

## **The social lives of hammerheads.**

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Hammerhead sharks form the family of Sphyrnidae, that includes eight species: the winghead shark (*Eusphyrna blochii*), scalloped bonnethead (*Sphyrna corona*), scalloped hammerhead (*S. lewini*), scoophead shark (*S. media*), great hammerhead (*S. mokarran*), bonnethead shark (*S. tiburo*), golden hammerhead (*S. tudes*) and the smooth hammerhead (*S. zygaena*).

In the hammerhead shark, the front part of the head is flattened dorsoventrally and laterally increased to form what we call the "cephalofoil," or two wide flattened expansions that constitute the characteristic shape of a hammer. These two expansions are made out of muscular and connective tissues supported by a cartilaginous skeleton that is an integrated part of the skull. The round shaped eyes are placed very wide apart at the two lateral extremities of these expansions. Also placed at the front margin of these lateral expansions are the nostrils. The "hammer" or cephalofoil of the hammerheads unfolds into a series of functions correlated to the movement and the predation of these sharks.

It has been observed that hammerhead sharks possess a very highly developed brain, and perhaps this could be the reason for the ability to lead the social life particular to these animals. Without a doubt, the most surprising aspect of socialization in hammerhead sharks is that of the immensely huge gatherings that different species form in numerous geographical areas. These gatherings could be formed from resident populations in that area or can be composed of individuals that migrate in masses.

Huge gatherings of scalloped hammerhead sharks have been observed at the Sea of Cortez, near the Galapagos Island, near Cocos Island (Costa Rica), Malpelo (Columbia), and San Salvador (Bahamas), Hawaii, the Red Sea, Natal (South Africa), in Australia, the China Sea and near Cabilao Island (Philippines). Each of these schools consisted of up to around five hundred individuals.

Such massive gatherings have provoked the curiosity of many researchers, who then questioned the reasons for which such sharks group together in these waters in such large numbers. Extensive studies on the schools of scalloped hammerhead sharks were done by researchers A. Peter Klimley, Donald R. Nelson and their collaborators in the Sea of Cortez. This is how it was discovered that during the day, these fish establish a precise social organization inside these groups, communicating through a complex

series of body movements.

It has been observed that although individuals of both sexes and of various sizes, (from juveniles less than a meter to the adults of beyond three m), are present in these mass gatherings, a very large percentage are young females of about 1.7 m length. These females, through a precise body language contend for the most prominent position in the centre of the pack.

This body language is made up of a series of ritual movements which include, shaking of the head, pushing others aside with their body, swimming in pronounced curves; hitting other individuals with the head, swimming by spinning along its body axis, and partially opening the mouth. The female hammerhead sharks may have signs of male "love bites," and these have also been observed on female scalloped hammerheads, but similar wounds have also been seen on males.

By tagging specimens with ultrasonic transmitters, A. Peter Klimley and his collaborators, could follow and note the movements of scalloped hammerheads resident in the area of the sea mount El Bajo Espiritu Santo, Sea of Cortez, and construct the following picture. In the early evening, the schooling scalloped hammerhead sharks disperse and the individuals move away to hunt for fish and cephalopods around the sea mounts.

The animals navigate with the earths magnetic field; particularly useful for orientation seem to be the lava formations on the ocean bottom. A little before dawn, the hammerhead sharks return to their sea mount, seemingly knowing with precision the exact point of reunion and to prefer it to other similar points in the vicinity.

During the day however, some individuals may singularly swim away from the sea mount and return after a short time, just like during the night. Very rarely, it can happen that there are single specimens near the sea mounts. It is also interesting to note that during the day the schooling scalloped hammerheads do not usually show any interest in any food source.

Scalloped hammerheads form gatherings in many seas and, according to the location, the relative composition and structure of the gatherings are different. However, the reason for which the scalloped hammerhead sharks form such large gatherings is still not all that clear, or at least is not clear for the schools that are more frequently observed.

In other cases, the reason for the gatherings appears more easily comprehensible. In waters near the Sanganeb atoll, in the Red Sea, photographer Jeremy Stafford-Deitsch has observed a group of scalloped hammerhead sharks composed of between eighty to one hundred individuals having one particular formation. At the center of the group was a thick group of juvenile specimens, not larger than two meters, whilst on the outside were the adults which, as far as the witness could see, were all females. It is clear in this case, that the grouping formation was a defensive one to protect the juveniles from predators.

Another gathering with similar structure was observed by researcher R. Aidan Martin, also in the Red Sea. The hypothesis of this author is that such structure is more common in these waters than in the other zones, because in the Red Sea the fish density is greater and consequently greater would also be the probability that the small ones get eaten by the predators.

Furthermore, in some phases of their life cycle, hammerheads may sexually segregate, with the males and the females momentarily separating and occupying distant areas.

Strangely, the location in which the scalloped hammerhead sharks gather near Sanganeb is the center of a very strong current, and most of the animals are obliged to swim vigorously in order to remain still. Other gatherings with presumable functions were those observed near Moku Ho', Hawaii, composed mainly of females, with a total of sixty individuals. The females often have "love bites" on the dorsum, suggesting that the formation of this gathering is for reproductive reasons.

Another particular type of gathering was observed by researcher Kim Holland and his collaborators at Kaneohe Bay, Oahu, Hawaii. Here the scalloped hammerhead sharks arrive to give birth in an area that seems to be a nursery for the young. It has been observed that the juveniles form gatherings during the day, whilst at night they disperse for hunting; similar behaviour was also witnessed in Tahiti and Tuamotu, French Polynesia. Gatherings composed of individual juveniles of between 80 to 120 centimetres, were observed along the coast of Natal, South Africa.

The scalloped hammerheads can form large groups even when they travel long distances. These sharks are powerful swimmers and are able to complete long journeys. In some areas, for example as it occurs off the coast of the province of Natal, South Africa, during summer, these hammerheads gather in large groups and travel in the

direction of the poles. At San Salvador, Bahamas, they assemble in schools between November and June. Stuart J. Green has reported that at Cabilao Island, Philippines, the schoolings appeared from January to April.

With regards to the large gatherings of scalloped hammerheads, it has been noticed that the individuals are very shy and it is very difficult for scuba divers to get close to them due to the noise produced by the exhaled bubbles of air from their regulators. For this reason, researchers who have observed these gatherings have often had to dive in apnea (without diving cylinders and only using snorkelling equipment). Dive operators and photographers that want to dive and film these animals also adapt the same technique.

In the early 1990's, underwater photographers John McKenney and Marty Snyderman tested, with great success, a device designed by Eddie Paul, called "the Scuba Muffler," around Cocos Island, Costa Rica. The muffler trapped the exhaled air and broke down the bubbles to a much smaller size, thus eliminating ninety percent of the noise, and allowing the divers to get much closer to the schooling hammerheads. Today, with the use of closed circuit rebreathers divers can get within touching distance of the sharks.

All in all, every single human diving with these sharks must take extra care to make as little noise as possible; otherwise he can scare away a school of hundreds of hammerheads. This fact makes one think of how, in the past, the risk of diving with these shark species was exaggerated.

Another species that seems to possess a detached social life is the bonnethead shark. Although usually these sharks are found solitary or in small groups composed from three to fifteen individuals, in some cases they can be re-united to form great gatherings. To get an idea of how big these gatherings can be, just think that in 1962 some fisherman in Florida caught over seven hundred of these sharks, sixty to ninety cm long, in their nets at one go.

Like the scalloped hammerheads, the bonnethead sharks are also able to communicate between each other by means of a complex body language: Researchers Arthur A. Myrberg and Samuel H. Gruber, who have studied this shark in Florida, have recognized 18 ritualized movements. In some cases these movements are very similar to those observed in the scalloped hammerheads, and in some cases, the assumed explanations are not related to the communication between the individuals.

The ritualized movements include: swimming in a straight line near the bottom with the larger specimens tending to swim faster than the smallest ones, shaking of the head to the left and the right, body rotations followed by a slight elevation of the head therefore lowering it in a diagonal position, slight opening of the mouth, body spins accompanied by slight contact with the bottom (possibly to remove parasites), momentary expansion of the branchial pharynx (perhaps in order to clean them of food remains or accidentally ingested sediment); sometimes the males fold one of their claspers and accompany this gesture with swimming inclined to one side.

Undoubtedly, the following ritualized behaviours have a social context: swimming in a circle of two individuals holding one's head towards the other's tail, close approach of one individual to another keeping the head near the back of the other (so sometimes the shark hits the other with the head), arching of the back with the elevation of the head and lowering of the pectoral fins and the tail (similar to the threat behaviour shown by the grey reef sharks, *Carcharhinus amblyrhynchos*), unexpected change of swimming direction in order to follow another individual (often carried out by a male in confrontations with a female), one individual follows another and imitates its swimming movements (this behaviour is also usually carried out by a male towards a female), three to six individuals swimming in a row following a companion, two individuals swimming on a head-on collision course with a last minute retreat of one of them (to assert the mutual place in the hierarchical order).

On this last point, Myrberg and Gruber noted that the largest shark, a female, was the most dominant and all the others "gave way"; however when the confrontation happened between two individuals of equal size but different sex, it was the male to turn out dominant. It is interesting to note that although some behaviors are clearly antagonistic, actual combats never take place.

Like the scalloped hammerhead, even this species has shown to be extremely active and to possess precise rhythm in their levels of activity, with maximum action in the late afternoon. The bonnethead shark also completes regular seasonal movements. In the Atlantic waters of the United States, it becomes numerous in Florida in spring, summer and autumn, from where it migrates towards the north up to New England.

The smooth hammerhead is also another species that forms huge gatherings. These massive groups have been observed in the waters along the east coast of Cape Province in South Africa, along the east coast of the United States and in the area of Sicily in the Mediterranean. An immense group was sighted north of Cape Hatteras, North Carolina: it was estimated to be formed by approximately 1200 sharks, measuring from 1.8 to 3.6 meters in length.

Normally, groups of this species are formed from juvenile specimens with a maximum length of 1.8 meters. Large gatherings of specimens ranging from 1 to 1.5 meters have been observed on many occasions around the coast of South Africa between the months of November and February; in January 1973, an immense gathering that stretched over an area of twenty-six km between the rivers van Staden and Gamtoos was sighted.

Until some years ago, in the waters North-West of Capo Peloro, Sicily, Italy, schools of smooth hammerhead sharks were sighted between September and the beginning of December. In that season, the hammerheads came in following the bullet tuna (*Auxis rochei rochei*), on which they feed. Immense schools of hammerhead sharks measuring up to at least two m, swimming at a depth of about thirty m, were also observed on a bank off Lampedusa Island, in the Sicilian Channel, Italy, during the summer months. The schools of smooth hammerhead sharks would be formed from individuals in migration: in fact the species migrate moving in the direction of the poles in summer and back to the equator in winter.

The golden hammerhead may also form groups. In fact, although with regard to this species we have very little information, researcher Jose I. Castro has noted the presence of groups of these sharks in the waters of Trinidad and Tobago. Such groups were formed from adult males and juveniles of both sexes. Each group was composed of sharks of similar size. The females do not seem to stay in the groups.

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