnasch must bend over to inspect acorns for weevil damage. Brushing aside huckleberry plants, Robin Stuart checks the ground for hollow shells of decayed acorns occupied by slave-making ants.

As he combs the canopy, Bob shows me half-inch acorn weevils at work. Using tiny teeth at the tip of a long, slender snout, the weevil cuts through the acorn's tough shell. I am amazed to see that as it drills into the meat (facing page),



ing a larger chamber into the acorn—which continues developing until it falls from the tree. The jolt of the acorn hitting the ground often signals a fully grown weevil larva to emerge. It begins by gnawing a circular hole in the shell about the size of its head. Pushing and squirming, the plump body



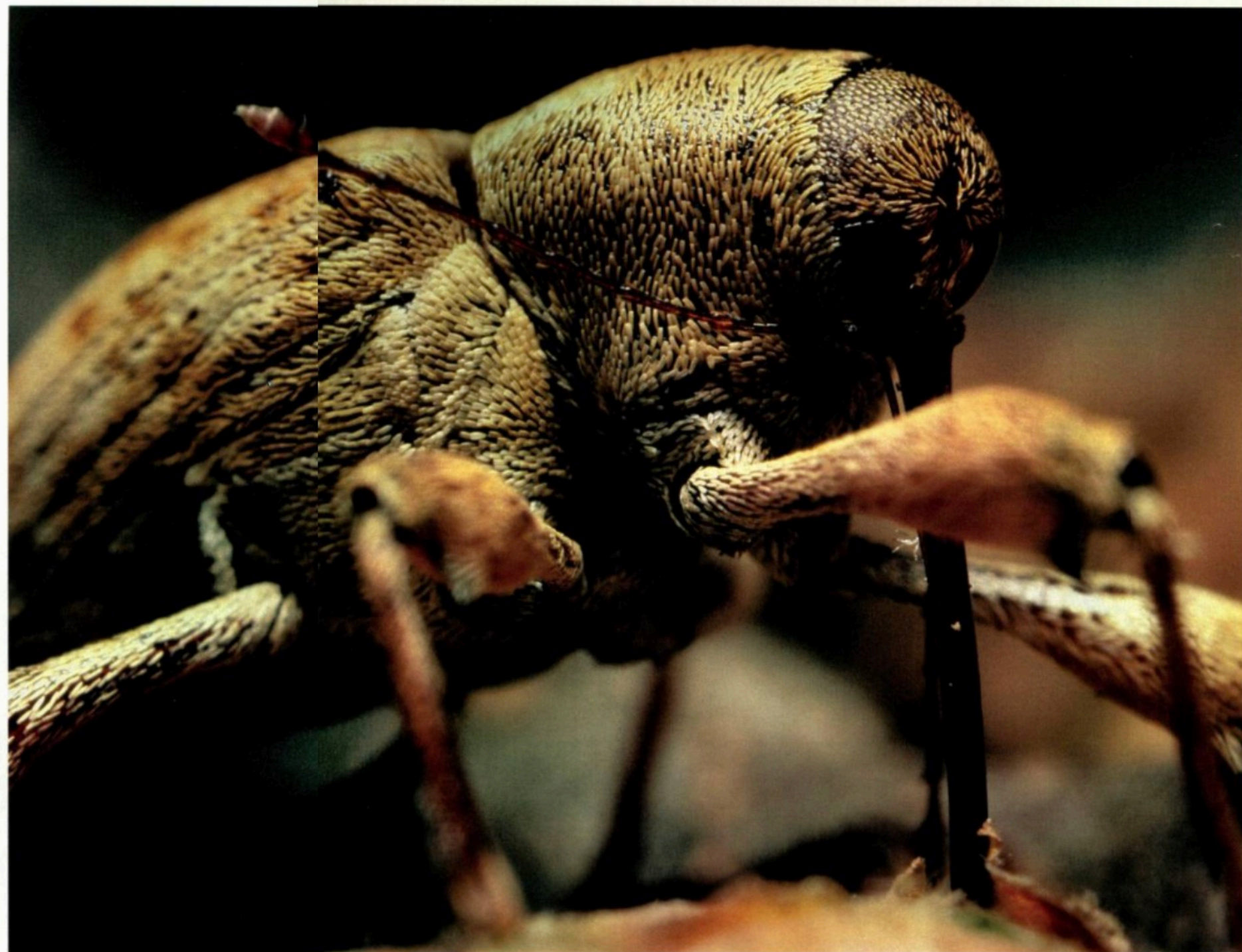
rotating its spherical head back and forth, each eye alternately disappears beneath the "collar" around its neck (diagram, top).

The weevil eats the nutmeat that enters its hollow snout during the drilling, usually stopping only when its head is pressed to the nut's surface. A female's snout, which may be longer than her body, can almost completely pierce small acorns.

MARK W. MOFFETT is curator of the ant collection at Harvard's Museum of Comparative Zoology.

emerges dramatically through this cramped exit (right).

Once on the ground, the larva burrows into the soil, sometimes as deep as 12 inches. There it lies dormant from one to five years. The irregular timing of this resting stage may be the weevil's response to acorn production that varies from year to year in many oak species; some larvae always will pupate and emerge as adult weevils during an advantageous year of a bumper crop of acorns.



A field guide: what to expect and when

CRACK OPEN an acorn and find a world of creatures that make it their home during the nut's growth and decay.

What you discover will depend on the condition of the acorn and its surroundings. Nuts lying on dry, bare ground may not have much to show. A decaying acorn protected by a layer of moist leaf litter is more likely to house a group of interacting individuals.

Acorn weevils and filbert worm moths set upon growing nuts during summer and early autumn; their larvae can be found in acorns freshly fallen from the tree.

As the autumn wears on, increasing numbers of acorn moths, short-snouted weevils, and sap beetles gain access to acorns on the ground through insect holes, cracks, and sprouts. Parasites of specific insects follow their hosts inside. Some acorn varieties that wait until spring to sprout are invaded then.

By summer all of last year's acorns have sprouted or been eaten in part or whole. Dead acorns usually contain a community of creatures, some cleaning out the decay. The husks may shelter animals for years before breaking down into humus.

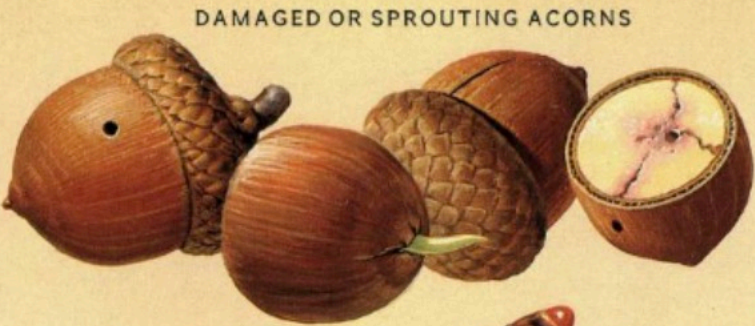
This guide applies to the northeastern United States, where most research on acorns has been done. If you live elsewhere, you

All acorns and pinned acorn weevil life-size; other specimens magnified four times except microscopic specimens. Species match those photographed.



FRESH ACORNS

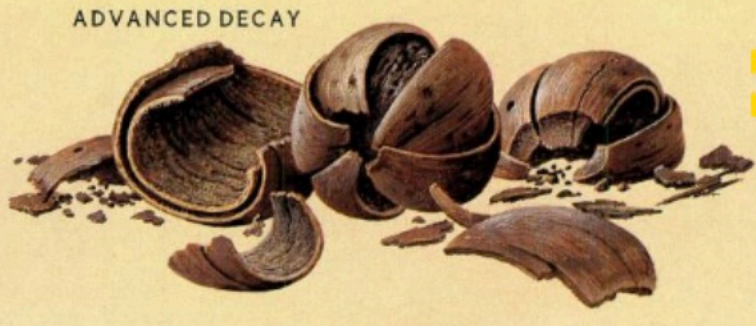
NORTHERN RED OAK
(*QUERCUS RUBRA*)



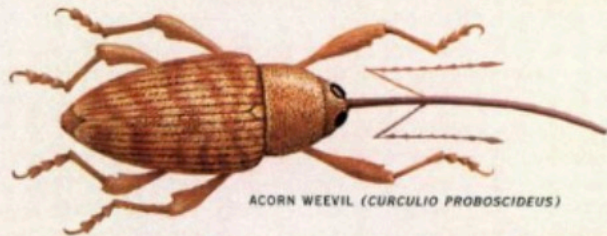
DAMAGED OR SPROUTING ACORNS



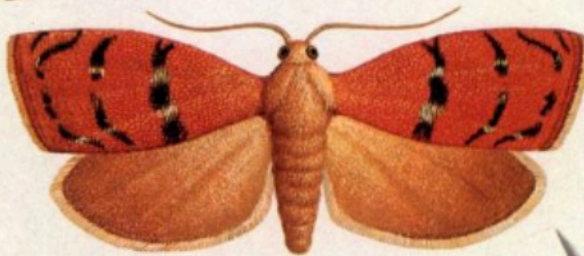
EARLY DECAY



ADVANCED DECAY



ACORN WEEVIL (*CURCULIO PROBOSCIDEUS*)



FILBERT WORM MOTH (*CYDIA LATIFERREANA*)



ACORN WEEVIL GRUB



FILBERT WORM



ACORN MOTH (*VALENTINIA GLANDULELLA*)



ACORN MOTH CATERPILLAR



LARVA OF
SHORT-SNOUTED WEEVIL



SHORT-SNOUTED WEEVIL (*CONOTRACHELUS NASO*)

Acorn weevil lays an egg in its drilled feeding hole; hatched larva feeds on acorn meat. Filbert worm moth lays an egg on the acorn; caterpillar chews through the shell to feed on the meat.

Acorn moth often lays an egg in the opening of a sprouted or damaged acorn; caterpillar feeds on the meat.

Short-snouted weevil feeds and lays an egg in an opening; larva feeds on the meat.



EARTHWORM

Animals that live in the soil, such as the earthworm and sow bug, compost the very decayed acorn.



SOW BUG

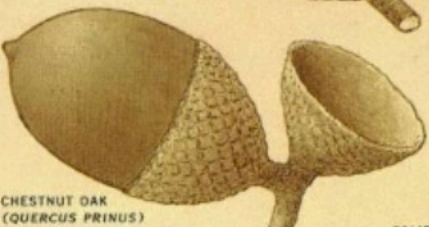
may find many of the same animals pictured here—and probably some new ones. Gather fresh acorns and drop them into a container of water. Most with insect damage will float. Open them to find larvae, or keep them damp in a loosely covered container. Moths, parasites, and other inhabitants will



GALL WASP (*CALLIRHYTIS FRUCTUOSA*)
Eggs are laid in a developing acorn; a gall forms around—and feeds—each larva.



OVERCUP OAK
(*QUERCUS LYRATA*)



CHESTNUT OAK
(*QUERCUS PRINUS*)



CALIFORNIA LIVE OAK
(*QUERCUS AGRIFOLIA*)



PIN OAK
(*QUERCUS PALUSTRIS*)



SAP BEETLE
(*STELIDOTA OCTOMACULATA*)

Sap beetle enters a damaged or sprouting surface. Adult and larvae feed on meat and may remain during early decay.



TACHINID FLY
(*PHYTOMYIA MELISSOPODIS*)



BRACONID WASP (*PHANEROTOMA FASCIATA*)



EULOPHID WASP (*HESOLYNX ISCHNOPTERAE*)

Fungi—shown 40 times life-size—and other microorganisms decompose the acorn and the remains of previous inhabitants.

The acorn ecosystem may include parasites—often wasps or flies—that live off each species pictured above.



SPRINGTAIL

CHEESE MITE

MINUTE FUNGUS BEETLE

BEETLE MITE

MAGNIFIED 40 TIMES



SNAILS



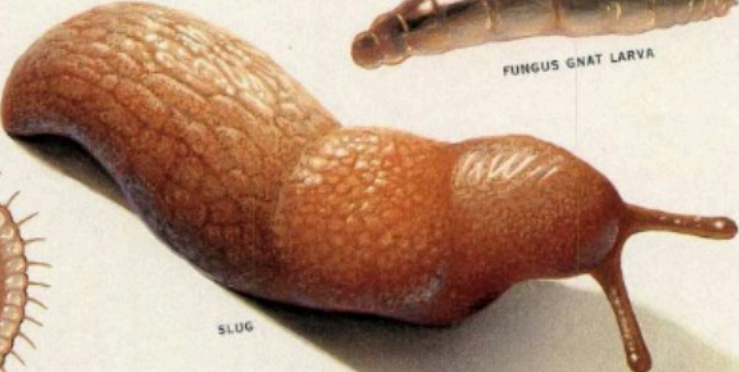
FLY MAGGOTS



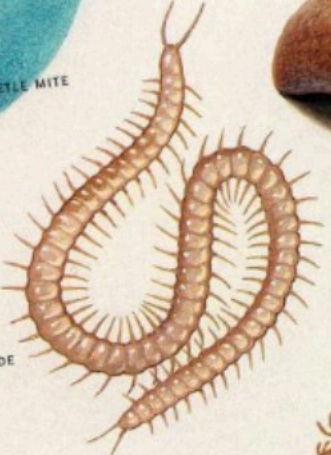
WIREWORM



FUNGUS GNAT LARVA



SLUG



CENTIPEDE

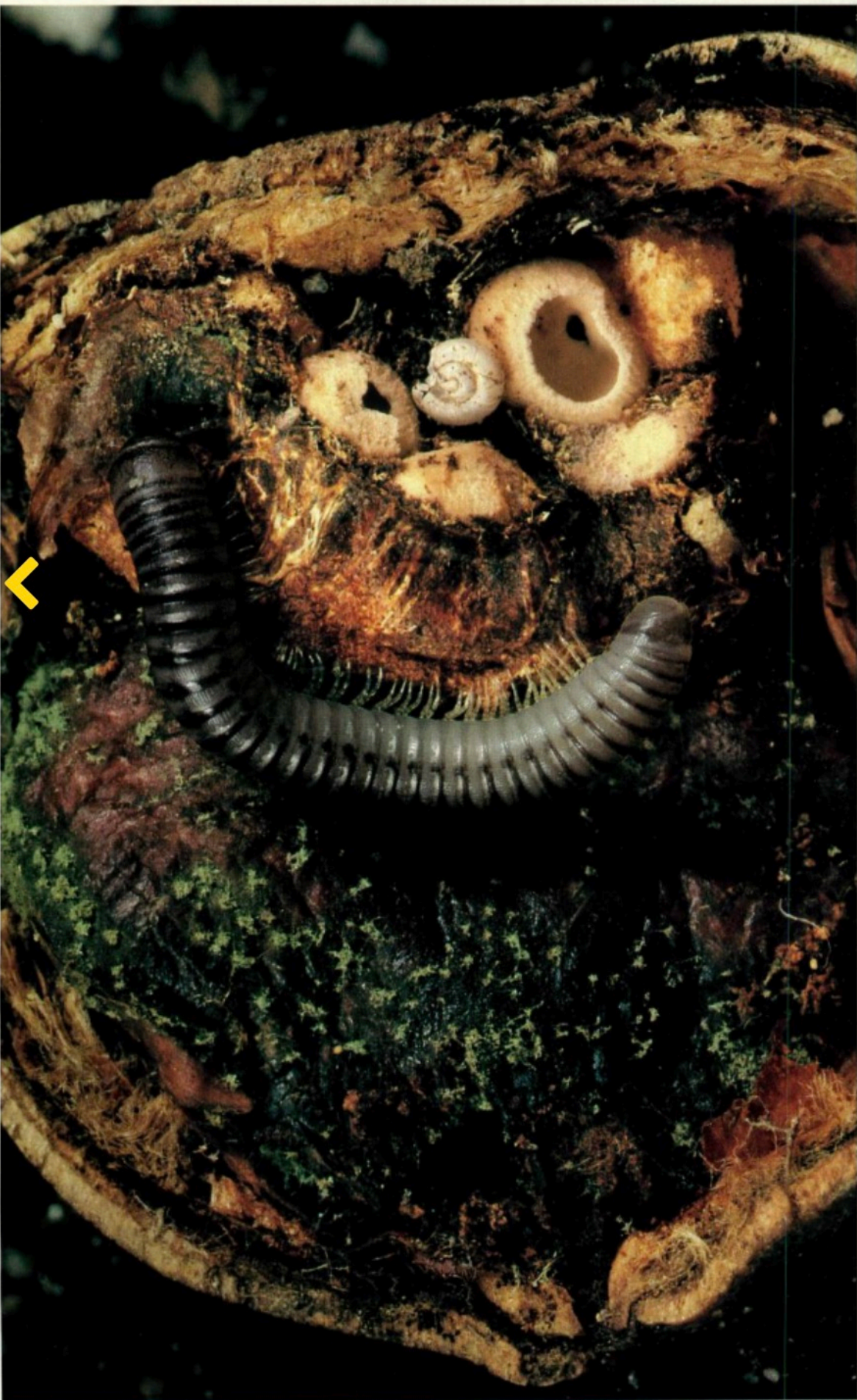


MILLIPEDE



QUEEN ANT WITH SLAVE

Wireworms, springtails, fly maggots, cheese mites, minute fungus beetles, and beetle mites eat the decaying nutmeat and fungi. Millipedes, slugs, and snails scavenge. Predators such as centipedes and some fungus gnat larvae attack other inhabitants. Ants sometimes make a home of the hollowed shell.



ONE OF THE FIRST to invade an acorn, the filbert worm moth presents a fierce visage when seen 40 times life-size. No one knows the purpose of the tiny eye just above the large compound eye.

After a filbert worm gnaws its way inside an acorn, it begins to feed. If it consumes a small acorn, it may move to others in the cluster. After metamorphosis, the moth begins the cycle again, laying an egg on an acorn, a filbert, or another nut.

Like others that take up residence in the acorn, filbert worms are vulnerable to specialized parasites. A braconid wasp will lay her own egg inside that of a filbert worm moth. As the host caterpillar hatches and develops, the wasp larva grows within it, eventually destroying the filbert worm by bursting from its body like a nightmare monster. The tachinid fly operates in similar fashion.

Round holes created by acorn weevil larvae and filbert worms often serve as entryways for other animals unable to breach the shell themselves. Called secondary colonists because they usually follow a first strike, such creatures also penetrate untouched acorns that are broken or sprouted. The short-snouted weevil, for example, hunts for openings, where it then feeds or lays eggs. When startled, it rolls over and plays dead.

Some sap beetles can detect damaged acorns from a distance, often swarming in and quickly destroying them. Although partial to tender acorn sprouts, sap beetles unleash their large appetites on a variety of plants. The one pictured even briefly gnawed at a spider's egg case inside an acorn.

As acorns die, more animals move in among remains of former inhabitants. Breaking open

a large acorn, I find a millipede eating detritus near pale galls (foldout, left). Holes in the galls indicate that gall wasp larvae have matured and adult wasps have left the acorn. A new species of eulophid wasp surprised me by emerging from a similar gall. Apparently it is a

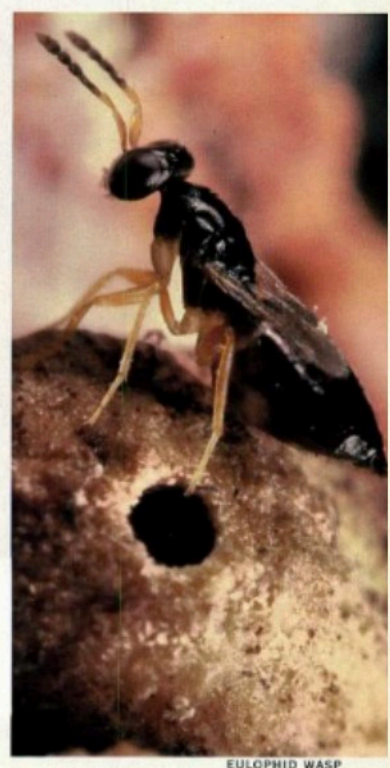


FILBERT WORM



BRACONID WASP

parasite of the gall wasp larva. At the other end of the shell, green fungus grows into the decaying meat. Hidden in crevices, minute springtails and maggots feed on both. I also find refuse of a weevil grub, a moth pupal skin, and broken snail shells—clues to the lives of a series of inhabitants that made up the history of this acorn.



EULOPHID WASP



HEAD OF FILBERT WORM MOTHS



TACHINID FLY



SHORT-SNOUTED WEEVIL



FILBERT WORM MOTHS



SAP BEETLE





HOW LONG an acorn survives invasion depends on its size and the sequence of insects involved. One acorn weevil larva or filbert worm can completely consume a small scrub oak acorn, for instance, but often will eat only part of a large acorn from a red oak.

The acorn moth, found in the eastern U. S., often lays eggs in nuts damaged by these two insects. After a caterpillar hatches, it creates a web across the opening in the shell, which keeps competitors out. It may then finish the contents, leaving a home neatly emptied of everything but frass—insect droppings (bottom left).

Wintering in the shell, some caterpillars emerge in the spring and find a sprouting acorn to continue feeding on. These insects do little permanent damage, since they confine meals to the meat near the cap. As long as the plant embryo at the pointed tip remains undisturbed, the acorn can produce a seedling.

While it lives, the acorn offers inhabitants a comfortable refuge. It protects them from most predators, shelters them from weather, and keeps them moist, cool, and away from sunlight. It also provides a diet rich in fats and carbohydrates.

Once dead, acorns contain plenty of pickings for scavengers. Lifting the cap off one rotting nut, I find the cocoon of a parasitic wasp alongside several snails (top left). The size of pinheads, the snails are browsing in pits that may have been chewed out by an acorn moth caterpillar while the nut was still alive. A close look at one snail in another acorn reveals an even more minute resident: a beetle mite (top center) with a bivalve shell that allows it to close up like a clam for protection. Soft, decaying acorn meat,



now interlaced with fungus, feeds snails and mites.

With their variety of scavengers, decaying acorns make ideal hunting grounds for carnivores. A fierce predator, this centipede (below) roams through one acorn after another in search of prey. Waiting on its web, a fungus gnat larva (right) will feast on the unwary insects that the poisonous strands kill on contact.





IN THE PALM of my hand I hold part of a tiny ant colony: three *Myrmica* workers tending a brood (left). Gently, so as not to disturb the inhabitants, I have broken this fragment from a hollow acorn filled with about 50 adults and their young. This species of ant often expands the colony into nearby nutshells when space gets tight. Although they may live in different quarters, colony members recognize one another by scent.

In another shell I find a society of slave workers, *Leptothorax*, attending to slave-making *Harpagoxenus* ants. A red slave grooms the large, black, slave-making queen, while others in the background groom and carry larvae (bottom center).

A slave-making worker's sole duty is to raid nests of slave species. Releasing a pheromone that confuses adult ants in the colony under attack, slave makers seize young and take them back to their own nest. When they mature, captured ants imprint on the slave makers and treat them as kin that need to be cared for. Receiving no benefits, the slaves gather food, tend the queen, nurse slave makers' young, and tidy up. As slaves die and food gets low, slave makers raid more often.

Hollow acorns may house other animals, large and small. A slug occupies almost the entire chamber of one nut I slice open (bottom far left). I find no major entryway in the shell—yet the slug must have squeezed in somehow. Able to stretch its body 11 times normal length and become correspondingly thinner, a slug can get through incredibly tight spaces.

At the other extreme, a minute fungus beetle (left) about the size of the period at the end of this sentence feeds on a fungus bed between the layers of an acorn shell.





Never satisfied, they move the hoards around each night. The mice rely on smell to locate the acorns underground—seemingly unaware of where they last dug—and thus constantly steal from one another. When Bob Unnasch buried a thousand marked acorns, mice had moved every one by the next morning.

More than 80 North American birds and mammals—from wild turkeys, bobwhites, and wood ducks to bears, deer, and gray foxes—include fresh acorns in their diet. Some collect right from trees. Others must wait until the nuts fall to the ground.

In addition to mice, a number of animals bury what they harvest. Magpies and jays create small hoards by poking acorns into the soil. Gray squirrels bury individual acorns as well as groups of hundreds, called larder hoards. Animals eat most of what they store, drawing their sustenance from the energy-packed part of the nut meant to nourish a new plant.

But hoarders sometimes lose track of the acorns they bury, leaving a few underground. Though termites or fungi may strike, the soil protects the nuts from foraging insects and larger animals above. Kept damp and cool, these acorns have a much better chance to take root and grow than those that remain exposed on the ground.

On a seedling that I dug up in Massachusetts (left), the remnant of a buried acorn hangs from the stem by a filament—evidence that some animal unwittingly helped nature renew a stand of sturdy oaks. □



POISED on a scrub oak branch, a white-footed mouse plucks an acorn from its cap. Most probably the nut will wind up as a winter meal. But it just may be that one, among many thousands, destined to sprout and carry on the species.

In the pygmy pine barrens of Long Island, mice subsist mostly on insects during the warmer months. In an autumn scramble, they bury small caches of one to three acorns, called scatter hoards, in preparation for the approaching cold weather.



JUST SAY NO.

America is hooked on foreign oil. Today, we import almost 40 percent of the oil we use—even more than in 1973, when the Arab embargo plunged us into gas lines, rationing, and recession.

The more we can use nuclear energy, instead of imported oil, to generate electricity, the less we have to

depend on foreign nations.

The 110 nuclear plants in the U.S. have cut our foreign oil dependence by over three billion barrels since 1973. And they have cut foreign oil payments by over one hundred billion dollars.

But 110 nuclear plants will not be enough to meet our growing electricity demand. More plants are needed.

To help kick the foreign oil habit, we need to rely more on our own energy sources, like nuclear energy.

For a free booklet on nuclear energy, write to the U.S. Council for Energy Awareness, P.O. Box 66103, Dept. SN04, Washington, D.C. 20035.

U.S. COUNCIL FOR ENERGY AWARENESS

Nuclear energy means more energy independence.