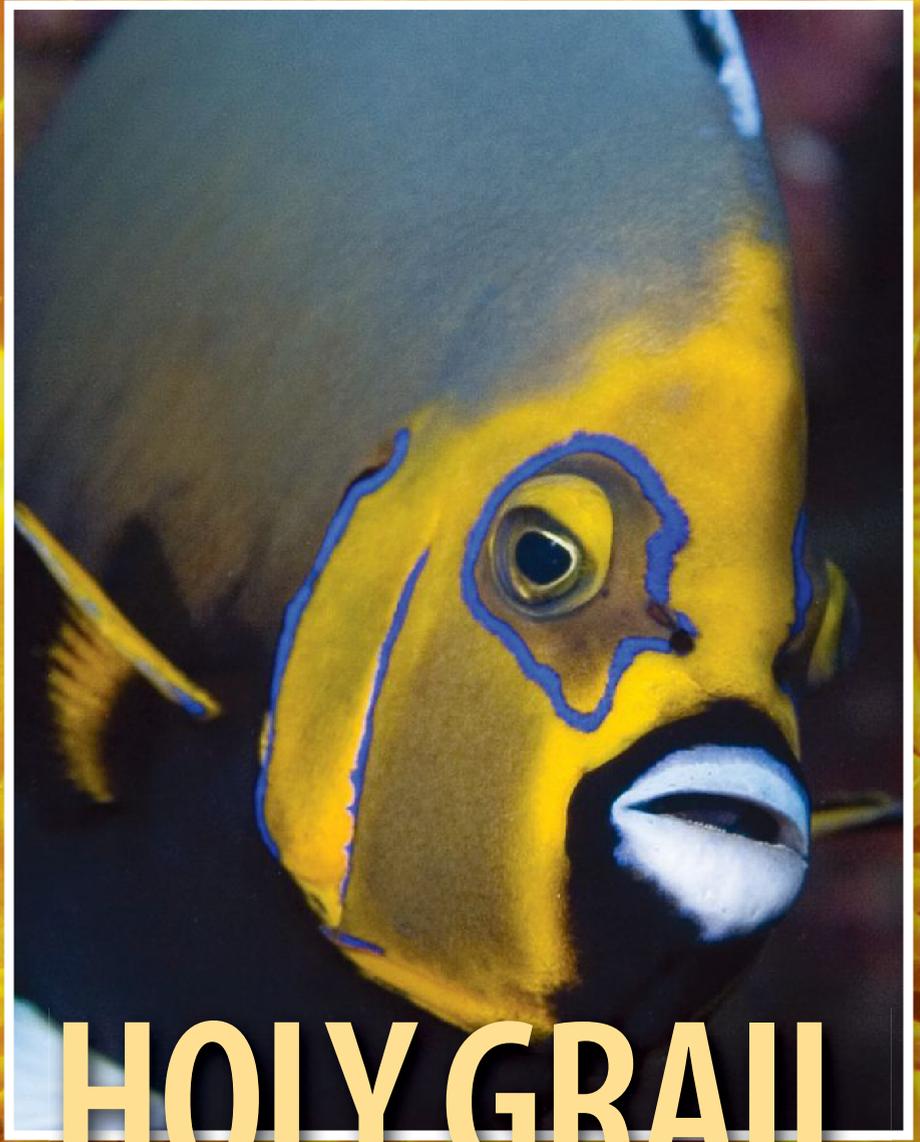




# CORAL REEF



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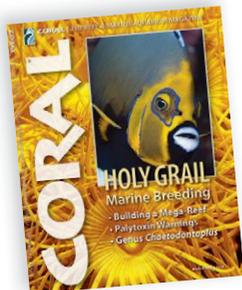
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**COVER CREDITS** Wild *Chaetodontoplus conspicillatus*: Frank Baensch.

Background: Yellow  
Zoanthid Polyps,  
Daniel Knop



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## REEF STEWARDSHIP |

ANDREW BRUCKNER, PH.D., & GEORGIA COWARD

# Distress Signals?

## Abnormal coloration in Blacktip Reef Sharks: A possible manifestation of climate change?

We are hearing with increasing frequency about the negative impacts of climate change on corals, but other animal groups, both marine and terrestrial, are also starting to exhibit worrisome signs of distress. For example, sea turtles use both marine and terrestrial habitats during different phases of their life cycle and are known to return to their birth site, usually a sandy beach, decades later to lay their eggs. But they are losing their nesting sites—beaches are disappearing due to rising sea levels and subsequent shoreline erosion.



A Hawksbill Turtle glides over our survey team during a dive.



A group of juvenile Blacktip Reef Sharks using a shallow lagoon for protection. The shark at near left displays abnormal coloration.

**O**f even greater consequence are rising temperatures and unusual temperature perturbations associated with climate change and El Niño events. These can threaten the survival of sea turtle eggs. As reptiles, sea turtles rely on the temperature of the sand to incubate their eggs, and this also determines the gender of the hatchlings. During a normal year the lower, cooler part of the nest contains males, while eggs in the upper, warmer part of the nest become females. During severe El Niño events, when temperatures are much higher than normal, there are more female hatchlings than males, and in extreme cases every hatchling is a female. The reduction in the number of male sea turtles creates a significant shift in the genetic makeup of turtle populations, and this can affect future generations of turtles.



Encountering turtles is common during SCUBA dives and snorkels in the Maldives.



Sea turtles digging their nests on a beach.

Abnormal temperatures also influence embryonic development in other vertebrates, altering development rates and causing skeletal abnormalities and abnormal coloration and patterns. Last fall, while studying shark populations in the Maldives, we observed a novel, abnormal coloration pattern in juvenile (young of the year—YOY) Blacktip Reef Sharks (*Carcharhinus melanopterus*). Their normal body coloration is yellow-brown on the dorsal side and white on the ventral side, with a conspicuous black-tipped dorsal fin and dark

edging on the pectoral fins and the upper lobe of the caudal fin. In our study area in Baa Atoll, we identified eight 16–24-inch (40–60-cm) YOY Blacktip Reef Sharks that had irregularly shaped, dark color patches extending over their dorsal surfaces, pectoral fins, and caudal fins. The eyes showed normal retinal pigmentation, and the black tip and dark edging was still present on the fins. Similar patterns were also noted among juvenile Blacktip Reef Sharks elsewhere in the Maldives.

#### ALTERED PIGMENTATION

This abnormal skin pigmentation resembled leucism, a genetic disorder that has been reported in mammals, reptiles, amphibians, teleosts (bony, ray-finned fishes), and, more recently, several species of elasmobranch.

Leucism can be caused by a prenatal enzyme deficiency involved in the metabolism of melanin, but it differs from true albinism, a genetically inherited condition in which the pigment protein melanin is either absent or nonfunctional. Animals with total albinism exhibit a complete absence of melanin over the entire body, while leucism is the absence or reduction of melanin in part of the body, and typically the color of the eyes is normal. To date, total albinism has been reported in 26 shark species, including a single report in a Blacktip Reef Shark



Abnormal skin pigmentation in a juvenile Blacktip Reef Shark in the Maldives.

mission in the Maldives. These sharks occurred in an important near-shore habitat as part of a larger sample population of healthy, fully pigmented YOY. Furthermore, the YOY individuals have been utilizing this habitat for at least the previous six years, but this is the first observation of abnormally pigmented individuals.

Although leucism has been related to genetic alterations in melanin production, it may be exacerbated due

from India, as well as 15 ray species. To our knowledge, the only shark in which leucism has been reported is the Spadenose Shark (*Scoliodon laticudus*) from India.

The coloration of sharks is known to vary among individuals, and they can gradually change color when moving from one habitat to another. Nevertheless, this is not what we observed. The discoloration in this group of Blacktip Reef Sharks persisted for at least six months and was still present by the time we completed our field

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A shark in the sea is worth 100 times more than a shark in our soup



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Normal skin coloration (left) vs. abnormal skin pigmentation in two Blacktip Reef Sharks from the same age cohort.



to inbreeding within isolated populations, or it may be triggered by environmental stress associated with areas of high human activity and exposure to elevated temperatures. It is likely that all of these factors play a role in the abnormal pigmentation we observed in Blacktip Reef Sharks in the Maldives.

### REEF HOMEBODIES

Blacktip Reef Sharks are found throughout the tropical Indian and Pacific Oceans, in the Red Sea, and even in the Mediterranean. Even though they are widely distributed, they tend to have a small home range—it is reported to be as little as 0.2 square miles (about 128 acres, or .5 km<sup>2</sup>), which is one of the smallest ranges of any shark species. They also have a very specific habitat preference: younger sharks prefer shallow, sandy flats, while adults are most common around the reef crest and slope. Many sharks spend their entire life span on a single reef.

Blacktip Reef Sharks have been listed as near-threatened on the IUCN Red List, largely because overfishing has led to the decline of this species due to their late age at sexual maturity and low fecundity. In the Maldives, Blacktip Reef Sharks and other shark species were heavily fished until 2010 and populations were reported to have been depleted. Even though the fish-

ery was closed in 2010, they are frequently landed as by-catch, and tourists illegally fishing from the beach often target the juveniles.

Concurrently, there is an ongoing development boom, including extensive land reclamation and burial of reefs to create artificial islands, and dredging of shallow sandy habitats used by Blacktip Reef Sharks as nursery areas. Of more immediate concern, during the 2015–2016 El Niño, marine habitats throughout the Maldives were exposed to prolonged periods of abnormally high seawater temperatures, and these calm, protected lagoonal areas that juvenile Blacktips prefer tended to heat up more than outer reef areas.

What is most disconcerting about the sharks' abnormal pigmentation is that it may impact their biological fitness and survival, because color patterns are often required for camouflage, to

attract mates, and to deter predators. Ultimately, if elevated water temperatures trigger the development of abnormal color patterns, future El Niño events and continued ocean warming could prevent the recovery of these species and impact their long-term survival.



**Andrew Bruckner, Ph.D.**, is a former coral ecologist for NOAA, former chief scientist for the six-year *Global Reef Expedition*, and currently director of the nonprofit *Coral Reef CPR*, based in Sandy Spring, Maryland. **Georgia Coward** is a British fisheries biologist and program manager of *Coral Reef CPR* in the Maldives.

*Coral Reef CPR* is conducting research on the status of reef-associated shark populations and is working to identify important nursery, juvenile, and adult habitats in hopes of protecting these areas from unsustainable resort construction. This work was partially supported by a grant from the *Greenville Zoo Conservation Fund*, but additional funding is necessary to complete this work. Please consider donating to *Coral Reef CPR* today.

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