Tropical Areas: Ciguatera Fish Poisoning (CFP)

Bride dies after eating toxic fish in Mexico

Christine Fensome had eaten grouper fish in a restaurant the night before she died
GETTY IMAGES

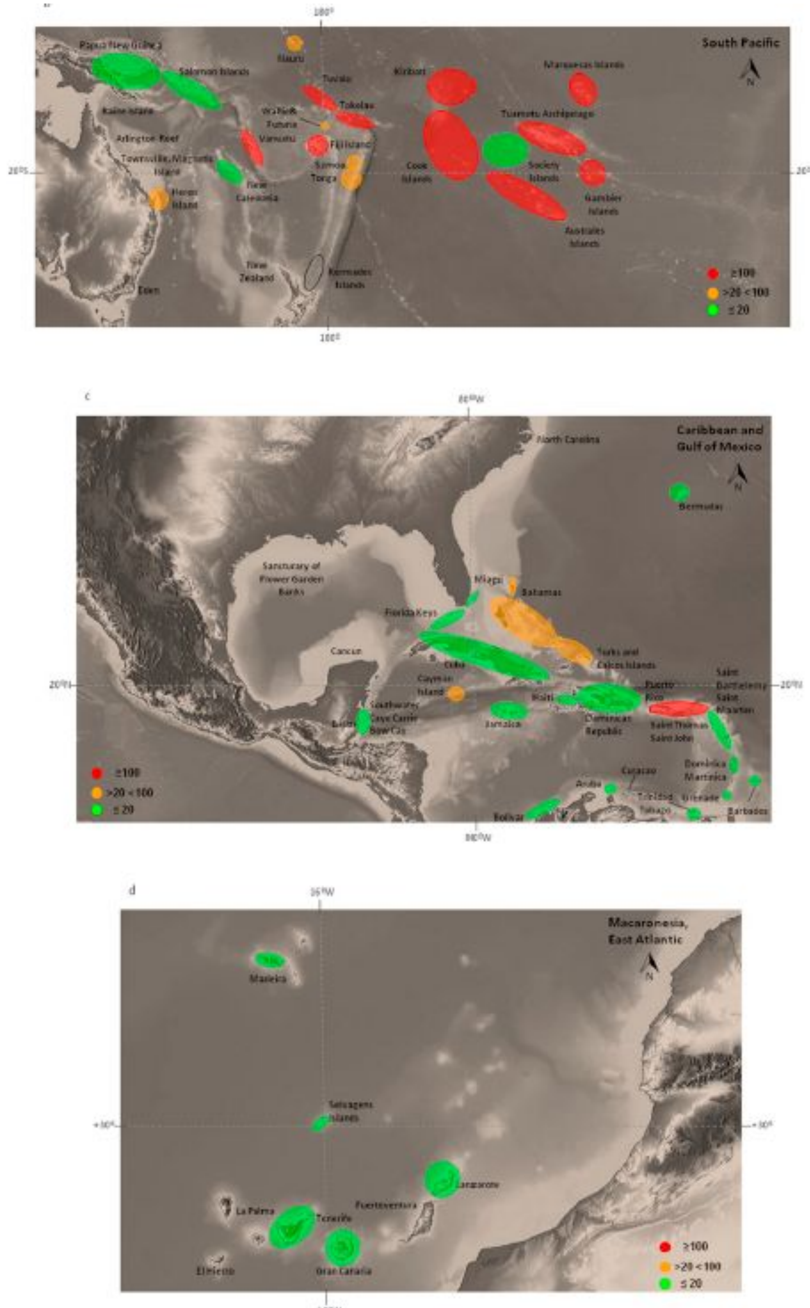
A woman has died on her honeymoon after having a heart attack believed to have been caused by eating contaminated fish.

The New York Times

GLOBAL HEALTH

Fish Poisoning More Common Than Believed

A Great Barracuda in the water near Singer Island, Fla. Because the fish may contain ciguatera toxin, an epidemologist recommended not eating the fish. Science Source



Soliño & Costa (2020)

Fig. 2. Geographical distribution of ciguatera fish poisoning incidence. The colors reflect the incidence rate (100,000 persons-year). Location names indicate the spots where *Gambierdiscus* spp. were reported. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

(Bloom) Characteristics and Impacts

Characteristics:

- Ciguatera is **not** associated with **large scale blooms** of the causative organism
- Ciguatoxins are produced by certain microalga (dinoflagellate) species in the genus ***Gambierdiscus***, which live on the surfaces of **macroalgae** and **dead coral** in coral reef ecosystems
- Dinoflagellates are inadvertently consumed by herbivorous reef fish while they graze on macroalgae, and these **fish accumulate ciguatoxins** in their body tissues
- Toxins also may undergo biotransformation and accumulate in the coral reef food web
- **Highest toxin levels** are generally found in **larger predatory fish**, such as barracuda, moray eel, snapper, grouper, mackerel, and amberjack, although herbivorous fishes can also be ciguatoxic
- *Gambierdiscu*s **cell densities and toxicity may not track each other** in the environment, because the toxin is derived from a few species that are often not very abundant.
- **Global expansion** of ciguatera may be fostered by ocean warming, expanding beyond tropical areas
- Efforts to develop rapid screening methods for toxins in fish have not been successful

Impacts:

- Ciguatera is the **most common marine toxin disease** in the world
- Estimated disease **incidence**: 10^4 cases worldwide; 10^3 cases in US jurisdictions
- Ciguatera is a poisoning syndrome ("CFP") caused by **eating coral reef fish contaminated** with a suite of toxins known as ciguatoxins
- **Symptoms of ciguatera are diverse** and include gastrointestinal, cardiovascular, and neurological disturbances, the latter of which may last from days to years
- There is **no cure**; treatment is supportive
- Impacts of ciguatera may be **most severe in isolated island communities** that are dependent on subsistence fishing for food
- Risk of ciguatera is a significant **impediment to development of shallow water fisheries** in the Pacific
- The Hong Kong market for live reef fish results in significant sales revenues for many small island communities of the South Pacific, but ciguatera outbreaks can **jeopardize access to this market**

Consequences and Human Responses

<u>Consequences</u>:

- CFP is the consequence of the **human consumption of fish** associated with coral reef environments
- Health impacts to subsistence fishers and seafood consumers (recreationalists, fresh markets, groceries, restaurants; local markets and international trade)
- **Acute and chronic illness**; symptoms diverse; diagnosis problematic; treatment only partially effective
- Economic impacts on the production of fish and its distribution to downstream markets
- Possible more general (halo-type) **impacts to seafood markets** due to miscommunication of risk
- **Impacts to local tourist industry**, including impairment of “destination image”
- Increased **costs to fishers** of shifts away from preferred fishing locations
- **Emergent local ecological knowledge** (LEK) comprising avoidance of “hot spots”
- **Litigation** as a consequence of illness

<u>Responses</u>:

- **No direct measures to control** *Gambierdiscus spp*. or ciguatoxins are known to exist
- **Mitigation of impacts** is likely the most relevant response pathway
- But, **actions taken to improve reef health** (control of CO2 releases, or local sedimentation or nutrients) could have the side-effect of reducing CFP occurrence
- **Monitoring and testing** of the environment, fish and humans to characterize the distribution of toxins and the incidence of CFP in humans (limited at present)
- A “ciguatoxin flux model” for **forecasting** is under development incorporating data on growth characteristics of toxic Gambierdiscus, cellular toxin content, toxin uptake or assimilation
- Potential for implementation of more formal **testing, monitoring, management of fisheries (formal fishery closures)** to mitigate health impacts
- **Medical treatment** of CFP illnesses (limited effect, can be chronic)
- Seafood “**consumption heuristics”** comprising preferences, norms, and local ecological knowledge (LEK)
- **Consumption advisories** focusing on higher trophic level reef fish (e.g., barracuda, grouper, etc.)
- LEK comprises a “**cognitive construct**” involving **avoidance of CFP “hot spots”** (an “informal” closure policy)
- **Warnings** based upon diagnosis, FDA test kits, and limited reporting of CFP illness (delayed reporting is problematic)
- Poison control hotlines, social media, and other forms of **risk communication**

Gaps and Recommended Approaches

<u>Gaps</u>:

- Scientific understanding of **environmental drivers** (reef health, ocean changes due to climate change)
- Scientific understanding of **spatial/temporal distributions** of toxic algae and toxic fish stocks and changes over time (including the potential effects of climate change on the "spread" of CFP)
- Human **exposure pathways** (species, locations, supply sources, cumulative loadings)
- Data on CFP **incidence** (rate) and **prevalence** (chronic cases): spatial/temporal distributions and changes
- CFP is **not a "reportable" illness** nationally; physicians are not typically trained in its diagnosis
- **Communication of health risks** to seafood consumers
- Descriptions of both acute and chronic **health effects**
- Estimates of **cost-of-illness** (including effects on the quality of life)
- **Effectiveness of informal closures** due to local ecological knowledge (LEK)
- **Cognitive constructs of LEK** and their variability across user groups
- Effects of communication about the risks of CFP outbreaks on **tourism and broader economic development**

<u>Approaches</u>:

- Detailed characterizations of the **relevant "markets" and institutions**: fishers, locations, technologies, consumers
- **Rapid ethnographic assessments** of fishing communities
- **Network analyses** of the emergence of LEK as a consequence of CFP illness diagnoses
- Applications of advances in valuing economic losses due to **human morbidities and mortalities** (EPA 2020)
- Estimated economic **value of improvements to diagnosis and reporting** of CFP outbreaks
- Estimated **stated preferences for the consumption of safe fish**
- **Value of information approaches** relating consumer preferences or improved health outcomes to advances in scientific understanding of the occurrence of CFP
- Estimated **predictors of reef health** (reduced-form models)
- Experimental testing of **risk communication strategies** (warnings, labels, placemats)
- Experimental testing of alternative approaches to **incentivize fishers to share their LEK** about ciguatera hot spots
- **Cost-benefit analyses** of formal institutions for testing, monitoring, and fishery closures (the counterfactual to extant informal LEK approaches)
- Estimated **costs to user groups** (e.g., commercial, subsistence, or recreational fishers) of fishery regulations
- Estimated **benefits to fish stocks** and ecosystems of either informal or formal closures