

ICHA
BRAZIL 2016

MARINE AND FRESH-WATER HARMFUL ALGAE

PROCEEDINGS OF THE 17TH
INTERNATIONAL CONFERENCE ON HARMFUL ALGAE

9-14 October 2016 | Florianópolis, Brazil

Edited by: Luis A. O. Proença and Gustaaf M. Hallegraeff

International Society for the Study of Harmful Algae

Published in cooperation with

Intergovernmental Oceanographic Commission of UNESCO

DISCLAIMER

Authors are responsible for the choice and the presentation of the facts contained in signed articles and for the opinions expressed therein, which are not necessarily those of ISSHA or UNESCO and do not commit the organizations.

The designations employed and the presentation of material throughout this publication do not imply the expression of any opinion whatsoever on the part of ISSHA or UNESCO concerning the legal status of any country, territory, city or area or of its authorities or concerning the delimitation of its frontiers or boundaries.

For Bibliographic purposes, this document should be cited as follows:

Proença, L. A. O. and Hallegraef, G. (eds). Marine and Fresh-Water Harmful Algae. Proceedings of the 17th International Conference on Harmful Algae. International Society for the Study of Harmful Algae 2017

ISBN 978-87-990827-6-6



TABLE OF CONTENTS

HABs AND CLIMATE CHANGE

Are HABs and their societal impacts expanding and intensifying? A call for answers from the HAB scientific community Adriana Zingone, Henrik Enevoldsen and Gustaaf M. Hallegraef.....	14
Climate shift triggers shellfish harvesting bans in Uruguay (south west Atlantic Ocean) Amelia Fabre, Leonardo Ortega, Silvia Méndez and Ana Martínez	18
Extreme abundant bloom of <i>Dinophysis ovum</i> associated to positive SST anomalies in Uruguay Silvia M. Méndez, Ana Martinez and Amelia Fabre	22
Characterization of <i>Dinophysis ovum</i> as the causative agent of the exceptional DSP event in Uruguay during 2015 Silvia M. Méndez, Francisco Rodriguez, Beatriz Reguera, José M. Franco, Pilar Riobo and Amelia Fabre	26
Watch out for ASP in the Chilean Subantarctic region Gemita Pizarro, Máximo Frangópulos, Bernd Krock, Claudia Zamora, Hernán Pacheco, César Alarcón, Carolina Toro, Marco Pinto, Rodrigo Torres and Leonardo Guzmán.....	30
Climatic anomalies and harmful flagellate blooms in Southern Chile Alejandro Clément, Francisca Muñoz, Carmen G. Brito, Nicole Correa, Marcela Saldivia, César Fernández, Felipe Pérez, Carmen P. Maluje, Gustavo Contreras and Osvaldo Egenau.....	34
Unprecedented <i>Alexandrium</i> blooms in a previously low biotoxin risk area of Tasmania, Australia Gustaaf Hallegraeff, Christopher Bolch, Scott Condie, Juan José Dorantes-Aranda, Shauna Murray, Rae Quinlan, Rendy Ruvindy, Alison Turnbull, Sarah Ugalde, and Kate Wilson.....	38
The extraordinary 2016 autumn DSP outbreak in Santa Catarina, Southern Brazil explained by large-scale oceanographic processes Luis A. O. Proença, Mathias A. Schramm, Thiago P. Alves and Alberto R. Piola	42

HAB ECOLOGY

- Origins of *Dinophysis* blooms which impact Irish aquaculture
Robin Raine, Sarah Cosgrove, Sheena Fennell, Clynton Gregory, Michelle Barnett,
Duncan Purdie, and Rachel Cave.....46
- Fine scale physical biological interactions in a *Dinophysis acuminata*
population during an upwelling-relaxation transition
Patricio A. Díaz, Manuel Ruiz-Villarreal, Francisco Rodríguez, José Luis Garrido,
Beatriz Mourino-Carballido, Pilar Riobó and Beatriz Reguera.....50
- Effect of different taxonomic groups on the growth and toxin
content in *Gymnodinium catenatum* cultures from the Pacific
coast of México
Christine J. Band-Schmidt, Leyberth J. Fernández-Herrera, Dulce V. Ramírez-Rodríguez,
Miriam G. Zumaya-Higuera, Francisco E. Hernández-Sandoval, Erick J. Núñez-Vázquez,
José J. Bustillos-Guzmán, David J. López-Cortés and Leyva-Valencia, I.54
- Distribution and abundance of cyst and vegetative cells of harmful
dinoflagellates in Quellón Bay, Southeast of Chiloé Island
Leonardo Guzmán, Pablo Salgado, Gissela Labra and Ximena Vivanco.....58
- Changes in phytoplankton species composition during
various algal blooms in bays of Manzanillo and Santiago Colima,
Mexico (April May 2015)
D.U. Hernández-Becerril and H. Villagrán-Lorenzana62
- Relationship between viable cell transport of the diatom
Didymosphenia geminata and other invasive species in Tierra
del Fuego Island, Chile
Marco Pinto, Máximo Frangópulos, Sebastián Ruiz and Carla Mora.....66
- Using a matrix of scales to understand the effects of toxicity
components produced by harmful algae
Ian R. Jenkinson.....70
- Imaging FlowCytobot provides novel insights on phytoplankton
community dynamics
Lisa Campbell, Darren W. Henrichs, Emily E. Peacock, Joe Futrelle and Heidi M. Sosik.....74

BENTHIC HABS

- First report of the epiphytic genera *Gambierdiscus* and *Ostreopsis* in the coast of El Salvador Eastern Tropical Pacific
Cesiah Rebeca Quintanilla and Oscar Amaya80
- Systematics and diversity of genus *Ostreopsis* in the East Australian Current region
Arjun Verma, Gurjeet S. Kohli, Mona Hoppenrath, D. Tim Harwood,
Unnikrishnan Kuzhiumparambil, Peter J. Ralph and Shauna A. Murray.....84
- Notes on morphology, phylogeny and toxicity of a dominant community of toxic benthic dinoflagellates from southern central coast of Cuba
Angel Ramón Moreira González, Luciano Felicio Fernandes, Rosely Peraza Escarrá,
Lisbet Díaz Asencio, Francisco Rodríguez, Pilar Riobó, Mark W. Vandersea,
Richard Wayne Litaker, Carlos Manuel Alonso Hernández and Luiz Laurenno Mafra Jr.88
- Ecophysiological responses of the toxic species *Ostreopsis* cf. *ovata* under different water motion conditions. Preliminary results.
Magda Vila, Valentina Giussani, Laia Viure, Élide Alechaga, Encarnación Moyano,
Soraya Hernández-Llamas and Elisa Berdalet.....92
- Influence of environmental factors on the bloom dynamics of the benthic dinoflagellate *Ostreopsis* cf. *ovata* in the Mediterranean Sea
Stefano Accoroni, Salvatore Pichierri, Tiziana Romagnoli, Emanuela Razza,
Neil Ellwood and Cecilia Totti.....96

CYANOBACTERIA

- Distribution of cyanobacteria blooms in the Baltic Sea
Bengt Karlson, Kari Eilola, Johannes Johansson, Johanna Linders, Malin Mohlin,
Anna Willstrand Wranne and Irene Wåhlström100

Occurrence of nodularin in a cyanobacterial bloom in a shrimp farm in South Brazil Luiza Dy F. Costa , Lucas A. Pacheco , Nathália Kunrath, Carolina M. Costa, Geraldo K. Foes, Wilson Wasielesky Jr. and João S. Yunes.....	104
--	-----

Monitoring of cyanobacterial populations and the detection of cyanotoxin genes in Billings Reservoir (Diadema/São Paulo - Brazil) Matheus Santos Freitas Ribeiro, Fellipe Henrique Martins Moutinho, Werner S. Hanisch, Cristina Viana Niero and Cristina Souza Freire Nordi.....	108
---	-----

TOXICOLOGY

Chemical and analytical sciences in a whirlwind of global change Philipp Hess.....	112
---	-----

Biotransformation and chemical degradation of paralytic shellfish toxins in mussels Michael A. Quilliam, Aifeng Li, Nancy Lewis, Pearse McCarron, Krista Thomas and John A. Walter.....	118
--	-----

Benzoyl analogs of the dinoflagellate <i>Gymnodinium catenatum</i> from the Gulf of California and the Pacific coast of Mexico as characterized by LC-MS/MS and NMR Lorena M. Durán-Riveroll, Bernd Krock, Allan Cembella, Javier Peralta-Cruz, José J. Bustillos-Guzmán and Christine J. Band-Schmidt	122
--	-----

Physico-chemical and functional characterization of Portimine purified from <i>Vulcanodinium rugosum</i> strain IFR-VRU-01 Claire Lamoise, Amandine Gaudin, Philipp Hess, Véronique Séchet, Robert Thai, Denis Servent, Sophie Zinn-Justin and Rómulo Aráoz	126
---	-----

Five years of application of the receptor binding assay (RBA) on seafood products and threatened species during outbreaks HABs in El Salvador Oscar Amaya, Marie-Yasmine Dechraoui Bottein, Tod Leighfield and Gerardo Ruíz	130
--	-----

Paralytic Shellfish Poisoning and Pet Dogs in Southern Chile Leonardo Guzmán, Cristina Hernández, Gemita Pizarro, Claudia Zamora and Sandra Silva.....	134
---	-----

GENOMICS

- Phylogenetic Analysis of Acetyl CoA Carboxylases in Dinoflagellates
Saddef Haq, Allen R. Place and Tsvetan R. Bachvaroff.....138
- Detection of a gene encoding for saxitoxin biosynthesis (sxtU)
in non-toxic *Alexandrium fraterculus*
Ana Martínez, Gabriela Martínez de la Escalera and Claudia Piccini.....142
- Assessment of DNA extraction efficiency and quantification
based on *Alexandrium* sp. cultures
Gemma Giménez Papiol and Marta Schuhmacher146

HAB MITIGATION

- Review of Progress in our Understanding of Fish-Killing Microalgae:
Implications for Management and Mitigation
Gustaaf Hallegraeff, Juan José Dorantes-Aranda, Jorge Mardones and Andreas Seger.....150
- Mitigating fish-killing algal blooms with PAC modified clays:
efficacy for cell flocculation and ichthyotoxin adsorption
Andreas Seger and Gustaaf Hallegraeff.....156
- Environment-friendly strategies for prevention of harmful
algal blooms using algicidal bacteria associated with seagrass beds
Ichiro Imai, Nobuharu Inaba and Tomoko Sakami.....160

Ecophysiological responses of the toxic dinoflagellate *Ostreopsis cf. ovata* under different water motion conditions

Magda Vila^{1*}, Valentina Giussani^{2,4}, Laia Viure¹, Élide Alechaga³, Encarnación Moyano³, Soraya Hernández-Llamas¹ and Elisa Berdalet¹

¹Institut de Ciències del Mar (ICM-CSIC), Barcelona, Spain; *magda@icm.csic.es, ²Dipartimento di Scienze della Terra dell'Ambiente e della Vita (DISTAV) University of Genoa, Italy,

³Department of Chemical Engineering and Analytical Chemistry, University of Barcelona, Barcelona, Spain,

⁴Regional Agency for the Protection of the Environment (ARPAL), La Spezia, Italy,

Abstract

Hydrodynamic conditions affect marine microalgae. In the case of some harmful epiphytic species, field observations suggest that water motion and wave action play a selective role in determining their spatial distribution and ecology and regulating cell physiology. In order to obtain new insights on this topic, laboratory experiments were performed with Mediterranean strains of *Ostreopsis cf. ovata*. Monospecific cultures were exposed during 3 weeks to the turbulent motion generated by an orbital shaker at 50 rpm in order to simulate the wave movements in their natural habitat. The growth curve and toxin concentrations in the shaken cultures were compared to those maintained under still, control conditions. Shaken *O. cf. ovata* populations entered stationary phase earlier, reached lower cell yield and had 30% lower ovatoxin-a intracellular content compared to control ones. In the two treatments, the cell toxin content in the exponential phase was lower than in the stationary phase. These results contribute to understand the dynamics of benthic HABs and their impacts to the ecosystem and human health.

Keywords: *Ostreopsis*, BHAB, Mediterranean, toxicity, small-scale turbulence

Introduction

Since the late 1990s, the toxic benthic dinoflagellate *Ostreopsis* has caused recurrent blooms in temperate areas, including the Mediterranean coasts. Some of these bloom have been associated with human respiratory disorders (Fig. 1 in Ciminiello *et al.* 2014 and references therein). Interestingly, these adverse effects only occurred during certain phases of the bloom (Vila *et al.* 2016). Some of the blooms have also been associated with massive macrofauna mortalities (e.g. Shears and Ross 2009). These negative impacts on the marine habitat and human health have motivated research on *Ostreopsis* bloom dynamics. Field observations suggest that water motion and wave action, among other environmental factors, could play a selective role on the spatial distribution and ecology of this harmful epiphytic species although no clear relationship has been defined so far. For instance in the Mediterranean, *O. cf. ovata* was reported from shaken and slightly shaken habitats by Vila *et al.* (2001) while it was found in sheltered areas by Accoroni *et al.* (2012). These apparent

contradictory observations arise in part from the lack of quantification of water turbulence in the field, and from the difficulty to discriminate the specific role of this factor from its interaction with other drivers (e.g. depth, light intensity, macroalgal substrates). However, small-scale turbulence has been described to exert negative species-specific effects in some planktonic dinoflagellates (e.g. Berdalet *et al.*, 2011 and references there in). In this study, we present the preliminary results of our investigation of physiological responses of an *Ostreopsis cf. ovata* strain exposed to still and turbulent conditions.

Material and Methods

Ostreopsis cf. ovata strain "Ostreo BCN1_2014" was isolated from Llavanes beach, a hot spot where the species bloomed annually since, at least, 2004 but probably since 1998. Aliquots of an exponential monospecific culture grown in f/2 medium were used as inoculum for the 12 experimental (250 ml sterile plastic flasks) cultures with 200 cells·ml⁻¹ as initial concentration. The 12 flasks were incubated at

23°C under a 12-12 hours light-dark cycle, and an irradiance of $150 \mu\text{mol photon}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$. After 24h, the initial cell concentration in each flask was determined on 1-ml Sedgewick Rafter chamber (in duplicate). Six experimental flasks, so called "Control", were maintained under still conditions. The other six flasks, referred to as "Turbulence" were continuously agitated on an orbital shaker at 50 rpm with a $0 - 10^\circ$ angle inclination variability range in order to simulate the wave movement in their natural habitat. Shaking started on day 1, i.e. 24 hours following inoculation. The experiment lasted for three weeks.

Population growth was characterized by sampling each flask every 2 days. Cell counts on Lugol fixed samples were performed in duplicate as described above. Growth rate was calculated following Guillard (1973) where the growth rate is the slope of the Ln of the cell counts over time during the exponential phase.

At the beginning of the stationary phase (day 11), when the differences between the growth curves in Control and Turbulence treatments were evident, cell size analyses were conducted on around 100 randomly chosen cells from each treatment. Four cell measures were done: dorsoventral diameter including the theca (DVt), dorso-ventral diameter of the inner cytoplasm (DVc), trans-diameter including the theca (Wt) and trans-diameter of the inner cell (Wc). Cell size parameters at each treatment were compared by one-way analyses of variance (one-way ANOVA; STATISTICA). The shape of each measured cell was noted and several microphotographs were also taken using Leica-Leitz DMIRB inverted microscope (Leica Microsystems, Wetzlar, Germany) and ProgRes CapturePro image analysis software (JENOPTIK Laser, Optik Systeme).

Samples for toxin determination were collected twice, during the exponential phase (day 7) and at the end of the experiment (day 23). Each sampling day, the total remaining content of three Control and Turbulence flasks (from 100 to 230 ml depending on the day) were filtered through GF/F fiber filter (Whatman) and kept frozen at -80°C until analysis. Thus, after day 7, the number of flask replicates of each treatment was reduced from 6 to 3. Filters were extracted with 100% methanol and palytoxin and ovatoxins were determined by UHPLC-HRMS using a Hypersil Gold C18 column (100 x 2.1 mm, $1.9 \mu\text{m}$, Thermofisher Scientific) and a mobile phase gradient elution of acetonitrile : water (0.1%

formic acid) for the chromatographic separation and coupled to a Q-Exactive quadrupole-Orbitrap mass spectrometer (Thermofisher Scientific) with electrospray as ionization source in positive ion mode.

In summary, two treatments were done, six 250-ml plastic culture flasks containing *O. cf. ovata* were maintained under still conditions, used as Control and six 250-ml culture flasks were permanently shaken after day 1 (Turbulence). Parameters measured were cell number, cell size and shape, toxin content and growth rate. The effect of turbulence on these parameters is discussed.

Results and Discussion

Ostreopsis cf. ovata showed the typical sigmoid growth curve and grew similarly under Control (still) and Turbulence (shaken) conditions (Fig. 1). However, the final cell numbers reached in the Controls ($5300 \text{ cells}\cdot\text{ml}^{-1}$) almost doubled the final yield reached by the Turbulence experiments ($3000 \text{ cells}\cdot\text{ml}^{-1}$). Furthermore, whereas *O. cf. ovata* growth rate was similar in both treatments (0.32 d^{-1} and 0.39 d^{-1} in Control and Turbulence, respectively), the exponential phase lasted for 11 days in the still flasks and only 5 days in the shaken ones. This result suggests some kind of disturbance on their reproduction or life history processes as has been observed previously in dinoflagellates (e.g. Berdalet *et al.* (2011) and references there in). In the natural environment, indeed, notably high *Ostreopsis* cell concentrations have been recorded during long lasting calm sea conditions (e.g. Giussani 2016, Accoroni & Totti 2016 and references there in).

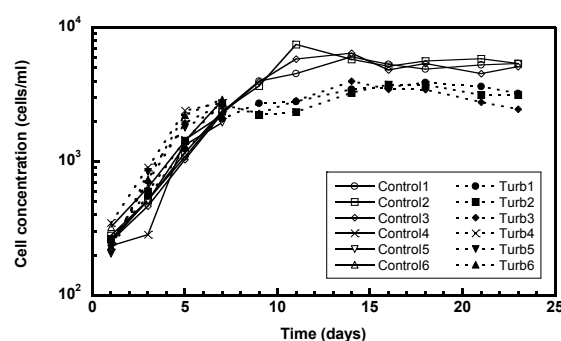


Fig. 1. Growth curves of *O. cf. ovata* in the Control (still) and Turbulence (shaken) treatments. Note that, for each treatment, there were 6 replicates until day 7, and 3 replicates until the end of the experiment. Each data point

corresponds to the average of two replicate cell counts per flask.

The mean cell size measured in the Turbulence treatment (see Table 1) was statistically significantly larger than cells measured in the Control ($p < 0.01$) considering the four measured parameters.

Table 1. Cell sizes of Control and Turbulence treatments considering all the cells together (without taking account morphotypes).

	Control				Turbulence			
	n	Mean	Min-Max	SD	n	Mean	Min-Max	SD
DVt	97	32,7	22,1-51,0	5,3	101	34,0	20,2-49,9	5,0
DVc	101	26,4	14,7-45,1	5,5	103	28,2	17,6-41,7	4,4
Wt	97	24,4	16,0-43,0	6,1	101	24,9	13,6-41,8	4,5
Wc	101	20,4	11,8-39,1	6,0	103	20,9	10,7-37,5	4,3

Such increase in cell size under turbulence conditions has been described in other experiments and is related to interference of turbulence with cell division. However, as has already been reported by several authors, cultures of *Ostreopsis* show a large variability in shape and size (e.g. Accoroni *et al.* 2014). Bravo *et al.* (2012) classified cultured cells into three size-categories (25–35 μm , 35–50 μm and >50 μm in DV diameter). In this experiment, five morphotypes were identified at the beginning of the stationary phase based on their shape (drop-shaped to round-shaped cells), content (clear or dark cytoplasm), life history stage (vegetative or pellicle cysts), and cell size range (from 20 to 51 μm). The five morphotypes were designated as DropClear (DC), Dark (D), Round (R), Without theca (WT) and others (O). The three dominant morphotypes are illustrated Fig 2.

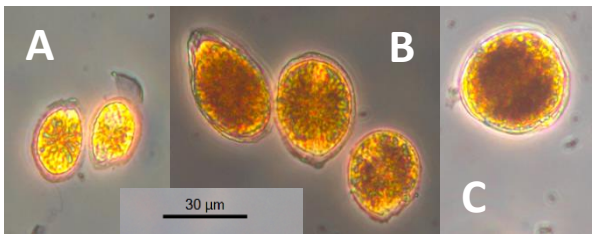


Fig. 2. Microphotographs of the three dominant morphotypes at the beginning of the stationary phase (day 11). A) Drop-shaped clear cells ("DC"), B) Dark cells ("D") and C) Round cells ("R").

DC comprised small cells (Table 2) that clearly dominated both treatments (61% in Control and 63% in Turbulence), followed by large dark cells (D) (16% in Control vs. 22% in Turbulence conditions); and finally, by rounded cells (R) (13% vs. 11%). The two last categories (WT and O) represented less than 10% of cell counts.

Table 2. Mean cell sizes (DVt, Wt) of the three dominant morphotypes in Control and Turbulence treatments. Standard deviation is indicated.

		Control	Turbulence
DropClear (DC)	DVt	31,0 \pm 2,8	33,6 \pm 3,7
	Wt	21,6 \pm 3,2	23,0 \pm 3,3
	n	62	65
Dark (D)	DVt	41,5 \pm 5,7	38,2 \pm 5,0
	Wt	34,4 \pm 5,9	30,2 \pm 4,0
	n	16	23
Round (R)	DVt	30,9 \pm 4,3	27,3 \pm 3,5
	Wt	26,8 \pm 3,9	23,8 \pm 2,6
	n	13	11

In this study we observed that whereas the most abundant DC cells were larger in the Turbulence treatments than in the Control ones (for the 4 parameters measured), D and R cells were larger in the Control than in the Turbulence flasks (Fig. 3). More studies are required to understand the specific role that each *Ostreopsis* morphotype plays in the life history of this organism.

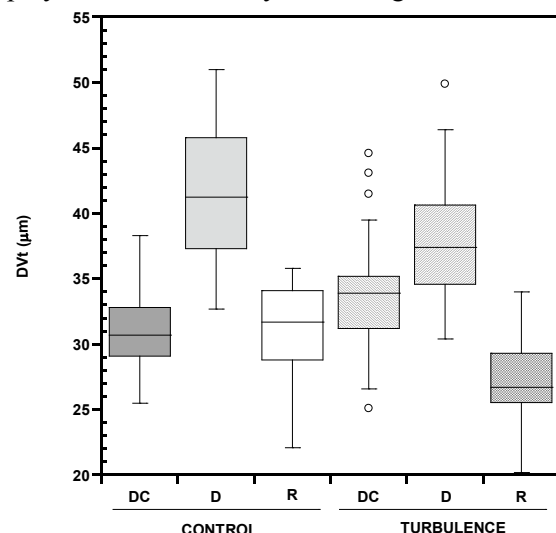


Fig. 3. Median (horizont line), 25 and 75 quartiles (box), minimum and maximum (whiskers) and outlier (point) of the dorsoventral diameter including the theca (DVt) measured for

the three dominant morphotypes (see Fig. 2) in Control and Turbulence treatments.

Regarding toxins, OVTXa was the dominant one with small amounts of palytoxin analogues such as OVTXb-g and putative palytoxin (not shown). *O. cf. ovata* toxin production was four times higher in the stationary phase than in the exponential one (Fig. 4); shaken cells had 30% lower toxin content (23 pg OVTXa·cell⁻¹) than the still cultures (32 pg OVTXa·cell⁻¹). In addition, intracellular toxin concentration was also lower in the Turbulence than in the Control flasks. Such trends have also been observed in *Alexandrium minutum* and *A. catenella* (Bolli *et al.* 2007) exposed to laboratory generated turbulence. These results reinforce the possible link of toxin production with reproduction processes.

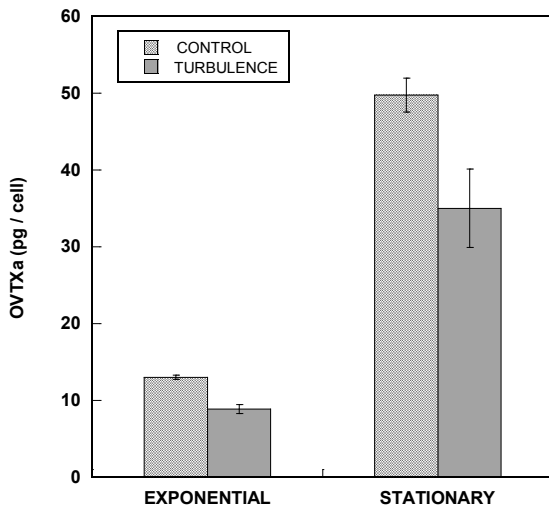


Fig. 4. Toxin content as OVTXa in Control and Turbulence conditions during the exponential and the stationary phase.

Respiratory outbreaks caused by suspected toxic aerosols seem to occur under low wind episodes (below 4 m·s⁻¹, Vila *et al.* 2016). In this study, the unshaken control treatments resulted in higher cell densities than the corresponding turbulence treatment. Control stationary phase cells also had higher toxin content per cell. Though it is not possible to extrapolate the results of this laboratory study to the natural events with certainty, the data do indicate that calm conditions may have allowed higher densities of more toxic stationary phase cells to accumulate. Release of these toxins from this higher biomass population, either by excretion or by lysis of senescent cells, accompanied by onshore wind direction, may account for observed intermittent respiratory

illness. More work is needed, but results of this study do provides a new piece to the puzzle with respect to understand the *Ostreopsis* bloom and its negative effects on human health.

Acknowledgements

This study was supported by the CTM2014-53818-R (Ostreorisk) and CTQ2015-63968-C2-1-P projects funded by the Spanish Government (MINECO), the financial assistance of the European Union under the ENPI CBC Mediterranean Sea Basin Programme (M3-HABs project). Authors belong to Quality Groups of Catalonian Governement 2014 SGR 1642, 2014 SGR 588 and 2014 SGR 539. The authors thank Ana Arós for technical assistance.

References

- Accoroni, S., Romagnoli, T., Pichierri, S., Colombo, F. & Totti, C. (2012). *Har. Algae*. 19: 15-22.
- Accoroni, S., Romagnoli, T., Pichierri, S., Totti, C. (2014). *Har. Algae*. 34: 7-16.
- Accoroni, S. & Totti, C. (2016). *Adv. Oceanogr. Limnol.* 7(1): 1-15.
- Berdalet, E., Llaveria, G., Simó, R. (2011). *Har. Algae* 10: 88-95.
- Bolli, L., Llaveria, G., Garcés, E. *et al.*, (2007). *Biogeosciences*. 4: 559-567.
- Bravo, I., Vila, M., Casabianca, S. *et al.* (2012). *Har. Algae*. 18: 24-34.
- Ciminiello, P., Dell'Aversano, C., Dello Iacovo, et al. (2014). *Environ. Sci. Technol.* 48: 3532-3540.
- Giussani, V. (2016), PhD Thesis, Univ. Genova. "Study of Mediterranean Benthic Harmful Algal Blooms by using a multidisciplinary approach" p. 19-29.
- Guillard, R.R.L. (1973). In: *Handbook of Phycological Culture Methods and Growth Measurements*, Stein, J.R. (Ed.), Cambridge University Press, pp. 289-311.
- Shears, N.T., & Ross, P.M. (2009). *Har. Algae*. 8: 916-925.
- Vila, M., Abós-Herrándiz, R., Isern-Fontanet, J., Álvarez, J. & Berdalet, E. (2016). *Sci. Mar.* 80S1: 107-115.
- Vila, M., Garcés, E. & Masó, M. (2001). *Aquat. Microb. Ecol.* 26: 51-60.

INDEX

- abalone..... 38
Akashiwo sanguinea..... 62, 63, 139
Alexandrium.... 15, 16, 18, 19, 20, 32, 34, 38,
 39, 40, 41, 58, 59, 60, 62, 63, 64, 70, 71,
 72, 77, 95, 114, 118, 126, 134, 136, 142,
 143, 144, 145, 146, 147, 148, 149, 150, 152,
 153, 154, 155, 156, 157, 162
A. catenella. 32, 34, 58, 70, 71, 134, 136,
 153, 154, 156, 157
A. fundyense..... 40, 59, 77
A. minutum 62, 63, 95
A. ostenfeldii..... 114, 126
A. pacificum..... 38
A. tamarense..... 19, 20, 38, 40, 145, 162
 algal bloom.. 14, 62, 63, 66, 80, 100 112, 132,
 150, 151, 152, 153, 156, 159, 160
 algal culture 55, 120, 157
 algicidal bacteria..... 160, 161, 162, 163
Amoebophrya..... 140
Amphidinium..... 90, 138
Anabaena..... 100
 anatoxin..... 108, 109
Aphanizomenon..... 100, 102, 103, 110, 142
 aquaculture 15, 19, 38, 42, 46, 49, 105, 107,
 112, 116, 132, 146, 147, 150, 151, 156, 159
 Argentina 24 42 66
Artemia salina..... 104, 106
Azadinium..... 15
 Azaspiracids 15

 Bahia Manzanillo..... 62, 63
 barnacles 134, 135
 benthic dinoflagellates 88, 90, 97
 benthic HAB 92
 bentonites 158
 bioassay 42, 114, 134, 150, 151
 BMAA..... 115
 brevetoxin..... 15 54, 154, 158
 Brazil 23 24 42 43 44 45 104 105 108 110
 California..... 55, 122, 123, 125
 Caribbean..... 88, 89, 91, 132
 CFP..... 80, 82
Chattonella.... 54, 55, 57, 150, 151, 152, 153,
 154, 155, 156, 157, 160, 161
C. antiqua..... 160, 161
C. marina..... 54, 55, 151, 153, 156, 157
 Chile .. 16, 30, 31, 32, 33, 34, 35, 36, 58, 61,
 66, 68, 69, 134, 136, 150, 151, 155, 157
 Chilean fjords..... 30, 31, 134
 chlorophyll a..... 44, 100
 ciguatera 16, 80, 90
 ciguatoxins..... 80, 88, 89, 115
 climate change... 16, 18, 34, 40, 79, 82, 112,
 146, 149
 copepods..... 32, 72
 coral reef 80, 88, 90, 91
Crassostrea..... 38, 39, 130, 131
C. gigas 38, 39
 culture collection..... 147, 149
 cyanobacteria.... 62, 100, 101, 102, 104, 105,
 107, 108, 109, 110, 111, 115, 142, 146, 160
 cyanotoxin 108, 109, 110, 111
 cyclic imine toxins 115 126
Cylindrospermopsis raciborskii 143
 cyst..... 41, 56, 58, 59, 60, 77, 97, 99, 135

 diarrhetic shellfish poisoning .. 22 42 26, 50,
 75
 diarrhetic shellfish toxins 18, 19, 59
Didymosphenia geminata..... 66, 68
 dinoflagellates 14 26 30, 32, 40, 41, 42, 54,
 58, 60, 62, 63, 76, 78, 80, 81, 88, 90, 92,
 93, 96, 97, 118, 138, 139, 140, 141, 142,
 143, 144, 148, 151 161
Dinophysis. 15, 16, 18, 19, 20, 22, 23, 24, 26,
 27, 28, 42, 43, 45, 46, 47, 48, 50, 51,
 52, 53, 58, 59, 62, 63, 64, 74, 75, 76,
 77, 78, 79, 114
D. acuminata.. 18, 19, 20, 23, 26, 42, 45, 50,
 52, 58, 59
D. acuminata complex 18, 19, 20, 26, 45

- D. acuta*..... 46, 47, 48, 58
D. caudata..... 62, 63
Dolichospermum..... 100, 109, 110
domoic acid..... 63, 113
- East China Sea..... 57
eutrophication 15, 98, 100, 112, 163
- Fibrocapsa japonica*..... 161
fish. 15, 34, 35, 70, 72, 73, 80, 84, 107, 112,
115, 130, 150, 151, 152, 153, 154, 155, 156,
157, 158, 159, 160
fish kill 150, 154
fish-killing algae... 151, 152, 153, 155, 156, 159
- Galician Rías..... 50
Gambierdiscus . 15, 16, 70, 71, 80, 81, 82, 88,
89, 115, 140
G. australes 140
gill cell 155, 156, 157, 158
global change..... 112
global warming 97
glycocalyx..... 73
Gomphonema..... 68
gymnocin..... 154
Gymnodinium catenatum.. 18, 19, 38, 54, 62,
63, 64, 118, 122, 123, 154
- HAB monitoring 34, 49, 143, 146, 155
haemolytic assay..... 89
Heterocapsa..... 161
Heterosigma. 58, 150, 152, 153, 154, 155, 161,
162
HRMS..... 93, 113, 114, 115, 126, 128
HTS..... 146
- ichthyotoxic.. 34, 72, 132, 151, 152, 153, 154,
157
invasive species..... 66, 68, 81
- Karenia*.. 48, 64, 70, 71, 72, 73, 74, 75, 76,
79, 126, 139, 140, 150, 151, 152, 153, 154,
157, 161
K. brevis..... 75, 139, 140, 154, 157
K. mikimotoi..... 153, 161
- Karlodinium*.. 139, 140, 150, 152, 153, 154, 155
K. veneficum..... 139, 140, 152, 154
kelp seaweed..... 134
Korea..... 116, 143, 150, 156, 159
- LC-MS/MS.... 31, 84, 85, 88, 89, 113, 118, 119,
120, 122 123, 124, 125, 128
Lingulodinium polyedrum..... 58, 60
LSU..... 90
- management. 14, 15, 66, 68, 71, 115, 116, 146,
147, 163
mass spectrometry.... 15, 30, 113, 122, 123,
124, 125, 138, 141
mcyE 109, 110, 111
Mediterranean Sea..... 59, 95, 97, 98
Mesodinium..... 49, 50, 51, 52, 78
Mexican Pacific..... 55, 62, 63
microcystins.. 104, 105, 107, 108, 109, 110, 111
Microcystis..... 107, 108, 109, 110, 111
mitigation..... 74, 156, 158, 160
monitoring.. 14, 15, 16, 18, 19, 27, 30, 32, 36,
38, 42, 43, 44, 45, 48, 59, 62, 74, 79,
110, 112, 115, 124, 127, 131, 146, 147, 148,
149
mouse bioassay... 15, 18, 27, 43, 58, 59, 113,
131, 134
- New Zealand..... 35, 37, 84, 85, 87, 126, 150
nicotinic acetylcholine receptors..... 126
Nigeria..... 114
Nodularia..... 100, 102, 104, 105, 106, 107
nodularin..... 104, 105, 106
North Atlantic..... 104
- okadaic acid .. 26, 42, 45, 49, 61, 75, 88, 89
Ostreopsis 15, 70, 71, 80, 81, 82, 84, 85, 86,
88, 89, 90, 92, 93, 94, 95, 96, 97, 98, 99
Ostreopsis cf. *ovata* 92, 93, 96, 98
Ostreopsis cf. *siamensis* 85
Ostreopsis siamensis..... 86
ovatoxins (OVTXs) 96
- palytoxin..... 84, 88, 89, 90, 93, 95, 96
paralytic shellfish poison..... 38, 80, 113, 118

- paralytic shellfish toxin. 18, 54, 58, 118, 122, 142
- passive sampling..... 112, 114
- PCR..... 27, 89, 109, 110, 142, 143, 146
- Phormidium*..... 110
- Planktothrix agardhii*..... 108, 109
- Prorocentrum*... 42, 62, 63, 74, 75, 76, 80, 81, 88, 89, 90, 114, 140
- Protoceratium reticulatum*..... 58
- Protoperdinium*..... 63
- Prymnesium*..... 150, 153, 154, 157, 158
- P. parvum*..... 153, 154, 157, 158
- Pseudochattonella*..... 34, 35, 58
- Pseudo-nitzschia*... 15, 16, 17, 30, 31, 32, 33, 62, 63, 74, 113, 151
- PSP.... 32, 38, 55, 72, 113, 130, 131, 132, 134, 135, 136, 142, 144, 147
- PST. 18, 38, 39, 41, 55, 58, 59, 60, 72, 73, 118, 119, 120, 130, 131, 132, 134, 135, 136, 147, 154
- PTX-2..... 61
- Pyrodinium*..... 118, 130, 131, 144
- P. bahamense*..... 130
- qPCR..... 38, 142, 146
- raphidophyte..... 54, 154, 156, 162
- receptor binding assay..... 127, 129, 130, 131
- Rhizosolenia*..... 62, 63, 77, 151
- Richelia intracellularis*..... 77
- risk assessment..... 39
- risk management..... 115
- RTgill-W1..... 152, 156, 157
- saxitoxin.. 59, 115, 122, 123, 130, 131, 132, 135, 142, 154
- Scrippsiella trochoidea*..... 63
- seagrass..... 84, 85, 160, 161, 162, 163, 164
- sediment..... 39, 40, 41, 58, 59, 60, 101
- Skeletonema*..... 62, 63
- Southern Chile..... 34, 60
- SPE..... 126, 127
- sub-toxic levels..... 30, 31
- Symbiodinium*..... 140
- toxicity... 20, 31, 32, 34, 38, 40, 54, 55, 58, 70, 72, 75, 88, 90, 92, 104, 105, 106, 107, 125, 130, 132, 136, 144, 158
- transcriptome..... 140, 141
- transcriptomics..... 143
- UHPLC..... 93, 115
- Uruguay.. 18, 19, 22, 23, 24, 26, 27, 28, 44, 45, 142, 143, 145
- Vulcanodinium*..... 15, 114, 126
- Vulcanodinium rugosum*..... 126

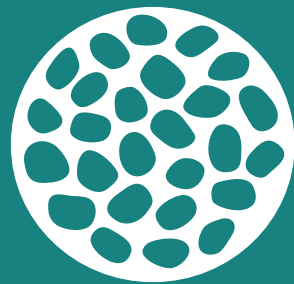
AUTHOR INDEX

- Accoroni, Stefano 96
- Alarcón, César 30
- Alechaga, Élide 92
- Alonso Hernández, Carlos Manuel 88
- Alves, Thiago P. 42
- Amaya, Oscar 80, 130
- Aráoz, Rómulo..... 126
- Arjun Verma..... 84
- Bachvaroff, Tsvetan R. 138
- Band-Schmidt, Christine J. 54, 122
- Barnett, Michelle 46
- Bengt Karlson..... 100
- Berdalet, Elisa..... 92
- Bolch, Christopher..... 38
- Brito, Carmen G. 34
- Bustillos-Guzmán, José J. 54, 122
- Campbell, Lisa..... 74
- Cave, Rachel..... 46
- Cembella, Allan 122
- Clément, Alejandro 34
- Condie, Scott 38
- Contreras, Gustavo 34
- Correa, Nicole 34
- Cosgrove, Sarah 46
- Costa, Carolina M. 104
- Costa, Luiza Dy F..... 104
- Cristina Hernández..... 134
- Dechraoui Bottein, Marie-Yasmine 130
- Díaz Asencio, Lisbet..... 88
- Díaz, Patricio A. 50
- Dorantes-Aranda, Juan José..... 38, 150
- Durán-Riveroll, Lorena M. 122
- Egenau, Osvaldo..... 34
- Eilola, Kari..... 100
- Ellwood, Neil..... 96
- Enevoldsen, Henrik..... 14
- Fabre, Amelia..... 18, 22, 26
- Fennell, Sheena..... 46
- Fernandes, Luciano Felicio 88
- Fernández, César 34
- Fernández-Herrera, Leyberth J. 54
- Franco, José M. 26
- Frangópulos, Máximo..... 30, 66
- Futrelle, Joe 74
- Garrido, José Luis..... 50
- Gaudin, Amandine 126
- Geraldo K. Foes..... 104
- Giménez Papiol, Gemma 146
- Giussani Valentina..... 92
- Gregory, Clynton 46
- Guzmán, Leonardo 30, 58, 134
- Hallegraeff, Gustaaf 14, 38, 150, 156
- Hanisch, Werner S. 108
- Haq, Saddef 138
- Harwood, D. Tim..... 84
- Henrichs, Darren W. 74
- Hernández-Becerril, David U. 62
- Hernández-Llamas, Soraya 92
- Hernández-Sandoval, Francisco E. 54
- Hess, Philipp..... 112, 126
- Hoppenrath, Mona..... 84
- Imai, Ichiro 160
- Inaba, Nobuharu 160
- Jenkinson, Ian R. 70
- Johansson, Johannes 100
- Justin, Sophie Zinn..... 126
- Kohli, Gurjeet S. 84
- Krock, Bernd 30, 122
- Kunrath, Nathália 104
- Kuzhiumparambil, Unnikrishnan 84
- Labra, Gissela..... 58
- Lamoise, Claire 126
- Leighfield, Tod..... 130
- Lewis, Nancy..... 118
- Leyva-Valencia, Ignacio..... 54
- Li, Aifeng..... 118
- Linders, Johanna..... 100
- Litaker, Richard Wayne..... 88
- López-Cortés, David J..... 54
- Mafrá Jr, Luiz Laureno..... 88

Maluje, Carmen P.	34	Reguera, Beatriz	26, 50
Mardones, Jorge	150	Ribeiro, Matheus Santos Freitas.....	108
Martínez, Ana	18, 22, 142	Riobo, Pilar	26, 50, 88
Martínez de la Escalera, Gabriela.....	142	Rodríguez, Francisco	26, 50, 88
McCarron, Pearse.....	118	Romagnoli, Tiziana	96
Méndez, Silvia	18, 22, 26	Ruíz, Gerardo	130
Mohlin, Malin	100	Ruiz, Sebastián	66
Mora, Carla.....	66	Ruvindy, Rendy	38
Moreira González, Angel Ramón.....	88	Sakami, Tomoko.....	160
Mourino-Carballido, Beatriz	50	Saldivia, Marcela	34
Moutinho, Fellipe Henrique Martins	108	Salgado, Pablo.....	58
Moyano, Encarnación	92	Schramm, Mathias A.	42
Muñoz, Francisca.....	34	Schuhmacher, Marta	146
Murray, Shauna	38, 84	Séchet, Véronique.....	126
Niero, Cristina Viana	108	Seger, Ana	150, 156
Nordi, Cristina Souza Freire	108	Servent, Denis.....	126
Núñez-Vázquez, Erick J.....	54	Silva, Sandra	134
Ortega, Leonardo	18	Sosik, Heidi M.	74
Pacheco, Hernán.....	30	Thai, Robert	126
Pacheco, Lucas A.	104	Thomas, Krista	118
Peacock, Emily E.	74	Toro, Carolina.....	30
Peralta-Cruz, Javier	122	Torres, Rodrigo	30
Peraza Escarrá, Rosely	88	Totti, Cecilia.....	96
Pérez, Felipe.....	34	Turnbull, Alison.....	38
Piccini, Claudia	142	Ugalde, Sarah	38
Pichierri, Salvatore.....	96	Vandersea, Mark W.....	88
Pinto, Marco	30, 66	Vila, Magda	92
Piola, Alberto R.....	42	Villagrán-Lorenzana, Héctor	62
Pizarro, Gemita.....	30, 134	Viure, Laia	92
Place, Allen R.....	138	Vivanco, Ximena.....	58
Proença, Luis A. O.....	42	Wählström, Irene.....	100
Purdie, Duncan	46	Walter, John A.	118
Quilliam, Michael A.	118	Wasiolesky Jr, Wilson.	104
Quinlan, Rae.....	38	Wilson, Kate	38
Quintanilla, Cesiah Rebeca.....	80	Wranne, Anna Willstrand.....	100
Raine, Robin.....	46	Yunes, João S.	104
Ralph, Peter J.	84	Zamora, Claudia	30, 134
Ramírez-Rodríguez, Dulce V.	54	Zingone, Adriana	14
Razza, Emanuela	96	Zumaya-Higuera, Miriam G.	54



IOC



ICHA

PROCEEDINGS OF THE 17TH
INTERNATIONAL CONFERENCE ON HARMFUL ALGAE