

Parenthood: Male sharks need not apply

By Dina Fine Maron

November 8, 2008 When male sharks are not available, female sharks may have a back-up option for reproduction — do it themselves.

The same team of geneticists that verified the first-ever “virgin” shark birth in May 2007 has confirmed a sex-free pregnancy in a different species of live-birthing shark, *Carcharhinus limbatus*. The finding, published in the Oct. 10 *Journal of Fish Biology*, suggests that many female sharks may have the ability to reproduce without mating.

Geneticists contacted the Virginia Aquarium after they heard a resident female blacktip shark — who had lived in isolation from males of her species for the previous eight years — was pregnant.

The mother-to-be, 'Tidbit', had died during a routine tranquilization, and the necropsy, or animal autopsy, showed that, unbeknownst to the aquarium, she was close to term with a well-developed embryo.

Mahmood Shivji of the Guy Harvey Research Institute of Nova Southeastern University in Dania Beach, Florida, and his colleagues used DNA fingerprint analysis to test the embryo's DNA for paternal markings. The embryo, which was also dead by the time it was discovered, did not show any genetic markings of having a father, says Shivji.

Shivji and his colleagues think the pregnancy occurred through an asexual reproductive process called parthenogenesis, found in certain types of reptiles, birds and more recently discovered in vertebrates such as Komodo dragons. In this form of reproduction the mother's chromosomes split during egg development and pair with a copy of themselves.

Unlike parthenogenesis in birds and reptiles, which can result in male offspring (and the possibility of future mates) since females carry two types of sex chromosomes, in sharks the resulting embryo will always be female because the mother only has X chromosomes to contribute.

Parthenogenesis also results in decreased genetic diversity because it only offers the mother's chromosomes. Lead author Demian Chapman of the Institute for Ocean Conservation Science at Stony Brook University in New York warns that asexual reproduction could result in more congenital defects and weakened immune system problems that could be problematic for surviving in the wild.

In both confirmed cases of shark parthenogenesis the shark produced only one female pup, as opposed to average litters of four to six pups.

Because of these reasons, "This is not the great white hope for the shark population," Chapman points out. "This is not a solution to overfishing," he says.

Jackie Wilson, a fisheries management specialist with the National Oceanic and Atmospheric Administration in Washington, D.C., says the blacktip shark was included in the large coastal shark group labeled as "overfished" in the 2002 assessment of the Atlantic Ocean by NOAA. Since July, large coastal sharks in the Atlantic have been protected with new commercial fishing restrictions that place the fishing limit at 187.8 metric tons per year.

Amongst scientists, there is no consensus on what triggers parthenogenesis in sharks.

"We still don't know whether it occurs in the wild or would really have any significant impact on shark population rebounds even if it occurred relatively frequently," comments Mike Heithaus, director of the Marine Science Program at Florida International University in North Miami. Still, he says there is "a lot of interesting work to be done on shark reproduction - as this study illustrates - which is important in light of the collapses in populations."

Chapman thinks that parthenogenesis can occur in the wild, but that it is less likely because there are more males. "The reason this has happened in captivity isn't because there's a change in their reproductive biology," he explains. "It is more likely to happen if female sharks aren't having enough dates," he says. "These females did it because they were in captivity and ovulating."

In both confirmed cases of shark parthenogenesis the mother sharks were born in the wild, caught as young pups and then lived in captivity isolated from males of their species.



Although sharks have been known to store sperm for as long as a year, Chapman points out that the pups were caught young and "glands that hold sperm at that age are not fully developed."

Last year, when Chapman and his colleagues studied the first sex-free birth in a bonnethead shark - a small type of hammerhead - he assumed it was a case of stored sperm until DNA fingerprint analysis showed there were no male contributions. Even then, he said, he still thought parthenogenesis "only happens as an occasional fluke." He now thinks, "It's definitely more common and widespread than we think."

Chapman is currently testing to confirm another reported case of parthenogenesis in a white spotted bamboo shark with Kevin Feldheim of the Field Museum in Chicago.

"I think in the next five years we will be able to show many species of sharks - if not all - [have this ability]," says Chapman.
