Biology

Safely telling she- from he-turtles

The endangered Kemp's ridley sea turtle makes its home off Mexico's Gulf Coast, near Rancho Nuevo. Some 500 miles north, at the National Marine Fisheries Service in Galveston, Tex., researchers working on a captive breeding project hope to repopulate native waters with egg-laying ridley females. That effort, however, has posed a dilemma for biologist Charles Caillouet and his Fisheries Service colleagues: Although a harmless radioimmunoassay for testosterone can reveal the gender of prepubescent ridley sea turtles with 90 percent accuracy, the most reliable method of identifying the sex of newly hatched turtles would require killing them. Waiting the necessary two years for the turtles to come of age for the radioimmunoassay would slow repopulation efforts; releasing hatchlings of undetermined gender would leave researchers unable to guarantee an ample supply of females.

Now, scientists from the University of Tennessee at Memphis have developed a promising alternative based on genetic fingerprinting techniques. After fragmenting DNA extracted from a small blood sample, Suzanne Demas and her co-workers apply a genetic probe that selectively binds to gender-specific DNA fragments. The probe, a DNA sequence first isolated in a highly poisonous Asian snake, can distinguish sexes even in hatchlings, Demas says. It also works in the green sea turtle—a ridley relative — and Demas thinks it may assist gender identification in other reptiles as well.

In a study of 30 ridleys whose sex had been determined by others using a different method, Demas and her colleagues accurately identified the gender of 15 females and 14 males. They also identified the gender of nine of 10 green sea turtles, the researchers report in a forthcoming EXPERIMENTAL ZOOLOGY.

The DNA probe may also lead to a more precise determination of the relationship between gender and incubation temperature for ridley eggs. The Galveston group has observed that a relatively warm incubation environment produces predominantly female hatchlings, while temperatures just 5°C to 8°C cooler produce mostly males. The probe "should aid researchers in determining whether turtles raised in hatcheries for release into the wild interfere with the normal ratio of male to female animals," Demas says.

Saving ridleys from extinction may depend on precisely controlled repopulation, Demas asserts. She notes that the creatures face several dangers in the wild: They often feed near drilling platforms, where underwater shock waves can kill them, and many drown when entangled in shrimpers' nets.

Laser beefs up livestock digestion

Cows, sheep and other livestock with a special stomach compartment called a rumen are among the few animals that can digest cellulose, the plentiful plant fiber. But even ruminants must regurgitate and rechew their cud several times in order for rumen microbes to break down the cellulose in grass. New tests indicate that pretreating grass with a laser zap may shorten digestion time and increase the amount of nutrients these animals can extract from their fibrous meals.

Range scientist James R. Forwood aimed an optical laser at grasses and then immersed them in steer digestive juices. The laser treatment, he found, improved the digestibility of tall fescue and switchgrass by 11 and 14 percent respectively. Increasing digestibility by just 3 percent can boost livestock weight gains by 25 to 30 percent, according to previous USDA studies. Forwood, of the USDA's Agricultural Research Service in Ft. Collins, Colo., notes that the laser appears to work by puncturing the grass. While many farmers today use electric grinders to achieve this result, he says, "our hope is that the laser is more effective than just chopping."

Physics

Leaping into the '90s with new constants

The last second of 1989 and the first of 1990 were humdingers, at least for people who worry about trillionths of seconds and millionths of volts. For the fastidious keepers of atomic clocks, 1989's last minute lingered for a leap second. They injected the extra second to keep the world's most accurate clocks in step with Earth's subtly slowing spin. Although many might view the exercise as temporal nitpicking, such recalibrations can mean a world of difference for scientists involved in such projects as tracking nuclear missiles or spacecraft.

As champagne corks sailed past partygoers during the premier second of 1990, water's boiling temperature officially dropped from the customary 100°C to 99.97°C. Although it still takes the same amount of energy to bring a cup of water to a boil, scientists have slightly redrawn the scale they use to measure the temperatures corresponding to such physical phenomena. The International Committee of Weights and Standards agreed last year that 1990 would usher in a new temperature scale with values that correspond more closely with true thermodynamic temperatures (ideal measures independent of any scale), says physicist Barry N. Taylor, who coordinates work on fundamental constants at the National Institute of Standards and Technology in Gaithersburg, Md. Since a point on any temperature scale only approximates the thermodynamic temperature at which a physical event such as the melting of gold occurs, ever-more-precise data pertaining to such phenomena allow scientists to calibrate their scales with less uncertainty.

The way scientists and engineers measure electrical quantities such as voltage and resistance also changed slightly on New Year's Day. Before 1972, the standard reference for voltage measurements was based on electrochemical cells maintained under specified, but never entirely repeatable, conditions. Resistance standards were based on precision wire wrapped around resistors immersed in a temperature-controlled oil bath. The actual electrical behavior of such reference systems depends on real experimental conditions such as fluctuating temperatures and the age of the system's materials. For a more reliable voltage reference, some scientists in 1972 started switching to the constant ratio between a Josephson junction's easily measured frequency and its voltage, Taylor notes. Like the speed of light, this constant remains invariable under different experimental conditions — a feature that makes it superior to earlier, more fickle reference systems.

A similarly universal quantity known as the quantized Hall resistance has more recently become available as a standard for the ohm, the unit of electrical resistance. By international agreement, scientists around the world have now begun using the same updated values of the two constants. In the United States, this means the volt's value has increased by about 9.26 parts per million; the ohm got a more modest hike of 1.69 parts per million, comparable to adding about an inch to a 10-mile run.

The stainless steel kilogram standards used for legal purposes by the U.S. Department of Commerce have undergone a similar fine-tuning. Careful recalibration against the so-called international prototype of the kilogram—a lump of platinum-iridium alloy that sits in a vault at the International Bureau of Weights and Measures in Sèvres, France—showed the U.S. legal standards were about 0.17 milligrams overweight. Mass stands out as the last physical parameter of the International System of Units that still rests on a specific artifact. "It would be nice to have some atomic standard of mass" that would be independent of any particular object, Taylor says. He notes that the master kilogram in France remains vulnerable to slight changes in mass due to intermittent cleanings or shedding of atoms.