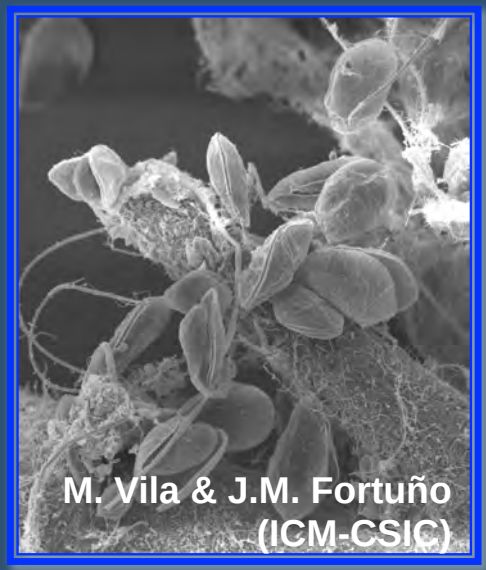
Expansion of the benthic dinoflagellate *Ostreopsis* with climate change? Health risks assessment and policy strategies for management

Elisa Berdalet[1], Magda Vila[1], Rafael Abós-Herràndiz[2]



Harmful Algal Blooms and Climate Change
Scientific Symposium, May 20015, Sweden

Elisa Berdalet[1] **Magda Vila[1]** **Rafael Abós-Herràndiz[3]**

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Harmful Algal Blooms and Climate Change
Scientific Symposium, May 20015, Sweden

MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD

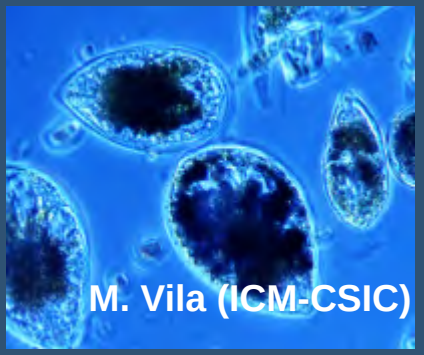
75 AÑOS CSIC

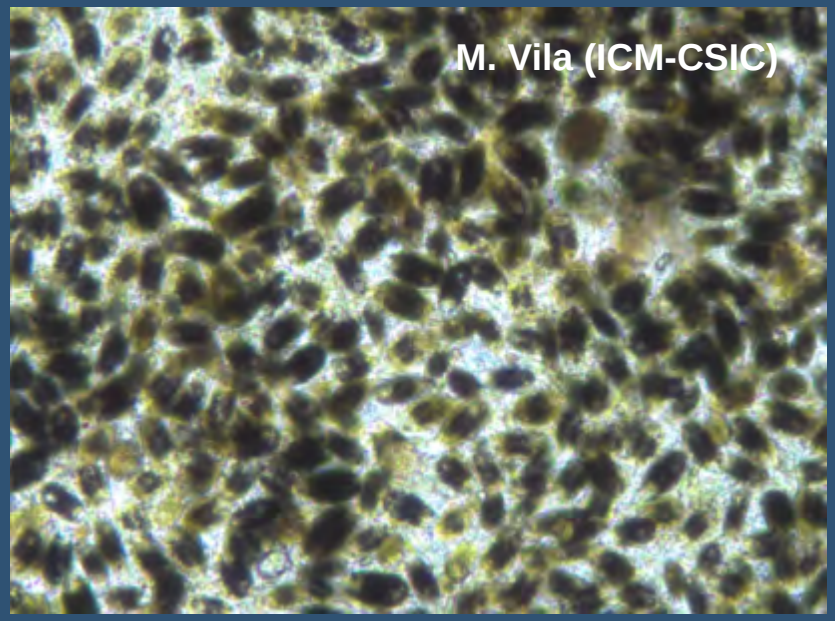
Generalitat de Catalunya
Agència de Salut Pública de Catalunya

Research part of the international program:

GEOHAB
Global Ecology and Oceanography of Harmful Algal Blooms

1) Problem overview
2) A case study: Llavaneres beach – joint epidemiology and ecology
3) Exploring future impacts





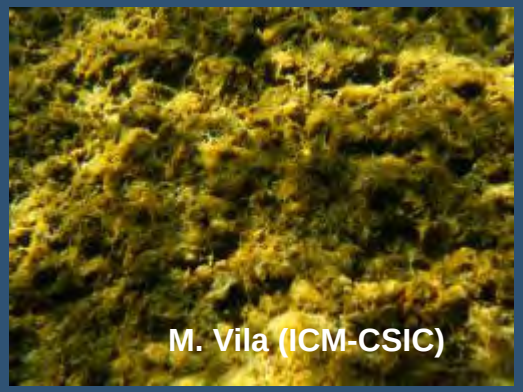
1) Problem overview

✓ *Ostreopsis* benthic HABs:

- It produces palytoxin (PLTX) and analogues (ostreocin, ovatoxin, …) (e.g. Ciminiello et al. 2008; Taniyama et al. 2003; Sansoni et al. 2003)
- In tropical tropical latitudes: associated to serious seafood intoxications clupeotoxisms (Randall 2005)
- Detection of huge concentrations and blooms in temperate latitudes (Rhodes 2011): risk of PLTX intoxication (detected in certain macrofauna, not well characterized yet; Amzil et al. 2012; Biré et al. 2013), lag of legislation on BHAB related toxins (EFSA, 2009 warning)

✓ *Ostreopsis* blooms in the Mediterranean Sea:

- associated to respiratory and cutaneous irritations (Brescianini et al. 2006; Barroso et al. 2008, etc.)
- macrofauna mortalities (Sansoni et al. 2003; Shears & Ross 2009- New Zealand)



Self-produced mucilage, dense, sticky, attachment to surfaces (macroalgae, sea urchins, rocks, sand, …).

1) The problem: in the Mediterranean, respiratory irritation symptoms in people exposed to aerosols coinciding with high cell numbers

Year	Location	Human cases	Ecosystem impacts	Ostreopsis Cells/L (max)	Reference
1998	Spain (Llavaneres)	?	Sea urchins, mussels	$200 \cdot 10^3$/L	Vila et al. 2008
1998, 2000, 2001	Italy (Tirren.)	~100	Yes		Sansoni et al. 2003
2001, 2003, 2004	Italy (S Adria.)	28	-		Gallitelli et al. 2005
2004	Spain (Llavaneres)	74 (~200)	No	$23 \cdot 10^3$/L	Vila et al. 2008; Álvarez et al. 2005
2005, 2006	Italy (Genoa)	228, 19	-		Brescianini et al. 2006; Durando et al. 2007
2006	Spain (Llav.)	37	No	? – $2 \cdot 10^3$/L (2 days after)	Álvarez 2006
2006-2009	France	47	-	>$30 \cdot 10^3$/L	Tichadou et al. 2010
2008	Spain (Murcia)	57	-	$1{,}2 \cdot 10^3$/L	Barroso et al. 2008
2009	Algeria	150-200	Yes	$80 \cdot 10^3$/L	Illoul et al. 2012
2013	Spain (Llav.)	13	No	$50 \cdot 10^3$/L	Abós-Herràndiz et al. 2014
2014	Spain (Llav.)	7	No	$2000 \cdot 10^3$/L	Berdalet, Vila, Abós-Herràndiz

1) The problem: Presence of *Ostreopsis in the Mediterranean and noxious events*

Impacts on human health: through skin contact and inhalation of toxic aerosols

= toxic blooms (aerosol)
= blooms
= presence

www.bentoxnet.it +Ciminiello et al. 2014

1) The problem: Harmful Events in the Mediterranean (example)

ALGERIA. Illoul et al. 2012.

* Toxic episodes in July 2009 in certain beaches
* Monitoring started after the toxic events: July 2009 - Feb 2011
* Health impacts (150-250 cases) during 24h – 48h coinciding with high cell densities in the water only in certain cases.

The genus *Ostreopsis* in Algerian coastal waters related to a toxic event 213

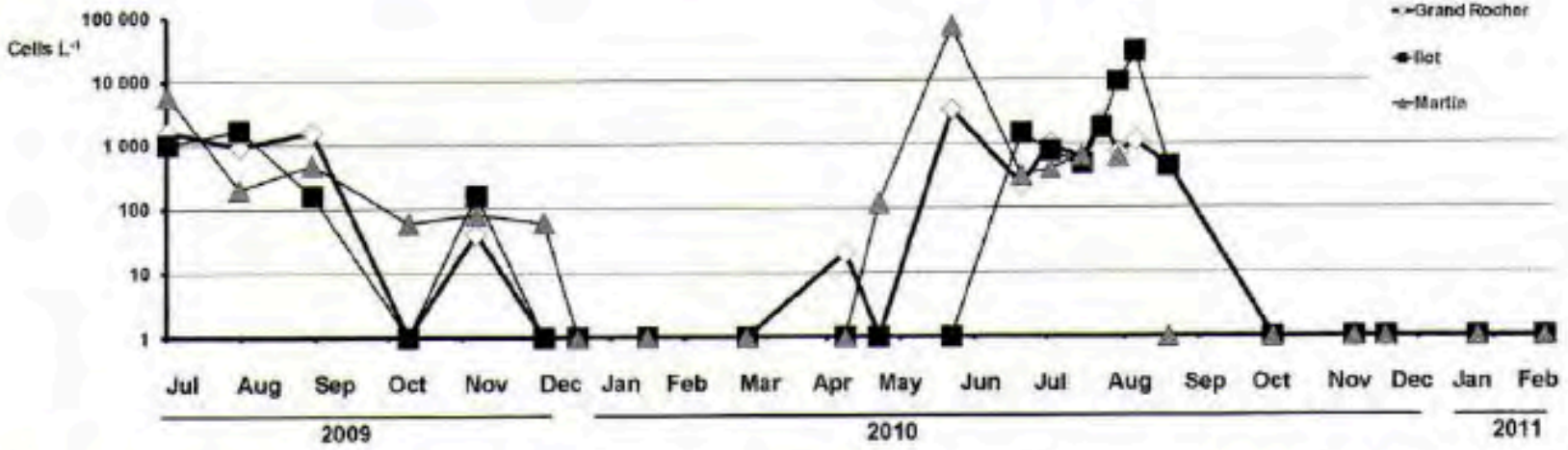


Fig. 2. Distribution of *Ostreopsis* spp from July 2009 to February 2011 in Grand Rocher, Ilot and Martin beaches.

2) A case study: Llavaneres beach – joint epidemiology and ecology

The paradox:

in the Mediterranean,

while the *Ostreopsis* blooms persisted for more than two months,

health symptoms lasted only for a short time.

Is there a ***direct link*** between the *Ostreopsis* blooms and the respiratory and cutaneous disorders?

Difficulties:

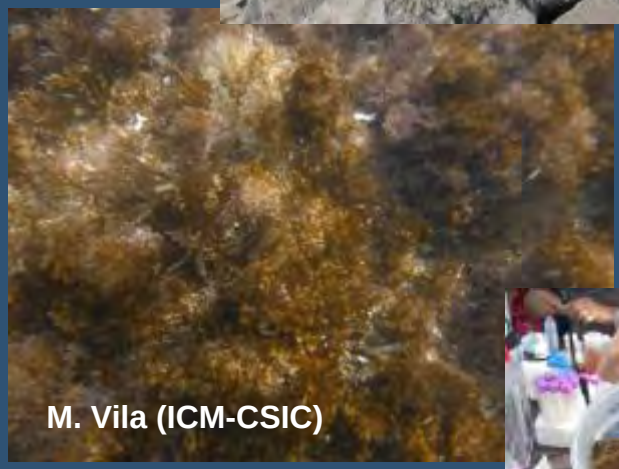
- Not specific symptoms: eye irritation, fever, sore throat, cough, dyspnoea, headache, nausea, rhinorrhea, lacrimation, vomiting, dermatitis. Mild leukocytosis, neutrophilia (Tubaro et al. 2011).
- Misdiagnosis, under-reporting

2) A case study: Llavaneres beach – an *Ostreopsis* hot spot in the NW Mediterranean
Joint epidemiology and ecology study (2013-2014) - Methods

EPIDEMIOLOGY SURVEY:

- Human cohort: 16 workers of the restaurant
- Location: 10 m in front of the hot spot
- Humans exposed for ≥ 8hours/day
- Already experienced the symptoms in previous outbreaks (Àlvarez et al. 2005; 2006)
- Questionnaire completed individually and daily (similar to Tubaro et al. 2011)


M. Vila (ICM-CSIC)

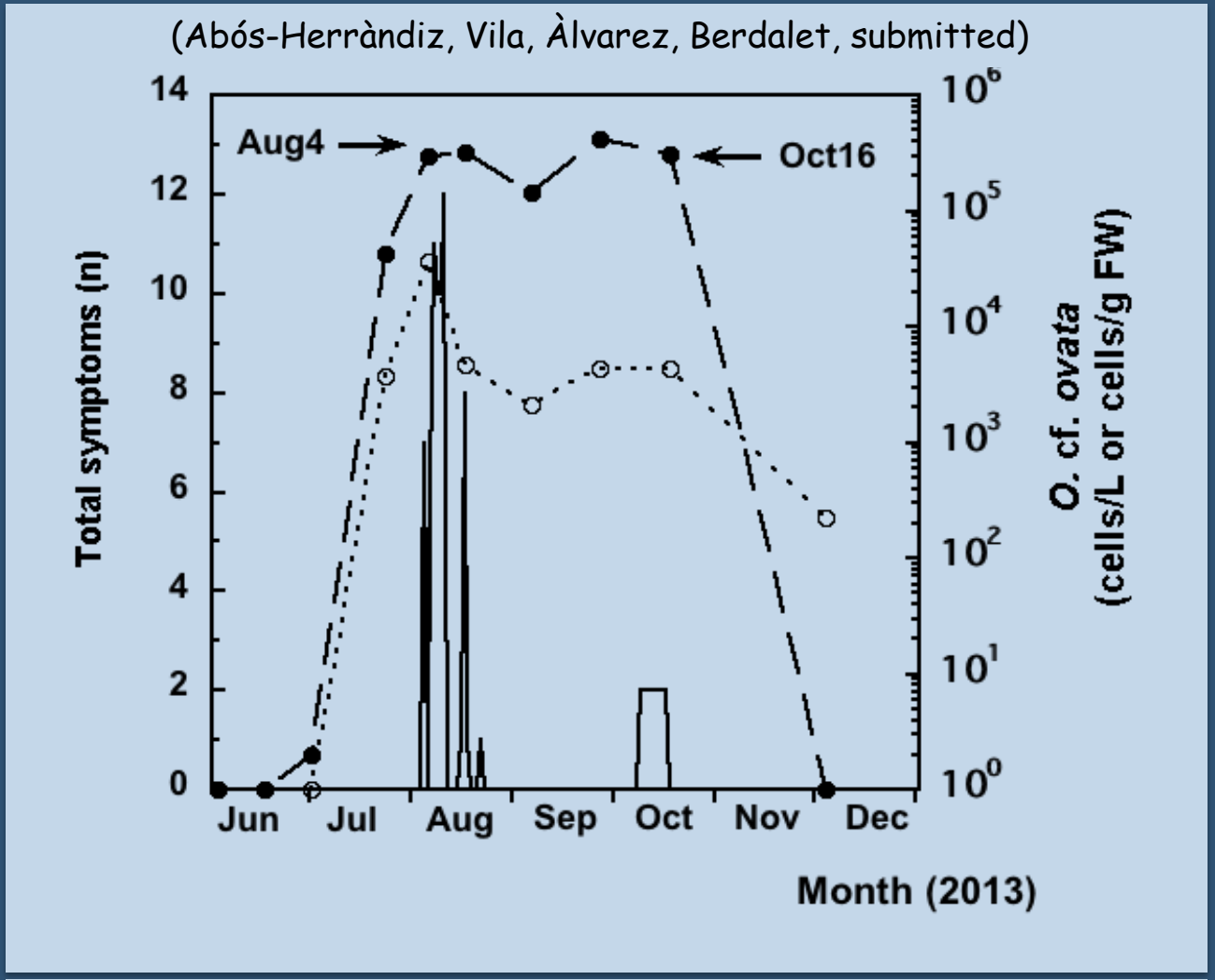

M. Vila (ICM-CSIC)

ECOLOGY STUDY:

- T, S, meteorology
- Nutrients (Inorganic and Organic)
- Plankton & epiphytic characterization:
  Chl *a*, taxonomy (phyto assemblages, bacteria)
- Toxins


M. Vila (ICM-CSIC)

2) A case study – Results:
Irritative symptoms occur only during a small time window



Ostreopsis **bloom followed the typical pattern described in the area (Mangialajo et al. 2012)**

2) A case study – Open questions – A combination of processes and hypotheses

<u>Hypothesis 1</u>: environmental – weather conditions?

On going, joint study with meteorologists

<u>Hypothesis 2</u>: The irritative compounds are <u>released during certain physiological conditions of the bloom</u> (at the end of the exponential early stationary phase?)

- Toxin analyses on going (2014)
- Experiments with the natural assemblages along the bloom (2015)

<u>Hypothesis 3</u>: "immuno-adaptation"?

On going (since 2014) studies:

- New human cohorts - variation in aerosol exposure in collaboration with Llavaneres City Hall and Catalan Public - Health authorities, "Red Cross" beach watchers, pharmacies, primary health care centres
- Outreach activities with end users

E. Berdalet (ICM-CSIC)

OstreoRisk (2015-2017)*:* Multidisciplinary study

Impacts on human health - Epidemiology

- **Respiratory problems**
- **Potential Seafood intoxication**

Impacts on the environment - Ecology

Macrofauna mortalities or sensitivity

Communication with the society

Science
ICM (CSIC)
Univ. Barcelona

Health & Environmental authorities

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CSIC
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1) Problem overview
2) A case study: Llavaneres beach – joint epidemiology and ecology

3) Exploring future impacts

- ✓ Human health risk assessment, concerning seafood intoxication, respiratory and cutaneous irritations.
- ✓ Multidisciplinary and coordination structures to elaborate prevention and mitigation plans.
- ✓ Increase the understanding of *Ostreopsis* ecophysiology and toxicity.
- ✓ Ascertain risks for the environment (e.g. macrofauna mortality, food webs alteration).
- ✓ Improve monitoring methodological limitations (early warning systems).
- ✓ To ascertain the present distribution of the genus worldwide.

3) Exploring future impacts:

- ✓ **Human health risk assessment, concerning seafood intoxication, respiratory and cutaneous irritations.**

- ✓ **Multidisciplinary and coordination structures to elaborate prevention and mitigation plans.**

Other multidisciplinary studies on *Ostreopsis* in the Mediterranean:
- EBITOX project (Vila, Franco, Riobó; 2009-2011)
- MediOs – France (Lemée et al. 2008-2010)
- RAMOGE (on going) Monaco, France, Italy, Spain

Cryptogamie,Algologie,2012,33(2):137-142

Interactions between scientist, managers and policy makers in the framework of the French MediOs project *on Ostreopsis* (2008-2010)

RodolpheLEMÉE[a,b],LuisaMANGIALAJO[c],StéphanieCOHU[a,b,c],ZouherAMZIL[d],AurélieBLANFUNE[a,b,c],NicolasCHOMERAT[d],NicolasGANZIN[d],StéphaneGASPARINI[a,b],HubertGROSSEL[d],LaurenceGUIDI-GUIVARD[a,b],LaurentHOAREAU[e],FranckleDUFF[f],SophieMARRO[a,b],NathalieSIMON[g],ElisabethNEZAN[d],Maria-LuizaPEDROTTI[a,b],VéroniqueSECHET[d],OdileSOLIVERES[e],ThierryTHIBAUT[c]*

3) Exploring future impacts:

3) Exploring future impacts:

- ✓ **Multidisciplinary and coordination structures to elaborate prevention and mitigation plans.**

http://www.ramoge.org/fr/ostreopsis_ovata.aspx

ramoge monaco

Escola de música CASP | wifiparaudepas | C.T. INFANTI... Basquetbol | Proyectos I... Retos 2014 | Proyectos I... Retos 2014 | INFRAESTRUCTURAS | NOAA_Searc...RANTS.GOV

Accord RAMOGE

Prévention & Lutte contre la Pollution du Milieu Marin

Accueil | Accord RAMOGE | Gestion intégrée de la zone côtière | Plan RAMOGEPOL | Education et Communication | Documents RAMOGE | Partenaires & Liens | Urgence | Contact

Suivi de la problématique Ostreopsis

Ostreopsis ovata est une algue microscopique unicellulaire qui vit habituellement dans les eaux chaudes des mers tropicales. Le transport par les eaux de ballast des navires et des conditions climatiques très favorables ont permis à cette microalgue de se développer sous nos latitudes.

Ainsi, depuis quelques années, des phénomènes d'efflorescence impliquant cette algue ont été observés dans toute la partie nord-ouest de la Méditerranée et dans certains cas une toxicité sur l'homme a été observée.

Les effets toxiques se limitent habituellement à des **symptômes de type grippal** tels que fièvre, toux, nausées, rhume, conjonctivite, troubles respiratoires. **Les personnes atteintes n'ont pas forcément été en contact direct avec l'eau ; il suffit d'inhaler les gouttelettes transportées par le vent pour que les symptômes se manifestent.**

Avec le soutien de l'Accord RAMOGE, des recherches sont actuellement en cours sur les causes et effets de la toxicité de cette algue.

En 2010 une réunion regroupant des scientifiques et des autorités sanitaires des trois Etats a permis de faire le point sur **le mode de surveillance** de cette algue dans chaque Etat, sur leur **gestion de la crise liée à une efflorescence** ainsi que sur les **problèmes sanitaires induits** par cette algue et leur gestion.

En 2011, l'Accord RAMOGE a apporté son soutien à l'organisation du Congrès International sur l'algue Ostreopsis ICOD, organisé par l'Observatoire de Villefranche-sur-Mer, l'Université de Nice-Sophia Antipolis et l'Université de Gênes.

Durant la dernière décennie une grande attention a été portée sur le développement des espèces du genre *Ostreopsis* (dinoflagellés benthiques), dont certaines ont proliféré dans les mers tempérées. Ce Congrès International sur le Développement d'*Ostreopsis* a permis de dresser un bilan des connaissances sur :"

- les aspects écologique, chimique et toxicologique en relation avec les espèces du genre *Ostreopsis*
- les méthodes écologique, économique et sanitaire liées à la gestion de ce problème.

Le congrès a été une grande réussite, avec 4 conférences plénières, plus de 25 communications orales et 20 communications affichées, concernant l'écologie, la biogéographie et les impacts d'*Ostreopsis* sur les écosystèmes côtiers, la toxicité des métabolites secondaires et la gestion environnementale, sanitaire et économique du problème.

3) Exploring future impacts:

✓ **Increase the understanding of *Ostreopsis* ecophysiology and toxicity.**

- Role of nutrients (organic and inorganic)
- Role of water motion
- Rheology properties of the mucus
- Field and laboratory studies
- Strain specific responses
- Variability in growth rate, biomass yield, toxin production
- Substrate colonization specificity

3) Exploring future impacts:

✓ Increase the understanding of *Ostreopsis* ecophysiology and toxicity.

Collecting air samples to detect the presence of PLTX in the aerosol

Environmental Science & Technology

Article

pubs.acs.org/est

Quantification of the Toxic Dinoflagellate *Ostreopsis* spp. by qPCR Assay in Marine Aerosol

Silvia Casabianca,[†] Anna Casabianca,[†] Pilar Riobó,[‡] José M. Franco,[‡] Magda Vila,[§] and Antonella Penna*[,†]

[†]Department of Biomolecular Sciences, Section of Environmental Biology, University of Urbino, Pesaro, Italy
[‡]Unidad Asociada CSIC-IEO, Instituto de Investigaciones Marinas (IIM-CSIC), Vigo, Spain
[§]Institut de Ciències del Mar (ICM-CSIC), Barcelona, Spain

PLTX

PCR

SEM

3) Exploring future impacts:

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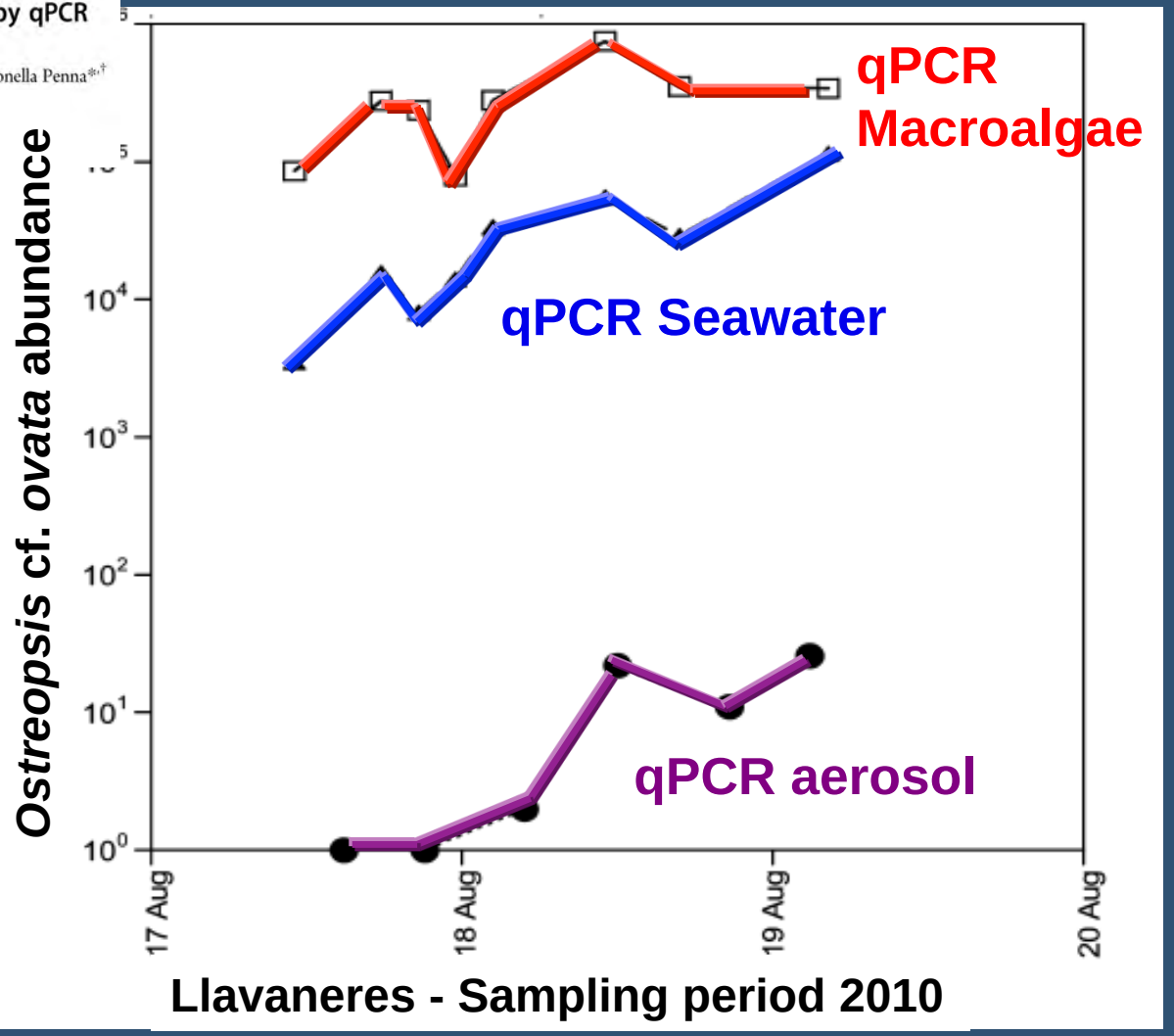

3) Exploring future impacts:

✓ **Increase the understanding of *Ostreopsis* ecophysiology and toxicity.**

ENVIRONMENTAL Science & Technology

Article

First Finding of *Ostreopsis* cf. *ovata* Toxins in Marine Aerosols

Patrizia Ciminiello,[†] Carmela Dell'Aversano,*[,†] Emma Dello Iacovo,[†] Ernesto Fattorusso,[†] Martino Forino,[†] Luciana Tartaglione,[†] Gioia Benedettini,[‡] Marzia Onorari,[‡] Fabrizio Serena,[‡] Cecilia Battocchi,[§] Silvia Casabianca,[§] and Antonella Penna[§,⊥]

[†]Dipartimento di Farmacia, Università degli Studi di Napoli Federico II, Via D. Montesano 49, 80131 Napoli, Italy
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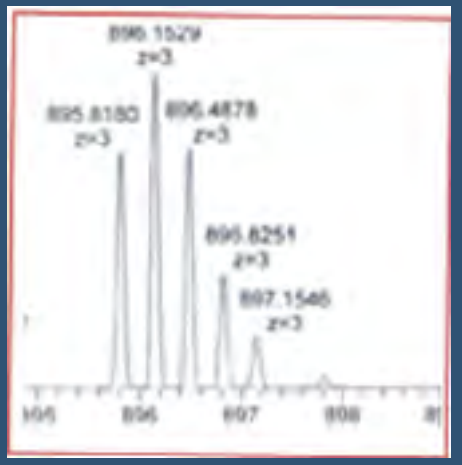


First step toward a more comprehensive understanding of the *Ostreopsis*-related respiratory syndrome:

- Small scale monitoring study of the aerosols along the Tuscan coast (Italy, 2009, 2010)
- PCR assays and LC-HRMS
- First detection of ovatoxins in the aerosol (2.4 pg of ovatoxins per liter of air)
- However, lack of toxicological data on palytoxins by inhalation exposure.

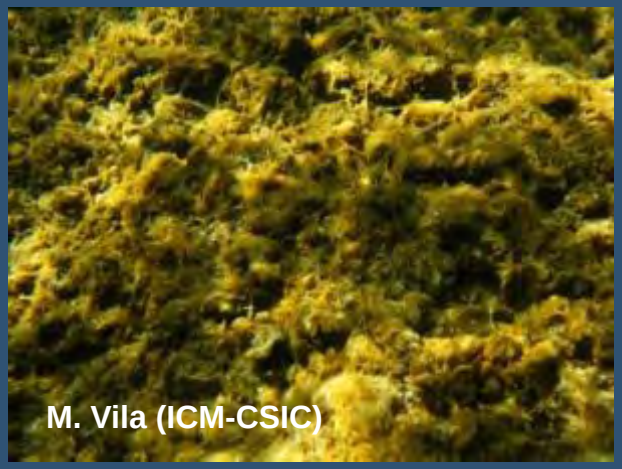
3) Exploring future impacts:

✓ **Ascertain risks for the environment (e.g. macrofauna mortality, food webs alteration).**

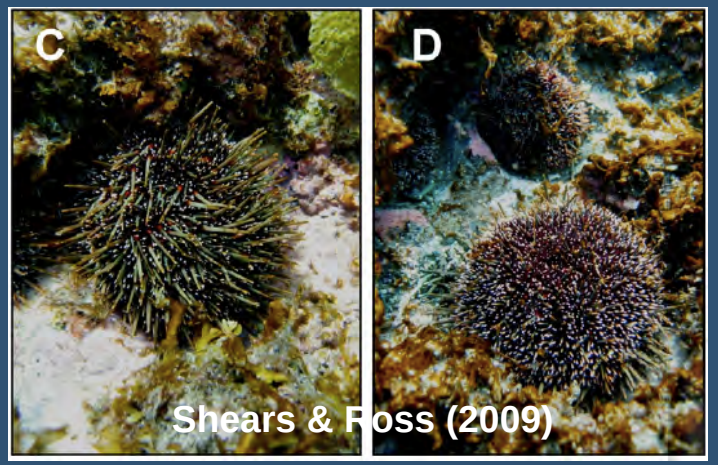
Llavaneres: Natural microalgae community (light microscopy)

BEFORE the BLOOM

BLOOM



Sea urchins (*Evechinus chlorotychus*):
(C) spines folded over
(D) loss of guard spines
Shears & Ross (2009). New Zealand.
***O. siamensis* bloom 2005**



3) Exploring future impacts:

✓ **Improve monitoring methodological limitations (early warning systems).**

- Monitoring of the concentration of *Ostreopsis* in the macroalgae is the most reliable "early warning system" for *Ostreopsis*
- This is a substantial difference with the plankton blooms, that require e.g. qPCR and biosensor tools.
- The O*streopsis* blooms cause problems at high-biomass levels.
- The concentration covering the macroalgae has less variability than the concentration on the water column.
- Then, water motion and aerosolization distribute the irritative agents that affect people.
- The problem is when *Ostreopsis* colonizes sands and rocks: artificial beaches and harbors constitute a serious problems in Italy and it is likely going to cause problems in the Catalan coast.

3) Exploring future impacts:

✓ **To ascertain the present distribution of the genus worldwide.**

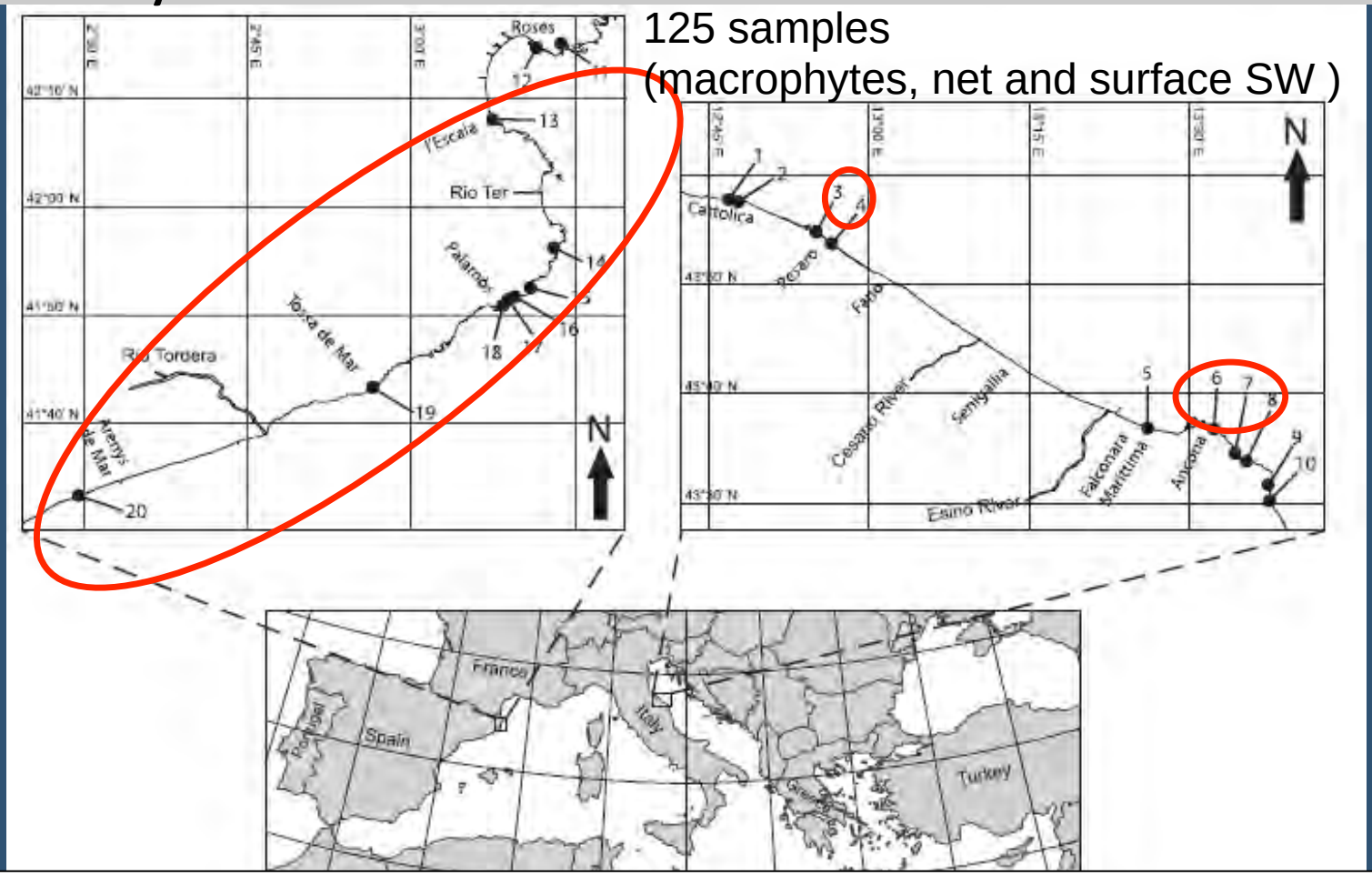
To ascertain the potential impact of climate change we need to establish a solid base-line on the present distribution of blooms and their impact

RAMOGE is a platform in the Mediterranean Sea.

We should strength and enlarge international coordination.

3) Exploring future impacts:

- ✓ **To ascertain the present distribution of the genus worldwide. Implications for toxicity**



PCR-based assay in macrophyte and seawater samples detected:

72% of *O.* cf. *ovata*

20 % of *O.* cf. *siamensis* --- 10 st. along the CC, but only 3 st. in the Adriatic

Battocchi et al 2010, Mar Poll. Bull. 60: 1074–1084

In this Symposium, together we can design new strategies to ascertain …

the "Expansion of the benthic dinoflagellate *Ostreopsis* with climate change"

and to design "health risks assessment and policy strategies for management"

Thanks for your attention!!!