

Harmful Algae News

AN IOC NEWSLETTER ON TOXIC ALGAE AND ALGAL BLOOMS

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Commission

Highlights of the XVI International Conference on Harmful Algae

Aotearoa ("land of the long white cloud") was the name given to New Zealand in the Maori language. As a result of its remoteness, 1500 km east of Australia and 1000 km south of New Caledonia, this South Pacific country was the last major habitable land mass to be occupied by humans. New Zealand's economy is largely based on primary products for export to international markets, a growing tourist industry attracted by its beautiful and varied natural parks (distributed in a range from subtropical to alpine climate). The hospitality of this egalitarian country that has set an example in terms of democracy, standard of living and environmental protection. Shellfish and aquaculture are important components of New Zealand's primary sector and seafood is an important component in their local cuisine. Not surprisingly, the country has devoted important efforts to research and management of their marine and freshwater resources. Innovative and dynamic R+D centres were set up more than 20 years ago along with the increasing seafood exports, and strict controls are imposed on visitors to make sure they do not introduce undesirable pests.

The 16th International Conference on Harmful Algae was held in Wellington (New Zealand) in October 27-31, 2014. The theme of the conference was *Advancement Through Shared Science* in recognition of the multidisciplinary nature of the field and the important

role that international collaboration has played in the understanding of HAB phenomena and the mitigation of their effects. More than 400 participants of 41 countries from all five continents flew thousands of miles to attend this event. This is the third (Tasmania 2000, South Africa 2004) time the conference has been held in the Southern hemisphere, but not the last (the 17th ICHA will be held in Brazil).

There were two key note (**Moe-strup, Paerl**) and 7 plenary (**Burford, Kilroy, Munday, Murray, Suzuki, Tester, Turnbull**) speakers, 196 orals and 150 poster communications, including one innovation in the ICHA series: two sessions with 10 posters each presented as 4-min speed talks. The presenters of those rose to the challenge magnificently and gave a series of succinct, well prepared and interesting talks.

It was obvious throughout the conference that almost every single detail had been carefully planned in advance by the local organizing committee, chaired by Lincoln Mackenzie (Cawthron Institute). The facilities of the modern *Michael Fowler* Conference Centre were excellent. A key component of the success of the conference was the great job done by the professional conference organisers *Conferences and Events*. Special thanks are due to Michelle Kane, Amy Abel and Francie Gaiger who ensured that handbook and abstracts were well presented, that the

Content

Highlights of the ICHA 16.....	1
Post conference workshops.....	9

Harmful Macroalgal Blooms

And eutrophication in Florida's Indian River Lagoon ...	10
<i>Chaetomorpha linum</i> in the International Biosphere Reserve Seaflower	12
Pelagic <i>Sargassum</i> in SW Caribbean	13

Fish Killers

<i>Cochlodinium polykrikoides</i> in Indonesia.....	14
<i>Heterosigma akashiwo</i> in western Canada	16

Book review.....	18
------------------	----

Ciguatera

Novel pathways in French Polynesia	19
First report of <i>Gambierdiscus</i> in Atlantic Morocco	20
PACE-Net+ Think Tank initiatives	21

ISSHA's Corner.....	22
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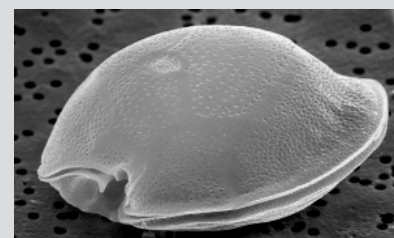
Forthcoming Events	26
--------------------------	----



Government and institutional authorities singing during the traditional Maori Powhiri opening ceremony (Photo J. Camp)



Maori dancers at the Conference Banquet (Photo B. Reguera)



conference ran smoothly, and delegates were well fed and watered.

Conferences always get the imprint of the host country. New Zealand is close to Polynesia, where the most intense Ciguatera Fish Poisoning outbreaks occur. The study of freshwater HABs is also of paramount importance in a country with a tourist industry focused among other activities on angler-fishing and canoeing in pristine rivers and streams. For these reasons, Ciguatera and Freshwater HAB issues attracted more communications than ever before in the ICHA conference series. There were four full sessions devoted to Ciguatera research and management, and three others to the biology and ecology of freshwater (including benthic) HABs. Many of us heard for the first time about “Didymo” (*Didymosphenia geminata*), or “rock snot”, a cold, low nutrient-water diatom native to the northern hemisphere, and considered an invasive species in Australia, New Zealand and Chile. Didymo does not pose a human health risk, but is associated with massive production of extracellular polymeric substances (EPS) through its branching stalks which form multi-layered structures that are resistant to degradation. The plenary speaker (**Kilroy**) and presenters from New Zealand and Chile illustrated well the threat of this species and its impact in recreational waters, ecosystem disruption and irrigation problems.

Taxonomic designations, as usual, were the protagonists of hot debates. This time it was about *Alexandrium catenella*, a species name that some authors proposed should be reduced to a synonym of *Alexandrium fundyense*. The Linnaean classification collides with post-Darwinian evolutionary (cladistic) systematics!

But above all, the 16th ICHA witnessed a blooming of molecular biology developments (next generation sequencing, metagenomics, transcriptomics) which combined with other advanced instruments were applied to solve multiple scientific and managerial questions. New and maturing monitoring high technology (e.g. robots, *in situ* fluid imaging, receptor binding assays, near universal acceptance of LC-MS) were also illustrated. A review of the highlights from the main thematic sessions follows. The programme of the

conference and abstracts can be downloaded from <http://www.icha2014nz.com/>

Once more, the ICHA conference provided a unique atmosphere for scientific exchanges and social activities. These included a reception at the “Beehive”, the eye-catching New Zealand parliament building, mid-conference excursions (“Lord of the Rings” tour, Wellington Seal Safari and others), a great Conference Banquet at the National Te Papa Museum, and the ISSHA Society auction (see ISSHA’s Corner).

Remember March 1, 2015 is the deadline to submit your contribution for the 16th ICHA Proceedings to icha2014@confer.co.nz. More information and the template for your submission can be found at the ISSHA website (www.issha.org).

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Taxonomy and Genetics

In his opening address Prof. Moestrup presented microalgal taxonomy as a very complex topic. Some of the questions he posed were: “Is taxonomy getting easier because of the new modern tools?; Is taxonomy to be taken seriously?; Should we aim at a taxonomy which can be used outside taxonomist’s narrow circles?” The many problematic and so far unsolved cases described in this talk suggest negative responses to the three questions. Nevertheless, many resolved cases and deeper insights into species delimitation presented at ICHA 16 demonstrate that taxonomy is still alive and useful, especially in this transitional age between purely visual and purely molecular approaches. Cases of integrative taxonomy, where functional aspects are linked to morphology and taxonomy, were widespread in both oral communications and posters. These were clear examples of the fundamental role of taxonomy as a backbone needed to attach the information collected about organisms. As David Mann stated at the 12th ICHA in Copenhagen, *organisms lacking a formal name are generally ignored* [1]. *If the names are unknown, knowledge of the things also perishes ...*,

Carolus Linnaeus wrote in *Philosophia Botanica* 1751. More important than its infrastructural role, taxonomy, nowadays largely supported by molecular phylogenetics, aims at tracing the evolutionary history of organisms.

Problems related to frequent changes in species name can be understood if we accept that, rather than mere labelling, taxonomy is a science and as such it is ‘work in progress’ [2]. In this respect knowledge about *Alexandrium* species taxonomy has been evolving from conference to conference, at least since 1989, when experts at the 4th ICHA in Lund reached a *consensus* about the genus name. At the previous, 15th ICHA, *A. ostenfeldii* was shown to be a species complex. This time it was the turn of the *A. tamarense* species-complex, within which 5 taxa were separated. Two of them were assigned to *A. tamarense* and *A. fundyense*, while for the others the new names of *A. pacificum*, *A. mediterraneum* and *A. australiense* were established (**John**). Within this new scheme, the name *A. catenella* was not unequivocally usable for any of the recognized taxa, and so was superseded. Yet, some taxonomists strongly disagree with the latter decision.

The winners of the competition for the most taxonomically studied organisms at ICHA 16 were the small naked dinoflagellates, for a long time confined to a bulk categorization (e.g. *Gymnodinium*/*Gyrodinium* spp.) but now calling for detailed research (**Reñé**). New results were shown for *Amphidinium* (**Sasai**), woloszynskiod species (**Taka-**



Opening address by Prof. Øjvind Moestrup

hashi), Kareniaceae (new *Karlodinium gentienii*, **Nézan**), and *Gymnodinium* (new *G. smaydae*, **Kang**). Surprises and new species are also coming from small thecate *Azadinium* (**Tillmann, Proença**), and larger benthic *Ostreopsis* (**Giusani**), *Gambierdiscus* (*G. scabrosus*, **Nishimura**) and *Peridiniopsis* (**Prabowo**). Two new *Prymnesium* species (**Seoane**) and a new raphidophyte close to *Heterosigma* were also reported (**Engesmo**).

Intraspecific diversity reflects relevant functional and ecological differences. This concept clearly emerged from studies coupling molecular and physiological approaches in *Alexandrium ostenfeldii* (**Kremp**) and *Pseudo-nitzschia pungens* (**Kim**), the latter displaying three physiologically distinct ITS-clades. Two haplotypes and 7 microsatellite genetic markers were used to depict '*A. catenella*' (to be reconciled with the new taxonomy, see above) intra-specific diversity across coastal seas (**Nagai**). For *Gonyostomum semen*, an array of different tools was applied to study intraspecific diversity and spatial distribution patterns (**Leberet, Sassenhagen**), including a new genomic approach, RADtag sequencing (**Rengefors**). Using microsatellites, a study from the Baltic revealed a clear spatial structure during a bloom of *Skeletonema marinoi* (**Godhe**), while rapid genetic changes were reported during blooms of *Alexandrium minutum* (**Dia**) along French coasts.

Cryptic and pseudocryptic diversity has widely been demonstrated across microalgal taxa. Molecular tools nowadays support traditional optical methods and allow a sounder appraisal of species present at one place. This coupled approach effectively contributes to both a better knowledge of local diversity and a reliable definition of the geographical range of harmful species (**Tester**). New surveys with such tools were presented for *Pseudo-nitzschia* in Chinese (**Li**) and Singapore waters (**Peng**), harmful dinoflagellates in Arctic waters (**Tilman**), fish-killing dinoflagellates in the Baltic (**Eskola**), *Gambierdiscus* species in the Florida Keys and Virgin Islands (**Pitz**), and in Thai waters (**Tawong**).

In terms of identification of local diversity and biogeographical ranges, a novelty at ICHA 16 was the explosion of studies based on total environmental

DNA analysis, through clone libraries but, mainly, next generation sequencing (NGS) platforms (**Smith, Shaw, Le Bescot, Edvardsen, Ruggiero, Karlsson, Taylor**). Only one such study, on *Azadinium*, was presented during the previous ICHA 15. Clearly, this is a very promising and increasingly applied approach, which offers both adequate resolution for biodiversity assessment and a new tool for ecological studies of species otherwise difficult to trace in the environment. Some concern arises from the methodological differences among the studies, including the marker sequence chosen and the instrumentation used, mostly driven by the rapid technological evolution of NGS platforms. Definitely there is a need for the harmonization and intercalibration of NGS methods in order to ensure full comparability of results obtained at different places.

Moving towards functional aspects of genetic diversity, many research groups are now studying the transcriptome of harmful species (**Jones, Ki, Dong, Di Dato, Guo**), often with a comparative approach (**Campbell**). Many of these studies are taking advantage of the transcriptomics data provided by the Moore Foundation through the (Marine Microbes Transcriptome Project (MMTP). The whole genome of *Pseudo-nitzschia* species is also being investigated, while the possibility to genetically modify these species offers new models for functional studies in diatoms (**Ferrante**). Genome and transcriptome analysis in toxin producing species may help identifying genes responsible for toxin production (**Kohli**), as well as functional and niche differences among species (**Coyne, Gobler, Jason-Smith, Jenke-Kodama, Kim**). Certainly at the next conference these recently begun studies will be developed further.

1. Mann DG & KM Evans 2008. In: Moestrup O. et al (Eds) *Proceedings of 12th International Conference on Harmful Algae. ISSHA and IOC of UNESCO, Copenhagen*, pp. 262-68.
2. Zingone A 2006. *Harmful Algae News* 32:1-3

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HABs Biology, Life Cycles and Parasites

The role and contribution of sexuality to the life cycles of HAB species remains unclear, but there is no doubt about their relevance in understanding algal population structures, bloom dynamics and recurrence, and their susceptibility to control by parasite infections. However, step-by-step, we are reaching a better understanding about their real contributions to HAB species life cycles, and the number of species for which sexual resting cysts are described is increasing. At this congress we learnt more about the factors contributing to sexual induction and meiosis in *Pseudo-nitzschia* (**Montresor**). Additionally, the resting cysts and germination patterns of *Akashiwo sanguinea* were described for the first time (**Tang**), and modifications to previous life cycle models of *Alexandrium* species (from haplontic to biphasic) were proposed (**Figueroa**).

Most of the diversity in parasites infecting HAB species has yet to be explored. Three new parasite species infecting *Alexandrium tamarense* have been discovered (**Yamaguchi**), and *Amoebophyra* has been found infecting at least eight dinoflagellate species (including *Alexandrium* sp., *Gonyaulax spinifera* and *Prorocentrum minimum*) from Chinese coastal waters (**Li**). Parasites have been suggested as a control factor in HAB population dynamics. However, laboratory experiments with the parasite *Parvilucifera* cannot accurately reproduce host-parasite interactions in the field. This parasite reaches high infection rates in laboratory cultures but seems to have a lower potential to control dinoflagellate populations in the field. Dimethylsulphide (DMS) appears to induce parasite activation, working as a density-dependent cue to the presence of potential hosts (**Alacid**). Therefore, the role of HAB parasites in the real world will probably continue to be a debated topic in future HAB conferences.

Given the huge genome of many HAB species, genomic insights into the biology of these species are being achieved through transcriptomics. During the two sessions devoted to transcriptomics we learnt about "Eco-transcriptomics" as a new tool to deepen our understanding of the molecular biology of harm-



Ostreopsis ovata mats on a macroalgal turf dominated by *Jania* spp. (Cala San Basilio, Gulf of Naples, Italy). Winner of the ICHA16 photo competition (Photo D. di Cioccio, Stazione Zoologica di Napoli).

ful algae, and in particular the factors regulating toxin production (**Gobler**). Transcriptome analyses are shedding light also on phytoplankton responses to environmental conditions (**JS Ki, Wohlrab, Jin**), community succession (**Coyne**), competition strategies (**HY Li**), and toxin biosynthesis pathways in relevant dinoflagellate HAB groups (**Campbell, Kohli, GJ Smith**). Furthermore, we are finally approaching the development of specific mitigation strategies, because increased understanding of gene regulation is allowing us to target key specific pathways in algal proliferation.

Regarding resting cysts, the role and regulation of endogenous clocks controlling their germination is still under intense research; new data support the view that they are a key to the life strategy and environmental adaptation of some *Alexandrium* species (**Fischer, Greengrove**). Resting cyst diversity reveal a lot about species biogeography. An unexpected high diversity of cysts, not previously reported in plankton sampling, was found at some Mediterranean sites (**Satta**).

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Freshwater HABs

A session was held on freshwater HAB Biology and Ecology. This included two

plenary talks by Prof Hans **Paerl** (University of North Carolina, USA) and Michele **Burford** (Griffith University, Australia). Paerl talked about the relative importance of controlling nitrogen versus phosphorus in systems dominated by cyanobacteria. He gave examples of studies demonstrating that both nitrogen and phosphorus promote cyanobacteria, and hence management



Didymosphenia geminata cell (~ 250 µm) and stalk (Photo C. Kilroy)



Didymosphenia geminata mat cut open to show the mass of stalk material cells at the surface. The mat is about 5 cm thick (Photo C. Kilroy)

of both is required. Burford examined nutrient utilisation by a toxic cyanobacterial species, *Cylindrospermopsis raciborskii*, and demonstrated the need to incorporate ecological, physiological and molecular findings on nutrient responses by the species and individual strains into algal growth models. There followed a series of interesting talks on *Microcystis* ecological studies in a New Zealand lake with a focus on fine scale variability in toxin production, and the role of strain dominance (**Hamilton**), *Microcystis* photosynthesis in a surface bloom (**Puddick**), and response of *Microcystis* in mesocosms and modelling approaches (**Borges**). Interestingly, there was a report of accumulation of freshwater algal toxins in marine mussels on the west coast of USA (**Preece**).

Later in the week there was also a session on freshwater benthic HABs. Dr Cathy **Kilroy** (NIWA, New Zealand) in her plenary talk summarised the history of research on the freshwater invasive diatom species, *Didymosphenia geminata* in New Zealand. She illustrated the site of its probable introduction and subsequent spread throughout the South Island of NZ. This work has also lead to a greater recognition of the world-wide invasion of this diatom. Surprisingly, this species appears to prefer low dissolved phosphorus concentrations. A session followed with a focus on *Didymosphenia* and the benthic cyanobacterial species, *Phormidium*. Both species have major impacts on New Zealand river systems. Current research is focusing on understanding the ecology and habitat of these species to assist in bloom prediction and toxin production.

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Ciguatera

Ciguatera Fish Poisoning (CFP), caused by ciguatoxins produced by *Gambierdiscus* spp. and bioaccumulated in reef fishes is the most common phycotoxin-related illnesses. Globally, CFP affects the greatest number of victims and often with significant long-term health effects. Although traditionally considered as a tropical sickness, CFP is also being recently reported on subtropical

waters and the Mediterranean Sea, and new species of *Gambierdiscus* have been identified in these areas.

During the 16th ICHA, Ciguatera at last occupied the place it deserved. **Rob Magnien**, Chair of the IOC Intergovernmental Panel on HABs (IPHAB) presented a Global HAB Strategy supporting the science and management of ciguatera fish poisoning. The World Health Organization (WHO) will be contacted to designate CFP a “neglected tropical disease”.

In her plenary session, **Pat Tester** reviewed the state of knowledge on taxonomy, genetics and biogeography of the increasing list of CFP species. Originally thought of as a monotypic genus (*G. toxicus*) there are now at least 13 species described (*G. silvae* and *G. scabrosus* in 2014), and based on DNA sequence data, two of the previous species (*G. yasumotoi* and *G. ruetzleri*) have been re-adscribed to the new genus *Fukuyoa*. New results on the light physiology of *Gambierdiscus* were presented (**Adachi**) and a new FISH assay has been developed which allows identification of four *Gambierdiscus* species (**Pitz**). *Gambierdiscus* substrate attachment dynamics on altered reef ecosystems was described (**Parsons**); artificial substrates were recommended as standard monitoring protocol for benthic HABs (**Kibler**). The long term exposure of groupers to CTX added useful information to the effects of *Gambierdiscus*/CTXs (**Mak**) as did the first widespread study of the CTX toxicity of lionfish in the Caribbean (**Litaker**). An overview of both *Gambierdiscus* and *Ostreopsis* from the Cook Islands and the risk of CFP from New Zealand sea food provided a management perspective (**Rhodes**).

There have been considerable advances in more and more sensitive LC-MS technologies and considerable efforts devoted to obtain toxin standards to be distributed worldwide. Further, new vectors of CTXs have been identified (see section on Toxins).

A French Polynesian outbreak of CFP occurred in 2010 in Rapa, a remote area previously known to be CFP free (**Chinain**). There were two fatalities in this small community but comprehensive science and education outreach provided information on what had happened. The residents of Rapa have been

provided some safer fishing alternatives and their awareness of CFP is now quite high. Toxins other than CTX were considered in this study but 77% of the 250 fish samples tested positive for CTX. Epidemiological data from 2011-2012 indicate altered fishing practices has helped reduce the risk of CFP. A quite innovative and badly needed self-reporting website for CFP victims was developed so data can be shared across the vast French Polynesian archipelagos (**Gatti**).

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HABs in a Changing World

This topic, which first received considerable attention during ICHA 14 in Crete, continued ticking over in New Zealand; the slow pace of progress undoubtedly a result of coming to grips with the daunting scale of the problem. Attempts are continuing to link HAB time series to e.g. ENSO events (**Guzmán**), or use palaeoecological records to resolve species shifts in Chinese coastal waters (**Lu**). Potential range expansion of *Alexandrium* into the Arctic (**Cembella**) was raised, as well as Australian dust storms adding mycotoxins to seafood security problems (**Hallegraeff**). Genetic diversity and phenotypic variability provide physiological plasticity to different Baltic populations of *Alexandrium ostenfeldii* and suggest they should be able to adapt to changing climate conditions (**Kemp**). Ciguatera featured prominently at this conference, partly because of increasing concerns that this syndrome will be a winner of climate change (**Tester**). Multi-stressor laboratory experiments with the fish-killer *Heterosigma akashiwo* were tentatively extrapolated to future climate scenarios (**Matheson**). Increasing attention was also focused on threats to inland water quality from *Prymnesium* (**Brooks**) and cyanobacteria (**Pearl**), where climate change tends to render the synergy between anthropogenic nutrient loading and hydrological regimes more favorable to the development of HABs.

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Ichthyotoxic HABs

Fish-killing HABs, identified as a priority issue during the last IOC Intergovernmental Panel on Harmful Algal Blooms (IPHAB-XI, April 2013), may cause much more economic damage than HABs producing shellfish toxins but remain poorly studied and understood. The 16th ICHA devoted two sessions to different fish-killing genera: *Heterosigma* (**Trainer, Ikeda, Ueki**), *Karlodinium* (**Cosgrove**), *Prymnesium* (**Andersen**), *Karenia* (**Sakamoto**), *Alexandrium* (**Mardones**), *Chattonella*/*Pseudochattonella* (**Haigh**). The increased use by different research groups (US, Australia, Europe) of plate-reader based assays using comparable fish-gill cell lines has allowed important progress (**Dorantes-Aranda**), but the full calibration of these results against adult fish bioassays has not yet been conducted. For some fish-killers (e.g. *Heterosigma*, *Karlodinium*) lysis is a key factor. The precise nature and relative importance of the active molecules involved (ion-channel activators, prymnesins, PST, KTX, ROS) remains disputed.

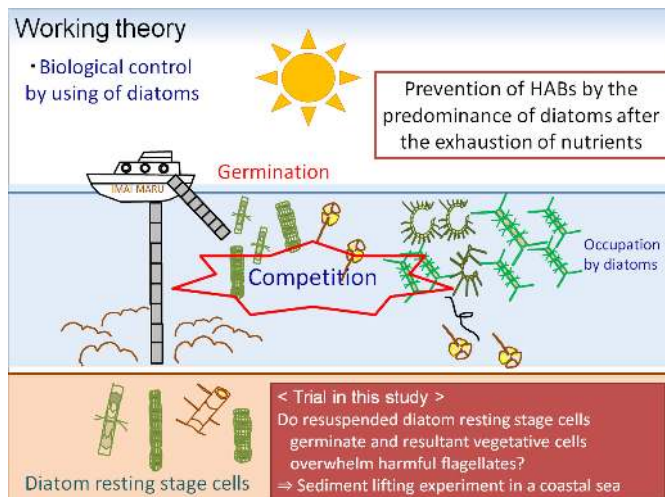
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HABs Mitigation

Ultimate HAB control remains reducing nutrient loads into watersheds but mandated load reductions remain impossible to implement so band-aid temporary fixes (mitigation) remain as the research and management foci.

Traditionally, phosphorus (P) input reductions were prescribed to control CyanoHABs. This is because P limitation is widespread and some CyanoHABs can fix atmospheric nitrogen (N₂), thereby satisfying their nitrogen (N) requirements. However, eutrophying systems are increasingly plagued with non-N₂ fixing CyanoHABs that are N and P co-limited or even N limited. In many of these systems N loads are increasing faster than P loads. Therefore N and P input constraints are likely needed for long-term CyanoHAB control (**Paerl, Sellner**).

There is continued exploration of clay application techniques for removing toxins (**Seeger**) and taxa (**Jung, Rivera**) from mariculture and natural ar-



Scheme of mitigation practice (Photo I. Imai)

eas experiencing blooms. Lytic bacteria (**Moon**), terrestrial plant extracts (**He**), and facilitated aerobic-anaerobic operational (**Lee**) approaches continue at small scales and in controlled settings.

'Lifting' and dispersing bottom sediment-associated diatom assemblages into surface waters is a recent attempt to enhance euphotic zone diatom growth instead of motile HABs that routinely dominate stratified surface waters in mariculture-rich areas of Japan (**Imai**, attached figure). In a similar approach, deployment of structures in euphotic depths that facilitate periphyton growth (**Ahn**) is an attempt to reduce ambient nutrient pools and HAB prevalence.

Freshwater HABs control seems realistic in systems where increased rates of hydraulic flushing are possible and low-cost barley straw can be deployed early in the HAB growing season (**Japareng, Sellner**).

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HABs Modelling and Forecast

A major goal is to achieve operational forecast models. In some areas this is beginning to get closer to reality. A near operational model for *Pseudo-nitzschia* spp and associated toxicity in California was presented (**Kudela**). This model uses statistical approaches that get round the need for difficult to measure driving variables (nutrients etc). Illustrations of it can be seen at <http://www.cencoos.org/sections/conditions/blooms/habforecast/>. A model-based

forecasting system for *A.catenella* in New Zealand waters is being developed (**Knight**). It draws on the work already carried out for the Gulf of Maine, USA, but also employs an unstructured grid-based physical model that allows detailed resolution of the fjord of interest, similar to an approach, presented during 15th ICHA

(**Aleynik**) for the Scottish fjords. Given that much aquaculture occurs in fjords or other sheltered embayments, such fine resolution modeling approaches are likely to become increasingly important.

An innovative approach was the use of remotely piloted aircraft "drones" to help with the survey of freshwater benthic microalgae (**Milne**). This approach, which requires significant development, is taking off in many areas of ecology and looks to have particular application for high biomass blooms in freshwater, but may also help to overcome the issues with cloud cover related to satellites when one wants to observe in marine waters.

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HAB Technologies

In the last decade, powerful new technological developments in optical instruments combined with species-specific probes have altered the way HABs can be monitored and opened new avenues for experimental research [1]. Likewise, the recent discovery of nuclear encoded genes for saxitoxins [2,3] now makes it possible to target the specific genes (e.g. *stxA*) controlling PSP toxin production in dinoflagellates and cyanobacteria. During 16th ICHA there were four full sessions devoted to "HAB Technologies" where at-

tendants could learn the latest exciting developments on: i) new instruments and sensors and ii) new methods for cell and toxin detection.

Progress on the development of universal microarrays and other products to detect HAB cells and their toxins (from previous EU projects MIDTAL and μ acqua) is leading to high-density microelectrode arrays (MEA) that can detect up to 100 targets. This development is ultimately intended for use on *in situ* buoy sensor systems (**Medlin**). A qPCR test that simultaneously identifies and quantifies the presence of cyanobacterial 16srRNA along with three genes responsible for four different toxins, (microcystin/nodularin (*mcyE*), cylindrospermopsin (*cyrA*), saxitoxin (*sxtA4*)), was presented (**Van Asten**). The *Phytoxigene CyanoDTec* test can be completed within 3 hours and represents a new tool for monitoring of toxin producing species and their toxins. Other novel methods for cell and toxin detection were based on pre-shaped sensor elements with a natural affinity for algal biotoxins (**Richter**). These were isolated from tunicates and are termed xenobiotic-activated nuclear receptors, XANRs.

Within the world of imaging particle analysis system, FlowCAM is now introducing its next generation FlowCAM SV, with new classification software, bio-volume estimation, and expanded particle properties (**Nelson**). A 'Cyano'CAM for freshwater plankton analysis is coming soon. The FlowCAM was also used with Fluorescent *in-situ* Hybridization (FISH) and species-specific probes to quantify *Alexandrium* abundance in plankton samples (**Sirois**).

A new solar-powered, multi-sensor platform for remote deployments of the



Photo D.M. Anderson



Scandinavian ladies of the Prodiversa network (NordForsk 2011-2014) having an opportunistic meeting. (Photo D.M. Anderson)



View of a poster session, Fowler Center, Wellington.

Imaging FlowCytoBot (IFCB) and other instruments was presented that allows high-frequency, high-resolution detection of fusing gametes, planozygotes, and other life cycle transitions during an *Alexandrium* bloom (**DM Anderson**). The IFCB has been used for a successful early warning of *Karenia* blooms weeks earlier than visible signs (water discoloration and dead fish) appeared (**Campbell**); it is also used to characterize the phytoplankton community composition (*Karenia* is not always dominant during bloom conditions) (**Anglés**).

The Environmental Sample Processor (ESP) is now being used in multiple HAB research programs. In the US Pacific northwest, five ESP deployments totaling ~100 days provided advanced warning of HABs in the inland coastal waters of Puget Sound to support proactive fisheries management efforts (**Moore**). Deployment sites included a tribal shellfish and finfish hatchery and a commercial shellfish farm. The ESPs were configured to sample daily and detect *Heterosigma akashiwo*, *Alexandrium* spp., and *Pseudo-nitzschia* spp. along with bacterial targets and microbial source-tracking indicators. In another application of the ESP technology, excellent agreement was found between estimates of shellfish toxicity based on ESP cell count measurements and flesh testing results at downstream shellfish monitoring stations (**DM Anderson**). This instrument has also proven to be a good research tool for resolving HAB bloom dynamics in complex systems when used in conjunction with AUVs and other observing assets (**Marin**). A smaller, 3rd generation ESP is now under development that can be deployed

in a small AUV. Other advanced technologies to test just the toxins are discussed in the Toxins section.

Anderson DM 2014. In: *Harmful Algae 2012*, Kim HG et al (eds), ISSHA 2014, pp. 3-17 (available on line at www.issha.org/Conferences)

Stüken A et al 2011 *PLoS One* **2011**, 6, e20096

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TOXINS

New Toxins: Improved performance of liquid chromatography-coupled to mass spectrometry equipments (LC-MS/MS), now replacing mouse bioassays in many countries, is leading to increased detection of different toxins in new parts of the world (“the more you look the more you find”). Azaspiracids (AZAs) have now been detected in New Zealand, Brazil and even in Greenland. Pinnatoxins (PnTX-G), presumably from *Vulcanodinium* spp., was found in kelp (*Saccharina latissima*) from Norway (**de la Iglesia**). Two new toxin groups, brevisulcenals (KBTs) and brevisulcatatoxins (BSXs), isolated from *Karenia brevisulcata* were described (**Satake**). In addition, new analogues of already known toxins were reported. These included new analogues of AZAs, DTXs, six new spirolides from *Alexandrium ostendfeldii* and five karlotoxins from *Karlodinium veneficum* (**Krock, Place**); of ovatoxins: OvTX-g and a new PLTX analogue from *Ostreopsis cf ovata* (**García-Altares**) and OvTX-h (**Hess**); of

yessotoxins: 22-OH-YTX from *Gonyaulax spinifera* (**Chikwililwa**), and gymnodimine analogues from *A. ostendfeldii* (**Harju**).

New vectors: Tetradotoxins (TTXs) were found in slugs (**Wood**), and ciguatoxins (CTXs) in sharks (**Arnich**), giant clams (**Roue**) and lionfish (**Litaker**).

Detection methods, structure elucidation and reference materials.

Highly sensitive ultraperformance liquid chromatography coupled to mass spectrometry (UHPLC-MS/MS) methods are being increasingly used for toxin detection, e.g. for CTXs/MTXs (**Selwood**), and HILIC (hydrophilic interaction) UPLC-MS/MS for STXs (**Boundy**). UPLC with fluorimetric detection (FLD) has also been used for STXs (**Watanabe**). LC-MS/MS methods have been optimized for analyses of CTXs/MTXs related to Caribbean/Pacific *Gambierdiscus* species (**Lewis**), and a turn-key multitoxin method for marine cyanobacterial toxins is in development (**Quilliam/McCarron**). Passive sampling (SPATT) has been widely used (**Dumalan, Hess, Roué, Frangopoulos, Chinain, Li, Qu, Lian**), not only for lipophilic toxins but also for hydrophilic toxins, including STXs. Mass spectrometry applications are more and more used for structure elucidation: LC-TOFMS (**Yasumoto**) and (LC-HRMSn) (**Dell'Aversano**) for palytoxin and ovatoxin congeners from Japanese and Mediterranean *Ostreopsis* spp. Semi-synthesis of acyl-esters of AZA1, PTX2 and cyclic imines was achieved (**de la Iglesia**). Increased efforts are being invested at the Japan Fisheries Research Laboratories (**Suzuki**) and Japan Food

Research Laboratories (**Kato** for CTX) in addition to those at the Canadian NRC (**Quilliam, McCarron**) to isolate, purify and certify reference materials for toxin analyses.

Effects in human health

Epidemiology of *O. ovata* blooms showed that impacts in humans coincided with the transition from exponential to stationary growth phase (**Berdal**). Following experiments with *Artemia salina* nauplii and with ephyrae of *Aurelia aurita*, an innovative model organism, suspicions were raised that the toxins are actually delivered with the mucus (**Giussani**) but the relationship between the blooms and the aerosol/contact problems are still elusive. Intestinal absorption and toxic effects of PnTXs from *Vulcanodinium rugosum*, and their cellular nicotinic acetylcholine receptors (nAChR) were studied in depth (**Fessard, Molgó, Hellyer**). The effects of brevetoxins (BTX) in mammals have been compared with those in freshwater turtles used as a model (**Cocilova**). Other studies showed that domoic acid (DA) causes learning impediments and hyperactivity in mice at sub-acute dose levels (**Lefebvre**). Cytotoxic assays with toxin mixtures showed a potential synergy between AZA1 and YTX (**Ferron**). New toxicity equivalence factors (TEFs) have been established for some STX-analogues, e.g. NEO=2.54 x STX (**Munday**). The revision of the risk assessment of saxitoxins and other toxins groups will have an impact on the revision of regulatory levels.

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Preparations for the 17th International Conference on Harmful Algae (ICHA) have started

Following the successful meeting at Wellington, NZ, preparations for the



The 18 ICHA logo (Photo L. Proença)



The ISSHA flag has arrived safely to Itajaí, its home for the next 2 years. It will be proudly guarded by young brave and hard working scientists until next ICHA in Florianópolis 2016 (Photo L. Proença)

17th edition of ICHA, to be held in Florianópolis, the beautiful island and capital of Santa Catarina State, South Brazil, have started. Local organization of the conference will be carried out by the Latin American Association for Studies on Harmful Algae (ALEAN) and by the Federal Institute of Santa Catarina (IFSC). The 17th ICHA will be held from 9 to 15 October 2016 at the CentroSul convention center. The FANSA regional committee is formed by colleagues from Brazil, Uruguay, Argentina, Chile, Peru and Ecuador and is now discussing major issues to bring to the conference.

The logo of the conference uses strong but friendly colours, inspired by the South-American region. The logo also recalls the astonishing dinoflagellate illustrations by Ernst Haeckel (1834-1919). The detailed cell wall, ornamented with pores, where information flows connecting the inside to the outside, resembles a network-shaped world of information and knowledge.

Registration for the event will be opened at the ICHA Brazil 2016 web site (to be launched). See you at ICHA Brazil 2016!

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IFREMER will host the 18th International Conference on Harmful Algae (ICHA) in Nantes, France

After submitting an application to the International Society for the Study of Harmful Algae (ISSHA) in July 2014, a 17-member strong French delegation led by Philipp Hess (IFREMER, Nantes) presented the French bid at the last ICHA conference in October 2014 in Wellington, New Zealand. Votes have confirmed Nantes (France) as the venue for the 18th edition of this conference in 2018.

The French initiative is supported by scientists from over 20 scientific institutions, including IFREMER, the French research institute on marine topics. The proposal arose from the recently created French research network *GdR PHYCOTOX* (<http://www.phycotox.fr>), coordinated by Hélène Hegaret (CNRS, LEMAR, IUEM, Brest) and Philipp Hess (IFREMER and IUML, Nantes). The City of Nantes and the Region Pays de la Loire have already committed to lend support to the initiative, as has the French Ministry for Food Agriculture and Forestry. The 25-strong scientific committee will draw its members from a wide range of research institutes and universities representing the two main scientific communities around harmful marine algae and freshwater cyanobacteria. Allan Cembella, from the competing-bid institution (Alfred Wegener



The French delegation celebrates winning the bid to host the 18 ICHA in Nantes, France, 2018 (Photo J. Camp)

Institute, Germany) will be an honorary member of this committee. The local organizing committee will include IFREMER staff and representatives from local

stakeholders such as the University of Nantes and the industrial cluster organization *Atlanpole Blue Cluster* (Pôle Mer Bretagne-Atlantique).

IFREMER: Institut Français de Recherche pour l'Exploitation de la Mer/
French Research Institute for Exploitation of the Sea ;

CNRS: Centre National de la Recherche Scientifique/National Center for Scientific Research

LEMAR: Laboratoire des Sciences et de l'Environnement Marin/Marine Environmental Science Laboratory

IUEM: Institut Universitaire Européen de la Mer/European Institute for Marine Studies

IUML: Institut Universitaire Mer et Littoral

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Workshop on quantitative PCR techniques for harmful algae

In association with the 16th International Conference on Harmful Algae, a two day workshop on qPCR techniques for harmful algae was held at the Cawthron Institute in Nelson, New Zealand (23-24 October). It was attended by 22 people from Australia, the United States, Germany, the Netherlands and New Zealand. The workshop combined presentations with demonstrations of qPCR assays for *Gambierdiscus* species and toxin genes in the new molecular facility at the Cawthron Institute. Topics discussed included target genes, advantages/disadvantages of detection systems, generation of standard curves, DNA extraction methods and sample storage issues. Workshop presenters were Wayne Litaker (NOAA, USA), Shauna Murray (University of Technology, Sydney), Uwe John (Alfred Wegener Institute, Germany) and Mark van Asten (Diagnostic Technology, Australia).

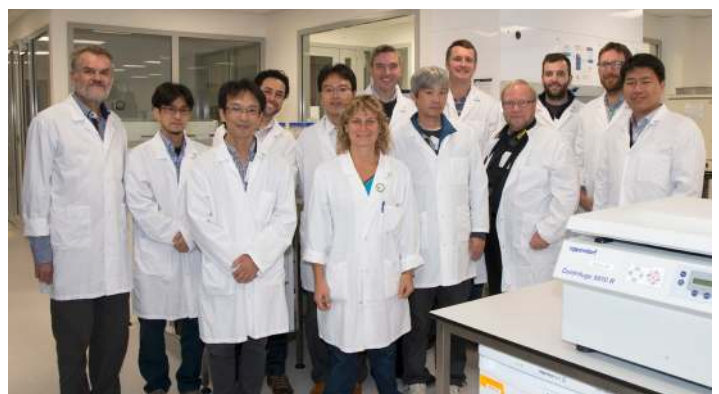
If you are interested to receive the hand-outs and presentations from the workshop, please contact Kirsty Smith).

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Cawthron visitors post ICHA meeting

In the week after the ICHA conference in Wellington, New Zealand, the Cawthron Institute enjoyed hosting about 20 delegates representing at least 10 countries who chose to extend their New Zealand trip to include a visit to the beautiful South Island. The Cawthron Institute is situated in Nelson, in the north of the South Island. It was a busy couple of days with visits to the various Cawthron laboratories, including the new Envirotech complex, an excursion to the Cawthron Aquaculture Park, a barbeque and various collaborative meetings. Many also enjoyed the nearby Abel Tasman National Park and the rugged Kaikoura Coast.

*Tim Harwood and Lesley Rhodes are co-leaders of the government-funded Safe New Zealand Seafood programme.
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Visitors to the new molecular laboratories at Cawthron Institute, Nelson, New Zealand.

Eutrophication and Harmful Macroalgal Blooms in Florida's Indian River Lagoon

The Indian River Lagoon (IRL) along Florida's east-central coast is a shallow (~0.8 m) and narrow (~3 km) bar-built estuary extending 248 km between New Smyrna Beach and Jupiter, Florida. As a result of its overlapping position along the temperate to subtropical ecotone, the IRL is regarded as one of the most species diverse estuaries in North America, and includes 7 species of seagrasses and >225 species of benthic macroalgae. Because of the limited number of oceanic inlets and the addition of several man-made causeways, tidal influence is restricted to several kilometers around each inlet and residence time can be high within the inner basins of the IRL. The significant freshwater and nutrient loads associated with urban and agricultural land uses, combined with restricted flushing and dilution, make the IRL highly susceptible to eutrophication [1].

Historically, macroalgae were not an important component of the flora in the IRL. However, with increasing nutrient availability in the water column, the IRL now supports extensive blooms of unattached, drift macroalgal communities (Fig. 1) and the attached rhizomatous alga *Caulerpa prolifera* (Fig. 2). Unlike toxic phytoplankton blooms, macroalgal blooms generally lack direct chemical toxicity but typically have a broader range of ecological impacts including: i) oxygen depletion; ii) loss of

habitat and biodiversity; iii) alteration of biogeochemical cycles and iv) die-off of important keystone species, such as seagrasses and corals. Increasingly, macroalgal blooms foul beaches and shorelines important to local tourist economies and require expensive biomass removal programs.

Blooms of red macroalgae (Rhodophyta) have been especially prevalent in the IRL in recent decades. In comparison to seagrass light requirements, experimental studies of the growth rate-irradiance relationship of an abundant red drift macroalga in the IRL – *Gracilaria tikvahiae* – showed that when growing at the seagrass compensation irradiance of $0.2 I_0$ (I_0 = full natural irradiance) under nutrient-replete conditions, this alga can grow at 0.1 doublings·d⁻¹, corresponding to a doubling of biomass in 10 days; when growing at I_0 such as in shallow waters, this macroalga can grow at 0.37 doublings·d⁻¹, or a doubling of biomass in only 2.7 days [2]. Increased nitrogen availability and reduced irradiance lead to elevated chlorophyll *a* and phycobiliprotein pigments in *G. tikvahiae*, increasing photosynthetic efficiency under low irradiance. As a result, *G. tikvahiae* is capable of high productivity under the increasingly eutrophic environmental conditions in the IRL where light attenuation (*K*) is relatively high and where seagrass

growth is limited or absent.

To examine the role of nutrient enrichment in eutrophication and HABs in the IRL, we sampled a network of 20 fixed stations throughout the entire IRL to document spatial and temporal variability in nutrients, chlorophyll *a*, and seagrass/macroalgae communities during 2011/2012. Following a prolonged drought between 2006 and 2010 and heavy rainfall between 2011 and 2013, unprecedented phytoplankton blooms developed in the northern IRL in the beginning of our study. A “super bloom” (the green alga *Resutor* and small cyanobacteria; ~100 µg/l) developed in summer 2011 in the Banana River [3], which was followed by brown tides (*Aureoumbra lagunensis*, >200 µg/l) in the Mosquito Lagoon and northern IRL in summers of 2012 and 2013 [4]. Total dissolved nitrogen (TDN) in both the wet and dry seasons increased from the southern to the northern IRL, with mean concentrations exceeding 70 µM in the northern IRL segments where the phytoplankton blooms developed. This high TDN concentration largely reflects dissolved organic nitrogen (DON), which could support the emerging brown tides in Mosquito Lagoon, as similar brown tides in northeastern and mid-Atlantic U.S. estuaries are known to utilize DON. The nitrogen build-up in the northern IRL was also reflected in a high TDN:TDP ratio, which increased from ~28 in the southern segments to >59 in the northern segments, suggesting shifts towards P-limitation in



Fig. 1. Blooms of drift macroalgae in the Indian River Lagoon, including the rhodophytes *Hydropuntia secunda* and *Gracilaria tikvahiae*, and the chlorophyte *Chaetomorpha linum*. Photo courtesy of St. Johns River Water Management District.



Fig. 2. Bloom of the attached, rhizomatous chlorophyte *Caulerpa prolifera*. Photo courtesy of St. Johns River Water Management District.

the northern IRL segments. This could be ecologically significant, as the brown tide organism *Aureoumbra lagunensis* outcompetes other phytoplankton under P-limited conditions [5].

The dense phytoplankton blooms in 2011 and 2012 caused extensive seagrass loss (~ 60%) and coincided with unusual mortality events (UME) involving manatees, dolphins, and pelicans [6]. Necropsies of dead manatees showed evidence of abundant macroalgae, including *Gracilaria* spp., in their stomachs, along with severe intestinal irritation and bleeding, suggesting an apparent “toxic shock syndrome.” This raised concerns about possible intoxication of the manatees following the HAB events. During the period of unusually high manatee mortalities in the northern IRL in spring and summer 2013, we sampled *Gracilaria tikvahiae* and associated drift macroalgal communities, which became a primary food source for manatees following seagrass die-off, at a manatee mortality “hot spot” at Shorty’s Pocket in the Banana River in May and July, 2013. The mixed macroalgal communities were dominated by red drift algal species including *G. tikvahiae*, *Acanthophora spicifera*, *Hypnea musciformis* and *Hydropuntia secunda*, but also included conspicuous blooms of the green alga *Chaetomorpha linum* (Fig. 1) as well as cyanobacteria mats (Fig. 3).

Although these drift macroalgal communities in the IRL are generally not considered toxic, human intoxication

due to consumption of *Gracilaria edulis* (now *Polycavernosa tsudai*) did affect 13 people who ingested the raw seaweed in Guam, 3 of whom died [7]. A novel glycosidic macrolide, polycavernoside A, was isolated from the *G. edulis* and was considered responsible for the poisoning [8]. A sewage outfall at 18 m depth to the north of the reef flat where the *G. edulis* was collected, was considered a possible factor by the Guam Environmental Protection Agency; to date, however, no evidence exists that sewage pollution was a direct cause of the seaweed toxicity in Guam.

In the IRL, however, stable nitrogen isotope values ($\delta^{15}\text{N}$) of macroalgae tissue sampled during our 2011/2012 studies averaged +6.3 ‰, a highly enriched value similar to that reported for macroalgal blooms in a variety of sewage polluted estuaries and coastal waters [9]. With the exception of periodic wet weather discharges, all wastewater treatment plants in the IRL watershed are presently in compliance with current water quality protection codes, rules, and statutes [10]. Despite the elimination of point-source sewage inputs (i.e. outfalls) to the IRL through the IRL Act of 1990, non-point source sewage pollution from septic tanks (on-site sewage treatment and disposal systems, OSTDS) has continued to expand and remains a serious environmental and human health concern [11]. Federal and state agencies have long recognized the harmful impacts of OSTDS to groundwaters and surface

waters in Florida, including the IRL [10, 12]. Currently, there are ~300,000 OSTDS installed in the counties adjacent to the IRL. Contamination of groundwaters with nutrients derived from non-sewered human wastewater has long been known to contribute to eutrophication of lakes, estuaries, and coastal waters [13, 14] and could be an important pathway for nutrient pollution of the IRL. Such groundwater-borne nutrient inputs would negatively impact the seagrass communities and biodiversity of the IRL by fueling both macroalgae and phytoplankton [4, 11, 15] HABs.

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Fig. 3. Bloom of the rhodophyte *Gracilaria tikvahiae* with epiphytic cyanobacteria at Shorty’s Pocket, Banana River, Florida.

Conspicuous blooms of *Chaetomorpha linum* in the International Biosphere Reserve Seaflower, SW Caribbean

Blooms of ephemeral macroalgae are a well-known consequence of nutrient enrichment and eutrophication in coastal waters, especially in oligotrophic tropical and subtropical waters, where their frequency has increased over the last decades [1, 2]. These blooms may have detrimental effects on seagrass and coral reefs, overgrowing coral colonies and seagrass beds, inhibiting the recruitment of juvenile corals, reducing light availability and leading to hypoxia [1, 3, 4].

These ephemeral blooms usually involve one or more species of early successional, opportunistic green algae, from the genera *Ulva*, *Chaetomorpha* or *Cladophora* [2]. In the Caribbean, recurrent blooms of the green algal species *Chaetomorpha linum* have been reported in Jamaica, and on seagrass beds in the Florida Keys [1]. Generally, these blooms have been attributed to nitrogen enrichment of the coastal waters [1, 3, 5].

San Andres island is part of the International Biosphere Reserve *Seaflower* in the Southwestern Caribbean, and, with a resident population of 70069 habitants [6], equivalent to 2803 hab/km², it is one of the most populated islands in the Caribbean [7]. Furthermore, tourist affluence is high and constant throughout the year, increasing the anthropogenic pressure on the nearshore coastal ecosystems. From February to May 2013, and again from September to October of the same year, San Andres experienced unusual blooms of *Chaetomorpha linum* (Fig. 1), which smothered seagrass beds (Fig. 2) before being washed ashore (Fig. 3).

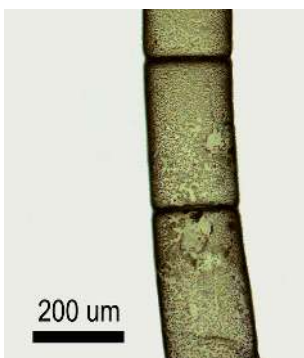


Fig. 1. Filament of *Chaetomorpha linum*. Scale bar: 200 μm

The alga formed large mats or “pillows” with sediment trapped within (Fig. 2, arrows). These moved and attached to seagrass for several days, before ending up on the beaches. The sediment-coated mats (Fig. 2) may have a scouring effect on seagrass leaves. The algae were not floating on the surface, instead they were always found tumbling along the substrate, sometimes attaching to seagrass leaves and shoots. This behavior has already been reported for this species in other locations [8]. On the adjacent coral reefs, the presence of the green alga was not observed.

In Jamaica, the first observed macroalgal blooms in shallow coastal waters were mainly due to *Chaetomorpha linum*, which smothered coral reefs and seagrass [9]. Those events have been directly related to an increase of nutrient pollution from raw sewage. According to [10] green tides composed of *Chaetomorpha linum* expanded in areas most influenced by sewage discharge.

Although we did not perform nutrient analysis of seawater, it is probable that the progressive nutrification of the coastal waters of the island, which has occurred for at least the last 15 years [11] is responsible for these conspicuous blooms. The wastewater disposal is highly inefficient, and does not include any treatment prior to the sewage discharge at sea [11]. In order to prevent the appearance of these blooms and their negative effects on the nearshore ecosystems in the future improvements to the management of wastewater discharge and reduction of nutrient input on the coastal waters are urgently required.

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Fig. 2. Mats of *Chaetomorpha linum* with sediments (arrows) smothering seagrass leaves.



Fig. 3. *Chaetomorpha linum* washed ashore. Spratt Bight, San Andrés Island, Colombia, May 10, 2013.

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Unusual biomass of pelagic *Sargassum* reached the Southwestern Caribbean



Fig. 1. Map showing location of San Andrés Island in the Caribbean Sea (modified from www.worldatlas.com)

Offshore from the coast of Florida, northeast of the Great Caribbean Basin, the Sargasso Sea, an extensive pelagic ecosystem is sustained by two species of holoplanktonic *Sargassum*: *S. fluitans* and *S. natans*. Under the influence of the Trade Winds blowing from a Northeast to Southwest direction in the second part of the year, drift algae coming from the Sargasso Sea are a common site from September to January in the Gulf of Mexico and the Antilles [1]. Periodically, atypical quantities of *Sargassum* have been observed in the Gulf of Mexico, where sightings have been very abundant followed by a decline in the biomass reaching the coast some years [2]. Despite the traditional belief that these floating seaweeds originated from the Sargasso Sea, it was recently demonstrated that the biomass flux is transported in the opposite way, i.e., the algae grows at the beginning of the year in the Gulf of Mexico, and during spring-summer is transported, by the Loop Current and Gulf Stream, to the Sargasso Sea [3].

In 2011, the above mentioned phenomenon reached dimensions never previously reported. Huge quantities of pelagic *Sargassum* were washed ashore along all the eastern coastline of the Caribbean Sea, and crossed the Atlantic to reach the western coast of Africa,

from Sierra Leona to Ghana [4, 5] in an unprecedented event. The biomass observed in the Caribbean was estimated to be 200-fold higher than the average seasonal peak and it was the first time drift *Sargassum* reached the coast of Africa in living memory [5]. It was demonstrated that the seaweeds originated in an area north of the estuary of the Amazon River, offshore the coast of Brazil [4, 6]. This region, in the past, had never been associated with *Sargassum* growth, and scientists suggest a link with global warming and perhaps nutrient load from the Amazon River [4]. In 2012, less striking, although atypical, sightings of drifting *Sargassum* have been reported from Cuba [1].

San Andrés Island lies in the Southwestern Caribbean, about 280 km off the coast of Nicaragua (Fig. 1). Its coast is periodically subjected to drifting biomass during winter months, generally from November to January, when Trade Winds are strong and great amounts of drift are driven to the coast. The drift reaching the island is mainly composed of seagrass species (*Thalassia testudinum* and *Syringodium filiforme*), and a diverse community of seaweeds, including a reduced biomass of *Sargassum natans* and *S. fluitans* [7]. Most of the drift annually washed ashore is local in origin, coming from seagrass and coral ecosystems nearby.

During September 17-20 2014, an unusual tide of *Sargassum* (Figs 2, 3), composed by the planktonic species *S. fluitans* and *S. natans*, reached the northeastern coast of the island, covering an estimated surface of 32.520 m² [8]. Meanwhile, reports of floating algae reaching the coastline of the Lesser Antilles have been documented between August and September of this year [9].



Fig. 2. Floating *Sargassum* along the coast of San Andrés island.



Fig. 3. Beached *Sargassum* on the coast of San Andrés Island.

During the 2011 event, San Andrés was not affected by the anomalous event impacting the Eastern Caribbean.

Although the origin of this 2014 event has yet to be identified, the drift in San Andrés was observed shortly after the passage of hurricane *Edouard* towards the Atlantic coast of United States, and currents deriving from this atmospheric event may have blown seaweeds to San Andrés Island [10].

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First record of the harmful dinoflagellate *Cochlodinium polykrikoides* in Lampung Bay, Indonesia

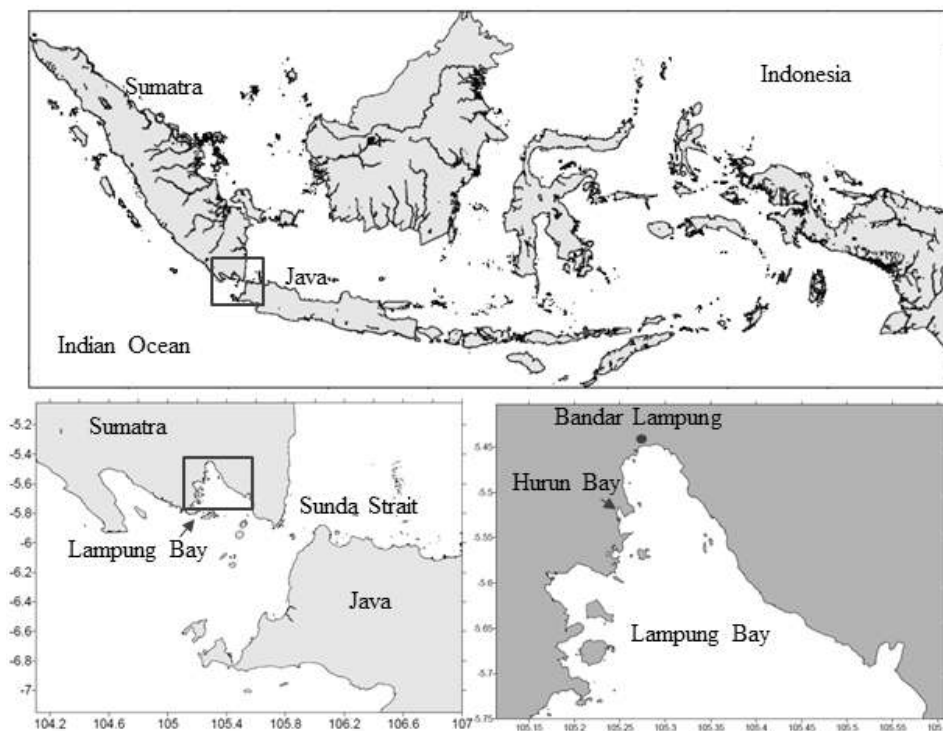


Fig. 1. Location of sampling site at Lampung Bay, southeast Sumatra coast

The Millennium Ecosystem Assessment (2005) [1] pointed out the indisputable impact of invasive alien species (IAS) on island ecosystems. One of the major causes of loss of biodiversity in coastal areas, these species are implicated in changes to the structure and functioning of these particularly sensitive ecosystems. Some harmful algal bloom (HAB) species are considered by the *International Union for Conservation of Nature* (IUCN) to be invasive. Their expansion is indisputably worrisome.

In Asia, where intensive aquaculture endeavors to meet the increasing need for food, thousands of poisonings have been attributed to HABs since the 1980's [2]. Indonesia, with more than 253 million inhabitants, has a vast maritime territory, with nearly 108,000 km of coastline. Although no detailed information is available, it is recognized that the number of HAB events has been increasing in recent years and now affects most Indonesian coastal waters, especially in semi-confined areas [3, 4].

Lampung Bay, located southeast of the island of Sumatra, facing the Sunda Strait (Fig. 1), hosts numerous economic activities (aquaculture, shellfish farming, pearl farming, fishing and har-

bour activities). Bandar Lampung, the main town in eastern Sumatra, is on the bay which is in a strategic location and is absolutely vital for thousands of people.

In October 2012, the surface coastal waters off Bandar Lampung became dark brown (Fig. 2 a). The phytoplankton bloom progressively spread in the southern part of the bay (Fig. 2 b). In November 2012, mass mortalities occurred in many fish-farms in Lampung Bay resulting in the loss of millions of dollars (Fig. 2 c). This phenomenon continued over the following months. During this phytoplankton bloom, vegetative cell densities reached 7.4×10^5 cells L^{-1} in December 2012. After microscopic observations, it appeared that the unarmoured dinoflagellate *Cochlodinium polykrikoides* was the species involved in this fish killing event. Based on the position of the sulcus and shape of chloroplasts the causative species was identified as *C. polykrikoides* and clearly differentiated from the similar species *C. fulvescens* [5]. In October 2013, the abundance of this species ranged from 8.1×10^5 to 1.05×10^8 cells L^{-1} . Fish kills associated with *Cochlodinium polykrikoides* bloom were re-

ported in Indonesia for the first time. The economic losses for mariculture industries and fishermen around the bay were unprecedented.

This species was then scarcely observed in the water column. The putative explanation of such sudden events is the existence of numerous cysts beds of *C. polykrikoides* in the bottom sediments. Numerous cysts were isolated from sediment samples collected in May 2014, and their morphology was very similar to that described by Tang and Gobler [6] and somewhat different from the forms described by Li et al. [7] (Fig. 3 a, b). An exact identification will be possible after cultivation. In October 2014, *Cochlodinium polykrikoides* was again observed in the waters of Lampung Bay (Fig. 3 c, d, e, f).

The harmful unarmoured dinoflagellate *Cochlodinium polykrikoides* (Gymnodiniales, Dinophyceae) displays features of an invasive species: cosmopolitanism, geographic discontinuity and a wide ecological spectrum. It is considered as an invasive alien species according to DAISIE (Delivering Alien Invasive Species Inventories for Europe, DAISIE European Invasive Alien Species Gateway (<http://www.europe-aliens.org>). Kudela and Gobler described a complete inventory of its expansion and its ecological strategies [8]. Before 1990, blooms of this species were observed mainly in Southeast Asia. Then, in the 1990s, the South Korea's fishing industry suffered annual losses of more than 100 million US dollars. Since then, blooms have been seen throughout the Asian area and on European and North American coasts. Iwataki et al. identified three *C. polykrikoides* sub-clades or ribotypes: the East Asian ribotype (which refers to the original Japanese-Korean clade), the American/Malaysian ribotype and the Philippine ribotype [9]. This latter species has been observed in the Mediterranean Sea, where the Italian coast is affected since the late 1990s, and in the Black Sea since 2001 (see references cited in [8, 10]. Until recently, it had rarely been detected on the Catalan coast, but in 2011, concentrations up to 2×10^4 cells L^{-1} were recorded in the port of Arenys, North of Tarragona [10].

Investigations will be conducted to study the cysts beds distribution of this harmful species in Lampung bay



Fig 2. (a) *Cochlodinium polykrikoides* bloom forming dark brown patches off Bandar Lampung. (b) Mrs Muawanah, research scientist from BBPBL, collecting water samples and (c) mass groupers mortality in BBPBL fish farm, in Hurun Bay, November 2012

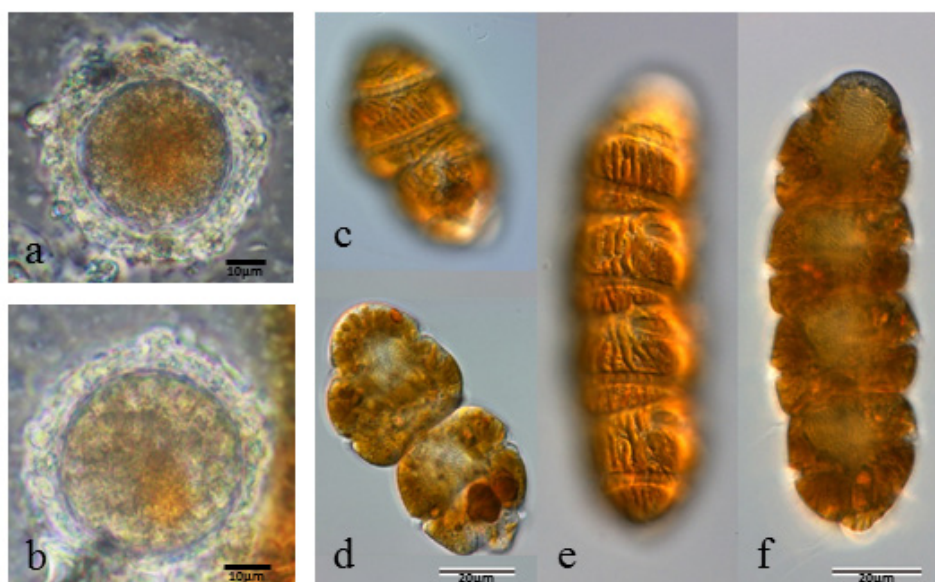


Fig 3. (a, b) *Cochlodinium polykrikoides*-like cysts collected in 0-5 cm of the surface sediment sampled in May 2014 off the city at Lampung Bay, where the highest cell abundance of *C. polykrikoides*, from 2012 to date, was recorded; (c, d) Two-celled and (e, f) four-celled chains of *C. polykrikoides* collected in Lampung Bay, October 2014

and molecular identification will allow us to determine the sub-clade of the *C. polykrikoides* isolated and help us to understand its expansion.

Acknowledgements

This work was supported by the Research Center for Oceanography-LIPI and the Balai Besar Perikanan Budi-daya Laut Lampung (Indonesia), the Institut de Recherche pour le Développement and the University of Montpellier (France) and the Grants-in-Aid for Scientific Research, JSPS KAKENHI 25304029 and the JSPS ACOE-COM-SEA program (Japan).

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Observations of *Heterosigma akashiwo* bloom and associated wild salmon lethargic behavior in Cowichan Bay, Canada, 2014

Heterosigma akashiwo is the most well-known and widely distributed fish killer and the main killer of farmed salmon in the Pacific Northwest region of Canada [1; Nicky Haigh, pers. com.]. In recent years (2009 - 2012), harmful algal blooms (HABs) caused \$16 million of direct economic losses in farmed British Columbia (BC) salmon, with *Heterosigma* being the causative agent for the majority of these losses [2]. While the direct effects of *Heterosigma* on farmed BC salmon are evident, wild salmon losses and fish stress responses during *Heterosigma* blooms are currently understudied [3].

Over the past 20 years, there have been dramatic declines in the abundance of wild Chinook Salmon and Coho Salmon in the Strait of Georgia, BC. In response, the Pacific Salmon Foundation (PSF), an independent non-governmental organization, initiated the *Salish Sea Marine Survival Project (SSMSP)*. The SSMSP is a five year project of ecosystem research and habitat restoration designed to improve fisheries management and enhance economic and cultural benefits for Salish Sea communities. The current multi-disciplinary project team consists of over 20 federal and provincial agencies, First

Nations tribes, academics and non-profit organizations [4]. The project seeks to improve our understanding of the causes of salmon mortality in the Salish Sea and explain wide fluctuations in salmon returns over the years. As part of the project, we initiated a pilot study to monitor HABs and investigate their possible effects on juvenile salmon (wild and hatchery) in the Cowichan Bay estuary and outer bay.

From the beginning of May to mid-July 2014, a team of technicians from PSF and Fisheries and Oceans Canada (DFO) collected fish samples using both beach seines (Fig. 1) and purse seines (Fig. 2). We also collected corresponding surface water samples at each set location for phytoplankton analysis. After collection, water samples were preserved with Lugol's Iodine solution; subsequent phytoplankton analysis was performed on a Sedgewick Rafter slide and dominant and harmful algae species were identified and enumerated under a light microscope.

During the late spring to mid-summer period, we observed three high phytoplankton biomass events or blooms. The first and third bloom were caused by *Pseudo-nitzschia* spp. (May 20, 21) and *Skeletonema costatum* (July

8, 9). During these blooms, the water was brown but the captured fish did not appear to be affected by the blooms. The second bloom was recorded during the first week of June and was caused by *Heterosigma* (Fig. 3); below we describe in detail this bloom development and associated changes in fish behavior.

The first few cells (≤ 10 cells mL⁻¹) of *Heterosigma* were recorded on the north side of Cowichan Bay on May 26-27 while purse seining (Table 1, Fig. 4). Much higher concentrations (mostly in the range of 100-1000 cells mL⁻¹) were observed the next day when beach seining.

In the first week of June, *Heterosigma* concentrations did not exceed 100 cells mL⁻¹ in both beach and purse seines (Table 1, 2).

On the beach seining day of the second week of June, all near shore areas were covered in a highly visible, thick orange bloom. *Heterosigma* concentrations reached $3-4 \times 10^4$ cells mL⁻¹ at the north area of the Bay (Table 2, Fig. 4). During sampling, we did not notice any unusual fish behavior at these locations, though very few fish were caught at that time.

In the third week of June the water was brown/orange in color and most of Cowichan Bay was covered in swathes of highly visible phytoplankton bloom. Subsequent laboratory analyses of these water samples confirmed high concentrations of *Heterosigma*, ranging from 800 to 12×10^3 cells mL⁻¹ on June 16, and $3.2-8 \times 10^3$ cells mL⁻¹ on June 17. The highest concentration of $12 \times$



Fig. 1. Beach seine in Cowichan Bay, 2014.



Fig. 2. Purse seine in Cowichan Bay, 2014.

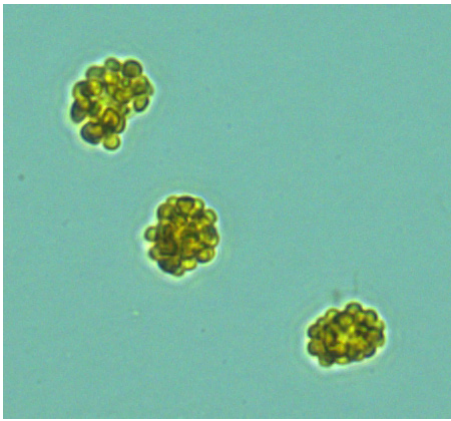


Fig. 3. *Heterosigma akashiwo* cells from the bloom in Cowichan Bay, June 2014.

10^3 cells mL^{-1} was collected from the north side of the Bay.

On these days we observed unusual behavior in the salmon that were captured in the net. In general, fish appeared to move more slowly; salmon species (Chum, Chinook, Coho, Sockeye) appeared to be lethargic (*i.e.* inactive and disoriented). We observed differences in behaviour between salmon species - while Chum Salmon were also slowed in their responses, the lethargy was very pronounced among Chinook Salmon in the net. Chinook Salmon did not exhibit any avoidance response when approached with a dipnet; several of them rolled over after approximately a half hour of sampling even without being handled. It should also be noted that on these two days of seining, we were collaborating with a team doing a Passive Integrated Transponder (PIT) tagging pilot project in which all captured Chinook Salmon were lightly sedated, PIT-tagged and carefully re-

leased upon full revival. The team's historical mortality rate associated with tagging has been about 1%; on this day the mortality rate rose dramatically to 25%. Some of these post-tagging morts were retained and frozen on dry ice for further laboratory analyses.

To test the hypothesis that the bloom could be the source of the apparent physiological stress condition of salmon, we selected one site away from the visible bloom and observed their behavior. Fish at this site did not appear lethargic; however causal associations must be qualified by the fact that Chinook Salmon catches were low at that site. (Note: subsequent laboratory analyses confirmed that *Heterosigma* concentrations at that site were the lowest recorded that day – 800 cells mL^{-1} .)

On June 18, beach seine samples had significantly lower concentrations of *Heterosigma* than those recorded the previous days of purse seining and only two sites had *Heterosigma* counts

exceeding 10^3 cells mL^{-1} . That was also the last day that we observed *Heterosigma* in Cowichan Bay that summer and in all following samples, *Heterosigma* was absent.

In summary, over the period ranging from late spring to mid-summer, we observed the development and decline of *Heterosigma* bloom in Cowichan Bay. *Heterosigma* cells first appeared on May 26 in very low numbers (<10 cells mL^{-1}) in offshore waters. It reached maximum concentrations of 4×10^4 cells mL^{-1} at a near shore site on June 11 and 1.2×10^4 cells mL^{-1} at an offshore site on June 16. High concentrations of *Heterosigma* at open water sites were associated with lethargic fish behavior, with Chinook Salmon appearing to be the most affected. *Heterosigma* cells were last seen on June 18th in high concentrations ($>1,000$ cells mL^{-1}). All later samples from June 25 to July 16 did not have *Heterosigma* cells. Based on these observations, the north side of the Bay appeared to be a

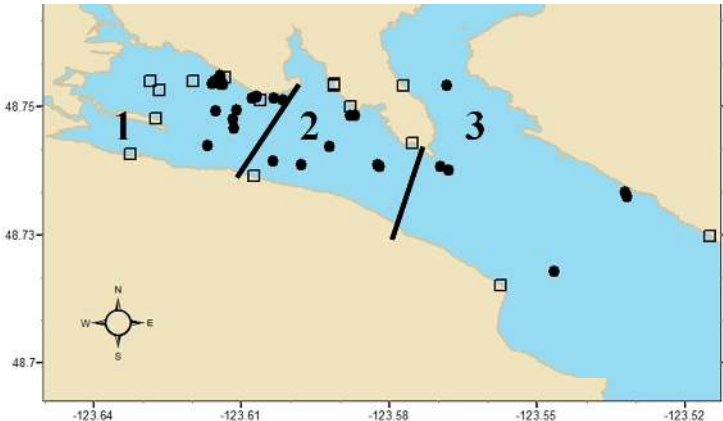


Fig. 4. Map showing purse seine (circles) and beach seine (squares) locations in Cowichan Bay, British Columbia, Canada from May 26 to June 18 of 2014.

Table 1. Purse seine locations and *Heterosigma akashiwo* cell mL^{-1} at surface water samples.

Day	Area	Number of sets	<i>Heterosigma akashiwo</i> (cell mL^{-1})	<i>H. akashiwo</i> (cell mL^{-1}) (average per area)
26-May	1	5	0-5	1
	2	1	0	0
	3	1	0	0
27-May	1	4	0-5	2
	2	1	0	0
2-Jun	1	2	0	0
	2	3	0-10	5
	3	2	0-8	4
3-Jun	1	3	30-60	43
	2	1	20	20
	3	1	30	30
16-Jun	1	3	2500-5000	3500
	2	2	800-12000	6400
17-Jun	1	3	3200-5000	4067
	3	2	7000-8000	6500

Table 2. Beach seine locations and *Heterosigma akashiwo* cell mL^{-1} at surface water samples.

Day	Area	Number of sets	<i>Heterosigma akashiwo</i> (cell mL^{-1})	<i>H. akashiwo</i> (cell mL^{-1}) (average per area)
28-May	1	1	220	220
	2	3	120-850	490
	3	1	10	10
4-Jun	1	3	0-15	5
	2	3	0-3	1
11-Jun	1	5	900-3200	2300
	2	3	4000-40000	24667
18-Jun	1	3	20-2500	907
	2	3	170-2000	957
	3	2	300-800	550

“hot spot” with consistently higher *Heterosigma* concentrations than other areas. Sampling will continue in Cowichan Bay for another three years and the cumulative data will provide insights into the effects of *Heterosigma* blooms on local juvenile wild salmon.

Acknowledgments

We are grateful to all the contributors and financial supporters who made Salish Sea Marine Survival Project possible. We thank Dennis Woloshuk, captain of the fishing vessel *Ocean Venture* and his crew for providing smooth and safe sailing. We thank Ewa Sniatycka for volunteering her sampling skills. Very

special thanks to SSMSp technicians - Chelsea Adams and August Jones for making the sampling process enjoyable and setting an excellent example for future sampling crews.

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Book review

Marine benthic dinoflagellates – unveiling their worldwide biodiversity

Mona Hoppenrath, Shauna Murray, Nicolas Chomérat & Takeo Horiguchi

Kleine Senckenberg-Reihe, Band 54, Schweizerbart, Stuttgart, Germany 2014, 276 pp., 93 Figs (more than 200 colour images, approximately 150 scanning electron micrographs, and more than 250 drawings), 8 Tables, in English. ISBN 978-3-510-61402-8, paperback, 19.90€.

In 1974 Georg Thieme Verlag published the book *Marines Phytoplankton* by Gerhard Drebes, which was based on photographs of living organisms when, at that time, the usual focus on taxonomy work was on dead parts of the cells. A new updated and enlarged version of that book was published in 2009 by Schweizerbart on the collection Kleine Senckenberg-Reihe and was authored, in addition to Gerhard Drebes, by Mona Hoppenrath and Malte Elbrächter. Now, using the same collection, Mona Hoppenrath, this time together with Shauna Murray, Nicolas Chomérat and Takeo Horiguchi, has published *Marine benthic*

dinoflagellates – Unveiling their worldwide biodiversity. Benthic dinoflagellates have been overlooked for a long time or even included as phytoplankton in many works. With this new publication, these authors give the benthic dinoflagellates the importance they merit. For many years within HABs studies, the focus of interest was on blooms of planktonic species. Nevertheless, given the importance of the Ciguatera syndrome caused by benthic dinoflagellate blooms, and the increasing number of benthic dinoflagellates identified as toxin-producers, the SCOR-IOC GEOHAB programme decided to include benthic HABs as a new distinct Core Research Project in addition to the initial four projects (Upwelling-, Eutrophic-, Stratified Systems, and Fjords and Coastal Embayments).

This book, which is devoted to all benthic dinoflagellates, both harmful and benign, fills a gap on this important topic and gives an appropriate context for the studies on benthic HABs independent of the phytoplankton literature. For this reason it was endorsed by the GEOHAB Steering Committee in the category “Framework Activity” related to the core re-

search project on Benthic Harmful Algal Blooms (BHAB).

The book is based on astonishing light and electron microscopy images but the abundant ink drawings are a valuable tool for a better understanding of the photographs. As there is much work still to be performed on the phylogeny of benthic dinoflagellates, the genera are presented on alphabetic order. Due to the huge information provided by the book, it will be a must beside the microscope and it will induce many phytoplanktologists to work with benthic dinoflagellates. Although it is full of colour pictures and very good quality printing, it has a very affordable price of less than 20 €. More information in: http://www.schweizerbart.de/publications/detail/isbn/9783510614028/Kleine_Senckenberg_Reihe_Nr_54_Marine_benthic_dino?l=EN

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First report of a mass-poisoning outbreak following the consumption of *Tectus niloticus* (Gastropod) in French Polynesia: a novel pathway of Ciguatera Shellfish Poisoning?

Marine products represent a major food source in many French Polynesian islands. The high risk of seafood poisoning, well known in several of these islands has the potential to pose significant health issues to local populations [1]. Ciguatera Fish Poisoning (CFP) is a toxic syndrome classically related to the consumption of tropical fish contaminated with ciguatoxins produced by dinoflagellate genus *Gambierdiscus*. CFP is the most prevalent ichthyosarcotoxin reported in French Polynesia [2], with an average incidence rate of 19/10,000 inhabitants reported annually, although this number may reach 1,800/10,000 in the areas most severely affected by this disease. These data are even more worrying based on the general assumption that actual reports may represent only 10% of the cases [3].

Moreover, reports of atypical forms of ciguatera tentatively designated as Ciguatera Shellfish Poisoning (CSP), and associated with the consumption of various marine invertebrates highly popular among local populations (e.g. giant-clams, sea urchins), have also been documented in French Polynesia [4]. Until very recently, these CSP incidents, which represent less than 10 cases/year were known to affect only the Australes (Tubuai, Raivavae and Rurutu islands) archipelago.

On June 2014, nine tourists suffered from a CFP-like syndrome following the consumption of several specimens of a gastropod, *Tectus niloticus* ("troca", Fig. 1), collected in Anaho Bay, Nuku-Hiva Island (Marquesas archipelago, French Polynesia, Fig. 2). All patients displayed clinical symptoms similar to

those of CFP, e.g. gastrointestinal (diarrhea, vomiting), neurological (paresthesia, cold allodynia) and cardiovascular (bradycardia, hypotension) disorders. However, the rapid (2 h) onset of symptoms associated to a burning/tingling sensation of the mouth and throat, their unusual severity (requiring the hospitalization of 7 of the patients) and the long-standing persistence of gastrointestinal symptoms, suggested the involvement of other toxic compounds in addition to ciguatoxins (CTXs). At the time of going to press, the two most severely intoxicated patients were still under medical surveillance in the Poison Control Centre of Pavia (Italia) and are presently subjected to a 5-month follow-up protocol. Other tourists agreed to answer a comprehensive medical questionnaire. The results of this clinical survey will be presented elsewhere.

To further investigate the etiology of this novel form of poisoning, 20 specimens of trocas from the incriminated fishing area in Anaho Bay were sampled in July 2014 with the assistance of the Sentinel Network of the Public Health Directorate and the Marine and Mining Resources Directorate of French Polynesia. Following their extraction using the protocol previously described by Pawlowicz et al. [5], RBA- and CBA-based toxicological analysis were conducted. Preliminary results con-

firmed the presence of both lipophilic ciguatoxin-like compounds and hydrophilic toxins in the extracts, whose identification by LC-MS/MS techniques is currently underway.

Although there were previous reports of CSP incidents in several South Pacific islands [6], the present report is the first to document a cluster directly associated with the consumption of *T. niloticus* in French Polynesia. Following our laboratory investigations, the local population was recommended by local health authorities not to consume trocas collected from the incriminated area.

It should be noted that *T. niloticus* is classified as a protected species in French Polynesia. However, its exploitation by the local population for shell trading and meat consumption is possible once a year through an official permit issued by the Ministry of Marine Resources. Therefore, increased outreach about the potential health risk associated with the consumption of trocas will undoubtedly benefit future CFP/CSP risk management plans not only in French Polynesia, but also in any PICT (Pacific Islands Countries and Territo-

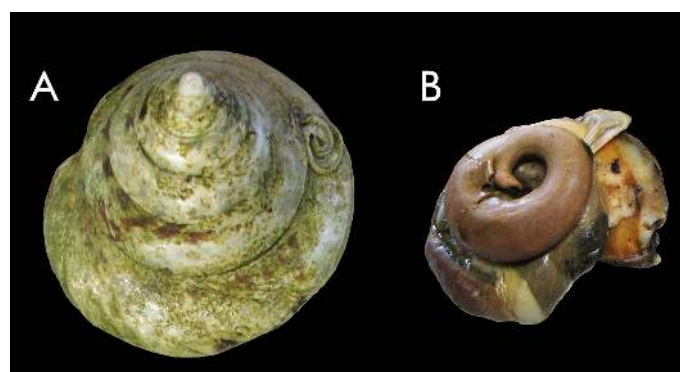


Fig. 1. A: Shell and B: mollusk flesh from a "troca" (*Tectus niloticus*).

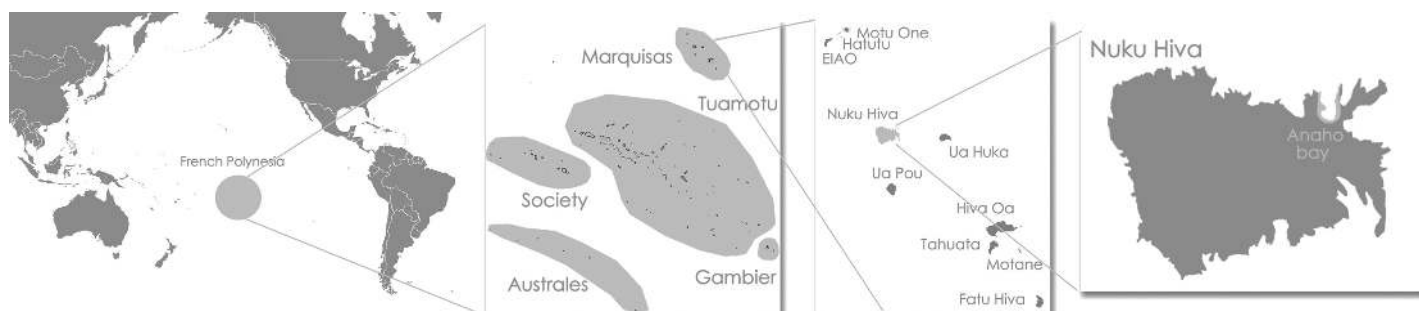


Fig. 2. Map of Anaho Bay in Nuku-Hiva Island (Marquesas archipelago, French Polynesia)

ries) where they constitute a significant subsistence and economic resource.

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First report of *Gambierdiscus* in Moroccan Atlantic waters

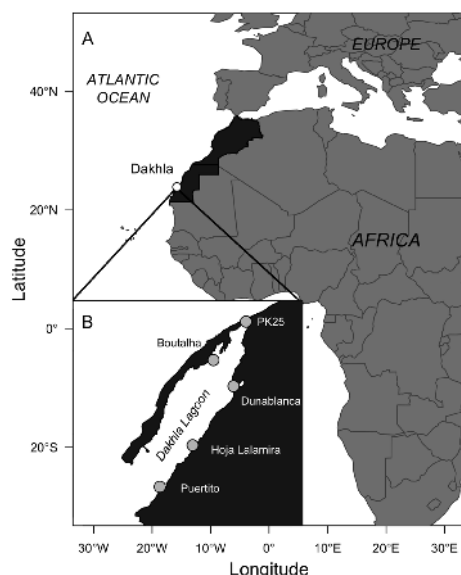


Fig. 1. Dakhla shores on the Atlantic Moroccan coast

Gambierdiscus species have been described as epiphytic and benthic dinoflagellates living on tropical reefs and attached to macroalgae surface, algal turf, detritus and sand [1-3]. Some species/strains of this genus have been shown to produce ciguatera fish poisoning (CFP) toxins [4]. These toxins cause gastrointestinal, neurological and cardiovascular disorders in humans [5].

Different species of toxin-producing dinoflagellates are present in the Atlantic coasts of Morocco, but *Gambierdiscus* spp. had never been reported [6,7]. Here we report the first detection of *Gambierdiscus* species on the Atlantic coast of Morocco.

During summer 2012, *Gambierdiscus*-like cells were observed in water samples collected from shellfish growing areas on the Bay of Dakhla, on the Southern Atlantic coasts of Morocco (Fig.1). Cell morphology was observed using light microscope and scanning electron microscopy. The taxonomic study is ongoing, but the morphological analysis showed the presence of the first plate (P1) and the apical pore complex (P0) corresponding to the genus *Gambierdiscus* (Fig. 2).

This finding should alert managers of fisheries resources and highlights the need to include *Gambierdiscus* spp. in the list of potentially toxic microalgae monitored in Moroccan waters.

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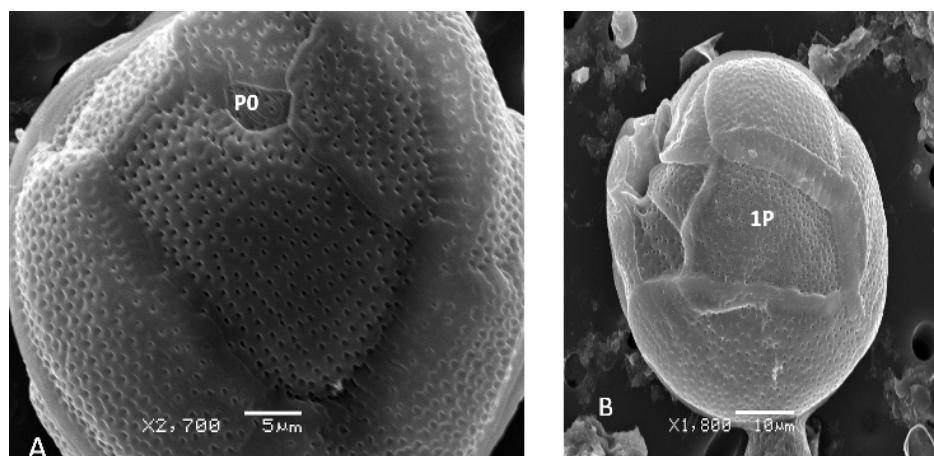


Fig. 2. *Gambierdiscus* sp. detected in Dakhla bay in Moroccan Atlantic coast: Scanning electron micrograph of epithecal plates with P0 (A) and 1 P (B) in apical view.

PACE-Net+ Think Tank: Coastal ecosystem disturbances, fish and shellfish poisoning and their socio-economic implications

Secretariat of the Pacific Community (SPC), Nouméa, 18-20 November 2014

In the Pacific, epidemics and food poisoning caused by fish consumption are widespread and can lead to severe illness and death. Their effects jeopardise food security and local economies. Population growth and climate change are likely to make these events more common. There is therefore an urgent need to conduct relevant research and find new ways of restricting these occurrences.

To help produce proposals in this regard, from 18 to 20 November 2014, the Secretariat of the Pacific Community, with European Commission, French Pacific Fund and ACIAR support, organised a think tank session on the theme of *Coastal ecosystem disturbances, fish and shellfish poisoning and their socio-economic implications*.

Four thematic areas were discussed: marine toxins, the effects of climate change and environmental disturbances, health and society, and cultural and economic aspects.

Some fifty experts (scientists, senior government officers, industry representatives) from the Pacific (Australia, Fiji, Cook Islands, Marshall Islands, Solomon Islands, New Caledonia, New Zealand, Papua New Guinea, French Polynesia, Samoa, Tonga, Tuvalu) and Europe (Germany, Denmark, Spain, France) actively contributed to the meeting.

After constructive discussions, the participants selected a number of priority research areas, highlighting the need to consolidate regional data bases so as to enhance the knowledge available and enable enlightened decision-making. The need to use traditional knowledge was also emphasized. The innovations seen as necessary by participants included easy-to-use diagnosis kits to identify fish and affected persons.

Some ten new project ideas designed to find solutions were also outlined. These project concepts were based on cooperation between the European and Pacific partners present over the 3 days. As always with PACE-Net+, relationships were formed and paths opened up for new networks with future potential.

Joint endeavors of this kind are fully consistent with European policy. Indeed, in his introduction at the think tank, Mr Efstratios Pegidis, European Bureau Chief for the Pacific Overseas Countries and Territories, stressed the importance of scientific and technical cooperation between Europe and the Pacific, in a setting where challenges such as climate change and food security are global in nature.

Lastly, the participants drafted recommendations that will inform regional and bi-regional political dialogue on scientific and technical cooperation and innovation, to be encouraged by PACE-Net+ with the main research players and decision-makers.

The outcomes of the Think Tank will be presented at the bi-regional dialogue to be held in Auckland on 10 and 11 December 2014.

For more information on PACE-Net+ and this Think Tank: <http://pacenet.eu>



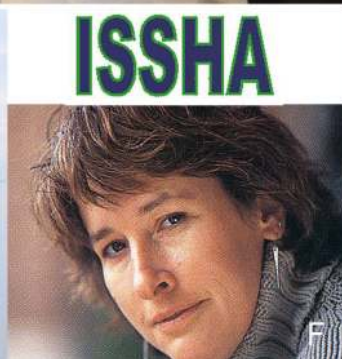
Australian Government
Australian Centre for
International Agricultural Research



ISSHA



International Society for the Study of Harmful Algae



*A&B: Frantic activity at the ISSHA Auction, coordinated by Esther, with Robin Raine as auctioneer.
C. A beautiful Takayama carving is given to Lincoln Mackenzie in recognition of a well done job organizing the ICHA 16.
D. Vera Trainer, newly elected ISSHA President, gives a present to the past President, Beatriz Reguera.
E. Anke Kremp (Finland), new ISSHA Secretary. F. Vera Trainer (USA), new ISSHA President
G. ISSHA Council meeting 2014 held on November 1 after the conference.*

ISSHA Corner

The International Society for the Study of Harmful Algae (ISSHA) convened the 16th International Conference on Harmful Algae (ICHA 16), held in Wellington, New Zealand, 27-31 October 2014.

The ISSHA Council had two opportunistic meetings: the first before the conference on Sunday 26 October and the second after the Conference, on Sunday 1 November morning. The ISSHA General Assembly was held on Thursday 30 October from 18.30 to 20.00, followed by a generous wine and snacks party which preceded the traditional ISSHA Auction. Robin Raine did a superb performance as our new ISSHA auctioneer. Bids (from France and Germany) to host the ICHA 18 (2018) were presented in plenary on Monday 27 October at the end of the first day of scientific presentations.

The 9th ISSHA General Assembly was opened by Beatriz Reguera and minutes from the previous assembly were approved. Karin Rengefors (Secretary) announced the results of the elections for Council members. The President (B. Reguera) and the Secretary (K. Rengefors) had to step down because their period of service for the same office was due. The newly elected President is Vera Trainer (USA), and the new Secretary, Anke Kremp (Finland). Two new council members are Luis Proença (Brazil) and Catherine Lebet (Sweden). The others were re-elected members and Gustaaf Hallegraeff was elected as Vicepresident to replace Minjiang Zhou (who had to resign for personal reasons). Committee chairs summarized activities and achievements in the previous two years. There were 27 travel awardees (ISSHA funds plus the generous support from FAO and SCOR); publication of the 15th ICHA Conference Proceedings was on-line and freely distributed through the ISSHA website.

During the conference closing ceremony on 31st October, the new achievement awardees (Yasumoto Award; Maureen Keller student awards) were announced. Luis Proença (Brazil), on behalf of the local organizing committee, presented the venue for the 17th ICHA to be held in Florianópolis (Santa Catarina, Brazil) in 2016. The French bid was the winner, so the ICHA 18 will be held in Nantes (France). Finally the beautiful hand-embroidered ISSHA flag,

a gift from the Korean hosts of the previous ICHA 15, was passed from Lincoln MacKenzie (Chair of the 16th ICHA local committee) to the future Brazilian organizers.

Officers and Council members 2014

Officers

President: Vera Trainer (USA)
Vice-Presidents: Robin Raine (Ireland) & Gustaaf Hallegraeff (Australia)
Secretary: Anke Kremp (Finland)
Treasurer: Henrik Enevoldsen (Denmark)
Past-President: Beatriz Reguera (Spain)

Council

Aligizaki, Katerina (Greece)
Amorin, Ana (Portugal)
Band-Schmidt, Christine (Mexico)
Davidson, Keith (United Kingdom)
Estrada, Marta (Spain)
Garcés, Esther (Spain)
Godhe, Anna (Sweden)
Hess, Philipp (France)
Jenkinson, Ian (China, France)
Lebet, Catherine (Sweden)
MacKenzie, Lincoln (New Zealand)
Proença, Luis (Brazil)
Roy, Suzanne (Canada)
Tubaro, Aurelia (Italy)

The profiles of the ISSHA officers and council members can be found at <http://www.issha.org/Society/ISSHA-Council-Members>

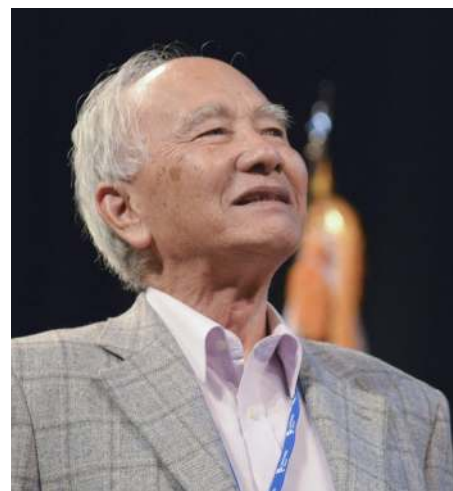
2014 Achievement Awards

The *Yasumoto Lifetime Achievement Award* was given to Prof. Gustaaf Hallegraeff (University of Tasmania). The *Maureen Keller Awards* for the best student communications were given to: Amanda Neilen (Sydney, Australia), Andres Seger (Tasmania, Australia), Wittaya Tawong (Japan) and Sara Harðardóttir (Denmark).

Gustaaf Hallegraeff was born in the Netherlands, received his doctorate from the University of Amsterdam, and in 1978 moved to Australia as a post doc with Dr. S. Jeffrey at CSIRO working on phytoplankton pigments and taxonomy. At this time, he established HAB research in Australia and sub-



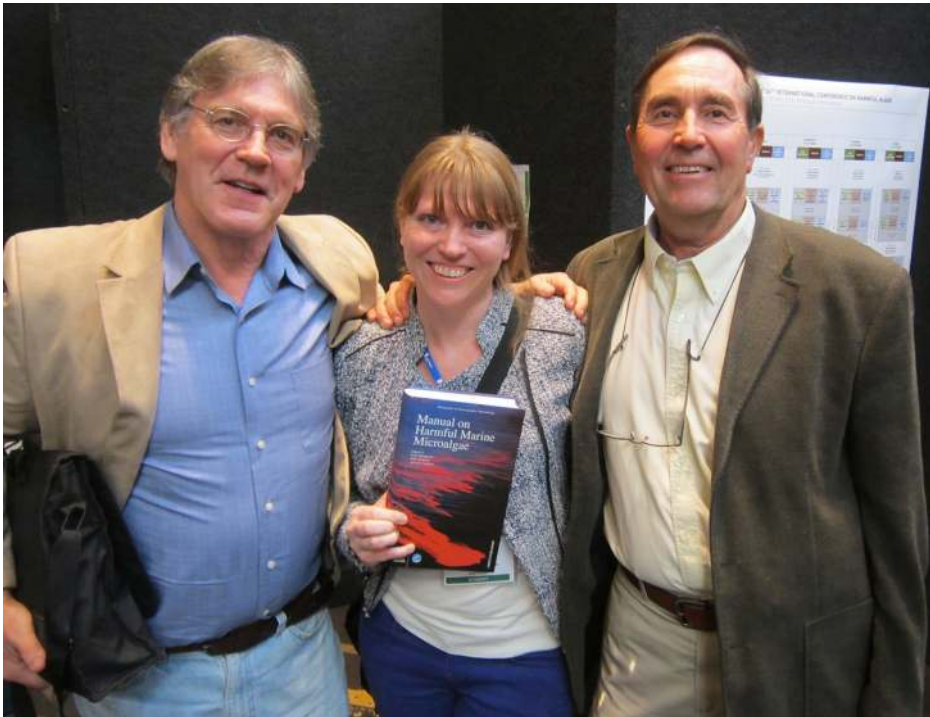
Prof Gustaaf Hallegraeff after receiving the Yasumoto Award (Photo J Camp)



Prof. Yasumoto listens to Hallegraeff's speech after giving him the prize named after him (Photo J Camp)

research. In 1992 Gustaaf moved from his Principal Research Scientist role at CSIRO to become a Professor in the UTAS School of Plant Science where he has continued to foster the next generation of HAB researchers. He is currently a Professor at the Institute for Marine and Antarctic Studies, University of Tasmania, Australia, where he has graduated over 30 PhD, 2 MSc. and countless Honours students across a diverse range of HAB topics.

A review of Gustaaf's more than 150 publications demonstrates the breadth of his scientific knowledge, enquiring mind, and even his artistic talent. His expertise in taxonomy, physiology, ecology and algal toxins is evident through many publications, reviews, and book chapters on key HAB species and groups such as *Gymnodinium catenatum*, *Alexandrium* and *Pseudo-nitzschia* species, and ichthyotoxic flagellates. More recently, Gustaaf's research has focused on the impact of climate change on phy-



Amanda Neilen (Sydney, Australia) after getting her HAB Manual gift signed by authors Allan Cembella (left) and Don Anderson (right) (Photo DM Anderson).

toplankton. Just as importantly, Gustaaf established ballast water introduction and global spread of toxic marine as an international issue. Over three decades his research has tackled treatment and control, risk mitigation, ballast water management and regulation, and ultimately prompted development of international policy and regulation of ballast water. The positive impact of this research on marine industries, as well as human and environmental health protection, resulted in the 2004 Eureka Prize for Environmental Research and his election as a Fellow of the Australian Academy for Technological Sciences and Engineering (2005).

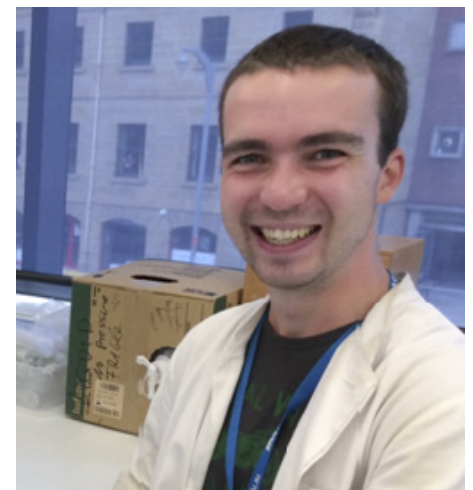
Gustaaf has been a member of the Harmful Algal Bloom community and a leader in the field for 35 years. He has served the broader HAB community by authoring and editing many HAB methods and identification guides and state-of-the-science books such as *Manual on Harmful Marine Microalgae* (1995, 2003), *Aquaculturists' Guide to Harmful Australian Microalgae* (2002), and *Algae of Australia: Phytoplankton of Temperate Coastal Waters* (2010). In particular his expertise, research training and leadership has developed or inspired almost all HAB research capacity in the Australasian region. Gustaaf hosted the Ninth International Conference on Harmful Algal Blooms in 2000 in Hobart, Australia, attended by 526

participants from 47 countries. The first Yasumoto Award was given to FJR "Max" Taylor at this meeting. All conveners of such conferences know what sacrifices Gustaaf made to provide such a successful meeting. Gustaaf has always played a very active role in ISSHA devoting considerable time and energy to the publication of the Proceedings, and now serves as Vice-President and on several committees.

Professor Hallegraeff is a gracious, meticulous, hard-working individual. His contributions to the advancement of HAB science, mentoring of students, and support and leadership in the HAB community and to this Society have been truly outstanding over his whole career and fully merit the honor of the Yasumoto Award.

Best student oral presentation was awarded to **Amanda Neilen**, from the Australian Rivers Institute, Griffith University, Australia, for her contribution on "Sources of Dissolved Organic Nitrogen and implications for Harmful Algae Blooms", co-authored with her supervisors, Michele Burford and Chengrong Chen. The research Amanda presented was produced from her honours degree that was submitted only days before the 16th ICHA conference in Wellington. Amanda had relocated to live in Bris-

bane city (Queensland, Australia) to join the Australia Rivers Institute, after graduating in 2013 from the University of Sunshine Coast with a Bachelor of Environment Science (minors in chemistry and mathematics). Amanda's keen interest in chemistry and mathematical modeling led her into this exciting world of CyanoHABs, dissolved organic nitrogen and reactive oxygen species (ROS). Fascinated by the dominance of recurring freshwater CyanoHABs in South East Queensland reservoirs and elevated organic nitrogen loads, Amanda 'submerged' herself in her project. The work presented investigated the relationship between land use, nitrogen loads and the associated impacts on *Cylindrospermopsis raciborskii* growth, the results from a series of soil and aquatic microcosm experiments. Amanda's research found that amount of bovine urine applied to the soil affected the concentration and composition of nitrogen that leached from the soil. Leaf litter leachates were a potential source of bioavailable organic nutrients to *Cylindrospermopsis raciborskii* proceeding photolysis reactions. Currently, Amanda is designing a series of field experiments for her PhD to fulfill her interest in catchment land use practices, nitrogen cycling mechanisms and the downstream effect on CyanoHABs.



Andres Seger (Tasmania, Australia)

Honorary mention for students' oral presentation to **Andres Seger**, from the Institute for Marine and Antarctic Studies (IMAS), Tasmania, for his contribution on: "Mitigating fish-killing algal blooms: clay revisited to remove ichthyotoxins" co-authored with Juan José Dorantes-Aranda, Marius Müller and Gustaaf Hallegraeff.

Born and raised in Hanover, Germany, Andreas moved to scorching hot Queensland, Australia in 2006, where he visited the last two years of high school. Seeking milder climates more comparable to home, he migrated to Tasmania in 2008 to complete his bachelor of marine science degree at the University of Tasmania in 2010. Thanks to Gustaaf Hallegraeff's teachings, he quickly developed a keen interest in ichthyotoxic algae that led him to complete an honours project with him at the Institute of Marine and Antarctic Studies in Hobart, Tasmania (2011). The project investigated the use of clay to mitigate ichthyotoxic *Prymnesium parvum* blooms in response to fish mortalities at an Australian Barramundi's farm. Hooked on harmful algae, he is now working on his PhD project (supervised by Gustaaf Hallegraeff and Zanna Chase) to further explore the ichthyotoxin adsorptive properties of clay minerals and assess their potential application to other harmful algal species. "I have developed a strong interest in the physiology of fish-killing algae, particularly with regard to their toxic principles and quantification of ichthyotoxicity through cell line assays. I greatly enjoy utilising this knowledge in an applied way to help develop strategies to mitigate fish-killing effects".

Adachi. Born and raised in Chiang Rai (Thailand) in 1982, Wittaya received his bachelor's degree of Fisheries in 2005 and Master of Fisheries Technology in 2008 from Maejo University (Chiang Mai, Thailand). During 2005–2008, he had a great experience as a research assistant with Japanese researchers in the topic of toxic cyanobacteria species and algal toxins in aquaculture ponds. That opportunity was very important to inspire him and improve his knowledge on the interesting topic of harmful algae. Furthermore, he received a scholarship from Naresuan University since 2010 to undertake a doctoral program under the supervision of Masao Adachi at the Laboratory of Aquatic Environment Science (LAQES), Kochi University, Japan. "My Ph.D dissertation was focused on the morphology, molecular biology, distribution, toxicity and growth factors of toxic benthic dinoflagellates causing ciguatera fish poisoning, in particular *Gambierdiscus*, *Ostreopsis* and *Coolia* from Thai coasts. Currently, I am working as lecturer and researcher at Naresuan University and continuing research with the application of molecular tools in the study of marine and freshwater harmful algae species from Thailand".

Nielsen and Nina Lundholm. Sara was born in Iceland but migrated to Denmark to undertake her studies. In 2009 she obtained a BSc in Molecular Biology and in Philosophy and Science studies from Roskilde University, Denmark. On a cruise between Tromsø Norway and Nuuk Greenland in 2010, she met Nina Lundholm, her supervisor for the master project and the current PhD project. Since then Sara has been working with phytoplankton from Arctic waters. In 2012 she graduated with MSc in Engineering - Aquatic Science and Technology from the Technical University of Denmark. Sara did her thesis on phytoplankton succession during a *Phaeocystis pouchettii* dominated spring bloom in Disko Bay, west Greenland. The project had an additional focus on succession of sea ice algae in newly forming sea ice and she found and described a new species, *Pyramimonas diskoicola*. Currently she is working on her PhD studies, supervised by Nina Lundholm, Torkel Gissel Nielsen and Uwe John, at the Natural History Museum of Denmark. The main theme of her project is to study toxin (domoic acid) producing diatoms in the arctic marine food web. In her thesis she investigates the interaction between domoic acid-producers *Pseudo-nitzschia* spp. and their grazers.



Wittaya Tawong (Japan)



Sara Harðardóttir (Denmark)

Best poster presentation was awarded to **Wittaya Tawong**, Kochi University, Japan, for his contribution on: "Characterization of *Gambierdiscus* and *Coolia* (Dinophyceae) isolates from Thailand based on morphology, phylogeny and toxicity", co-authored with Tomohiro Nishimura, Hiroshi Sakanari, Shinya Sato, Haruo Yamaguchi and Masao

Honorable mention for poster presentation to **Sara Harðardóttir**, University of Copenhagen, for her poster on: toxic diatoms in the Arctic marine food web: "The effect of domoic acid on arctic *Calanus* copepodites grazing on the diatom *Pseudo-nitzschia seriata*", co-authored with Marina Pančić, Anna Tammilehto, Bernd Krock, Torkel Gissel



United Nations
Educational, Scientific and
Cultural Organization



Intergovernmental
Oceanographic
Commission



PICES



International Council for
the Exploration of the Sea
Conseil International pour
l'Exploration de la Mer

ICESCIEM



International Council for Science
Scientific Committee on Oceanic Research

First announcement

Scientific Symposium on Harmful Algal Blooms and Climate Change

Gothenburg Sweden 19-22 May 2015

A Scientific Symposium on climate change effects on the global distribution, frequency and intensity of harmful Algal blooms will be held 19-22 May 2015, at Gothenburg, Sweden.

The central purpose of this symposium will be to bring together HAB scientists and climate change scientists to ascertain what is known about climate change and its potential linkages to HABs, to identify the most pressing, achievable research goals over the next decade, and to determine the minimal long term monitoring infrastructure needed to provide the data for global HAB assessment in the context of climate change.

The symposium will include invited speakers, oral and poster presentations by participants, with concentration on participant-led break-out sessions on specific topics.

Prepare for registration and submission of abstracts in early 2015.

Conveners: Bengt Karlson, Sweden, Mark Wells, USA, Raphael Kudela, USA and Angela Wulff, Sweden

About the symposium

Climate change will significantly affect marine ecosystems, and it is expected that there will be effects on the character, frequency and intensity of Harmful algal blooms. Examples of the potential drivers of HAB change include:

- warming – changed distribution of HAB species, including range expansion/contraction
- ocean acidification – possibly increased total primary production, positive for some HAB-species
- increased water column stability – increased stratification favour many HAB-species
- changes in rain fall distribution and dynamics - altered nutrient supply and input of humic substances, both potential drivers for change in the occurrence of HAB's
- + several other ways

However, these anticipated linkages to increases or decreases in HAB impacts remain largely undemonstrated, and it is unlikely that all potential avenues of affect are known. Presentations at the symposium will include findings from observations, experimental work and modelling.

A second announcement with information on registration, abstract submission etc. will be distributed in early 2015. Information on symposium fee and possibilities for young scientists travel awards also will be part of the second announcement.



Global Ecology and Oceanography of
Harmful Algal Blooms



Forthcoming events

The Impact of Global Change on Toxic Phytoplankton

Session 011 at the ASLO 2015 Aquatic Sciences Meeting, Granada, Spain, 22-27 February 2015, Aquatic Science: Global And Regional Perspectives—North Meets South.

Session Organizers:

Val H. Smith, University of Kansas, vs-mith@ku.edu

Dedmer B. Van de Waal, Netherlands Institute of Ecology, d.vandewaal@nioo.knaw.nl

Hans W. Paerl, University of North Carolina at Chapel Hill, hans_paerl@unc.edu
Programme and abstracts: <http://www.sgmeet.com/aslo/granada2015/sessionschedule.asp?SessionID=011>

The ICES-IOC Working Group on Harmful Algal Bloom Dynamics (WGHABD)

This group is focused on HABs in the North Atlantic and marginal seas. The next meeting will be held in Lisbon, Portugal, 13-17 April 2015. One task of the group is to gather information about HABs. Please report harmful algal events observed in your nation to your country representative in WGHABD for inclusion in the Harmful Algae Event Database, <http://haedat.iode.org>. Eileen Bresnan, United Kingdom, is the new chair of the group. Bengt Karlson, Sweden, resigned in autumn 2014 after end of term. More information about WGHABD activities: <http://ices.dk/community/groups/Pages/WGHABD.aspx>

Twelfth Session of the IOC Inter-governmental Panel on Harmful Algal Blooms (IPHAB-XII), UNESCO, Paris, 28-30 April 2015.

The Panel (IPHAB) was formed in 1991 to set priorities for and ensure the financial resources for implementation of a global HAB Programme. A primary task is still to identify the required resources, so that the international community jointly can continue to implement activities on capacity building, international cooperative research, and

communication networks. The membership of the IPHAB is open to Member States of IOC which have declared to the Secretary IOC their involvement or intention to participate in the development and implementation of the HAB Programme on a global, regional, or national scale. The Provisional Agenda and other documents for the Session is available at <http://hab.ioc-unesco.org/>.

The major focus of the Twelfth Session of IPHAB is tentatively the Global HAB Research Programme; Global Assessments of HAB events; capacity building; formulation and endorsement of specific regional activities; a plan for improved Ciguatera research and management, and Improving HAB forecasting capabilities for more effective mitigation strategies. The Agenda is furthermore open to the priorities of Member States. Based on its discussions the IPHAB will recommend to the IOC Assembly a work plan for the IOC HAB Programme for 2016-2017.

If you wish to know if your country is member of IPHAB you will also find the IPHAB List of Members at <http://hab.ioc-unesco.org/>. If you have questions regarding participation in IPHAB do not hesitate to contact the IPHAB Technical Secretary at h.enevoldsen@unesco.org.

IOC Training Course and Identification Qualification in Harmful Marine Microalgae 2015 (with optional workshops on enumeration and/or culture techniques):

Dates: Mandatory E-learning part over 4-5 weeks in the period May-July. Practical course 9-19 August 2015. Optional workshops on enumeration/culture techniques from 19-22 August.

Venue: IOC Science and Communication Centre on Harmful Algae, Department of Biology, University of Copenhagen, Denmark

The course includes 90 hours of teaching and is divided into two parts, each consisting of 45 hours of teaching. The first part of the course is an internet teaching programme, while the second part is a practical workshop on species identification. The Course ends with an

examination in species identification.

Part I - Distant learning: The distant learning programme consists of 8 modules. There is a short introductory text to each module, and at the beginning of this text is given a list of suggested reading, which will usually include selected articles or paragraphs of general text books. All exercises are mandatory. This part of the course includes 45 hours of teaching or a work load of about one working day per week for six weeks.

Part II - Practical course on species identification: The workshop will focus on identification of harmful algal species, with particular reference to the 'IOC Taxonomic Reference List on Toxic Plankton Algae'. During the workshop species will be demonstrated as live cultures, mixed samples or as preserved material. Focus will be on light microscopy. All participants will be urged to bring material for the course.

Details and application form: http://hab.ioc-unesco.org/index.php?option=com_content&view=article&id=32&Itemid=0

Deadline for applications: 1 April 2015.

Eighth Symposium on Harmful Algae in the U.S.

November 15 - 19, 2015

Long Beach, California

Further details will be posted to the following website, as they become available:

<http://www.whoi.edu/habsymposia/>



Ciguatera in the South Pacific

The IOC has established a list-server for Ciguatera and HABs in the South Pacific as a service to the community and as a means to facilitate communication.

If you are interested in this region and wish to subscribe, send an e-mail to sympa@sympa.iode.org with empty subject line and in the text body: subscribe picthab your name. You then receive a confirmation e-mail from picthab-request@sympa.iode.org. List-servers grow and become useful to the community if used!

As part of its strategy to develop a multi-agency plan for ciguatera the IOC welcome ideas, cooperation, linkages and partnerships with regional organizations and institutions on HABs and Ciguatera.



IOC meeting on Ciguatera in the South Pacific

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Please feel free to contact any of the editors if you have article, ideas for article or special issues and we will work with you!

Coming deadlines are:

15 February 2015, for HAN 51
15 May 2015 for HAN 52
15 August 2015, for HAN 53
15 November 2015, for HAN 54

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Lay-out

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