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OCEAN explorer

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NOW YOU SEE ME, NOW YOU DON'T

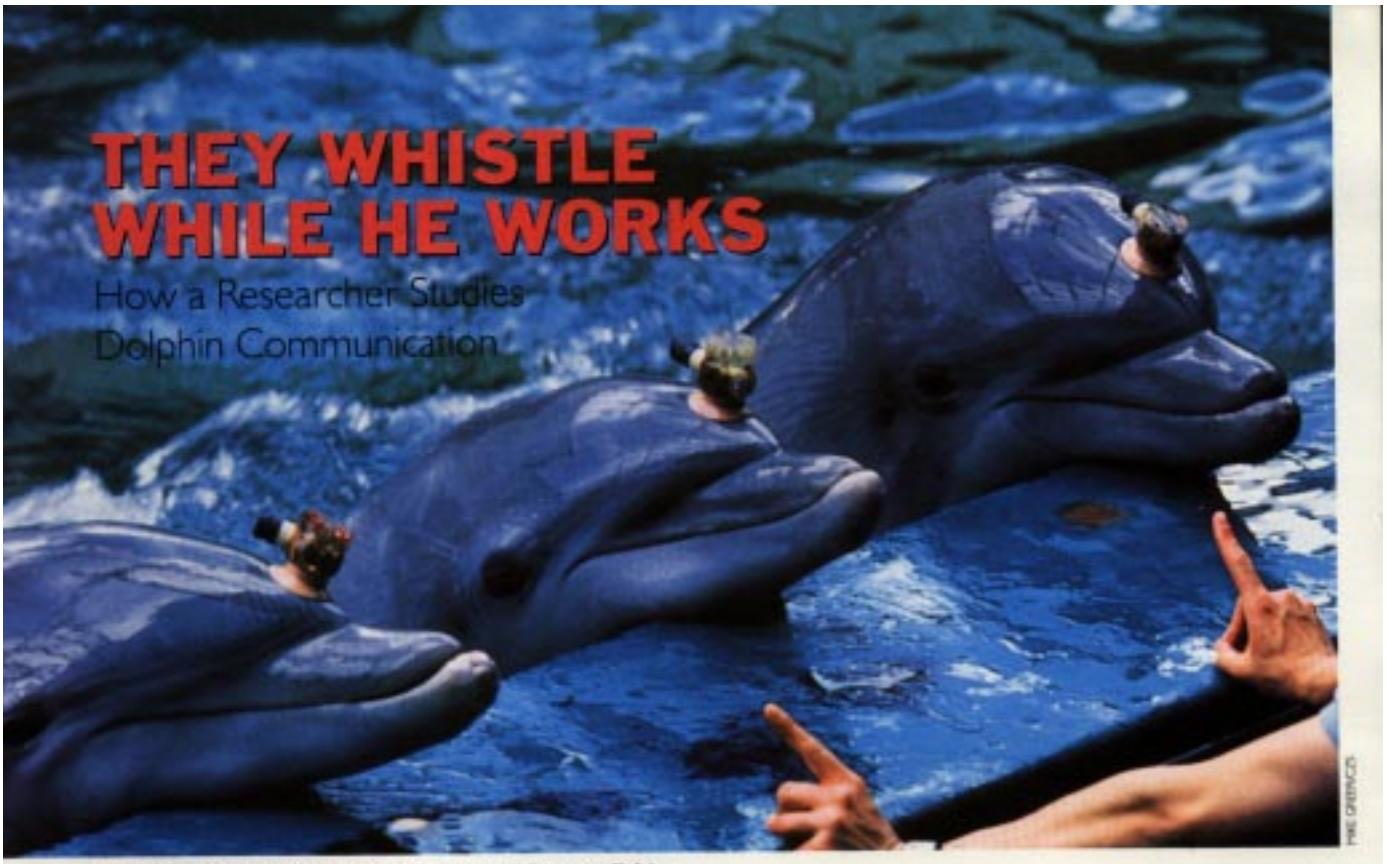
Basic Research in Dolphin Communication and Behavior

If you wanted to study the behavior and communication of land-based wild mammals, you could travel to their habitat, carrying along still and video cameras, a tape recorder, and keen powers of observation. You might sit near a group of chimpanzees for hours at a time, keeping records of everything you saw. If a chimp made a noise, you'd know which chimp it was, because you could see it moving as it vocalized. Quickly, you would collect lots of data.

Studying the behavior of marine mammals, like dolphins, is another kettle of fish. Because they live mostly underwater, coming to the surface usually only to breathe, observations of their behavior in the wild are fleeting, at best. Most dolphin research has been based on observations made in captivity, at zoos, aquariums, and marine parks.

What little is known about dolphins has compelled researchers to want to know more. Dolpins appear to have highly organized societies that are based on long-term associations among related females and long-term bonds among males. And scientists are beginning to suspect that marine mammals, alone among all other mammals except humans, may be capable of learning vocalizations.

In this issue, you'll read about dolphin researchers and about techniques they have developed to find out how these mysterious mammals spend their days.



THEY WHISTLE WHILE HE WORKS

How a Researcher Studies Dolphin Communication

Dolphins at Chicago's Brookfield Zoo wearing vocalights.

"Dolphins can be trained to imitate whistles," says Peter Tyack, Associate Scientist in the Biology Department at WHOI. "Why do they have that skill? How does a dolphin's whistle develop?" These questions have driven Peter's research for fifteen years. To study dolphin communication, Peter makes tape recordings of whistling dolphins, both in captive facilities, such as the Seven Seas Panorama at Brookfield Zoo in Chicago *(see pages 6-7)* and in the wild, at places like Sarasota, Florida *(see pages 4-5)*. He studies these recordings, and analyzes them.

"There tend to be two types of researchers in the field of animal behavior," says Peter. "One type are the psychologists, who run rats through mazes in laboratories. The other type does observations in the wild. I like to do both: I develop my ideas in a captive dolphin facility, which to me is like a lab. Then I test my ideas in the wild."

WONDERING ABOUT WHISTLES

Dolphins, and many other cetaceans, make several types of sounds, including pulses, which they use for echolocation (finding objects underwater by bouncing the pulses off of them), and whistles. A dolphin's whistle rises and falls like a tune, though at a frequency more than ten times higher than a dial tone. Each whistle lasts only a second or so. Humans must slow down recordings of dolphin whistles to hear them well. Researchers also use a device called a spectrogram, which translates a recorded sound into a picture.

In the 1960s, various researchers first discovered that dolphins are excellent mimics, and later that each dolphin produces its own "signa-

BASIC RESEARCH: A PATH TO DISCOVERY

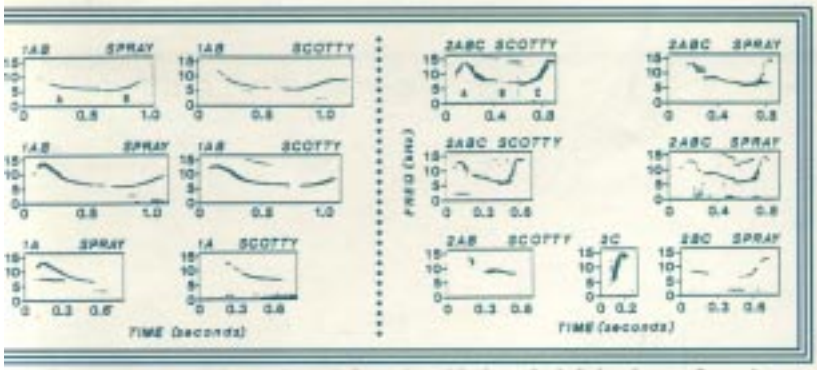
The scientists profiled in this issue conduct "basic" research, meant to advance knowledge generally rather than to solve specific problems. In the following sequence of some of the discoveries in dolphin communication, notice how research conducted today is influenced by previous discoveries and achievements.

Early 1960s

John Lilly, a physician and neurophysiologist, discovers dolphins' ability to mimic sounds. He thinks dolphins' whistles may be "words." He suggests dolphins can be taught to understand and produce human language. His later work is eventually discredited.

1950s

Bill Schevill and Bill Watkins of WHOI and Barbara Lawrence of Harvard make first recordings of whales. Bill Watkins develops an underwater recording device.



Spectrograms of Scotty's and Spray's whistles. At left is shown Spray's signature whistle, and Scotty's imitation. The reverse is shown at right.

Peter Tyack studies dolphin data.

ture whistle"— as individual to it as your name is to you. Signature whistles comprise 90% of a dolphin's whistle repertoire. Building on this knowledge, Peter made an important discovery in 1984, at an aquarium on Cape Cod called Sea Land. There, two captive dolphins named Scotty and Spray lived together for many years. Peter wondered: do dolphins who live together ever mimic each other's signature whistles?

NEW INVENTIONS

Answering this question required some technical tinkering. Peter wanted to make tape recordings of whistle exchanges between the two dolphins. He also needed a way to keep track of which dolphin produced each whistle. No one had ever been able to do both of these things at the same time before. Unlike many other mammals, dolphins don't usually move when they vocalize. And humans have a very hard time hearing sounds directionally underwater. What Peter wanted to do was impossible with existing technology. So he developed new technology.

For his study of Scotty and Spray, Peter developed the vocalight. Attached to a dolphin's head by a suction cup, the vocalight lights up when the dolphin emits a sound. The louder the sound, the more lights flash, like light displays on the control panel of a stereo amplifier.

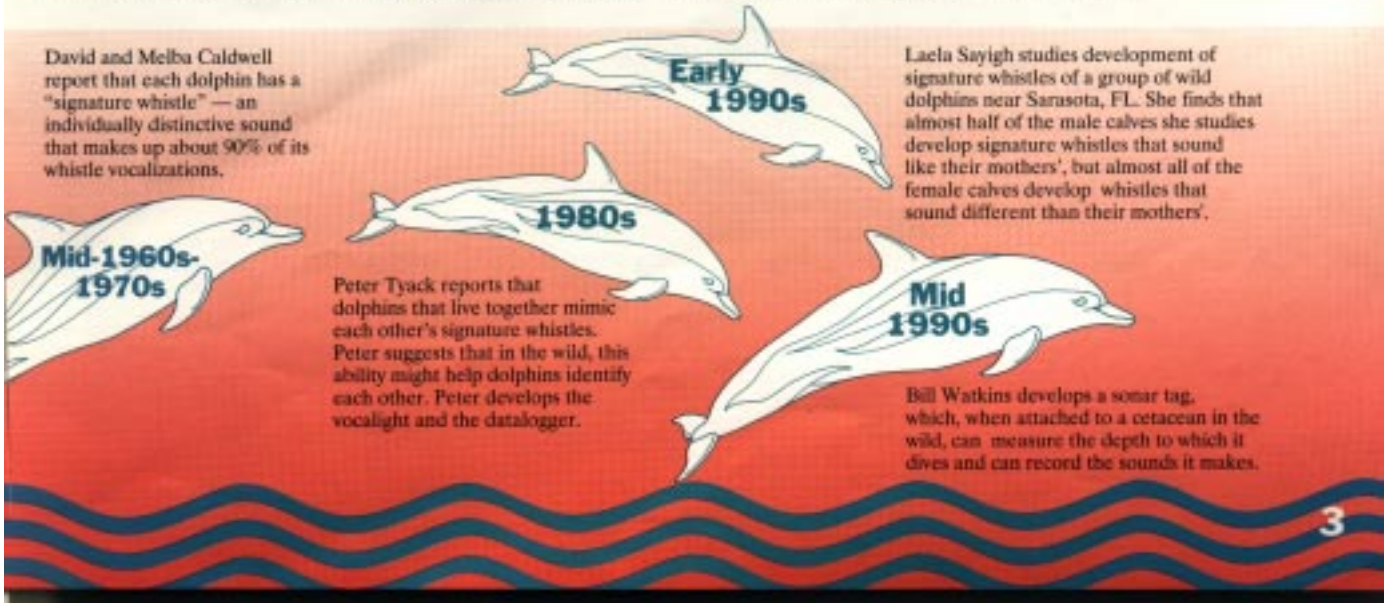
TESTING THE VOCALIGHT

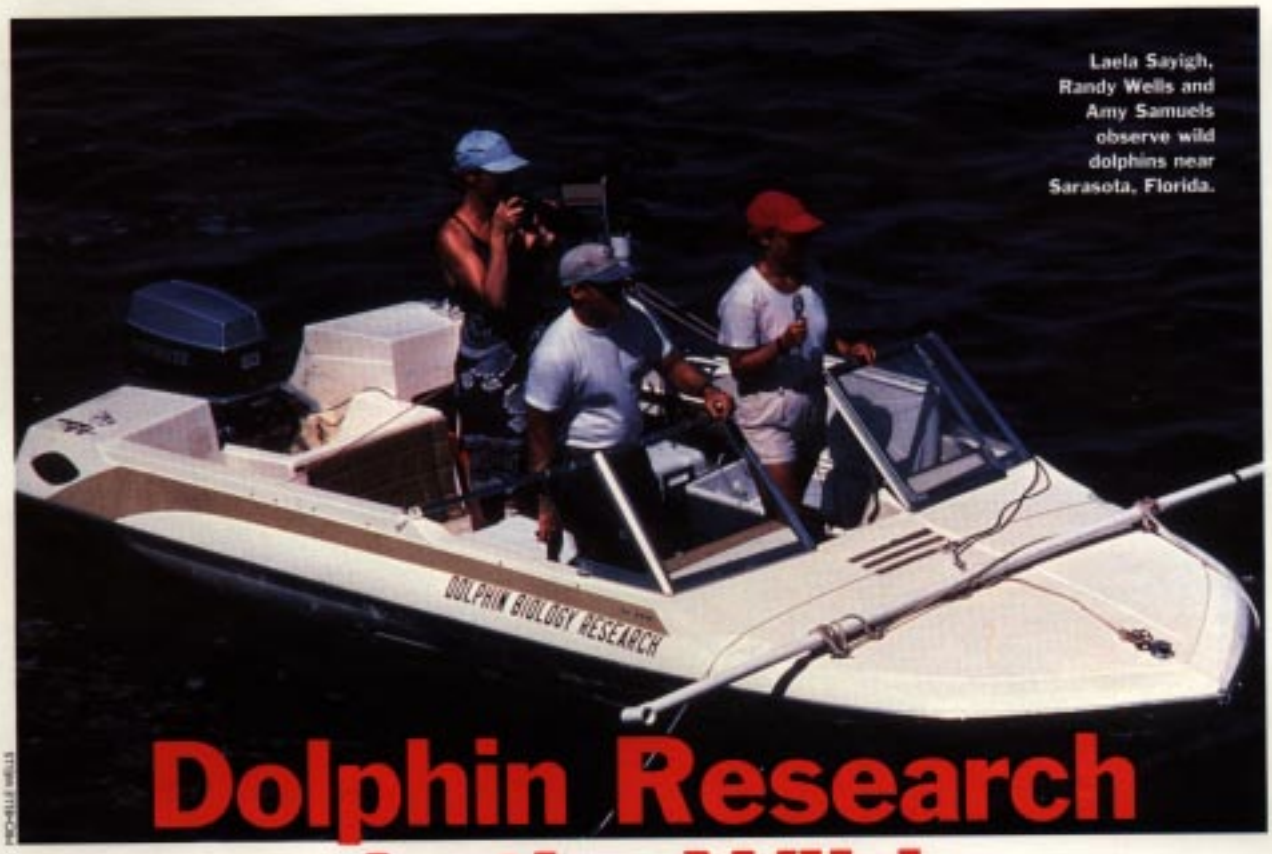
Early one morning, Peter and his assistants attached the vocalights to Scotty and Spray. One vocalight had red lights, the other had green lights. For one long, intense day, recordings were made of the whistle exchanges between the two dolphins.

The vocalights seemed to work very well. When Peter analyzed the whistles with a spectrograph *(see box above)*, he found out that 90% of the time, Scotty produced his own signature whistle, and 10% of the time he produced a whistle that was very much like Spray's. The opposite was also true. "We asked ourselves whether this wasn't a hint as to why dolphins have developed such impressive skill at vocal imitation," says Peter.

In the years since Peter's work with Scotty and Spray, he has developed other tools to aid in his whistle studies. While the vocalights are very effective tools, sometimes a vocalight lights up when a non-whistling dolphin passes near a whistling dolphin. Peter wanted a tool that would be more accurate. Working with graduate student Cheri Recchia and several WHOI engineers, Peter has developed a device called an acoustic datalogger. Also attached by a suction cup, this is a microcomputer that can store information on how loud certain sounds are, as well as some information on the sounds' frequency.

The newest device Peter is helping test has been developed by WHOI biologist William Watkins. It is called a sonar tag, and can be attached to whales and dolphins in the wild. When the sonar tag is fully operational, it will be able to tell researchers how deeply an animal dives and how long it stays underwater, while also recording its vocalizations. Peter is excited about sonar tags. He says: "these tiny little tags will tell us all there is to know about the dolphin's experience in the wild."





Laela Sayigh, Randy Wells and Amy Samuels observe wild dolphins near Sarasota, Florida.

Dolphin Research in the Wild

Theories Developed in Captive Settings Tested in Nature

The fishing boat travels in a circle, spooling out a five-hundred yard net. When the circle is completed, eight dolphins are temporarily confined. Volunteers and researchers hop off the boat and wade toward the dolphins. A female with a year-old male calf is examined first. A veterinarian weighs and measures her, and samples her blood. Later, the blood will be analyzed in the laboratory for genetic information–to determine who her parents are, for example. Also the level of environmental contaminants in her blood will be measured.

On this day, another type of information is recorded, too. Laela Sayigh, a Guest Investigator at WHOI who was a PhD student in the joint WHOI/ MIT Graduate Program in Oceanography, attaches a hydrophone to the female's head with a suction cup. Nearby, but out of sight, is her calf, a hydrophone attached to his head as well. As the mother is examined, she whistles very frequently, and her calf responds. Laela tape records the whistles. After the mother and her calf are released, Laela converts the tapes she made into spectrograms—pictures of the sounds. Then she compares the whistles. They are alike.

ANSWERING QUESTIONS

When Laela arrived at WHOI in 1986 to study dolphins with Peter Tyack, he asked if she would help him investigate signature whistle development. She remembers, "I got to work within days of my arrival."

At that time, Peter had recently completed his studies of Scotty and Spray *(see pages 2-3)*. He suspected that dolphins in captivity used their whistles to communicate. Now he was eager to test his ideas in the field. Do dolphins who have important ties to one another mimic each other's whistles? Peter knew that the place to conduct this field research was Sarasota, Florida, where Randy Wells, Blair Irvine and Michael Scott have been conducting an ongoing study of a population of about 100

Wild dolphins are identified by their dorsal fins, which can be as individual as fingerprints. This dolphin, who lives near Monkey Mia in Western Australia, is called "Captain Hook."

Early engraving of a dolphin *(left)*. Laela in the field *(right)*.

wild dolphins since the early 1970s.

Over the years, the researchers have followed, observed, and studied these dolphins, tracing the family relations amongst them and observing their behavior. Many mother-calf pairs in the Sarasota population are recognizable to the researchers.

LAELA'S RESEARCH

Laela travelled to Sarasota often over the next several years, sometimes making recordings during temporary captures, and other times following mother-calf pairs in a motorboat, observing their actions using the technique of "focal animal sampling" *(see pages 6-7)*. "With focal animal sampling," says Laela, "You don't just watch what's interesting. You concentrate on the mother-calf pair you want to watch, even if leaping is going on ten feet away. That always bummed my assistant out," she laughs.

As she conducted her research, Laela began to ask herself new questions. Do dolphins learn to vocalize? Do calves develop signature whistles similar to their mothers'? Do whistles change after calves attain independence? Do signature whistles of adult bottlenose dolphins remain stable over periods of many years? "Most people expect that we know as much about dolphins as we do about chimps," says Laela. "But what we see of their lives is so minimal."

RESULTS

Laela studied forty-two mother-calf pairs. She found that signature whistles stay the same for a period of up to at least fourteen years. She found that males appear to have a wider repertoire of whistles than females do. When she studied recordings of mother-son pairs, she noticed that the whistles the sons made most often — their signature whistles — were in 45% of the cases imitations their mothers' signature whistles. Daughters, in all but two cases Laela studied, developed signature whistles that were different from their mothers'.

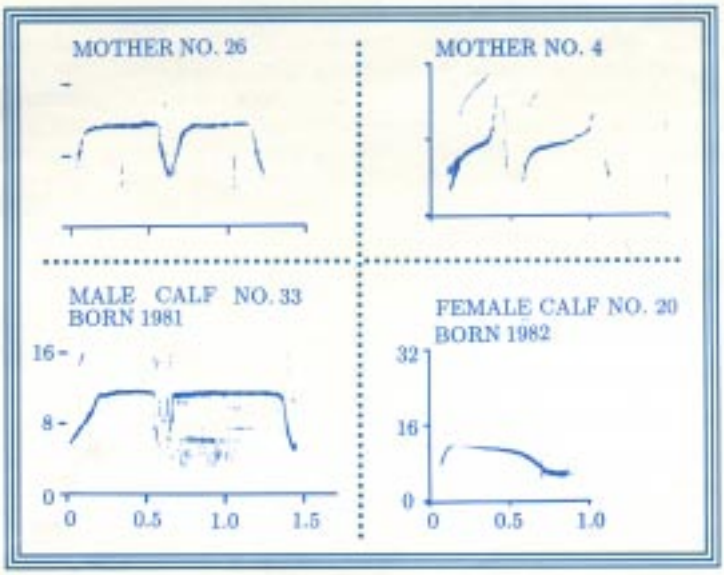
Laela thinks the reason for this difference might lie in the structure of dolphin societies. Often, a daughter will stay with her mother's "band" (the group of mostly female dolphins with which her mother lives) throughout her life. Since several daughters of one mother might continue to live in the same band, things could get confusing pretty quickly if they all had the same whistle.

Male dolphins leave the band when they mature, returning infrequently. A male with a whistle like his mother's would seem familiar to her and others in the band. Having similar whistles might stop the mother and her son from inbreeding, because they would recognize each other. Also, males often compete when they are interested in a female. If two competing males had the same whistle, they might realize that they were kin and back off from a confrontation.

WHERE TO GO FROM HERE!

These days, Laela, Peter, and other researchers are asking new questions about dolphin communications. In what circumstances does a dolphin produce its own signature whistle? When does it imitate the whistles of others? When a dolphin imitates another's signature whistle, is it attempting to "call" that dolphin?

As one discovery leads to the next, the secrets of dolphin communication continue to be revealed, little by little.



Spectrograms of whistles produced by a mother and her son. Notice how similar they are.

Spectrograms of whistles produced by a mother and her daughter. Notice how different they are.

FOLLOW THE MOVING DORSAL FIN

How a Behavioral Researcher Studies Dolphins

Nemo and Stormy "face to face."

Amy Samuels stands motionless beside the big glass window, focusing with all her energy. She holds a clipboard, a timer, and a voice-activated tape recorder, into which she speaks from time to time. Eight feet away, behind the glass, two male dolphins mouth each other. "Face-to-face," she says into her tape recorder. The dolphins separate. Each swims alone. Amy notes this behavior. After ten minutes and many more short comments, the session ends.

Amy is a graduate student at WHOI who also works at the Brookfield Zoo in Chicago. She often studies the bottlenose dolphins who live at the zoo's Seven Seas Panorama. Amy specializes in nonverbal communication — those subtle body movements that animals make as they interact with one another. Her observations help caretakers at the zoo understand and manage behavior problems among the animals, and help them identify which individuals are allies and which are enemies. The data she collects also helps dolphin researchers everywhere better understand the private lives of these mysterious animals.

PRIMATE TECHNIQUES IN A DOLPHIN WORLD

Amy did not always study dolphins. She began her career as a primate researcher — observing the behavior of baboons, both in captivity, and in the wild, near Amboseli, Kenya. "What I'm doing is applying what I learned in the study of primates to the study of marine mammals," says Amy. "I have access to a lot of techniques and methods that haven't been used in marine mammal studies."

One technique Amy has helped bring to this field is focal animal sampling. When conducting focal-animal sampling, the researcher studies just one animal at a time, recording precisely-defined units of behavior.

In the past, dolphin researchers made behavioral observations by watching entire groups. As a result, much was learned about large body movements of dolphins, such as breaching (jumping out of the water) but very little was learned about the smaller, subtler, more gentle movements that make up a bigger part of a dolphin's day.

"When I first started studying dolphins at the zoo it was very hard to interpret the function of their behaviors," says Amy. "No one had written a recipe for how to study dolphin behavior." Still, with only a few dolphins to get to know, it was possible to develop systematic techniques.

Focal animal sampling requires extreme patience. "For the observation session to be worthwhile," says Amy, "it's necessary to concentrate completely on what the animal being studied is doing. There's a whole lot of 'ho-hum,' punctuated by a few bursts of 'oh, wow!'"

DOLPHIN DREAMS

In the field, Amy's skills as an observer are really put to the test. There, it's harder to tell individual dolphins apart. The only positive method of identification is the dorsal fin, distinctive to each dol-

Amy observes Nemo at Brookfield Zoo.

phin, that pokes briefly above the surface of the water when the dolphin breathes.

Amy has done field research in Sarasota FL *(see pages 4-5)*, and in Western Australia, where a population of wild dolpins lives near a cove called Monkey Mia. "In the field, especially in Sarasota where the water is kind of murky, all you can see are the dorsal fins. There are not many clues to work with," says Amy. When she began working in the field, Amy says she had "dolphin dreams" in which she saw an unending series of dorsal fins that rose above the water and sank back down.

SPIT-SAMPLING

These days, Amy is also studying dolphin endocrinology (the internal secretions of the body), as she tries to better understand dolphin behavior. She and fellow researchers at Brookfield Zoo have developed a new, non-invasive technique for monitoring the reproductive hormones of dolphins, using saliva rather than blood. Comparing physiological information with behavioral observations may help Amy discover connections between a dolphin's actions and its body chemistry.

OPPORTUNITIES

To those who would like study dolphins, Amy advises: "The best training you can get is not from studying dolphins, but from learning about animal behavior in general, particularly about the behavior of terrestrial mammals, and the techniques developed for studying them."

JOAN M. THOMPSON

Amy studying baboons in Amboseli, Kenya, in the foothills of Mt. Kilimanjaro.

EXCERPT OF A 15-MINUTE TRAINING SESSION WITH STORMY

DATE/TIME: 30 June 87 0930
SUBJECT: Stormy
OBSERVER: JS

MINUTE	1	2	3	4	5
NEIGHBOR	A	W	A	W,N	Ø
ACTIVITY	FS	*	ES	*	SS

*INTERACTIONS: 2. T/W SB+GR
4. T/W MO+TH+CH → W IT
NOTES: N/H CH

Translation: At the beginning of the observation session, Stormy (designated by T) was swimming in Angie's (A) slipstream, that is, with his head positioned near her tail (FS = follow-swimming), then Stormy approached Windy (W), touching her gently with his snout (T/W = Stormy to Windy, SB = snout-to-body), gently rubbing his body against hers (GR = gentle rubbing) as he swam past her. Stormy resumed swimming with Angie, this time nearly touching each other while swimming side-by-side (ES = echelon-swimming). Windy joined them, and Angie swam away as Nemo (N) approached. Stormy made threatening gestures to Windy (MO = abrupt open-mouth, TH = head-jerk threat) and chased her (CH) until Windy retreated into shallow water (IT). Stormy was left swimming by himself (0 = no neighbor, SS = solo-swimming). Nemo chased Shana (Notes: N/H CH) while Stormy was solo-swimming and the observer glanced over to see what was happening, but the observer continued to watch Stormy for the duration of the fifteen minutes, even though he was doing no more than slowly swimming around the tank by himself. Quietly swimming alone is as much a part of Stormy's behavioral profile as vigorous chasing.

From "The Private Lives of Dolphins: Studying Behavior at Brookfield Zoo's Seven Seas Panorama" by Amy Samuels, which appeared in *BISON*, Vol. 3, No. 1, published by the Chicago Zoological Society. Reprinted by permission.