Asymmetry in Animals

As left-right asymmetry turns up here and there in the radially symmetric world of plants, so also does it turn up in the bilaterally symmetric world of animals. An entire volume could easily be devoted to these asymmetries. We have space only to discuss a few of the most interesting examples.

As in the plant world, asymmetry is automatically introduced whenever a single helix forms part of the structure of an animal. Of course, when a helix on one side of an animal's body is balanced by a helix of opposite handedness on the other side, bilateral symmetry is preserved. This applies to pairs of tusks that have helical twists (for example, the tusks of extinct mammoths), and to the large magnificent horns of rams, goats, antelopes, and other animals. Many large bones in the chest, legs, and other parts of animals (including man) have helical twists, but those on the left side have their mirror counterparts on the right. Insect antennae sometimes coil in pairs of enantiomorphic helices. The wings of birds, bats, and insects also have slight helical twists of opposite handedness on opposite sides of the body.

When a single helix is prominent in the structure of an animal, then an obvious asymmetry exists. Many types of bacteria and the spermatozoa of
all higher animals have such helical structures, but the most striking examples are provided by the shells of snails and other molluscs. Not all spiral shells are asymmetric. The chambered nautilus, for instance, coils on one plane and therefore can be bisected, like a spiral nebula, by a plane of symmetry. But there are thousands of beautiful molluscan shells, such as those shown in Figure 27, that are obviously either right-or left-handed conical helices. As in the case of twining plants, most shells of this type are right-handed, but both types of handedness are common. Some species are always right-handed, some always left-handed. Each species has occasional "sports" that go the wrong way; they are rare and much prized by shell collectors. Thousands of different species of fossil shells, with right- or left-handed helices, have been classified by the paleontologists.

An odd type of helical fossil known as the devil's corkscrew is found in great abundance in parts of Nebraska and Wyoming. These are huge quartz spirals, 6 feet or more in height, that are sometimes right-handed, sometimes left-handed. For decades, geologists argued with each other about what they were, the chief division being between those who thought they were fossils of long-extinct twining plants and those who thought they were casts of helical burrows made by ancestors of modern beavers. The beaver theory finally won out after remains of small beavers were found in some of them. Similar spiral fossils, of similar origin, are found in parts of Europe.

A remarkable instance of helical flight is furnished by the hundreds of thousands of Mexican free-tailed bats that sleep in the limestone caverns of Carlsbad, New Mexico. Joseph Wood Krutch in his book *The Desert Year* (Sloan, 1952) gives a vivid description of how these bats, when they swarm out of a cave, invariably gyrate upward in a right-handed spiral. Mr. Krutch wonders just how the bats managed to agree on which type of helix to adopt. "Their convention is certainly a 'socially useful one,'" he writes. "Without it, a bat would find leaving the cave almost as dangerous as driving to work in a car."

Is it possible that Coriolis forces have something to do with this: that bats tend to emerge from northern hemisphere caves in right-handed helices, from southern hemisphere caves in left-handed helices? Krutch checked with a number of leading bat authorities but was unable to find any significant information bearing on the question. A Coriolis influence seems highly unlikely; nevertheless, the handedness of helical paths taken by emerging bats remains an interesting area that seems not to have been explored by the naturalists. "Perhaps someday someone will turn a discarded wind tunnel on end," says Mr. Krutch, "and put a few hundred bats at the bottom of it. . . . The bats have got into my belfry . . . . I can already see my application to one of the foundations. Proposed Project: 'A Study of the Coriolis Effect in Relation to Bat Flight.'"

Turning to animal asymmetries other than helical, one of the most absurd is the huge left or right pincer of the male fiddler crab (Figure 28). The large claw is left or right with equal probability. The little crab makes a kind of fiddling motion with this pincer, which gives the crab its name. Among birds, a pleasant example of asymmetry is provided by the crossbill, a small red bird in the finch family. The bird's upper beak crosses over the lower beak like the blades of a pair of scissors, and, like

![Figure 27](https://via.placeholder.com/150)

*Figure 27* Some right-handed mollusc shells: Thatcheria (*a*), Natica (*b*), and Fusinus (*c*). (Copyright © 1982 Discover Magazine, photographs by Paul Taylor.)

![Figure 28](https://via.placeholder.com/150)

*Figure 28* The left-handed fiddler crab.
The eyes turn independently; the fish can look forward with one, backward with the other, or even turn completely around, as the bird matures, the organs on the right degenerate and become useless. Only the left oviduct, which greatly enlarges during the egg-laying season, remains functional.

In the fish world the outstanding instance of asymmetry is supplied by the flatfish, a large family which includes the soles and flounders. The young of these fish are bilaterally symmetric with respect to their ovaries and oviducts. In young birds, both the left and the right ovaries and their ducts are equal in size; as the bird matures, the organs on the right degenerate and become useless. Only the left oviduct, which greatly enlarges during the egg-laying season, remains functional.

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The female birds of all genera, with few exceptions, exhibit a curious left-right asymmetry with respect to their ovaries and oviducts. In young birds, both the left and the right ovaries and their ducts are equal in size; as the bird matures, the organs on the right degenerate and become useless. Only the left oviduct, which greatly enlarges during the egg-laying season, remains functional.

In the fish world the outstanding instance of asymmetry is supplied by the flatfish, a large family which includes the soles and flounders. The young of these fish are bilaterally symmetric with an eye on each side. They paddle about near the surface of the sea, but as they grow older, one eye slowly migrates around over the top of the head until both eyes are on the same side, like the eyes in the profile of a face painted by Picasso. The poor fish then sinks to the bottom of the sea, where it lies in the mud or sand, on its eyeless side, with its two eyes projecting upward. The eyes turn independently; the fish can look forward with one, backward with the other. The blind underside of the fish is whitish, but the upper side is colored and speckled to imitate the bottom of the sea. Some species even have the power of altering their color to conform to wherever they are lying and thus better escape detection by enemies.

There are hundreds of different species of flatfish, most of them with eyes invariably on the right side, others that always have their eyes on the left. The halibut, for example, is a dextral, or right-eyed, flounder; the turbot is a sinistral, or left-eyed, flounder. There are dextral soles found only in European waters, sinistral soles found only in tropical and semitropical waters. In every species an occasional "sport" will differ in handedness from his cousins. There is an interesting discussion of flatfish in Chapter 7 of Charles Darwin's Origin of Species. (Darwin replies effectively to a critic of evolution who maintains that there is no conceivable way by which the peculiar migration of the flatfish eye could take place as a result of natural selection.) See also "The Asymmetry of Flounders," by David Policansky, in Scientific American, May 1982.

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The anableps, the little "four-eyed" fish mentioned at the end of the preceding chapter, has an asymmetric sex life which is absolutely unique among vertebrates. Its young are born alive, which means that a male must fertilize the female's eggs inside her body. But the female has an opening only on the left or right side, and the male organ is also only on the left or right. In other words, each individual fish is sexually either sinistral or dextral, their genetically programmed behavior making it impossible for two fish of the same handedness to mate. Fortunately, the handedness of both males and females is mixed 50-50; if both sexes had the same handedness, the species would soon be in serious trouble. Here we have an amusing analogy in the fish world to the mating of the bindweed and honeysuckle.

The tusks of animals (tusks are simply teeth that have been enlarged to serve some special purpose), such as those of the elephant and walrus, are seldom exactly the same size. Usually a species tends to be either right- or left-tusked, in the sense that one tusk is a bit larger than the other and more often used. In Africa, the right tusk of elephants is sometimes called the servant tusk, because the elephant prefers to use it for digging.

The narwhal, a special of small whale that flourishes in north polar seas, exhibits the most extreme example of asymmetric tusk development. Both sexes of the narwhal have only two teeth; they lie side by side, on either side of the plane of symmetry, within the creature's upper jaw. In the female narwhal both teeth stay permanently inside the jawbone. The right tooth of the male remains similarly concealed throughout life, but the left tooth grows straight forward into an ivory tusk which is longer than half the whale's length! If the whale has a length of 12 feet from tail to snout, this ridiculous tooth will be 7 or 8 feet long and as straight as a spear. It is, in fact, the longest tooth in the world (see Figure 29).

Around the tusk are helical grooves and ridges, which always spiral forward in a counterclockwise direction as seen by the narwhal. On rare occasions, both teeth of a male narwhal may grow into tusks. When this happens, one might expect that, like the horns on rams and goats, one tusk would have right-handed grooves, the other left-handed ones. But no, both tusks invariably coil in the same left-handed way! This has long puzzled zoologists. One theory, advanced by Sir D'Arcy Thompson in his famous book On Growth and Form (an abridged edition was published by Cambridge University Press in 1961), rests on the fact that the narwhal swims forward with a slight screw motion to the right. The inertia of the tooth would tend to keep it in place while the body twisted, thus imparting to the tusk a torque that would cause it to rotate slowly counterclockwise as it grew forward.

"The horn does not twist round in perfect synchronism with the animal," Thompson writes, "but the animal (so to speak) goes slowly,
slowly, little by little, round its own horn! The play of motion, the lag, between head and horn is slight indeed; but it is repeated with every stroke of the tail. It is felt just at the growing root, the permanent pulp, of the tooth; and it puts a strain, or exercises a torque, at the very seat, and during the very process of calcification." Thompson's theory has been criticized, but so far no biologist seems to have found a better one.

The narwhal is sometimes called a sea unicorn because of its single "horn." In fact, during the fifteenth and sixteenth centuries the creature’s tusks were sold throughout Europe, mainly by Scandinavian traders, as horns of actual unicorns. Powder made from such a horn was widely believed to have all sorts of miraculous prophylactic properties. The racket was finally exposed by a Dutch zoologist in the early seventeenth century.

Exactly what purpose the giant tooth serves remains to this day a mystery. There is no evidence that it is ever used for stabbing enemies, as early zoologists thought, or for punching through ice to make breathing holes. During the mating season male narwhals sometimes cross horns with each other, like a pair of fencers, so it may be that the tooth’s only purpose is to serve in fighting other males as part of a sex ritual.

James Nisbet, a reader of this book’s second revision, called my attention to a strange little marine polyp called *Valella valella*. It floats on the Pacific Ocean, mouth and tentacles downward, with a triangular sail on top. The animal is longer than wide. On about half the individuals the sail is angled slightly in one direction, and on the others it is angled the opposite way. Animals with their sail running northwest to southeast are found on the North American side of the Pacific. Those with sails angled the other way are found on the Japanese side. It is believed that the two forms occur in about equal numbers in the middle of the ocean, but because they tack in opposite directions, the wind sorts them into right- and left-handed forms.

There are thousands of other striking instances of animal asymmetries: the way wings overlap on crickets, grasshoppers, cockroaches, and other insects; the asymmetric ears of certain owls that help them locate sound origins; the akita dog in Japan with a tail that curls one way on males, the other way on females; the tendency of dolphins to swim counterclockwise around tanks; the asymmetric sex organ of the male bedbug; a fungus called *laboulbeniales* that grows only on the back left leg of a certain beetle. A. C. Neville, a British zoologist, has collected many more examples in his splendid little book *Animal Asymmetry* (Edward Arnold, 1976).

What about animals’ ability to distinguish left from right asymmetric patterns, or to be taught to make left or right responses to stimuli that have no left or right cues? You’ll find a good summary of the research that has been done on both questions in Chapter 4 of *The Psychology of Left and Right*, a valuable book by Michael Corballis and Ivan Beale (Wiley, 1976). Octopuses, although they have excellent eyesight, are almost impossible to teach either kind of task. Pigeons do better than cats and dogs. Small children are about on the same level as chimpanzees.

Even adult humans experience difficulty in remembering whether asymmetric patterns go one way or the other. Can you recall, for example (Corballis and Beale ask), whether Whistler’s mother faces to your left or right when you view his famous painting? On a dollar bill is Washington’s face turned to your left or right? Lincoln’s profile on a penny? The profile of the king of diamonds, the deck’s only one-eyed king?

The human body, like the bodies of most animals, has an overall bilateral symmetry coupled with minor deviations from symmetry. The topic is sufficiently curious and complicated to call for a separate chapter.