

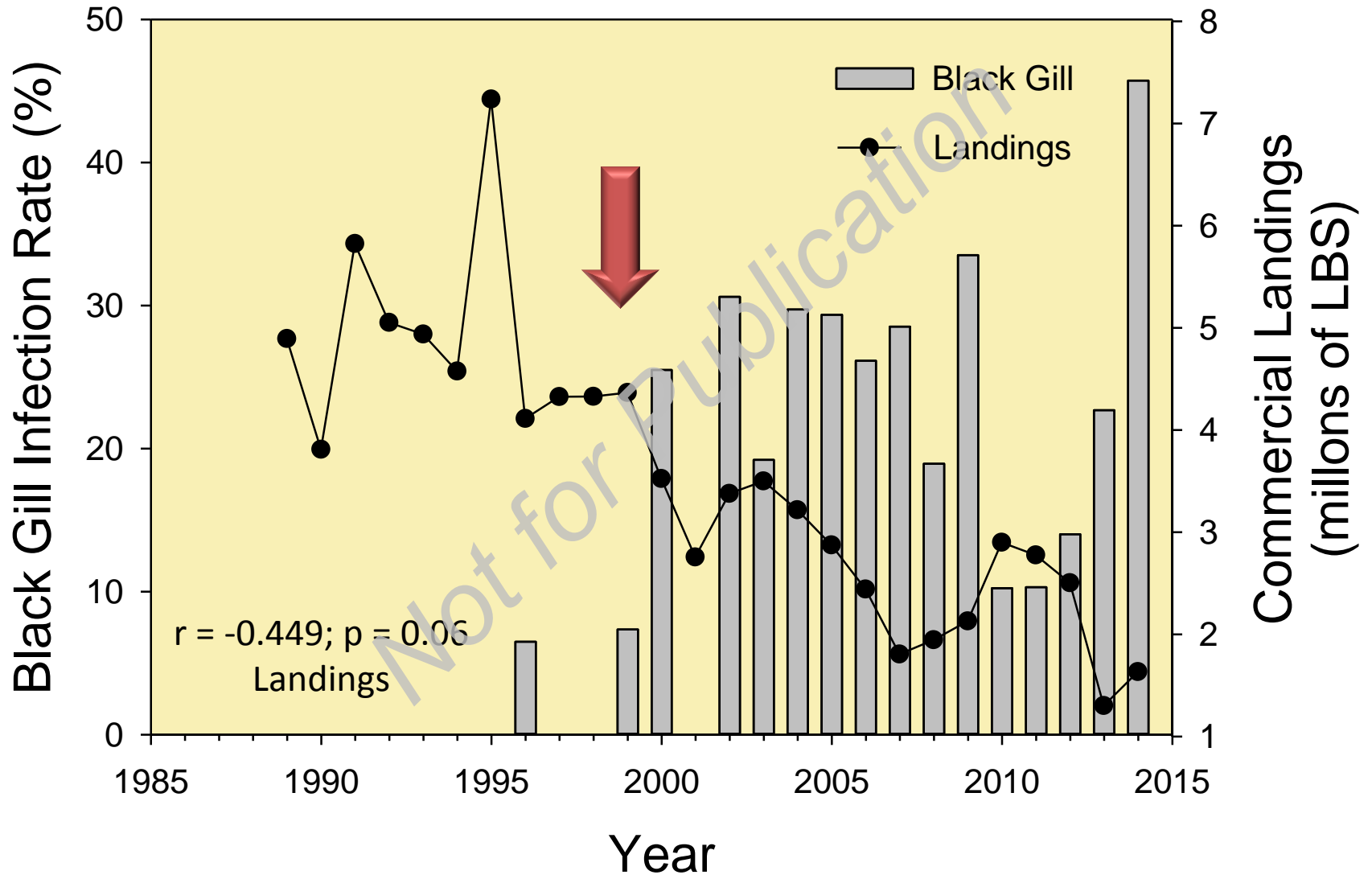
# SHRIMP BLACK GILL

## Causes, Consequences & Solutions?



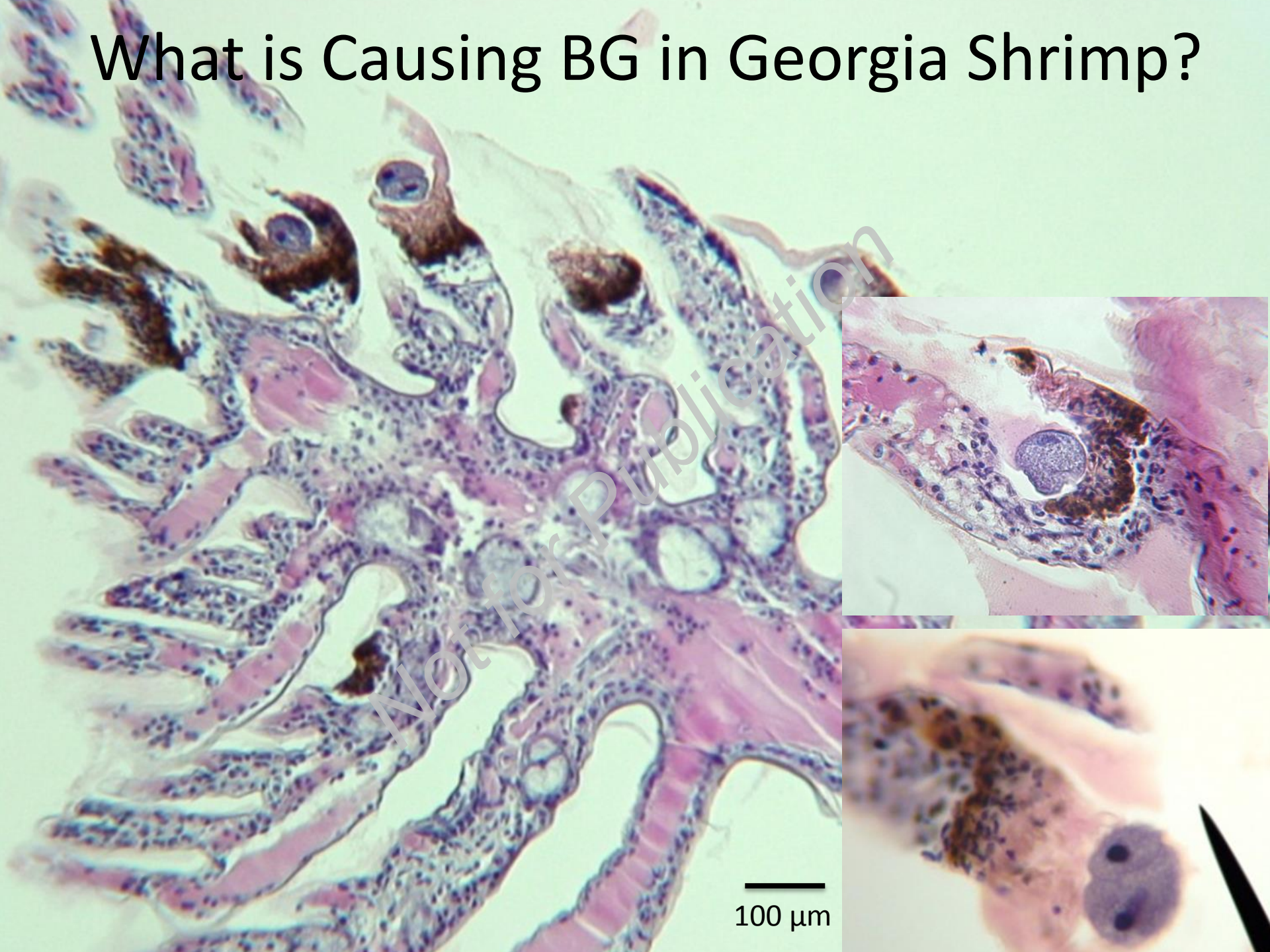
# Does Black Gill Kill Shrimp?

## A Fishery In Decline

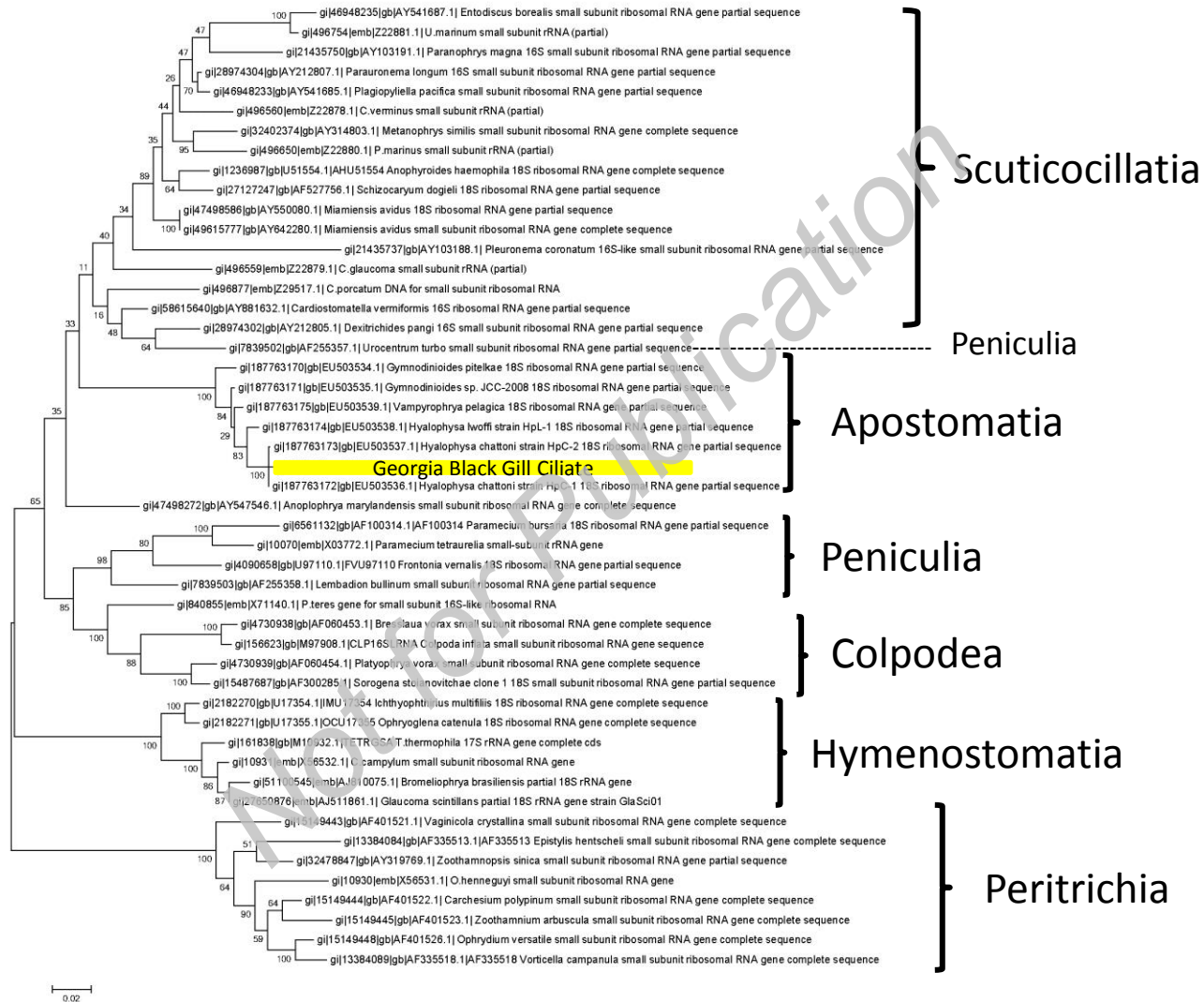




# What is Causing BG in Georgia Shrimp?



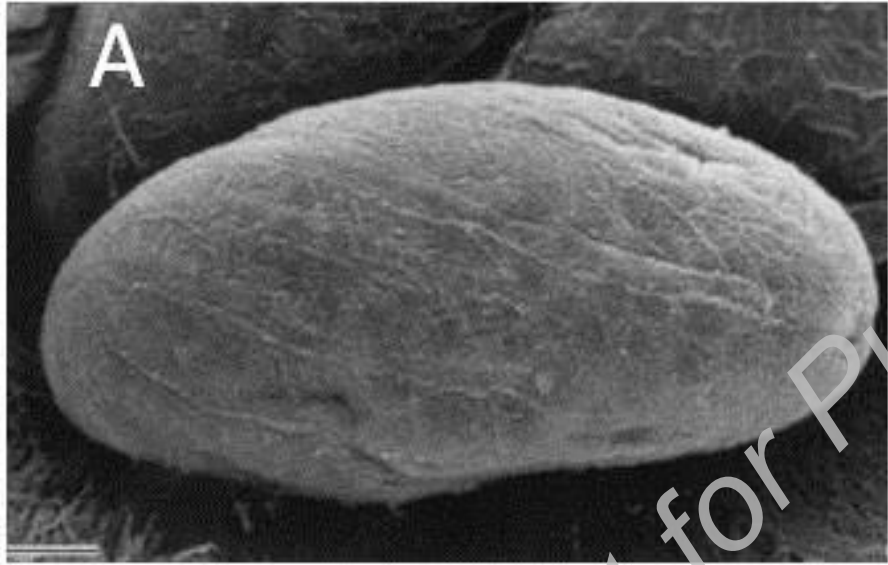
# 18S rRNA Gene Sequence-Based Identification



~ 99.6% similarity to the apostome ciliate *H. chattoni*



# But We Still Don't Know the Ciliate

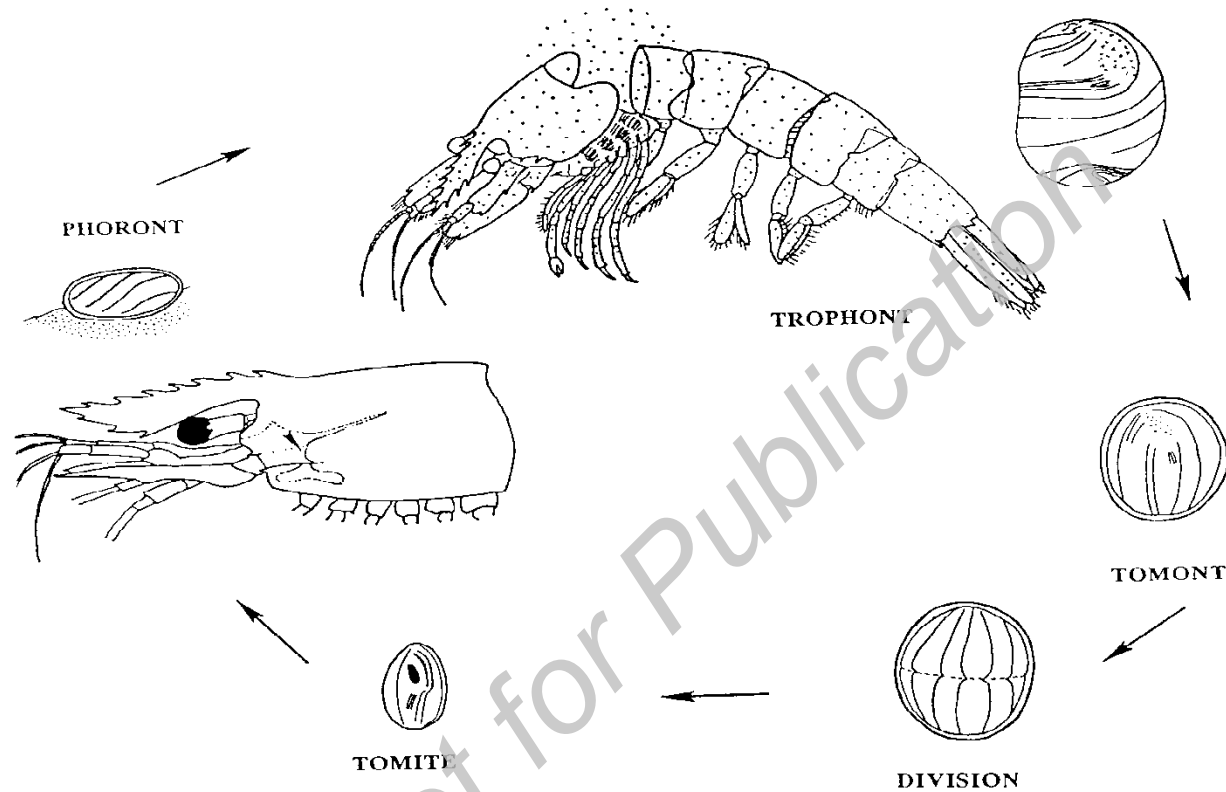


Genetic analysis suggest it is a common ciliate (Apostome) identified as a harmless ciliate associated with crustaceans.

***Hyalophysa chattoni***

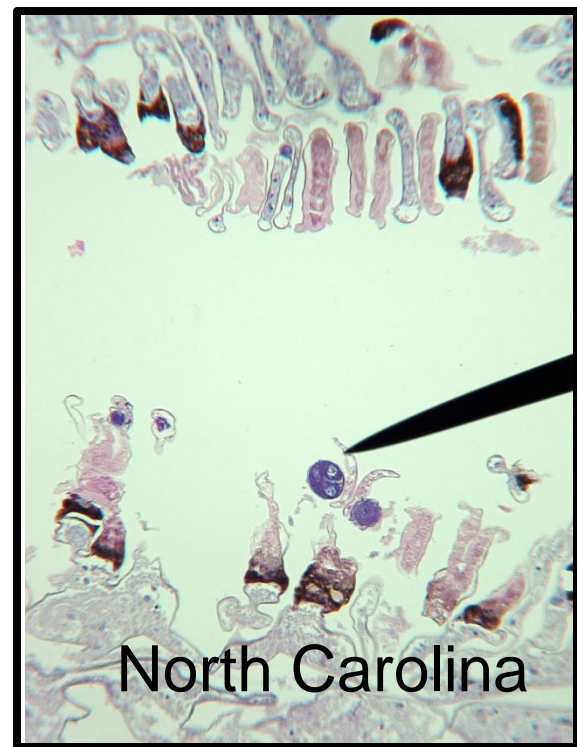
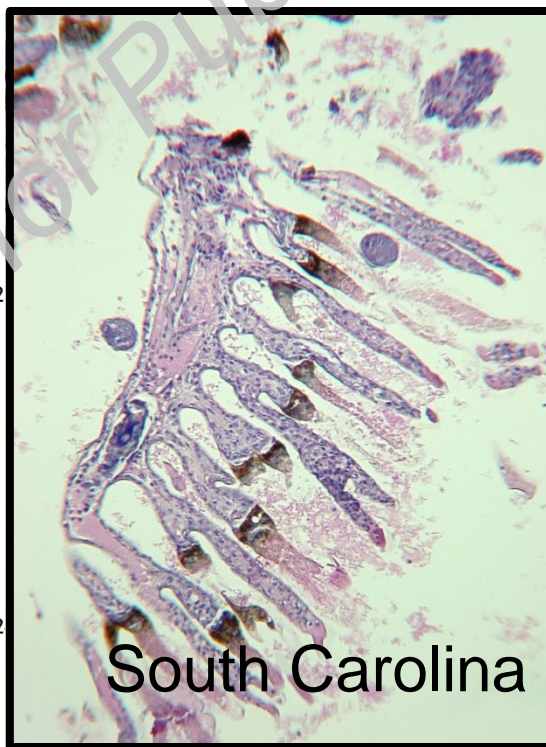
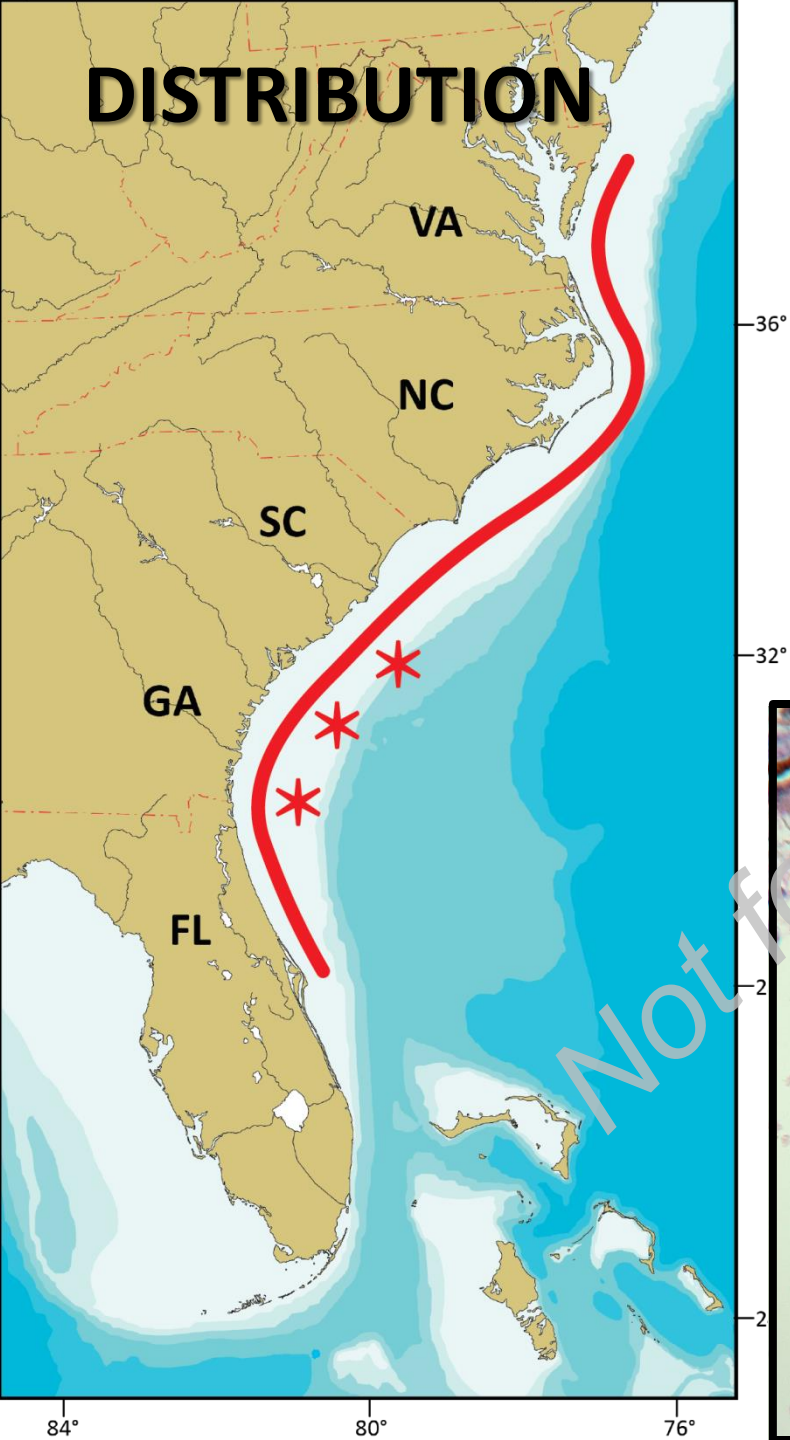
**Georgia Black Gill Ciliate**  
***It does NOT look like***  
***H. chattoni***

# Theoretical Life History of an Apostomate Ciliate

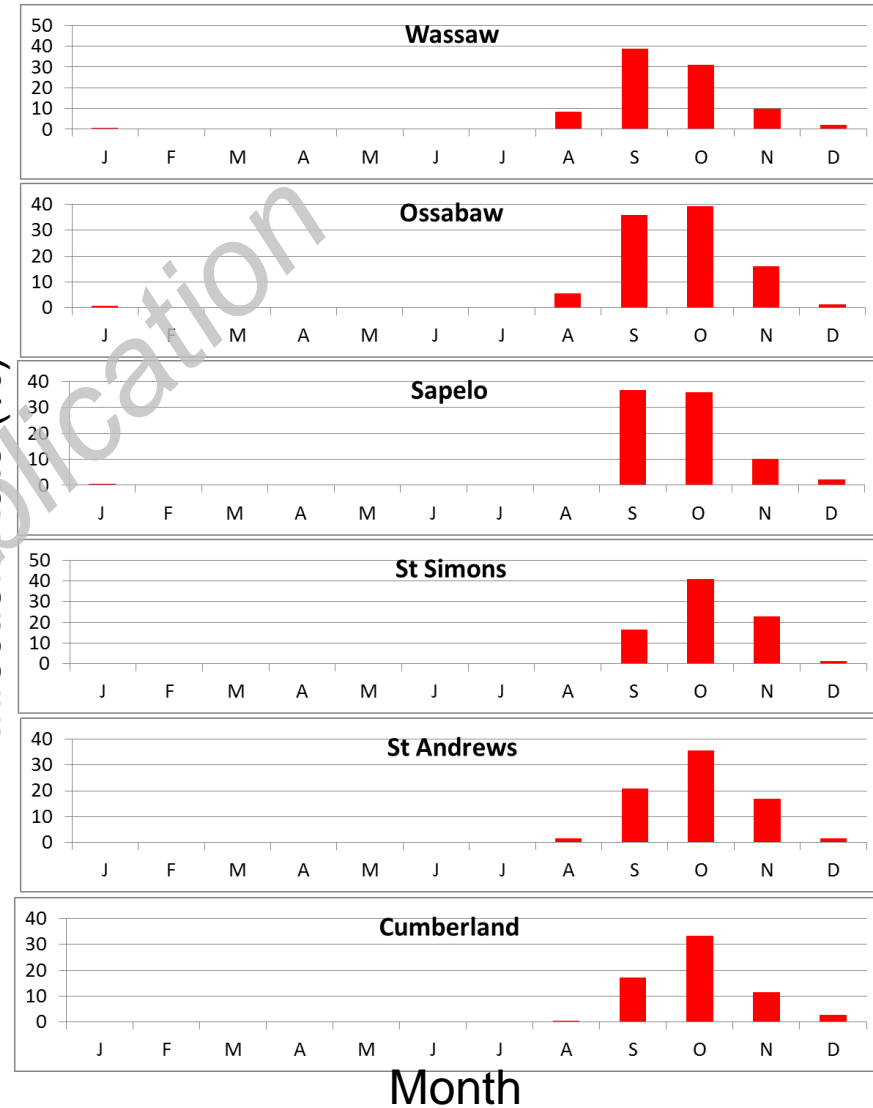
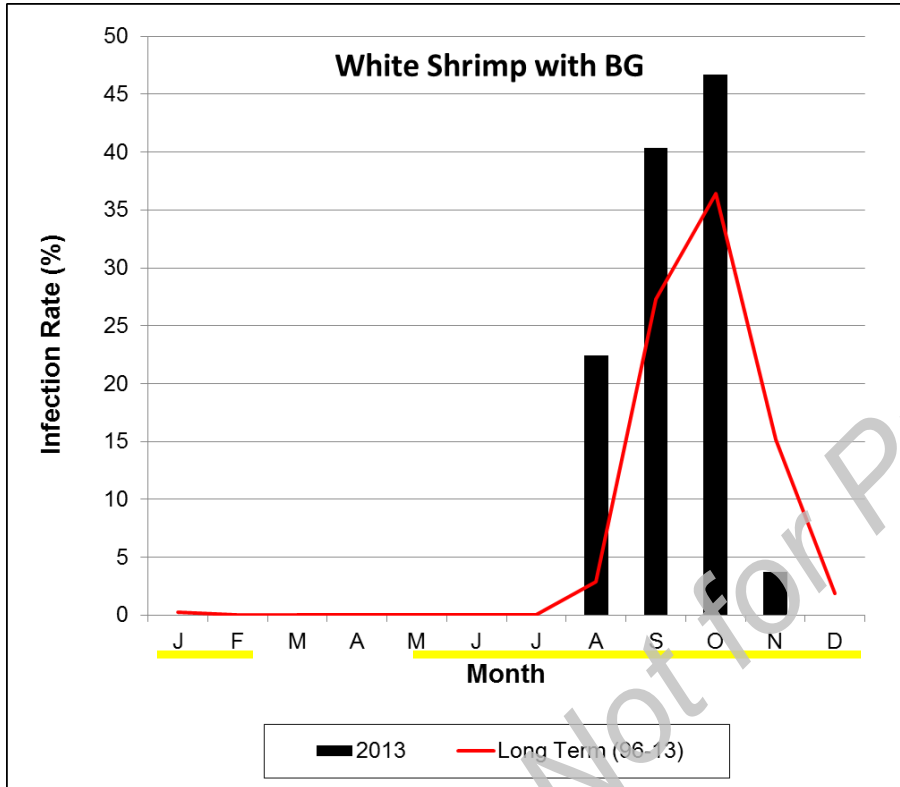


Apostomes have an encysted phoretic stage (the phoront) and at molting change to a structurally different feeding stage, the trophont. The trophont feeds on exuvial fluid in the molted exoskeleton and encysts into the tomont stage and then forms swimming tomites that search out a new host.

# DISTRIBUTION

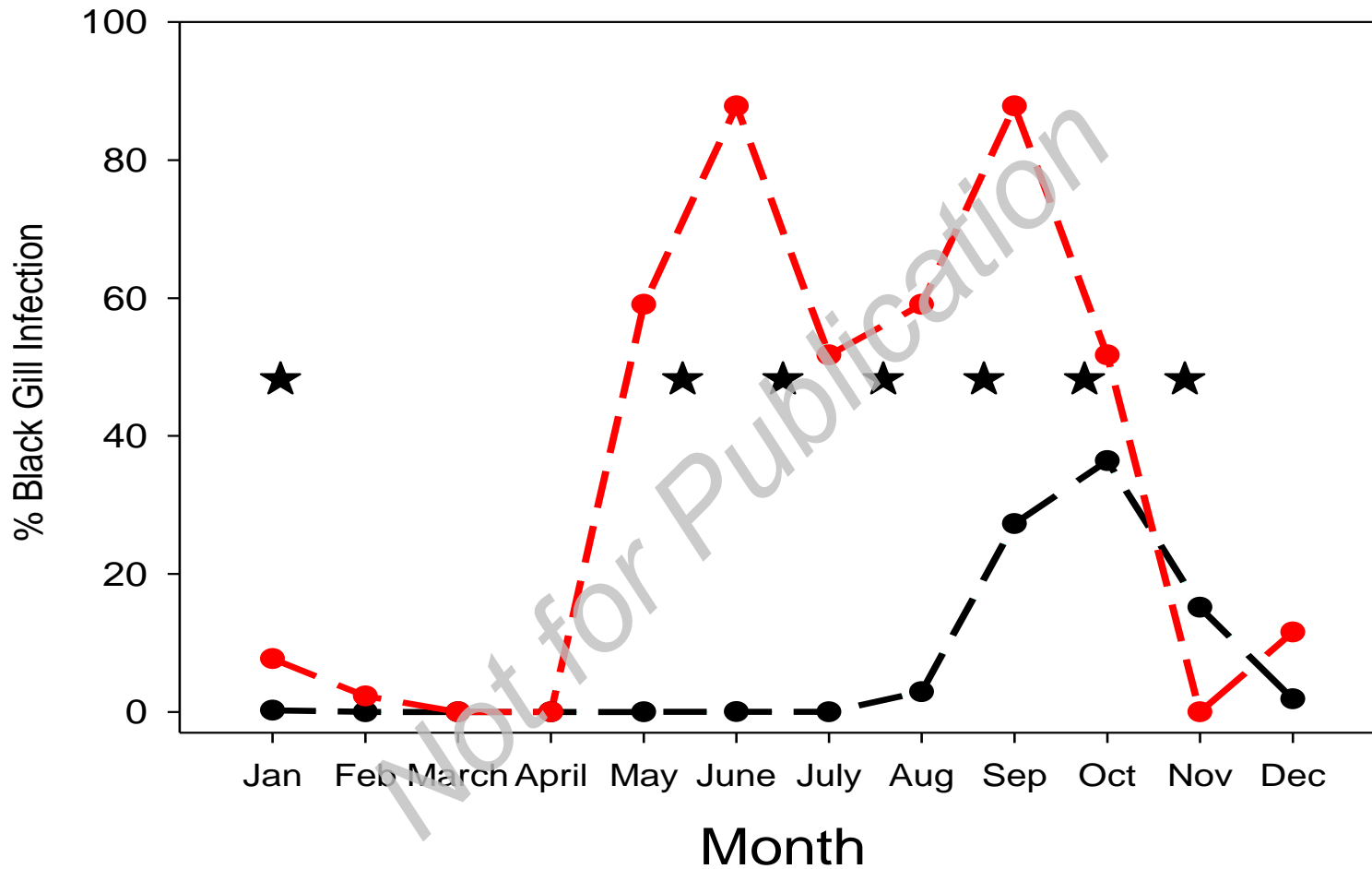


# BG Infect Rate by Sound System and Month, 1996-2013





# Seasonal Occurrence and Detection of Black Gill



★ Hemocytic Nodules Present

—●— Visual (Average 1996-2013)

—●— Molecular (March 2014 - July 2015)

Not for Publication

Watch the Full Video: YouTube : [xJQkORTHuVE](https://www.youtube.com/watch?v=xJQkORTHuVE)



**is it a pathogen? Looks like it!**

**Tissue Invasion**



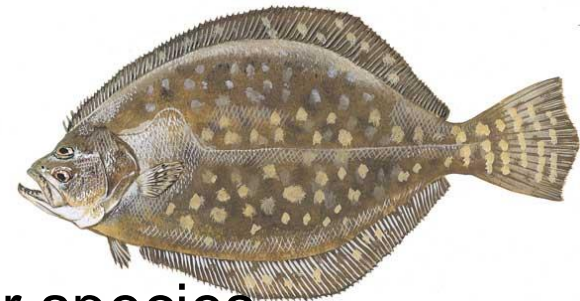
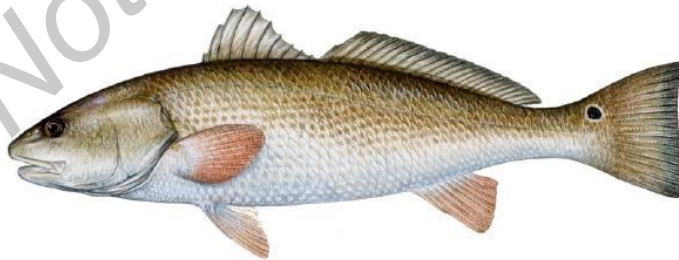


Not for Publication

#368 (X400) small brown shrimp with BG; lots of ciliates and the nearby gill lamellae appear to be necrotic.

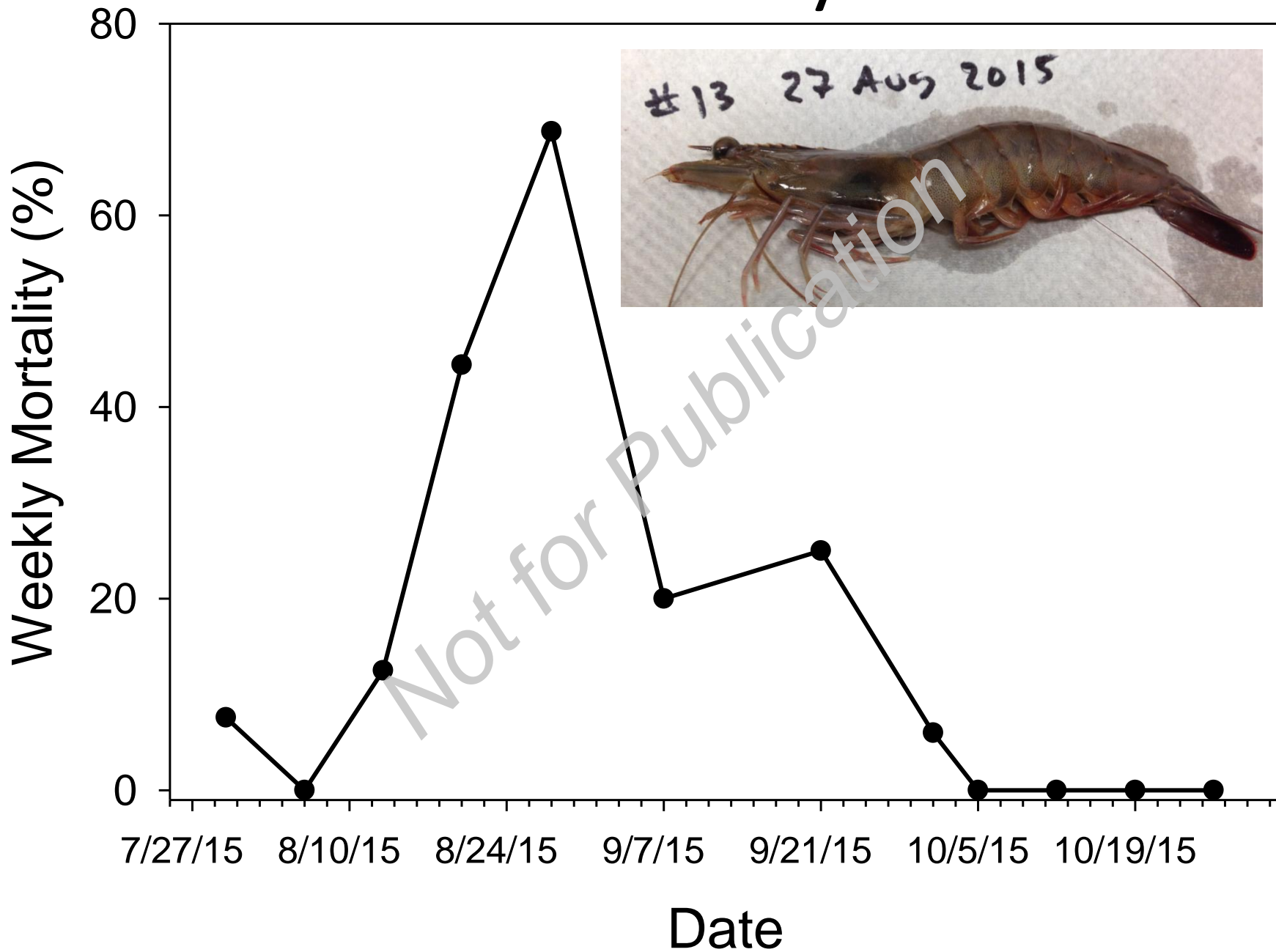


# Not Harmful to Humans!



Or, as far as reported, to other species

# Mortality





# Secondary Effects



Mean Time to Exhaustion	
Control	Black Gill
4.30 hours	2.75 hours

# Solutions

The ability to predict in the short-term the severity of BG outbreaks will improve the ability of individual shrimpers to manage their efforts

Understanding the life cycle, transmission pathways & reservoirs of the black gill ciliate may create opportunities for mitigation

Understanding the causes, consequences and possible solutions will be the basis for accurate long-term predictions regarding shrimp populations & the industry





# SHRIMP BLACK GILL IN GEORGIA

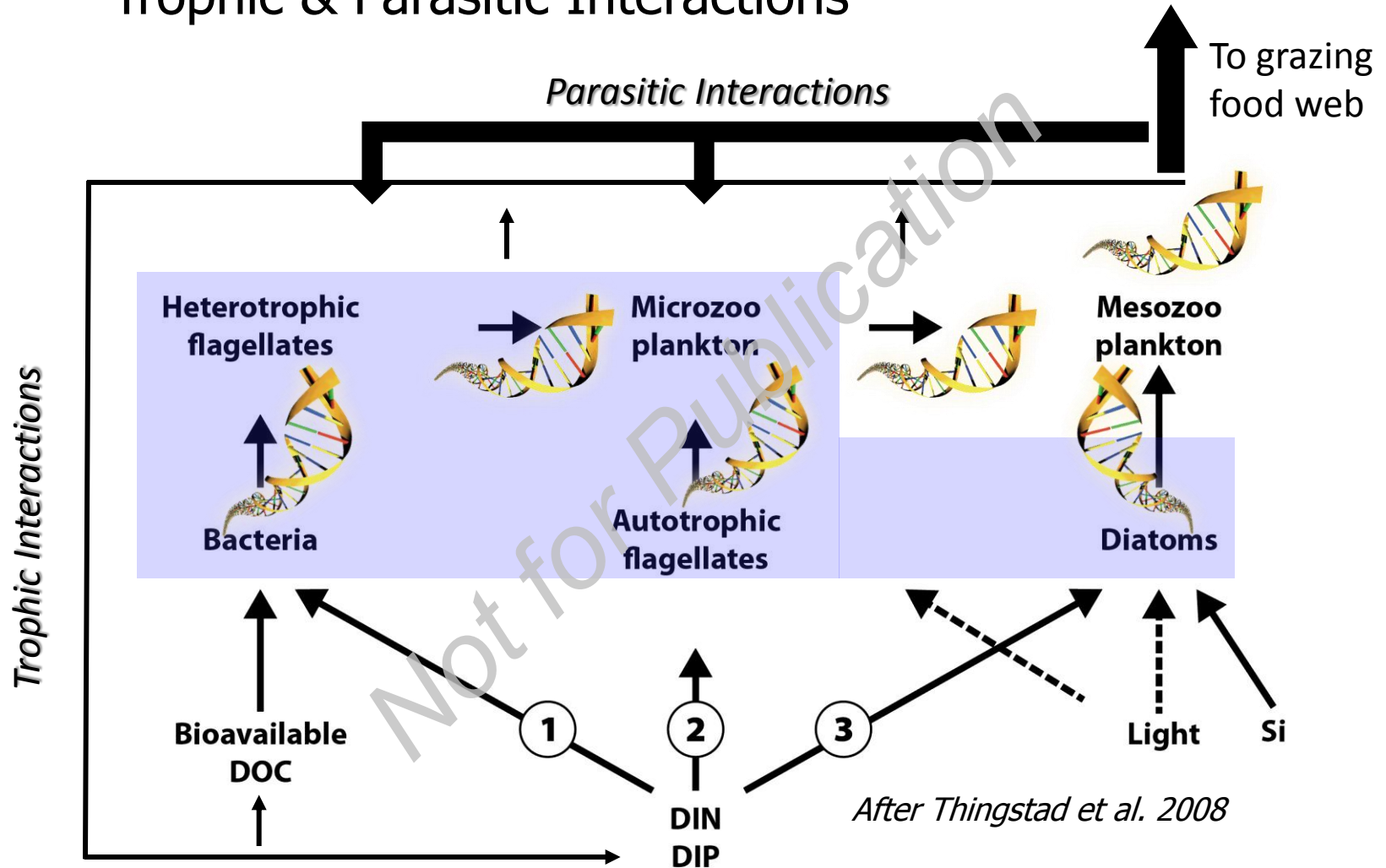
- Widely distributed, appears to be caused by the same ciliate.
- Present from May – February (absent March & April)
- Extremely high prevalence, in 2014 at its peak, nearly 100% infected.
- Causative agent identified as a ciliate but we still don't know its name.
- Agent is pathogenic and infectious in shrimp, BUT NOT FOR HUMANS.
- Significant mortality in August associated with BG.
- Likely increased secondary mortality in other parts of BG season.
- Molecular diagnostics available.
- Environmental triggers unclear.
- It is probably not alone.



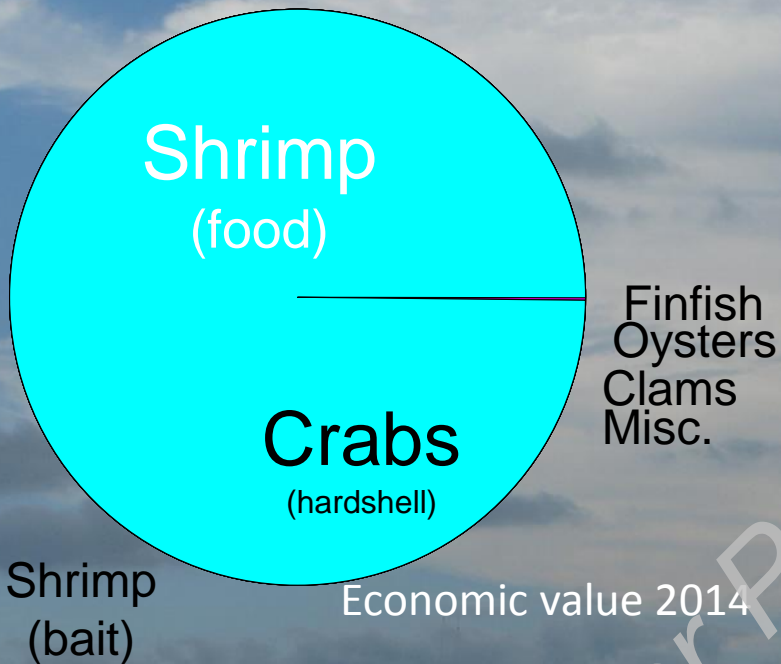


# Marc Frischer – Microbial Ecology

Biogeochemical Processes & Nutrient Cycling  
Trophic & Parasitic Interactions



# Georgia's Fisheries

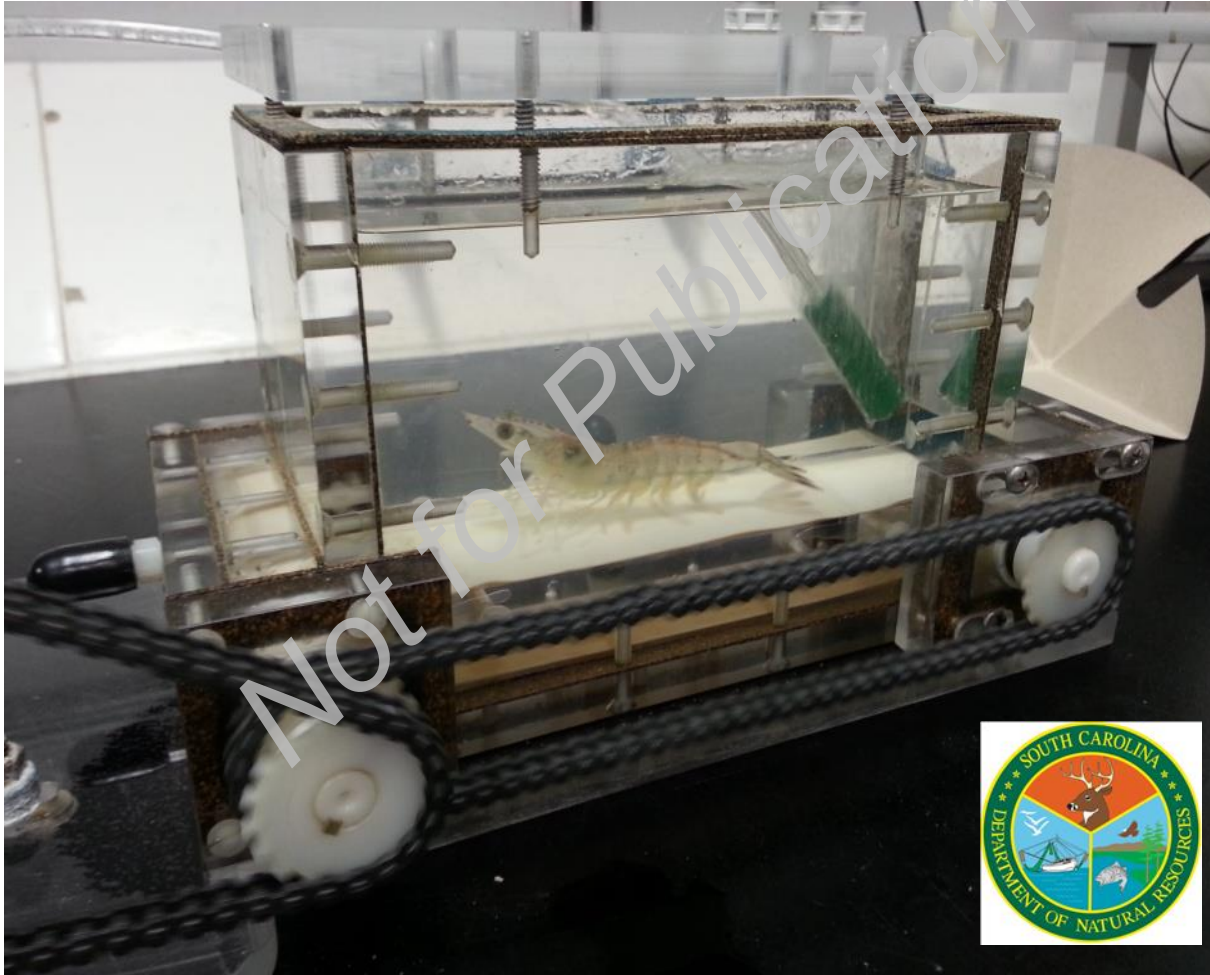


2004, ~\$10 million  
2014 ~\$5.5 million

**Commercial Trawling Licenses**  
1980 ~ 1,400  
2004 ~ 350  
2014 ~ 250

# Morbidity – Leading to Secondary Mortality?

## Endurance Trials – Shrimp on a Treadmill



Courtesy of Burnett lab



Not for Publication

Start

Not for Publication

3hr 18min - Getting Tired

Not for Publication

4h 50 min - Exhausted



# The Shrimp Gill “Parasitome”

White Shrimp M656

August 2014

Black Gill

*Hyalophysa* sp.

Not for Publication  
Trematoda  
Hydrozoa  
Zoothamnium sp.

n = 79,325

White Shrimp WS49G

May 2014

Clean

Hydrozoa

*Zoothamnium* sp.

Scyphozoa

Other ciliates  
(including *Hyalophysa*),  
fungi & micro-eukaryotes

n = 78,743

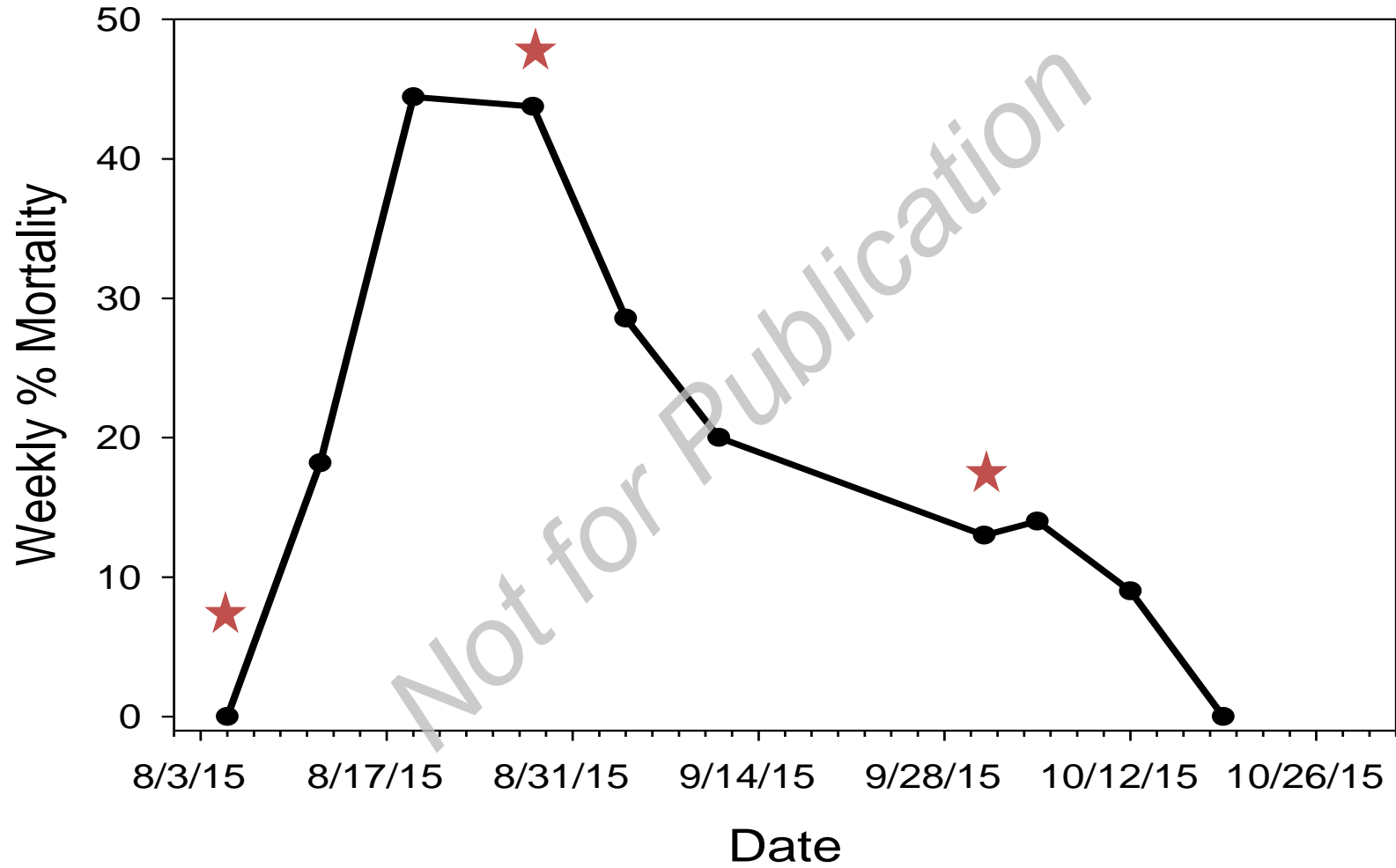
# The Shrimp Gill “Parasitome”

Group	# Unique Groups	# Sequences	Most Common Replicates	# Sequences
<b>Potential Microparasites</b>				
Ciliophora	38	176315	<i>Hyalophysa</i> sp.	114640
			<i>Zoetianmnum</i> sp.	54990
Fungi	64	2051	<i>Malassezia</i> sp.	608
			Capnodaes	607
Apicomplexa	8	21	Cardisporidium	7
				3
Cercozoa				284
				286
Retaria				220
Choanomonada				62
Dinoflagellata				1290
				171
Euglenozoa	6	128	Petalomonas	107
MAST	4	21	MAST-3J	14
<b>Animalia</b>				
Plathelminthes	6	90587	Digenea	90546
Annelida	5	54	Unidentified	36
Nematoda	3	3	Phanodermatidae	1
			Trichuridae	1
			Tripylidae	1

Proactive Management Requires Proactive Science

195 Distinct Groups of Potential Shrimp Parasites Detected in 13 Specimens  
(March – December 2014)

# Mortality



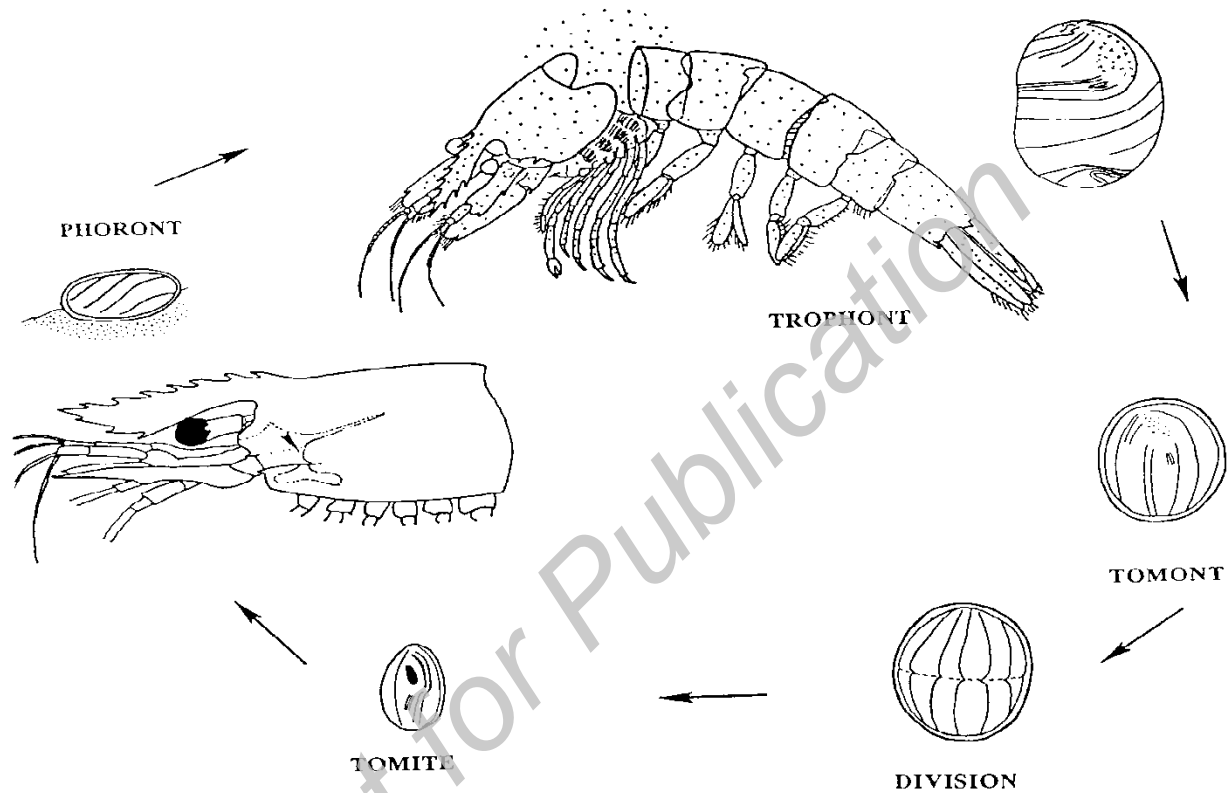


# What is Causing BG in Georgia Shrimp?



100 μm

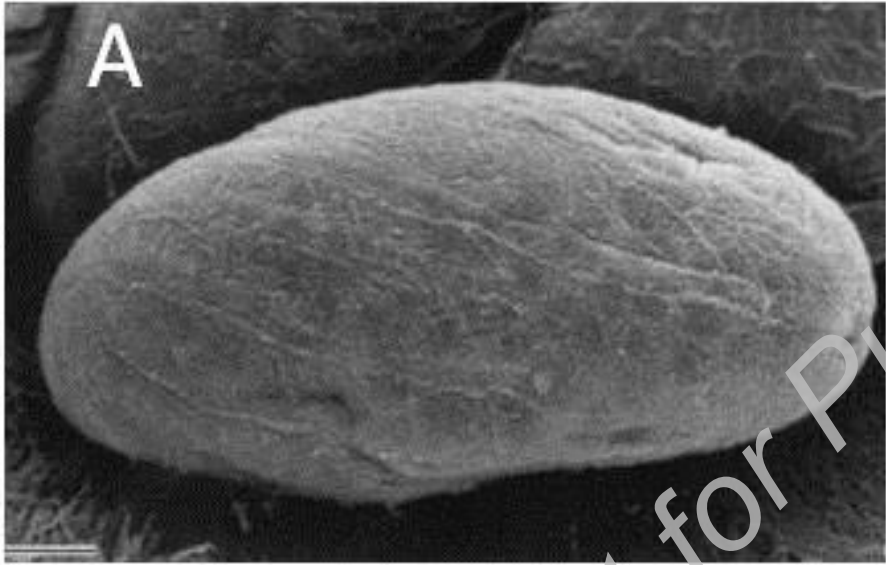
# Theoretical Life History of an Apostomate Ciliate



Based on this ID we expect it to:

- **NOT BE HARMFUL TO SHRIMP**
- Be infectious through the water column.
- Be common in a wide range of other crustacean species.

# But We Still Don't Know the Ciliate

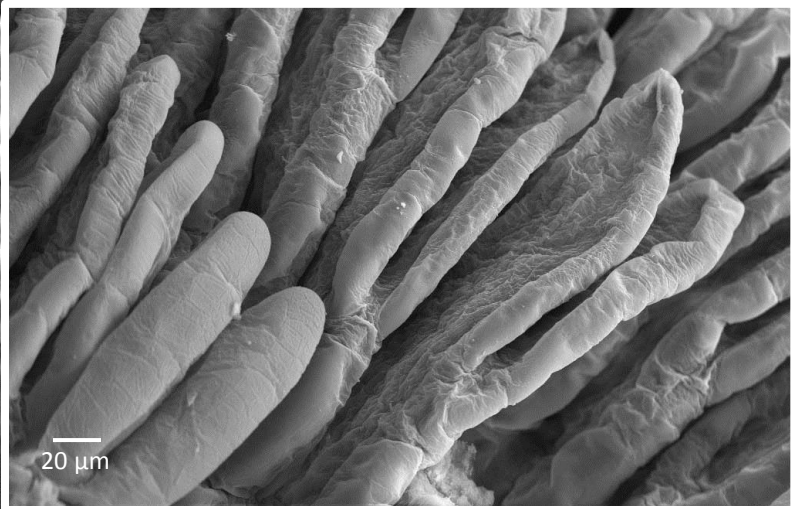


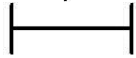
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***Hyalophysa chattoni***

**Georgia Black Gill Ciliate**  
***It does NOT look like***  
***H. chattoni***





10 µm  


Mag = 2.23 K X

EHT = 7.00 kV

WD = 12.0 mm

Signal A = SE1

Photo No. = 7739

Date : 16 Oct 2014

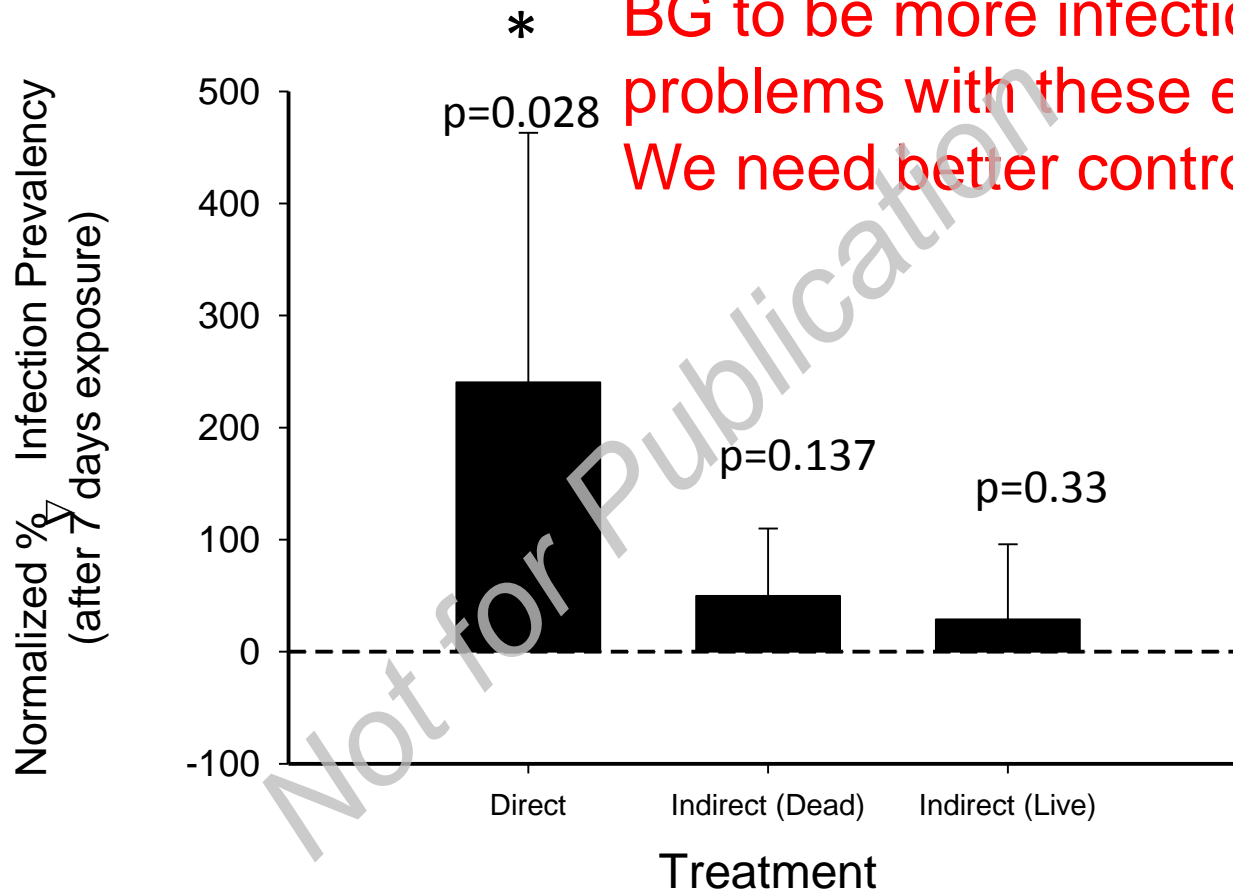
Time : 12:17:10



*Photo By: S. Landers, Troy University*

# Shrimp Black Gill Transmission Studies 2013 - 2014

A surprising result, we expected BG to be more infectious – But problems with these experiments. We need better control animals.



Synthesis of all Transmission experiments.

Data normalized relative to experimental control treatment