Ciguatera and Climate Change:
New Evidence for a Blunting of Effect by Population Changes

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Study Partners

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Impact of climate on dinoflagellates and ciguatera fish poisoning

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Ciguatera

• Results from eating tropical reef fish that carry “ciguatoxin”

• Causes clinical syndrome marked initially by GI symptoms, followed by neurologic and cardiac symptoms
• Most frequently reported marine toxin disease in the world, affecting > 50,000 people per year

• Major constraint on fisheries in many regions (tourism, recreational economies)
Ciguatera Fish Poisoning - Fish

• Fish are unaffected by toxin
• Fish look and taste normal
• Toxin is not affected by cooking
• Internal organs more likely to be toxic
• Larger fish more likely to be toxic
  – St. Thomas study: toxicity increased for larger fish in any given species
• May be geographic localization of toxicity
• No good method currently available for identifying toxic fish
Ciguatera: Incidence

- U.S. Virgin Islands: 7.3 cases/1,000 population/year*
- Miami: 0.05 cases/1,000 population/year
- South Pacific: 0.97-2.19 cases/1,000 population/year
- Reunion Island: 0.08 cases/1,000 population/year

*Population-based survey
Understanding Ciguatera
And how to Prevent it

- Environmental Studies (UVI, WHOI)
- Climate Studies (FSU)
- Toxin Studies (FDA)
- Clinical Studies (Schneider Hosp, UMB, UF)
- Epidemiologic Studies (UMB, UF)
Changing Caribbean Climate and Threats to Reefs
54 Years of Atlantic Hurricanes (1950-2003)

Busy hurricane years = years for which the number of late-season hurricanes fall within the top tercile of all years.

Of the 18 years with small warm pools:
- 3 busy years, 23 storms

Of the 18 years with large warm pools:
- 11 busy years, 82 storms
Increasing Sea Surface Temperatures

- Sea surfaces temperature 1°C above the maximum monthly mean can cause mass coral bleaching
- In USVI, every year of the last decade has seen warmer summers than our climate mean
Gambierdiscus spp. abundance, Benner Bay

Max temp: 30.1 (Aug 10)
Min temp: 25.4 (Mar 11)

Gambierdiscus spp. abundance **positively correlated with** SW temperature, precipitation; **negatively correlated with** wind velocity (Spearman’s rank correlation, p<0.05)
Ciguatera Cases, Emergency Department, Schneider Hospital, St. Thomas, by Month, 1995-1999

![Chart showing ciguatera cases by month from January to November, 1995-1999. The highest number of cases occurred in September.](chart.png)
Background

- Incidence surveys performed in St. Thomas in 1980
  - 7 per 1000 (approximately 14 per 1000 among adults)
    - In person survey, Morris, et al.
  - 22\% of households affected in a five year period
    - Telephone survey, McMillan, et al.

- Since this time, seawater temperatures have risen.
  - Has been suggested that increasing seawater temperature, in the context of global warming, will lead to an increase in ciguatera incidence
Research Questions

• Has ciguatera incidence in St. Thomas changed from 1980 to 2010/2011?
  – We hypothesized that incidence would have increased due to the rise in seawater temperatures

• What demographic and behavioral factors are associated with ciguatera illness in St. Thomas?
Two island-wide random digit dial telephone surveys in St. Thomas (November 2010 and October 2011) - Landline and cellular telephones

Eligibility criteria: adult residents of St. Thomas
1. Demographics
2. Recent fish consumption (frequency, type of fish, how obtained)
3. History of ciguatera episodes in the participant and their household members
4. Ciguatera awareness

Telephone Survey Questionnaire
Survey population

- 807 individuals participated in the telephone surveys
  - 400 in 2011 provided information about ciguatera in the past five years
- 186 (23%) had ever had ciguatera
  - 339 total episodes
- 43 households (11%, 95% CI=8-14%) had a ciguatera episode in the previous five years
- 56 (30%, 95% CI=21-39%) visited the emergency department for their most recent ciguatera illness
Emergency Department Visits

- Medical record review of emergency department at Roy Schneider Hospital
- All available records with discharge diagnosis of ciguatera were identified and reviewed
- Data from pre 1980 were obtained from past research
Incidence estimates

- Telephone survey:
  - 12 per 1000 (95% CI=10-21) 2010/2011
  - 14 per 1000 in 1970’s survey

- Emergency department visits:
  - 18 per 1000 in 1970s
  - 6 per 1000 (95% CI=5-8) in 2007-11
Survey Results

- 22% of households were affected in the 1970’s over 5 years.

- 11% of households were affected in 2010/2011 over the same time period.
Population Differences

- Between 1980 and 2010/2011, we found significant differences in education (higher), age (older), and fish consumption (lower).

- Combined risk difference of -2.7 per 1000
Conclusion

- We observed a *decline* in ciguatera incidence in St. Thomas from 1980 to 2010/2011

- This may be due to a population shift: Higher socioeconomic status, aging and lower fish consumption

Radke et al. (2013) *American Journal of Tropical Medicine and Hygiene*, In Press
Alternatively

- St. Thomas may have reached an upper temperature threshold that is limiting *Gambierdiscus* growth

- A positive association with seawater temperature may exist but the effect of temperature is obscured by other factors (change in toxin profiles, primary dinoflagellate, or fish populations).

- Despite the decline in incidence in STX over the past 30 years, ciguatera remains a major public health problem, affecting about 1% of the US population each year.
Socioeconomic

Climate

Toxin

Toxic Fish

Perceived Risk

Behavioral

Community Knowledge

Dietary Patterns

Exposure

Individual Susceptibility

Ciguatera Fish Poisoning