CONTENTS

"LISTENING" IN THE AIR

For an animal of their size, jumping spiders have extraordinarily good eyesight and see as well as some primates. Recently, researchers used tiny micro-electrodes implanted in the brain of the North American jumping spider *Phidippus audax* (Salticidae). They wanted to identify the part of the brain used to process the visual information coming from its two big, forward-facing eyes, which allow these spiders to see as well as they do.

"LISTENING" TO BRAINS

When a researcher stood up, their chair squeaked on the floor and the spider's brain responded. As part of the recording device, when the electrodes in the spider's brain picked up a signal from the firing of nearby nerve cells, it caused a "pop" sound in a speaker that the researchers could hear. Soon, the researchers were clapping their hands from 10–15 ft (3–5 m) away and with each clap came a pop sound from the speaker. It was thought spiders can only "hear" sounds nearby and those far away are only audible to an animal with a tympanic membrane. They found the frequencies to which the spider responded matched the sound of the wing beats of parasitoid wasps, a jumping spider enemy.

~ Jumping spiders can hear ~

Previous research had shown that jumping spiders freeze when they hear parasitoid wasps flying nearby. Sensory hairs on the spider's legs are moved by sound vibrations and send signals to its brain. It is amazing to think jumping spiders may be able to hear you talking from across a room.

SPIDER HEARS A VIOLIN

The special sensory hairs on the legs of spiders that can pick up airborne vibrations are called trichobothria. This was discovered in the late 19th century by a spider specialist who was looking at the hairs on a spider's leg. He noticed that the hairs moved in response to the sound coming from a violin being played nearby. The researchers who discovered that jumping spiders could hear sounds from much farther away than previously thought have also been looking to see whether fishing and wolf spiders can hear sounds from a distance too. Since all spiders have trichobothria it is not surprising that they can. Talk to spiders in different tones and they may respond.

↓ Although jumping spiders are famous for their eyesight, the North American jumping spider *Phidippus audax* showed researchers that they are able to hear sounds very well too.

AMAZING EYES

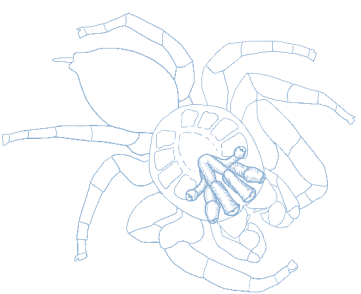
Although most spiders have eight eyes, the majority have poor eyesight and rely on vibrations, touch, and chemical cues to perceive their world. The exceptions are exceptional, from jumping spiders with tiny telescopes inside their heads to net-casting spiders with the equivalent of night-vision goggles (see Chapter 7, page 92).

JUMPING SPIDER EYES

Jumping spiders are unusual because, unlike the majority of spiders, they are active during the day and rely on their excellent vision to find prey and mates and to avoid predators. From the outside the spider's most distinctive feature are the two large, forward-facing eyes with their convex lenses. Behind these lenses extend two long eye tubes.

~ Incredible vision ~

Just like our own camera-like eyes, the lenses in the principal eyes of jumping spiders focus images on a retina. In jumping spiders the retina lies at the end of the eye tube and is made up of four different layers. Due to the length of the eye tube and a second lens close to the retina, the eyes work a bit like a telescope and make distant objects appear closer. The first three layers of the retina allow the spider to see different colors, while the rear layer has the highest number of light-sensitive receptors and allows the spider to see details about one-sixth as good as our own eyes.



→ A jumping spider's two large, telescope-like eye tubes combined with the six smaller eyes means that it has excellent eyesight.

FLY TIGERS

Hundreds of years ago, the Chinese called jumping spiders "fly tigers" because they hunt prey like a tiger. Researchers have similarly called them "eight-legged cats," and when you watch a jumping spider stalk prey, it is easy to see why. While no other spiders, or any animals of a similar size, have eyesight to rival that of a jumping spider, wolf spiders and crab spiders both have reasonable eyesight and can see objects they are close to. Male wolf spiders even wave their front legs at females during courtship. Crab spiders can see nearby prey and will grab it with their long front legs.

~ Tiny retinas ~

Since the image captured by the front lenses is so much bigger than what can be captured by the relatively tiny retina, the spider has muscles around the eye tubes and can move them around to scan what the lenses are looking at. Each retina is shaped like a boomerang, the center of which has the highest density of photoreceptors. This is similar to the fovea centralis of our own eyes, which allows us to see in incredible detail. By scanning with both eyes, so the viewing area of the two boomerangs comes together and forms an X-shape, the spider can see the details of what it is viewing. Two of the spider's other six eyes are located beside the main eyes and the other four eyes are behind them. These are much simpler than the main eyes, but are excellent motion detectors, giving the spider a 360-degree view of its world. The eyes either side of the main eyes are essential for guiding the spider to look at the detail of an object. Researchers have described this as similar to looking around a dark room with a flashlight, while motion detectors tell you where to look.

SNIFFING PERFUMES

Native to East Africa, *Evarcha culicivora* (Salticidae) dines on mosquitoes filled with human blood. The spiders are able to target blood-engorged female mosquitoes and drain them of their blood meal. Male mosquitoes do not drink blood.

BLOOD-BASED PERFUME

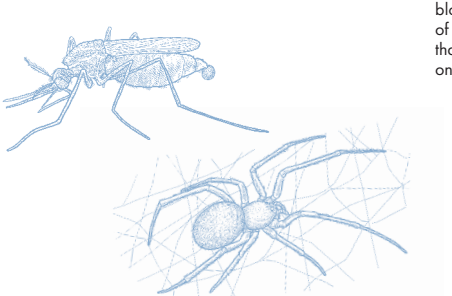
Once the blood is inside the spider it is not only used as a meal. It is also used to make a perfume (pheromone) that makes both males and females more attractive to each other. The blood-based aphrodisiac lowers the threshold of both sexes to mating. Possibly, the bloody perfume tells both sexes that they are good at hunting and would make good parents for their offspring.

Given spiders are mostly solitary, many different adult females produce airborne perfumes to tell males where they are located and that they have not mated. By following the female's scent the male can find her. He can then court her to see if she considers him a worthy suitor to father her offspring.

↓ A female mosquito (*Anopheles gambiae*) with an engorged abdomen after feeding on blood, possibly passing on malaria.

↓ When a female wolf spider *Pardosa milvina* (Lycosidae) detects a courting male's silk, she spins more of her own attractive silk.

→ Sitting on a leaf near Lake Victoria, in Kenya, a female vampire spider, *Evarcha culicivora*, feeds by sucking human blood from the body of a female mosquito that has recently fed on a person.



BUILDING AN ORB WEB

Researchers in the United States wanted to see the details of orb web building to gain insights into how a spider's tiny nervous system can build such an elaborate structure.

ARTIFICIAL INTELLIGENCE

Using six female hackled orb web spiders—*Uloborus diversus* (Uloboridae), native to the western United States—researchers at Johns Hopkins University built an arena in their lab to record their web building, which takes place at night over a number of hours. They used infra-red cameras and lights, so they could film the spiders in the dark. Recording every movement the spiders made during web building would have involved analyzing millions of individual movements. But the researchers had help from an artificial intelligence program that had been trained to track the movement of limbs. It monitored the movements of 26 different points on each spider—3 points on each of its 8 legs and the front and rear of the spider—as the 6 spiders built 21 different webs.

STICKY STRETCHY DROPLETS

Orb web spiders have very elastic webs that can absorb the impact of a flying insect without breaking. Gluey droplets are also added to the spiral lines of orb webs, which look like beads arranged along a string. The droplets are not only sticky but, like the web, also very elastic. When prey fly into the web, the droplets stretch but do not detach from the silken threads. As the web relaxes from the impact, the stretched glue also bounces back to the shape of droplets. This causes them to stick to prey and trap it in the web, before the spider rushes across and captures its detained meal.

↑ The orb web stabilimentum of a species of *Cyclosa* (Araneidae) from the Philippines may deter birds from flying into it. *Cyclosa* are known as trashline orbweavers.

~ Web development ~

The researchers found that each spider built its webs using similar movements for each stage of the webs' construction. The finished webs may have looked slightly different from one another, but the steps required for their construction were very predictable. Just knowing the position of a spider's legs told researchers what part of the web the spider was building.

~ Tiny brains ~

The results suggest to researchers that a web-building program is encoded into spiders' brains. It is amazing that such a high level of behavioral complexity can come from such a tiny brain.

LIQUID GOLD

The evolution of silk in spiders has been compared to the evolution of flight in insects as being responsible for the incredible diversity of species in both groups. The strength and elasticity of silk has seen it evolve for use in a seemingly endless number of ways, from ingenious prey-trapping devices to silken retreats high in the Himalayas and ones beneath the sea. While many people associate spider silk with webs, new discoveries, such as the lassoing acrobatic ant-slaying spider, see it used in almost unimaginably clever ways.

Spider silk is stored as a liquid in silk glands inside the spider's abdomen. There are ten different types of silk glands and spiders can have up to seven different glands, with each gland producing different types of silk. For example, web builders have glands that produce silk for building webs, capturing prey, wrapping prey and eggs, ballooning, and making safety draglines.

WEB DECORATIONS

Some of the spiders that build orb webs decorate the hub of their web with a silken decoration known as a stabilimentum. These may be a spiral or cross of thick lines, or some other shape. The St. Andrew's cross spider, *Argiope keyserlingi* (Araneidae), is named after the cross-shaped stabilimentum in its web. These silk decorations were so named because it was originally thought they helped stabilize the web. Research has shown this is not the case. The decorations are more likely used to deter predators like birds from flying into the web. Since the only orb web spiders with stabilimenta are in their webs during the day, it seems a good explanation for reducing risk for an exposed web spider.

SPITTING SILK

Spitting spiders (Scytodidae) produce silken threads from silk glands in their abdomen. They also have a large gland in their head filled with a silk-like liquid and glue. They use this mixture as a liquid weapon to trap prey, similar to the sticky threads of an orb web. The mixture is fired out of the spider's enlarged fang ducts in long, thin fibrils. Since the spider shakes its head from side to side as it fires, the prey is covered in two zigzag lines of liquid silk and glue. Almost immediately the silk shrinks by about 60 percent and this contraction and the sticky glue trap prey long enough for the spider to inject its venom.

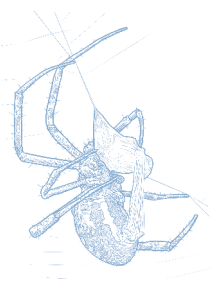
FROM LIQUID TO SOLID

Pulling silk as it emerges from the spider's spinnerets (silk-spinning organs at the end of the abdomen) causes a change in how the proteins making up the silk are arranged, so they form a solid thread. The liquid silk travels along a narrowing duct until it reaches spigots, which are tiny, tube-like pores on the spinnerets, and from here it is pulled out as a silken thread.

FROM LIQUID TO LIQUID

The glue droplets used to trap prey, mostly flying insects, in orb webs remain as a liquid from inside the silk gland to when they are applied to the spiral lines of the web. Once on the web the elastic sticky droplets stop prey from escaping.

↓ *Argiope picta* (Araneidae), a species of orb web spider, pulls out swathes of silk and uses this to wrap prey it has just captured.



HANGING BY A THREAD

Just as mountain and rock climbers often attach themselves to an anchored length of rope to prevent injury if they fall, many spiders are also anchored as they move around their environment. In the case of jumping spiders, which can jump up to around forty times their own body length, an anchored safety line of silk means that if they fall, they only drop the length of the lifeline. The safety line also stops the spider's body from drifting to the left or right as it jumps and is used as a brake to slow the spider down as it lands. This means the spider lands on its legs and is not traveling as fast as when it first jumped.

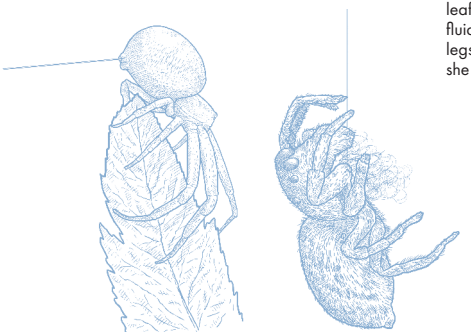
FLEEING AND FEEDING

Web spiders will drop on a dragline of silk when threatened by predators or parasitoids. A crab spider—species of *Mystaria* (Thomisidae)—from Africa hangs from a silk line while feeding.

↓ Having jumped onto a leaf, a female goldenrod spider, *Misumena vatia* (Thomisidae), still has a dragline of silk.

↓ The jumping spider *Hypoblemum albovittatum* (Saliticidae) climbs a dragline and gathers up the silk.

→ This female zebra jumping spider, *Salticus scenicus* (Salticidae), is preparing to launch herself from a leaf. After attaching a safety dragline of silk to the leaf, she increases the fluid pressure in her rear legs. They straighten and she becomes airborne.



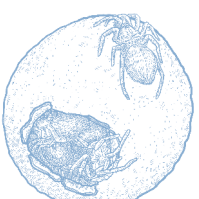
PROTECTIVE COCOONS

Female spiders lay eggs and use silk to varying degrees to protect the developing embryos once they are outside her body. Some species only cover the eggs with a few strands of silk and guard the eggs inside a silken nest. But many species build elaborate silken cocoons with a soft, pillow-like layer on which the eggs lie and a tough, thick outer layer of silk to keep the humidity inside the cocoon high enough to prevent the eggs drying out.

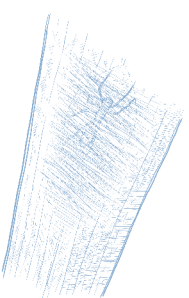
SILKEN FORTRESSES

The silken fortresses created by some spiders also protect the eggs from egg parasitoids, like some flies and wasps, which will lay their own egg inside a spider egg, as well as predators that eat spider eggs. Often, egg cocoons are camouflaged with debris, while others match the color of the background, so they blend in. Spiderlings emerge from the eggs and remain inside the cocoon until they have molted at least once before leaving.

↓ Young cobalt blue tarantulas, *Cyriopagopus lividus* (Theraphosidae), emerge from an opening in their egg sac.



↓ Female ant-mimicking jumping spiders *Myrmaplata plataleoides* (Salticidae) guard their eggs inside a silken nest.



→ With a bowl-shaped egg sac, a female wasp spider, *Argiope bruennichi* (Araneidae), sits in her web. The baby spiders remain inside the egg sac during winter and then emerge in the summer. The female's yellow markings act as a lure to flying insects.

SPIDERS CAN FLY

Since the 19th century it has been observed that very small spiders can travel vast distances by using silk to become airborne. The spider points its abdomen upward and releases a thread or threads of silk. Wind currents lift the spider off the ground and into the air. Called ballooning, although it is more like kiting, it was thought that this is how spiders came to colonize remote islands. Traveling by air for spiders can be very hazardous, unless they only travel a short distance and can alight on land. Longer flights increase the risk of being preyed on by birds or landing in the sea. Spiders have even been picked up by planes that were flying at high altitudes.

ELECTRICALLY CHARGED SPIDERS

Spiders have also been observed kiting when there was no wind to lift them. Spiders weighing around a hundred times more than was thought possible for kiting have also been seen flying. Recently, it has been shown that the threads of silk released from spiders before they become airborne are negatively charged. Given that the surface of the Earth is also negatively charged, the electrostatic repulsion between the negatively charged silk and the Earth allows the spiders to become airborne without any air currents.

~ Sensing electricity ~

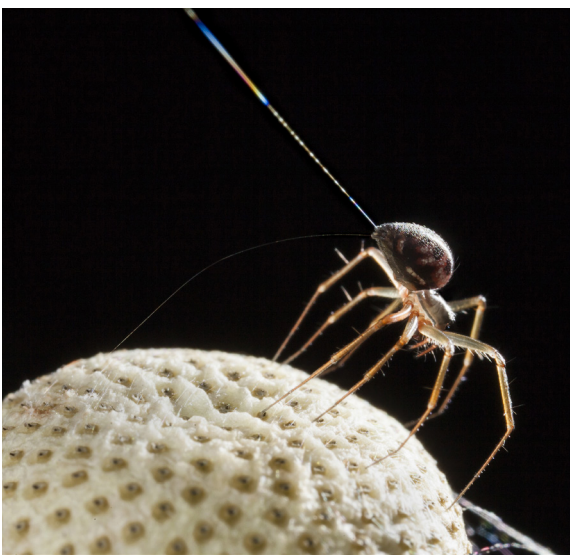
Special sensory hairs on spider legs, called trichobothria, can detect electric fields. In a large, windless container researchers showed that spiders ballooned when an electric field was present. They did not balloon when the field was turned off.

→ Sitting on a tiny seedhead, this money spider—a species of *Tenuiphantes* (Linyphiidae)—prepares to be carried away, attached to its dragline, by wind currents.

FLYING IN THE 19TH CENTURY

In 1883, an enormous volcanic explosion blew apart the island of Krakatoa, located off the coast of Java. Three months after the explosion, visitors to the new island created from the explosion found small spiders living there. The only way they could have arrived on the island was by kiting from the mainland 20 miles (32 km) away.

When Charles Darwin (1809–1882) was traveling the world on HMS *Beagle*, he noticed hundreds of tiny spiders had drifted onboard the ship when it was 60 miles (100 km) from the coast of South America. They had also ballooned from the mainland and then ballooned from the *Beagle* and continued on their journey.



ANT EATERS

Less than 1 percent of known spiders eat ants because they are aggressive and can sting and bite. However, some spiders have evolved very novel ways to use silk, so the ants' defenses do not pose a threat.

ACROBATIC ANT SLAYER

The Australian ant-slayer spider, *Euryopis umbilicata* (Theridiidae), is probably one of the most remarkable ant-eating spiders. This spider can even take on an aggressive ant, the banded sugar ant, which is twice its size. It also captures its prey around 90 percent of time. This is almost double the success rate of a predator like a lion or wolf. During the day the spider hides under the bark of eucalyptus trees. After dusk the ant slayer emerges and, facing downward, attaches itself to the bark with a single silken line. It waits for an ant to walk by as it climbs the trees looking for food.

WRAPPING AND RUNNING

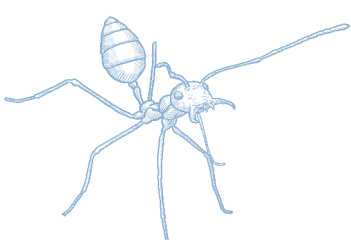
Flatmesh weaver spiders—species of *Oecobius* (Oecobiidae)—build flat webs, which are used for shelter and waiting for prey rather than hunting. These spiders are also known as star-legged spiders because all their legs point outward like an eight-legged starburst. This leg arrangement helps the spider with its unusual method for catching ants, its common prey. Attached to the spider's shelter are long lines of silk that act as trip-wires if prey comes into contact with them. When the spider picks up vibrations from a trip-wire, it rushes from its shelter and runs around the prey, covering it in a shroud of fine silk strands. It then bites the prey and takes it back to its shelter to feed.

ANT BASKET

The Australian basket web spider, *Saccodomus formivorous* (Thomisidae), is not only unusual for what it eats but also how it traps its prey. This spider eats ants and catches them with a basket that looks like a lobster pot. While the pot has a diameter of about 7/16 in (11 mm) and a length of about 9/16 in (14 mm), it is a rigid structure, unlike a web. The spider taps its legs on the basket to lure ants inside, then quickly injects them with venom. Researchers have found that the basket always contains an egg sac made of a similar silk to the one used by spiders to wrap their eggs. The basket web spider has used this silk not only to protect its eggs, but also to make an elaborate trap for ants.

~ Somersaulting spider ~

Using high-speed cameras, researchers filmed what an ant-slayer spider does when it launches an attack. It happens so quickly that it is impossible to see without slowing down the action. When the ant is close enough, the spider launches itself into the air and, traveling at about 10 in (25 cm) a second, somersaults over the ant, dragging a line of sticky silk behind it. It attaches this line to the ant before hanging freely while still attached to the silk. These acrobatics take place in about a tenth of a second. The spider then climbs back toward the ant and covers it in more sticky silk before injecting it with venom and dragging it away for feeding. The acrobatic ant slayer could be the inspiration for a spider-like superhero!



→ A green weaver ant (*Oecophylla smaragdina*) in an aggressive pose: holding open its very sharp mandibles.

SPERM WEBS AND EGGS

Spiders have a pair of short, leg-like appendages called palps on either side of the chelicerae. These are used by males and females as sensory organs and to help hold prey. In males they are also modified to hold and transfer sperm to inside the female's epigynum (genital opening).

CHARGING PALPS

Although males make sperm in their abdomen, there is no internal route for the sperm to travel from this site to the palps. Instead, males make a silken sperm web that is used to temporarily hold the secreted sperm before it is drawn up inside the palps. Some male spiders have palps that look similar to those of females, while others resemble miniature boxing gloves. Once males have molted a final time and are

PROTECTING FATHERHOOD

After mating, male spiders have evolved strategies to try and ensure they will be the only father of the female's offspring. They want to ensure their sperm will fertilize the female's eggs, rather than that of a competitor that may remove their sperm and replace it with their own. One of the most extreme strategies must be those of male *Nephila komaci* (Araneidae). Following mating, where they transfer their sperm to the two genital openings of the female, males break off both their palps and leave them inside the female as a physical barrier to other males mating. The eunuch males, who live for about a year, then spend their time guarding the female from the advances of other males.

adults, they transfer sperm to their palps. With charged palps the behavior of the male spider changes: it may no longer feed and instead will go searching for females. While most females live for a year or two, many adult males are only around for a few weeks.

FERTILIZING EGGS

Females produce eggs in their abdomen and various ducts connect the eggs to the female's genital opening. During mating the male's palp fits inside the female like a lock and key. Most males can only transfer sperm to females of the same species.

STORING SPERM

The sperm is stored inside the female in special packages called spermathecae and when she is ready to lay eggs, the stored sperm is used to fertilize the eggs.

← Male jumping spider *Cosmophasis umbratica* (Salticidae) from Singapore courts a nearby female by showing off his bright yellow pedipalps and dance moves.

COURTING WITH AND WITHOUT GIFTS

Spider courtship can be complicated since they are predators and it is prey rather than potential mates with which they usually interact. While most female spiders are bigger than the males, both sexes will cannibalize each other. Males and females need to be on guard and tread carefully in the mating game.

Since different spiders perceive the world with different senses, courtship signals are sent in many different ways and are usually initiated by males. Most web builders do not have good eyesight and males court by plucking the web to signal their intentions to females. Jumping spiders have excellent eyesight and males will perform elaborate dances for the females. Wolf spiders have reasonable eyesight and the males wave their legs at females and drum their palps on the ground. Females often prefer the fastest drummers. Displays identify the male as a potential mate rather than a meal, though both outcomes are possible.

COLORFUL DANCER

Probably the most colorful spider courtship displays are by tiny (1/16–1/4 in/2–6 mm) jumping spiders from Australia—around 50 species of *Maratus* (Salticidae). They are called peacock spiders and it is easy to see why. While the females are plain brown, the male's third pair of legs are elongated and tipped with white tufts of hair. Many males have fan-like flaps on their abdomen, so they can make it wider and turn it into a courting canvas covered in scales that produce a kaleidoscope of garish colors. By waving their abdomen and legs in synchrony and dancing energetically, the males try to convince females they would make great fathers.

DEVIOUS SUITOR

In Australia, a female jumping spider—a species of *Euryattus* from Queensland (Salticidae)—makes her home inside a rolled-up leaf hung from silken threads. Male *Euryattus* climb down the silk and court the female by shaking her leaf with vibratory signals. If she emerges and is keen, he will dance for her. *Portia fimbriata* (Salticidae) is a jumping spider that hunts other spiders. The male climbs down onto the female's leaf and mimics the vibratory courtship display of male *Euryattus* to entice the female out of her leaf, so he can eat her.

Pheromones on the silk of the North American female wolf spider *Gladicosa bellamyi* (Lycosidae) can tell the male if he should attempt to court her. They tell him whether she has mated or not before and, most importantly, whether she has cannibalized previous suitors. It is not surprising that males avoid courting female cannibals.

GIVING GIFTS

Whether they are strummers, drummers, or dancers, males also show their worth as a suitor by giving the female the insect equivalent of a box of chocolates—the perfect gift might be an insect wrapped in silk.

~ Deceptive gifts ~

Some males nibble on part of the gift and give the female a partially eaten box of insect chocolates. Other males that couldn't quite capture an insect gift give the female a silk-wrapped leaf. The next level of deception is to give the female an empty silk wrapping. By the time the female realizes she has been duped with the empty wrapping, the male has mated and left.

↓ A male nursery web spider, *Pisaura mirabilis* (Pisauridae), carries a worthless gift in an attempt to deceive a courting female.

MALES FIGHTING MALES

When engaged in combat, two males will eye each other up before locking tusks and pushing and shoving. While it's easy to imagine this is a fight between elephants, it is actually between two tusk-bearing jumping spiders.

TUSKED SPIDERS

With a body length of around 3/16 in (5 mm), the tiny jumping spider *Thorelliola ensifera* (Salticidae) is common in rainforests in Southeast Asia. Just below the two large, forward-facing eyes, which are common to all jumping spiders, the males have two curved tusks (around 0.02 in/0.5 mm long), which extend horizontally out from the spider's face.

DYING FOR A FIGHT

Although male spiders often compete for mating opportunities with females, it is much rarer for females to compete with one another. With the common North American jumping spider *Phidippus clarus* (Salticidae), it is not unusual for two females to fight until one is badly injured or killed. Unlike males, it is not the biggest or strongest female that is likely to win. And it is also not a female defending her silken nest made within a rolled-up leaf that is likely to win. It is females about to molt to sexual maturity that do not have a nest, which is necessary to molt safely, that are prepared to fight to the death for a resource necessary for survival.

These are enlarged hairs, which are also found on females, but they are much smaller and look like the hairs covering the spider's body. Another difference is that the chelicerae of females are convex (curved outward), while those of males are concave (curved inward).

~ Contests of strength ~

When the little tuskers eye each other up, the smaller male usually runs away. It is only when the two males are the same size that they come together and lock tusks for a few seconds. This usually ends with one male unlocking their tusks and running away.

~ Charging males ~

Sometimes, if the contest of strength is not decided quickly, the fight escalates and the males will charge at each other, locking tusks and jaws as well as shoving each other with their outstretched front legs. A full-on charge is settled after one male retreats and runs away. The victor is likely to be a successful suitor for nearby females.

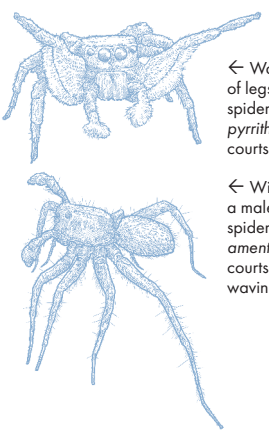
← The forward-facing curved tusks of the jumping spider *Thorelliola ensifera* are used in contests of strength with rival males. Only males of the same size compete in this way.

FEMALES FIGURING OUT MALES

Like the females of most species, female spiders invest a lot more in reproduction than males. Most female spiders are bigger than most males and need to eat more to have sufficient nutrient reserves to produce eggs. After laying eggs, females vary in how much they invest in protecting and feeding their offspring. All that males invest in the development of offspring is mating with females that use their sperm to fertilize their eggs. It is not surprising that many females want an indicator of the genetic fitness of the male that will father their offspring.

DANCING MALES

Females may choose males on the basis of their elaborate courtship behavior. Many male jumping spiders have garish colors and impressive dance moves. This is to show females that they are a good investment and, by sharing their genes in the next generation, they will produce males with impressive dance moves and females that make good choices.



← Waving his front pair of legs, the jumping spider *Habronattus pyrrithrix* (Salticidae) courts a female.

← With extended legs, a male spotted wolf spider, *Pardosa amentata* (Lycosidae), courts the female by waving his palps.

→ While the rather drab-colored, but camouflaged, female peacock jumping spider, *Maratus speciosus* (Salticidae), looks on, a colorful male performs elaborate dance moves with his legs and body. His colorful abdomen is fringed with orange hairs, which are only visible during courtship.

MATING WITH CANNIBALS

Mating with cannibals is how the reproductive lives of spiders is often imagined. The most infamous spider cannibal is probably the black widow spider *Latrodectus mactans* (Theridiidae), although the females only kill and rarely eat the males after mating. The myth may have started because males and females were often kept in cages from which the males could not escape and so they became prey. In nature, males almost always live to mate another day.

FEMALE CANNIBALS

Female redback spiders from Australia, *Latrodectus hasselti* (Theridiidae), cannibalize over 60 percent of males during mating. The female has two genital openings leading to separate sperm storage organs. During mating, the male inserts his palp into one of the openings and transfers sperm. He also twists the rear end of his abdomen into the fangs of the female who begins to feed on the male. The male is much smaller than the female, so he is more of a snack than a full meal. To guarantee he will father all or most of her offspring, the male also needs to insert his second palp into the female's second genital opening.

GRUESOME SUCCESS

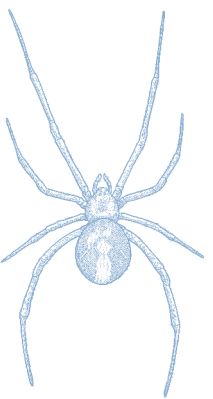
For one tiny male orb web spider, which weighs only 1 percent of the female, mating is violent and fatal, but it has nothing to do with the behavior of the female. Before courting, the male self-amputates and discards one of his two sperm-carrying palps. When the male finds a female willing to mate, he inserts his other palp into the female's epigynum and dies. His heart stops, but the hydraulic pressure in his body focuses on transferring sperm to the female. Then she dines on the tiny snack.

DEADLY SILENCE

For some male six-spotted fishing spiders (*Dolomedes triton;* Pisauridae) in North America, courting mated females leads to a silence that speaks volumes. Doomed males that detect a nearby female start courting by sending out vibratory signals across the water's surface. When there is no reply to their signals, they move closer to the female, expecting a courting reply. Soon the silent female pounces, grabs, and eats the male whose courting signals have led to a less-than-desired outcome.

Of course, the male can only do this if he is still alive. However, the odds are not looking good because he is being consumed and still needs to transfer sperm from his second palp. If he fails to transfer sperm from his second palp, then a second male who mates with the female will transfer his own sperm to the female's second sperm storage organ. This means the first male will only father half of her offspring. But males do something extraordinary with their abdomens while courting females. They contract muscles and constrict their abdomens, so the part of their abdomen being eaten by the female is sealed off from the rest of the body. This buys the male enough time to transfer sperm from the second palp to the female before he dies and is eaten. All rather gruesome, but it does mean the male will be the father of the female's offspring. In closely related species of *Latrodectus*, where the risk of sexual cannibalism is low, males do not constrict their abdomens.

↓ Mating with the highly cannibalistic female redback spider, *Latrodectus hasselti,* can be a life-changing experience for males.



MATERNAL INSTINCTS

Many female spiders show no maternal care beyond laying their eggs in a protective egg sac. Others stay to protect and feed their offspring until they can survive on their own. Some male spiders allow themselves to be eaten by the female. After mating, they become a nutritious gift to help the development of the offspring they have fathered. Similarly, some female spiders become the last meal their offspring have before leaving the nest.

FEEDING BABIES

A social Australian crab spider *Australomisidia ergandros* (Thomisidae) lays only one clutch of fertilized eggs. The female keeps a second clutch of unfertilized eggs inside her body, which she converts to hemolymph and her babies start to feed on her body (behavior known as matriphagy). Over a few weeks, her body shrinks as the babies grow bigger. Larger cannibalized females produce bigger and more offspring since there is less sibling cannibalism than those feeding from a smaller female.

↓ A female fishing spider *Pisaurina mira* (Pisauridae) protects her egg sac by holding it with her chelicerae.

↓ Offspring of the desert spider *Stegodyphus lineatus* (Eresidae) gather around their mother's mouth to feed on regurgitated food.

→ A female wolf spider (Lycosidae) with around 100 babies on top of her abdomen. The female carries her egg sac around and when it hatches the babies climb onto her back, clinging to each other and to hairs on her abdomen.

SPIDER SYRINGES

Almost all spiders produce venom, which they inject through a pair of fangs into their prey to paralyze them. Two venom glands each have a duct that travels from the gland and down to the fang duct. When muscles around the gland contract, venom is squeezed out of the gland and moves down and out of the fang duct. Spiders can alter how much venom they inject into prey by controlling how much the gland is squeezed. If the initial injection does not subdue the prey, the spider will inject more venom.

HOW FANGS STAB

The fangs are located at the bottom of the muscularly powerful basal segments of the chelicerae, which help the spider stab prey. Within the basal segments are muscles that open and close the fangs.

(continued...)

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