August 29, 2006


By ERICA GOODE

It is a good thing the manatee has thick skin.

To the dolphins, the whales, the sea otters go the admiring oohs and ahs, the cries of, “How sleek!” “How beautiful!”

The manatee, sluggish, squinty-eyed and bewhiskered, is more likely to have its rotund bulk compared to “a sweet potato,” its homely, almost fetal looks deemed “prehistoric” — terms applied by startled New Yorkers this month to a Florida manatee that made an unexpected appearance in the Hudson River.

Cleverness is unhesitatingly ascribed to the dolphin. But the manatee is not seen leaping through hoops or performing somersaults on command, and even scientists have suspected it may not be the smartest mammal in the sea. Writing in 1902, a British anatomist, Grafton Elliot Smith, groused that manatee brains — tiny in proportion to the animals’ bodies and smooth as a baby’s cheek — resembled “the brains of idiots.”

Yet the conception of the simple sea cow is being turned on its head by the recent work of Roger L. Reep, a neuroscientist at the University of Florida at Gainesville, and a small group of other manatee researchers, including Gordon B. Bauer, a professor of psychology at New College of Florida, and David Mann, a biologist at the University of South Florida.

In studies over the last decade, they have shown that the endangered Florida manatee (Trichechus manatus latirostris) is as unusual in its physiology, sensory capabilities and brain organization as in its external appearance.

Far from being slow learners, manatees, it turns out, are as adept at experimental tasks as dolphins, though they are slower-moving and, having no taste for fish, more difficult to motivate. They have a highly developed sense of touch, mediated by thick hairs called vibrissae that adorn not just the face, as in other mammals, but the entire body, according to the researchers’ recent work.

And where earlier scientists saw in the manatee’s brain the evidence of deficient intelligence, Dr. Reep sees evolution’s shaping of an animal perfectly adapted to its environment.
Dr. Reep — a co-author, with Robert K. Bonde, a biologist at the Sirenia Project of the United States Geological Survey, of a recently published book, “The Florida Manatee: Biology and Conservation” (University Press of Florida) — argues that the small size of the manatee brain may have little or nothing to do with its intelligence.

Brain size has been linked by some biologists with the elaborateness of the survival strategies an animal must develop to find food and avoid predators. Manatees have the lowest brain-to-body ratio of any mammal. But, as Dr. Reep noted, they are aquatic herbivores, subsisting on sea grass and other vegetation, with no need to catch prey. And with the exception of powerboats piloted by speed-happy Floridians, which kill about 80 manatees a year and maim dozens more, they have no predators.

“Manatees don’t eat anybody, and they’re not eaten by anybody,” Dr. Reep said.

But he also suspects that rather than the manatee’s brain being unusually small for its body, the situation may be the other way around: that its body, for sound evolutionary reasons, has grown unusually large in proportion to its brain.

A large body makes it easier to keep warm in the water — essential for a mammal, like the manatee, with a glacially slow metabolism. It also provides room for the large digestive system necessary to process giant quantities of low-protein, low-calorie food.

The manatee must consume 10 percent of its 800-pound to 1,200-pound body weight daily. Hugh, 22, and Buffett, 19, captive manatees at the Mote Marine Laboratory in Sarasota, Fla., are fed 72 heads of lettuce and 12 bunches of kale a day, their trainers say. And in a 2000 study, Iske Larkin, a researcher in Dr. Reep’s laboratory, used colored kernels of corn to determine that food took an average of seven days to pass through a captive manatee’s intestinal tract — a leisurely digestive pace comparable to that of a koala or a two-toed sloth.

The smooth surface of the manatee’s brain — it generally has only one main vertical fissure, or sulcus, and no surface ridges to speak of — is more puzzling, Dr. Reep concedes. The brains of virtually every other mammal bigger than a small rodent show some degree of folding. And scientists have generally taken the human cortex, a study in ridges and crevasses, as a model of higher-order mental process, assuming accordingly that brain convolution is a sign of intelligence.

“I would make a guess that if you showed a manatee brain to a modern neuroscientist, to this day, most would consider that the manatee is not very smart, that idea is so ingrained,” Dr. Reep said.

But he added that scientists still know almost nothing about what drives the development of brain formation. Evolutionary lineage appears to have an influence. The brains of primates tend to have
different patterns of convolution than those of carnivores, for example. And mechanical factors like brain size and the denseness of neural tissue in the cortex may play a role.

Manatees have a relatively thick cerebrum, with multiple layers that may, Dr. Reep suspects, indicate complexity despite a lack of folding.

In any case, he said, brain convolution “doesn’t seem to be correlated with the capacity to do things.”

More to the point, intelligence — in animals or in humans — is hard to define, much less compare between species, Dr. Reep said. Is the intelligence of a gifted concert pianist the same as that of a math whiz? Is a lion’s cunning the same as the cleverness of a Norwegian rat?

The manatee is good at what it needs to be good at.

Sirenia, a biological order that includes the dugong and three extant species of manatees, appear in the fossil record in the early to middle Eocene, about 50 million years ago, around the same time as whales, horses and other mammals, said Daryl P. Domning, a professor of anatomy at Howard University who has collected and studied the fossils of manatees and other sirenians around the world.

Four-legged land mammals that returned to the sea, the sirenians shed their hind legs but retained vestigial pelvic bones and, in two manatee species, nails on their flippers. Manatees count among their close relatives the elephant and the rock hyrax. Another sirenian, Steller’s sea cow, lived in the Bering Sea and exceeded 5,000 pounds. It was hunted into extinction in the 1700’s.

Although dugongs appear in the folklore of Palau, sirenians in general “don’t seem to have inspired the amount of awe that other animals did, like pumas and jaguars and things like that,” Dr. Domning said. “You don’t find them putting up monuments or statues to them.”

Florida manatees, a subspecies of the West Indian manatee, thrive in warm, shallow coastal waters and migrate when the temperature drops. They spend a great deal of time eating, with frequent naps between meals. Their social world is relatively straightforward. Males mate with females in a violent affair that resembles a gang rape; manatee calves stick close to their mothers for about two years, then head off on their own.

Groups of manatees may cluster, playing, grazing and dozing at a warm-water source — a power plant, for example. But they are just as likely to be loners, striking out wherever the warm currents take them, even if that means passing the Statue of Liberty and heading up the East River to Rhode Island, as an earlier northward manatee pioneer, Chessie, did in 1995. (The manatee spotted in the Hudson in early August was seen on Aug. 17 even farther north, off Cape Cod. But two days later it had turned
south again to Rhode Island. The last reported sighting was the afternoon of Aug. 25, in Bristol Harbor, R.I.

The manatee’s sensory capacities and brain organization, researchers are learning, are perfectly suited to its style of life.

In the dim, muddy shallows where manatees feed, for example, sharp eyes are less than useful. And sight is not a manatee’s strong suit, though the heavy-lidded wrinkled dimples that serve as eyes are undoubtedly part of the animal’s charm.

Manatees distinguish colors. The orange of carrots in a trainer’s hand can inspire a captive manatee to an uncharacteristic speed. But they are bad at distinguishing brightness, and they are clumsy, frequently bumping into things.

In 2003, Dr. Bauer and four colleagues, including Debborah Colbert and Joseph Gaspard III of the Mote Marine Laboratory, reported in The International Journal of Comparative Psychology on the visual testing of the Mote manatees, Hugh and Buffett. The manatees were trained to discriminate between two underwater panels of evenly spaced vertical lines, swimming toward the correct panel for a reward of apples, beets, carrots and monkey biscuits. By varying the distance between the lines, the researchers showed that Buffett’s eyesight was about 20/420, similar to a cow’s and far worse than a human’s.

Poor Hugh, Dr. Bauer said, was blind “even by manatee standards.”

Yet far more valuable than sight in murky water is an acute sense of touch, and it is here that manatees excel. Their mastery of the tactile world, Dr. Reep and his colleagues have recently established, comes from the thick, bristly hairs called vibrissae. Unlike normal hair fibers, each vibrissa is a finely calibrated sensory device, its follicle surrounded by a blood-filled pocket or blood sinus. The movement of the hair produces changes in the fluid that are registered by receptors around the hair follicle, which transmit the information to the brain via hundreds of nerve fibers. An increase in blood pressure increases the sensitivity of the hairs.

In research over the last five years, Dr. Reep and his colleagues have shown that manatees have 2,000 facial vibrissae of varying thickness, 600 of them in the so-called oral disk, a circular region between mouth and nose that the manatee uses much like an elephant’s trunk, to grasp or explore objects. Each facial vibrissa is linked with 50 to 200 nerve fibers. An additional 3,000 vibrissae are spaced less densely over the rest of the body.
Rats, dogs, sea lions and other whiskered animals also have vibrissae, but not in such large numbers and typically only on the face. In research not yet published, Diana Sarko, a graduate student in Dr. Reep’s lab, confirmed that another mammal has vibrissae dispersed over its body, the rodent-faced, rabbit-size rock hyrax, the manatee’s distant cousin.

Like the manatee, the hyrax, which inhabits rocky outcroppings, spends much of its time in dim light and has poor vision.

“Rock hyraxes live in little cave dwellings, so they probably use these hairs to navigate in these dark surroundings,” Ms. Sarko said.

In testing, Buffett, Hugh and other captive animals have proved just how acute a manatee’s tactile sense can be. Using the bristles on the oral disk and the upper lips, manatees can detect minute differences in the width of grooves and ridges on an underwater panel. A manatee tested by a team of researchers in Germany could distinguish differences as small as 0.05 millimeters, as well as an elephant performing the same task with its trunk, and almost as well as a human. Hugh and Buffett did even better, outperforming the elephant and, in Buffett’s case, the human.

The findings were presented at the 16th Biennial Conference on the Biology of Marine Mammals in 2005.

A sensory modality that is so important should be prominently represented in the brain. And, confirming an observation first made by a German scientist in 1912, Dr. Reep’s research team has identified large clusters of cells called Rindenkerne in sensory processing areas in the deep layers of the manatee’s cerebral cortex. These clusters, the researchers suspect, are the manatee equivalents of the cell groupings called barrels found in other whiskered species like mice and rats, regions that process sensory information from the vibrissae.

Even more tantalizing is that, in the manatee, these clusters extend into a region of the brain believed to be centrally involved with sound perception.

“Either these things have nothing to do with the hair at all, or the more exciting possibility is that perhaps somatic sensation is so important that the specialized structure is overlapping with processing going on in auditory areas,” Dr. Reep said.

The normal hearing of manatees is known to be quite good in certain ranges, better than that of humans. In studies published in 1999 and 2000, Edmund and Laura Gerstein of Florida Atlantic University found that the underwater hearing of two captive manatees in a pool was sharpest at high frequencies — in the 16-to-18-kilohertz range — findings that have complicated the debate about
But in a study also presented at the marine mammal meetings, Dr. Bauer, Dr. Reep and colleagues have found hints that manatees can also “hear” low-frequency sounds, perhaps by using the vibrissae on their bodies to detect subtle changes in water movement. Hugh and Buffett were able to determine the location of three-second low-frequency vibrations in the 23-to-1,000-hertz range with up to 100 percent accuracy. The researchers plan to repeat these experiments with the vibrissae covered, to see whether the manatees still score highly.

If they do, it will suggest that they have a capacity unique among mammals and may help biologists explain, among other things, how they navigate back to their favorite patches of sea grass each year and how they monitor the movements of other manatees in cloudy water. Fish and some amphibians have similar sensory systems, mediated by cells running down the sides of their bodies. Called the lateral line, this system is “the reason why we can sneak up behind a fish but cannot grab it,” Dr. Reep writes.

For now, the question of how intertwined the sensory abilities of manatees might be remains unanswered. Yet even what is known reveals a degree of complexity that argues against labeling them as sweet but dumb — peaceable simpletons.

Dr. Domning of Howard could not agree more.

“They’re too smart to jump through hoops the way those dumb dolphins do,” he said.
Studies show that the Florida manatee has unusual physiology, sensory abilities and brain organization.

Clark Wheeler
Reading Assignment (25 pts.)
“Sleek? Well, No. Complex? Yes, Indeed” By Erica Goode

Remember, do not just copy the text word for word in order to answer these questions. Use your own words. Assignment must be typed.

1. Describe the general size of the manatee’s brain and discuss why scientists believe that its brain size may have little to do with its intelligence. (6 pts.)

2. Describe how the surface of the manatee’s brain differs from other mammals. Also, discuss why this difference has caused puzzlement among scientists. Lastly, discuss why manatee brains may still be rather complex even given this difference. (5 pts.)

3. Using your lecture notes, state the Class and Order that manatees fall under. Using the article, describe how manatees are related to land mammals and state the manatee’s closest living relatives. (5 pts.)

4. State the sensory activity that manatees rely the most on and describe why they rely on this one the most. (2 pts.)

5. State the name of the sensory structures that manatees use most and where on the body they are found. State how acute or effective these structures are and describe how they work. (4 pts.)

6. Describe the hearing capabilities of manatees and how the sensory structures that you described in the previous question may assist their hearing. Lastly, state the name of the structures that fish have that may have a similar function. (3 pts.)