VOL. 140, NO. 2 AUGUST 1971

NATIONAL GEOGRAPHIC

OFFICIAL JOURNAL OF THE NATIONAL GEOGRAPHIC SOCIETY WASHINGTON, D.C.

What's So Special About Spiders?

By PAUL A. ZAHL, Ph.D.
NATIONAL GEOGRAPHIC SENIOR SCIENTIST

SPIDERS DO NOT INTIMIDATE Dr. Willis J. Gertsch. When I visited him in his studio-laboratory at the foot of the Chiricahua Mountains in southeastern Arizona, he dumped a live tarantula from a glass jar onto the top of his desk. The gray-brown, eight-legged shaggy thing—nearly the size of my fist—was clearly the stuff of which bad dreams are made.

"During a lifetime with spiders," reflected the scientist, his bare fingers guiding and restraining the restless creature, "I've been bitten by tarantulas of a dozen different species. And as you see, I'm still here and in moderately good health."

The big furry spider prowled inquisitively across the back of his hand. "Regardless of old Hollywood horror films," Dr. Gertsch continued, "a tarantula bite is hardly worse than a bee or wasp sting, unless you happen to have a particular allergy. As a matter of fact, some ants, bees, and wasps are far more dangerous. But it's the spiders that always make the headlines."

Dr. Gertsch had a point. Spiders are among the most feared and maligned of nature's smaller creatures—and among the most fascinating. An incredible number of species inhabit the world, but only a dozen or so can be dangerous to man. And, on the other face of the coin, nearly all do their part in keeping incalculable hordes of harmful insects in check.

Wind Wafts Spiders Far Out to Sea

One finds spiders almost everywhere—four miles up in the Himalayas, in below-sea-level deserts, in tropical treetops, and burrowed into the earth. Mariners have even sighted them far at sea, drifting on the wind, suspended from threadlike "parachutes."

The average life of a spider spans only a year, yet a tarantula may live as long as three decades, and take eight to ten years to mature. Most spiders lead solitary lives, but a few are social, with many individuals sharing a common web. Some species are as small as pinheads, others the size of dinner plates. Though many people think of spiders as insects, they are more closely related to ticks, scorpions, and, remotely, to horseshoe crabs.

But chief among the marvels of the spider is its mastery of spinning. I have watched

Spurred by hunger and guided by instinct, a garden spider wraps a grasshopper in a shroud of silk. The efficient predator has killed the insect with a bite and now will dine on its juices. Spiders have changed little from their ancestors of hundreds of millions of years ago; they differ from insects in that they possess eight legs instead of six, and have neither compound eyes nor antennae. Essential to the balance of nature, the world's spiders—averaging at least 50,000 per acre in green areas—annually destroy a hundred times their number in insects. Scientists have named more than 30,000 species and estimate that four times that many remain unclassified.

ARGIOPE AURANTIA, 5 TIMES LIFE-SIZE, TROPICAL AND TEMPERATE REGIONS; BY JANICE HEALEY © N.G.S.

human lacemakers work a spider-web motif into handkerchiefs, napkins, and tablecloths, but the result is clumsy compared to nature's often exquisite products.

Oddly enough, though, Greek mythology attributes the spider's skill to human origins. An artful weaver named Arachne impudently challenged the goddess Athena to a contest. Later, shamed and mortified by her own conceit, Arachne hanged herself. The goddess, in a moment of compassion, brought Arachne back to life, transformed her into a spider, and made her noose into a web.

"Live," Athena commanded, "... and that you may preserve the memory of this lesson, continue to hang, both you and your descendants, to all future times." And so the name of that superb classical spinstress has been perpetuated by scientists: Arachnologists like Dr. Gertsch study the class Arachnida and the order Araneida—spiders as a group.

Dr. Gertsch amiably coaxed his eight-legged friend back into its jar. Then the scientist, retired after many years as curator of spiders at the American Museum of Natural History in New York City, gave me a quick refresher course on arachnid evolution.

"Spiders' bodies and habits have become adapted to harvesting insect food supplies in a multitude of habitats. Most hunting spiders prowl on the ground, relying mainly on strength. Keen-sighted wolf spiders and jumpers use sheer speed in overtaking prey. Aerial

(Continued on page 198)

6 1/2 TIMES LIFE-SIZE, TROPICAL AND TEMPERATE REGIONS; BY JOHN A. L. COOKE (ABOVE) AND PAUL A. ZAHL © N.G.S.

"Murderous biting robber": The translation of the black widow's scientific name, *Latrodectus mactans,* attests to the infamy of the little weaver (**above**). This most dangerous of spiders usually bears a red hourglass marking on its underside (**left**). One of about a dozen species that need be feared by man, it occurs commonly throughout most of the United States.

The black widow's venom—more potent drop for drop than a rattlesnake's—causes intense pain. Deaths, however, occur from only four or five of the more than 1,000 bites reported in the U. S. each year.

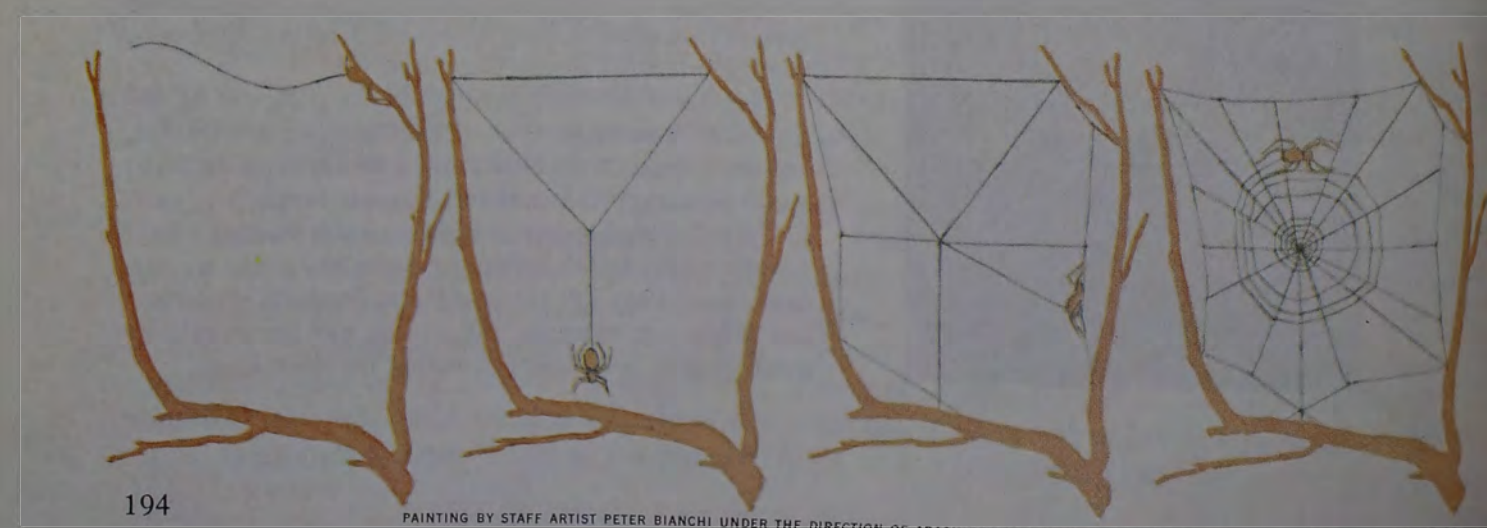
Only the female black widow causes human fatalities. Contrary to the belief that gave her the name, she does not always kill the much smaller male after mating. If hungry, however, the widow, like the females of most spiders, will resort to eating her own kind.

Nature's master spinner

SPECIALIZED TOOLS *of survival set spiders apart from all other creatures in the animal kingdom. Silk and the way spiders use it head the list of adaptations that have helped them weather eons of environmental change. A black-and-yellow argiope—a common garden spider—serves to illustrate:*

Pocked with tiny openings, the six spinnerets at the rear of the abdomen **(inset A, above)** *control and shape the silk, a liquid protein that solidifies when drawn from the body. With its silk glands, the spider can produce either dry or sticky fibers as thin as one-millionth of an inch.*

The mouth lies concealed beneath two hairy lobes at the base of leglike feelers called pedipalps **(inset B)**. *After killing or paralyzing prey with venom, the spider crushes its victim between lobes and jaws.*



As the body juices are sucked up, lobe hairs filter out solid particles.

Curved claws and thick barbed hairs at the tip of each leg (**inset C**) *permit orb-web spiders to race across silken lines. They avoid entanglement in their own snares by walking only on the dry radial strands and shunning the sticky spiral threads.*

The spider tugs thread from the spinnerets by snagging it with the saw-tooth hairs and gripping with the bent median claw. The faster silk is drawn from the body, the stronger it becomes.

An orb weaver uses the wind to set the bridge line of its home (**far left**). *Dropping from the center of a second strand stretched across the gap, it anchors a vertical thread and quickly secures more radial lines. Then, starting from the hub, it puts down a temporary dry-thread spiral. That done, it reverses direction and lays down a new one of sticky insect-trapping silk, while rolling up the first spiral.*

Often lovely, always functional, the silken traps fashioned by spiders give them a clear advantage over their insect prey.

Unlike her cousins who patiently wait in their webs for dinner to arrive, the ogre-faced spider (**left**), lassos her victims with a sticky net of parallel threads. Controlling it by lines held with her front legs, the nocturnal lurker spreads and flings the snare whenever an unsuspecting insect approaches her hiding place. The grotesque face that prompted the spider's name is not visible in this photograph.

Interior decorator of the spider world, silver argiope (**below**) rests head downward at the hub of her nearly three-foot-wide home. Weaver of one of nature's most perfect webs, she adorns the middle section of her geometric masterpiece with crossed zigzag bands; their function remains a mystery.

Beaded by morning dew, an orb web (**right**) rivals the beauty of the finest strands of pearls.

BY LARRY J. WEST

DINOPIS SPINOSUS (OPPOSITE) 4 TIMES LIFE-SIZE, SOUTHEASTERN U. S.; BY JAMES A. KERN;
ARGIOPE ARGENTATA (ABOVE) 3/4 LIFE-SIZE, NEW WORLD TROPICS; JOHN A. L. COOKE © N.G.S.

Goliath among spiders, an American tarantula calmly submits to a close-up inspection by Arizona collector Lorin Honetschlager and his daughter Julie.

New World tarantulas—unrelated to Europe's *Lycosa tarentula*—retain features of the most primitive spiders: four lungs, jaws that move vertically instead of horizontally, and minimal use of silk. Some have legs spanning nearly ten inches, making them the world's largest spiders. Despite their formidable appearance, American tarantulas pose no danger to man.

spiders have devised three-dimensional webs within which they hang upside down (page 219), mazes of lines to entrap crawling insects, and sheets and aerial tangles to intercept jumping insects. And the orb weavers spin round geometrical webs that efficiently entangle flying or jumping insects."

Dr. Gertsch's own favorites are the more primitive spiders: American tarantulas, trapdoor spiders, purse-web spiders, and the most primitive of all, the liphistiids, little changed since Carboniferous times, some 340,000,000 years ago.

Walking Factories Produce Varied Silks

In my own exploration of the spider world, I found myself endlessly fascinated by the orb weavers. The raw material of their gossamer creations—a complex protein substance—is manufactured by five or six special glands in the spider's abdomen, each producing its own variety of silk. Acting separately or in combination, these glands supply dry or sticky threads for lines, cables, and attachment disks for webs; egg sacs; anchor lines; and swathing bands to bind prey.

The precise form of the filaments is determined by spinnerets—clusters of tiny nozzled jets from which the spider draws the silk with its hindmost pair of legs. The resulting strands of spider silk are incredibly elastic and tough—some can stretch more than 20 percent and are stronger than steel wire of the same diameter!

For all its beauty and dewy sparkle, the spider web is a diabolical achievement. To be sure, heavy insects like beetles and wasps, blundering into the snare, are apt to rip right through. But for lighter prey, the sticky, almost invisible network means death.

When delicate touch receptors pick up the slightest impact of an insect on the web, the spider skims across it to paralyze the victim with a single bite and binds it with silk (page 191). The hapless insect will either be eaten summarily—the body sucked dry of its nutritious fluids, the remains discarded—or left hanging in its mummylike wrapping for a future meal. In his classic work *The Life of the Spider,* J. Henri Fabre puts words into the mouth of a simple garden spider, "We must eat to have silk," the spider exclaims, "we must have silk to eat. . . ."

Instinct alone controls the weaving. But alter ever so slightly the spider's internal chemistry, and the web will show it. I saw this demonstrated one morning in the laboratories of North Carolina's Department of Mental Health, which experiments with spiders in one phase of a search for diagnostic clues to various mental illnesses (pages 200-201).

Within an aluminum frame an orb weaver was performing a sequence of rapid runs, ascents, and descents. Tattered remnants of an earlier web stuck to one edge of the frame.

"Every morning we make her spin a new web," said Mrs. Mabel Scarboro, a research assistant. "In the wild, a web seldom lasts more than a day or so; it's ripped by wind, or insects, or even the movement of the spider itself. Even though we feed this one, her instinct tells her to keep her web in good repair or she'll starve."

In half an hour a completed web filled the frame. It was a circular marvel of straight lines, angles, and more than 800 individual

Cautious but eager to perform his mission in life—mating—a male tarantula warily approaches the attack-ready female at extreme right. Leglike palpi carry sperm, transferred from a pore on his underside.

He advances with spurred forelegs poised. The female rears on her back legs, raising awesome fangs to deliver a death-dealing bite. But before she can strike, the male's forelegs shoot up, catching the fangs with his spurs. Thus protected, he forces her upward, exposing a furrow on her abdomen in which he deposits the sperm from his palpi (**below**).

APHONOPELMA CHALCODES, SOUTHWESTERN U. S.; BY PAUL A. ZAHL (OPPOSITE) AND JOHN A. L. COOKE © N.G.S.

Drug trips for science: Web weavers perform in the laboratory of the North Carolina Department of Mental Health at Raleigh. Research Director Dr. Peter N. Witt and his associates permit a spider to construct her normal orb web (**left**). Then they apply a drop of "speed"—the stimulant dexedrine sulphate—to the creature's mouth (**right**). Allowed to build another web (**center**), she spins an erratic, irregular copy. Taking information from photographs of normal and dexedrine-influenced webs (**bottom**),

ARANEUS DIADEMATUS, NORTHERN HEMISPHERE; BY VICTOR R. BOSWELL, JR. © N.G.S.

Dr. Witt and his assistant, Mrs. Mabel Scarboro, feed the data into a computer that compares 600 selected points.

Such research reveals that each drug tested produces consistent, characteristic changes in a spider's web-weaving activity. Amphetamines and barbiturates cause irregular webs; tranquilizers and marijuana, small webs; and LSD, more symmetrical webs—apparently because the drugged spider is less distracted by outside influences.

By observing the effects of drugs on spiders, scientists hope to learn more about human biochemistry.

attachments, all engineered with mathematical precision.

Another spider of the same species was busy spinning in a duplicate frame alongside. Earlier, this spider had demonstrated its ability to weave a regular, symmetrical web. But now it had been fed a droplet of sugar water containing "speed"—dexedrine sulphate.

Mrs. Scarboro sprayed the two webs with quick-drying white paint to make the threads stand out clearly. Then I saw the strange angles and illogical backtrackings in the weaving of the drugged spider. Laboratory measurements would record angles, affixment points, number of spokes, and other data for computer analysis.

Experimenters have found that different drugs—caffeine, mescaline, and LSD, for example—produce characteristic variations in a spider's web.

Some human mental illnesses seem to be accompanied by biochemical changes in the blood or tissue fluids. Could such fluids, administered to a spider, measurably influence its weaving patterns? If so, spiders might perhaps be able to tell us—through the varying patterns of their webs—the particular illness affecting a patient, or even his progress under psychiatric treatment. This is only one potential of the experiments, which are still in exploratory stages.

Spider Responds to Strange Vibrations

Researchers are on more certain ground in the field of normal spider behavior. Dr. Peter N. Witt, distinguished research pharmacologist and director of spider investigations at the North Carolina laboratory, repeated an experiment for me.

He tapped a tuning fork and touched it gently to a web tended by an *Argiope*. Instantly she rushed across the strands and furiously assaulted the quivering metal. With her legs she pulled a silken stream from her spinnerets, and in seconds the cold prongs were bound tight.

"A slave to innate behavior patterns," said Dr. Witt. "Spiders can't alter their reactions, can't discern or evaluate subtle changes in external influences. The vibration of a tuning fork or a thrashing insect—it's all the same to them."

Perhaps even more instinct-bound than the orb-web spiders are two enemies I encountered while spider hunting with young Nicholas Eltz, who was then helping scientists at the American Museum of Natural History's Southwestern Research Station near Portal, Arizona. Nicky's terrariums already held a dozen tarantulas.

Battle's Outcome Rarely Varies

The sun had set and the desert was losing its daytime heat as I drove slowly down a twisting roadway across rolling terrain covered with sage and cactus. Nicky perched on the hood, a flashlight in one hand and a wide-mouthed jar in the other. He had explained why at dusk in summer tarantulas leave their holes to forage or to find mates. "After dark it's cooler, and they're also safe from pompilid wasps."

Abruptly Nicky signaled me to stop. He jumped off the hood, ran ahead, and suddenly dropped to his knees on the macadam. In the headlight glare I saw him scoop up something with his collecting jar. A moment later he was back with his prize—a tarantula with a body thicker than my thumb, a leg spread of five inches, and two formidable black fangs. We bagged six more specimens within an hour, then returned to the research station.

Earlier that day we had netted a metallic-blue, topaz-winged pompilid wasp and released it in a glass terrarium partly filled with desert sand. Now we dumped one of our newly captured tarantulas in with the wasp.

"First they'll wrestle," Nicky predicted, "but the outcome is usually the same."

I watched the unequal struggle, the keen-eyed wasp circling like a gladiator and sizing up the near-sighted spider, which could assume only a threatening attitude until touched. The wasp quickly broke through the spider's guard. With a lightning-swift jab, she sank her stinger into the tarantula between its third and fourth leg sockets.

(Continued on page 208)

If it moves, it's probably food. The fishing spider, here feeding on a freshly caught minnow, devours insects, tadpoles, and even other spiders with equal gusto. Like all spiders, he must inject the victim with digestive enzymes before he dines, turning soft tissues into a soup that he can draw into his body. Venom for killing prey occurs in all but two small groups of spiders. DOLOMEDES VITTATUS, 2 1/4 TIMES LIFE-SIZE, EASTERN U. S.; BY HARRY ELLIS © N.G.S.

Nimble crab spider haunts a plant laden with delicate blossoms (**right**). Named for its ability to scurry sideways and backwards, the little hunter can turn white, pink, or yellow to blend with vegetation.

In a mini-jungle of stalks and stems, a green lynx spider snatches up a victim. It trails a dragline—a safety thread anchored at intervals—that most spiders put down as they move about.

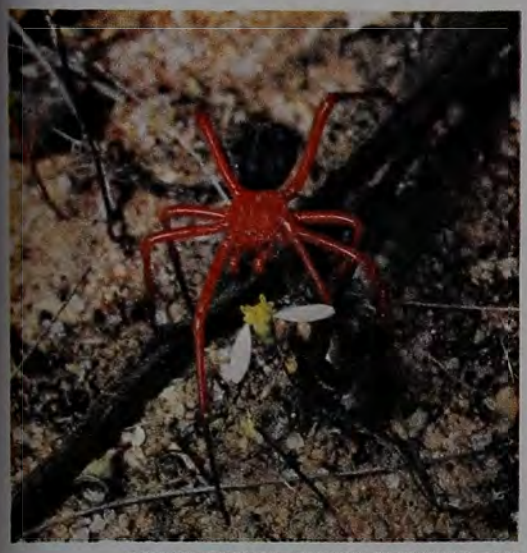
PEUCETIA VIRIDANS, 2 1/4 TIMES LIFE-SIZE, SOUTHERN U. S. TO CENTRAL AMERICA; BY JAMES AND RICHARD KERN

MISUMENOPS OBLONGUS, 2 1/2 TIMES LIFE-SIZE, EASTERN U. S.; BY F. TURNER REUTER

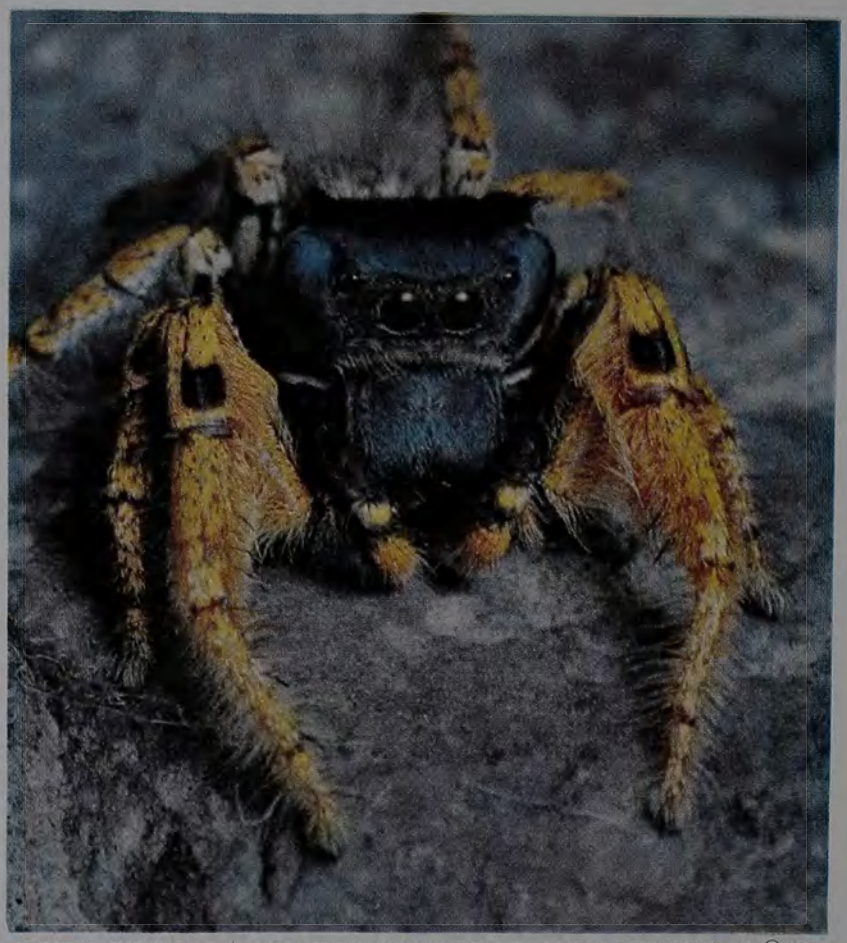
XYSTICUS CRISTATUS, 3 TIMES LIFE-SIZE, EUROPE; BY JOHN A. L. COOKE © N.G.S.

Ready-for-dinner stance: A hungry crab spider waits motionless for a flying insect to approach. When a victim draws near enough, the legs snap shut and the predator delivers a killing bite. Equipped with particularly potent toxin, these spiders readily attack wasps and bumblebees much larger than themselves.

In fashionable "wet-look" garb, Australia's red-and-black *Nicodamus* prances over the loose ground cover on which he makes his home. "The loveliness of many spiders remains unappreciated," author Zahl says, "simply because of their small size and the centuries of unwarranted prejudice against them."



NICODAMUS BICOLOR, LIFE-SIZE; BY EDWARD S. ROSS



PHIDIPPUS ARIZONENSIS, 4 1/2 TIMES LIFE-SIZE, SOUTHWESTERN U. S.; BY JAMES H. CARMICHAEL, JR. © N.G.S.

THIODINA SYLVANA, 8 TIMES LIFE-SIZE, SOUTHERN U. S.; BY JAMES H. CARMICHAEL, JR.

Some lurk, others chase, but a jumping spider pounces on its victim—in this case another spider—from a distance as great as forty times its body length. Like most spiders, it will even kill and eat its own offspring. No other spiders match the varied coloration of the jumpers.

Glowering visage belies the mild personality of the jumping spider. Apparently emboldened by the ability to perceive sharp images as far away as 10 to 12 inches—a record for spiders—these hunters often will sit calmly on a person's finger, raptly following his movements. Nearly all spiders have eight eyes differing in size and position, but only those species that pursue their prey possess keen vision. Others rely almost exclusively on the sense of touch.

In dank, dark places nearly everywhere in the world long-legged cellar spiders may be found. This one (**left**) carries an egg cluster in her jaws. More familial than most species, cellar spiders share their webs with mates; the female can sometimes be seen holding recently hatched young. These basement dwellers violently vibrate their webs when alarmed, but when mortal danger threatens they flee the snare to seek cover in dark corners. They share the nickname "daddy longlegs" with spiders' close relatives, the harvestmen (page 211).

PHOLCUS PHALANGIOIDES, 6 TIMES LIFE-SIZE, WORLDWIDE; BY PAUL A. ZAHL © N.G.S.

GENUS MISUMENOPS, 3 TIMES LIFE-SIZE, NORTHERN HEMISPHERE; BY PAUL A. ZAHL © N.G.S.

No female guards her progeny-to-be more fiercely than the crab spider (**above**). Crouched defiantly on her egg sac, she treats every intruder as an enemy. This one even stood her ground when author Zahl slit the cocoon with scissors to expose the eggs. Usually, however, the crab spider dies of old age before her babies emerge.

PEUCETIA VIRIDANS, TWICE LIFE-SIZE; BY JAMES AND RICHARD KERN

Motherly solicitude often persists among spiders after the young emerge from their sturdy egg cases.

Freed from their barbed-wire-anchored sac (**above**), green lynx spiderlings will remain with the female in the silken maze until able to fend for themselves.

Wolf-spider young stay even closer to home. The parent carries them on her back for a week or more (**right**), brushing them away from her eyes as she goes. During that time the spiderlings never feed. If a little one tumbles off, it quickly scrambles back up via the nearest leg.

Most spiders produce about a hundred eggs at a time; the extremes range from one to as many as a thousand.

For a full ten seconds the wasp held her deadly thrust, apparently discharging a full dose of tranquilizer. Then she withdrew her needle-sharp weapon, stepped back, and waited. The tranquilizer worked rapidly.

The motionless spider was ten times the size of the wasp, but the wasp seized one of the tarantula's legs in her jaws and tugged the gray-black hulk across the sand to a hole she had dug earlier. She backed down the hole, pulling her burden in after her.

I already knew the last act of this drama. Positioning the victim on its back underground, the wasp would lay a single egg on the anesthetized spider's abdomen, then return to the surface and plug the hole with sand or pebbles. The tarantula is thus literally buried alive for weeks. When the wasp's egg hatches into a squirming larva, the spider serves as a food supply. This small, savage

ritual helps control the tarantula population —a necessity even with a creature so seldom harmful to man.

Even the notorious black widow, *Latrodectus,* of world-girdling range, accounts for surprisingly few human fatalities. Of 1,000 cases of black-widow bite reported in the United States each year, only four or five are fatal. Black-widow venom—for which an antivenin was developed 25 years ago—can produce such symptoms as chills, nausea, pain, hypertension, breathing difficulties, and muscle cramps.

Trash Heaps Are Home to Deadly Widows

In the company of Lorin Honetschlager, an animal collector who some years earlier had helped me find scorpions,* I learned at first-hand much of what I know of black widows. Last summer, sitting in the kitchen of his suburban home near Phoenix, Arizona, Lorin laughed when I told him I thought *Latrodectus* was a scarce spider. "Widows?" he laughed. "Put on your hat, man. In three minutes I'll show you hundreds."

We walked down the street to the backyard of an abandoned house where a trash heap had accumulated. Amid waste paper, tin cans, and rotting lumber, we found a tangle of untidily strung webs. Each had a central tube-shaped netting harboring a shiny black eight-legger with a pea-size abdomen marked underneath with the scarlet figure of an hour-glass (pages 192-3).

Alleged fiend of the spider world and undoubtedly armed with a powerful poison, *Latrodectus* will bite, Lorin insisted, only when excessively provoked—that is, when

*See in NATIONAL GEOGRAPHIC, "Scorpions: Living Fossils of the Sands," by Paul A. Zahl, March 1968.

GENUS LYCOSA, 8 TIMES LIFE-SIZE, WORLDWIDE; BY F. TURNER REUTER © N.G.S.

Prickly "face" scowls from the back of a humped orb weaver. Many spiders display such elaborate markings. "Eyes" and "nostrils" in this bird's-eye view actually indicate the attachment points of internal muscles. The spider's legs conceal the real face.

GENUS ARANEUS, 9 1/2 TIMES LIFE-SIZE, NORTHERN HEMISPHERE; BY PAUL A. ZAHL © N.G.S.

Hidden in full view, a drab ogre-faced spider avoids enemies by simulating vegetation (**right**). It maintains the twiglike position—long legs stretched out fore and aft—while it sleeps away the day. At night it awakens to hunt for food.

DINOPIS SPINOSUS, 1 3/4 TIMES LIFE-SIZE, SOUTHEASTERN U. S.; BY JAMES AND RICHARD KERN

Life-saving mimicry protects this jumping spider from predators that find ants distasteful. Most ant-imitating spiders even copy the movements of their models, often waving front legs like antennae. When disturbed, however, they abandon pretense and flee.

SYNEMOSYNA FORMICA, 7 TIMES LIFE-SIZE, EASTERN U. S.;
BY JAMES H. CARMICHAEL, JR.

MEGABUNUS DIADEMA, 4 TIMES LIFE-SIZE, EUROPE; BY JOHN A. L. COOKE © N.G.S.

Spiders' look-alike kin, the harvestman—or daddy longlegs—has only two eyes, usually mounted atop a short, round body. Able to regenerate legs, it readily sheds them when in danger of capture; this one has lost two.

DRAPETISCA SOCIALIS, 3 1/2 TIMES LIFE-SIZE, EUROPE;
BY JOHN A. L. COOKE

Blotched costume conceals a cryptic bark spider as it stalks down a lichen-covered tree. Where polluted air has blackened tree trunks, darker spiders have evolved.

ARANEUS TRIFOLIUM, TWICE LIFE-SIZE, NORTH AMERICA; BY JANICE HEALEY

ALCIMOSPHENUS BIFURCATUS, 2 1/2 TIMES LIFE-SIZE, JAMAICA; BY JOHN A. L. COOKE

NEPHILA CLAVIPES, 1 1/2 TIMES LIFE-SIZE, NEW WORLD TROPICS; BY RICHARD C. KERN © N.G.S.

Lurking lady of the meadows (**top left**), this shamrock spider normally stays hidden in a retreat of folded leaves positioned near her 2½-foot-wide orb web. A taut trapline links hideout and snare. When an insect strikes, the trapline transmits the vibrations of its struggle from the web to the spider, who rushes in for the kill.

Pear-shaped and berry-bright, this Jamaican orb weaver (**above**) displays apparel befitting its tropical habitat.

GASTERACANTHA CANCRIFORMIS, 2 1/2 TIMES LIFE-SIZE, TROPICAL AND SUBTROPICAL AMERICAS; BY JOHN A. L. COOKE

World's strongest natural fibers form the web of the golden silk spider (**above**). Spider silk, once widely used for cross hairs in optical instruments, is finer, lighter, and tougher than silkworm thread. But the creatures' cannibalistic nature precludes raising them to produce silk for textiles.

Birds get the point: Spiny-backed spider, here upside down, wears pronged armor that discourages attackers.

uncomfortably confined, or unmercifully squeezed, or when its web is violently disturbed. With long chrome tweezers we picked off a dozen of the dreaded ladies, a few soft silken egg cases shaped like little marbles, and several males of the species. The latter are much smaller and pose no threat to man.

Back in the laboratory I had improvised in my Phoenix quarters, the unexpected happened. As I was transferring the black widows to a terrarium, one suddenly ran out of her jar, scurried across my right wrist and up my arm to the elbow, where she stopped to survey this new world of human skin. Despite Lorin's earlier assurances, I felt far from comfortable.

Trying not to move my right arm, I slowly reached with my left for an open jar on a nearby shelf. I eased it close to the lady who could, if she chose, bite me at any moment. Maneuvering ever so carefully, I gently coaxed the venomous creature back into the security of the jar.

In contrast to her tolerance toward me, she set upon and immediately killed the flies, moths, and other insects I dropped into her terrarium. The action seemed just as blindly purposeful as the orb-web spider's attack on the vibrating tuning fork. The widow then expertly twirled her victims into silken shrouds and hung them aside—neatly packaging provisions for the future.

Gleaming Eyes Betray Prowling Wolves

Next night Lorin and I drove out onto the desert east of Phoenix to the habitat of *Lycosa carolinensis,* a wolf spider. A member of the hunting group, this creature lives belowground in a hole rimmed with sand, bits of bark, twigs, leaf fragments, and grass.

Making no use whatever of the web-snare principle, and surfacing mainly at night, fast-moving wolf spiders streak across the ground in pursuit of prey. We found them easily, for in the beam of a flashlight their eyes glowed like the headlights of tiny automobiles, and when caught in the glare they tended to freeze in their tracks.

One species of European wolf spider, *Lycosa tarentula,* probably named after the Italian city of Taranto, inspired a popular folk dance. It was once thought that the effect of this spider's bite (actually not serious) could be shaken off by dancing wildly, hence the spirited *tarantella.* Despite the similarity in name, *Lycosa tarentula* bears no close relationship to the American tarantula.

Another variety of hunter, the funnel-web spider (family Agelenidae), spins a novel trap. At the entrance to almost any cranny she weaves a kind of tarpaulin with a central funnel-like opening where she sits in wait.

In the backyard of my home in Washington, D. C., stands a wall of unmortared stone. Here in the crevices spiders of this family live and thrive all spring, summer, and autumn. I never molest them, for their toll of harmful garden insects must be enormous. Many a summer evening after dark I have placed a chair a few feet from the wall and, with flashlight in hand, sat there for a session of spider watching.

Playing Catch With a Hungry Spider

One night I came with food—live insects netted earlier in the day. The beam of my flashlight found the mouth of a funnel where, just inside, alert and tense, sat a grayish spider with conspicuous eyes. When I made a sudden move forward with the flashlight, the creature vanished, but only for a second or two. I waited until I was sure she was accustomed to the light, then tossed a fly onto the web platform three or four inches from the funnel mouth. Instantly the spider streaked from ambush, made the catch, and disappeared back into the funnel.

Many hunting spiders have large, efficient eyes. Those with the keenest sight are the jumping spiders (family Salticidae). Although usually quite small and harmless to man, these richly colored spiders leap upon insects with the savagery of leopards. A species of jumper has been found 22,000 feet up on Mount Everest; others dwell in lowland gardens and wild woods.

Several of the hunters mimic ants in appearance and habit (page 211); some can buzz like bees; others squirt out a viscous substance to entangle their prey.

One of the strangest of the hunters, the fishing spider *(Dolomedes),* is at home in two environments. Not only can the fishing spider run across water, but it may remain submerged for as long as an hour, holding onto bottom debris in quiet streams and ponds.*

*This remarkable feat by some spiders and aquatic insects was described in "Teeming Life of a Pond," by William H. Amos, NATIONAL GEOGRAPHIC, August 1970.

BY CASS PIERONEK

Misstep 35,000,000 years ago mired this jumping spider in resin, which hardened into amber. The oldest fossil spider predates him by more than 315,000,000 years.

Nemesis of smaller creatures, the wolf spider (**left**) rarely threatens humans; if handled carefully, the hunter can make an interesting pet.

For spider collectors who want nonliving specimens, nature provides plentiful and perfect facsimiles such as this featherlight exoskeleton (**below**) abandoned by the animal when it molted. Spiders must discard their skins to grow, and they do so at least once even before emerging from their egg sacs. Most molt four to twelve times in all, reaching sexual maturity with the final shedding. Few spiders live more than two years, and the males, who die soon after mating, rarely survive even one.

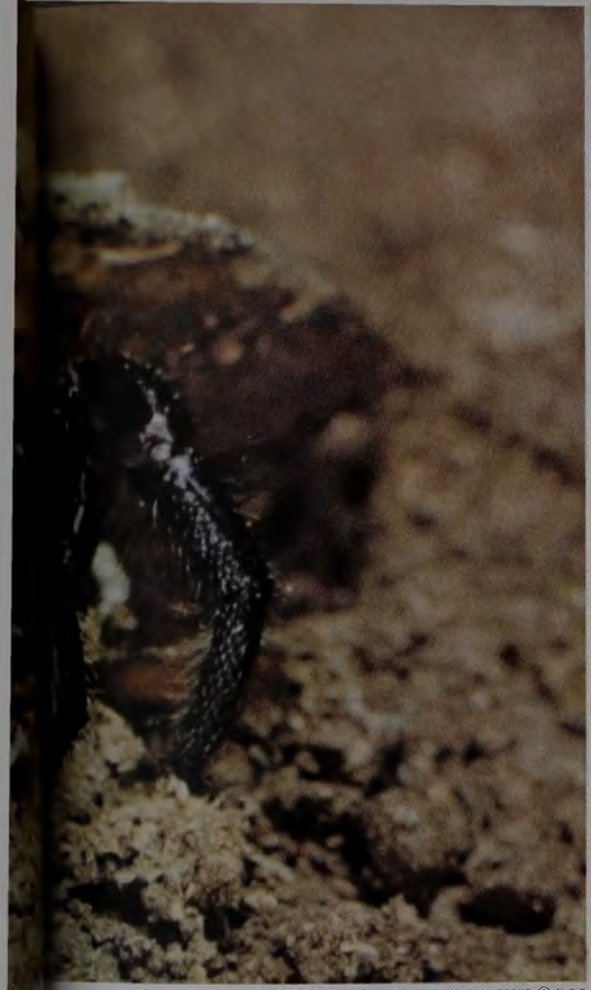
GENUS LYCOSA (OPPOSITE) 10 TIMES LIFE-SIZE; BY ALDO MARGIOCCO;
HETEROPODA VENATORIA (ABOVE) 3 TIMES LIFE-SIZE, TROPICAL REGIONS; PAUL A. ZAHL © N.G.S.

Peekaboo predator scouts for food from the entrance of her underground home (**above**). If an insect passes near enough, the trap-door spider will lunge at it, usually keeping the door propped open with her back legs to ensure a safe retreat.

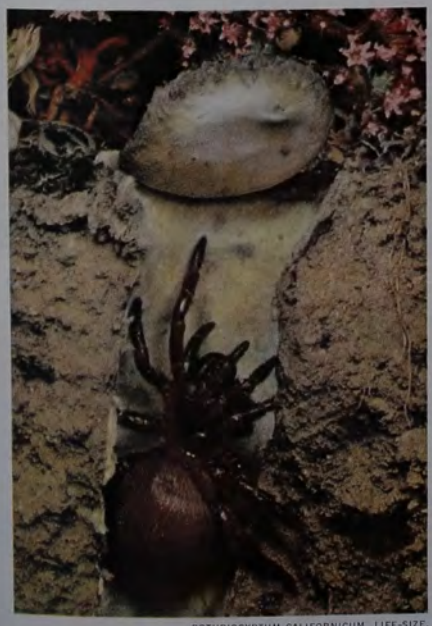
Using comblike rakes on the jaws, the builder of a trap-door nest such as the one being probed by Kathy Wilson Rottschafer (**below**) digs a hole five to eight inches deep, then caps it with a hinged, beveled door carefully camouflaged on top. Tiny punctures on the inside of the door (**below**) reveal how the spider uses her fangs to hold it tightly shut against intruders.

After waterproofing the walls with a coating of saliva and earth, the spider lines the interior of her snug lair with soft silk (**opposite**).

BY PAUL A. ZAHL (ABOVE) AND RICHARD C. KERN © N.G.S.



UMMIDIA NIDULANS, 9 TIMES LIFE-SIZE, JAMAICA; BY JOHN A. L. COOKE © N.G.S.



BOTHRIOCYRTUM CALIFORNICUM, LIFE-SIZE, SOUTHERN CALIFORNIA; BY PAUL A. ZAHL

A bubble of air held under the body enables it to pop to the surface at will. Insects are its usual prey, but some species capture small fish and tadpoles (page 203).

Even more remarkable, the water spider *Argyroneta*—a native of Europe and Asia—builds a diving bell underwater. The spider first spins a submerged web platform, then carries down small air bubbles from the surface to fill it like a tiny balloon. She spends virtually her entire life in or near the bell, adding new air whenever needed. *Argyroneta* even lays her eggs within the bubble, and hatchlings stay there until ready to set out on their own.

Camouflage Hides a Hunter's Lair

Trap-door spiders are unique by virtue of their ingenious dwellings. One spring I found myself in the hilly country east of San Diego, an area well known as a haunt of the California trap-door *Bothriocyrtum californicum*. Here my field collaborator was Kathy Wilson Rottschafer, a student of biology at San Diego State College, and a trap-door specialist in the making.

"When they're closed, the traps are so perfectly camouflaged that we've probably stepped on dozens already without knowing it," apologized Kathy. We were searching a little arroyo strewn with yellow spring flowers. Here and there lay patches of bare earth where one could examine the surface square inch by square inch.

For ten minutes I scrutinized the ground, looking for something I had previously seen only in photos. Then I heard a cry of triumph from Kathy. She pointed to a hair-thin arc barely visible on the surface of the soil.

"May I have your pocketknife, please?" she asked. With a surgeon's dexterity she eased the blade under the edge of the inch-wide door and pried gently. There was no give.

"A spider's in there, all right," she said, "braced just under the door, holding it shut. Surprising how strong they are."

She thumped the ground gently and the spider let go. With the blade she lifted the trap-door—a thick cap of tightly compacted silk and dry soil. Its beveled edges might have been fashioned on a lathe (left).

The young arachnologist beamed. "There you are. And six or eight inches down at the bottom of the shaft is the lady of the house."

With sharp rakes on each of its two jaws, the spider had excavated a neat vertical shaft just wide enough for her body; she had coated

its walls with saliva-moistened earth, and covered them with a sheet of tightly spun silk. Finally she had woven the hinged and camouflaged trapdoor—her shield against a hostile world.

She was now safe from most of her enemies but still vulnerable to the pompilid wasp—nemesis of all members of the tarantula group.

When such a wasp locates a trapdoor, it chews through the cap or simply rushes in if the spider lifts the door too high. Once inside, the wasp engages the spider in the same unequal contest I had observed against the tarantula in Arizona. Then the insect departs through the now-unguarded door.

The trap-door spider designs her abode not only for safety, but also as a shelter from sun, rain, and cold. It is her courtship parlor too, her nuptial chamber, and a nursery for her young. Seldom if ever does she leave its confines, and even then ventures out only a few inches to capture crawling insects.

Indians Believed in Spider Power

Greek mythology gave us Arachne. Other myths deify the spider. "To the American Indians," writes Dr. Gertsch, "the spider is a creature of mystery and power. . . ." To the Dakotas "the orb web is a symbol of the heavens . . . from the spirals of the orb emanate the mystery and power of the Great Spirit." And the lines connect sky and earth on which an ". . . Algonkin maiden, fallen from grace as wife of the Morning Star, is sent back to earth." To certain Southwest Indians, the original creator was a spider; to others, weaving was introduced by a spider woman.

Quaint myths. But where do spiders fit into nature's plan, and into the world which man has superimposed on nature?

To begin with, the arachnid line goes back 400 million years to the first land-dwelling invertebrates. Ages of adaptation followed, during which spiders infiltrated almost every climate and every ecological niche.

Housewives are aware that any closet or dark corner, even on the thirtieth floor of a New York apartment building, if left unswept or undusted for just a few weeks, will inevitably develop cobwebs. How they get there strains one's imagination.

Gossamer Webs Capture Morning's Glory

Not only are spiders found almost everywhere; they exist in incalculable numbers. Sampling techniques have revealed some 64,000 spiders in one acre of meadow in a Middle Atlantic state and a quarter of a million in an acre of tropical forest. The worldwide count would be beyond comprehension.

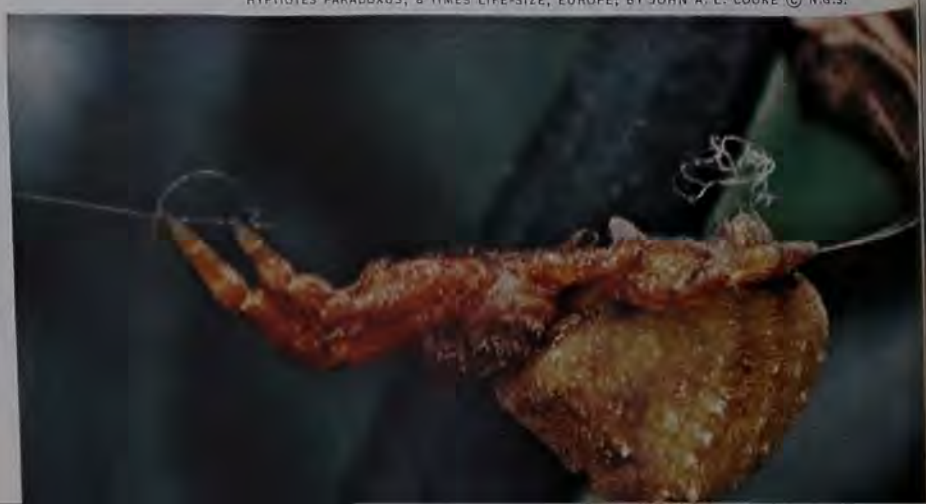
The spider's marvelously inventive modes are fueled by strictly carnivorous habits which, although deadly in the insect world, are man's distinct blessing. Man must live on what he grows, and thanks in part to his eight-legged friends, destructive insects are held in check. It seems ironic that such a benefactor should typify ugliness and connote menace—should have, as the nursery rhyme has it, "frightened Miss Muffet away."

Early one September morning on a New England hillside, I came upon a patch of mountain laurel in which scores of orb webs were strung. Their silken fibers, moist with dew, caught the rays of the rising sun, and the glitter was dazzling (page 197).

Perhaps a similar enchanting encounter in 1715 inspired 12-year-old Jonathan Edwards, the future Puritan theologian and scholar, to pen what I think of as the best tribute to man's plentiful eight-legged friends. (Edwards could not have known that a century later scientists would decide that spiders are not insects.)

". . . every thing belonging to this insect," wrote Edwards, "is admirable. . . ." □

HYPTIOTES PARADOXUS, 8 TIMES LIFE-SIZE, EUROPE; BY JOHN A. L. COOKE © N.G.S.



Bridging a gap in one of the anchor lines of her three-sided web, a triangle spider patiently waits for dinner. When an insect lands in her snare, she pulls the anchor line taut, then suddenly releases it, making the web vibrate and further entangling the victim. Then the venomless hunter swathes her prey in silk and sucks the juices from its body.

FRONTINELLA COMMUNIS, HALF LIFE-SIZE, EASTERN AND CENTRAL CANADA AND U. S.; BY LARRY J. WEST © N.G.S.

MISUMENOPS BELLULUS, 8 TIMES LIFE-SIZE, SOUTHEASTERN U. S.; BY RICHARD C. KERN

Tangled silk snare of the bowl and doily spider also foils enemies approaching from both above and below.

Up, up, and away! A young crab spider releases a strand of breeze-catching silk and waits for a gust to carry her aloft. Called ballooning, nature's way of distributing spiderlings has helped scatter the creatures worldwide.