



Sharks are usually peaceful together (as shown) but can display agonistic postures when threatened or irritated

Text by Ila France Porcher
Photos by Ila France Porcher
and Peter Symes

Meaningful posturing in sharks was first noticed in the gray reef shark. Richard Johnson of French Polynesia found that when sharks of this species were chased and cornered, they performed a complex display.

The animal would arch its back, raise its snout, depress its pectoral fins and swim toward the offending diver with exaggerated horizontal swimming movements, sometimes rolling or looping in a spiral. Then it would either flee, or, with a lightning gesture, deliver a warning slash. (One of the most startling things about sharks is the speed at which they can suddenly move.)

The intensity of the shark's display increased with the speed and directness of the diver's approach, and the degree to which its escape route was blocked. The gesture appeared to be a ritualized warning that the animal was being pushed too far, and was about to act

more decisively: to slash or flee.

Johnson termed this posturing an agonistic display—agonistic being the term used to describe social behaviors involving competition and conflict among animals. In contrast, acts of predation are done at high speed and very suddenly, with no signaling in advance by the shark.

Agonistic displays in other species

Aiden Marten's 2007 review of shark displays describes variations of the gray reef shark's dramatic posturing in 23 species of sharks from six families, including the great white shark, tiger shark, sand tiger shark, scalloped hammerhead shark, silky shark, blue shark, several reef sharks and basking shark.

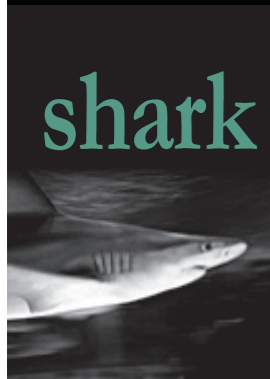
Jerky, exaggerated movements or sudden turns, accompanied by the depression of the pectoral fins, are most common. Sometimes the shark also holds its mouth open, gapes repeatedly, or billows its gills. While diving with sharks, the best indicator to look for is sudden changes of direction, and lowered pectoral fins.

One reported incident took place on the Great Barrier Reef when silvertip sharks were crowded by photographers. They accelerated away initially, then some charged back. At about two body lengths from the divers, they turned broadside and moved slowly past the divers. Each displaying shark lowered its pectoral fins and tail, gaped its jaws

Posturing Sharks

PETER SYMES





rhythmically and vibrated its entire body, as if shivering, as it passed the offending divers. Then it accelerated away.

The sandbar shark will also turn broadside to divers while depressing its pectoral fins. In one instance, female sandbar sharks were reported to ram a diver with their snouts, while the males veered away while still over a body length away.

The great white has been documented displaying with arched back toward other sharks during feeding, and gaping repeatedly.

The ritualization of conflict

Animals that have evolved weapons that are dangerous to others, will also have behavioral strate-

gies that keep them from mortally injuring others of their own kind. A wolf which finds itself on the losing end of a battle, for example, will roll over to display its unprotected underside to the teeth of its adversary. And no wolf—or dog for that matter—would ever break the unwritten rule that once the submissive gesture is given, the fight is over. Certain fighting birds will offer the back of the head in defeat, in a similar gesture. The agonistic displays of sharks are likely strategies serving the same purpose.

Shark ethologist Peter Klimley described in his book, *The Secret Life of Sharks*, how great white sharks ritualize their conflict when a seal that one of them has killed

comes under dispute. Each slaps the water at an angle with its tail, and the shark who raises the most water and blasts it farthest, wins the prey. For this ritual to be effective, each shark must read the gesture as a communication, and the loser must acknowledge the winner to avoid a physical battle for the seal, which would badly hurt both sharks.

Other shark gestures

Marten's comprehensive review suggests that agonistic displays are likely widespread among sharks of many species, but also that the gray reef shark's posturing is exceptional in its form and presentation. In other species, such displays are less clearly defined, or predictable. Agonistic displays are rarely seen on dives, so most sightings are anecdotal, which results in a tendency to view them as rigid and unchangeable. Marten himself found that, unlike the gray reef sharks of French Polynesia, those in the waters off Australia would not display. When chased, they simply departed.

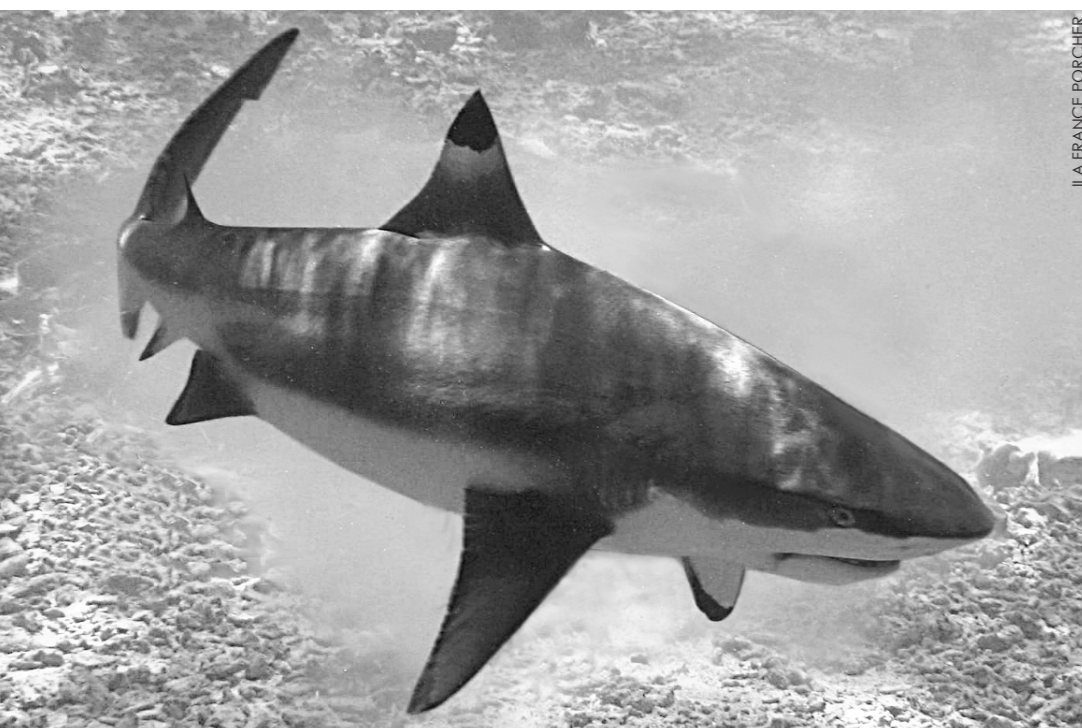
Shark diver Dr Brian W. Darvell reported that while diving with a

friend in the Java Sea, he saw a blacktip reef shark display the "classic back-arched, pectoral fins down" posture. The two divers were about five meters above the reef when the shark suddenly appeared and made several rushes toward Darvell's buddy. No food or scent was present, and the shark had been neither chased nor cornered.

The blacktip shark is known for its habit of dashing up to a person and turning away at the last minute, and spear fishermen will often complain about this harassing close approach. Except for the arched back and lowered fins, Darvell's unique account is reminiscent of such behavior. Had the shark learned from prior experience that divers may have fish to steal, its actions become more understandable.

In past field research with sharks, I was sometimes harassed by blacktips that had apparently learned that divers can trail dead or dying fish on lines behind them. These individuals would

approach me fast from behind, sometimes actually swimming over my back, in a strategy



Blacktip reef shark turning without displaying

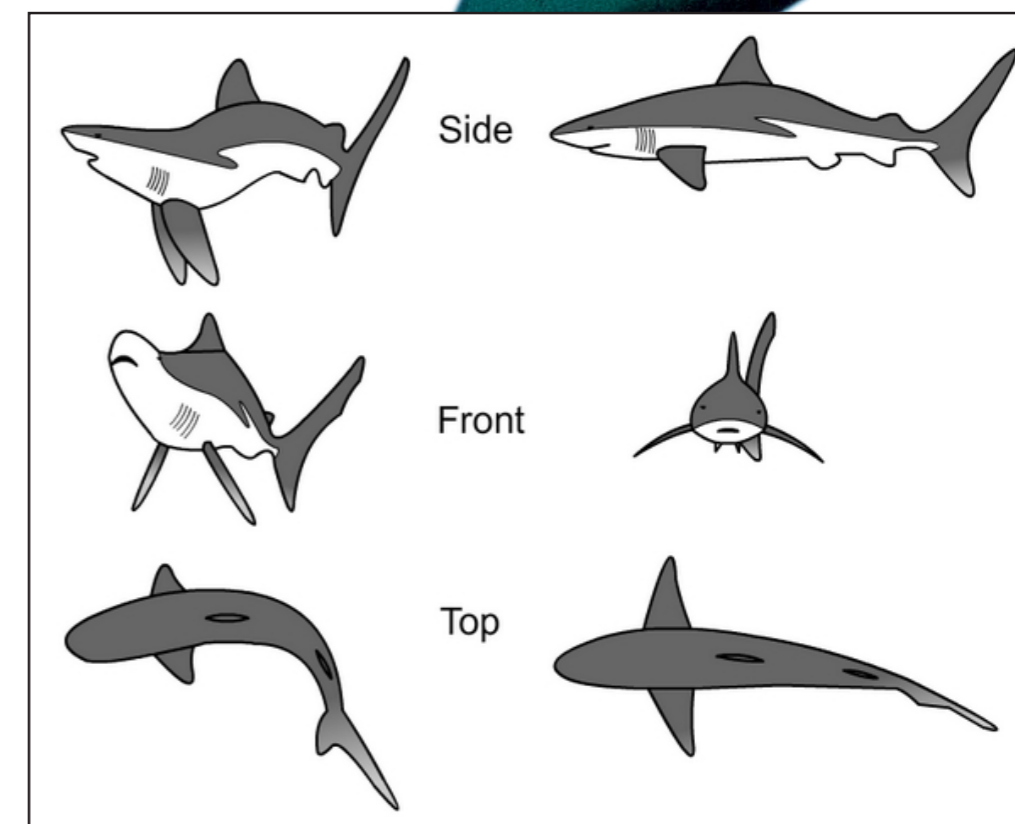


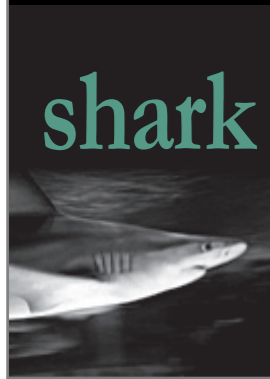
Diagram of the gray reef shark's agonistic display

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ILA FRANCE PORCHER

shark tales



learned from experience—learning is an important aspect of feeding in sharks. But once they learned that I did not trail fish behind me, their behavior changed accordingly, and they never swam over me from behind again.

Darvell's report is the only one of such a display in a blacktip reef shark.

One gesture may serve many purposes

Blacktips present a variety of other muscle-flexing and agonistic behaviors, which were not reported by Marten. Usually, for example, these sharks perform their close approach to divers slowly.



Tiger shark gaping at a lemon shark

of food. The shark would poise in front of the eel for a moment, before veering away. Its approach seemed to correlate with the eel's response in that the distance at which it paused, depended on the eel's reaction to its offensive gesture. So, in this case, the close approach seemed to be a test of the mettle of the other animal—would it flee or not? The shark's action suggested predator inspection, with the

Once the wild blacktip sharks I studied in French Polynesia had become familiar with my visits to their ranges, certain ones would swim slowly up to my face as soon as I appeared underwater, suggesting that in this context, the purpose of the gesture was connected with affirming my

identity. In the wild, animal gestures often appear to be adaptable for use in various situations.

Occasionally, at a feeding session, a shark would make a close approach to an eel, when one of the large ones—the Javanese moray—was stealing pieces

inspector highly attuned to the reaction of the inspectee.

The close approach of the blacktip shark, whether done quickly or not, never results in opening the mouth or biting, and presents as an agonistic display, though no muscle-flexing is involved.

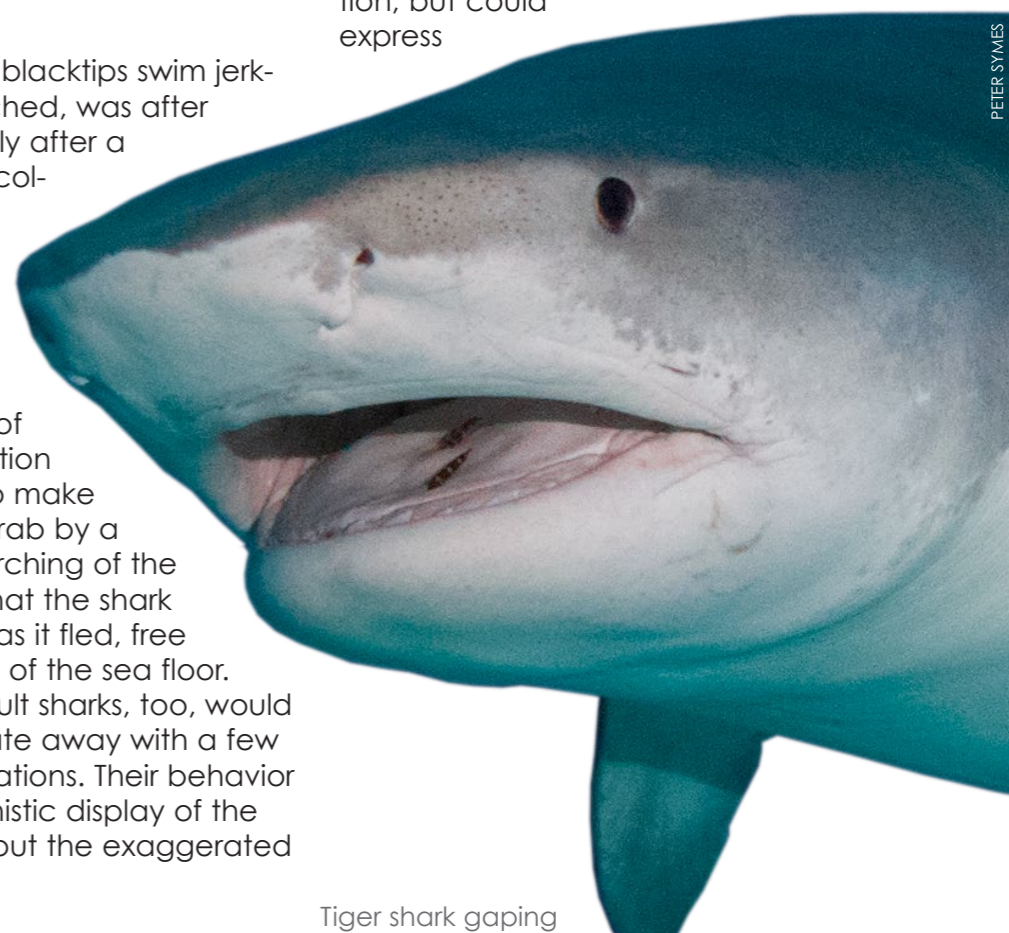
horizontal movements, yet it was neither agonistic nor a display. It appeared to be a reflex response that had evolved to protect the shark from injury.

After startling and rocketing away, the shark was likely to reappear some minutes later, in shiver mode. It would suddenly twist, and unpredictably, change direction. Often, the shark appeared to have shivers running through it as if it were made of water, and from time to time, someone disturbed it. This restless flicking and twisting at times continued for long periods.

One adult male shot into view one night in shiver mode, and remained in that state for more than 20 minutes, shuddering, jerking and making unpredictable flights, until it was too dark to see. It gave a performance of utterly erratic motion, yet was accompanied by two other males whose behavior was normal. This sighting suggested that the state was not always a brief reaction, but could express



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Tiger shark gaping

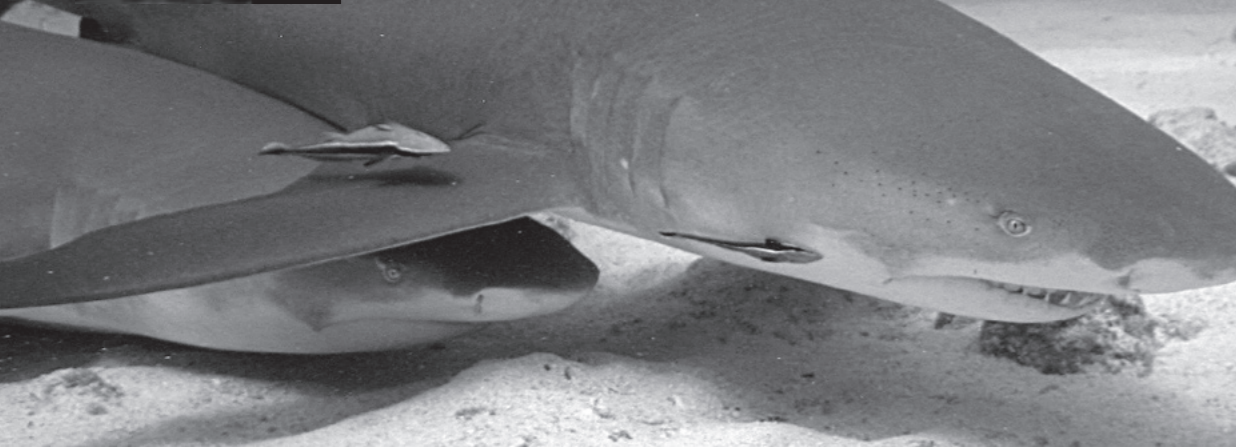
Fear reactions

The only times I saw blacktips swim jerkily with the back arched, was after being startled, usually after a juvenile had nearly collided with a larger shark of another species. The small shark would accelerate away, arching its back vertically in a series of rapid jerks. The reaction seemed adapted to make the pup harder to grab by a predator, and the arching of the back guaranteed that the shark would rise upwards as it fled, free from the hindrances of the sea floor.

When startled, adult sharks, too, would sometimes accelerate away with a few sharp vertical undulations. Their behavior resembled the agonistic display of the gray reef shark without the exaggerated



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No inter-animal distance

A charging shark might return a few minutes later to charge again, and as others followed, increasing numbers of sharks became involved. At such times, the repeated charges often resulted in menacing circling, which could continue for long periods. Sharks in this behavior mode tend-

ed to become aroused, and the behavior resulted in a state of palpable tension, as all the sharks present participated. At the center of their circles, you realized that any movement at all could trigger them, which in their case meant slamming you.

Slamming

Slamming was the natural consequence of menacing circling, and fortunately for me, the sharks only performed that against

me en masse, when I was in my kayak. Something would trigger their outburst, and the entire company of three dozen sharks would attack!

On many occasions, the heavy weight of the loaded boat was bashed with shocking force first one way, and then the other, as the sharks slammed it from multiple directions. For many minutes the slamming was continuous, and after the heavy blows from the first sharks, more slammed right behind, and more behind them.

The sea surface was replaced by sharks emerging at high speed, then twisting and shooting away together as more replaced them. The heavy blows came mostly from beneath, since they would arch their backs during this behavior while accelerating upwards from some distance directly below.

But there were other occasions in which sharks who knew me

a longer-term condition of stress or fear.

Though shivering was seen in an agonistic display in the silvertip shark, in blacktips, it is associated with a fear reaction. Traces of it appeared occasionally too, in sharks who arrived at the sessions in a state of agitation. Swimming swiftly, and twitching at times, the animal would make sudden rushes, then whip back around in a tight circle.

Blacktips with nurse sharks

As night fell on my shark sessions, nurse sharks would carpet the site, some of them as large as draft horses. At times, they would lay on the fish scraps, and though the blacktips would circle around them, they would make no effort to encourage them to move off their long-awaited food.

Only once did a large blacktip female dart up to the nurse shark in an intimidating close approach, with many more gliding in behind her, but the nurse shark did not move, and it did not bite. Sometimes, the blacktips became excited as the nurse

sharks tore the fish heads apart, and circled, about three meters away, intermittently charging in to try to get one. At times a tornado of blacktips surrounded the nurse sharks, all in high excitement, yet there was never any aggression among them.

While the blacktips would not threaten the nurse sharks, however, nurse sharks would occasionally threaten them. One would suddenly turn sharply toward the offending blacktip as it passed and then circle, watching it, while the blacktip would turn away and depart.

Other agonistic behaviors

The most direct form of agonistic behavior in the blacktips came in a different form than those reported so far. They were prone to charging, coming straight forward at medium to high speed, and passing just to one side. Other sharks would join in, and follow the leader in single file, which could result in a long line of sharks approaching. Sometimes they adopted a triangular formation, like a small fleet of fighter planes.



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became enraged enough to slam me personally. It was possible to recognize the imminent attack in the speed of their approach, straight into my solar-plexus, and just before they made contact, I would push them in another direction, or strike them on the

head with my hand, whereon, each time, they changed direction.

Thus, it seems possible that the blacktip's close approach can escalate from predator inspection, to intimidation, to charging, to slamming, under the right cir-



cumstances. Possibly the shark begins to arch its back as it passes a threshold of arousal when approaching at high speed to intimidate, as the video suggests.

However, these incidents were as rare as they were incomprehensible. Indeed, the few accounts we have of agonistic displays and behavior in sharks provide a tantalizing glimpse of how much is still mysterious about them. Among all predators, sharks may be the least conflictual.

They are not territorial. Hence, conflict among them is almost unknown. □

Illa France Porcher, author of The Shark Sessions, is an ethologist who focused on the study of reef sharks after she moved to Tahiti in 1995. Her observations, which are the first of their kind, have yielded valuable details about their lives, including their reproductive cycle, social biology,

population structure, daily behavior patterns, roaming tendencies and cognitive abilities. Her next book, On the Ethology of Reef Sharks, will soon be released.



Sand Tiger Shark. Evidence of complex social behaviors in sharks and other elasmobranchs is sparse, however we are beginning to understand the importance of studying shark aggregations



The friendly side of sand tiger sharks

Sand tiger sharks, *Carcharias taurus*, exhibit group behavior that has historically been associated with higher order mammals.

While many sharks are solitary predators, some are known to live in groups and are suspected of engaging in complex social behaviors. Meanwhile others simply aggregate due to similar habitat, food or mating requirements. Using a novel tagging procedure, scientists in the United States have discovered that some shark species like to spend their time mixing and chilling out together.

University of Delaware researchers collected tens of thousands of interactions between the 300 or so sand tiger sharks, fitted with electronic tags, over the past four years. In some cases, the sharks were found to spend up to 95 consecutive hours together.

Brainy

Sand tigers have high brain to body mass ratios when compared to other

Chondrichthyes (cartilaginous fishes), and therefore may have the ability to maintain complex social structures and social behaviors such as coordinated group feeding behaviors similar to those observed in marine mammals.

The University of Delaware project was launched in 2012 with only a modest 20 sand tiger sharks involved at first. Each had an implanted acoustic transceiver fitted to study their movements throughout the year. Initially focusing on two male sharks, the devices also recorded details of other animals carrying transmitters that came near the two sharks. These included Atlantic sturgeons, white and sandbar sharks, spiny dogfish and also lemon and bull sharks.

They all met up

The two sand tiger sharks did not always travel together, it was found, but they did reconnect at various times of the year and encountered more than 50 percent of all the other tagged sand tiger sharks on the east coast of the United States. ■ SOURCE: NATURE JOURNAL SCIENTIFIC REPORTS