RISK CHARACTERIZATION OF CIGUATERA FOOD POISONING IN EUROPE (GP/EFSA/AFSCO/2015/03)

EuroCigua

79th MEETING OF THE EFSA ADVISORY FORUM
3-4 March 2021

Ana Canals Caballero
Scientific Advisor AESAN

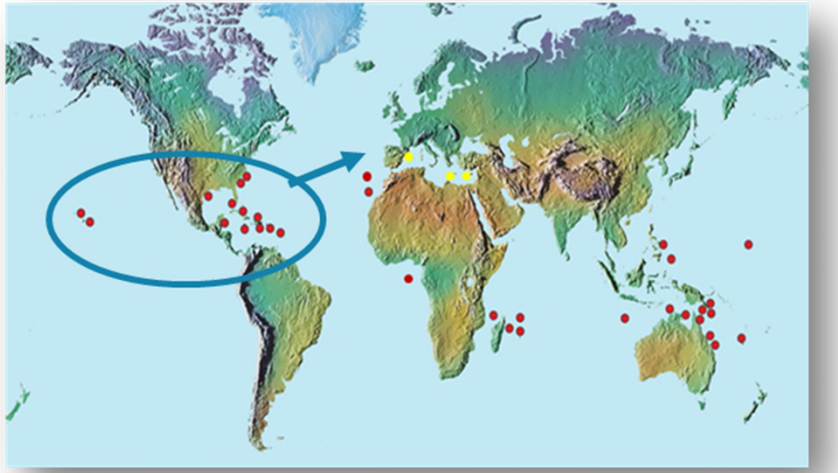
RISK CHARACTERIZATION OF CIGUATERA FOOD POISONING IN EUROPE (GP/EFSA/AFSCO/2015/03)

EUROCIGUA PROJECT

EuroCigua

Ciguatera in Europe

- In 2004 *Gambierdiscus* spp., in the waters of the Canary Islands and Madeira. First autochthonous ciguatera outbreak in Canary Islands
- 2008: autochthonous ciguatera outbreaks in Spain (Canary Islands) and in Portugal (Madeira)
- Between 2008 and 2015 continuous outbreaks and cases appeared in Canary Islands



- These new findings suggested CP is becoming an increasing risk for European countries.

- No official reference method
- No certified reference materials
- No toxicology data
- CP not well known in EU: **under-reported**

RISK CHARACTERIZATION OF CIGUATERA FOOD POISONING IN EUROPE (GP/EFSA/AFSCO/2015/03)
EUROCIGUA PROJECT

EuroCigua

- EuroCigua co-funded by the European Food Safety Authority (EFSA) **Framework Partnership Agreement** (FPA), coordinated by **AESAN**
- Cooperation between EFSA and **14 partners from six Member States.**
- **June 2016-January 2021**

Characterize the risk of ciguatera poisoning in Europe

Epidemiology	Environment	Analytical methods
• Incidence • Epidemiological characteristics	• Cell based assay • CTX producing microalgae • CTX in fish • environmental data • predictive models	• LC-MS/MS • reference materials

Epidemiology: Surveillance protocol

- Guidelines for surveillance of ciguatera at EU level from 2012 to 2019
- Case definition consensus
- Case and outbreak report forms
- List of fish previously associated with ciguatera
- Collecting Epidemiological data to implement prevention and control measures

marine drugs

MDPI

Review

An Updated Review of Ciguatera Fish Poisoning: Clinical, Epidemiological, Environmental, and Public Health Management

Melissa A. Friedman [1,*], Mercedes Fernandez [2], Lorraine C. Backer [3], Robert W. Dickey [4], Jeffrey Bernstein [5,6], Kathleen Schrank [5], Steven Kibler [7], Wendy Stephan [6], Matthew O. Gribble [8], Paul Bienfang [9], Robert E. Bowen [10], Stacey Degrasse [11], Harold A. Flores Quintana [12], Christopher R. Loeffler [12], Richard Weisman [6], Donna Blythe [13], Elisa Berdalet [14], Ram Ayyar [15], Danielle Clarkson-Townsend [8], Karen Swajian [11], Ronald Benner [12], Tom Brewer [16] and Lora E. Fleming [17]

EuroCigua

SURVEILLANCE PROTOCOL FOR CIGUATERA FOOD POISONING IN THE EU

2017

September 29th 2020

EuroCigua

Annex. List of fish previously associated with ciguatera

SPECIES	ENGLISH NAMES
Acanthuridae	
Acanthurus achilles	Redblotch surgeonfish
Acanthurus dussumieri	Black-spot surgeonfish
Acanthurus gahhm	Black surgeonfish
Acanthurus leucopareius	Whitebar surgeonfish
Acanthurus lineatus	Lined surgeonfish
Acanthurus maculiceps	Earbar surgeonfish
Acanthurus nigricans	Whitecheek surgeonfish
Acanthurus nigrofuscus	Brown surgeonfish
Acanthurus nigroris	Bluelined surgeonfish
Acanthurus olivaceus	Orangespot surgeonfish
Acanthurus striatus	Striated surgeonfish
Acanthurus xanthopterus	Yellowfin surgeonfish
Ctenochaetus flavicauda	Whitetailed surgeonfish
Ctenochaetus striatus	Striated surgeonfish
Naso brachycentron	Humpback unicornfish
Naso brevirostris	Spotted unicornfish
Naso hexacanthus	Sleek unicornfish
Naso lituratus	Orangespine unicornfish
Naso unicornis	Bluespine unicornfish
Albulidae	
Albula vulpes	Bonefish
Balistidae	
Balistapus undulatus	Orange-lined triggerfish
Balistes capriscus	Grey triggerfish
Balistes vetula	Queen triggerfish
Balistoides viridescens	Titan triggerfish
Canthidermis sufflamen	Ocean triggerfish
Melichthys niger	Black triggerfish
Melichthys vidua	Pinktail triggerfish
Pseudobalistes fuscus	Yellow-spotted triggerfish

RISK CHARACTERIZATION OF CIGUATERA FOOD POISONING IN EUROPE (GP/EFSA/AFSCO/2015/03)

EUROCIGUA PROJECT

EuroCigua

Epidemiology: CP outbreaks/cases in Europe 2012-2019

Autochthonous outbreaks

14 outbreaks

77 cases related

2 outbreaks

19 cases related

Imported and traveler outbreaks

3 imported; 1 traveler

16 cases related

6 imported; 3 traveler

84 cases related

Conclusions

- Information on outbreaks was provided by public health/food safety authorities and the information on single cases was provided by poison centres and travel and tropical medicine units. Information was fragmented.
- The total incidence rate of the ciguatera reported cases in the EU/EEA was very low 0,0055 cases/100.000 inhabitants. The incidence rate in the Canary Islands was 0,47 cases/100.000 inhabitants. No statistically significant trend in the number of reported outbreaks was observed between 2012-2019.
- PROBABLY UNDEREPORTED

Conclusions

- Outbreaks due to consumption of fish from the EU/EEA (autochthonous outbreaks) were reported only by Spain (Canary Islands) and Portugal (Madeira)
- Outbreaks due to imported fish were mostly reported by Germany and France. Netherlands reported one outbreak in 2020
- The type of fish most frequently associated with ciguatera in the EU/EEA were groupers and amberjack for autochthonous fish and *Lutjanus* spp. for imported fish from India and Vietnam.

RISK CHARACTERIZATION OF CIGUATERA FOOD POISONING IN EUROPE (GP/EFSA/AFSCO/2015/03)

EUROCIGUA PROJECT

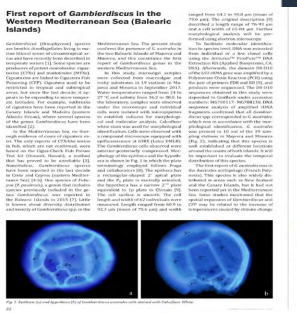
EuroCigua

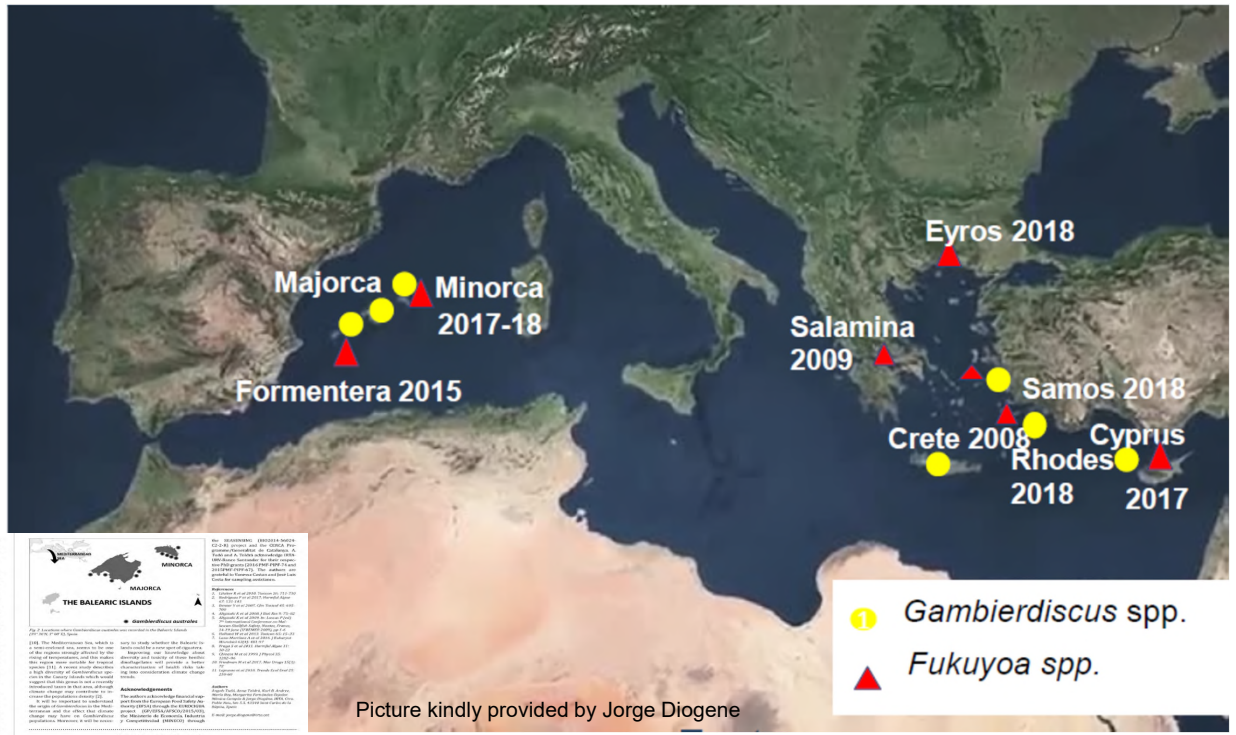
Environment: *Gambierdiscus and/or Fukuyoa in Europe*

Identified in:

- Canary Islands
- Madeira & Selvagens
- Crete, Cyprus, Samos and Rhodes
- Balearic Islands

Confirmation of *Gambierdiscus* in Western Mediterranean





Picture kindly provided by Jorge Diogene

CTX-like toxicity(N2a)

Gambierdiscus spp. Strains (positive/stablished)

- Canary Islands: **39/93**
- Madeira & Selvagens: **1/86**
- Balearic Islands: **26/113**
- Crete, Cyprus, Samos and Rhodes: **2/195**

EuroCigua

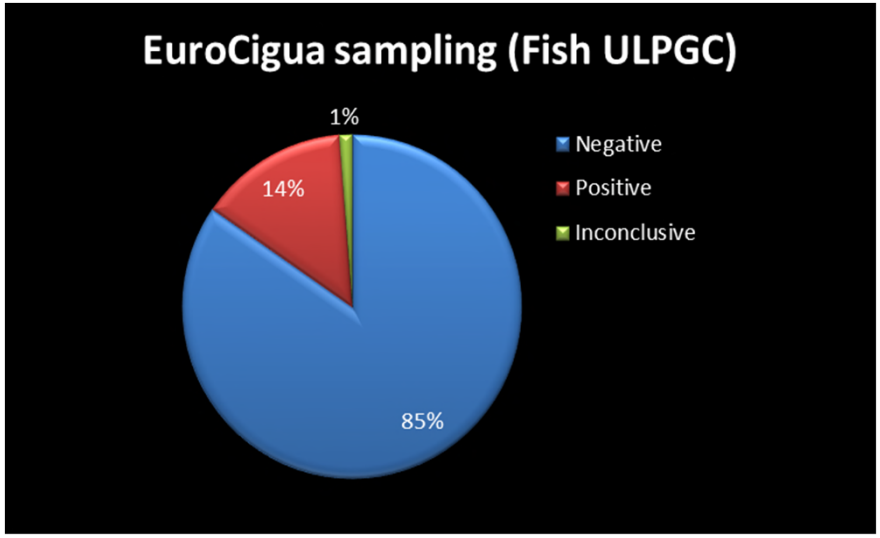
Fish sampling in Canary Islands

In The Canary Islands ciguatera was included as mandatory notifiable disease. **Official Control Program** (Fish species selected - specific weight):

- 2018: 1128 samples (16 % positive samples)
- 2019: 839 samples (12 % positive samples)

865 Fish from Canary Islands (ULPGC):

- 747 EuroCigua sampling – Data analysis
- 118 Official Control (O.C.) – High positive simples selected for Reference materials



RISK CHARACTERIZATION OF CIGUATERA FOOD POISONING IN EUROPE (GP/EFSA/AFSCO/2015/03)

EUROCIGUA PROJECT

EuroCigua

CTX in fish_Canary Islands

SPECIES	Latin name	Total	Negative	Positive	Inconcl.	Positive %	Weigh of positives (Kg)	LC-MS/MS detection
Island-grouper	Mycteroperca fusca	11	5	6		55	2.5-8	Yes
Tuna	Thunnus sp.	1	1			0		
Antoñito	Dentex macrophthalmus	10	10			0		
Axillary seabream	Pagellus acarne	1	1			0		
Yellowmouth barracuda	Sphyraena viridensis	17	17			0		
Blackbelly rosefish	Helicolenus dactylopterus dactylopterus	1	1			0		
Redporgy	Pagrus pagrus	28	26	2		7	1.65-4	Yes
Bogue	Boops boops	16	16			0		
Bonito	Katsuwonus pelamis	1	1			0		
Common pandora	Pagellus erythrinus	8	8			0		
Forkbeard	Phycis phycis	7	7			0		
African striped grunt	Parapristipoma octolineatum	20	19	1		5	0.29	Other CTX?
Mackerel	Scomber colias	27	26		1	0		
Blacktail comber	Serranus atricauda	12	12			0		
Comber	Serranus cabrilla	1	1			0		
Smooth-hound shark	Mustelus mustelus	1	1			0		
Atlantic wreckfish	Polyprion americanus	1	1			0		
Black seabream	Spondyliosoma cantharus	4	4			0		
European conger	Conger conger	4	4			0		
Brown meagre	Sciaena umbra	1	1			0		
Gilthead seabream	Sparus aurata	6	6			0		
Common dolphinfish	Coryphaena sp.	11	11			0		Other CTX?
Damselfish	Chromis limbata	1	1			0		
Alfonsino	Beryx splendens	10	10			0		
Saddled seabream	Oblada melanura	5	5			0		
Macaronesian sharpnose-puffer	Canthigaster capistrata	1		1		100	0.03	Sample N/A
Planehead filefish	Stephanolepis hispidus	2	2			0		
Grey triggerfish	Balistes capriscus	11	11			0		
Ocean triggerfish	Canthidermis sufflamen	1	1			0		
Striped seabream	Lithognathus mormyrus	3	3			0		
White trevally	Pseudocaranx dentex	31	25	6		19	0.23-7	*
Golden grey mullet	Liza aurata	1	1			0		
Seabass	Dicentrarchus labrax	2	2			0		

RISK CHARACTERIZATION OF CIGUATERA FOOD POISONING IN EUROPE (GP/EFSA/AFSCO/2015/03)

EUROCIGUA PROJECT

EuroCigua

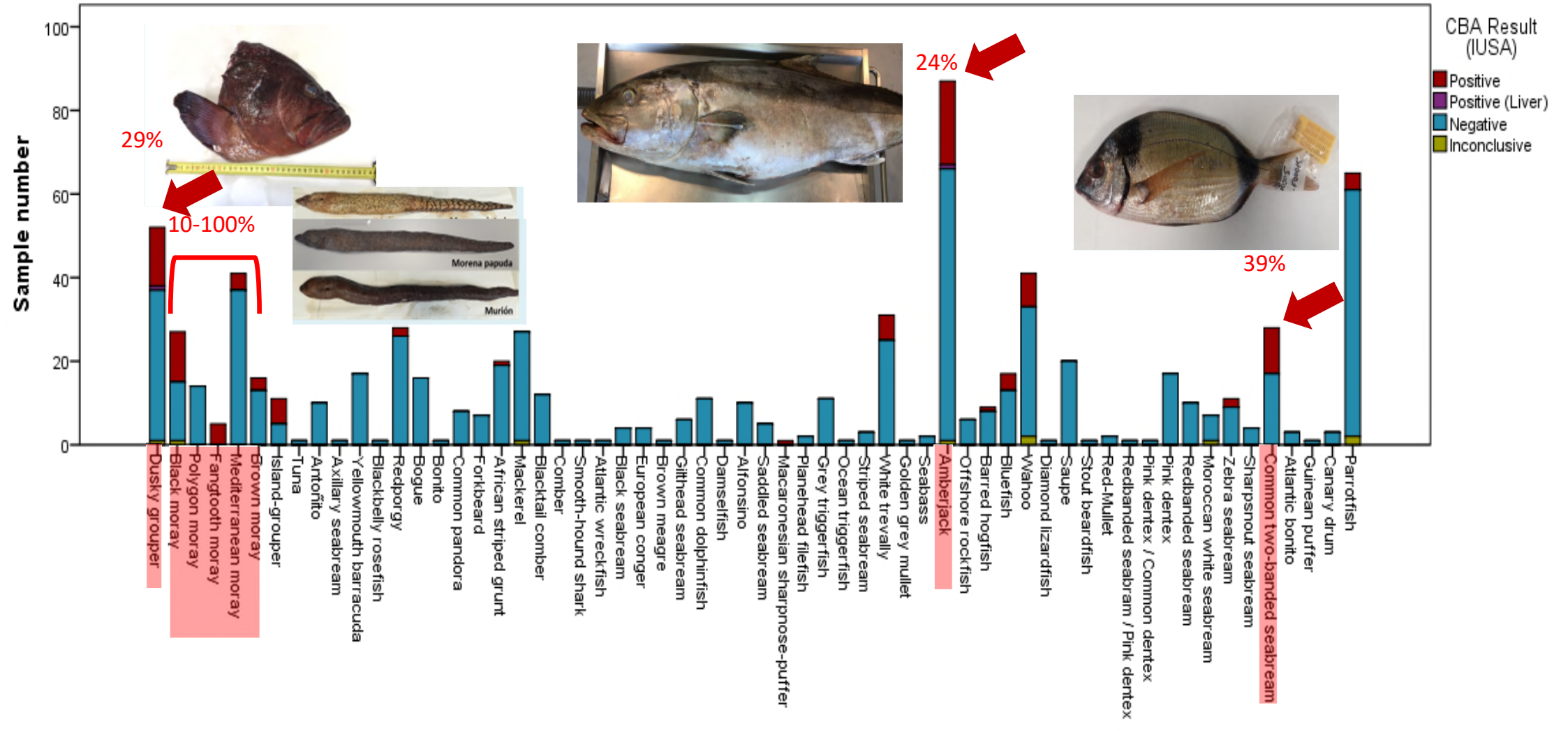
SPECIES	Latin name	Total	Negative	Positive	Inconcl.	Positive %	Weigh of positives (Kg)	LC-MS/MS detection
Amberjack*	Seriola sp*.	87	65	21	1	24	20-70	Yes
Dusky grouper*	Epinephelus marginatus*	52	36	15	1	29	6-30	Yes
Black moray*	Muraena augusti*	27	14	12	1	44	0.40-2.81	Yes
Polygon moray	Gymnothorax polygonius	14	14			0		
Fangtooth moray	Enchelycore anatina	5		5		100	0.36-1.44	Yes
Mediterranean moray	Muraena helena	41	37	4		10	1.05-5	Yes
Brown moray	Gymnothorax unicolor	16	13	3		19	0.51-2.72	Yes
Offshore rockfish	Pontinus kuhlii	6	6			0		
Barred hogfish	Bodianus scrofa	9	8	1		11	1.56	Other CTX?
Bluefish	Pomatomus saltatrix	17	13	4		24	6.10-8.80	Yes
Wahoo	Acanthocybium solandri	41	31	8	2	20	14-30	Yes
Diamond lizardfish	Synodus synodus	1	1			0		
Saupe	Sarpa salpa	20	20			0		
Stout beardfish	Polymixia nobilis	1	1			0		
Red-Mullet	Mullus surmuletus	2	2			0		
Redbanded seabram / Pink dentex	Pagrus auriga / Dentex gibbosus	1	1			0		
Pink dentex / Common dentex	Dentex sp.	1	1			0		
Pink dentex	Dentex gibbosus	17	17			0		
Redbanded seabream	Pagrus auriga	10	10			0		
Moroccan white seabream	Diplodus sargus cadenati	7	6		1	0		
Zebra seabream	Diplodus cervinus cervinus	11	9	2		18	0.69-1.15	Yes
Sharpsnout seabream	Diplodus puntazzo	4	4			0		
Common two-banded seabream	Diplodus vulgaris	28	17	11		39	0.26-0.71	Yes
Atlantic bonito	Sarda sarda	3	3			0		
Guinean puffer	Sphoeroides marmoratus	1	1			0		
Canary drum	Umbrina canariensis	3	3			0		
Parrotfish	Sparisoma cretense	65	59	4	2	6	0.37-0.48	Other CTX?
TOTAL SAMPLES (60 SPECIES STUDIED, 17 CIGUATOXIC)		747	632	106	9	14		

RISK CHARACTERIZATION OF CIGUATERA FOOD POISONING IN EUROPE
(GP/EFSA/AFSCO/2015/03)

EUROCIGUA PROJECT

EuroCigua

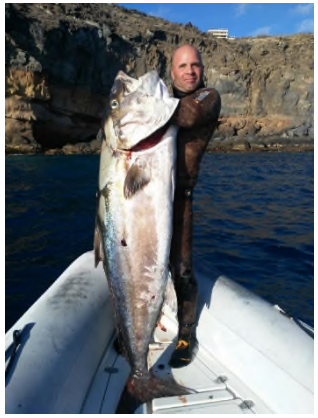
17 toxic species / 60 species studied

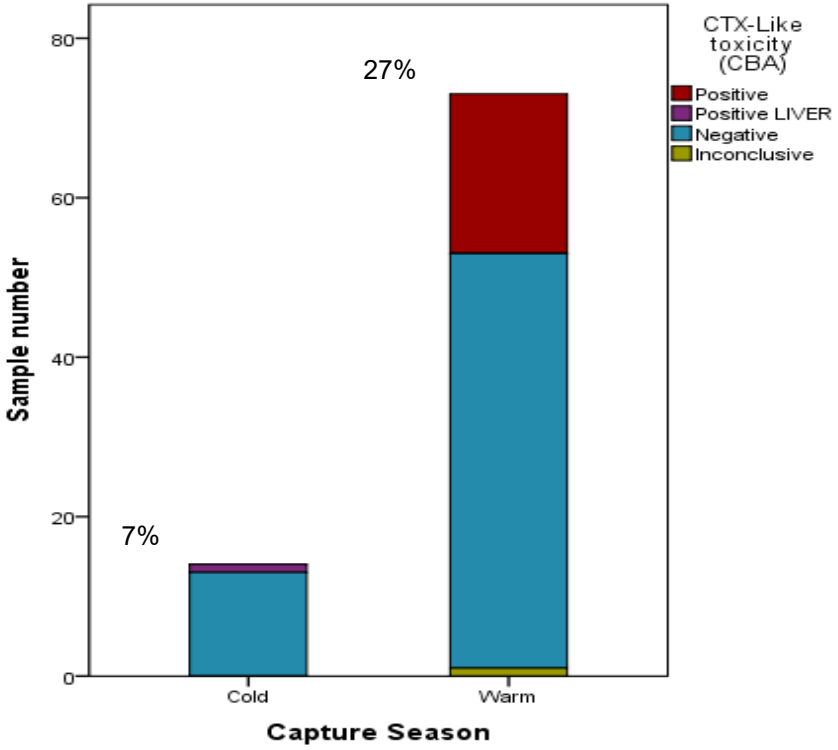


EuroCigua

REMARKABLE FISH SPECIES

Amberjack – *Seriola* spp.





Dusky Grouper – *Epinephelus marginatus*

29 % Positive

Involved in CP cases in the Canary Islands, 35 people affected

RISK CHARACTERIZATION OF CIGUATERA FOOD POISONING IN EUROPE (GP/EFSA/AFSCO/2015/03)

EUROCIGUA PROJECT

EuroCigua

REMARKABLE FISH SPECIES

Common two-banded seabream – *Diplodus vulgaris*

IUSA

39% (11/28)

- CTX-like toxicity in *Diplodus vulgaris*
- Low (36%) and medium (64%) toxicity.

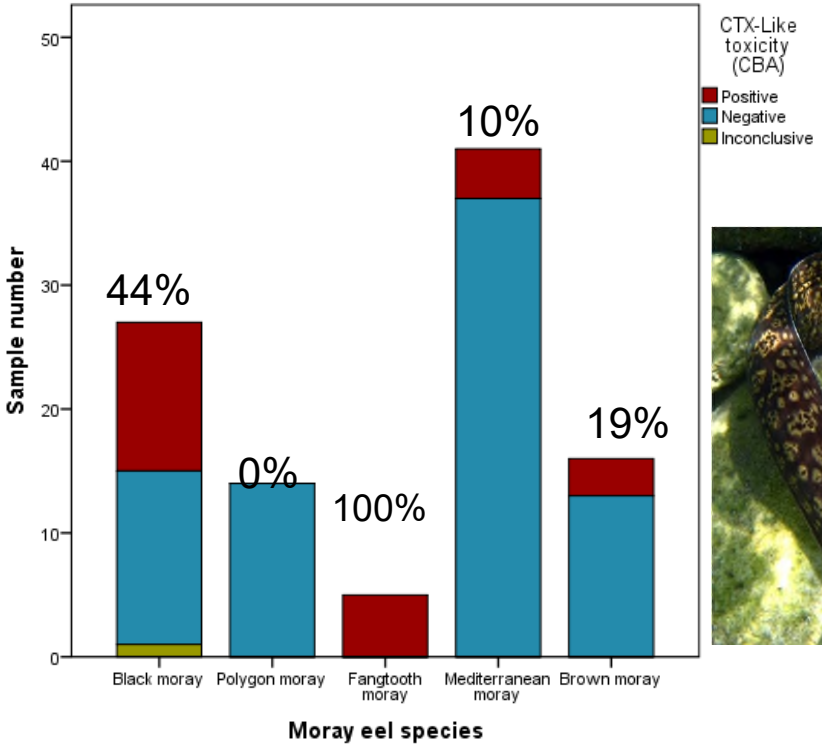
UNIVERSIDADE DE VIGO

64% confirmed (7/11)

- C-CTX in *Diplodus vulgaris*
- 0,02-0,07 ppb
- Neuro-2a cytotoxicity assay Vs. LC-MS / MS:
  - Mixture of analogues not known

No evidence of ciguatera outbreaks caused by *Diplodus vulgaris* in the Canary Islands but this species is known to be carriers of ciguatoxin (EuroCigua)

Moray eel



Important fish species for human consumption

Fish species	CTX-like toxicity[a]	LC-MS/MS[b]
Dusky grouper (*E. marginatus*)	0.032 ± 0.009 ppb	0.03 ppb C-CTX1
Black moray (*M. augusti*)	0.037 ± 0.015 ppb	0.05 ppb C-CTX1

El Hierro Island

- High contamination rate:
- 75% for seabream (*Diplodus vulgaris*) (9/11)
- 33% for moray eels (5/15)

- Similar results have been reported previously, showing high percentages (90.9%) of CTX in dusky groupers (*Epinephelus marginatus*) (Sánchez-Henao et al., 2019)

- **An algae bloom of G. caribaeus occurred in October 2016 in El Hierro** (Soler-Onís et al., 2016)

- These facts considered together with previous results obtained in this island, suggest El Hierro as a ciguatoxin hot spot in the Canary Archipelago.

RISK CHARACTERIZATION OF CIGUATERA FOOD POISONING IN EUROPE (GP/EFSA/AFSCO/2015/03)

EUROCIGUA PROJECT

EuroCigua

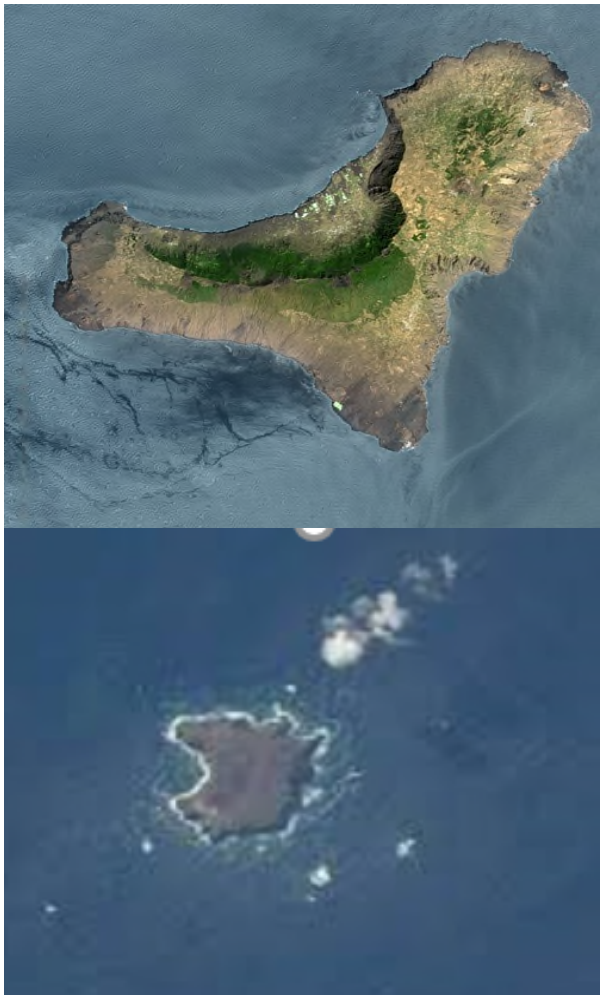
CTX in fish_Madeira

	FISH SPECIES	POSITIVE	ALL FISH	Weight (kg)	Length (mm)
	Epinephelus marginatus	1	1	19,5	970
	Bodianus scrofa	20	20	0.77-3.01	250-530
1 fish + by LC-MS and - by N2A	Balistes capriscus	3	7	1.966-2.64	444-500
	Mictoperca fusca	1	1	4,533	690
1 fish + by LC-MS and - by N2A	Serranus atricauda	6	10	0.193-0.81	250-380
	Dentex gibbosus	1	3	8,097	846
	Seriola dumerili	2	11	20,117-27,6	1232-1432
	Diplodus cervinus	1	1	2,84	520
	Sparisoma cretense	6	32	0.424-0.849	280-350
	Sphyreanea viridensis	2	4	4.139-5.955	1060-1170
	Seriola rivoliana	1	13	12,308	1060
	Katsuwonus pelamis	0	9		
	Kyphosus sectator	0	2		
	Makaira nigricans	0	1		
	Kyphosus sectatrix	0	7		
	Pomatus saltatrix	0	2		
	Seriola sp.	0	1		
	Seriola fasciata	0	2		
	Aluterus scriptus	0	1		
	Total	44	128		

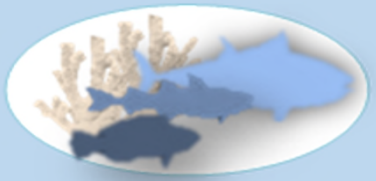
LOCATION	POSITIVE	TOTAL
Selvagens	**41**	**74**
Madeira	3	48
Desertas	0	5
Total	**44**	**127**

CTX in fish_Macaronesia

- Among 747 samples from the Canary Islands, **14%** were CTX-like positive
- Hotspot *El Hierro*: 34%
- Among 128 samples from Madeira and Selvagens, **34%** were CTX-like positive
- Hotspot Selvagens: 54%



EuroCigua



Evaluation of the presence/absence of CTX-like toxicity in fish

	Sampling areas	Tentative Plan	Collected fish	Weight (kg)	CTX-like toxicity (level)
Canary Islands	7	525	747 fish		**CTX-like positive: 216 cases,** CTX-like negative (negative): 632 cases CTX-like dubious: 17 cases
Madeira and Selvagens	3	100	128 fish (131 extracts)	0,2 – 300	**CTX-like positive: 44 cases** CTX-like negative (negative): 87 cases CTX-like dubious: 0 cases
Cyprus	2	70	75 (145 extracts)	0,3 – 30	**CTX-like positive: 1 cases** CTX-like negative (negative): 144 cases CTX-like dubious: 0 cases
Crete	2	70	70 (140 extracts)	0,6 - 12,2	**CTX-like positive: 0 cases** CTX-like negative (negative): 140 cases CTX-like dubious: 0 cases
Balearic Islands	2	40	36 (70 extracts)	0,7 - 3	**CTX-like positive: 0 cases** CTX-like negative (negative): 70 cases CTX-like dubious: 0 cases
TOTAL	16	805	1174		

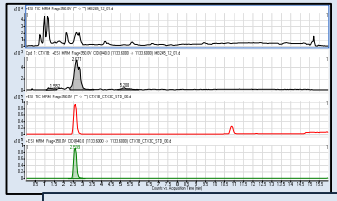
Conclusions

- Several dinoflagellates: *Gambierdiscus* spp. and *Fukuyoa* spp. as the causative organisms were identified in the Macaronesia area (Canary Islands and Madeira), Crete, Cyprus, and Balearic Islands.
- Cytotoxicity assays showed CTX-like toxicity in *Gambierdiscus* spp strains from the Canary Islands, Crete and the Balearic Islands.
- Evaluation for the toxicity in fish shows CTX-like toxicity (Cell-based assay) in fish from Madeira and the Canary Islands, and no toxicity in other fish from the Mediterranean Sea including Balearic Islands

Analytical methods: CTX characterisation

SOP for LC -MS determination of CTXs

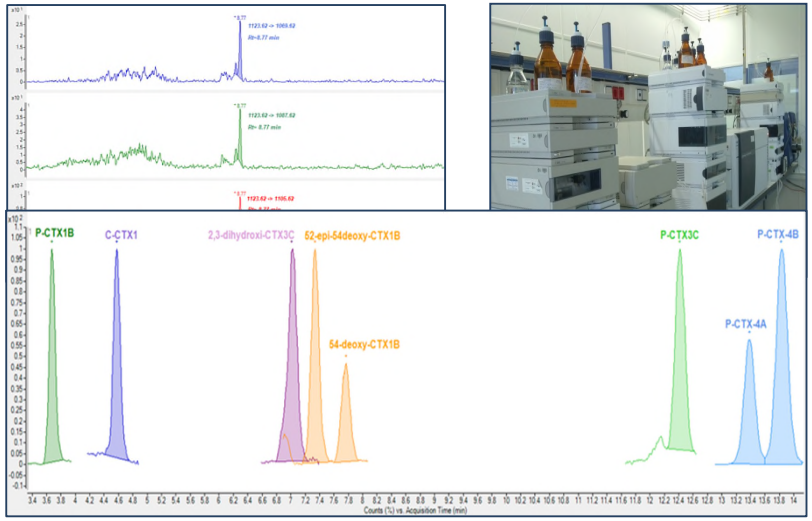
Confirmación of CTXs by LC-MS/MS and HRMS and CTX profile characterization



Preparation of reference materials

- LC-MS/MS – SOP
- C-CTX1 identified
- LC-HRMS
- CTX profile characterization
- Reference materials

After the screening of fish samples from Canary Islands, Madeira and Selvagens Islands, by N2a cell assay, the toxicity of CTX-like positive samples was confirmed by using the optimized LC-MS/MS



Food Chemistry
Volume 280, 15 May 2019, Pages 8-14

Implementation of liquid chromatography tandem mass spectrometry for the analysis of ciguatera fish poisoning in contaminated fish samples from Atlantic coasts

Pablo Estevez [a], David Castro [a], J. Manuel Leao [a, b], Takeshi Yasumoto [c], Robert Dickey [d], Ana Gago-Martinez [a, b]

[a] University of Vigo, Department of Analytical and Food Chemistry, Campus Universitario de Vigo, 36310 Vigo, Spain
[b] European Union Reference Laboratory for Marine Biotoxins, CITEXVI, Campus Universitario de Vigo, 36310 Vigo, Spain
[c] Japan Food Research Laboratories, 6-11-10 Nagayama, Tama, Tokyo 206-0025, Japan
[d] University of Texas at Austin Marine Science Institute, Port Aransas, TX 78373, United States

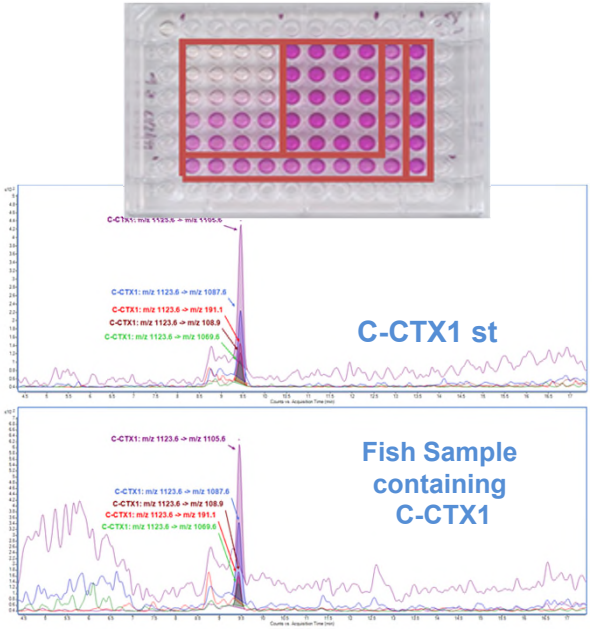
C-CTX1 is confirmed as the main responsible for the CP contamination of fish from Canary Islands and Madeira

RISK CHARACTERIZATION OF CIGUATERA FOOD POISONING IN EUROPE (GP/EFSA/AFSCO/2015/03)

EUROCIGUA PROJECT

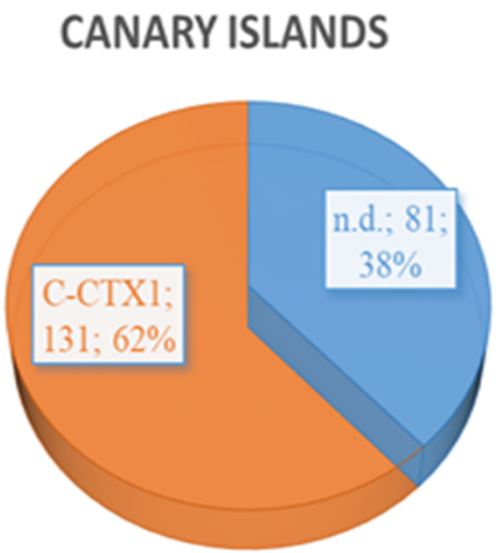
EuroCigua

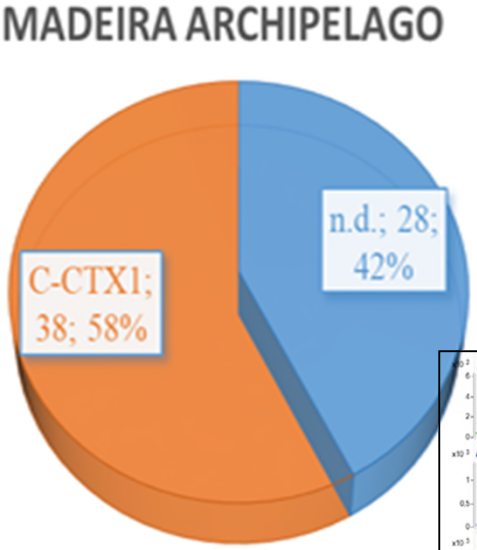
	Canary Islands	Madeira Archipelago
Total samples analysed	212	66
Max. (µg/Kg) C-CTX1	0.544	0.752
Min. (µg/Kg) C-CTX1	0.016	0.019
Average (µg/kg) C-CTX1	**0.065**	**0.187**



Levels of equivalent toxicity in fish

- **0.10 ppb C-CTX-1**
- **0.01 ppb P-CTX-1**

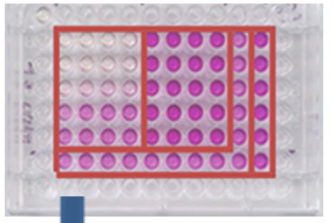




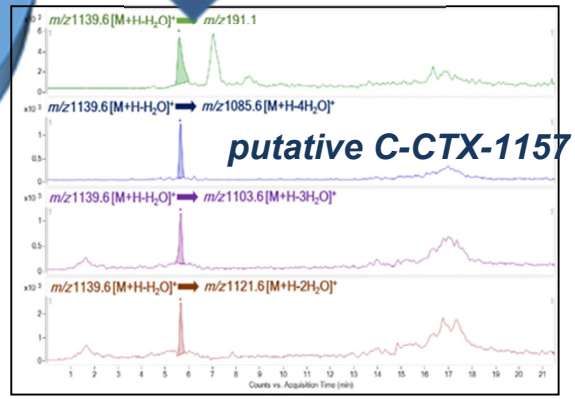
Ciguatera: A public health perspective

Robert W. Dickey*, Steven M. Plakas

U.S. FDA Center for Food Safety and Applied Nutrition, Office of Food Safety, Division of Seafood Science and Technology, Gulf Coast Seafood Laboratory, 1 Iberville Drive, Dauphin Island, AL 36528, USA



Other CTXs analogues



Black moray (Muraena augusti) from El Hierro (Canary Islands, Spain)

Reference Materials

Fish tissue reference materials autoclaved (≈ 12 kg):

Amberjack ≈ 0.26 ng C-CTX1/g
Amberjack ≈ 0.15 ng C-CTX1/g
Grouper ≈ 0.09 ng C-CTX1/g
Grouper ≈ 0.31 ng C-CTX1/g

Purified materials containing C-CTX1

Extraction and purification of ≈ 70 kg of fish tissue and liver

- Vials containing between 5-10 ng C-CTX1

Conclusions:

- An efficient **LC-MS/MS method** has been developed which allowed the characterization of C-CTX1 as the main responsible for the CP in the EU Coasts selected for this project. Further confirmation was carried out by LC-HRMS as well as using alternative tools.
- The LC-MS/MS method has been transferred to the EU REFERENCE LABORATORY FOR MARINE BIOTOXINS to make it available to the EURLMB NRLs Network

Conclusions

- The **low toxin concentration** on the samples evaluated from the selected areas, has been the main limitation that **justifies the establishment of contingency plans**, not only for the confirmation of the toxic profiles, but also for the toxin isolation and purification required for the preparation of reference materials. Neuroblastoma cell assay (N2a) played an important role on the accomplishment of this Task
- The analysis of *Gambierdiscus* sp from the areas selected did not allow to establish a correlation with the CTX profiles obtained for contaminated samples, several Maitotoxin analogues, including new ones, seem to be implicated in the toxic profile of these *Gambierdiscus* sp.

RISK CHARACTERIZATION OF CIGUATERA FOOD POISONING IN EUROPE (GP/EFSA/AFSCO/2015/03)

EUROCIGUA PROJECT

EuroCigua

EUROCIGUA PUBLICATIONS

First report of *Gambierdiscus* in the Western Mediterranean Sea (Balearic Islands)

Gambierdiscus (Dinophyceae) species are benthic dinoflagellates living in marine littoral zones of circumtropical areas and have recently been described in temperate waters [1]. Some species are producers of potent neurotoxins: ciguaMediterranean Sea. The present study confirms the presence of *G. australes* in the two Balearic Islands of Majorca and Minorca, and this constitutes the first report of *Gambierdiscus* genus in the western Mediterranean Sea.

ranged from 64.1 to 90.8 µm (mean of 78.6 µm). The original description [9] described a length range of
and a cell width of 65-84 µm
morphological analysis will
formed using electron micros
To facilitate molecular i
tion to species level, DNA was
from individual or a few cl
using the Arcturus™ PicoPu
Extraction Kit (Applied Biosys
USA). Afterwards, the domai

Contents lists available at ScienceDirect

Toxicon

journal homepage: www.elsevier.com/locate/toxicon

Review

Differential toxin profiles of ciguatoxins in marine organisms: Chemistry, fate and global distribution

Lucía Soliño[a,b,*], Pedro Reis Costa[a,b]

[a] IPMA - Instituto Português do Mar e da Atmosfera, Rua Alfredo Magalhães Ramalho, 6, 1495-006, Lisbon, Portugal
[b] CCMAR – Centre of Marine Sciences, University of Algarve, Campus de Gambelas, 8005-139, Faro, Portugal

foods

MDPI

Communication

Emerging Marine Biotoxins in Seafood from European Coasts: Incidence and Analytical Challenges

Pablo Estevez [1], David Castro [1], Ana Pequeño-Valtierra [1], Jorge Giraldez [1] and Ana Gago-Martinez [1,2,*]

1 Department of Analytical and Food Chemistry, University of Vigo, Campus Universitario de Vigo, 36310 Vigo, Spain; paestevez@uvigo.es (P.E.); dcastro@uvigo.es (D.C.); apequeno@uvigo.es (A.P.-V.); jgiraldez@uvigo.es (J.G.)
2 EU Reference Laboratory for marine biotoxins, Campus Universitario de Vigo, 36310 Vigo, Spain

toxins

MDPI

Article

An Attempt to Characterize the Ciguatoxin Profile in *Seriola fasciata* Causing Ciguatera Fish Poisoning in Macaronesia

Pablo Estevez [1], David Castro [1], Ana Pequeño-Valtierra [1], José M. Leao [1,2], Oscar Vilariño [1,2], Jorge Diogène [3] and Ana Gago-Martinez [1,2,*]

he Library

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Predictive score and probability of CTX-like toxicity in fish samples from the official control of ciguatera in the Canary Islands

J. Andres Sanchez-Henao [a], Natalia García-Álvarez [a,*], Antonio Fernández [a], Pedro Saavedra [b], Freddy Silva Sergent [a], Daniel Padilla [a], Begoña Acosta-Hernández [a], Manuela Martel Suárez [a], Jorge Diogène [c], Fernando Real [a]

[a] Division of Fish Health and Pathology, Institute of Animal Health and Food Safety (IUSA), University of Las Palmas de Gran Canaria, 35416 Arucas, Las Palmas, Spain
[b] Department of Mathematics, University of Las Palmas de Gran Canaria, Canary Islands, Spain
[c] Marine and Continental Waters Environmental Monitoring, IRTA, Ctra. Poble Nou, km 5.5, 43540 Sant Carles de la Ràpita, Spain

Journal of MASS SPECTROMETRY

RESEARCH ARTICLE

Design of experiments for the optimization of electrospray ionization in the LC-MS/MS analysis of ciguatoxins

Guillermo Moreiras, José Manuel Leão, Ana Gago-Martínez

Ciguatera fish poisoning outbreaks from 2012 to 2017 in Germany caused by snappers from India, Indonesia, and Vietnam

Miriam Friedemann [1]

Received: 9 January 2018 / Revised: 25 September 2018 / Accepted: 16 October 2018
© Bundesamt für Verbraucherschutz und Lebensmittelsicherheit (BVL) 2018

CrossMark

Assessment of cytotoxicity in ten strains of *Gambierdiscus australes* from Macaronesian Islands by neuro-2a cell-based assays

Laia Reverté [1] · Anna Toldrà [1] · Karl B. Andree [1] · Santiago Fraga [2] · Giada de Falco [1] · Mònica Campàs [1] · Jorge Diogène [1]

MS Number: TFAC-2019-466.R1
Title: Caribbean Ciguatoxin-1 stability under strongly acidic conditions: Characterization of a new C-CTX1 methoxy congener.
Authors: Estévez , Pablo ; Leao, Jose; Yasumoto, Takeshi; Dickey, Robert; Gago-Martinez, Ana

Fernando Real:3 publicaciones.

RISK CHARACTERIZATION OF CIGUATERA FOOD POISONING IN EUROPE (GP/EFSA/AFSCO/2015/03)

EUROCIGUA PROJECT

EuroCigua

Contents lists available at ScienceDirect

Aquatic Toxicology

journal homepage: www.elsevier.com/locate/aqtox

Presence of CTXs in moray eels and dusky groupers in the marine environment of the Canary Islands

Andres Sanchez-Henao[a], Natalia García-Álvarez[a,*], Freddy Silva Sergent[a], Pablo Estévez[b], Ana Gago-Martínez[b,c], Francisco Martín[d], María Ramos-Sosa[a], Antonio Fernández[a], Jorge Diogène[c], Fernando Real[a]

[a] Division of Fish Health and Pathology, University Institute of Animal Health and Food Safety (IUSA), University of Las Palmas de Gran Canaria, 35416 Arucas, Las Palmas, Spain
[b] University of Vigo, Department of Analytical and Food Chemistry, Campus Universitario de Vigo, 36310 Vigo, Spain
[c] European Union Reference Laboratory for Marine Biotoxins, CITEXVI, Campus Universitario de Vigo, 36310 Vigo, Spain
[d] Canary Health Service, Directorate-General for Public Health, Canary Islands, Spain
[e] Marine and Continental Waters Environmental Monitoring, IRTA, Ctra. Poble Nou, km 5.5, 43540 Sant Carles de la Ràpita, Spain

Contents lists available at ScienceDirect

Harmful Algae

journal homepage: www.elsevier.com/locate/hal

Gambierdiscus and *Fukuyoa* as potential indicators of ciguatera risk in the Balearic Islands

Àngels Tudó[a,b], Anna Toldrà[a], Maria Rey[a], Irene Todolí[a], Karl B. Andree[a], Margarita Fernández-Tejedor[a], Mònica Campàs[a], Francesc X. Sureda[b], Jorge Diogène[a,*]

[a] IRTA, Ctra. Poble Nou Km 5.5, 43540, Sant Carles de la Ràpita, Tarragona, Spain
[b] Pharmacology Unit, Faculty of Medicine and Health Sciences, Universitat Rovira i Virgili, C/St. Llorenç 21, E-43201, Reus (Tarragona), Spain

Contents lists available at ScienceDirect

Ecotoxicology and Environmental Safety

journal homepage: www.elsevier.com/locate/ecoenv

Rapid detection of ciguatoxins in *Gambierdiscus* and *Fukuyoa* with immunosensing tools

G. Gaiani[a], S. Leonardo[a], À. Tudó[a], A. Toldrà[a], M. Rey[a], K.B. Andree[a], T. Tsumuraya[b], M. Hirama[b], J. Diogène[a], C.K. O'Sullivan[c,d], C. Alcaraz[a], M. Campàs[a,*]

[a] IRTA, Ctra. Poble Nou Km 5.5, 43540, Sant Carles de La Ràpita, Spain
[b] Department of Biological Science, Graduate School of Science, Osaka Prefecture University, Osaka, 599-8570, Japan
[c] Departament D'Enginyeria Química, URV, Av. Països Catalans 26, 43007, Tarragona, Spain
[d] ICREA, Pg. Lluís Companys 23, 08010, Barcelona, Spain

toxins

MDPI

Article

New Insights into the Occurrence and Toxin Profile of Ciguatoxins in Selvagens Islands (Madeira, Portugal)

Pedro Reis Costa [1], Pablo Estevez [2], David Castro [2], Lucía Soliño [1], Neide Gouveia [3], Carolina Santos [4], Susana Margarida Rodrigues [1], José Manuel Leao [2] and Ana Gago-Martínez [2,*]

Food Chemistry

Volume 280, 15 May 2019, Pages 8-14

Implementation of liquid chromatography tandem mass spectrometry for the analysis of ciguatera fish poisoning in contaminated fish samples from Atlantic coasts

Pablo Estevez [a], David Castro [a], J. Manuel Leao [a, b], Takeshi Yasumoto [c], Robert Dickey [d], Ana Gago-Martinez [a, b]

[a] University of Vigo, Department of Analytical and Food Chemistry, Campus Universitario de Vigo, 36310 Vigo, Spain
[b] European Union Reference Laboratory for Marine Biotoxins, CITEXVI, Campus Universitario de Vigo, 36310 Vigo, Spain
[c] Japan Food Research Laboratories, 6-11-10 Nagayama, Tama, Tokyo 206-0025, Japan
[d] University of Texas at Austin Marine Science Institute, Port Aransas, TX 78373, United States

toxins

MDPI

Article

Further Advance of *Gambierdiscus* Species in the Canary Islands, with the First Report of *Gambierdiscus belizeanus*

Àngels Tudó [1], Greta Gaiani [1], Maria Rey Varela [1], Takeshi Tsumuraya [2], Karl B. Andree [1], Margarita Fernández-Tejedor [1], Mònica Campàs [1] and Jorge Diogène [1,*]

PRELIMINARY RESULTS OF RISK CHARACTERIZATION OF CIGUATERA FOOD POISONING IN EUROPE GP/EFSA/AFSCO/2015/03

EuroCigua

L. Cebadera-Miranda[1], A. Canals*[1], F. Melo[2], E.V. Martínez[3], D. Núñez[3], C. Varela*[3], F. Martín[4], M. Friedemann[5], M.Oleastro[6], I. Boziaris[7], Sánchez[8], N. García[8], P. Reis-Costa[9], N. Gouveia[10], G. Papageorgiou[11], A. Aligizaki[12], J. Diogène*[13], D. Castro[14], A. Pequeño[14], P. Estevez[14], J.M.Leao[14], A. Gago-Martínez*[14]

[1]Spanish Agency for Consumer Affairs, Food Safety and Nutrition (AECOSAN); [2]Portuguese Authority for Food and Economic Safety (ASAE); [3]Institute of Health Carlos III (ISCIII); [4]Canary Health Service (CH Institute for Risk Assessment (BfR); [5]Instituto Nacional de Saúde Doutor Ricardo Jorge, I.P. (INSA); [7]University of Thessaly; [8]University of las Palmas de Gran Canaria (ULPGC); [9]Instituto Português do Mar e d [10]Fisheries Department (FD). Direção Regional das Pescas of Madeira; [11]General State Laboratory (GSL); Ministry of Health of Cyprus; [12]Aristotle University of Thessaloniki; [13]Institute for Research and Tec Agriculture (IRTA); [14]University of Vigo (UVIGO).
*Corresponding authors
ciguatoxinas@mscbs.es

Brotes de ciguatera identificados en España. 2012-2018 GP/EFSA/AFSCO/2015/03

EuroCigua

C. Varela[1,2], I. Falcón[3], C. Crespillo[4], C. Subirá[5,6], J. Muñoz[5,6], D. Nuñez[3], EV. Martínez[7,2], R. Carmona[1,2], A. Canals[8]

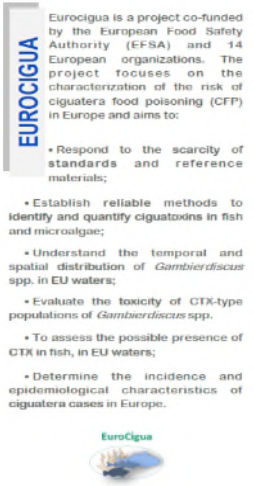
[1]Instituto de Salud Carlos III. [2]CIBERESP. [3]Dirección General Salud Pública Canarias. [4]Hospital Universitario La Paz-Carlos III. IdiPAZ. [5]Hospital Clínic-Universitat de Barcelona, [6]ISGlobal, Instituto de Salud Global, Barcelona. [7]Ministerio de Sanidad Consumo y Bienestar Social. [8]Agencia Española de Seguridad Alimentaria y Nutrición
mvarelam@isciii.es ciguatoxinas@mscbs.es

RISK CHARACTERIZATION OF CIGUATERA FOOD POISONING IN EUROPE (GP/EFSA/AFSCO/2015/03)
EUROCIGUA PROJECT

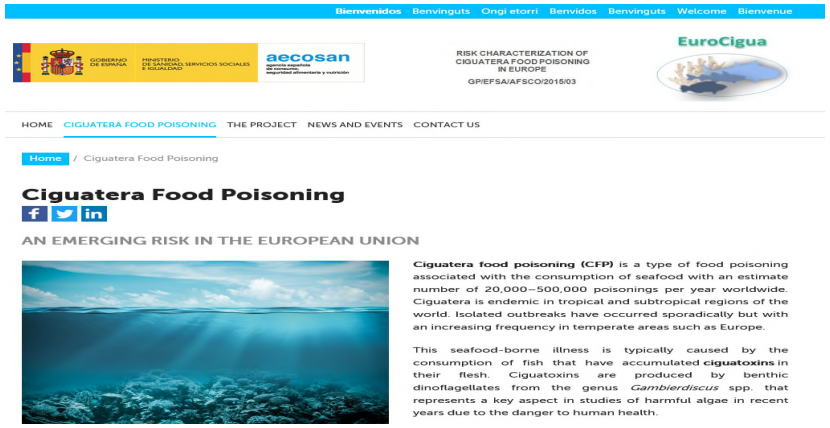
EuroCigua

External Communication Plan for dissemination

Leaflet



EuroCigua website



Factsheet

BUILD UP AWARENESS

English
Portuguese
Spanish

German
French
Greek

Italian

EuroCigua

International EuroCigua Workshop

- network for scientific excellence

The video is available here

Conclusions

- New endemic food-borne disease: emerging risk
- Surveillance protocol
- Harmonized methodologies for the extraction of toxins in microalgae and fish
- Implementation of N2a-cell based assay
- Develop methods to identify CTXs
- C-CTX1 was identified as the main responsible of CP in Macaronesia area
- Hierro and Selvagens were the main CP hotspots
- Network of scientific excellence

EuroCigua

FUTURE

- ✓ RAISING AWARENESS AND COLLECTING DATA OF CIGUATERA CASES AND OUTBREAKS AUTOCHTHONOUS AND IMPORTED FISH
- ✓ ESTABLISHMENT OF PREDICTION MODELS TO ANTICIPATE CIGUATERA EVENTS
- ✓ CONTINUE THE DATA COLLECTION FOR AN EFFICIENT STRATEGY FOR CIGUATERA RISK ASSESSMENT
- ✓ METHODOLOGICAL IMPLEMENTATION, DISSEMINATION , TRAINING AND PROFICIENCY