

# HARMFUL ALGAE NEWS



An IOC Newsletter on toxic algae and algal blooms

No. 4

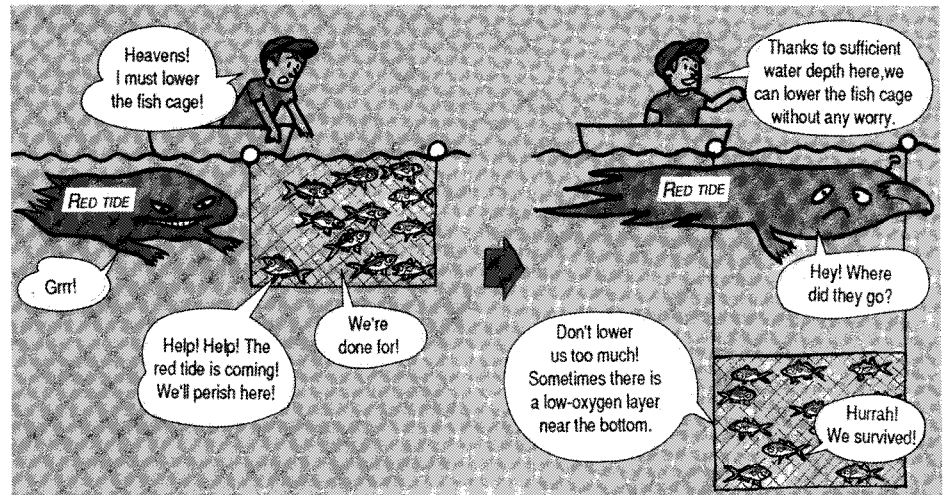
## Red tide action in Philippines: *Fishing community involvement sought*

Our vision in the Philippines is to have a nationwide, community-based red tide monitoring and management programme. Education of the community through video shows, slide shows and red tide information leaflets has been started. In one area, Bataan (Manila Bay), responsible fishermen and organizations have been mobilized in information dissemination during red tide outbreaks.

The project, entitled "Fisheries Sector Program (FSP) Training Package for Red Tide Monitoring and Data Management", is a collaborative endeavour between the Department of Agriculture of the Bureau of Fisheries and Aquatic Resources (BFAR) and the Marine Science Institute (MSI) of the University of the Philippines Science Research Foundation (UPSRF). Efforts are being made to involve fishermen in certain aspects of monitoring and management. After careful selection and intensive training of qualified fishermen, the latter will be integrated into the community-based red tide monitoring and management programme.

The project aims to: a) train government and interested university personnel in the major aspects of red tide monitoring and data management; b) ensure the use of standard methods in the collection, analysis and interpretation of data by providing trainees with the necessary skills, information and some kits; c) help develop systems of fast and reliable documentation and information exchange between the technical personnel and the general public; d) develop material that could be used beyond the project implementation period for information campaigns on red tides, and e) make recommendations to facilitate the development of a more sustained, permanent and comprehensive red tide monitoring programme to fit efficiently into the overall fisheries management programme of the country.

Involvement of rural inhabitants in coastal zone management is not new in



Example of red tide public information material; adapted from Japan's Ministry of Agriculture and Fisheries pamphlet on red tide countermeasures.

the Philippines. In 1986, the ASEAN\*-USA-sponsored Coastal Resource Management Project developed a community-based coastal resource management programme in Lingayen Gulf, in the north of the country. The commu-

nity-based approach has been summarized as "community-oriented, people-oriented and resource-based" (Ferrer, 1992).

For "participatory approaches to development" to succeed, careful planning

(Cont'd on p. 2)

## Algal bloom in NW Caribbean

Independent reports from Dr. Carolina Rogers (National Park Service, St. John, Virgin Islands) and Susan White (Saba Marine Park, Netherlands Antilles) indicate that there is an "unprecedented" planktonic algal bloom in progress across the NW Caribbean Sea. Underwater visibility is less than 3 m from an average of more than 20 m. This is the period of the year when the plume of the Orinoco River is known to make incursions into the Caribbean, as evidenced from CZCS<sup>(1)</sup> imagery, penetrating all the way to Puerto Rico on occasions (F.E. Müller-Karger et al. 1990. *Prog. Oceanog.* 23: 23-64). An attempt is being made to verify the geographic extent, composition and other features of this water mass through coordinated observations by other members of the CARICOMP<sup>(2)</sup> cooperative

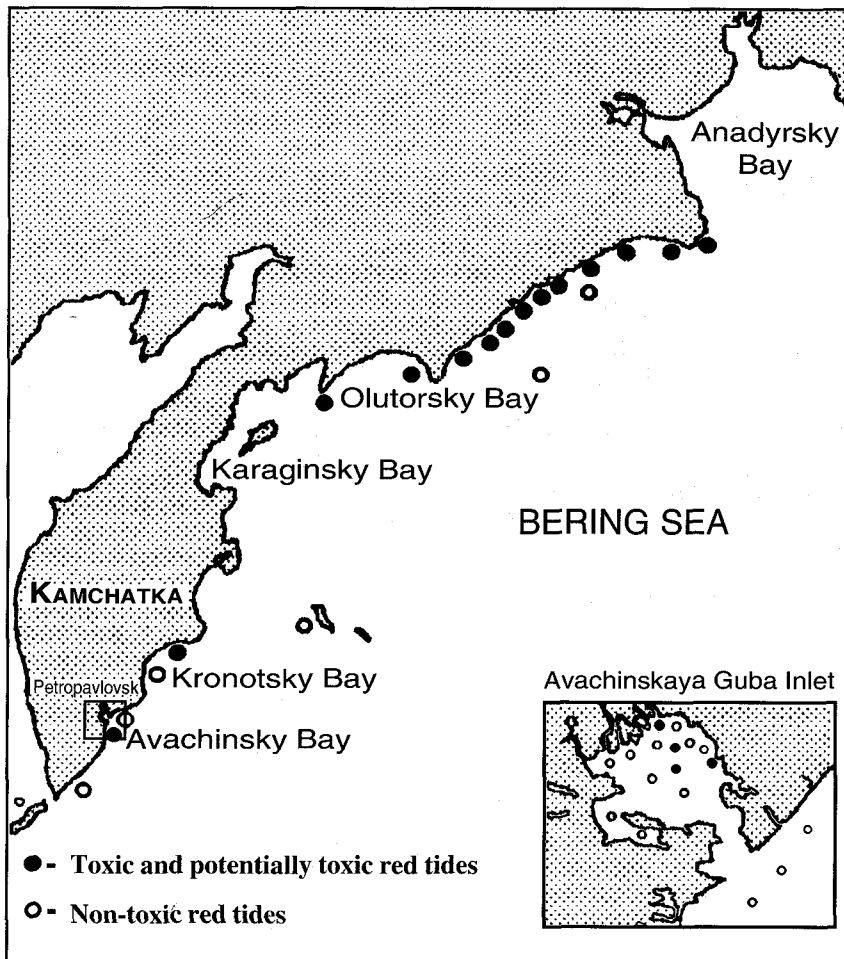
network of Caribbean marine laboratories.

The fact that this phenomenon cannot be examined from space through the current lack of an ocean colour scanner argues most strongly for the need for the SeaWIFS<sup>(3)</sup> sensor and its utility in large geographic scale examination of oceanographic events of potentially critical importance in the structure and function of coastal ecosystems.

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- (1) CZCS = Coastal Zone Colour Scanner
- (2) CARICOMP = Caribbean Coastal Marine Productivity
- (3) SeaWIFS = Sea-viewing Wide-field-of-view Sensor

## Harmful dinoflagellate blooms along the eastern coast of Kamchatka



The first dangerous red tide event along the coast of Kamchatka occurred in Pavla Bay and adjacent waters of the Bering Sea in the summer of 1945 and led to poisoning and death of some fishermen. The symptoms of poisoning by Pavla Bay shellfish which six men had for breakfast, resembled the effect of paralytic shellfish poisoning (PSP) produced by some species of the dinoflagellate *Alexandrium*. Further investigations proved their occurrence in these areas<sup>(1)</sup>. In August 1973 a similar tragedy was observed in Petropavlovsk-Kamchatsky on the shore of Avachinskaya Guba Inlet. Twelve people (mainly children) were poisoned after eating toxic shellfish collected in the Inlet and prepared on a fire. Two of them died. Some days before this event, intense water luminescence at night and red water by day were seen in some areas of the inlet. Poisoning of these people was found to be due to saxitoxin contained in mussels, probably derived from *Alexandrium tamarense* or *A. catenella*<sup>(2,3)</sup>. These species are com-

mon in the summer plankton of Avachinskaya Guba Inlet, and are responsible for red tides there.

Since 1983 red tide events have been observed annually in various areas along northeastern and eastern coasts of Kamchatka. Toxic red tides were observed in 1984, 1986, 1987, 1988 and 1990 in Avachinsky, Olutorsky and Kronotsky Bays including the northeastern coast of Kamchatka (see map). These blooms resulted in mortalities of marine mammals, birds and fish. There were no cases of human poisoning, possibly owing to the fact that newspapers and magazines widely disseminated information on the danger of eating mussels, especially during the periods of red tides.

Ten species of toxic and potentially toxic dinoflagellates belonging to the genera *Alexandrium*, *Dinophysis*, *Gymnodinium*, *Gyrodinium* and *Prorocentrum* have been identified in Kamchatka coastal waters. However, only four of them cause visible blooms, i.e. *Alexandrium tamarense*, *A. excava-*

(Cont'd from p. 1, "Red tide action")

for intensive education and mobilization of the people is needed. Education, being an important component of the approach, should be given much emphasis, for it will deepen the understanding of people as to the conditions of the coastal environment and its resources, heighten their consciousness and mobilize them for the activities that need to be undertaken.

In the Marine Conservation and Development Project of Silliman University (Dumaguete City, Negros) for example, rural people were mobilized and involved in the monitoring and care of coral reefs. They were given the opportunity to observe plankton samples under the microscope and coral reefs by snorkeling. Dr. Angel Alcala (then Director of Silliman Marine Laboratory, subsequently President of its University, and now the country's Secretary of Natural Resources and Environment) reports that marine reserve areas as in Sumilon Island are now being protected and developed by the community and the fishermen themselves.

\* ASEAN = Association of Southeast Asian Nations.

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Rhodora A. Corrales, Marine Sciences Institute, University of the Philippines, U.P.P.O. Box 1, Diliman, Quezon City 3004, Philippines.

*tum*, *A. acatenella* and *Dinophysis acuminata*.

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## Joint research programme between Hong Kong and China

A consortium aiming to promote research efforts on harmful red tides in the South China Sea which is a milestone of joint research between Hong Kong and China before 1997, i. e. the date that Hong Kong returns to China after 150 years' colonial administration by the British Government, was signed on July 1992. The institutions (which include Open Learning Institute of Hong Kong, Department of Biology in Hong Kong Baptist College, Department of Applied Science in City Polytechnic of Hong Kong and South China Sea Institute of Oceanology in China) have agreed to conduct a three-year collaborative project in identifying the limiting factors of red tide in the South China Sea, and in developing a computer model to forecast red tides on the basis of ecological data. Studies will concen-

trate on the harmful red tides, particularly those of *Alexandrium* spp., in the Pearl River Estuary, Hong Kong and Daya Bay. Studies of water quality, phytoplankton diversity and population dynamics, cysts, and limiting factors (by bottle bioassay) began in January 1993, and the institutions are raising grants from governments and private foundations to support this collaborative project.

In April 1992, widespread red tides were observed in the Pearl River estuary near Hong Kong. Characterized by their distinctive orange-juice colour, patches of *Noctiluca scintillans* were carried along the south China coast by the Kuroshio Current and tides. The incident caused temporary closure of 11 bathing beaches in Hong Kong and a severe kill of marine organisms by

deoxygenation in aquaculture facilities. The loss in this incident was more than US \$100,000.

In the winters of 1989 and 1990, Hong Kong was badly affected by the blooms (and toxicity) of *Alexandrium catenella*. This year, *A. catenella* was also present in the seawater but in low concentrations (<100 cell/ml). A survey suggested that cysts of the species persist in the bottom sediments of the South China Sea. Thus, there is a high possibility of paralytic shellfish poisoning (PSP) recurrence in the coming years.

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## Outbreak of black band disease in Caribbean

In the summer of 1992, a major outbreak of what is known as black band disease (BBD) was observed in Jamaican waters. This disease, first reported in Belize in 1973 as an algal infection responsible for coral mortality, has subsequently been found throughout the Caribbean and Indo-Pacific on scleractinian corals as well as on milleporinids and gorgonians.

In routine monitoring carried out since December 1991 on the north coast of Jamaica, less than 1% of scleractinian corals have been observed to be infected with BBD in most fore reef and back reef sites. This is comparable with published data reported for other Caribbean localities. However, two of

our study sites have shown a rapid rise in BBD cases, with up to 10% of the susceptible corals being infected at any one time.

The primary pathogen of BBD is the cyanophyte *Phormidium corallyticum*. In well developed cases BBD appears as a ring of finely interwoven black filaments separating living coral tissue from stark white skeleton. Severe infections in our study sites are characterized by a band up to 3 cm wide and a linear spread of 1 cm/day. We have found the disease most frequently attacking *Montastrea cavernosa*, *M. annularis*, *Diploria strigosa*, *D. clivosa* and *Siderastrea siderea*. Few cases have been observed on *Agaricia agaricites*.

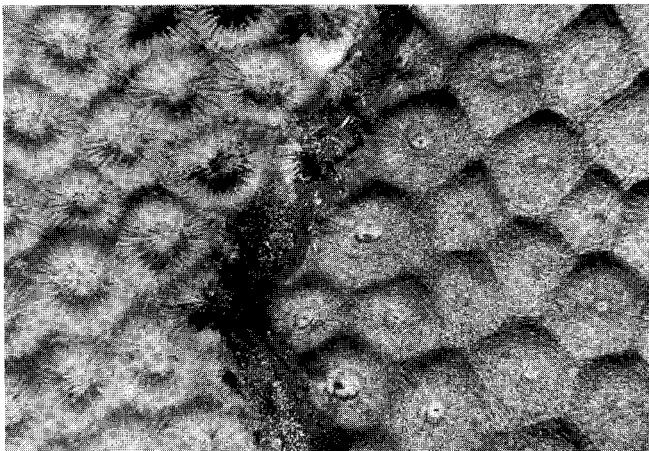
Three colonies of *Meandrina meandrites* (previously unreported in the literature) have been infected.

Mechanisms responsible for BBD are poorly understood. In

our study area the disease spreads most rapidly in the direction of prevailing water currents. The band is easily dislodged, flaking off during rough seas. Previously healthy corals down current of an infected colony most frequently acquire BBD, resulting in a clumped distribution of diseased colonies. Corals adjacent to colonies previously killed by black band disease frequently become infected. The disease can appear on a new victim several months after all signs of BBD have disappeared from the dead colony. Reef temperatures have not significantly increased for the duration of the study, remaining between 26°C and 28°C. The highest incidence of BBD overlaps with an area experiencing high siltation, a seasonal phenomenon which has persisted since March.

Jamaica's coral reefs have been dramatically effected by hurricanes, over fishing, pollution, sedimentation, algal overgrowth and frequent episodes of bleaching. Recent outbreaks of BBD suggest that the corals may be succumbing to environmental stress and the reefs may be rapidly converted to algal gardens, ultimately affecting tourism, shore protection and reef fisheries.

*Andrew Bruckner, Hofstra University Marine Lab, St. Ann's Bay, Jamaica.*



*Macrophotograph of Phormidium band on star coral, Montastrea cavernosa. Area represented is 6 cm long by 4 cm high.*

# Canadian workshops on harmful marine algae: *a review*

The domoic acid crisis in eastern Canada in late 1987 was the impetus for a major retargeting and expansion of phycotoxin research and monitoring efforts by several Canadian federal government agencies. A Department of Fisheries and Oceans (DFO) national action plan on harmful algal blooms and their associated effects on human health and marine ecosystems was implemented in 1989, under the direction of an *ad hoc* Phycotoxins Working Group (PWG). The PWG proposed an annual workshop on harmful algal blooms to serve as an informal forum for the exchange of information on phycotoxin research in a Canadian context.

The first DFO workshop, held in Moncton, New Brunswick, in the fall of 1989, was mainly devoted to issues arising from the domoic acid crisis of 1987-88. The second workshop, hosted by the Bedford Institute of Oceanography, Dartmouth, Nova Scotia in October 1990, was somewhat broader in scope, and reflected significant advances made in many areas of phycotoxin research.

The Third Workshop was held at the Maurice Lamontagne Institute, DFO, Mont-Joli, Quebec, from 12-14 May 1992. Nearly 100 people participated. Often at scientific conferences, the more prominent researchers are afforded special priority to give oral review presentations, while newcomers to the field (who may have the freshest insights and most relevant data) are relegated to an obscure poster session. This was avoided by eliminating plenary lectures, by making the poster sessions a focus of discussion, and by featuring a broad spectrum of oral presentations to include graduate students and outsiders.

## Third workshop issues

The thematic structure of the third workshop indicated the major issues in phycotoxin research pursued by Canadian scientists, and several new developments in phycotoxin detection methods were reported. Among the most significant were a modified mouse neuroblastoma cell bioassay for PSP, and a comparison of assay methods for ciguatoxins, which included the results of a protein phosphatase inhibition as-

say and a solid-phase immunobead test. A new competitive indirect enzyme-linked immunosorbent assay (ELISA) for okadaic acid, based on a monoclonal anti-idiotypic antibody, was also described.

Other presentations included: physiological and behavioural bioassays to study the responses of juvenile salmonids to potentially harmful microalgae; recent advances in analytical methods for phycotoxin detection and quantification, including ion-spray mass spectrometry (ISP-MS) coupled with flow injection (FI), high performance liquid chromatography (HPLC), and capillary electrophoresis (CE); the use of an immunofluorescence technique to discriminate closely related morphotypes in the diatom genus *Nitzschia*; proposal to use nucleotide sequences and PSP toxin profiles to characterize variation in PSP-toxin producing *Alexandrium* species.

## Focus on *Alexandrium*

The Maurice Lamontagne Institute has played a leading role in conducting studies on the population dynamics of *Alexandrium* and the transfer of PSP toxins within marine food webs. Participants from diverse laboratories gave presentations on the accumulation and metabolism of PSP toxins in blue mussels, lobsters and scallops, as well as on the effects of toxic species on copepod feeding behaviour and larval fish recruitment in the St. Lawrence ecosystem. The hypothesis that resuspended benthic cysts of *Alexandrium* are responsible for wintertime PSP toxicity in mussels was rejuvenated, with a correlation between toxicity and cyst numbers in the digestive tract in the apparent absence of motile *Alexandrium* cells in the water column. Some preliminary evidence tends to indicate that the endogenous clock hypothesis, rather than control by external environmental factors, is a more tenable explanation for *Alexandrium* cyst germination patterns in the lower St. Lawrence estuary.

Since DFO has instituted a national monitoring programme for harmful algae, the efficacy of various regional monitoring strategies was thoroughly

addressed. Modelling approaches to toxic bloom description and prediction were also considered. Colleagues from France and Belgium gave perspectives on DSP toxicity which proved useful in interpreting the results of experimental work on bivalve mollusc contamination.

Phycotoxin production and metabolism by various microalgal species grown under controlled conditions is an important component of current research programmes in Canada. The cage-culture turbidostat technique has been successfully applied, to study the effects of growth rate and environmental variables on PSP toxin production rates in *Alexandrium tamarense*. Researchers at the National Research Centre (NRC), Halifax have made great strides in understanding the biosynthesis of domoic acid in *Nitzschia pungens*, using <sup>13</sup>C-labelled precursors and nuclear magnetic resonance (NMR) to trace the biosynthetic pathway. The hypothesis that bacteria are ultimately responsible for the production of certain "phycotoxins" continues to attract attention. But it has been demonstrated that domoic acid production by *Nitzschia pungens f. multiseriis* can proceed unabated in the absence of associated extracellular bacteria. Arguments for a bacterial role in PSP toxin synthesis in *Alexandrium* are inconclusive and unconvincing, due to evident problems in maintaining good algal growth in control cultures.

In addition to the known phycotoxin-producing species of obvious concern to human health, plankton blooms of nuisance species also plague the Canadian seafood industry. A major project directed by the Maurice Lamontagne Institute on the "blackberry feed" problem, where the flesh of certain commercial fish species is rendered inedible due to a sulphurous odour, has established the link between a pteropod vector and certain prymnesiophyte species known to produce dimethylsulfide. Joint research effectively solved a mystery perplexing mussel culturists in Nova Scotia, which involves an alarming red colouration of the digestive gland. The source is the accumulation of a (non-toxic) ciliate *Mesodinium rubrum*, which harbours a red-pigmented cryptomonad endosymbiont.

## Working group assignments

Six highly effective Working Groups (WGs) were established, each containing less than a dozen participants. The major terms of reference were as follows: I. *Origin and propagation of harmful algae*: Group 1 - The American west coast domoic acid crisis; Group 2 - The problem of DSP in Canada; II. *Transfer of phycotoxins in the food web*: Group 3 - The benthic food web; Group 4 - The pelagic food web; III. *Methodology*: Group 5 - Detection and quantification of toxic algae and toxins; and IV. *Monitoring and prediction*: Group 6 - Monitoring toward the year 2000. A particular advantage of this format was that after some exchange of participants among WGs, the groups retained the expertise necessary to formulate realistic goals and recommendations, without becoming unwieldy in size.

Synopses of these discussions will appear in the workshop proceedings. However, a few key observations merit mention here. Phycotoxic events associated with domoic acid, originally believed to be localized in shellfish from eastern Prince Edward Island in Atlantic Canada, have now been reported as seabird mortalities associated with food chain transfer on the Pacific Coast of the United States. The high domoic acid levels in certain shellfish from the northeast Pacific, especially in razor clams and mussels, is particularly disturbing, as no definite causative organism has yet been identified. Canadian regulatory authorities must be vigilant in monitoring shellfish species from adjacent waters, to include non-filter-feeding species (e.g. Dungeness crabs) previously considered exempt from domoic acid accumulation.

## DSP in Canada

Even granted that under-reporting may occur, the limited number of cases of DSP in Canada is *a priori* evidence that a crisis does not currently exist. Nevertheless, the discussions revealed poor understanding of this phenomenon in Canada and inadequate knowledge of the taxonomy, ecophysiology and population dynamics of the causative species. At least ten *Dinophysis* species have been identified in Canadian waters, and two species (*D. acuminata* and *D. norvegica*) implicated elsewhere in DSP incidents can form blooms of  $>200,000$  cells  $L^{-1}$  along the Atlantic

coast. Thus the question arises: Why are DSP incidents not more common in Canada than the epidemiological literature indicates? Originally, the confirmed DSP cases in eastern Canada in 1990 were suspected to be due to the presence of *D. norvegica*, based upon circumstantial evidence. However, the lack of DSP toxins in subsequent blooms of this organism and the recent discovery of DSP toxins in *Prorocentrum lima* isolated from a mussel site known to be a source of DSP toxicity has complicated (but not refuted) this interpretation. The WG recommended that a retrospective survey of historical phytoplankton data on the spatial distribution of *Dinophysis* spp. in Canadian waters should be conducted to identify potential sources of DSP toxins in shellfish.

## Conclusions

Work is advancing rapidly on the transfer and detoxification kinetics, metabolism, and tissue compartmentalization of various phycotoxins in benthic invertebrates. In contrast, progress in determining the disposition of phycotoxins in the pelagic food web has lagged behind. Such fundamental questions as the acute effects of toxic algae on pelagic

grazers (fish larvae, zooplankton) and the resultant deleterious impact on recruitment of commercial fish species must be addressed from an oceanographic perspective. The excellent toxicological studies and bioassay methods emanating from the laboratory should now be extrapolated to the field.

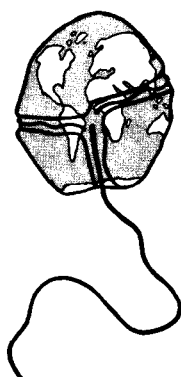
A consensus evolved that the harmful phytoplankton monitoring programmes recently initiated in Canada have been justified, but that they have not yielded much predictive capability. A plea by regulatory authorities and the seafood industry for the development of workable alternative methods for routine phycotoxin monitoring, and for increased availability of analytical standards and reference materials, is being heeded in a major continuing effort by the Halifax NRC laboratory.

The abstracts and proceedings of this workshop will be available in a few months as a Technical Report issued by the Maurice Lamontagne Institute, DFO, Mont-Joli, Quebec. Proceedings of previous workshops may be obtained from the respective DFO host institutions.

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## SECOND ANNOUNCEMENT

### *International Directory of Experts in Toxic and Harmful Algae*



An updated and expanded edition of this directory will be published in 1993 by IOC-NOAA. If you are involved in the basic scientific, applied fisheries, or public health aspects of harmful algae events in your country and would like to be included in this updated directory, please mail or fax your name and address to Alan White (see below) in order to receive a questionnaire. There is no need to send your name and address if you were included in the 1990 directory or if you attended the Fifth International

Conference on Toxic Marine Phytoplankton held in Rhode Island (USA), 1991. We would especially like to include individuals from countries not yet represented at the International Conference on Toxic Marine Phytoplankton.

Send your name and address to: Alan W. White, NOAA National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA 02543, USA; fax: (1-508) 548-5124.



# The French national programme on marine phycotoxins

Since 1990 a subprogramme has been implemented which targets phycotoxins produced by different harmful algae from French coastal waters. This subprogramme is part of the National Programme on Toxic Algal Blooms (PNEAT), another subprogramme of which deals with the causes of harmful blooms.

## Diarrhetic toxins produced by *Dinophysis* spp.

Every summer several photosynthetic species of *Dinophysis* are associated with positive assays of DSP on French coasts. These species have been shown to synthesize mainly okadaic acid (OA), as checked by HPLC analysis, although DTX1 (dinophysitoxin) is sporadically detected in contaminated shellfish. A monoclonal anti-OA antibody has now been produced, which shows strong affinity for the OA-BSA conjugate, but no affinity for OA alone. Further improvements of this immunological probe are in progress, as well as alternative bioassays for DSP, to replace the mouse bioassay. The *Daphnia* test has recently been used, giving  $0.16 \pm 0.1 \mu\text{g OA LC 50}$ .

OA extraction and purification procedures have also been investigated using *Prorocentrum lima* cultures as well as mussels contaminated with DSP. The purification procedures are now well defined, and the same approach is to be tried with DTX1. Production of large amounts of these toxins is a major priority of the programme, since they are required for neurophysiological studies. Both OA and DTX1 produce chronic effects on the cardiac activity of ischaemic Guinea pigs.

Finally, preliminary results have been obtained from an investigation of the role of bacteria associated with *P. lima* on OA production in culture. Traces of OA are easily detected by immunofluorescence in *P. lima* cytoplasm, whereas OA and DTX1 can be detected by HPLC not only in the algal fraction but also in the extracellular medium. Further work is in progress.

## Paralytic toxins of *Alexandrium* spp.

Experimental bioaccumulation of Paralytic Shellfish Poisons (PSP) by mussels and clams has been investigated

using a French strain of *A. minutum*, isolated in 1989. HPLC analysis of toxin profiles in shellfish meat during contamination and depuration phases has revealed the prevalence of GTX2/GTX3 (gonyantoxin), as previously found during similar work on *A. tamarense*. Different algal diets are to be tested during depuration in order to allow better post-contamination siting and management of shellfish by shellfish farmers.

Experimental contamination of scallops with PSP from *A. tamarense* has been carried out to investigate the changes in toxin profiles which take place between algae and different shellfish tissues, during and after bioaccumulation. Toxin biotransfer and hydrolysis were found, with a surprising increase in toxin levels in the gonads during depuration.

In conformity with European concern about the production of standards and the more accurate detection of the toxins prevalent in shellfish, extraction and purification of the GTX2/GTX3 complex has been performed on mass cultures of *A. tamarense*. Production of anti GTX2/GTX3 antibodies is also in progress. The chemical basis behind the studies was recently improved by the adoption of Oshima's HPLC method. Differentiation of C toxins in the toxin profiles of contaminated shellfish should thus be obtained, especially for experimental contamination by the French strain of *A. minutum*.

## Ichthyotoxins of *Gyrodinium* cf. *aureolum* (*Gymnodinium nagasakiense*)

Routine tests of both haemolytic activity and algal growth inhibition have been developed for the detection of *G. cf. aureolum* extracellular toxins. Fish kills associated with *G. cf. aureolum* blooms appear to be caused by the water-soluble part of these toxins. About 3 mg of purified toxins was obtained from mass culture in chemostat and the chemical

## Domoic acid threat in N. Europe

Reports of extensive blooms of the potentially toxic diatom *Pseudo-nitzschia pseudodelicatissima* in Danish, Norwegian, Swedish and German coastal waters have reached us just as we go to press. Shellfish harvesting was banned in the Danish Isefjord and parts of the Limfjord, where very high cell concentrations were detected. Fuller details will appear in the next issue.

structure of these toxins, as well as of their precursors, was elucidated by gas-phase chromatography and Iatroscan analysis. Environmental factors involved in release by *G. cf. aureolum* have been screened and partly identified.

## Ciguatera toxins.

The dinoflagellate, *Gambierdiscus toxicus*, which produces these toxins is tropical in distribution, and does not occur in the waters of mainland France. However, several analytical improvements have been carried out by teams working within the framework of PNEAT, as scientific support for toxicological and environmental studies carried out in French Polynesia and New Caledonia, as well as providing support for the authorities monitoring imported seafood.

Purification procedures for Maitotoxin (MTX) are now developed and verified by cytotoxicity bioassays using sea urchin ovocytes and mammalian neuroblastomas as cellular models. These bioassays appear to be about 100 times as sensitive as the conventional mouse test.

Concerning Ciguatoxin (CTX), trials are in progress using 9 - anthronitrile as the fluorescent reagent for HPLC detection, but further validation of this method with samples from the Caribbean and Polynesia are now needed.

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# Classification of dinoflagellates using artificial neural networks

It is a generally held belief that the majority of plankton samples will eventually be sorted, counted and taxonomically analysed using automatic techniques. This does not remove the role of experienced taxonomists, it only reinforces their position. No definitive system has yet been established but it is highly likely that pattern recognition and image processing will be the method to carry out the processing of the data. Recognition of biological patterns by neural networks is a new concept and one which we suggest could play a role in achieving these goals.

The current state of the art in automatic plankton classification is to employ standard statistical techniques and classical machine vision techniques<sup>(1)</sup>. The complex task of automated discrimination of morphologically similar species of phytoplankton has recently been attempted<sup>(2,3,4,5)</sup>. Although many problems must be solved before an automatic classifier of phytoplankton can exist, the work of a number of our research team members has shown that new computer learning algorithms based on neural network theories can provide a way forward in this difficult area of visual identification.

Our project involves the collaboration of four groups. Two expert groups in aspects of neural network techniques (University of Plymouth, UK and Università di Genova, Italy) possess complimentary skills in neural network research. Plymouth has developed an understanding of the Back Propagation algorithm associated with trainable networks and Genova has developed skills in handling Radial Basis Function (RBF) networks. These two network paradigms have become important research tools in the artificial intelligence community. The other two expert groups possess considerable expertise in marine phytoplankton analysis (Plymouth Marine Laboratory, UK, and Centro Oceanográfico de Vigo, Spain).

Our intention is to develop a computational system capable of automatic taxonomic classification of marine phytoplankton species. We have already shown that for such problems novel neural network (or brain-like) computational techniques appear to offer more robust discriminatory powers than traditional machine vision techniques. We

shall build on our previous work to develop a demonstrator device capable of classification of a wide range of dinoflagellates, with special reference to the toxic and nuisance species. An image database of species collected from the EEZ of the European Common Market countries will be created in the course of this project. With approximately 100 examples of each species, the database is expected to hold over 5,000 images of taxonomically labelled photo-micrographs, scanning electron micrographs and camera lucida drawings. Any assistance which can be given to us to achieve this will be greatly appreciated. The demonstrator will consist of a software-based artificial neural network (ANN) classifier that, having been trained on images from the database of dinoflagellate images, reliably classifies unseen examples taken from the same database. The application of the ANN to direct microscopic images of phytoplankton will be studied, and it is hoped that the generality and robustness of our solutions will be extended to operate with relatively unprocessed images and for a wide range of species. The validated phytoplankton image data set will be incorporated in a teaching system to provide marine ecologists with a computer-based teaching package for learning to differentiate between members of the *Dinophyceae*, in particular the toxic and nuisance species. Plymouth University has an up-link to the Olympus satellite and it is intended to use this to provide an alternative means of data dissemination than from computer disk. We hope to offer the teaching tool and validated image database on optical disk, data cartridge and via satellite. The satellite connection will be made via a low cost 100 kbit per second data transfer system (approx. US \$650), enabling potential users across Europe to invest in a low cost satellite receiving system connected to their personal computer.

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Alistair Lindley (PML), Phil Culverhouse, Rod Ellis and Rob Simpson (University of Plymouth, UK), Thomas Parasini (Università di Genova, Italy), Beatriz Reguera and Isabel Bravo (Centro Oceanográfico de Vigo, Spain).

## Korean-French seminar on red tides

The mariculture industry has grown rapidly in Korea since the 1970s, especially in the Chinhae Bay area on the South coast, and shellfish are exported to North America and Europe as well as supplying the home market. Although red tides have been reported since at least 1961, an unprecedented outbreak of *Gymnodinium mikimotoi* in 1981 and cases of PSP in 1986 have alerted the National Fisheries Research and Development Agency (NFRDA) as to the risks posed by red tides. This agency formed a "sistership" with the French Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER) in 1975, and in November 1990, a Korean-French seminar on red tides was held. The proceedings of this meeting are now available as a book entitled *Recent Approaches on Red Tides* edited by Drs. Joo Suck Park and Hak Gyóon Kim.

The book contains eleven chapters, five from Korean authors and five from French authors, and an invited contribution from Prof. T. Okaichi of Kagawa University, Japan. To obtain a copy, write to: Dr. Joo Suck Park, NFRDA, Kijang-up, Yangsan-Gun, Kyongsangnam-do, 626-900 Korea.

# Worldwide regulations for marine phycotoxins: current situation

An article under a similar title appeared in the *Journal of Natural Toxins*, Vol 1: 67 - 85, authored by H. P. van Egmond, G. J. A. Speyers, and H. J. van der Top. The abstract follows:

"An international enquiry was undertaken in 1990 within the framework of a project of the International Union of Pure and Applied Chemistry (IUPAC) to obtain up-to-date information about worldwide marine phycotoxin legislation.

Forty-seven countries have responded to the enquiry. The response, supplemented with published information, showed that 21 countries had (proposed) legislation for one or more phycotoxins in fishery products. Details about algal monitoring programmes,

tolerances, legal bases, responsible authorities and methods of analysis are given for paralytic shellfish poisons (PSP), diarrhetic shellfish poisons (DSP), amnesic shellfish poisons (ASP), neurotoxic shellfish poisons (NSP), and ciguatera toxins. There were some differences noted between nations in tolerance levels established for PSP and for DSP toxins. These differences should be eliminated for consistency of public health protection and for greater harmonization of international trade."

The information summarized is said to reflect the situation as of 1 July 1991. Copies are available from: National Institute of Public Health and Environmental Protection, PO Box 1, 3720 BA Bilthoven, The Netherlands.

## IOC Publications

### Available free of charge

The publications listed below are available free of charge from the IOC. Please address requests for these publications, as well as for extra copies of issues 1-4 of *Harmful Algae News* to: IOC Secretariat, Attn. Henrik Enevoldsen, UNESCO, 1 rue Miollis, 75732 Paris Cedex 15, France.

**Programme on Harmful Algal Blooms.** IOC-SCOR Workshop on Programme Development for Harmful Algal Blooms. IOC Workshop Report No. 80, 1991.

**Summary Report of the IOC-FAO Ad hoc Intergovernmental Panel on Harmful Algal Blooms**, Paris, 23-25 June, 1992. (Includes revised outline of the HAB Programme).

**Monitoring the Health of the Ocean: Defining the Role of the Continuous Plankton Recorder in Global Ecosystem Studies.** The Intergovernmental Oceanographic Commission and

The Sir Alister Hardy Foundation for Ocean Science, 1991. IOC/INF-869.

Also, a few copies are available for scientists in developing countries (priority to libraries) of:

**Biotoxines aquatiques (eau de mer et eau douce). Critères d'hygiène de l'environnement** 37. International Programme on Chemical safety (IPCS), World Health Organization, Geneva, 1986.

**Proceedings of the Third International Conference on Ciguatera**, Puerto Rico, 1990. Edited by T.R. Tosteson.

## Future events

### APRIL 93

**International Workshop on Ciguatera Management**, 13-16 April, Bribie Island, Australia. Contact: Workshop Secretariat, Southern Fisheries Centre, PO Box 76, Deception Bay, Queensland 4508, Australia. Tel: (61-7) 203 1444; fax: (61-7) 203 3517.

### AUGUST 93

#### **IOC Training Course on the Taxonomy of Harmful Marine Phytoplankton**

This course will be held at the University of Copenhagen, Denmark, 16-28 August 1993, and will focus on identification and preparation techniques supplemented by lectures on different aspects of harmful algae. The teaching staff will be: Dr. Yasuwo Fukuyo (University of Tokyo), Professor Øjvind Moestrup and Dr. Jacob Larsen (University of Copenhagen). The course is organized by the Botanical Institute, Department of Phycology, and co-sponsored by DANIDA (Danish Ministry of Foreign Affairs, Department of International Development Cooperation). Priority will be given to applicants from developing countries.

Application forms can be requested from the IOC Secretariat, Paris.

### OCTOBER 93

**Sixth International Conference on Toxic Marine Phytoplankton**, 18-22 October, Nantes, France. Contact: Cité des Congrès, 5 rue Valmy, 44041 Nantes Cedex 10, France. Tel: (33) 40 37 41 30; fax: (33) 40 37 40 73.

**Eleventh International Symposium of the World Association of Veterinary Food Hygienists (XI WAVFH)**, 24-29 October, Bangkok, Thailand. Contact: Dr. Vanda Sujarit, Faculty of Veterinary Medicine, Kasetsart University, Bangkok, Bangkok 10903, Thailand. Tel: (66-2) 5797539; fax: (66-2) 5798781/5790524; telex: 21957 RECOFTC TH.

## HARMFUL ALGAE NEWS

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