Harmful Algae News

An IOC Newsletter on Toxic Algae and Algal Blooms

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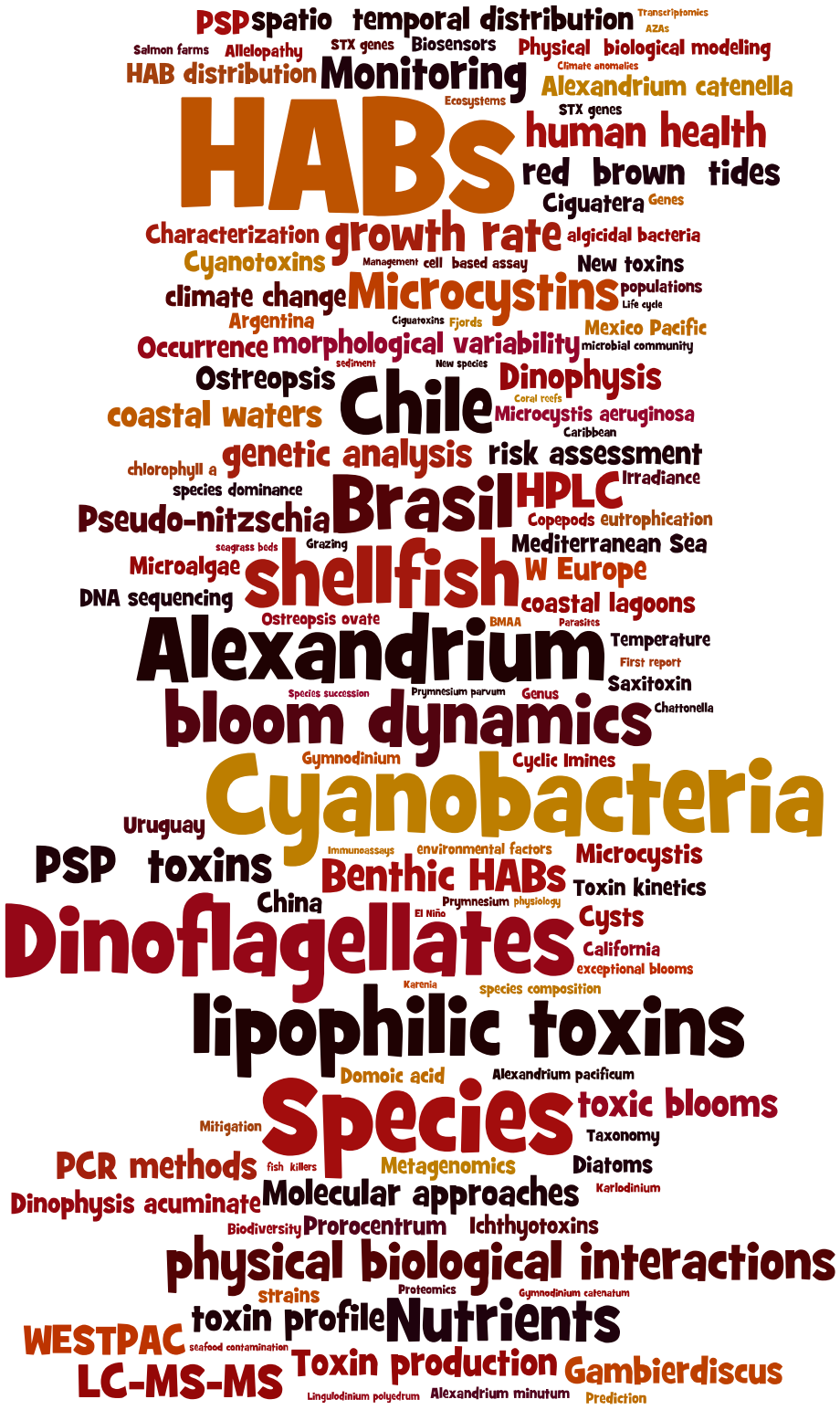
United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

Highlights of the XVII International Conference on Harmful Algae



"Words Cloud" generated from the key words and titles of all contributions to 17 ICHA.

Content

Gambierdiscus *cells on a cnidarian colony (see p 14)*

Florianópolis, "Floripa" to the locals, is the capital city of the state of Santa Catarina, in southern Brazil. Many small commercial fishermen populate the island, and the fishing boats, the folklore, the cuisine and the colonial architecture contribute to make it a very attractive tourist resource for many Brazilians and Argentineans escaping from overpopulated cities. But most important for us, the Florianópolis area is the major producer of cultured oysters and mussels in the country and suffers from periodic harmful algal bloom events caused by *Alexandrium*, *Dinophysis* and *Gymnodinium* species. All this contributed to make the Brazilian colleagues choose Floripa as the venue for the XVII International Conference on Harmful Algae (ICHA 17), 9-14 October 2016, the first one to be held in Latin America.

ICHA 17 was hosted by *The Federal Institute of Santa Catarina* (IF-SC). The local organizing committee was chaired by Dr Luis Antonio Proença. The theme of the conference was: "Harmful Algae, from cells to fisheries: species, toxins, ecology, management and new technologies"

The Conference was attended by 350 participants from 35 countries. There were 2 keynote speakers, 8 plenary speakers, 145 orals presentations, 20 fast-talks, 250 posters and a heavily attended round table to discuss about the recent events in Chile.

The outstanding topics of the Conference were:

- **Climate anomalies**, global change, record blooms, heavily influenced by the dramatic salmon-kills and PSP events suffered by Chilean producers in 2016.
- **Advanced 'omics** and in situ sensors, enabling tests of and answers to scientific questions that had been limited by technology
- **Cyanobacteria**: over 60 contributions. Not surprising considering that cyanobacterial toxins have been traditionally the main threat to public health of Brazilian freshwater bodies.

The "words cloud" generated from titles and keywords from oral and poster contributions illustrates well the dominant issues. As usual, *Alexandrium*, in particular the highly toxic *Alexandrium catenella* (=*Alexandrium fundyense* or *Alexandrium* Group 1) was the predominant genus, followed by an increasing number of contributions on benthic HABs (*Gambierdiscus* + *Ostreopsis*) and *Dinophysis,* now matching those of *Pseudo-nitzschia*. Morphological, toxinological and genetic descriptions of SPECIES were top of the list. Emerging (cyclic imines) toxins, cyanobacterial microcystins and the arduous identification of fish-killing substances attracted much attention. The location of the venue favoured a good list of contributions from Chile, Argentina, Uruguay and Mexico in addition to those from the host country.

Detailed scientific highlights of different conference topics were prepared by senior participants to summarize the main research and management advances for the HAB scientific community, especially for those who were not able to make it to Floripa.

Beatriz Reguera (IEO, Vigo, Spain) & Luis Proença (IF-SC, Santa Catarina, Brazil)

At the Public Market during the 17th National Oyster Festival in Florianópolis: Left, hanging baskets of oysters and scallops and right, mussel seed collectors (Photo Yolanda Pazos).

HABs in a Changing Climate

Much of the session focused on the extraordinary natural bloom events in 2015-2016, including in Chile, the Western USA, and the eastern coastline of Tasmania.

There is a long history of *Alexandrium* blooms along the Chilean coast, and the more recent blooms have progressed northwards up the coast over the past several decades (**Alejandro Clement**, **Leonardo Guzmán**). The extraordinary bloom of *Pseudochattonella verruculosa* and *Alexandrium catenella* in 2016 began in the outer coastal waters and was transported into the inland sea region, where it devastated fish farms leading to economic and social upheavals. There is a long history of *Alexandrium catenella* along the Chilean open coast, going back over 40 years of records, so the bloom stemmed from shifting environmental conditions rather than recent species introduction. The event coincided with an anomalous movement of the southeast Pacific high pressure region offshore linked to the Pacific Decadal Oscillation, suggesting there may be a climatic link that enhanced this bloom event.

Blooms of a more toxic *Alexandrium* species, *Alexandrium* Group 1 (*A. catenella* = *A. fundyense*), along the eastern coast of Tasmania appeared in 2012, for the first time in over 30 years of observations, and expanded greatly in 2015 and 2016. This coastal region is a climate change "hotspot", resulting from the southward movement of the East Australian Current, bringing more warm water further south. The working hypothesis is that the recent appearance of the more toxic *Alexandrium* strain is the consequence of a complex interaction of increased temperature, flood events and changes in the southward extension of the East Australian Current enhancing growth of the ende-

mic, but rare, more toxic strain. (**Gustaaf Hallegraeff**)

The massive *Pseudo-nitzschia* bloom event along the western USA also appears to be associated with an anomalous warm "blob" of surface waters that pushed onto, and retracted from, the entire coastal region. Data suggest that these anomalous warm conditions inshore led to the selection of *Pseudo-nitzschia* over other diatoms in the near shore waters, due to their competitive ability at low nutrient concentrations. As the warm waters retracted with the onset of upwelling, this seed population of *Pseudo-nitzschia* was stimulated and sustained to create the bloom conditions along the entire coastline. (**Vera Trainer**)

There is laboratory evidence of a potential link between increasing ocean acidification, nutrient limitation and toxicity of phytoplankton. Although dinoflagellates and cyanobacteria are anticipated to benefit from increasing pCO2, by reducing the need for energy-consuming carbon concentrating mechanisms, the expected benefits are small for *Alexandrium fundyense* and *Scrippsiella trochoidea*. However, decreased pH enhanced N assimilation under N limiting conditions, leading to increased toxin production. The findings suggest that ocean acidification may lessen the negative effects of N limitation and influence the composition and toxicity of phytoplankton assemblages. (**Dedmer Van de Waal**)

Warming of the surface ocean has coincided with the increasing presence of HABs globally over the last 3 decades, and modelling of the optimal growth conditions of *Cochlodinium*, *Dinophysis*, and *Alexandrium* shows expansion of the optimal growth conditions and bloom windows in the Atlantic and Pacific regions by more than a month between 1982 and 2015. While ocean warming is expanding the niche for HABs, coinciding with increasing HAB frequency, the mechanistic for this linkage is not understood. (**Chris Gobler**)

Studying anomalous HAB blooms, or HAB "weather", can provide insights to how climate pressures might affect HABs in the future, but forecasting climate driven changes in HABs will require new research approaches. Improved response planning for extraordinary HAB events, better focus Intergovernmental Panel on Climate Change (IPCC) projections for regional changing conditions, and unification of experimental methods will be necessary if we are to move forward quickly enough to forecast, rather than hindcast, the effect of climate on HABs. (**Mark Wells**)

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Taxonomy at the XVII ICHA

The word 'species' appears 550 times in the abstract book of the conference, pointing at the importance of giving names and assessing relationships between the entities around which harmful algae science accumulates. Yet still many taxa exist without our recognition. Indeed a steady number of new species are introduced at each ICHA as well as in the intersessional periods, which reminds us that our knowledge on the diversity of harmful algae is still work in progress. Luckily and despite the long blamed taxonomy crisis there are still scientists that are able to recognise the novelties and produce nice accounts of shapes and patterns that allow other scientist to recognize them too. This time also we were presented with new players in the game of HABs.

A new, non-toxic species of *Alexandrium*, *A. fragae* was desccribed from Brazilian waters, along with the first finding of *A. tamutum* in the same area (**Suema Branco**). The new species morphologically resembles some Mediterranean forms of *A. minutum* that have a smooth epitheca and heavy reticulated hypotheca, which were shown at the ICHA conference in Lund [1]. Two new *Gambierdiscus*, *G. balechii* and *G. lapillus* were identified, the former in Celebes Sea (**Santiago Fraga**) and the latter in the Great Barrier Reef (Australia) (**Anna Liza Kretzschmar),** further raising the number of species in a genus considered as monospecific until a few years ago. Another new microbenthic species, *Ostreopsis rhodesae* from East Australian Coast was introduced (**Arjun Verma**). Although no palytoxin-like molecules were produced in this species, transcripts related to polyketide synthases (PKSs) and non-ribosomal peptide synthases (NRPSs) multi-enzyme complexes were found, which are active in the synthesis of palytoxin-like substances. The recently described *Ostreopsis fattorussoi* [2] instead does produce ovatoxins.

Diversity knowledge is growing at a very high pace also in the plankton genus *Azadinium* (**Urban Tillmann**), where 11 species have been recognised in 7 years since its establishment, some of which (e.g. *A. poporum*) are quite widespread worldwide. We can blame the small size of these species (generally < 15 **µm**) for the late recognition of so much diversity, which may also explain why the discovery of the real culprit of azaspiracid production took some time. Interestingly, some of the 10 species in the related genus *Amphidoma* also produce AZAs. A new entry is registered also in naked dinoflagellates with a

Birds of a feather flock together. Prof Moestrup and other well known taxonomists solving nomenclature problems (Photo Mathias Schramm)

still unnamed woloszynskioid species showing characters intermediate between the families Borghiellaceae and Suessiaceae (**Kazuya Takahashi**).

The fast evolution of molecular approaches at times may show contrasting scenarios over time: despite distinct morphologies: three *Chattonella* species, *C. antiqua*, *C. marina*, *C. ovata* had been merged in a single species based on the identity of most molecular markers [3]. Now, using a more sensitive technique relying on microsatellites – ISSR genotyping by sequencing (MIG-seq) analysis–it is shown that the three can be at least identified molecularly, although this does not prove they are separate species (**Satoshi Nagai**). With all these novelty and due to some taxonomic changes, it is not surprising that to keep the IOC taxonomic list of Harmful Species updated is a hard job (**Øjvind Moestrup**).

Montresor M et al 1990. In: Granéli E et al (eds) Toxic marine phytoplankton (Elsevier, Amsterdam) pp 82-87
Accoroni S et al 2016. J Phycol: doi:10.1111/jpy.12464
Demura M et al 2009. Phycologia 48: 518-535

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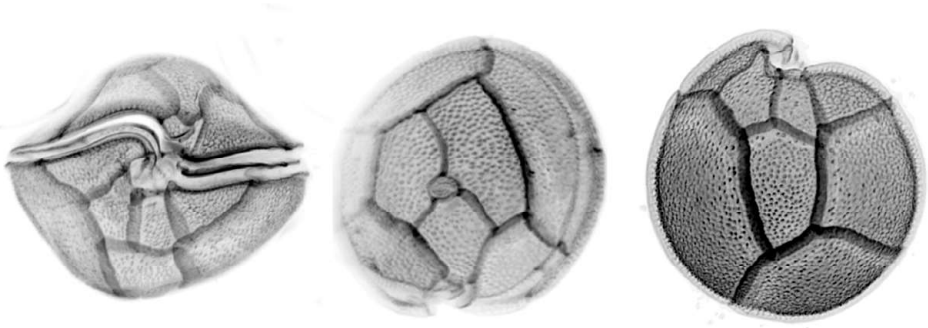
Benthic HABs

Benthic harmful algal blooms (BHABs) have an increasing interest based primarily in ciguatera but also due to problems caused by *Ostreopsis* in some coastal waters. The knowledge of the ecology of benthic microalgae is far from the well developed studies on plankton ecology, but some important progresses in the ecology of *Gambierdiscus* (**Chui Pin Leaw, Masao Adachi, Michaela Larsson, Ingrid Sassenhagen**) was presented as well as in modelling *Gambierdiscus* bloom dynamics (**Michael Parsons, Steven Kibler**). In parallel to the description of new *Gambierdiscus* species, the known distribution of the genus has increased considerably including some new reports: Cuba (**Lisbet Díaz Asencio, Angel Moreira**), El Salvador (**Rebeca Quintanilla**), Colombian Caribbean (**Anderson Ruiz Gómez**), Brazil (**Silvia Nascimento**), Philippines (**Rhodora Azanza**) Indonesia (**Santiago Fraga**) and Canary Islands (**Francisco Rodríguez**), and their expansion to new areas (**Michaela Larsson**). For the first time, the transfer of *Gambierdiscus* toxins to herbivorous fish in laboratory conditions was studied and clearly demostrated (**Rachel Clausing**).



SEM micrograph of Gambierdiscus balechii *(Photo Santiago Fraga).*

Far from the planktonic HABs is the monitoring of BHABs. *Gambierdiscus* monitoring was only reported from the Philippines (**Ma Llorina Rañada**) but due to the efforts of IAEA on training scientist of many countries (**Yasmine Bottein**) the implementation of BHABs monitoring programs in the near future can be expected.

Although ciguatera is the most important harmful effect of benthic algal blooms, other genera like *Ostreopsis* may cause harm when some blooms of species of this genus were related to human respiratory problems. Reports of the presence of *Ostreopsis* were abundant from many countries and the presence of toxic and non toxic species was reported (**Olga Carnicer, Cristina Mendes, Silvia Nascimento, Mariana Santos**). Progress in the study of the *Ostreopsis* bloom conditions and/or associated macroalgae were reported (**Rodolphe Lemée, Daniela Catania, Stefano Accoroni, Chui Pin Leaw, Elisa Berdalet**).

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Cyanobacteria

Over 60 studies were presented and distributed in 5 main areas: i) Toxins analysis; Surveillance and management; iii) Ecology and bloom dynamics; iv) Toxicology; v) Cell physiology and vi) Others.

New reports about human oral exposure in different continents (South America and Africa) were presented including relevant case studies about recreational exposure to microcystins in Mozambique (**Olivia Pedro**) and Uruguay (**Daniela Sedan**). The later represented a serious health risk that included a case of a child suffering fulminant hepatitis requiring a liver transplant.

Advances on cyanobacterial cell physiology and intraspecific diversity analysis were given by **Iame Guedes** and **Elena Galvanese.** Other highlights included: Nodularin records in South America (**Luiza Costa**, **Savênia Silveira**); increasing surveillance and management data from different regions and continued exploration of clay and flocculants for removing cells and/or cyanotoxins (**Valeria Magalhães**, **Cinthia Bogarín**)

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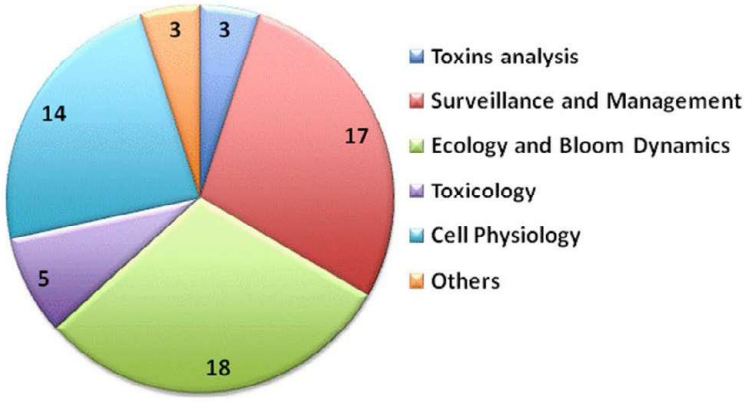

Percentage of contributions on different issues related to Cyanobacteria.

HABs Biology and Ecology

The recent advent of 'omics' technologies made possible the exploration of additional features to understand functional aspects of the biology and physiology of harmful species (reviewed in next section on molecular technologies), including the intricate sexual reproduction of *Pseudo-nitzschia* species (**Marina Montresor** keynote speech).

There was a good session about the diversity and role of parasites affecting various dinoflagellate (host) species with different susceptibility (**Esther Garcés**, **Albert Reñé**). In the field, recurrent blooms of *Alexandrium pacificum* in the Marlborough Sounds of South Island New Zealand were described. While hydrological modelling of the bloom environments were successful, biological modelling showed far less success. Bloom termination tended to be by encystment, but complications associated with parasitism may have accounted for the difficulty in the biological modelling (**Lincoln MacKenzie)**.

The role of β-N-methylamino-L-alanine (BMAA), the producer organism and their actual effects, continue to be a mystery (**Sandra Lage**).

Allelopathic interactions received considerable attention. Algicidal bacteria act on HABs, particularly those bacteria growing on macroalgae and seagrasses, which underlines the likely importance of conserving natural macrophyte vegetation in marine and freshwater habitats to stabilize the pelagic ecological system (**Ichiro Imai**). But there are at least class-specific relations. In this context, **Kathryn Coyne,** showed us the algicide IRI-160, produced by bacteria, and which is active against dinoflagellates, particularly *Pfiesteria*, but not against non-dinoflagellate algae. The harmful effects of toxin-producing *Dinophysis* cf *ovum* in culture on its ciliate prey *Mesodinium rubrum* were shown in videos of *Dinophysis* cells secreting mucus aggregates and strands that trapped the ciliates as they swam. We saw *Mesodinium* cells which appeared to be trying to escape from their elastic trap, much as a fly tries to escape from a sticky spider's web. However, perhaps weakened by some toxins (ROS, PUFAs?) different from okadaic acid and dinophysistoxins, they are eventually captured by the *Dinophysis* that suck out their contents with a feeding tube (myzocytosis) (**Luiz Mafra)**. **Yolanda Pazos** showed how blooms of *Dinophysis* in the real world generally follow blooms of their prey, *Mesodinium.* **Marc Long** (honorary mention for student oral presentation) treated the impact of *Alexandrium minutum* culture filtrate on *Chaetoceros neogracile*. An allelopathic action on the diatom's thylakoids and cell membranes, apparently involving ROS, was observed very quickly (~5 min) after exposure.

Turning to ecology, **Beatriz Reguera's** presentation on fine-scale physical-biological interactions in *Dinophysis acuta* dynamics showed the short-term impact of upwelling on net growth due to dispersion, but also decreased division rates due to the effect of increased shear stress and mixing on the cells. **Raphael Siano** showed us how *Alexandrium minutum* has now invaded the Bay of Brest, France, to give regular blooms now of up to 40 million cells/L^{-1}, whereas back in 1990, the cyst record (PCR detection) shows that it was totally absent. *Vulcanodinium rugosa*, a pinnotoxin producer from a Mediterranean lagoon, has increased in all NW Mediterranean lagoons in the last decade, but in this case introduction by shellfish transfer is suspected. **Alejandro Clément** showed how changes in climate and ocean circulation appear to be changing not only the timing of blooms in southern Chile, but also the synergistic effect of blooms of the diatom *Leptocylindrus danicus* and the flagellate *Pseudochattonella.*

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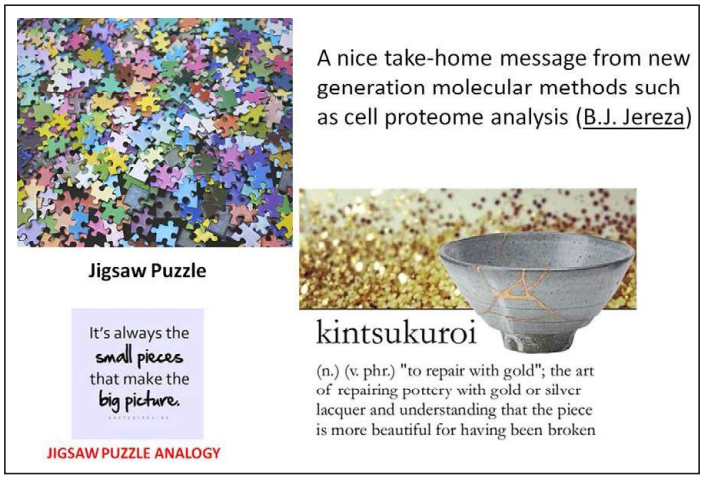
Application of Molecular Technologies in HAB Research and Monitoring

Molecular approaches for HAB studies covered a vast number of issues, with special emphasis on the use of "omic" technologies to understand functional aspects of the biology and physiology of harmful species, as well as their detection in the field for monitoring purposes.

Genomic and transcriptomic studies on the domoic acid producer *Pseudonitzschia multistriata* (**Mariela Ferrante**) provided new information on the structure and evolution of diatom genomes, as well as the identification of a series of genes involved in sexual reproduction. The complexity of dinoflagellates genomes and their unique features was addressed on *Amphidinium carterae* (**Allan Place**), regarding the characterization of mechanisms that regulate translational processes involved in the synthesis of proteins (novel mRNA caps and eIF4Es). Diversity of Poliketide Synthase genes was shown in dinoflagellate genera such as *Ostreopsis* (**Arjun Verma**) and *Gambierdiscus* (**Gurjeet Kohli**). Saxitoxin production and its variability are known in several dinoflagellate species and genera. Genes involved in their synthesis have been explored (**Armando Mendoza-Flores**) to gain new insights on the evolutionary pathways through which these genes have been transferred from cyanobacteria to dinoflagellates. The proteomes of dinoflagellate species provide another approach to understand specific metabolic pathways and a novel technique (shotgun proteomics) for mapping the proteome of *Pyrodinium bahamense* was presented (**Bryan Subong**).

The study of population genetics and plankton communities was also highlighted during the conference by metagenomic studies on Japanese coastal waters (**Satochi Nagai**) and population genetic studies using microsatellites in benthic dinoflagellates (*Gambierdiscus caribaeus*; **Ingrid Sassenhagen**), *Pseudonitzschia multistriata* (**Marina Montresor**), *Cochlodinium polikrikoides* (**Satochi Nagai**), as well as RAD-TAG studies in freshwater systems (*Gonyostum semen*; **Karin Rengefors**), to reveal geographical expansion and spatial differentiation among populations.

Studies of population genetic structure (SSU, V4rDNA) allowed the detection of entries of new species in the Gulf of Naples (**Adriana Zingone**). There are still some methodological issues (associated with DNA extraction, PCR efficiency and copy number per gene) to be improved for quantitation with metagenomics, but these are very helpful to unveil annual trends of plankton communities and their disturbances, as shown in Japanese coastal waters (**Nagai**) and in the Gulf of Naples (HTS metabarcoding; **Adriana Zingone**). Multiple studies also addressed the use



Cell proteome analysis, or how to use individual molecules, to make a beautiful picture about the nature of an organism, seen by the author as a jigsaw puzzle or "kintsukuroi".

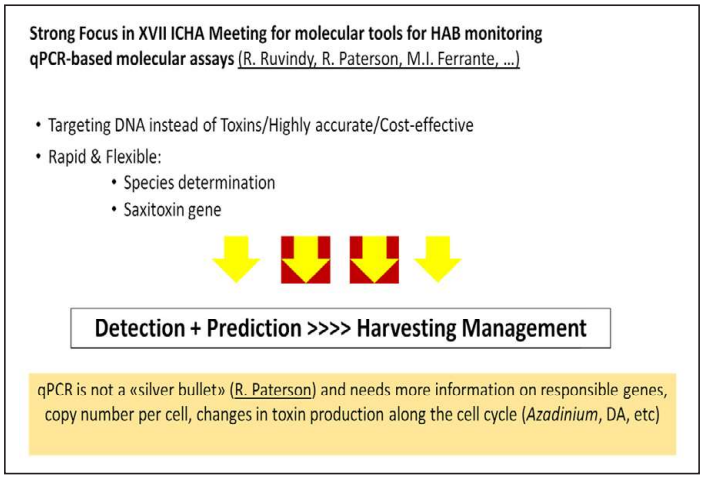


Diagram about the application of molecular tools (qPCR) for monitoring purposes.

of qPCR assays for HAB cells and cysts detection and enumeration (**Marcela Mora**, **Ruth Paterson**, **Raffaele Siano**), including the use of saxitoxin genes as a target (**Henna Savela**, **Claudia Piccini**, **Bruna Buch**, **Rendy Ruvindy**). Detection and prediction are two important issues for harvesting management that can be tackled by qPCR assays. In addition, we need more information on responsible genes, copy number per cell, changes in toxin production along the cell cycle, etc (**Ruth Paterson**).

Continuing a trend that started at least 20 years earlier, there was a strong set of talks on molecular assays for identifying and enumerating cells in monitoring programs. **Linda Medlin** updated participants on the status of phylochips now being used for multiple HAB species in five countries. Other highlights in this topic area were descriptions of the "Lab on a Chip", electrochemical detector (**Jahir Holguin**), and a fully automated, ship-based algal biosensor using electrochemical detection and phylochips (**Pim Sprong**). During a discussion at the end of the molecular detection session, it was clear that despite extensive development and testing by the research community and positive outcomes of that work, broad acceptance of molecular assays by monitoring and regulatory communities has not yet been achieved.

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Marina Montresor, Stazione Zoologica Anton Dohrn, Napoli,Italy, mmontr@szn.it
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New HAB Technologies

A noteworthy feature of the ICHA conference in Florianopolis was the clear advancement in the use of *in situ* biosensors and autonomous vehicles for HAB studies. **Lisa Campbell** gave a plenary presentation about the use of the Imaging FlowCytobot (IFCB), a submersible microscope capable of imaging thousands of cells every hour. She described how the IFCB is being used in Texas for early warning of HABs, resolution of phytoplankton community structure, and for long-term time series. Where the IFCB deployments in Texas were on dock or mobile (ship) platforms, **Mike Brosnahan** described an uncabled IFCB deployment with solar power, automated winch, and Wi-Fi for real-time profiling of the instrument and other contextual sensors. This yielded unprecedented insights of life cycle transitions underlying *Alexandrium* blooms. That talk also briefly described the co-deployment of an IFCB and ESP (Environmental Sample Processor), in which the high-frequency observations of the IFCB were used to guide the timing of the more limited sampling capabilities of the ESP – in that instance, used to measure toxin concentrations directly in the water.

Other instrument highlights included a plenary talk by **Raphe Kudela** on the use of multiple technologies for HAB studies (wave-powered profilers, AUVs, ESPs, IFCBs, and satellite remote sensing). Yet another talk in this context was by **Beatrix Siemering** on the use of a satellite-guided glider in mapping of hydrography and chlorophyll in HAB monitoring and forecasting.

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Solar powered raft platform for uncabled IFCB deployment for Alexandrium *and* Dinophysis *studies in Salt Pond, MA (USA). The submerged IFCB (and other instruments) is raised and lowered with an automated profiling winch. (Photo: M. Brosnahan)*

Fish Killing Algae

Fish-killing algae were well covered at ICHA17 with one key note address, 10 talks, 9 posters, and a dedicated round table event. Special attention focused on the massive February-March 2016 Chilean *Pseudochattonella* cf.*verruculosa/Alexandrium catenella* bloom (**Alejandro Clement**, **Ximena Rojas**, **Leonardo Guzmán**, **Alejandra Aguilera**, **Fabiola Villanueva**, **Rodrigo Montes**, *Óscar* **Espinoza-González**, **Daniel Varela**, **Ximena Vivanco**, **Javier Paredes**) that killed 40,000 tonnes of salmon and trout. This event impacted on global markets and triggered social unrest. **Gustaaf Hallegraeff** (keynote speech) proposed that the unrelated flagellates *Chattonella*, *Heterosigma*, *Karenia*, *Cochlodinium* cause irreversible fish gill damage through the release of free fatty acids (EPA, DHA, OPA) which in synergism with reactive oxygen species generate labile lipid peroxidation products. Microelectrode ion flux estimation (MIFE) techniques are pursuing a fuller understanding of this process (**Jorge Mardones**). The role of HAB cell lysis (*Alexandrium catenella*), ROS (*Chattonella*), and strain variation in ichthyotoxicity was emphasized. Aeration increased toxicity by *Prymnesium* (**Edna Granéli**). Critically, none of these "ichthyotoxins" (with exception perhaps of brevetoxins produced by *Karenia brevis* and relatives) are of human health significance. This means that recently killed fish are still fit for human consumption. We therefore need more investment in fish farm harvest techniques that allow fish to be kept alive while emergency harvesting operations can be instigated. In addition to airlift upwelling to dilute fish killing algal concentrations, the application of fine-ground clays which at environmentally acceptable concentrations can mop up ichthyotoxins offers considerable promise (**Andreas Seger**). Novel chemical structures were reported for metabolites from *Prymnesium* (B and C type prymnesins: **Per Juel Hansen**, **Aaron Andersen**, **Silas Rasmussen**) and *Karlodinium armiger* (karlotoxin congener termed karmitoxin: **Thomas Larsen**, **Sofie Binzer**). Karlotoxins disrupt lipid membranes via pore formation (**Allan Place**). Nighttime respiration by high biomass HAB events was demonstrated to drive anoxia in South Africa (**Grant Pitcher**).

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Surveillance, management and mitigation

Two sessions considered the development of approaches for the role of surveillance, management and mitigation of HABs and their impacts.

In terms of surveillance many of the presented papers were related to the better understanding of how anthropogenic and/or climate drivers impacted HAB populations, with **Rajan Anbian** and **Kedong Yin** providing examples from Abu Dhabi and Hong Kong waters respectively.

The role of physical oceanography was highlighted by **Robin Raine**. In the culmination of many years of work on *Dinophysis* in Irish waters, he was able to demonstrate the role of a tidal front between the tidally mixed Irish Sea and the thermally stratified Celtic sea in developing populations of *Dinophysis acuta* that are subsequently transported to locations of aquaculture production.

The management of HABs is increasingly likely to require a diversity of approaches. An example of this was illustrated in the presentation of **Mercy Borbor-Cordova** who described a collaborative partnership between interdisciplinary researchers, public health staff, and key local stakeholders, to achieve HAB risk assessment and management in relation to climate-ocean drivers in Ecuador.

Alexis Fisher (best ISSHA student presentation) presented a novel paper that demonstrated the potential role of winter chilling in governing *Alexandrium* excystment and hence offering new opportunities to predict the time and location of bloom initiation.

A number of the papers considered the issue of mitigation of toxins present in the water column. Some techniques are well known to the HAB community such as using clay, but the technique continues to be optimised with **Andreas Seger** demonstrating refinement of the technique with different materials and low clay concentrations that reduces both cost and environmental impact.

Other novel approaches reported were the use of compounds secreted by algicidal bacteria (**Eva Ternon**) to control dinoflagellates

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Toxins and toxicity

The monograph by Lassus et al., 2016, presented at the conference, made it clear that the largest uncertainties in the toxicity of algal metabolites reside in the ichtyotoxicity of many algae. This was also a theme at this conference. Significant progress was reported on metabolites from *Prymnesium parvum*; the chemical diversity in several strains from US and Europe was clarified with novel Prymnesin classes identified and chemically characterised in European

Co-deployment of IFCB (left) and ESP (right) in Salt Pond (USA) during 2016 Alexandrium *bloom. (Photo: B. Keafer)*

strains (**Kristian Nielsen**, **Silas Rasmussen**, **Per Juel Hansen**).

Investigation of recently isolated strains of the genera *Azadinium* and Amphidoma led to the identification of more than ten novel analogues of Azaspiracids (**Bernd Krock**, **Urban Tillmann**).

STX analogues in *G. catenatum* were reviewed and several reports on allelopathic compounds of *G. catenatum*, *Alexandrium* spp. and several other species were presented (**Mike Quilliam**, **Elise van Meerssche**, **Hélène Hégaret**, **Chris Gobler**, **Stefanie Moorthi**, **Eva Ternon**, **Stefano Accaroni**, **Rui Wang**, **Mathias Chia**, **Kemal Ger**, **Lincoln MacKenzie**, **Renan Arruda**, **Anneke Purz**).

The combination of passive sampling and High Resolution Mass Spectrometry for algal and environmental metabolomics was presented as a break-through technology to investigate several aspects of toxin chemistry, including pinpointing towards novel toxins, chemogeography of toxins and spatio-temporal changes in the chemical profiles of coastal waters (**Phil Hess**).

Some progress was also reported in the evaluation of the toxicity of *Gambierdiscus* species, especially Atlantic strains (**Francesco Pisapia**).

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Effects of HABs in shellfish and other higher trophic level organisms

Despite not causing an obvious harmful effect characteristic of the toxic syndrome, toxic harmful events can modify the susceptibility of bivalves to pathogens (**Celina Abi-Khalil**)

The HAB impacts observed on bivalves are not always due to the known toxins causing shellfish poisonings, such as PSP and DSP toxins, but can be associated to other un-characterized bioactive compounds produced by the toxin-producing species (**Elodie Borcier**; **Leila Basti**)

Intravenous Lipid Injection (ILE) increases the clearance of brevetoxins (PbTx) in turtle tissues and ameliorates symptoms of specimens exposed to toxic blooms of *Karenia brevis* (**Courtney Cocilova**)

Hélène Hégaret, LEMAR, Institut Universitaire Européen de la Mer, France, Helene.Hegaret@univ-brest.fr

Homage to Edna Granéli

Edna Granéli, Professor Emeritus at the Linnaeus University, Kalmar, Sweden, and Guest Professor at the University of Lund, Sweden, has devoted her life to the ecology and ecophysiology of harmful microalgae and their blooms. First in Lund and later in Kalmar, she had PhD-students and visiting post-docs from different countries. Nevertheless, Edna never forgot her Brazilian origins, and she was a key person in the promotion of scientific exchanges and international cooperation with her fellow countrymen. For these reasons, Brazilian HAB experts wanted to thank Edna for her strong support to PhD students, some of them now with good academic positions in Brazil or elsewhere. Homage to Edna was done in a very Brazilian way: a barbecue and good samba music and dancing open to all participants in the 17 ICHA.

Edna Granéli with Luis Proença (top, photo M Schramm) and in the barbecue party with Proença and Paulo Salomon (bottom, photo P Salomon)

DEADLINE submission of manuscripts for the 17 ICHA Proceedings

The proceedings of the 17 ICHA conference will be published under the auspices of the International Society for the Study of Harmful Algae (ISSHA). The complete proceedings will be published in digital format on the ISSHA web site, no later than 12 months after submission deadline, but reviewed, revised and accepted submissions will be uploaded prior to that as they are completed. Past conference proceedings can be accessed at www.issha.org

Only manuscripts relating to conference presentations will be considered.

Deadline for manuscript submission is 1st March 2017

The proceedings template and guidelines can be found at: *http://www.issha.org/News/ICHA17-Proceedings*

From left to right and from top to bottom: 1-3, registration and icebreaker; 4-5, poster sessions; 6-7, socializing at the first day reception, including a "Macarena" dance. All photos by M Schramm, except 4 (Yolanda Pazos) and 6 (Don Anderson)