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Black Gill Syndrome Found in Shrimp in Galveston Bay

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Never fear, despite the appearance of an unusual shrimp "disease" in recent trawl catches, Galveston Bay shrimp are safe to consume. Samples examined at the Texas A&M AgriLife Aquatic Diagnostics Laboratory (ADL) for disease pathology were positive for black gill syndrome. The syndrome and causative pathogen have no effect on humans.

Shrimpers in Galveston bay have reported shrimp with black gills during the 2016 season. There are various causes of black or brown looking gills in shrimp, with potential causes including bacterial infections, poor water quality, fungal infections, or parasites called ciliates. A dozen shrimp with easily visible black gills recently submitted to the ADL were confirmed to be infested with one of the causative ciliates.

Figure 1. Black gills are clearly visible through the exoskeleton of specimens from Galveston Bay captured September 9th 2016.

The shrimp sampled from Galveston Bay, south of the Morgan's point area, were provided by Captain Ira Hansley, of the shrimp trawler Elizabeth R. Several shrimp in the sample were also

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confirmed to have a fungal infection, believed to be a secondary pathogen, potentially caused by the syndrome. There is much speculation among the shrimping industry, regulatory agencies, and researchers on what this may mean for the Galveston Bay shrimping industry for the rest of the 2016 season and subsequent seasons to follow.

What is Black Gill Syndrome?

Black gill syndrome itself is not actually a disease, even though it is commonly referred to as such. Rather, it is a condition, or syndrome, that is most appropriately described as branchiostegite melanization.

Figure 2. A shrimp exhibiting visible black gill syndrome (above) compared to a shrimp with normal gill pigmentation below.

Melanization refers to an increase in the amount of the dark brown pigment melanin present in the tissue. Melanin is a pigment occurring in the hair, skin, and eye in people and animals. It is the pigment responsible for tanning of skin exposed to sunlight. Melanization is an immune response that is triggered locally in response to an injury in some tissues.

Branchiostegite melanization is a natural response to gill fouling or parasitic infestations of the gills in shrimp and occurs due to melanization at sites of tissue necrosis, or dying tissue. In other words, the shrimp's natural immune response to protect the gills where the protozoan parasites (ciliates) have damaged the gill tissue is by incasing the damaged area in protective tissue containing a dark pigment.

However, this natural response can prove problematic. The protective tissue encasing the gill also blocks oxygen transfer and waste excretion through the gill. Over time, if enough of the gill area becomes encased in protective tissue, the shrimp cannot breathe or secrete waste efficiently. In severe cases, the condition can eventually result in death of the shrimp.

Biology

Black gill syndrome can be caused by many things in densely cultured marine shrimp populations including ciliated protozoa in the Genus *Hyalophysa* or gill fouling organisms such as bacteria or fungi (ambient, not infectious), and in

instances of poor management decomposing organic materials. Even water conditions where there are high concentrations of suspended particles such as sand have been shown to cause a darkening of the gills due to irritation.

However, only ciliates in the Genus *Hyalophysa* and gill fouling by decomposing organic materials are currently believed to cause black gill syndrome in wild shrimp populations. Bacterial and fungal infections and protozoan infestations were thought to also cause black gill syndrome in wild shrimp populations, but recent research has shown that bacterial and fungal infections associated with black gill syndrome in shrimp are actually secondary invasive pathogens that only become established due to the presence of necrotic tissue.

Ciliates are complex single-celled organisms that infect the gills of the shrimp upon contact. They damage gill tissue directly making it difficult for the shrimp to breathe efficiently. This difficulty breathing slows the shrimp down and triggers repeated molting (shedding the exoskeleton) as the shrimp try to rid themselves of the parasite. The process of molting depletes the shrimp's energy and nutrient levels and stresses the shrimp, leaving it vulnerable to predation.

When an infected shrimp molts, it triggers the ciliate to enter the next stage in its life cycle. The parasite feeds on the molted shrimp carapace and eventually becomes a free swimming organism that seeks out a new host. It is believed that this is the method of distribution that the ciliate utilizes to spread the syndrome.

What Causes Black Gill Syndrome?

Although there are other causes for black gills in shrimp, the ciliate that has caused significant mortality in Georgia and elsewhere has sparked alarm in shrimping communities throughout the Eastern U.S. and Gulf of Mexico. Although the ciliate responsible is likely widely distributed throughout western Atlantic waters, it is normally present at very low to undetectable concentrations in most shrimp populations and is not problematic.

To date, scientist have not identified a specific trigger for mass infestation in shrimp. It is currently speculated that large increases in freshwater inflow and/or prolonged low marsh and bay salinity are related to the prevalence of infestation, although reports from the Galveston Bay support the idea that the incidence of black gill syndrome is higher in years with lower rainfall. The ciliate affects many crustacean species, having previously been found in spiny lobster and several species of shrimp. Current data reports that black gill

syndrome has been found only in white shrimp in Galveston Bay.

History

In the late 1990's black gill syndrome was thought to be indicative of poor water quality, feeding habits, and pond preparation in aquaculture systems. It was believed that pond grown shrimp, having escaped or been released from farms infected wild populations. In recent years black gill syndrome has been a contributing factor in the decline of wild caught shrimp in Georgia. It is believed that black gill syndrome, or the ciliate parasite that causes excessive molting and mortality, along with rainfall quantities, water quality, and a shrinking shrimping fleet caused the excessive decline in shrimp catch. It is important to note that while the exact causes of shrimp catch decline may vary, black gill syndrome is not solely responsible. Continued monitoring and research on the disease is necessary to prevent it becoming a contributing factor to decline in other shrimping hot spots.

Current Findings

Texas shrimp trawlers report that black gill syndrome is present in approximately 5% of the total Texas shrimp landings this year (2016), and 8 to 14% of the total white shrimp landings. It does not appear to be an issue in brown or pink shrimp in Texas at this time. Captain Ira Hansley provided shrimp to be examined at the Texas A&M AgriLife Aquatic Diagnostics Laboratory based on concerns about black gill syndrome effects on shrimp populations in Galveston Bay.

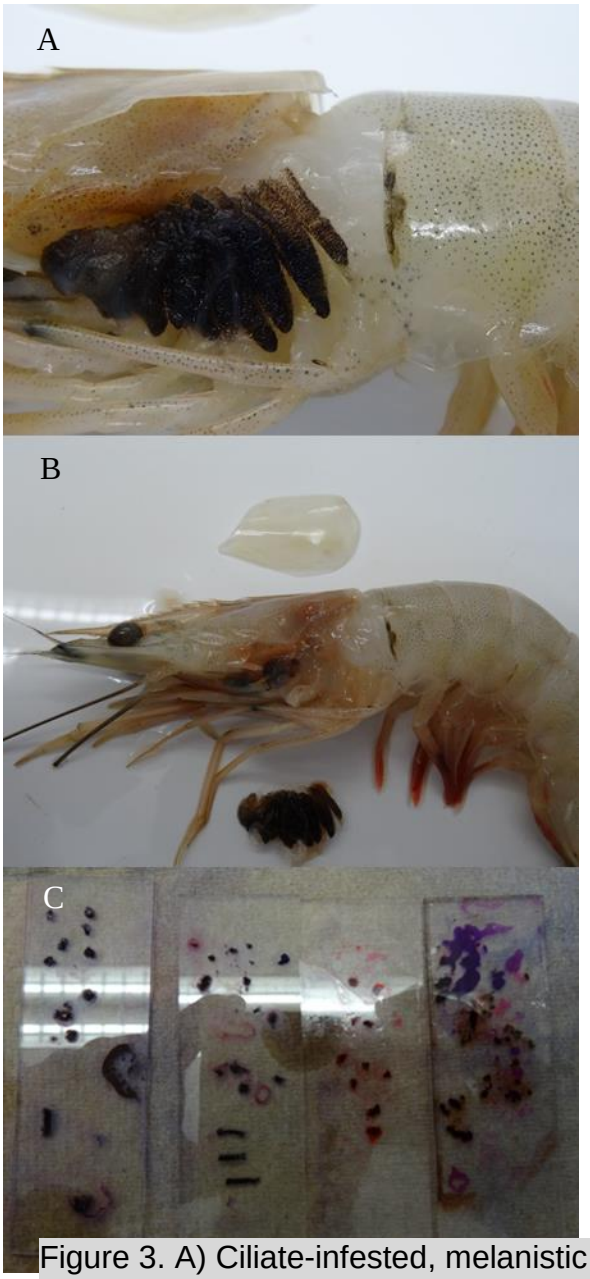

Figure 3. A) Ciliate-infested, melanistic gill tissue of shrimp with carapace removed. B) Melanistic gill excised for microscopic examination. C) Slides with fixed and stained gill and organ tissues.

The shrimp exhibiting melanistic gills had gill tissue aseptically removed, differential biochemical media testing was conducted to determine if bacterial pathogens were present, the gill tissue was then stained to improve contrast, and microscopic examination was conducted to determine the presence of fungal infection or parasite infestation. Shrimp expressing darkened gills were found to have only a 20% fungal infection rate and no bacterial pathogens were isolated. These findings ruled out fungal or bacterial infections as the primary pathogen, as only 1 in 5 shrimp expressing dark kills had any hyphae (fungus filaments) present.

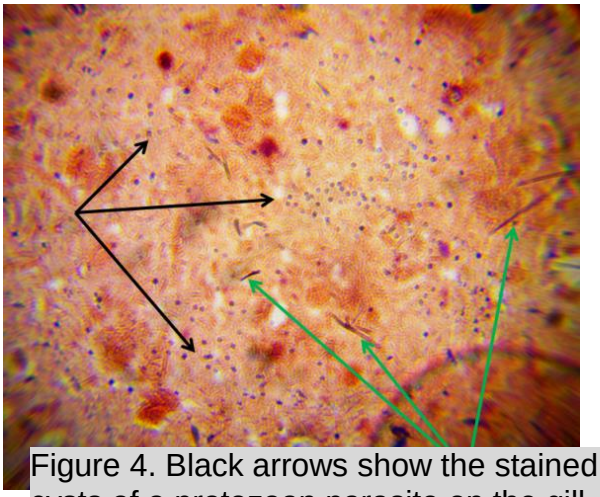

Figure 4. Black arrows show the stained cysts of a protozoan parasite on the gill tissue of shrimp, while the green arrows indicate a secondary fungal infection.

Slides of non-fixed gill tissue stained with Gomori trichrome clearly demonstrated the presence of large quantities of ciliated protozoans. Two species of ciliated protozoans were commonly present on the gills based upon differences in morphological shape, and length and arrangement of cilia when viewed under 800x to 1,200x magnification using dark field microscopy.

It cannot be determined at this time which species of protozoa were present due to limitations of microscopic examinations. Heat fixed tissue samples stained with Masson's trichrome clearly show necrotic shrimp gill tissue with numerous protozoa encysted.

Status in Galveston Bay

The scale of black gill syndrome in Galveston Bay and along the Texas coast is largely unknown at this time. Researchers at the Aquatic Diagnostics Laboratory have notified the Texas Parks and Wildlife Department administration of their findings and are currently applying for grant funding to map the density of black gill syndrome and associated ciliate infected shrimp in Galveston Bay. It is vital to fully understand the causes of the syndrome before preventative measures can be taken to protect wild shrimp populations. Voluntary data regarding black gill catch densities and locations will be gathered in the coming months.

For further information, please contact the Texas A&M AgriLife Aquatic Diagnostics Laboratory: https://fisheries.tamu.edu/aquatic-diagnostics-lab/.

Additional Readings

Aquafarmer Information Sheet: Prevention of Black Gill Disease in Marine Shrimp. (1997). Center for Tropical and Subtropical Aquaculture No. 126.

Joining Forces to Understand Black Gill. (2013). Georgia SeaGrant and Marine Extension Service.