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What are sharks doing when no one is looking? —On the Ethology of Reef Sharks

Text and images by Ila France Porcher

In my last article, *When Sharks Really Attack (X-RAY MAG #52)*, I described an unusual series of events indicating that sharks experience subjective states, or emotions. This follow-up piece provides further information about the reef sharks I studied closely underwater for seven years.

A difficulty in obtaining information about the natural behaviour of wild animals is that detailed observations of the activities of different individuals is necessary over long periods of time. This is especially hard to achieve with sharks.

Fortunately, in the wide lagoon near my home in French Polynesia, which averages a depth of two meters, it was possible to observe the sharks easily for long periods and collect a large amount of data on their movements and behaviour. The blackfin reef shark, (*Carcharhinus melanopterus*) was especially easy to observe. Over the years, I identified six hundred individuals and could recognize three hundred on sight.

Ethology is a field of zoology, and one of its major principles is to “know your animal” by observing its behaviour

over an extended period of time. Such observations take so long in today's rapid pace of science that it's far easier to place tags on them. There are excellent advantages in accomplishing studies of numerous animals by such means, and the field of behavioural science can well use such information. Its popularity is without question, but it cannot often

explain, except in the broadest sense, why animals do what they do, since individuals often don't do what others around them do. That's why the work of ethologists will always be valuable.

Following the ideas of Konrad Lorenz, Nikolaas Tinbergen, Arthur Myrberg, Donald Griffin, and others, I identified the sharks by drawing the markings on both

sides of the dorsal fin, and found that observing them as individuals revealed a whole new dimension of behaviour. One of the most surprising things was the degree and variety of individual differences that they displayed.

Individuality

Each shark's behaviour was unique and

seemed flexible from day to day. Not only was their behaviour towards me unique, but so was their use of time and their patterns of roaming. Sometimes a shark passed the same coral formation at almost exactly the same time each evening for several nights in a row, then disappeared from the area for a year. Sometimes, day after day, a shark could





be found in exactly the same place in her home range at the same time, then the following day she was roaming on the outer slope of the reef at that time. There were some days that all the females left the study area, and others when it was filled with visiting neighbors.

Study

Once a week I brought them some scraps from local fishers so that I could identify the sharks in the area that evening, and I visited at random times to observe them and to accompany them when possible while they roamed. Eventually, they became so used to my presence that they treated me as they would another shark. (One cannot expect an animal to treat one in a brand new way because one is a different species). Thus I was able to witness their intimate social and emotional behaviour as if no one was watching them. For all the years I knew them, I kept seeing new behaviour patterns, some which would have been unbelievable to me in the beginning.

The study area was seldom visited by other people, so observations could be obtained without disturbance, and the sharks were relatively unaffected by other human encounters.

Home range

The lagoon was the domain of the female blackfin reef sharks, each of whom spent much of her time in a favoured region called a home range; the pups were born and matured in those sheltered waters. Beside the resident females, others whose home ranges were farther away came from time to time, and there were many juveniles. The youngest were two to three years old, since they remain in hiding until

they grow enough to mix with the rest of the community. While most of the males lived in the ocean on the outer slope of the barrier reef, a very few ranged through the lagoon. These male sharks were smaller than the females, lithe and muscular, most being less than four feet long. They seemed less attached to a home range and roamed much farther afield during their daily travels.

In the mating season, bands of males from the ocean would arrive at nightfall, to the excitement of the females. The largest females were close to six feet in length, and maternally heavy with a more rounded silhouette.

The residents of the study area soon recognized the sound of my kayak crossing into the lagoon from the adjacent bay, and anchoring at my usual place, and when I slid underwater, they were waiting, no matter what time I came. But the one I had dubbed "Bratworst" would always arrive two minutes after me. This began to puzzle me so much that I decided to investigate and anchored and slid underwater without a pause on my next visit. Not a shark was visible. So I drifted silently with the current and found Bratworst lurking behind a coral, just beyond visual range of my boat. It was my first clue that sharks listen from beyond the visual range, and come when they decide to.

Senses

I had learned years before, when first observing them and learning to move swiftly and silently, that sharks can hear a person swimming long before he or she comes within visual range. The shark usually vanishes before the person sees that it is there, but the possibility that members of such an ancient line of animals could use the limit of visibility as a



veil behind which to conceal themselves, was new.

I often observed sharks following each other beyond the visual range. The shark I was with would catch up to the one she was following, and swim nose to tail with her or side by side. Then, after resuming her arcing path for a time, she often caught up to another shark and briefly swam beside her. The sharks generally roamed in circular or oval paths of various diameters which crossed at the centre and formed rough figure of eights or cloverleaves. Such patterns likely brought them repeatedly into contact

with each other's scent trail, allowing them to keep track of each other while travelling in circling paths, out of visual range of each other much of the time .

Curious sharks also followed me, always remaining hidden behind the veiling light except for an occasional pass into view. Apparently they listened and used their lateral line sense to monitor my actions, instead of eye-sight. I began regularly checking to see who was following me by stopping and drifting with the current, whereon the sneaky sharks behind soon came into view.

Shark friendship

These sharks knew each other as individuals, and it was soon clear that they had preferred companions with whom they liked to travel. Some companionships were so strong that I never found one shark without the other. Some friends separated on occasion and travelled with different companions for a time, reappearing months later together again, while some sharks always travelled alone.

At times groups of sharks, all from a particular region, and often accompanied by specific males,

shark tales



travelled together. They moved in loose contact along the fringe lagoons of the island, and were joined temporarily by local residents as they went. But their tendency to roam out of visual range of each other complicated the problem of figuring out who was with who.

Kimberley and Twilight

One of the elderly female visitors was nearly black, with two pure white markings symmetrically placed, one on each side of her head. It looked as if someone had stuck two large snowflakes on her. Arriving always at dusk, she was a dramatic sight with the twin white points

glowing bright. I called her "Kimberley".

She remained in the area for an entire lunar cycle, and when she left, another very similar shark appeared. Not only was the patterning of their colour lines and dorsal fins alike—the opposite sides were nearly identical—but this shark, too, had pale markings placed precisely the same way on her head. She also arrived just at nightfall, and I called her "Twilight". Since none of the other sharks had such white markings, I speculated that the two were sisters.

It was months before either of them returned to the area, but there came an evening when the twin snowflakes

approached again through the gloom. Kimberley glided in, and the following week, I saw Twilight. For three years I watched these sharks come and go every few months, only occasionally together. Was it chance? Or could there really be an association between them?

One night it was so late that the sharks were just movements in the darkness when I put the anchor in the boat, and began to drift with it. But after only five metres, Kimberley appeared in the gloom. I waited. A minute passed. Then Twilight approached, following Kimberley's trail. The two sharks were not within visual range.

Trailing the kayak, I finned toward Twilight and was able to approach and swim with her. She went toward the feeding site but turned to pass down current from it. Had I been at my usual location, she would not have been visible. Then she turned back.

Kimberley appeared, equidistant on my other side. She had apparently already crossed the site and circled back. The two immense sharks curved onward as though following arcs of the same circle. They met in front of me, passing close by each other. I took in every detail, but saw no signal from either of them, and wondered whether something more was exchanged between the old friends than what a human eye could discern.

Twilight languidly cruised back and forth in large figure of eight patterns. Time after time, she overtook another female shark, apparently by pursuing her trail of scent. Had she been targeting the other shark's vibrations, it was unlikely that we would always have joined her by coming up behind her. Each time, the two big females passed close beside each other, and continued on their

Portrait of a shark name Martha, by Ila France Porcher (right); The shark named Kimberly (lower left)



separate ways. When I left, the visitors were still socializing with the residents down current from the feeding site. Often they came only to visit, and not to eat.

Gleefully concluding that I had been right—that there was a companionship between the two sharks after all—I left. Kimberley and Twilight arrived swimming together on their next three visits, months apart, and on several more occasions before Kimberley died, confirming what had taken years to verify.

Visual range

There were other ways in which the various species of sharks on the reef used the limits of visibility. Their pattern of approach, for example, generally involved just a single pass into visible range, often repeated within a few minutes. This pattern is so common that it is easily seen on any shark dive. Though I initially analysed the pattern in reef sharks, it was clear to see when I dove with tiger sharks, too. Shyer individuals intermittently passed at the limit of the

visual range, never approaching.

If the shark was very interested or curious, it would come closer on each pass until it swam straight in, but shy sharks would not approach at all unless there was a group present, and if anything was different about my routine, even the resident sharks would retreat beyond their curtain of blue, only passing into view from time to time. This was especially problematic when the BBC came to film them for Shark Week. Mike DeGruy didn't believe me at first when I assured him, as we surveyed the empty coral landscape, that 30 sharks were hiding just out of sight.

Whenever a second person came with me, the sharks remained behind the visual limit for up to ten minutes before approaching. Sometimes when they appeared they approached in long lines, led by the boldest ones, and went straight to the stranger. This reaction never happened when I was alone, and demonstrated the sharks' ability to recognize changes in routine, and to





Illustration of author's interaction with a shark named Madonna, by Ila France Porcher

make rapid decisions to stay or leave depending on unfolding events. It is closely associated with learning, which has been experimentally shown many times in elasmobranches.

Awareness

Sharks are also aware of the direction a person is facing and may respond instantaneously when the person of whom they are nervous puts his or her head above the surface, or even looks the other way; a common move is to approach from behind.

Once I was swimming through the study area with my step-son when he climbed on a coral to look around above the surface. The shark accompanying us instantly glided over to him and, unseen by the boy, sniffed his legs.

The sharks indicated their awareness of whether the person was able to see them or not in many ways, and used this awareness to their advantage. Other species of reef sharks in the community, including white-tip reef sharks (*Triaenodon obesus*), and sicklefin lemon sharks (*Negaprion acutidens*) displayed the same awareness and general behaviour with regards to hiding in the veiling light. They also would often approach from behind, when a person was looking the other way, or had raised his or her head above the surface.

Thus the best thing to do when with sharks, is to face them eye to eye, and they will respect you. Its useful to look around often too!

Sharks party

When there were many visitors in the study area, there was much excitement and socializing. The most dramatic

feeding sessions that I mentioned in my former article, *When Sharks Really Attack*, occurred when there were many visitors and the moon was full. Since their roaming correlated with the lunar phase, I began to think of the thrilled shark tornadoes that developed as the full moon rose as "partying behaviour."

An old lady shark who normally never accelerated would suddenly shoot vertical, shake off her remora, and streak away out of sight so fast that the eye could scarcely follow her. Then she would rocket through the scene again, with many others shooting with her out of view in the opposite direction.

The resident sharks were always more excited when the moon was full, especially when visitors had joined them. The incidents described in my former article, when the sharks unanimously slammed the boat and leaped out of the water to snap at whatever fish-scrap they could reach, happened at such times. Sharks of this species do not naturally put their heads above the surface to eat nor to look around, so this was a completely new foraging behaviour. It was initiated by specific individuals, and was instantaneously adopted by the others present. This finding of a new foraging technique occurred in two different locations, years apart, with different groups of sharks, and presents examples of social learning.

Lunar connection

That sharks timed their travels according to the lunar phase was clear to see when watching them. For example, two elderly female sharks appeared in my study area during the period of the dark of the moon at the end of April four years in a row, staying in the region about two



weeks, until the moon waxed bright, when they left. They came at no other time. Presumably they chose the study area in which to wait through the dark period, and left when they would have two weeks of bright nights to facilitate their travels.

I observed their visits each year until the sharks were finned in 2004, after which no elderly sharks ever appeared. One visiting male's first four visits, though months apart, occurred precisely at sunset, four days before the dark of the moon. Visitors tended to stay in the region for half or a whole lunar cycle, and residents often left during the period of the full moon, returning in ten days to

two weeks as the moon waned and the light at night faded.

Most birthing and mating events also took place during the period of the full moon. The resident females left their ranges about a week before, and generally returned about two weeks later, when it was waning. Perhaps it was because of the need to travel, sometimes many kilometers or even to another island (Mourier, J. & Planes, S. 2013), that such a high percentage of births took place during the full moon. Since the tides on the islands are solar, it seems that the light at night is the important factor—sharks use both sources of planetary light for travelling, not just the sun.

When the sharks I had come to know so well were finned by a company in Singapore, I wrote down the story of what it was like to get to know them, what they were like, and what happened, in an effort to get their story out of French Polynesia. The name of the book is *My Sunset Rendezvous: Crisis in Tahiti*. ■

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(File photo) A great white shark at Isla Guadalupe, Mexico

Pacific Great White Shark not endangered NOAA finds

Northeastern Pacific Ocean population of great white sharks does not warrant listing under the Endangered Species Act, NOAA announced Friday.

Scientists of the U.S. National Oceanic and Atmospheric Administration (NOAA) concluded that the white shark population is a distinct genetic group with a low to very low risk of extinction now and in the foreseeable future.

NOAA had been investigating the great white population since last year, when the environmental groups Oceana, Shark Stewards and the Center for Biological Diversity filed a petition calling for endangered species protection.

The petitioners were reacting to the first ever census of great whites, which was conducted by University of California-Davis and Stanford University researchers, and published in the journal *Biology Letters* in 2011. The cen-

sus estimated that only 219 adult and sub-adult great whites lived off the Central California coast, and perhaps double that many were in the entire northeastern Pacific Ocean, including Southern California.

A joint statement from Oceana, Center for Biological Diversity, Shark Stewards and WildEarth Guardians said federal authorities ignored studies that listed less than 700 sharks off the California coast.

"Our team felt that there were more than 200 mature females alone, an indication of a total population of at least 3,000," countered Heidi Dewar, a fisheries research biologist at NOAA. NOAA's analysis, which will be made public Monday, was based

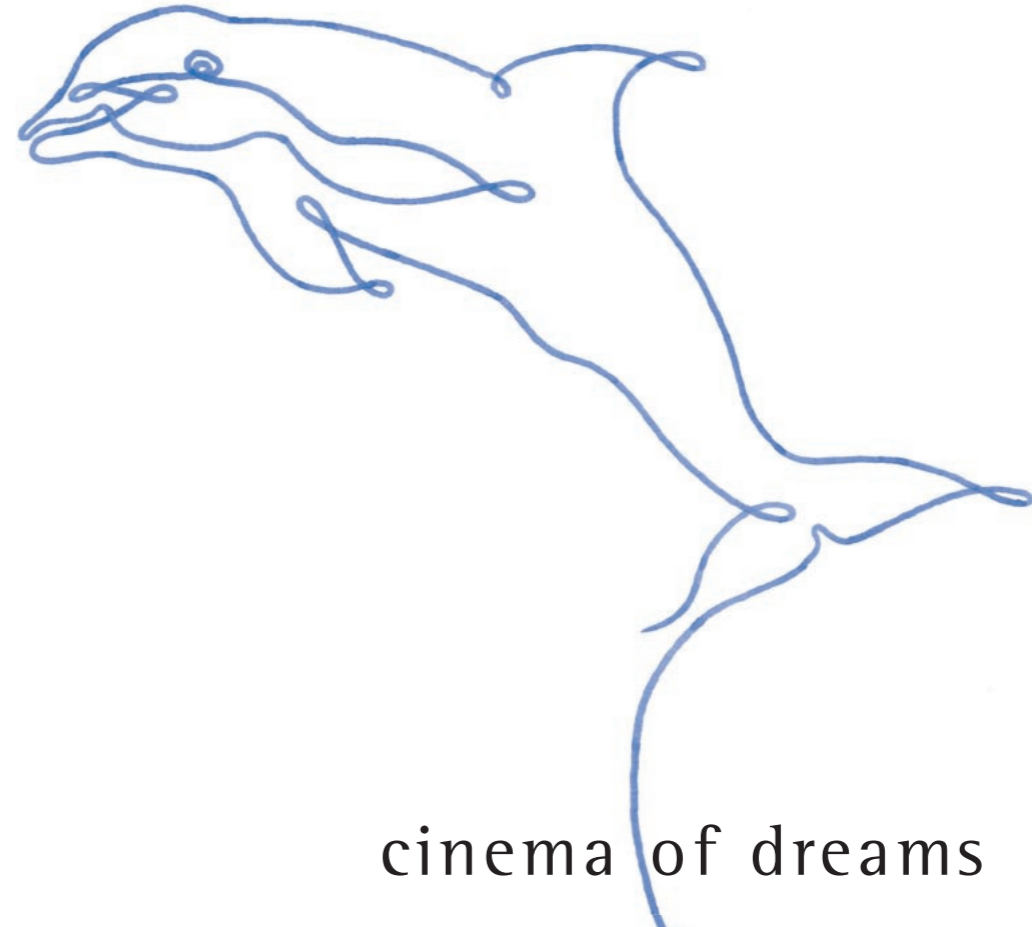
on a comprehensive review of threats to the population, direct and indirect indicators of abundance trends and analysis of fisheries by catch in the United States and Mexico, Dewar said.

Margaret Spring, vice president at Monterey Bay Aquarium for conservation and science, said in a news release the organization appreciated the "thorough review" by the National Oceanic and Atmospheric Administration.

"We are fully committed to supporting rigorous science, public education efforts and ocean policy reform," she wrote, "to ensure that great white sharks do not become more vulnerable in the future." ■ SOURCE: NOAA

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