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Spiders and the Cobwebs of Myth about Them

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Laypeople often wonder why their tax dollars should support science that seems to have no relevance to everyday problems. Why, for example, should they give money to people to study spiders or scorpions? What makes arachnology, the study of these creatures, relevant? The importance of arachnology became apparent to me many years ago. As I lay on a mound during an Army maneuver in Texas, I felt a shooting pain move down my left arm toward my chest. I thought I was having a heart attack. It turned out to be a scorpion sting. Many years later, I was reminded of the relevance of arachnology while living on an asparagus farm with my son in New Jersey. A small child was bitten by a black widow spider in an outhouse. Fortunately, the child survived.

Apart from the relevance of such obscure subjects as arachnology, scientists have another problem. We seem to enjoy what we do too much. The average person can't comprehend why anyone would enjoy working with all those "things" they fear most: spiders, corpses, diseases, etc. Scientists need to be reminded that our lay friends have not acquired the knowledge that overcomes common myth and superstition. Like snakes and wolves, spiders have received a bum rap. Perhaps this essay will indicate why.

Few animals are more universally feared than spiders. Why people fear them has never been precisely explained. The late Theodore H. Savory, a British author of textbooks about spiders, could find "no obvious justification for so disproportionate, so widespread, so illogical a horror, which may well have been an obstacle to serious arachnology."[1] Savory believed that the fear of spiders is complex and no single explanation can cover all cases. Like many other phobias, however, it can often be traced to early childhood. Perhaps a child, warned about poisonous and ferocious animals, transferred the fear to spiders. Or maybe the child was once frightened by a spider. As Savory notes, "Few creatures are more likely than a house spider to appear unexpectedly and give a shock to a child."[1]

Anthropologist Marvin Harris, University of Florida, Gainesville, agrees that the fear is learned in childhood. Since some spiders can be dangerous, he says, it makes "good cultural sense" to teach children to stay away from them. The fear need not be permanent. Humans can learn to love spiders and let them walk on their arms without fear.[2]

Edward O. Wilson, Harvard University, Cambridge, Massachusetts, believes the phobia is rooted in our genes. "While there is a strong predisposition to develop phobias against spiders, snakes, closed places and cliffs—the ancient perils of humankind—there is no predisposition whatever to form phobias against knives, electric sockets and automobiles, which are far more dangerous in modern society."[2]

Whatever the root of human fear of spiders, these creatures have held a certain fascination as well. Spiders figure in ancient myths. In 8 AD, the Roman poet

Ovid told the story of Arachne, a peasant girl who challenged the goddess Athena to a weaving contest. The women produced cloth of equal beauty, but the jealous Athena punished Arachne, changing her into a creature that spends its life weaving silk: a spider.[3]

Spiders belong to the phylum Arthropoda, which they share with insects and crustaceans.[4] Arachnida, the subdivision or class of arthropods spiders belong to, is named after Arachne. It also includes scorpions, mites, and ticks. Like most of their fellow arachnids, spiders are air-breathing invertebrates. Their bodies have two divisions, four pairs of legs, and no antennae.[5] Unlike other arachnids, all spiders spin silk, though not all build webs.[6]

Most spiders have eight eyes, though some species have fewer. Most spiders secrete venom, although only about 12 species are harmful to humans. Their main diet is insects. They eat by first injecting the victim with venom and treating it with digestive enzymes that dissolve its inner organs. Then they drink the resulting nutritive broth. Spiders hatch from eggs and change little as they mature, except in size. They usually molt (shed their chitinous outer skin) seven or eight times before maturing. Females are often larger than males, and sometimes devour males after mating.[6]

There are about 35,000 known species of spiders.[6] Some scholars, including Norman I. Platnick, American Museum of Natural History, New York, believe that at least 100,000 species inhabit the Earth.[7] During the course of their 400 million-year history, spiders have adapted to almost every climate and every ecological niche. According to Paul A. Zahl, National Geographic Society, Washington, DC, they exist in great variety among the trees, bushes, and grasses of every forest in the world. Spiders are found from the tropics to the Arctic. And some species, though they breathe air, live underwater.[8]

Spiders clearly have efficient survival mechanisms, since they are so numerous and widespread. Newly hatched spiders are as mobile and fierce as adults. Eight legs allow them to step quickly over rugged terrain. Chitinous exoskeletons make them unappetizing to many predators. And venoms, in tiny amounts, paralyze their insect prey. A spider caught by the leg can leave it behind and grow another at next molt.[8] Thomas Eisner and Scott Camazine, Cornell University, Ithaca, New York, recently made an amazing discovery. When a spider is stung in the leg by a venomous insect, such as a wasp or honeybee, it lets go of the leg within seconds, before the venom spreads through its body.[9]

In addition to these adaptations, the spider's use of silk is one of its tools for survival. According to F. Lucas, Shirley Institute, a fiber-research organization in England, spider silk is stronger than nylon. It is also finer, lighter, and more tenacious than silk from the common silkworm, *Bombyx mori*.[10] All silks are made of a protein called fibroin. Spiders produce it in up to six sets of glands in their abdomens. They secrete it through valve-like openings, or spinnerets, which help regulate the flow.[11]

Spiders' silk is the basis for one of their most prominent survival tactics: the web. About half of all spider species build them. Peter N. Witt, an arachnologist-pharmacologist retired from the North Carolina Department of Human Resources, points out in a recent news story that webs are great energy savers for spiders. Web-builders do not have to roam in search of prey. They simply wait for insects to get caught in the web. Building a web costs a spider the energy equivalent of two or three insects; on an average day, a spider may catch 30. And many spiders recycle their webs. They eat all or part of the silk at the end of the day and use its amino acids in their next web.[12]

According to Witt and colleagues, spiders build their webs according to instructions encoded in their genes. They can build the day they hatch, though most produce their first web after two weeks.[13] While each species spins a characteristic web, individuals vary it in minor ways, making each web almost as distinctive as a fingerprint. And even

though a spiderling rarely gets to meet its parents, its web closely resembles theirs.[12]

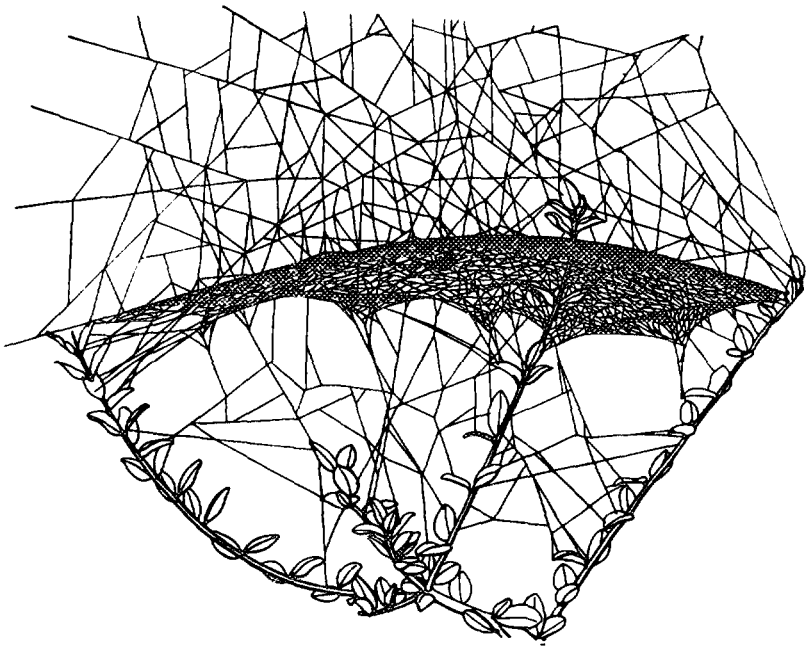
Different species of spiders build different webs which vary greatly in their degree of complexity. One of the structurally simpler webs is the single line web of the tropical spider *Phoroncidia studo*. The web consists of a strand or two of silk stretched across a path or stream. Observing in a forest near Yotoco, Valle, Colombia, William G. Eberhard, University of Costa Rica, Costa Rica, found that insects move more slowly when flying near the web, and end up being caught by their feet. He concluded that this flying pattern indicates the presence of a chemical attractant, or pheromone, in the silk.[14]

Another simple web, the cobweb, is spun by the common house spider *Achaeranea tepidariorum*. The cobweb gets its name from the Old English word *cob*, for spider.[15] According to a 1964 book by Laura B. Lougee, then with the Cranbrook Institute of Science, Bloomfield Hills, Michigan, this modest maze of tangled threads is attached to surrounding structures in a haphazard-looking way.[16] Although the cobweb is considered a nuisance by people who encounter it, Anne Moreton, an amateur arachnologist from Powhaton, Virginia, has found that it helps the spider catch more than 1,000 flies, mosquitoes, and moths a year.[17]

A more ambitious web is called the sheet web. It's a thick plane of hundreds of fine silk filaments placed very close together. Some spiders crawl atop the mesh. Others, such as *Linyphia triangularis*, hang from beneath with specially adapted toothed claws. This spider extends thin filaments from the web to structures high above it. Insects fly into the filaments and fall onto the web surface, where the spider can pull them through from underneath.[16] (See Figure 1.)

Some spiders, such as the 1,300 species in the families Dipluridae and Agelenidae, weave their snares into the

Figure 1: *Linyphia triangularis* hangs underneath its horizontal sheet web and pulls trapped prey through.



(From: *The World of Spiders*, Bristowe, WS, William Collins Sons & Co. Ltd.)

shape of a flaring tube with a rim extending into a sheet web. At the apex of the tube is the spider's retreat, which may be buried underground or below vegetation.[16] One type of funnel weaver, the European water spider *Argyoneta aquatica*, constructs an airtight silk dome beneath the surface of slow-moving waters. It carries bubbles of air to its web nest, where it lives, mates, lays its eggs, and raises its young.[18]

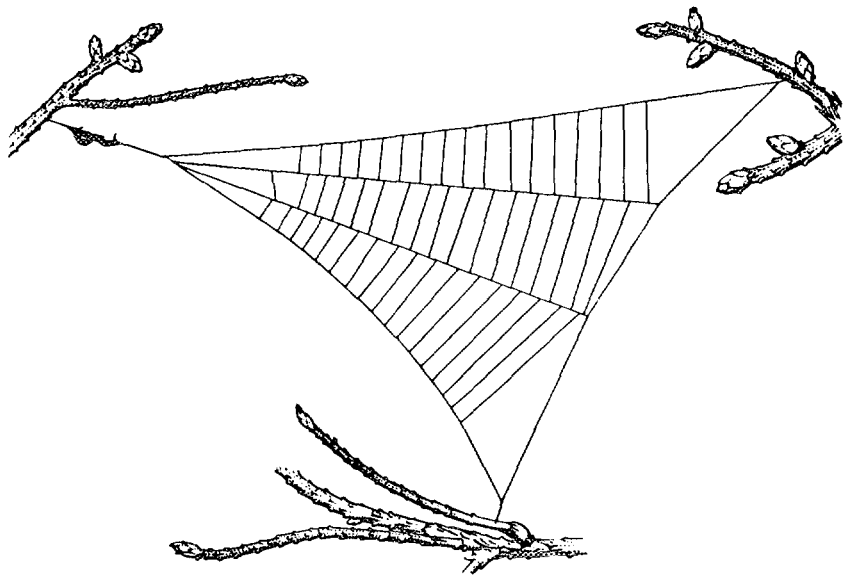
One group of spiders builds the triangle web which, unlike sheet and funnel webs, Lougee notes, is characterized by the careful positioning of each strand. The result is a strong, triangle-shaped silk net anchored with a long thread to a nearby plant, wall, or other structure. One species, *Hyptiotes cavatus*, anchors the main thread to tree trunks and sits at the junction disguised as a bud. It holds the anchoring thread taut, and when prey strikes the web, lets slack out of the line, further entangling the victim.[16] (See Figure 2.)

About 2,500 species build the most beautiful and complex of webs, the orb web.[19] The word orb comes from the Latin *orbis*, for ring, circle, or disk.[20] Savory and many naturalists before him have found that in orb webs, dry silk filaments radiate from a central point like spokes of a wheel, while sticky threads cross over them in a spiral that ends near the center.[21] (See Figure 3.) The orb web of an adult can have up to 60 radii, 80 spiral turns, and more than 1,500 intersections.[19]

Orb webs are so finely made that they are almost invisible, except when drenched with rain or dew. But, Witt notes, they are strong, efficient prey-catching devices. They stop fast-flying insects and foil their attempts to escape. They support the weight of the spider, its mates, and sometimes several accumulated prey.[22]

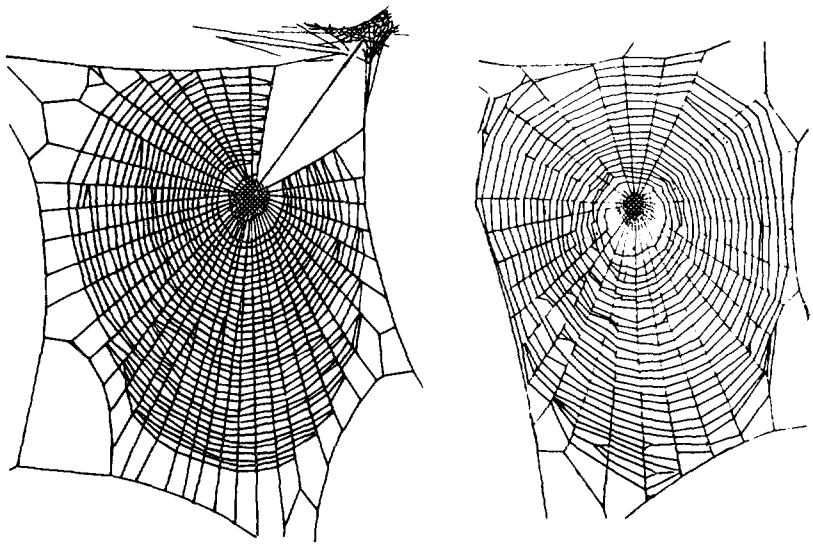
Witt and his colleagues have also found that orb-weavers take about half an hour each day to build the web. Some work in the hours before dawn, others in the early evening. One species, *Zygiella x-notata*, keeps a 60 degree slice of the web free of sticky spirals, where it leaves

Figure 2: The triangle web of *Hyptiotes cavatus*.



(From: *The World of Spiders*, Bristowe, WS, William Collins Sons & Co. Ltd.)

Figure 3: Left: the orb web of *Zygiella x-notata* has a free sector with a signal thread leading to the spider's retreat. Right: the orb web of the cross spider *Araneus diadematus*.



(From: *Biology of Spiders*, Foelix RF, Harvard University Press.)

a single dry filament leading to its retreat.[13] (See Figure 3.) Some use special combs on their feet to knit dry spirals into loops of woolly lace.[12]

Some species weave white, conspicuous slashes, crosses, or ovals across their orb webs. Until recently, this puzzled arachnologists. Webs, after all, are supposed to be invisible, to trick insects into flying into them. The mystery was solved in January 1983 by Eisner and Stephen Nowicki, Cornell. They reported that these markers, called stabilimenta, serve as detour signs for birds. Otherwise, birds would fly through a web and demolish it. They found that webs with stabilimenta have a 60 percent chance of surviving until noon. Webs without these markers have only an eight percent chance.[23]

The orb web is more than a trap. It compensates for the poor vision some spiders have. Diemut Klärner and Friedrich G. Barth, Zoology Institute, Johann Wolfgang Goethe University, Frankfurt, Federal Republic of Germany, have found that when prey strikes an orb web, the spider runs to the hub and feels each radial thread, orienting itself toward the quadrant sending the strongest vibration. If the spider feels vibrations that are too strong, it may deem the captive too big or lively to handle. In this case, the spider cuts the threads surrounding the captive and lets it fall to the ground. It does the same if a twig or other inanimate object falls into the web. It can determine the size and position of a twig by plucking the threads and "reading" the reverberations. Of course, spiders also use these methods to find edible prey, which they bite and wrap in silk to eat or store.[24]

Webs, besides helping individual spiders catch food, serve in some species as communal homes for up to several hundred thousand spiders. About 30 species build communal webs in tropical and subtropical climates, where prey is superabundant. J. Wesley Burgess, University of California, Davis, found a web of the species *Mallos gregalis* near Guadalajara in Mexico that covered the upper three-quarters of a 60-foot mimosa tree. Most communal webs, however, are smaller. The spiders collaborate in

the capture of prey, and in the Guadalajara web, they attack insects much larger than any that the five millimeter-long spiders could disable alone.[25]

A less spectacular but still remarkable example of coexistence was found in the US in 1982 by George W. Uetz and Wendy Allen, University of Cincinnati, Ohio. Large numbers of *Nuctenea sclopetaria*, a solitary orb-weaver, were found attaching webs together near the Riverfront Coliseum Sports Arena in Cincinnati, where floodlights had attracted a great deal of prey. Tolerance went only so far, however. The spiders refused to share food with each other, and fiercely defended their individual webs from intruders.[26]

Webs and their manipulation can also help male spiders survive the often dangerous rite of mating. The male, if mistaken for prey by the much larger female, faces certain death. Michael H. Robinson and Barbara Robinson, Smithsonian Tropical Research Institute, Balboa, Canal Zone, have studied spider mating in orb-weavers. They found that some males, when they arrive at a female's web, pluck the threads in a certain way to advertise their intentions. Others attach a thread of their own to her web and pluck that. If the female behaves menacingly as she runs onto the thread, the male may cut the line and run away, or try to tire her out by running away while letting out line.[27] In some species, the male uses a few strands of silk to immobilize the female. In a few, males wait until the females eat something else before they get too close.[28]

Courtship survival strategies don't rely exclusively on the spider's skill and silk. Lyn M. Forster, Otago Museum, Dunedin, New Zealand, found that in some species of hunting spiders, which are more sharp-eyed than web-builders, the male dances before the female. She appears to watch as he zigzags across her field of vision, displaying his brightly colored body markings and waving his legs.[29] In other species, the male rushes up to the female and strokes her legs with his, apparently enchanting her. In still other species, the male plays it safe—he presents his mate with a gift of neatly packaged prey to satisfy her hunger.[30]

Not all spiders rely on webs alone to catch food. An ogre-faced spider found in the tropics, for example, has developed a way of capturing ants from colonies that combines web and hunting techniques. The spider places itself above an ant trail and spins a small, sticky web which it holds between its legs. When an ant crawls by, the spider lowers the net, gluing the ant by the head. The captor then lifts the ant and wraps it in silk. The Robinsons have observed ogre-faced spiders trapping many ants this way while avoiding the potentially dangerous retaliation of other ants.[31]

Some spiders do not use webs at *all* to catch prey. According to Zahl, trapdoor spiders, of which there are about 750 species, dig retreats six to eight inches into the ground, waterproofing the dirt with saliva and lining it with soft silk. These spiders construct hinged, carefully camouflaged doors at the surface. When threatened, they hold the doors tightly shut. The trap-door spiders are timid, rarely leaving their burrows and attacking only prey that comes within easy reach. Even while attacking, many keep the trapdoor open with their hind legs, for an easy retreat.[8]

Jumping spiders, of which there are about 4,000 species, pounce on prey from a distance of up to 40 times their body length.[8] Able to see up to 12 inches away, they possess the best vision among spiders. Jumping spiders often live in close competition for resources within a habitat. Forster has observed them performing complex ritualistic dances to communicate with each other about claiming territory and attacking prey.[29,32]

Some spiders have adopted a chameleon-like survival tactic, according to Zahl. Some members of the 3,000 species of crab spiders change color to pink, white, or yellow to match the flowers

they sit in to wait for prey. The camouflage prevents the spiders from being seen by birds or other predators. When prey comes near, the spiders snap their legs shut on it and inject an extra-potent venom. These small spiders attack wasps and bumblebees that are large by comparison.[8]

Probably the most famous spider of all is the tarantula. In North America, what is commonly called the tarantula belongs to the family Theraphosidae. It has a leg span of up to five inches. It lives longer than most spiders—sometimes up to 30 years—and takes nearly a decade to grow to full size. Its bite is rarely worse than a wasp or bee sting, and it shies away from humans, usually biting only if provoked. Many species live in the dry, sun-baked regions of the American Southwest and Mexico.[8]

South American tarantulas live in the temperate and tropical zones of that continent. Their bodies alone can be up to six inches long, and they can catch and eat small birds.[33]

The European tarantula, about an inch long, belongs to the family Lycosidae and lives in the regions surrounding the Mediterranean. It is also known as the wolf spider. It has been studied by Zvonimir Maretić and Drago Lebez, University of Ljubljana, Yugoslavia. They have found that the European tarantula's bite is usually no worse than a bee sting. In sensitive persons, however, it can cause redness, swelling, and the eventual death of large patches of tissue surrounding the bite.[34]

Maretić and Lebez found that in the fifteenth to seventeenth centuries, this species was believed responsible for epidemics of spider bites in towns throughout southern Europe. Bitten people ran through towns, alternately laughing and crying, and performing unusual, sometimes vulgar, acts. The "tarantati," as they came to be called, suffered pain, sweating, convulsions, paralysis, delirium, and death.[34]

The cure was dancing. Victims danced to lively tunes, sometimes for days, until they fell to the ground, exhausted. It was important to play the right tune for the victim. Otherwise, it was believed, the symptoms could worsen. All that remains today of the tarantati is the lively dance, the tarantella, and an old German saying, "bitten by tarantula," meaning crazy.[34]

Since the time of the tarantati, the culprit has been found to be not the tarantula, but the black widow spider, *Latrodectus*.[34] Black widows get their name from the habit of females of consuming males after mating. The ten or so species of black widow inhabit warm to moderate climates throughout the world. The venom of a mature female, drop for drop, is 14 times as potent as rattlesnake venom. Venom from males is weak by comparison, and poses no serious danger to humans.[34,35]

Herbert E. Longenecker and colleagues, Rockefeller University, New York, found that female black widow venom makes the body's nerve endings release their supply of neurotransmitters, the chemicals that carry messages across the spaces between nerves.[36] Resulting symptoms are those exhibited by the tarantati.

Maretić and Lebez say that intense pain is the most prominent feature. Interestingly enough, the pain is somewhat alleviated by physical exertion. A 23-year-old farmer, bitten in a field in Yugoslavia, bicycled nearly 12 and a half miles over bad roads in severe heat to the nearest hospital. He reported that the pain lessened when he cycled, but whenever he stopped to rest, it flared up quickly. Three hours after he was bitten, he was diagnosed as in good condition. In another case, a victim who was inactive could not even stand up three hours after the bite.[34]

Bite victims usually have a flushed face; swollen, tearful eyes; and a look of apprehension and pain.[35] Though serious, bites are rarely fatal, Zahl reports. Hospitals use antivenoms to treat victims. Only four or five of the 1,000 Americans bitten each year die.[8]

Maretić and Lebez list four species of black widow as common to the Ameri-

cas. The most venomous and widespread is *L. mactans*, which has a black body with a red hourglass shape on the underside of its abdomen. It hangs upside down in silk nests in low bushes and grass, and can be found in trash heaps and outhouses. Its relative, *L. variolus*, looks similar, but builds its webs in trees. It lives mostly in the western areas of North America. Black with a gray or brown abdomen, *L. geometricus* lives in tropical cities. And a native to the scrub pine of Florida, *L. bishopi*, has an orange-red body and legs.[34]

The brown recluse spider, *Loxosceles reclusa*, is another spider native to North America whose bite is harmful to humans. In a letter to *Science* in 1957, J.A. Atkins, C.W. Wingo, and W.A. Sodeman, University of Missouri, Columbia, first described the symptoms of the *Loxosceles* bite: the skin surrounding the bite becomes painful, raised, and scabrous; turns black and dry; and eventually sloughs off.[37] A scar remains that takes several weeks to heal.[36] South American species cause larger and more painful lesions than other varieties.[33]

Ironically, the spider survival tactic that people fear most may provide a way to enhance human life. Black widow venom is being used in laboratory animals to study the effects of botulism and progressive muscular dystrophy. One characteristic of both afflictions is that nerve endings are prevented from releasing neurotransmitters, resulting in paralysis. This is exactly the opposite effect of black widow venom, which forces nerves to release neurotransmitters. P. Stern and K. Valjevac, University of Sarajevo, Yugoslavia, and S. Gomez, National Hospital, Institute of Neurology, London, England, have found that rats with botulism live longer when treated with extracts from black widow spider glands. If they survive, they recover more quickly with the treatment.[38,39]

Rats with progressive muscular dystrophy, Stern and Valjevac found, retain muscle control longer and recover much more quickly when treated with gland extracts.[40] While the side effects of the venom must be treated along with the original ailments, these encouraging results may soon be surpassed as methods of collecting and purifying black widow venom improve.[38-40]

Although some spiders are harmful, they are greatly outnumbered by the thousands of species that, directly or indirectly, benefit mankind. Spiders are increasingly recognized as a valuable natural means of controlling caterpillars, aphids, mites, and grasshoppers in apple and peach orchards; in soybean, cotton, and alfalfa fields; and in avocado and citrus groves.[41] M. Nyffeler and G. Benz, Swiss Federal Institute of Technology, Zurich, report that spiders have been introduced into rice fields in the People's Republic of China and other Asian countries to help control the more than 800 species of rice pests.[42] And around the world, spiders quietly and consistently keep insect populations in balance—annually destroying 100 times their number in insects.[17]

There are about 800 arachnologists in the world, according to Jonathan Reiskind, Department of Zoology, University of Florida, Gainesville, Florida 32601, president of the American Arachnological Association. His address is also the present address of the association, which publishes the *Journal of Arachnology*.[43]

Reiskind's figure includes amateur arachnologists, who contribute a great deal to the field, but excludes acarologists, who study mites and ticks.[43] The number of professional arachnologists worldwide "is probably 300 to 400 at most," says Herbert W. Levi, Harvard University Museum of Comparative Zoology.[44] Furthermore, many arachnologists combine their study with other fields, such as biochemistry, ecology, or physiology.[43]

Arachnologists are sometimes entomologists as well, or are closely associated with them. Many belong to entomological societies such as the Entomological Society of America, 4603 Calvert Road, College Park, Maryland 20740,

which publishes the *Annals of the Entomological Society of America*. Arachnological work appears often in entomology journals.

The British Arachnological Society, 42 Lakeland Park, Keswick, Cumbria CA12 4AT, England, publishes the *Bulletin of the British Arachnological Society*. And most arachnologists belong to the Centre International de Documentation Arachnologique (CIDA), Laboratoire de Zoologie (arthropodes), 61 rue Buffon, F-75005 Paris, France.

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Naturalist John Henry Comstock noted in 1912, "If spiders did not occur in our fauna, and if the keepers of a zoological garden were to bring from some remote part of the world living examples of the little animals that spin from their bodies threads of silk of different kinds...and with these threads construct snares of surprising regularity for trapping their prey, the presence of such marvellous animals would attract general attention, and we would make long journeys to see them."[45]

Perhaps there is too much in the modern world to distract us from nature's everyday marvels. But whether you are fascinated by spiders or simply afraid of them for no apparent reason at all, remember that they are indeed relevant. If the aesthetic value of understanding spiders does not appeal to your sense of practicality, remember that some little known research in arachnology might one day open up an important pathway to solving many practical human problems.

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