Harmful algal blooms

by Tim Wyatt and Yolanda Pazos

For about a century, studies of phytoplankton and algal blooms have been regarded as fundamental components of fisheries research, since in the last analysis the yields of fisheries must depend on them. The notion that algal blooms can be harmful therefore requires some explanation. The word 'bloom' in the present context refers to discolouration of the water caused by plankton growth, and was used in this sense at least as early as 1838(1). These of 1898 have only been noted once in the entire recorded history of Narragansett Bay. The *Chrysochromulina polyplepis* bloom which took place in the Skagerrak in 1988 provides a recent example.

Harm is inflicted by these events in a variety of ways. Growth and accumulation, followed by cessation of photosynthesis and subsequent decay of the accumulated plankton can cause deoxygenation of the water, leading to death of fish and invertebrates. Even normally innocuous species can cause harm in this way. Some species when abundant secrete polymers into their surroundings which can render the water so viscous that fish have difficulty in pumping it through their gills. Others, like the diatom *Chaetoceros concavicornis*, are spiny, and can irritate fish gills, leading to mucus production, gill damage, and reduced gaseous exchange. Blooms of these kinds are causing serious losses every year to fish farmers in several countries, and put a serious brake on future investments in this industry.

(Cont'd on p. 5)
One of the results of our Conference in Newport is the appearance of this newsletter, which I hope will be the first of several new initiatives to network our global activities and concerns about harmful algal blooms. It also gives me this opportunity, as Convener of the Fifth Conference, to thank those of you who attended, gave presentations, chaired sessions, entered into scientific dialogue with your colleagues, and also contributed to its social success. In my judgement, the conference was a great achievement at several levels, and a direct result of your collective participation. I am pleased with the results and promise for the future.

In retrospect, the conference ended one phase in the development of our growing discipline and brought us to the next phase which will probably be characterized by a more integrated, interdisciplinary approach to HAB events. The results of this new approach should already be evident at our 1993 Conference in Nantes, and certainly by 1998 in Sendai. The six conferences (including the 1987 Takamatsu meeting) have now, collectively, provided enough information to allow us to formulate testable paradigms and hypotheses in several key areas. Analyses of these hypotheses should be facilitated by the remarkable advances and application of molecular biology that we heard about in Newport; by the increased sophistication with regard to toxigenesis; and our keener insights into the patterns and varieties of HAB events and organisms. The accumulated data now allowing formulation of a framework of theory and background on bloom patterns and consequences should also allow individual investigators to evaluate bloom events in their local area from regional, global, organismal and toxicological perspectives. This will help to establish the first principles - the commonalities - involved in HAB events. We need such insight to move us from anecdotal or descriptive approaches to such bloom events to quantitative ecological approaches. The diverse expressions, causative organisms and dynamics of HAB events increasingly indicate the need to incorporate regional comparisons into our search (during this next phase) for the causes, mechanisms and underlying principles of such blooms. The number of attendees at the Newport Conference and their global distribution suggest that our regional networks in Asia, Europe and North America are both thriving and increasing, and should facilitate this common need for both regional and interregional perspectives. Unfortunately, we have little information on the status of HAB events in African coastal waters and many coastal regions of South and Central America. We should encourage international bodies such as UNEP, IOC, FAO, WHO, etc., to help nurture such efforts, both in the training of scientists and in sponsoring needed research in these regions.

Another result of the Newport Conference was the very successful post-conference IOC-SCOR meeting, during which plans for a multidisciplinary, multinational integrated program on HAB events and consequences were drafted. This represents a giant step towards bringing us to a period of more collaborative, interdisciplinary and interregional research - a scientific networking. I believe that this proposed effort is important for several reasons, including its potential for helping to minimize several shortcomings or possible dangers which I am concerned may compromise our collective efforts. For example, our ecological activities directed towards understanding HAB events are woefully inadequate; we have serious problems here, including lack of trained personnel. The collaborative, interdisciplinary research initiatives being proposed should be helpful in this area through the teamwork approach. I am also a little concerned about the seeming proliferation of national, regional and/or agency-sponsored HAB initiatives, carrying with it the risk of duplication or dilution of scientific effort, and possibly fostering a localized focus at the expense of a more holistic, global view. The proposed collaborative, interdisciplinary initiatives should be helpful here, as well as the linking of needed national and regional efforts, as part of an international programme. This might also be more cost effective.

I am mildly concerned about our ability to keep our 'group' together. The considerably increased attendance at Newport and the large number of papers were significant. Is our 'group' becoming too big for its present format? Is it just a matter of time before, say, the toxicologists and taxonomists each decide that they were more interested in hearing scientific reports primarily within their own specialties? That is, will the 'group' begin to splinter into subgroups reformed within their own interests? I believe that this possibility would be a disaster and one we must avoid. The proposed collaborative, interdisciplinary approach encouraged by IOC and SCOR should help, I hope, to reduce this possibility. An additional way to encourage group retention might be for us to establish a society and eventually to publish a journal, which might also be used to publish future conference proceedings.

These various scientific advances, new developments and collective needs of our growing discipline are partly the basis of my view that we are indeed in a new stage in the growth curve of our discipline. We now need to formulate new research problems, strategies and priorities: to evolve better linkages between our hard science and the concerns of aquaculture, public health and mass media; and to ensure a proper funding base, including both national and international sponsorship for our efforts. I wish to thank all of you who have brought us to this point, and to the many of you who sent me your Season's Greetings and kind expressions on the Newport Conference. To everyone, my best wishes for a happy, fulfilling and scientifically rewarding New Year.

Ted Smayda. Convener.
A Programme on Harmful Algae

The Intergovernmental Oceanographic Commission (IOC) of UNESCO, is responding to an identified need of its Member States to have a program to assist them in dealing with harmful algal events.

There is a wide array of scientific and managerial problems associated with harmful algae. In order to mitigate these problems more knowledge is required about the dynamics of blooms, the succession of species, types of toxins etc. There are also public health concerns, fisheries are affected, and there are financial impacts on the seafood industry etc.

Furthermore there is a need for management activities to interact with the scientific community in order to function as efficiently as possible. The managers dealing with harmful algal events need an organized scientific community so they can get effective help and advice.

The Harmful Algal Bloom Programme was initiated in 1987 as a sub-programme of the joint IOC-FAO programme on Ocean Science and Living Resources (OSLR). Since 1987 a group of experts has met three times to formulate the programme's goals and to outline its elements. The XVIIth Session of the IOC Assembly, Paris, March 1991, adopted a resolution with respect to the formation of an Ad hoc Intergovernmental Panel on Harmful Algal Blooms in order to identify adequate resources for a sufficiently broad programme to solve some of the real problems caused by algae.

The Food and Agriculture Organization of the United Nations (FAO) has agreed to cosponsor the Ad hoc Intergovernmental Panel, members of which are participating in the capacity of national representatives. The first session of the Panel is planned to take place 23-25 June 1992 in Paris.

There appear to be two major divisions of the problems - the scientific and the operational. It is the aim of the Harmful Algal Bloom Programme to cover both.

The scientific programme can be separated into three branches; ecology and oceanography, taxonomy and genetics, and toxicology and toxin chemistry. The operational problems can be divided into four branches; resource and aquaculture management, information network and training, monitoring, and public health and seafood safety.

The Overall Goal of the Harmful Algal Bloom Programme, which should embrace the short, medium and long term aspects of the above-mentioned elements, is to foster and organize the management of and scientific research on, Harmful Algal Blooms in order to understand the causes, predict the occurrences, and mitigate their effects.

To give an idea of the potential of the Programme, the goals for each of the Scientific and Operational Programme Elements are listed below.

Scientific elements:
- Ecology and oceanography.
  To understand the population dynamics of harmful algae.
- Taxonomy and genetics.
  To discriminate the causative organisms at the appropriate levels.
- Toxicology and toxin chemistry.
  To determine the physiological, chemical and toxicological mechanisms underlying toxin production and retention.

Operational elements:
- Resource and aquaculture management.
  To develop and improve methods to minimize the environmental and economic consequences of Harmful Algal Blooms.
- Information, network and training.
  To develop, encourage and maintain the flow of information, technology and expertise to scientists and administrators.
- Monitoring.
  To assist and facilitate the development and implementation of appropriate monitoring programs.
- Public health and seafood safety.
  To protect public health and ensure seafood quality.

In November 1991 a preliminary Planning Committee for the Programme was formed at the IOC-SCOR workshop which followed the Fifth International Conference on Toxich Marine Phytoplankton, Newport, USA. The Committee will sustain activities pending complete establishment of the aforementioned programme elements.

In order to ensure as close international collaboration as possible in the development and implementation of the Harmful Algal Bloom Programme, the IOC is cooperating with the Scientific Committee on Oceanic Research (SCOR) and the International Council for the Exploration of the Sea (ICES).

The HAB-Programme has been initiated and will hopefully accelerate during 1992 and 1993. Articles reporting on the development of the Programme will appear in *Harmful Algae News*.

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Global distribution (prior to November 1987) of human intoxication by Paralytic Shellfish Poison (PSP), Diarrheic Shellfish Poison (DSP) and Neurological Shellfish Poison (NSP). Fig. 1 in: Toxic Marine Phytoplankton, 1989. Grandell et al. (eds.), p. 338. Elsevier, N.Y.
WESTPAC Symposium and Harmful Blooms Workshop

From 2-6 December 1991 in Penang, Malaysia, the second WESTPAC Symposium was convened, sponsored in part by the IOC. The overall theme for this symposium which attracted scientists and administrators from 25 countries, was the management of the marine environment in the Western Pacific. Among the specific topics of interest were sea-level rise, climate change, and other global changes likely to have a significant impact on countries within the Western Pacific region.

During this symposium, workshops were held in nine different areas represented by task teams established previously by WESTPAC. One of these, the Task Team on ‘Toxic and Anoxic Phenomena Associated with Algal Blooms’ met for one and a half days to review recent events and to plan strategies for training, research, and networking in the coming years. It soon became clear that in the years since the last meetings of the Task Team in 1984 and 1987, the nature of the red tide or harmful algal bloom problem has changed considerably in the Western Pacific region. Where formerly the predominant problem was paralytic shellfish poisoning (PSP) caused by the dinoflagellate Pyrodinium bahamense, countries are now threatened by new species that produce PSP toxins (Gymnodinium catenatum, Alexandrium tamarenses, catenula) as well as by other species (Noctiluca, Trichodesmium, Chattonella, Heterosigma) that cause massive mortalities of fish and shrimp, both farmed and wild. These new problems threaten the rapidly growing aquaculture industry in the region. This regional expansion parallels similar increases in harmful blooms throughout the world, and has led some scientists to conclude that there has been a fundamental change in the structure of marine planktonic ecosystems on a global scale caused by human alterations to the coastal zone.

Red tide workers in the WESTPAC countries are relatively advanced with respect to the formation of a network and regional program, but considerable effort must now be focused on strengthening communication and increasing interactions and collaborations. To this end, three important recommendations from the Task Team were for WESTPAC to support the creation and distribution of: 1) a regional, informal newsletter on harmful blooms; 2) a manual of techniques for field and laboratory studies; and 3) photographs, slides, and preserved samples of harmful algal species. A related recommendation was for a regional symposium on harmful blooms (possibly in conjunction with WESTPAC marine pollution groups).

Considerable discussion was devoted to multi-lateral and bi-lateral programmes planned or underway for harmful bloom studies in the Western Pacific region. It became clear that concerted efforts are needed to start new programs or to expand the scope of existing programmes. Task Team members agreed to work closely with national planning and policy agencies to convince them that the bloom problems are severe, growing, and of high priority with respect to competing national needs. It is hoped that effective Task Team ‘lobbying’ will be directed towards UNDP, where a red tide/prawn recruitment initiative is under consideration, and towards FAO (through the Indo-Pacific Fisheries Commission) which has traditionally not considered harmful blooms to be a priority topic relative to other requests. It cannot be overemphasized that significant progress in funding will come only after those who hold influential national policy positions are convinced by Task Team scientists that it is in their nations’ interest to encourage international aid programmes in the area of harmful bloom research and training. An excellent opportunity exists for the IOC and the WESTPAC Subcommission Secretariats to use existing multi- and bi-lateral research and exchange programmes (such as the one between Japan and the Philippines) as leverage to obtain supplemental funds that will permit other countries to participate.

Participants in the Task Team workshop included: T. Okaichi (Chairman), Y. Fukuyo, K. Matsuoka, T. Ogata, M. Komada (Japan); Wu Gutiqu, Zou Jingzhong (China); R. Corrales, C. Gonzales (Philippines); A. Soegiarto, A. Sedikj, K. Adnan (Indonesia); V.P. Devassy (India); Choo Poh Sze, Wong Tat Meng, Lee Lay Wee, Goh Siew Hoon, Tan Shau Hwau (Malaysia); T. Pykamchan (Thailand); Joo Suck Park (Korea); and D.M. Anderson (USA).

Donald M. Anderson, Woods Hole Oceanographic Institution.

International Directory of Experts in Toxic and Harmful Algal Blooms and their Impact on Fisheries and Public Health

Plans are underway to publish an updated and expanded edition of this directory. The directory is designed to assist countries facing toxic and harmful algal bloom emergencies by facilitating rapid access to scientists, fisheries managers, public health officials and physicians who are experienced in dealing with marine toxins, red tides and harmful algal blooms and their consequences to fisheries, aquaculture and public health.

If you are involved in the basic scientific, applied fisheries, or public health aspects of harmful algal bloom 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 recently attended the Fifth International Conference on Toxic Marine Phytoplankton held in Rhode Island (USA).

Send your name and address to: Alan W. White, NOAA National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA, USA 02543; fax: (1-508) 548-1158.
NEW - A Seawater Rheology Group

by Ian Jenkinson

Eutrophication in coastal waters seems to be causing more concern every year, with associated problems due to floating slime in the Adriatic, knee-deep Phaeocystis foam on North Sea beaches, and the perception that viscous phytoplankton-produced slime kills many millions of dollars worth of fish and shellfish per year, mostly during blooms.

Waves and ripples are also damped, and whitecap formation affected by organic material absorbed at the sea-air surface. All seafarers have noticed surface slicks in moderately calm weather. This surface material now seems to be similar to that secreted into the bulk seawater by phytoplankton, and its effects on air-sea fluxes of heat, gases and (in rough weather) aerosols of salts are intuitively obvious and scientifically demonstrated.

Are these slimes and surface films, however, just a more obvious manifestation of what phytoplankton organisms do with their secretions wherever they live? Observations by divers and from submarines have now shown that much of this slime coagulates into aggregates, which produce turbulence-free microhavens. Phytoplankton may even have evolved slime production partly to "manage" turbulent and molecular dispersion in their immediate environment. Sinking of these aggregates, along with that of zooplankton faecal pellets, controls vertical flux rates of fixed carbon and other elements, and prevents the return of the carbon to the atmosphere in the short term. These aggregates are mostly sticky and surface active, and their destruction, modulated largely by the interaction between turbulence and the aggregates' rheology, or deformation properties, is likely to slow down this flux. Tougher aggregates should increase flux rates, except that when they trap bubbles they can rise and float, to the annoyance of holidaymakers.

Description of the rheology of these aggregates and, on a larger scale, of the rheology of the water containing them, has been slow to develop because of the difficulty of sampling, the lack of suitable rheometers and the problem of describing space-time distributions which include exceptional events. Within the last decade, however, sufficiently sensitive rheometers have become available, better handling techniques have been developed, and space-time distributions can now be described by fractal geometry.

Study of seawater rheological properties has important implications for the statistics of marine turbulence, dispersion and fluxes of all properties and substances, pelagic ecology, mechanisms of toxicology, marine chemistry, particularly near surfaces, and climatology. It is frighteningly interdisciplinary. A Seawater Rheology Group has thus been set up. It is a new, informal interest group, composed of specialists in both in situ and theoretical turbulence, wave damping, whitecaps, rheology of bulk and surface phases, surface chemistry, ecological and physical modelling, plankton and fisheries ecology, fluid mud, gas and heat exchange at sea surfaces... Its aim is to promote interdisciplinary research in this field. If this excites you, as a scientist or an administrator, you can write or fax for further information to: Ian Jenkinson, Agency for Consultation and Research in Oceanography, Lavergne, 19320 La Roche Canillac, France; fax: (33) 5529 1982.

(cont'd from p. 1, 'algal blooms')

At the other end of the spectrum are species which are poisonous, and whose toxins can be passed through food chains. Many of these species are flagellates (including dinoflagellates), but a diatom, Nitzschia pungens, has recently been added to this group. Paralytic, diarrhetic, and amnesic syndromes resulting from these toxins usually reach man through the consumption of molluscs, and ciguatera via fish.

The word 'bloom' in the HAB context has not yet been effectively quantified. Since these events often take us by surprise, it is frequently only the near maximum cell concentrations which are reported, and the growth periods leading to these maxima are not sampled. These lacunae are now being filled in regions where monitoring programmes for potentially harmful species have been instituted, and studies of the population dynamics of exceptional blooms are becoming possible. When we can estimate the magnitudes of those processes which lead to both increases and decreases in population numbers, we shall be able to see more clearly what changes are needed to transform normal events into abnormal ones.

The virulence of HABs is likely to be exalted as man's demands on coastal zones intensify, and species which at present are harmless may in the future cause problems. This newsletter should provide a communication channel between all people concerned with harmful algal blooms and their effects on coastal zone development and human health. We look forward to your contributions.

Tim Wyatt and Yolanda Pazos,
Instituto de Investigaciones Marinas,
Spain.

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1) By B. M. Griffiths, in Proc. Linn. Soc., 151, to describe the greening of Glaslough in Country Monaghan, Ireland.
2) Scott Nixon's and John Sieburth's papers can both be found in E. M. Cosper et al (eds.): Novel phytoplankton blooms, courses and impacts of recurrent brown tides and other unusual blooms. Springer Verlag, 1989.

The flagellate Chrysochromulina polylepis bloomed in Skagerrak in June 1988. Concentrations as high as 100 million cells per litre were registered. C. polylepis produces a toxin harmful to fish, invertebrates, and even to other algae. During the massive bloom, some 600 tons of cultured rainbow trout were lost.
From: Larsen and Moestrup, 1989; Guide to Toxic and Potentially Toxic Marine Algae; Danish Ministry of Fisheries.
The Fifth International Conference on Toxic Marine Phytoplankton: A Personal Perspective

by Donald H. Anderson

One thing missing from the Newport Conference (see p. 2), that had been part of the earlier conferences in Lund and Takamatsu, was a retrospective overview, an attempt to place it in perspective relative to past meeting of the same type. Now, as the details of this conference rapidly fade from memory, I find myself charged to attempt just such an overview.

Looking backwards in time for perspective, I can see that each one of our conferences presented one or two topics that, in hindsight, were important steps forward. In Boston in 1974, the main topic was the massive 1972 New England red tide which extended the range of PSP (paralytic shellfish poisoning) in the region. That meeting was also noteworthy because Shantz and co-workers presented the structure of saxitoxin for the first time. In Florida in 1978, the origins of ciguatera poisoning were linked by Yasumoto to the benthic dinoflagellate Gambierdiscus toxicus. I also recall a mystified Marie Kat describing illnesses in human consumers who had eaten Dutch mussels that seemed to be free from bacterial contamination, yet which caused severe gastrointestinal distress. The next conference in St. Andrews in 1985 clarified this issue, as many papers discussed diarrhetic shellfish poisoning (DSP) and its links to dinoflagellates. It was also the time when Yuzuru Shimizu proposed a biosynthetic pathway for saxitoxin. In Takamatsu in 1987, the extensive work by the Japanese on the toxicology, ecology, taxonomy, and life cycles of several important fish-killing species were presented in great detail. This was also the time of the first public speculations and discussion that harmful algal blooms might be increasing on a global scale. In Lund in 1989, new species such as Chrysocromulina and Aureococcus took center stage as a result of massive harmful blooms in different parts of the world. In Newport, in 1991, we had a continuation of these themes and issues. New harmful species were identified, such as the fascinating Gymnodinium species (described by J.M. Burkholder) that cycles between dormancy and motility in response to the presence of fish, which this species kills in an unknown yet very rapid manner. In his seemingly never-ending series of important discoveries, T. Yasumoto reported the detailed structure of several ciguatoxins and described HPLC (high-pressure liquid chromatography) method for their analysis, findings that should dramatically change the nature of ciguatera research.

These, and other presentations at the Newport meeting continued the general trends established in previous conferences. In my mind at least, three issues set Newport apart:

1) New technologies were presented which will surely have a major impact on our field in coming years. For example, immunological methods are now being employed to develop much needed rapid and sensitive assay methods for toxins. Immunological techniques have also been directed towards the harmful algae themselves and we can now realistically look forward to the availability of a battery of species-specific antibodies to automate the identification and enumeration of harmful species, and perhaps to shed light on important issues in taxonomy and population biology.

In the context of new technology, it is of note that our field, though vibrant and growing in other ways, remains quite backward in the application of the tools of molecular biology to major questions that face us. Of the several hundred papers and posters presented in Newport only a handful involved molecular techniques, whereas in meetings of many other biological, chemical, or ecological disciplines, one would find a far higher percentage of workers using such techniques. One good example of the value of this approach can be found in the presentation by Jovine and co-workers, who have been exploring the molecular biology of pigment/protein complexes in dinoflagellates. Another noteworthy presentation was by C. Scholin who used ribosomal RNA (ribosomal nucleic acid) sequences from many isolates of Alexandrium to reveal genetic differences between geographically distant populations. We must now generate a large database containing this type of sequence information for all harmful species. Once we have done so, it will be possible to address issues in species dispersal using the same techniques now common in forensic medicine.

2) Another important characteristic of the Newport conference was the tremendous press coverage that accompanied it. This was in part a function of a well-orchestrated effort by the Department of Communications at the University of Rhode Island, but it was also a reflection of the great public interest in harmful bloom problems these days. This interest has been sparked by several major bloom events that have caused significant damage to coastal resources in different parts of the world. However, it also stems from the fact that more and more scientists are stating that significant changes are occurring in coastal planktonic ecosystems, leading to increased numbers of harmful algal blooms. For some, the publicity surrounding the Newport conference was a concern. Those who have had interviews with journalists are familiar with how difficult it is to control the interpretation of what is said, but somehow we must do more to voice our science rather than our speculations, since it is the speculations that typically get us in trouble. A good example is from an article published in a large Boston newspaper during the conference which indicated that 'a majority of the 325 scientist who met [in Newport] this week said that they have abandoned the previous view of red tide outbreaks as localized, episodic nuisances'. There was no open discussion of this issue, and no vote was taken. The article also claimed that 'the world's oceans are experiencing an explosion of algal blooms such as toxic red tide, and some scientists believe that the phenomenon is an early warning of a massive ecological breakdown'.

C.W. Kao cautioned us to avoid self-serving and unsubstantiated claims of global spreading, arguing
‘Whammies’

It may come as a surprise to readers of this newsletter to find cholera brought to their attention. But patterns and processes recognized in one science (in this case epidemiology) often illuminate problems in another. A recent news item by Christopher Anderson (in Nature, 25 Nov. 1991, p. 255) concerning the current cholera epidemic in Peru provides an analogy to the ‘chem-tech’ hypothesis which John Sieburth proposed at the ‘Novel Phytoplankton Blooms’ conference held in Stony Brook, New York, in October 1988) to explain outbreaks of brown tides.

Sieburth’s idea was that the fertilizers and pesticides used for shore-side lawn maintenance, when percolate into coastal embayments, provide the brown tide organisms with two opportunities. The fertilizers raise the potential growth ceiling of the organism (Aureococcus) while the pesticides kill its enemies and allow it to reach that ceiling unrestrained by grazing.

Sieburth called this ‘a double whammy’. The expression comes from Al Capp’s Li’l Abner®, and referred to a hex so powerful he hoped he’d never ‘hafta’ use it! But the cholera epidemic being witnessed in Peru is worse than Li’l Abner’s stare, and has, since January 1991, claimed over 300,000 victims and 3500 lives. The Pan American Health Organization (PAHO) attributes the epidemic to three causes. The inoculum is thought to have reached Peru in the bilge water of a freighter, it is traditional to eat certain seafoods raw in Peru, and a decision was made not to chlorinate drinking water supplies due to the slight risk of cancer that practice entails.

The factorial combinations of these causes inclined PAHO to the view that there would be no cholera epidemic in Peru at present if it were not for the fact that all three coincided.

People involved with harmful algal blooms might recognize, as PAHO has, that the decision on chlorination was a case of poor risk assessment, but without information on the frequency with which bilge waters are contaminated with dangerous pathogens. I doubt that anyone should be blamed for that. The advice on which it was based was sound enough. The delights of eating raw seafood cannot be denied, and custom is by definition conservative, and in any case above the law. So the epidemic hinges on the inadvertent transport of a microorganism, and that is a kind of event whose threat we are aware of in the context of toxin dinoflagellate blooms.

Gustaf Hallegraeff has maintained for several years that Gymnodinium catenatum which can cause paralytic shellfish poisoning (PSP), was introduced into Tasmanian coastal waters by ships which discharge their ballast water there. This view is strongly supported by detailed studies by Hallegraeff and his colleagues of historical plankton records, sedimentary deposits, G. catenatum genetics, and the ballast tank materials themselves of many ships entering Australian ports. Hallegraeff recently reported that twenty different dinoflagellate species have been germinated from cysts collected in these ships. Twelve ships contained cysts of three well known toxic species (two Alexandrium species, and G. catenatum itself), and one of them (A. tamarense) produced toxic cultures. So persistent has the search for the origin of G. catenatum in Tasmanian waters been, that it may eventually be possible to indicate with a respectably high probability with which ship the first guilty inoculum arrived.

L’il Abner would call this a single whammy, and it may have been sufficient. Perhaps a double whammy was not needed to introduce PSP to Tasmania. But the possibilities these studies reveal, the numbers of potentially troublesome candidates, and the volume of world shipping during the last century or more, all suggest that one or more additional factors might have been necessary to allow G. catenatum to establish itself in Tasmanian waters. Whether other factors were necessary, and of what nature they might have been, remain unknowns.

The more general point is that some algal blooms may be contingent on historical events, hence not predictable from even the most profound knowledge of ecological laws. Accident changes in coastal waters caused by human activities provide examples of such contingencies, as in the case of Tasmanian PSP. Natural events too may provide those elements of chance which frustrate prediction. Hurricanes and anomalous circulation patterns, just two examples, have both been invoked as preludes to exceptional blooms.

Sieburth’s hypothesis, like Hallegraeff’s draws attention to the role contingency may play in the creation of algal blooms and has the added virtue of combining ‘bottom-up’ and ‘top-down’ arguments. The former emphasize the importance to algal blooms of nutrients and other factors favoring growth, while the latter look to the role of processes damping or preventing population increase, such as grazing or parasitism. These are essential components of the ‘hard’ ecological theory, and if we can get them right, will improve our predictive powers. But we should not lose sight of those serendipitous events which can enrich nature, confound our predictions, and cause harmful algal blooms as well as cholera.

by Tim Wyatt

Donald M. Anderson, Woods Hole Oceanographic Institution

* A comic strip character (USA).
The First International Red Tide Newsletter

Sherkin Island Marine Station is a small private laboratory off the southwest coast of Ireland, run by Matt Murphy and his family without any State or European community funding. It was founded in 1975 by his late wife Eileen and himself. In 1978 work began on red tides when the waters around the marine station turned brown. The young graduate volunteer biologists that year began monitoring programmes for plankton which has been carried on each year from April to November ever since.

The monitoring programme at the Station has 11 sites in the area and water samples are taken from the surface to 50 metres. Species are identified. Sherkin’s monitoring has been the basis for all programmes in operation in Ireland.


From that conference the idea of a quarterly Red Tide Newsletter evolved and the first issue appeared in January 1987. 1992 sees the publication into its fifth year.

In 1989 a second workshop and conference on Toxic Dinoflagellate blooms was held at Sherkin with E. Balech, D. Dale, M. Elbraechter, K. Tangen, V.L. Trainer, S. Fraga, G. Hallegnaef, K. Steidinger.

Matt Murphy, Director, Sherkin Island Marine Station, Sherkin Island, Co. Cork, Ireland.

Future events

APRIL 92
ICES Study Group on the Dynamics of Algal Blooms, 7-9 April, Vigo, Spain. Contact: B. Regoum, Centro Oceanográfico de Vigo, Punta del Apio, San Miguel de Oya, Apdo. 1552, 36280 Vigo, Spain; fax: (34-86) 49 23 51.

ICES Symposium on Measurement of Primary Production from the Molecular to the Global Scale, 21-24 April, La Rochelle, France. Contact: ICES, Paléogade 2-4, DK-1261 Copenhagen K, Denmark; fax: (45-33) 93 42 15.

ICES Working Group on Phytoplankton and Management of their effects, 27-29 April, La Rochelle, France.

MAY 92
Fourth International Conference on Ciguatera Fish Poisoning, 4-8 May, Tahiti, French Polynesia. Contact: P.O. Box 39, Papeete, Tahiti; tel.: (689) 41 64 64; fax: (689) 43 15 90.

Third Canadian Workshop on Harmful Algal Blooms, 12-14 May, Mont Joli, Quebec, Canada. Contact: P.O. Box 1000, Mont Joli, Quebec, Canada, G5H 3Z4; tel.: (1-418) 775-0596; fax: (1-418) 775 0542.

JUNE 92

OCTOBER 92
International Workshop on Marine Environmental Protection and Coastal Living Resources, 29 September - 3 October, Bremer Maritime Training Center, Bremerhaven, Germany. Main topics: eutrophication in semi-enclosed seas, and harmful algal blooms. Contact: Polarmar GmbH, Burger 20, 2850 Bremerhaven, Germany; tel.: (49-471) 973 2191; fax: (49-471) 973 2215.

LATE 93
Vth International Conference on Toxic Marine Phytoplankton, Nantes, France.

Major events in the past

In the last two decades, there have been five international symposia concerning HABs. Their proceedings are listed below. Attention was focussed initially on dinoflagellates, but the scope has gradually expanded, as is reflected in the more recent titles.


Two other related symposia are:


HARMFUL ALGAE NEWS

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