Venus

The second planet in distance from the Sun, Venus has been called “Earth’s twin” because it is similar to Earth in gross characteristics, such as mass, radius, and density (see Table). In other ways, Venus is apparently different: Its atmospheric mass is almost a hundred times that of the Earth; its atmosphere is mostly carbon dioxide, rather than nitrogen and oxygen; an extensive cloud layer of concentrated sulfuric acid is present; its surface temperature is an unbearable 464°C (867°F); it rotates so that one Venusian day is equal to 243 Earth days and from east to west (clockwise as we look down from the north) in the opposite direction of most other planets. Some of these differences are due more to alternate evolutionary paths of the two planets than to totally different initial conditions.

Appearance. To the unaided eye, Venus is the brightest star-like object in the sky. It is usually visible during the night either soon after sunset or close to sunrise. It can sometimes be seen during the daytime. As observed through a pair of binoculars or a telescope, Venus exhibits a crescent-like or gibbous appearance. Similar to the Moon, Venus ranges over a full set of phases from a “new moon” to a “full moon.” This phase variation is caused by a changing fraction of the Sun-illuminated hemisphere facing toward the Earth. At “new moon,” only the dark nighttime side is seen, whereas, at “full moon,” all of the daytime hemisphere is seen. Venus undergoes a complete set of phase changes over its synodic period of 584 days. See PHASE (ASTRONOMY).

Transits of Venus. As viewed from Earth, Venus can appear to transit across the face of the Sun, although the only transits ever to have been observed took place in 1639, 1761, 1769, 1874, and 1882, until the recent pair in 2004 and 2012. By measuring the time of such transits, astronomers first attempted to calculate the distance of Earth to the Sun. However, the so-called black-drop effect, a combination of solar limb darkening and instrumental blurring, prevented adequately accurate timing to be made to accomplish the desired precision in distance. It may have been by observing such transits that the atmosphere of Venus was first detected, although the reports in 1761 and 1769 of an atmosphere may have been more because an atmosphere was expected on philosophical grounds, rather than because it was actually detected. The transits in 2004 and 2012, observed both from the ground and from space, remain highly relevant in studying the upper atmosphere of Venus, as well as in the context of detecting extrasolar planets in other planetary systems and their atmospheres. After 2012, no Venus transits will be visible from Earth until the pair of 2117 and 2125. See EXTRASOLAR PLANETS; TRANSIT (ASTRONOMY).

Clouds. The light seen coming from Venus is due entirely to sunlight that is reflected from a dense cloud layer whose top is located about 70 km (43 mi) above the surface and whose bottom lies near 50 km (31 mi) above the surface. In contrast to the Earth’s approximately 50% cloud cover, the clouds of Venus are present over the entire planet. In visible light they present a uniform appearance. However, the clouds show a banded and spotted pattern when viewed in ultraviolet light. These ultraviolet markings provide information about atmospheric motions at the cloud tops (Fig. 1). When viewed in infrared light, the clouds are silhouetted by the hot atmosphere below it, allowing the total vertical structure of the atmosphere to be deduced (Fig. 2). See ATMOSPHERE; PLANET (ASTRONOMY).
clouds to be seen (Fig. 2). A correlation exists between the cloud features seen in the ultraviolet and those seen in the infrared.

The clouds of Venus consist of a large number of tiny particles, about 1 μm in size, that are made of a water solution of concentrated sulfuric acid. Such a composition may at first seem very surprising when compared with the water clouds of the Earth's lower atmosphere. However, sulfuric acid particles are the dominant type of particles in the Earth's upper atmosphere, although the amount there is much less than the amount present in Venus's atmosphere. In the case of both planets, sulfuric acid is produced primarily from sulfur-containing gases that combine with water vapor and oxygen-containing gases. Compositional measurements made from the United States's Pioneer Venus Sounder probe, which descended through Venus's atmosphere on December 9, 1978, show that sulfur dioxide is the principal sulfur-containing gas in Venus's atmosphere. Sulfur dioxide is also the major gas species injected into the Earth's stratosphere by volcanic explosions. Such injections cause a large, but temporary, increase in the amount of sulfuric acid there.

Atmospheric composition. By far, the chief gas species of Venus's atmosphere is carbon dioxide, which makes up more than 96% of the atmospheric molecules, whereas nitrogen accounts for almost all the remainder. Trace amounts of sulfur dioxide (150 parts per million), water vapor (20 ppm), carbon monoxide (17 ppm), argon (70 ppm), helium (12 ppm), neon (7 ppm), hydrogen chloride (0.4 ppm), and hydrogen fluoride (0.005 ppm) are present in the lower atmosphere, with the concentration of the first two of these declining dramatically near the cloud tops because of the formation of new sulfuric acid there. Chemical transformations also occur in the deeper portions of the atmosphere, aided by the high temperatures there. For example, at altitudes below about 40 km (25 mi), carbon monoxide is gradually converted into carbonyl sulfide, a gas containing carbon, oxygen, and sulfur atoms. Occultations can also be used to determine precisely the structure of the upper atmosphere. By studying spectroscopically the dimming and gradual extinction of stellar or solar light as it disappears below the limb of Venus, the vertical profile of temperature and chemical species can be determined with great accuracy. This technique is called stellar/solar occultation and can be used in the ultraviolet through to the near-infrared. It has also been employed successfully for many other planetary atmospheres. The discoveries on Venus of ozone and a heavy isotope of carbon dioxide by the European spacecraft Venus Express were made with this technique. See OCCULTATION.

Carbon dioxide. In contrast to the dominance of carbon dioxide in Venus's atmosphere, the Earth's atmosphere consists mostly of nitrogen and oxygen, with carbon dioxide being present at a level of only 340 ppm. In part, this difference may stem more from temperature differences than from intrinsic differences. Over the lifetime of the Earth, an amount of carbon dioxide comparable to that in Venus's atmosphere was vented out of the Earth's hot interior. The outgassed carbon dioxide remained in the atmosphere for only a short time. Almost all of it, combined with rain, dissolved land rocks. Rivers carried the dissolved rock and carbon dioxide into the oceans, where they subsequently precipitated to form carbonate rocks, such as limestone. Venus's surface is much too hot for oceans of water to be present, and hence its atmosphere has been able to retain essentially all of the carbon dioxide vented from its interior.

Rare gases. There are two varieties of rare gases found in planetary atmospheres: those that were derived from the gas cloud (solar nebula) from which the planets formed (primitive rare gases) and those that were produced from the radioactive decay of certain elements, such as potassium, in the interior of the planets. A fundamental finding about the composition of Venus's atmosphere is the detection of much more primitive argon and neon than in Earth's atmosphere. Furthermore, Mars' atmosphere has an even smaller amount of these rare gases than does the Earth's. These differences in the abundances of rare gases among the atmospheres of Venus, Earth, and Mars may be due, in part, to sizable differences in the rates at which their earliest atmospheres were lost. See EARTH; MARS.

Water vapor. The amount of water vapor in Venus's atmosphere is much less (about 100,000 times) than
the amount of water in the Earth’s oceans. As it is unlikely that Venus was initially endowed with so much less water than the Earth, Venus probably lost almost all of its original water over its lifetime. The loss of water from a planet may be determined primarily by the amount that is in the upper atmosphere, the stratosphere, where solar ultraviolet radiation decomposes water vapor molecules into hydrogen and oxygen. The light gas hydrogen can eventually escape the planet’s gravity and be lost to space, whereas the leftover oxygen can combine with other gases, such as carbon monoxide, or with iron at the planet’s surface. Because Venus is closer to the Sun than the Earth, its lower atmosphere was hotter, water vapor was more abundant in early times there, and hence much more of the water vapor was able to penetrate into its stratosphere than was the case for the Earth. Consequently, Venus could have lost much more water over its lifetime than the Earth did. Some confirmation of this viewpoint has been given by the finding of both the Pioneer Venus and Venus Express spacecraft that there is about 100 times as much heavy water, or water containing deuterium, on Venus as on Earth. Such an enrichment of deuterium is expected, because light hydrogen can escape to space more easily than heavy hydrogen. The in-situ measurement by these spacecraft of solar wind interactions with the exosphere is helping to constrain the amount of neutral particles, ions and electrons, including atomic oxygen, hydrogen, and helium, escaping from the Venus atmosphere. These measurements can then be used to help constrain the evolutionary history of the atmosphere. See DEUTERIUM.

Temperature. By detecting long-wavelength heat radiation produced at the surface, radio telescopes first showed that the surface temperature was 730 K (854°F), that is, over 350 K (600°F) higher than the boiling point of water. This result was confirmed by direct temperature measurements of the atmosphere made from Soviet and U.S. spacecraft that descended through Venus’s atmosphere. The atmospheric temperature has a relatively cool value of 250 K (−10°F), about 25 K (45°F) below the freezing point of water, near the top of the cloud layer, which is at a pressure of about 1/20 of that at the Earth’s surface. The temperature gradually increases with decreasing altitude until it reaches about 730 K (854°F) at the surface, where the pressure is 90 times that at the Earth’s surface. Just as on Earth, temperatures on Venus decrease with higher elevations (the atmospheric lapse rate). At the top of Maxwell Montes, about 12 km (7.5 mi) higher than the average elevation, the temperature could be only about 620 K (656°F).

The high value of Venus’s surface temperature is not due to its closer proximity to the Sun than the Earth. Because its cloud layer reflects to space about 75% of the incident sunlight, Venus actually absorbs less solar energy than the Earth does. Rather, the high temperature is the result of a very efficient greenhouse effect that allows a small but significant fraction of the incident sunlight to penetrate to the surface (about 2.5%, according to Soviet and U.S. spacecraft measurements), but prevents all, except a negligible fraction of the heat generated by the surface, from escaping directly to space. The thermal energy produced by the surface and hot lower atmosphere, which occurs at infrared wavelengths, is very effectively absorbed by the carbon dioxide, water vapor, sulfur dioxide, and sulfuric acid particles of the atmosphere. However, these materials are poor absorbers at visible wavelengths, where most of the solar energy lies. The greenhouse effect raises Venus’s surface temperature by almost 500 K (900°F) but causes only a modest 35 K (63°F) rise in the surface temperature of the Earth. This difference is due to the Earth’s atmosphere being partially transparent at some infrared wavelengths, thus permitting some surface heat to escape to space. See GREENHOUSE EFFECT.

Meteorology. The atmosphere near the cloud tops is moving with a jet-stream-like velocity of about 100 m/s (224 mi/h) from east to west in the direction of Venus’s rotation. Although the solid surface rotates around in 243 days (clockwise as one looks down from the north, opposite the rotation of Earth), the clouds are observed to move around the planet in the same direction with a period of about 4 days. This motion is called superrotation. Only Saturn’s moon Titan shares this phenomenon
with Venus. There is a small component of cloud motion of about 5 m/s (11 mi/h) from the equator toward the pole. In contrast to the situation for the Earth, where only a small portion of the atmosphere moves at jet-stream speeds, the entire cloud-top region on Venus moves at these high speeds. For the most part, the wind speed decreases gradually, but in a few places sharply, with declining altitude and achieves values of a modest few meters per second within 10 km (6 mi) of the surface. Winds at the surface are also a few meters per second. However, wind streaks are seen on the surface, in the Magellan radar images, in the vicinity of the more recent impact craters, indicating that the formation of these craters produced temporary stormlike atmospheric winds near the surface. See SATURN.

Like the winds on the Earth, the winds on Venus are produced ultimately by differences in the amount of solar energy absorbed by different areas of the planet, such as areas at different latitudes. The large wind speeds near the cloud tops may be the result of Venus’s atmosphere being very deep. The transport of momentum by the mean circulation and the eddies from the deep dense portions near the surface to the much less dense regions near the cloud tops translates sluggish motions into fast ones. At mid-latitudes and in the polar regions of the Earth, the east–west wind speeds are determined primarily by a balance between variations of pressure with latitude and the Coriolis force due to the rotation of the Earth’s surface, which is shared by its atmosphere. But Venus’s surface rotates too slowly for the Coriolis force to be important in its atmosphere. Rather, centrifugal forces (analogous to those on a merry-go-round), owing to the rotating motions of the winds themselves around the planet, may provide the balance to the pressure gradient forces. See ATMOSPHERIC GENERAL CIRCULATION.

Temperature variations. Because Venus’s atmosphere is massive, atmospheric motions are very effective in reducing the horizontal variations of temperature in its lower atmosphere. In the region of the clouds and at lower altitudes, temperature variations occur mostly in the north–south direction, with the equator being only a few degrees warmer than the poles close to the surface and some tens of degrees warmer within the cloud region. Above the clouds, the atmosphere is actually somewhat warmer at the poles than near the equator because of the effects of heat transported by atmospheric motions. As Venus’s axis of rotation is almost exactly perpendicular to its orbital plane, its climate has little seasonal variability. Studying the circulation and dynamics of the Venus atmosphere provides new boundary-layer conditions to test general circulation models that are used to predict climate change on Earth.

Polar vortices. Two giant vortices circulate at the poles on Venus, one at each pole. These polar vortices have been studied by the Pioneer Venus and Venus Express spacecraft, in the northern and southern hemispheres, respectively. Within each polar vortex lies a dipole feature that rotates around the poles, much like the eye of a terrestrial hurricane, and is much brighter in the infrared than its surroundings (Fig. 3). The dipole structure extends approximately 2000 km (1243 mi) across and rotates prograde with respect to the atmosphere, completing one revolution approximately every 2.5 Earth days. The dipole structure can morph into a monopole or a tripole structure. Fluid dynamical computer and laboratory experiments are currently unable to reproduce this steady-state feature for any extended period of time. The polar vortex is associated with poleward and downward movement of compressed air. The vortex extends at least down to 50 km (31 mi), if not deeper. A similar vortex structure is also seen at Saturn’s poles, where it creates a hexagon feature.

Interior. The similar mean densities of Venus and the Earth imply that Venus is made of rocks similar to those that make up the Earth. However, because Venus formed closer to the Sun, in perhaps a somewhat warmer environment, it may have initially contained a smaller amount of sulfur and water-bearing compounds. Such an environmental difference would probably not have significantly affected Venus’s content of the long-lived radioactive elements uranium, potassium, and thorium. Over the lifetime of the Earth, and presumably that of Venus, the decay of these elements may have generated enough heat to cause these planets to become chemically differentiated, as free iron melted and sank toward their centers. Also, both planets probably formed “hot” because of gravitational energy released in bringing chunks of rock and planetesimals together to form them. In this case, they may have undergone substantial differentiation in their early histories, with an accompanying release of much of their atmospheric gases. Thus, Venus’s interior may be qualitatively similar to that of the Earth in having a central iron core, a middle mantle made of rocks rich in silicon, oxygen, iron, and magnesium, and a thin outer crust containing rocks enriched in silicon in comparison with the rocks of the mantle. However, in contrast to the Earth, Venus’s core may now be either entirely solid or entirely liquid, which could account for the absence of a detectable magnetic field. See EARTH INTERIOR.

Rotation. In contrast to the Earth and almost all other planets, Venus rotates in the opposite direction

![Fig. 3. Different views of the polar dipole within the polar vortex in the southern hemisphere. The dipole sits above the cloud tops and penetrates well into the cloud layers. These images were taken in the thermal infrared from Venus Express. (ESA/Venus Express/VIRTIS)]
with respect to its orbital motion about the Sun. It rotates so slowly that there are only two sunrises and sunsets per Venus year. Tides raised in the body of the planet by the Sun may have greatly reduced the rate of rotation from an initially large value, similar to the Earth’s, to its present low value. Because Venus’s atmosphere is so massive, tides raised by the Sun in the atmosphere may have also been important, with its current rate of rotation being determined chiefly by a balance between the oppositely directed torques arising from these two types of solar tides. Venus currently presents the same face to the Earth at the times of closest approach. This suggests that the tidal forces that were exerted by the Earth also played a role and helped lock Venus in its present rotational state.

**Life.** Venus may have had a hot ocean of water in its early history, when the Sun put out less energy than it does now. If so, it is unclear whether life could have arisen then. Any early life would have been destroyed when Venus lost its oceans and achieved its current high surface temperature. The current high surface temperatures preclude the existence of living organisms like those that inhabit the Earth on the surface. Life in the sulfuric acid clouds is a remote possibility given the moderate pressures and temperatures in the clouds, as well as our increased understanding of terrestrial organisms living in extreme conditions (extremophiles). The discovery of atmospheric ozone created by chlorine chemistry also suggests that ozone cannot be used as a unique biomarker to identify life on other extrasolar planets. See ASTROBIOLOGY.

**Spacecraft.** Venus has been more intensely explored by spacecraft than any other planet. Some 42 (18 of them unsuccessful) U.S., Soviet, European, and Japanese spacecraft have been sent to Venus. The Soviet Union Venera and Vega series of spacecraft and the U.S. Mariner and Pioneer series provided data on the composition of the surface and atmosphere and the dynamics of the upper atmosphere. Venera landers transmitted back the first images from the surface of another planet. The surface of Venus was seen in different places to be rocky, with little granular material. The Vega balloons are the only balloons to be floated in another planet’s atmosphere, sampling the aerosols and composition within the clouds. The U.S. Magellan mission, which ended in 1994, mapped nearly 98% of the surface using radar. Europeans sent the Venus Express spacecraft to study both the upper and lower atmosphere, as well as the thermal infrared surface of Venus. Notable achievements include discovery of possible evidence of volcanic activity in the geologically recent past, continuing evidence for lightning in the clouds of Venus, and discovery of a number of new molecular species in the upper atmosphere. The Japanese Akatsuki (also known as Planet-C or Venus Climate Orbiter), designed as a meteorological satellite to track cloud motions in fine detail, failed to enter orbit in 2010. See SPACE PROBE.

**Surface.** Magellan’s mapping mission revealed a unique global volcanic and tectonic style on Venus. Broad volcanic plains make up about 85% of the surface of Venus. The rest is tectonically deformed, higher-standing terrains with complex systems of folds and faults. Regional tectonism is evident in the widespread compressional and extensional deformation of much of the surface material (Fig. 4). Venus apparently has had a dynamic mantle that has driven crustal warping, which may be ongoing. However, although various regions of the planet show evidence of motion, no evidence of Earth-like plate tectonics has been found. See PLATE TECTONICS.

Long, narrow troughs are seen in many areas where the crust has ruptured; these linear rift zones are associated with extensive broad, domical rises and shield-volcano complexes. Examples are the Sif-Gula region, Beta Regio, and Atla Regio. Large areas of the planet are covered by lava that flowed from volcanic vents. Volcanism on Venus occurs globally, unlike on Earth, where volcanism is restricted mostly to linear zones that define plate boundaries.

The planet also has some unexplained surface features, including long channels meandering across the plains. One channel is 6800 km (4225 mi) long, which is longer than the Nile River. Its origin remains unknown. Many of the channels were clearly formed by lava, but even at the high temperature (730 K or 844°F) of the surface, most known volcanic lava compositions should solidify before they could flow far in open channels. A more exotic lava, such

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**Fig. 4.** Magellan image of the central and northern parts of the highland region Ovda Regio (north at top). Ridges running approximately east-west (horizontally) have been interpreted as resulting from crustal shortening (compression). Ridges are cut by through-going fractures and graben (faultbounded valleys), indicating that an episode of northeast-southwest extension followed the compressional event. The youngest event was flooding of low-lying areas by smooth (radardark) lava flows. (Courtesy of Jet Propulsion Laboratory; NASA)
as sulfur or a carbonate, may have formed some of the longer channels. Another unique landform is the scattered flat, circular volcanoes that resemble giant pancakes. These range in diameter from about 15 to 80 km (9 to 50 mi) and are a few hundred meters thick.

Coronae are classified as volcanic-tectonic structures (Fig. 5). These features are oval to circular and range in diameter from 100 to 2100 km (62 to 1305 mi). Most are around 300 km (186 mi) in diameter. They have low relief, up to 2–3 km (1–2 mi) high. The margins are generally irregular concentric ridges and troughs. The interiors may be quite irregular, including various tectonic and volcanic edifices. Many coronae have associated volcanic flows. A mantle plume model has been postulated for the formation of coronae, in which the rising lower-density plume causes doming, with contemporaneous or subsequent relaxation to form the bounding ridges and troughs. The higher elevations of Venus—Maxwell Mons, for example—have distinctly higher-than-average radar reflectivity and low emissivity. One explanation for this behavior is that, at slightly lower temperature and pressure in the more elevated regions, a metallic mineral is stable and distributed throughout the surface material to create higher reflectivity. Possible minerals could be pyrrhotite, pyrite, or magnetite.

Impact craters. Impact craters are much less abundant on Venus than on the Moon or Mars. Approximately 950 impact craters have been identified in Magellan images (Fig. 6). Most appear to be unmodified by erosion. Based on the abundance of impact craters, the average age of the surface appears to be about 300 to 500 million years old. This age implies a low rate of surface modification by erosional, or even by volcanic and tectonic, processes and suggests that parts of the planet have undergone relatively recent volcanic or tectonic activity. On a global scale, impact craters are randomly distributed, allowing the determination of the mean surface age of less than 500 million years, but the small number of total craters provides little age information at a local scale.

Asteroids and comets that collide with Venus should have typical velocities of about 20 km/s (12 mi/s). Venus’s thick atmosphere plays a significant role in meteorite impacts. Because the atmosphere is so dense, only craters larger than 3 km (2 mi) in diameter can form, except in crater clusters where large projectiles apparently broke up before...

Fig. 5. Magellan images of coronae on Venus. (a) Computer-simulated view of the corona Idem-Kuva, 97 km (60 mi) in diameter. Lava flows extend for hundreds of miles across the fractured plains in the background. (b) Artemis Chasma, whose diameter of 2100 km (1305 mi) makes it the largest corona identified. The interior contains complex systems of fractures, numerous flows, small volcanoes, and at least two impact craters. The margin forms a steep trough with raised rims. (Courtesy of Jet Propulsion Laboratory; NASA)

Fig. 6. Computer-simulated perspective view, based on data from Magellan spacecraft, showing three impact craters in the northwestern portion of Lavinia Planitia with diameters ranging from 37 to 63 km (23 to 39 mi). (Courtesy of Jet Propulsion Laboratory; NASA)
impact, peppering an area with smaller fragments. Ordinarily, a projectile that would produce a crater smaller than about 3 km (2 mi) in diameter would vaporize or break up in its transit to the surface. See METEORITE.

Wind features. It was of major scientific interest to discover wind activity on Venus. Magellan’s radar saw in many areas abundant bright and dark wind streaks near topographic barriers, such as small volcanic ridges. Wind streaks have been found to be most frequent near large impact craters. The craters may have provided the material that is moved by the wind. Also, the impact process itself may have produced some streaks. Some of the larger impact craters have large parabolic features hundreds of miles long. Many of the wind streaks are in the vicinity of these parabolas. Particulate crater ejecta may have been distributed downwind. Alternatively, the turbulent atmospheric disturbance created by the impact may have been carried to the west by the general atmospheric circulation, creating deposition or erosion patterns in the lee of the event. Further study of the orientations of some wind streaks may provide a better understanding of Venus’s global wind patterns.

History of volcanism. There is no definitive proof of active volcanism occurring on the surface of Venus today. One theory postulates cessation of a violent episode of global volcanism 300 to 500 million years ago. Subsequently there would have been less volcanic activity, forming the large shield volcanoes, such as Maat Mons, that are scattered over the planet. It is estimated that the activity represented by the younger volcanoes is less than 5% of the older plains flows. An alternative hypothesis holds that there is an equilibrium between the formation of impact craters and the volcanic outpourings that erase them, so that the surface always appears to be about 500 million years old. More recent Venus Express imaging has shown evidence for more geologically recent activity that may indicate active volcanism. These regions are related to hotspots identified by Magellan. Photons emitted by the surface at distinct near-infrared wavelengths are scattered but not absorbed by the thick atmosphere and subsequently escape into space. By comparing near-infrared images of the surface with the expected thermal emissions based on the atmospheric lapse rate and altimetry from Magellan, the amount of relative surface aging can be determined. Some regions were seen to be relatively young, indicating possible recent activity. However, no active hotspots in the near-infrared have yet been detected that might indicate volcanism today. See PLANET; VOLCANO.


Venus’ flytrap

Dionaea muscipula, a diminutive and increasingly rare carnivorous plant with snap traps. Although placed in the Droseraceae, the Venus’ flytrap species (Fig. 1) and Aldrovanda vesiculosa (waterwheel) diverged from the group at least 65 million years before the present and assumed highly modified leaves that actively capture and digest prey (Fig. 2). See CARYOPHYLLENES; INSECTIVOROUS PLANTS; SECRETORY STRUCTURES (PLANT).

Snap trap. A snap trap is a folded leaf with the mid-vein serving as a hinge. Leaf margins are lined with stiff hairs (teeth) that extend the trap dimensions. When twice touched by prey, smaller trigger hairs (three on the inside surface of each half of the leaf) stimulate the trap to partially close in about one-third of a second. This rapid movement is the result of a sudden change in the hydrostatic pressure differential that exists across different cell layers and is initiated by electric charge transduction. Complete trap closure is relatively slow and was historically interpreted as a mechanism for allowing small prey to escape. However, analysis of trap contents indicates mostly spiders, ants, and beetles, with no bias toward larger organisms. Digestive glands on the inside trap surfaces secrete enzymes that break down prey within 5–7 days. Amino acids released by digestion are taken up by the plant and then distributed

Fig. 1. Dionaea muscipula (the Venus’ flytrap) growing in a South Carolina nature preserve. Winged pedioles and traps in various stages of the capture cycle are visible. The plant is surrounded by Sphagnum moss, which is a frequent community associate. (Photo courtesy of James O. Luken)