Essay

LOOKING AT WILD DOLPHIN SCHOOLS

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Rather like trying to perceive motion from inside a moving airplane, it is hard to detect a revolution from within. But in the last fifty years, there has been a revolution in our knowledge of the biology of live dolphins. Most of what we know about dolphin sounds, dolphin physiology, and the dolphin mind, and virtually *everything* we know about the doings of wild schools, has been learned in that time.

The first captive dolphin community was established at Saint Augustine, Florida, in the late 1930s. Observers soon saw that these were complex mammals, emphatically not fish, and that out there in the ocean they had managed to evolve societies that seemed as complex as, say, those of primates or social carnivores.

Dolphins at sea seemed all but unreachable. In vast tracts of ocean, even the species of dolphins present were not fully known. As late as the middle 1960s, for example, the dolphins of tropical seas were the most mysterious of faunas on the planet. We called the pigmy killer whale (*Feresa attenuata*) the "rarest large mammal on earth," because until one was collected alive in Hawaii in 1964, all we knew of it was derived from a couple of skulls in museums. More abundant, but no better understood, were the many species of slim oceanic dolphins of the genus

Stenella. Since then, the pigmy killer whale has been observed around the world at several locations. It is, indeed, a fairly abundant little killer whale–like animal; and the *Stenellas* are known to comprise a group of species that occur in tens of millions in the tropical current systems of all oceans.

But knowing an animal exists still does not tell us much about how that wild dolphin lives; and the prospects of learning anything more were daunting. How could one hope to learn anything about the behavior of animals that only appeared now and then, flirted with a vessel, and were gone into the vast ocean?

The first attempts to understand wild dolphins were acoustic. In the late 1940s, William Schevill and Barbara Lawrence made the first at-sea recording of a cetacean's sounds. Their subject was the beluga, or white whale. They worked with a stenographic machine and a primitive hydrophone. Belugas, they found, were noisy animals. This simple discovery demonstrated that one could record and study dolphin sounds; it did not unravel much about what the sounds meant. That task became a principal activity of field-oriented cetologists in the decade of the 1950s. It is a task still actively pursued today.

Schevill and his colleague William Watkins have been central figures in the endeavor to record wild dolphin sounds, followed by many other workers from around the world. The task, as Schevill and Watkins admonished us, may sound simple, but it is not. The listening scientist must exercise the most careful judgment about what animal is actually making the sound one is recording. Because sounds travel well and far underwater, it is often difficult to pinpoint the phonating animal or even to assign the sound to a species if more than one kind of dolphin is somewhere in the area. This problem is exacerbated because nearly everyone listens through just one hydrophone at a time; there is no way, in such a circumstance, to determine the source of the sound.

The observations of the Saint Augustine captive school made it clear that whole societies of mammals were out there in the sea, and understanding of sounds alone would never reveal more than a single facet of their lives. Further, it was clear that only certain intimate things about dolphin lives could be learned from captive schools. Animals confined in pools, even big ones, obviously were not able to carry out all of their normal life patterns. The wild dolphin's long traverses along beaches and around rocky headlands were gone, its feeding forays into black nighttime water could not be undertaken, and the interactions between dozens or hundreds of schoolmates were only hinted at in the colony ashore. The outward face of dolphins, the ways they deal with their larger world, necessarily exists only as a hint in captive animals. But how else could one learn?

The first barrier for cetacean naturalists was simply to conceive that the problem was solvable. They had to learn to accept the possibility that one *could* learn about these fleet, remote animals whose world was separated from ours by that most difficult of barriers, the sea surface.

The second step was to learn to be content with tiny bits of understanding at any one time. Many little truths would have to be learned by many people and assembled into a coherent picture at some later date.

So, by the late 1960s, a few Western naturalists had hitched up their field pants and begun to seek out the best means and the best places to observe wild dolphins. They chose sea cliffs, they developed little radios that could be affixed to dolphin fins, and they began to watch dolphins underwater.

Probably the first concerted attempt was that of the South African team of Graham Saayman and C. K. Tayler. Saayman, a primate biologist, knew that one way to study social behavior was to start recording patterns, whatever one can see; in time, from the arid precincts of one's recorded measurements and numbers, an understanding might emerge.

Tayler and Saayman found a place on the Natal coast where two species of dolphins came close to shore. There they could watch Indian Ocean bottlenose dolphins crowd fish schools against the beach; and they could perch on a rocky promontory called Robbe Berg and look down on groups of humpback dolphins maneuvering in the surge along the rocks. Their work told us a few things about daily movements and about ecological separation between the species, and it revealed tantalizing hints of schoolwide cooperative fishing methods by the bottlenose dolphin.

Others began to test new methods. William Evans, working in California waters, was the cetologist most responsible for developing the dolphin radio tag that now allows us to follow dolphins at sea. Several vexing problems were involved. How could a radio be affixed to a dolphin so that it would stay in place? Could a package be designed which would withstand the pressures of deep dives? How could faint radio signals be made to penetrate the vapor barrier that hovers over the sea surface? Were there power sources available which would allow the tag to last a reasonable length of time and broadcast for a workable distance? Finally, could all this be made into a package that a dolphin could carry without harm to itself or disturbance to its place in the school? Evans located a fledgling electronics company, Ocean Applied Research, and together they built the first usable radio packages, which were affixed to the dorsal fins of dolphins.

By that time, William Cochran and others had designed tiny circuits for tracking the movements of migrating birds. Cochran glued these instruments to the feathers of his birds, released them, and then followed them with a big receiving antenna mounted in the back of his pickup, sometimes cruising the streets of Chicago with this rig, trying to stay within radio range of his subjects. Cochran's instruments influenced the design of the aquatic versions produced by Evans and his associates.

Evans devised modulated signals that told not only the animal's position but also the depth of its most recent dive. He was ultimately able to track dolphins for many days. Since his early studies, radio packages have become smaller and more powerful. Ranges of 30 to 40 miles have been achieved on the surface and even vertically to a receiving satellite circling above. Workers such as Bruce Mate and William Watkins have recently followed whales for very long distances, through a significant fraction of their oceanic migrations.

During the 1960s, Karen Pryor and I worked in the same institution on the island of Oahu, she as head dolphin trainer at Sea Life Park oceanarium and I as scientific director of the affiliated Oceanic Institute. Not infrequently, we collaborated on studies where trained animals were used, such as our studies, with Thomas Lang, of dolphin swimming performance in the open sea. At that time, my mind began to turn to the problem of learning about the lives of wild dolphins at sea. Hawaii was certainly a perfect place for such work. Several species of dolphins and whales occurred nearby. Sometimes they were encountered in calm, clear waters near shore. For example, off the lee of the Waianae Coast of Oahu, I knew of a school of spotted dolphins that was repeatedly seen under the lee hook of Kaena Point. Ashore of that point lay the steep, fluted slopes of high mountains. It occurred to me that there I could establish two listening stations hooked together with a long wire laid along that slope. With Evans's new radios I might be able to triangulate on animals swimming offshore, just as a sailor would make a navigational fix on points of land from offshore. But the Kaena animals proved elusive, and two other promising developments turned my mind elsewhere. The first was the location of a "resident school" of dolphins in Kealake'akua Bay, on the distant island of Hawaii, and the second was the successful launching of my first porpoise-watching vehicle, the mobile observation chamber (MOC), or more colloquially, the semisubmersible seasick machine (SSSM).

The Kealake'akua Bay topography was perfect for dolphin work. A magnificent, nearly vertical 500-foot cliff loomed over the almost-always calm and clear semicircular bay. A group of dolphins rested in the bay nearly every day. One could look down almost on top of those resting dolphins, and their behavior could often be seen in toto as they moved offshore, until they faded from view into the gray disk of the sea. My colleague Tom Dohl and I established a camp near the brink of the cliff, cutting trails through the dense brush to vantage points where telescopes and cameras could be set up. And we brought along the new viewing vehicle.

Then we set about trying to learn to recognize individual dolphins. We drew pictures of them, including scars and any distinctive markings we noted. By this means, we began to recognize some individuals over and over. The "school" proved to be a transient and ever-changing group. A broad outline of the spinner dolphin's daily life emerged from this work, and we had some glimpses of their behavior underwater, though we found that the SSSM was so slow, and so frightening to be in if the sea got at all rough, that we had to restrict her operations to within the arc of the bay.

William Evans took part in one of our early voyages in the SSSM and was so impressed with the potential of underwater viewing that he returned to the navy laboratory where he worked and designed a larger and much grander version, which placed observers within an entirely transparent plastic viewing sphere, a vessel he called the *See Sea*.

After a proud prototypical career, our SSSM was finally relegated to scrap metal. Only some years later, for studies of dolphin mortality in the yellowfin tuna fishery, did I use another such vehicle, the *Maka Ala*, or Watchful One. This craft, built from a trihull skiff, required the observer to lie down on a mattress with his or her head in a transparent plastic ship's bow. Though the *Maka Ala* was maneuverable and fast compared to the SSSM, she was a less-than-optimum platform for long-term observation. Aside from the permanent crick in the neck induced in users, her major fault was a sloping bow that prevented the observer from looking upward toward the sea surface. Only through small side panels could one see the sea surface above. This nearly eliminated the chance for an observer to identify the sex of animals that swam close to the bow, an all-important activity if one wants to unravel the social structure of a dolphin school.

A new viewing vehicle for which we have high hopes is now being built at my laboratory in Santa Cruz, California. My Swedish student Jan Östman has dubbed her the *Smygg tittar'n,* or Tiptoeing Peeping Tom. The *Smygg tittar'n* features a retractable viewing cylinder. The vessel will travel with the cylinder in the "up" position. When a subject of interest is sighted, the cylinder will be lowered, and an observer will enter and don headphones that allow communication between driver and observer. Animals will be visible in all directions, including upward toward the surface. We expect to achieve some degree of directional hearing through two hydrophones and in this way, to be able to connect dolphin sounds to their proper behavioral contexts.

The value of these viewing vessels is, first, to introduce the observer to the world of the dolphin. We naturalists need to see and understand the shafts of downwelling light in the open sea, the flicker of sunlight magnified through thousands of lenses of curved water on the sea surface, that are so constantly part of what a dolphin sees. We need to understand the underside of the surface as dolphins see it, a wavy silvery sheet extending off into the blue distance, with, directly overhead, a permanent disk of transparent water, Snell's Window, through which the dolphin sees into the air above.

We need to see other dolphins as a dolphin sees them. Traveling dolphins in a school look primarily sideways at each other for the signs and signals of their visual communication; we understand them only if we look sideways too, not down from above. Underwater, a human observer can clearly see the flashing white bellies of mating dolphins, long before the dolphins themselves come into view through the blue. That, of course, is what dolphins see too. One can see postural signals: anger shown by flashing eye whites; the wholly diagnostic jerky swimming of dolphin calves; the open spaces within schools in which babies play; mothers nursing, playing with, and disciplining their young; the serious troops of males that usually interpose themselves between the observer and the remainder of the school. And one can watch dolphins caress in what we have come to believe is a ritual of reaffirmation between animals. In short, looking from beneath the surface, one penetrates the animal's world and sees the texture and intimate structure of dolphin life.

The data from these viewing vehicles come as a collection of vignettes, each usually only seconds long. But with patience, and frame-by-frame analysis of film and videotape, much comes into focus and much can be quantified.

While I was testing my first viewing vehicle, Roger Payne began plans to watch wild right whales from a clifftop at the Golfo de San Jose on the Patagonian coast of Argentina. He built a station there, right on the brink of the cliff, and began to devise ways of extracting those vital numbers from his observations. One way, he decided, was to track the animals with a surveyor's theodolite. He set two of his student team to work with this instrument—Bernd Würsig and Melany Würsig. As a project of their own, they turned the theodolite technique to the task of describing the movements of the dusky dolphins and southern bottlenose dolphins that shared the bay with the whales. Bernd, a skilled photographer, took photographs of every school he encountered. From this trove of images, he and Melany began to assemble a dossier of animals that they could recognize. This record was a far better way to identify animals than my drawings. Many dolphins, it turned out, had subtle but definite scars and nicks on their fins which, taken together, allowed positive identification where no drawing would suffice. The method of *scars and marks analysis* has since revealed many things about how dolphins live at many places in the world oceans. It lets scientists follow individual animals over time and come to know their associates; it gives insights into such societal features as courtship, movement patterns, and site fidelity.

The Würsigs contributed another important change to our way of doing things. Once the data gathering from the cliffs and boats was done, they began a statistical search through their numbers for relationships the eye could not discern. They were able to *quantify* many aspects of the lives of the dolphins they watched, events that previously had been recorded only in words. Their papers are peppered with parentheses containing probability values and other more esoteric statistics. Though these notations may clutter the story line, they provide the most precious of scientific treasures—little truths on which future understandings of the dolphins may be anchored.

I will mention two further studies, both begun in the early 1970s, that have lifted their subjects, the killer whale and the bottlenose dolphin, from being among the least known to among the best known of large mammals. Michael Bigg, a fisheries biologist at the Pacific Biological Station on Vancouver Island, began to record the killer whales of Washington and British Columbia by the shapes of their fins, their patterns, and their scars and marks. Now every individual in these waters can be recognized and allocated to a given pod and dialect group. When a new baby is born or an animal disappears, researchers not only know that this has happened but which individual it is, its family, and its lineage, sometimes to three generations. Bigg's study is now being extended by other biologists working in Alaska, Canada, and the northwestern United States.

At about the same time Bigg was beginning his work, a team of three biologists, Blair Irvine, Randall Wells, and Michael Scott, began to assemble data from the bottlenose dolphins living in the shallow bays of the west coast of Florida. Year after year, these biologists have returned to this group of about one hundred animals to ask new and deeper questions of the dolphins. Many animals have been captured briefly and tagged; blood samples are taken which illuminate genetic relationships of nearly all animals in this population, as well as where they go, how old they are, when they give birth, what their annual hormonal cycles are, what it is like to grow up in a dolphin school, and even how thick their blubber is at any time of year (measured by ultrasound), which allows us to assess how well they are eating.

This study is backed up by other investigations of bottlenose dolphins. The Russians continue to study dolphins in the Black Sea. Susan Shane, working both in Texas and Florida, has defined the behavioral flexibility of the species by showing that the intimate patterns of daily dolphin life vary from place to place. First Elizabeth Gawain and then Richard Conner and Rachel Smolker have begun to learn about a group of Australian bottlenose dolphins that have become habituated to people at Monkey Mia, Shark Bay, north of Perth, Australia. There they can see and hear the most intimate interactions between the dolphins. Because they can wade among those dolphins that come closest to shore and because the remainder seem remarkably tame, many details of dolphin life can be seen and studied, firsthand. This work is commanding the attention of primatologists and seems to hold great promise.

The chapters that follow are samples of contemporary work on wild dolphins, ranging from the studies of young workers reporting on their first serious piece of research to established workers, those who have laid the groundwork, defining where we find ourselves now.