Botany

Ron Cowen reports from Richmond, Va., at the annual meeting of the American Institute of Biological Sciences

Costa Rica's patchwork diversity

Costa Rica, though no bigger than West Virginia, holds more plant species than all of North America. Having surveyed Costa Rica's floral bounty for 25 years, taxonomist William C. Burger of Chicago's Field Museum of Natural History proposes a theory to explain both its species diversity and the puzzling observation that closely related plants in the region resist hybridation, even when growing only a kilometer apart.

In this lush, hilly country, altitudes and soils change substantially over short distances, creating a pastiche of varying habitats. Burger theorizes that chance mutations in a plant at the edge of one habitat may improve its disease resistance over plants adapted to slightly different conditions nearby. In order to keep the lifesaving trait, the newly emerging species must avoid swapping genes with its closely related neighbors. Such a scenario, Burger posits, could foster new species without large-scale geographic isolation or major climate change — two factors often cited as triggers for diversity. To test his theory, he suggests looking for reduced disease resistance in crops transplanted into adjacent habitats.

Aging leaves: Sex and death

Withering leaves mark the end of a perennial plant's photosynthesis for that growing season. This leafy demise has at least one fortifying benefit: It enables plants to recover nutrients from the leaves and divert them to needy parts elsewhere. Researchers are now trying to determine the conditions under which plants sometimes take the opposite approach, prolonging photosynthesis by delaying leaf death.

For two years, Ying Lu and Maxine A. Watson of Indiana University in Bloomington studied leaf survival in several colonies of mayapple, a fruit-bearing perennial. They found that leaves survived eight to 14 days longer in plants that reproduced sexually and bore fruit and in plants with larger-than-normal new rhizomes, or underground stems. This suggests the plants replenish the extra energy expended in sexual reproduction by extending the photosynthetic period, says Lu. Carbohydrates produced in photosynthesis apparently provide more sustenance than does the release of mineral nutrients stored in dying leaves, she concludes. The researchers observed that mayapples undergoing asexual reproduction seem to favor earlier leaf death and nutrient release. Other scientists have found similar patterns of leaf survival in different plants.

The source of floral chaos

Virtually all flowering plants display their blossoms in highly symmetric arrangements, spacing them evenly from top to bottom and left to right along each branch. Moreover, all flowers on a given plant tend to have the same number of petals, stamens and other parts. But on the honey locust, flower formation appears downright chaotic.

This tree's saucer-shaped flowers orient themselves haphazardly, vary unpredictably in size, and sometimes have inverted carpels, the organs that hold the female reproductive tissue. Electron microscopy of six species of honey locust — a primitive member of the legume family — reveals asymmetry even within unopened buds, says Shirley C. Tucker of Louisiana State University in Baton Rouge.

Tucker proposes that the unruly flower formation stems from the locust's lack of bracts, the leaf-like sheaths that envelop most flower buds. Her comparisons of plants with and without bracts suggest that these structures orient individual flowers and establish their pattern of distribution. Noting that several other primitive trees also exhibit floral asymmetry, Tucker says studies of those species may help to verify the bract's apparent link to floral chaos.

Space Sciences

Voyager instruments get new instructions

Flight controllers have equipped each of two Voyager spacecraft — already beyond the orbits of the known planets — with a new computer program. Radioed up from the Jet Propulsion Laboratory (JPL) in Pasadena, Calif., the programs provide each craft with operating instructions to help keep their Earth-bound messages clear as the Voyagers approach and perhaps even travel beyond the heliopause — the yet-undetected outer boundary of the sun's vast magnetic field.

On June 4, Voyager 2 became the first to start using the new program. Since both of its on-board computer memories are still working, the craft was able to hold — and check out — the program in one memory while retaining a simplified backup program in the other. Had design flaws turned up in the new instructions, this would have allowed Voyager 2 to continue sending its data home. No such flaws appeared, and Voyager 1 — which has long had only one memory in operation — began using the program on Aug. 9.

The new instructions should help on-board scientific instruments compensate for a weakening of the radio messages reaching Earth as the Voyagers travel ever farther from home. Electronic interference may make signals even harder to read when and if the craft reach the far side of the heliopause.

As messages weaken, the newly activated computer programs will slow the release of scientific information so that the data are less likely to be misread. The programs have already slowed data transmission rates to 600 bits per second — down from former rates of tens of thousands of bits per second. And within a few years, the rates may drop to 160 bits per second, says Ernest J. Franzgrote of JPL, chief of the Voyager Science Planning and Operations Team.

The slower transmission of data became possible in part because controllers had already turned off three of the 10 scientific instruments on each craft — the camera, the photopolarimeter and the infrared interferometer spectrometer — as each device completed its planned mission. Although the new instructions do not control the camera, turning off the other two instruments allows on-board computers to operate the remaining seven instruments more efficiently, says Mission Director Richard P. Rudd of JPL. This permits the computers to take on a new function: routine checking for errors in data headed for Earth, Franzgrote says.

In addition to protecting the dimming radio signals, the new programs have already enabled researchers in charge of each scientific instrument to restructure the way in which it prepares data for transmittal. For example, by changing the timing with which the plasma-wave sensor runs through a range of wavelengths, scientists can now eliminate the static created in its radio messages by another instrument's motor. The part of the program that controls the magnetometer improves that instrument's accuracy in measuring weak magnetic fields. Another sensor that measures charged-particle plasmas now runs through its full operating range four times as often as it used to. And the instrument measuring radio emissions from space has become more sensitive by integrating, or building up, weak signals for 6 seconds instead of a mere 30 milliseconds.

Engineers first began to think about protecting spacecraft signals radioed from beyond the heliopause back in the mid-1970s, Franzgrote says. At the time, NASA was planning a mission called Mariner Jupiter-Saturn, known as the "grand tour" because of a rare planetary alignment that would have allowed the probes to reach all the way to Uranus and Neptune, and perhaps to the far side of the heliopause. Budget pressures nipped that project, but when the possibility of exploring beyond the heliopause resurfaced with the Voyager mission, NASA worked the message-protecting measures into its plan.