

Are Dolphins Too Smart for Captivity?

A new movement seeks to end all dolphin research in zoos and aquariums, but critics say that could kill a productive field and hurt these animals in the wild

TAB AND PRESLEY WERE YOUR TYPICAL show dolphins. They spent their days at Brooklyn's New York Aquarium gliding through the turquoise water of their large outdoor pool, rocketing into the air for cheering spectators, and being ogled through thick windows of Plexiglas. But in 1998, they had the chance to participate in a revolutionary science experiment.

Working in the morning before shows, cognitive psychologist Diana Reiss scribbled a few black triangles and circles on Tab's and Presley's foreheads, backs, and flippers—all places the bottlenose dolphins couldn't see. Then, while biopsychologist Lori Marino watched from afar, Reiss put a mirror in the

tank. The two dolphins swam to it and immediately began checking out their new tattoos, twisting their bodies so they could make out every mark.

Though it seemed a simple behavior, Tab and Presley had just done something extraordinary. They had shown that they could recognize their own reflections—a test of self-awareness that only chimpanzees and humans had passed at the time.

The finding was a breakthrough in dolphin research and a milestone in the field of animal cognition. But it also sowed an uncomfortable seed in Marino's mind. If dolphins were as self-aware as people, she recalls thinking, how can we keep them locked up in concrete pens?

Marino tried to repress the thought. The science, she told herself, had to come first. But when she and Reiss attempted to continue the mirror studies a couple of years later, they learned that Tab and Presley had been transferred to other aquariums where both had died of infections at about 20 years of age, half a dolphin's normal life span in the wild.

The deaths affected Marino profoundly. In the following years, she abandoned her aquarium work, severed her relationship with Reiss, and launched a crusade to free all dolphins from captivity.

Marino is swimming upstream, however. Although her colleagues are concerned about the welfare of dolphins, most have concluded that captive research is both the best way to learn about the intelligence of these creatures and the best way to protect them in the wild. "There are always ethical issues with working with animals in captivity," says Richard Connor, an animal behaviorist at the University of Massachusetts, Dartmouth, who studies wild dolphins in Shark Bay, Australia. "But what Marino is proposing would completely kill the field of dolphin cognition."

Early show. Some of the first work on dolphin cognition took place at Florida's Marine Studios, now Marineland.

Flipper's brain

Tab and Presley may have proved that dolphins have brains to be reckoned with, but their predecessors were a black box to early researchers. The first serious studies of dolphin intelligence took place at a decidedly nonserious location: Marine Studios, an aquarium on Florida's northeast coast that served as the backdrop for B movies such as 1954's *Creature from the Black Lagoon*. (Its name was later changed to Marineland.)

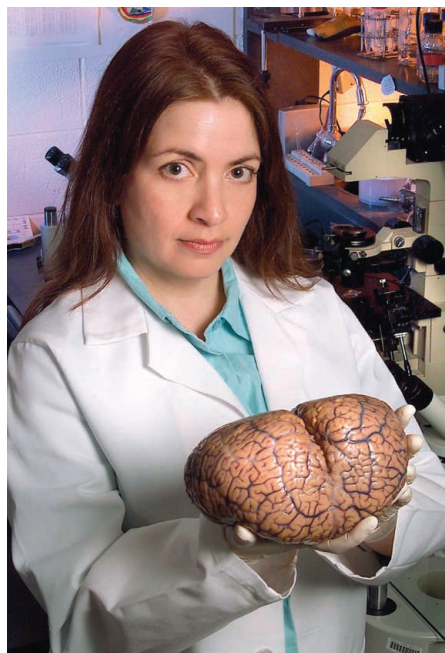
During a visit to the park in 1955, a pioneering brain researcher named John Lilly became fascinated with its bottlenoses and set up a research lab there. His early experiments were crude. He hammered electrodes into the skulls of live dolphins, for example. But he also performed less invasive studies, analyzing the animals' chirps, whistles, and other sounds. Lilly's work convinced him that dolphins were highly intelligent and possessed a complex vocabulary—findings that enticed a new breed of researcher to study them.

By the 1960s, the U.S. Navy had invested heavily in dolphin research. Its primary interest was militaristic, training some of its first dolphins to recover practice rockets and mines from the sea floor. Working in large, open-water pens, the Navy also made major advances in understanding dolphin physiology and echolocation. (Using a focused beam of clicks, dolphins can find a fish buried in the sand from several meters away.)

Meanwhile, Lilly had begun to wander off the deep end. Although his work had captured the public's imagination—inspiring movies like 1963's *Flipper* and helping foster the rise of marine parks—he began making increasingly fantastic claims, arguing, for example, that dolphins held the key to communicating with extraterrestrials. He also gave some dolphins LSD in an attempt to talk to them. Lilly's behavior threatened to torpedo the entire field.

But dolphin research found a savior in Lou Herman, a former Air Force intelligence officer who founded a research-only dolphin facility in Honolulu, Hawaii, in 1970. Working in former shark tanks, Herman showed that dolphins could understand two artificial languages—one based on electronic sounds, and the other on a trainer's hand gestures—and that they grasped grammar and syntax. They could even create their own novel behaviors on command and comprehend human pointing, a skill that eludes chimpanzees.

By the time Herman closed his lab in 2004, he had seeded the field with countless researchers, many of whom continue to demonstrate additional signs of dolphin intelligence, including tool use and cultural traditions. When Marino had her epiphany at the New York Aquarium, it wasn't just the deaths of Tab and Presley that moved her. It



Deep thoughts. Lori Marino's work on dolphin brains helped convince her that the animals were too sentient for captivity.

was the mounting weight of decades of this research suggesting that the dolphin brain isn't that much different from our own.

The crusade against captivity

In late January of 2006, a young bottlenose dolphin named Harley jumped out of his tank at the Minnesota Zoo and smacked his head on the surrounding concrete. His trainers, assuming nothing was wrong, returned him to the water, where he soon stopped coming up for air. By the time divers reached him, Harley had died, the victim of a fractured skull.

Marino, now at Emory University in Atlanta, says such incidents illustrate the ills of captivity. Dolphin tanks are chemically treated, bereft of other marine life, and just a tiny fraction of the hundred-square-kilometer ranges these animals are used to, she says. In these bland and sterile environments,

Marino says, it's no wonder that intelligent, social dolphins swim in circles and jump out of their pools, and that these stresses contribute to their premature deaths from gastroenteritis, fungal infections, and other ailments: "You can't replicate the natural settings for these animals."

A 2009 report sponsored by The Humane Society of the United States and the World Society for the Protection of Animals came to a similar conclusion. Citing figures from marine parks and aquariums, the U.S. National Marine Fisheries Service, and longitudinal studies of wild dolphins, *The Case Against Marine Mammals in Captivity* found that between 5.6% and 7.4% of dolphins die each year in captivity versus 3.9% in the wild. The numbers for orca whales are even more dramatic: 6.2% to 7% mortality rates in captivity versus 2.3% in the wild. "The totality of the captive experience for marine mammals is so contrary to their natural experience that it should be rejected outright," the report concludes.

After Tab and Presley died, Marino began refusing offers to work in aquariums and studied only dolphins that had already died. Conducting MRI and CT scans on stranded wild dolphins, she found that—adjusted for body size—the animals sported the second biggest brains on the planet, larger than chimps' and just below humans'. She also discovered that dolphins have a very complex neocortex, which has been linked to problem solving, self-awareness, and processing emotions in people (*Science*, 26 February 2010, p. 1070).

Armed with these data, "I couldn't in good conscience continue to support captive research," Marino says. She now calls herself a "scholar advocate" and has gathered allies, such as Denise Herzing, a psychologist at Florida Atlantic University in Boca Raton, who works only in the wild. Other dolphin researchers have objected to captivity, Herzing says, but like her they simply moved their studies outdoors. What's different about Marino is that she's trying to foment a revolution.

Marino has also teamed with advocacy groups like TerraMar Research, a nonprofit organization based in Seattle, Washington, dedicated to protecting marine wildlife. TerraMar's director, Toni Frohoff, argues that if dolphins are as self-aware as people, they deserve the same basic rights. "The more sentient we see dolphins to be," she says, "the greater our ethical obligation to them. We can't study them like goldfish or lab rats."

Taking a cue from the Great Ape Proj-

Online

sciencemag.org



Podcast interview with author David Grimm and an online discussion on ScienceLIVE.

his head on the surrounding concrete. His trainers, assuming nothing was wrong, returned him to the water, where he soon stopped coming up for air.

By the time divers reached him, Harley had died, the victim of a fractured skull.

Marino, now at Emory University in Atlanta, says such incidents illustrate the ills of captivity. Dolphin tanks are chemically treated, bereft of other marine life, and just a tiny fraction of the hundred-square-kilometer ranges these animals are used to, she says. In these bland and sterile environments,

ect, a collection of scientists and advocates who have argued that chimps and their relatives deserve basic legal rights (*Science*, 1 April, p. 28), Marino banded together with other scientists, activists, and philosophers to draft a “Declaration of Rights for Cetaceans” in 2010. It states that no cetaceans—a group that includes whales and dolphins—“should be held in captivity ... or removed from their natural environment.” Instead, live cetaceans should only be studied in the wild. Marino and her allies have gathered more than 3200 signatures and hope eventually to bring the declaration before the United Nations. “We want to use this as a jumping-off point for changing policy,” Marino says. “We need to move the science to a place that doesn’t compromise our ethics.”

Counterattack

Stan Kuczaj hadn’t even heard of Marino’s fledgling movement when, in 2010, he commissioned a barrage of articles on marine animals for the *International Journal of Comparative Psychology*, which he edits. His target was the 2009 Humane Society report, and over the course of two issues and 600 pages, some of the biggest names in the field argued that captive research was critical to understanding dolphins and other marine mammals and to protecting them in the wild.

Kuczaj, a psychologist at the University of Southern Mississippi in Hattiesburg who studies dolphin behavior and communication in captivity and the wild, also feels that the papers are an effective rebuttal to Marino and her allies. “I don’t think there are unequivocal data to support some of the claims that they make,” he says. He agrees that dolphins are smart, for example, but says there’s no evidence that they’re comparable to people. “We suck at being able to validly measure intelligence in humans. We’re even worse when we try to compare species,” he says. Marino and her allies are “trying to push their personal opinion on the field.”

Herman agrees. The godfather of research on dolphin cognition and a contributor to the journal package, he says that the evidence for higher dolphin mortality in captivity versus in the wild is “very, very questionable,” adding that a recent study based on National Marine Fisheries Service data showed no significant difference. “The mortality is horrific in the wild. Fifty percent of wild dolphins bear shark scars—and those are the ones that are still alive.” Marino, he says, reminds him of John Lilly,



Finned soldier. Navy research has revealed much about the physiology of dolphins.

who eventually railed against captivity as a concentration camp: “Once you mix politics with science, you lose objectivity.”

Herman says he, too, has struggled with the ethics of keeping dolphins in captivity. But he notes that Marino is basing many of her ethical arguments on understanding gained from captive research. “That’s the irony of it. How do they know dolphins are intelligent? Because of the captive studies. And now they don’t want us to do that research.” Herman says he never could have made his cognitive breakthroughs in the wild. Researchers have to train animals, collect baseline readings, and follow individuals for months or years, he notes: “Science demands controls and replication. What they’re proposing is a fantasy.”



Getting the message. Lou Herman’s work in a Hawaii facility has shown that dolphins grasp grammar and syntax.

And are dolphins really unhappy in captivity? Dorian Houser, director of biological research at the National Marine Mammal Foundation in San Diego, California, doesn’t think so. “Humans have forgotten what it’s like to forage for their own food and be the prey item of another animal,” says Houser, who has worked with Navy dolphins. “These animals get three square meals a day and regular medical care that’s probably better than most people have.” In San Diego Bay, the only thing that separates the Navy’s open-water pens from the rest of the ocean is a small walkway, he says, which the dolphins could easily jump over—but don’t.

Plus, says Houser, information gleaned from captive studies has helped scientists understand dolphins’ sensitivity to noise, pollution, and other dangers—all of which have helped the Navy draft better conservation guidelines—while decades of research on dolphin physiology has helped rescuers save stranded animals. Captive research, he notes, is also heavily regulated by a variety of government agencies, a position echoed by Marilee Menard, the executive director of the Alliance of Marine Mammal Parks and Aquariums, which represents 55 facilities around the globe. “These animals are stress-free, they’re reproducing fabulously,” she says. “What other standards do you want?”

The biggest concern among those who study dolphins in captivity, however, is that removing the animals from zoos and aquariums would destroy the field of dolphin cognition. In the past decade, researchers have made astounding cognitive discoveries in other animals, showing, for example, that jays can plan ahead and dogs understand



Marine lab. Denise Herzing studies dolphins in the Bahamas, where the animals come and go as they choose.

inequity. “Well, dammit, we need to have that looked at in dolphins,” says Connor of the University of Massachusetts. “We’ve just scratched the surface of figuring out what these animals are capable of,” he says. “You can’t just say, ‘Hey, a dolphin recognizes itself in the mirror,’ and go home.”

Still, Connor says he is open to exploring ways of studying cognition in the wild: “If they can do these studies in free-ranging dolphins, great. But the burden of proof is on them.”

A new paradigm

Marino and her crew plan to spend the next several years overcoming that burden. But even in the wild, they want ethics to be paramount. That means working only with whales and dolphins that have “decided” to interact with humans—either because they’re curious or because they’ve become used to people—a controversial approach Marino and Frohoff call “collaborative research.”

Their model is the work of Florida Atlantic University’s Herzing. For more than 2 decades, Herzing and her colleagues have been hanging out on a catamaran in the Bahamas, about 65 kilometers from shore. The water is shallow and clear, and two communities of dolphins come and go as they please. The researchers have been there so long that the dolphins ignore them, as habituated great apes and elephants ignore human observers in the wild. Snorkeling

nearby, Herzing and her colleagues use cameras and hydrophones to record behaviors and sounds, and collect genetic data from feces, all without interfering with the animals. In 2008, her team showed that mothers teach calves how to fish, considered the highest form of social learning and usually thought restricted to primates. “We want to get scientists thinking about new tools and new techniques,” Herzing says. Kuczaj says she has been “living the goal” of doing good cognitive work in the wild.

Marino herself is working on adapting several captive-research protocols to the wild. She’d like to see, for example, if she can replicate her mirror studies in the open ocean by modifying the techniques she and Reiss used at the New York Aquarium.

While Marino and her allies work out the details, they’re also developing an ambitious plan to phase out all whale and dolphin captivity in the United States. They hope their efforts will sway public sentiment against the 30 U.S. marine parks and aquariums, forcing them to close their dolphin and whale exhibits, which house about 400 animals. Herzing dreams of creating some sort of “retirement center,” such as a lagoon where these animals could live with other members of their species until they died, similar to chimp and elephant sanctuaries.

Marino says her ultimate goal is to convince the next generation of dolphin researchers that they don’t need to work in

captivity. She wants them to go straight to the wild, without having to endure a Tab and Presley moment first.

Reiss, who continues to work with dolphins in captivity—a position that drove Marino to stop speaking to her in 2009—doesn’t support Marino’s movement, arguing that there’s still value in captive research. But Reiss does think dolphin researchers can find common ground. Now at Hunter College in New York City, she is spearheading a campaign to stop the bloody dolphin hunts in Taiji, Japan, for example. Marino joined this effort, as did scientists on both sides of the captivity debate. Reiss and others who support captive research also believe that many zoos and aquariums should improve their dolphin facilities. Everyone wants the best for these animals, Reiss says: “To me, the biggest thing is to keep the knowledge coming, whether they’re in captivity or in the wild.”

The issue reaches far beyond dolphins, says Karen McComb, a behavioral ecologist at the University of Sussex in the U.K. who has chosen to study elephant cognition in the wild rather than in zoos. The more we learn about the intelligence of other animals, she says, the more we’re forced to consider the ethical implications of studying them. “Everyone is coming to a point where it’s relevant to stand back and reconsider these issues,” she says. “It’s a really important debate.”

—DAVID GRIMM