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HARMFUL ALGAE NEWS

An IOC Newsletter on toxic algae and algal blooms

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Cape Agulhas

Cape Agulhas marks the geographical boundary between Indian and Atlantic Oceans, but the dynamic boundary where the Agulhas and Benguela Currents meet fluctuates, and usually lies nearer Cape Point where the Agulhas casts eddies into the Atlantic. Here Asian (*A. tamiyavanichi*) and American (*A. catenella*) clades of *Alexandrium* meet (**Carlos Ruiz Sebastián**). One of them may have been responsible for the deaths of half a million fur seals on Possession Island in the early 19th century [1]. This conjunction of members of different clades centred on distant waters leads to the question of whether there are genuinely cosmopolitan species. *Karenia brevis* was briefly regarded as cosmopolitan, but improved taxonomic knowledge has shown that it is not, and now we have several newly described ones to contend with (**Miguel de Salas**). Grethe Hasle recently reviewed the cosmopolitanism of *Pseudo-nitzschia* [2], and it is clear from her discussion that the concept is as much operational as biological. Morphologically 'difficult' species are more cosmopolitan than others [3], but sexual compatibility and genetic studies of *P. pungens* appear to support a cosmopolitan interpretation (**Griet Casteleyn**). If true cosmopolitanism (in Ekman's [4] sense) should eventually be rejected ('we are still far from a reliable assessment of taxonomic units that are phylogenetically significant [5]), yet genetic homogeneity of some widespread species convincingly demonstrated, then anthropogenic spreading by vectors like ballast water would be even more strongly indicated [6].

*Ehrenberg's sketches (from sheet 957) of «*Peridinium splendor-maris*», courtesy the Ehrenberg Collection, Museum für Naturkunde, Berlin. The entire collection of drawings is online an available free for non-commercial uses at: http://www.museum.hu-berlin.de:55080/Ehrenberg/.*

Studies of intra- and interspecific diversity make essential contributions to this debate, and several were presented at this conference, amongst them of *Alexandrium catenella* in the NE Pacific, in which a latitudinal gradient in toxicity is provisionally identified (**Rozalind Antropus**), similar perhaps to gradients described in the NW Atlantic and NW Pacific, of *Karlodinium micrum* (**Tsvetan Bachvaroff**), *Karenia mikimotoi* (**K.A. Soltysiak**; **Lisa Campbell**), *Cochlodinium polykrikoides* (**C.M. Mikulski**), and *Skeletonema costatum* (**Anna Godhe**). A new look at *Prorocentrum* leads **Shauna Murray** to wonder whether *Exuviaella* should be revived; the distinctions between *Gymnodinium galatheanum*, *K. micrum* (now found to be a synonym of *K. veneficum* by **Bergholtz**, see comment below), and *Karenia mikimotoi* are still not easily resolved and *cf aureolum* is back again (**Violeta Velikova**). There are suggestions that *Alexandrium tamiyavanichii* and *cohorticula* are conspecific (**Po-Teen Lim**), and also *A. ostenfeldii* and *peruvianum* (**Linda Percy**). The fallout after the revision/explosion of the genus *Gymnodinium* is continuing with several new *Takayama* and *Karlodinium* species (**Miguel de Salas, T. Bergholtz**). Max Taylor at an earlier conference in this series asked «What's in a name?» – a great deal, obviously.

(Cont'd on p. 2)

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The story here is that once upon a time there was a genus, *Gymnodinium* and a closely related genus *Gyrodinium*, including several harmful species, classified on the basis of external morphological characters. Then Daugbjerg *et al*. [7], based on ultrastructural characters and molecular information, took out of *Gymnodinium* several new genera (*Akashiwo, Karlodinium, Karenia*), moved *Gyrodinium impudicum* to *Gymnodinium impudicum* (provisionally), plus other things. Once new criteria were established to look at these 'naked' dinoflagellates (actually their cellulose plates are just thinner), a lot of new species started to be described, and the new genus *Takayama* was established for species similar to *Gyrodinium corsicum* [8].

No doubt such 'revolutions' are very beneficial for taxonomy, and for ecology as well (see later comment on *Karlodinium* in Spain).

Sympatric genetic differentiation within morphospecies such as *Pseudo-nitzschia delicatissima*, *P. pseudodelicatissima* (**A. Amato**) and *P. galaxiae* (**S.M. McDonald**) highlights our ignorance of mechanisms of speciation in phytoplankton. How is it that such similar cryptic species exist and cooccur? Did they stop mating and then diverge, or did they diverge in different areas and then meet again? McDonald finds that the three populations of *P. galaxiae* forming three consecutive blooms in the Gulf of Naples are genetically distinct, which suggests sympatric speciation could occur by fractionation of a temporal niche, perhaps by virtue of different life forms (the three populations are dominated by different size classes).

Decades ago, the canonical view held that *Karenia* blooms off western Florida developed offshore (in the Loop Current), and subsequently moved towards the coast; an offshore current inoculates coastal waters where upwelling injects nutrients, and blooms appear. Several regional variations on this theme were presented in Cape Town. Extensive blooms of *Prorocentrum donghaiense* in the East China Sea appear in the upwelling front after inoculation by the Taiwan Current (**Mingyuan Zhou**); analogous blooms of the newly described *Karenia concordia* appear in upwelled water in Hauraki Gulf, New Zealand, following inoculation by the East Aukland Current (**Hoe Chang**), of *Cochlodinium polykrikoides* at the confluence of the Kuroshio with South Korean coastal waters (**Changkyu Lee**), and of *Phaeocystis* cf *globosa* off Vietnam (**DanLing Tang**).

A different mechanism operates off British Columbia and Washington in the northeast Pacific, where the nutrient-rich semi-permanent topographically trapped Juan de Fuca eddy acts as a 'bioreactor' for *Pseudo-nitzschia*; populations growing there can be entrained by the upwelling plume and thence blown shorewards by gales (**Susan Geier**; **Nicholaus Adams**); the eddy itself can collapse during downwelling conditions (**Michael Foreman**). Models are being used, to explore the hydrographic variability of this region (**Amy MacFadyen**) and relations between nutrient budgets and toxicity (**Angelica Peña**). River plumes, for example those of the Yangtze, Mekong, and Columbia Rivers in the preceding case studies, can exert important constraints on the different mechanisms mentioned, perhaps by providing nutrients, but more importantly by blocking upwelling.

Eddy-trapped populations were invoked too in the Gulf of California, where stratified Taylor columns provide (in the authors' words) «bed and breakfast for red tide producers» (**Arturo Sierra-Beltran**), and in Biscay where **Patrick Gentien** suggests retention in small (10 nautical miles across) gyres or «holding zones» is essential for mating of *Dinophysis*. Do dinoflagellates lek? Yet another mechanism which brings blooms nearshore was described for the southwest approaches to Ireland and Britain; here the seasonal thermocline traps 'cold pools' of water marked by bottom fronts [9], and the resulting geostrophic jets which lie above the fronts can transport plankton into the coastal zone (**Robin Raine**).

Near the coast is not quite on the coast where many commercially important shellfish live, and where many fish farms are located. Several contributions looked at this last hurdle to intoxification of resources by offshore and nearshore blooms. *Dinophysis* and *Karenia* can escape the cold pool jets just mentioned and be advected by local currents into fjords and bays such as Killary Harbour (**Caroline Cusack**) and Bantry Bay (**Georgina McDermott**) in western Ireland; interannual variations in upwelling and downwelling may also determine whether resources in Aveiro, Portugal (**Teresa Moita**), or the Rías Bajas of northwest Spain (**Beatriz Reguera**) are

threatened by *Dinophysis acuminata* or *D. acuta* in particular years, or by both. Shelf populations of *Karenia mikimotoi* can enter the same rías with downwelling winds (**Francisco Figueiras**), and *Pseudo-nitzschia* can move in and out of Saldanha Bay as upwelling rates vary (**Claudio Marangoni**). Loss of topographic control may allow Gentien's holding zones to impact the shore.

What all these hydrodynamic mechanisms have in common is that plankton is moved from one place to another, just as etymology says it should be. A question infrequently asked is, how do the surviving progeny get back to where they started, for example to the cyst beds which seed annual blooms? Countercurrents at depths reached by vertical movement are one solution to the spatial problem, proposed for upwelling systems and estuaries respectively [10]. **Lincoln MacKenzie**, noting that *Gymnodinium catenatum* moves 'upstream', suggests a role for nearshore buoyant plumes as countercurrents. Control of vertical position can be used to achieve shoreward movement and might be the basis of the navigational challenge in this case too [11]. But what signals the cells need to decide *when* to navigate remain unknown.

A growing number of time series of harmful algae, and in some cases of their toxins, is becoming available. These give us the possibility of searching for the causes of decadal trends. The abstracts published in *Harmful Algae* **3** (June 2004) contain introductions to several long-term data sets now available, e.g., *Alexandrium fundyense* in Bay of Fundy (J. Martin, p238), *Prorocentrum* spp. in Narragansett Bay (T. Smayda, p250; for *Heterosigma akashiwo* there see also [12]), and the southward spread of PSP in Puget Sound (J.C. Weckell, p264). From this conference we can add *Pseudo-nitzschia* in Mexican waters 1979-2004 (**Sergio Licea**) and in the Gulf of Naples, 1984-2004 (**Adriana Zingone**), and *Alexandrium peruvianum* on the Peruvian coast, 1981-2004 (**Sonia Sánchez**). Multiannual trends in phytoplankton abundance and composition are variously attributed to eutrophication, introductions, climate change, and overfishing; all these possibilities were brought up at this conference.

The dynamics of *Aureococcus anophagefferens* (brown tide) blooms were once explained by the 'chem-tech' hypothesis [13], as a response to increased nutrient availability which raises carrying capacity coupled with pesticides which reduce grazing. More recent work indicates that overfishing of hard clams allows *Aureococcus* to pass a threshold concentration beyond which the clams are unable to control them, and assigns nutrients a secondary rôle (**Chris Gobler**) [14]. Another study, in parts of the Chesapeake system, comes to a comparable conclusion; there overfishing of eastern oysters combined with increased algal production following eutrophication are implicated [15]. There is no obvious link between HABs and nutrients from aquaculture in Scottish waters (**Matthew Gubbins**). The report of a study group recently convened by the ICES Advisory Committee on Ecosystems (ICES CM 2004/ACE: 04) records that «We find no convincing evidence that HAB events are nutrient enrichment driven events, either generally or for individual HAB species.»

Nevertheless, it is still plausible that HABs are driven at least partly by eutrophication, although the mechanisms must be more complex than simple more-in/more-out or bottom-up models indicate. **Patricia Glibert** provides a global view of the enormous increase in the use of urea as a fertilizer, and suggests that insufficient attention has been directed towards such organic inputs when they reach coastal waters. The European MOLTEN project has been exploring a possible way to reconstruct past nutrient environments based on transfer functions (**Marianne Ellegaard**) which may provide an additional tool for tackling these questions.

Based on two sediment cores representing a time span of about 2000 years, **Ana Amorim** maintains that *Gymnodinium catenatum* was introduced into Portuguese waters in the early 20th century; this species was not found in a 9000 year record in the nearby Ría de Vigo [16], which strengthens the liklihood that it is recently introduced to this region. The importance of controlling such introductions in so far as ballast discharges are responsible was stressed by **Martina Doblin**, and **Gustaaf Hallegraeff** summarized international progress on this front. In the long run 'ballast free ships' offer one possible solution to these problem [17].

Time series integrate variability over different time scales; in general high frequency events echo short spatial scales, and low frequency events larger ones (the spatial coherence of change is exemplified in Stommel diagrams [18]). An example of the former

was provided for Alfacs Bay in the Ebro Delta area of the W Mediterranean where the normally winter blooming *Karlodinium micrum* (now, following **Bergholtz**, *K. veneficum*) formed a summer bloom during an unusual combination of runoff and stratification (**M. Fernández-Tejedor**). Are the winter blooming and summer blooming *Karlodinium* two different species? The second hypothesis is attractive since **T. Bergholtz** describes *K. armiger* from Alfacs, and *K. veneficum* is there too.This reminds us that there is no good ecology without good taxonomy. The complication faced when species are split is enormous, but the obverse is that some ecological paradoxes (how can a winter species survive in summer conditions) are resolved by acknowledging the extent of diversity. Whatever

our favourite species concept is, there is nothing simpler than to call different things by different names.

Several contributors invoked climatic indices to account for interannual trends in phytoplankton abundance on intermediate time scales. Trends in *Alexandrium catenella* since the 1970s in Chilean waters were linked to El Niño Southern Oscillation or ENSO (**Leonardo Guzmán**), and in *Dinophysis* spp in the Galician rías to the North Atlantic Oscillation or NAO (**Beatriz Reguera**). Changes associated with ENSO were also invoked to account for the appearance of *Gymnodinium catenatum* and other species in Pacific Mexican waters (**Alejandro Morales-Blake**) and *Alexandrium peruvianum* in Peru (**Sonia Sánchez**). Climatological indices like ENSO and NAO are part of the stock-in-trade of fisheries oceanography, and we shall probably hear a lot more of such indices as our algal time series lengthen.

A recent paper [19] based on North Sea time series indicates that dinoflagellates are in general phenologically more plastic than diatoms, thus while diatoms tend to express their flowering periods at fixed times in the solar year, responding for example to day-length or to internal clocks (like *Pseudo-nitzschia* in the Gulf of Naples), dinoflagellates flower at times determined by such events as the timing of stratification. Fisheries science has long recognized the existence of trends in stock abundance on decadal time scales related to climatic trends, and the occurrence of 'regime shifts'. Similar patterns were recognized by several contributors to this conference. Regime shifts based on bifurcation theory are suggested to lie behind changing HAB frequencies in the Bohai Sea, China (**J. Feng**), and there may be decadal trends in the range of *Gymnodinium catenatum* in New Zealand waters (**Lincoln MacKenzie**). Changing species dominance in the Black Sea (**Violeta Velikova**) and on the Sonora coast of Mexico (**R.C. Altamirano**), and the 'opening of a raphidophyte niche' in Delaware estuaries (**Kathryn Coyne**) may be further examples pointing to regime shifts. The absence of HAB problems - *Gymnodinium catenatum* has hardly appeared in Galician waters for a decade, and *Pyrodinium bahamense* has not been prominent in the Philippines for several years – may also be aspects of analogous phenomena.

Hydrodynamic processes set the stage for algal blooms, but as Australian entomologist A.J. Nicholson taught us [20], to understand population dynamics we need to «find which of the factors are influenced, and how readily they are influenced, by changes in the density of animals», or, in our case, algae. He meant in part that climatic events, being density independent, cannot *regulate* population numbers in any dynamical sense. At the end of *On the Origin of Species* (1859), Darwin wrote: «It is interesting to contemplate a tangled bank, clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, so different from each other, and dependent upon each other in so complex a manner, have all been produced by laws acting around us. These laws ... being growth with reproduction; inheritance ... and ... natural selection ...»; these are the laws which *do* regulate numbers, and are the same laws Nicholson had in mind insofar as they act on ecological time scales.

The planktonic and benthic communities in which harmful algae live are also tangled in many ways. Zooplankton in some circumstances avoid phytoplankton, eg. *Chrysochromulina polylepis* [21], *Karenia mikimotoi*; it has been shown that two freshwater species of *Peridinium* can control their recruitment to the water column in response to grazer abundance [22], and thus gain a

head start. These are just a few examples. At this conference we heard of ‘predatory’ bacteria which lyse *Microcystis* cells (**Jabulani Gumbo**) as well as algicidal (**Patricia Blair**) and symbiotic ones (**Christoher Bolch**; **David Green**), endosymbiosis of *Pedinomonas* in *Noctiluca* (**Ken Furuya**), allelopathy and parasitism (see below), and of a variety of predator-prey relations; *Favella* eats *Alexandrium* (**Takashi Kamiyama**), as does *Acartia* (**M. Laabir**), *Amphidinium* eats raphidophytes (**Sascha Kloepper**), *Prymnesium* eats bacteria and algae when starved of nitrogen (**Wanderson Carvalho**), *Metridia* eats *Pseudo-nitzschia*, apparently without harm (**Evelyn Lessard**), *Eurytemora* eats *Dinophysis* (**O. Setälä**). These things at least *can* happen, whether they *do* is another matter [23]. Organ transplants too are a component of eukaryote technology (**Tsvetan Bachvaroff**). There was also speculation about a *positive* predator-prey relation; grazing on the tasty stuff followed by nutrient regeneration allows other species to bloom (**Tore Johannessen**).

Social interactions have been classified as mutualistic, altruistic, selfish, or spiteful [24]. These are the «non-predatory» forces [25] which integrate population and community ecology. Quorum sensing is a kind of mutualism, and was raised as a possibility in phytoplankton again (**Louis Peperzak**). *Gyrodinium instriatum* zygotes produce cysts in the presence of other cells, but vegetative cells if cultured alone; thus «... zygotes are able to distinguish the existence, and further, the approximate density of other cells of the same population» [26], so that population growth rate is controlled socially. Maybe some similar mechanism accounts for the fact that planozygotes of several other species in some circumstances divide rather than encyst (**Rosa Figueroa**). Spite is equivalent to allelopathy, it reduces the fitness of others, if only temporarily. Allelopathic effects were observed in food crops millenia ago, and some modern agronomists think they may in the future be able to use allelochemicals to replace synthetic chemicals for the management of weeds and pests.

Allelopathy is usually mediated by ectocrines, *secondary* metabolites (i.e., which influence ecological interactions, as opposed to *primary* metabolites involved in essential processes within the cell) released from the cells, and a standard if not entirely conclusive procedure (there may be direct competition for resources too, not easily manipulated independently) is to test the impact of filtrates from one species on the growth rate of another. The effectiveness of such strategies in natural conditions must depend on mixing rates, which will determine if functional concentrations can be achieved and maintained [27]. A simple logistic model of allelopathic interactions between two species suggests that the equilibrium is unstable, so that local extinction of one of the pair should result [28]; Ushida [29] uses a logistic model to look at the relations between co-cultured *Heterocapsa circularisquama* and *Gymnodinium mikimotoi*, and provides evidence that the different outcomes depends on contact rates as well as on ectocrines.

The potential importance of allelopathic mechanisms is perhaps indicated by invasive species when they form monospecific blooms, indicating that some strong competitive mechanism is at work; recipient communities may be naïve to newcomers’ ectocrines. In the HAB context, several studies have emphasized that the compounds involved in allelopathy are distinct from those we usually refer to as toxins [30], and the same point was made several times at this meeting (**Julia Kubanek** for *Karenia brevis*, **Sanna Suikannen** for two cyanophytes (and see [31]), **Tilman Alpermann** and **Urban Tillman** for *Alexandrium*). The powerful toxins produced by *Pseudo-nitzschia multiseries* do not have any allelopathical effect (**Nina Lundholm**).

Amoebophrya is a parasitic dinoflagellate whose vegetative phase infests various free-living forms including *Alexandrium*, *Scrippsiella* and *Dinophysis*, and which may offer «the somewhat remote possibility of biological control» of harmful species [32]. The infestation

rates are usually only a few percent, but in a Chesapeake Bay study, it was found that the dynamics of the host-parasite relationship are quite complex, and that epidemics are restricted to a thin layer near the thermocline [33], and that the parasites may be host specific [34]; so *A. ceratii* may contain several cryptic species, a point frequently made with unicellular organisms [35]. Coats reported mortality rates of infected *Gymnodinium sanguineum* of 5-8%/ day, but epidemics were also observed in a thin layer near the pycnocline, with infection rates of 20 to 80% and mortality as high as 54%; mortality rates <5% from this cause were estimated in *Dinophysis norvegica* in the Baltic [36]. New details of this parasite's life and new hosts were reported - **Jong-Gyu Park** lists nine hosts from Korean waters, and **Mario Sengco** four which can be infected with *A. ceratii* derived from *Alexandrium*. *Amoebophrya* can infect *Karlodinium micrum* (= *veneficum*), and protects itself from the host's karlotoxin by imitating the dominant sterol (**Allen Place**) with which the host protects itself (**Jonathan Deeds**). Just how complex the responses of individual phytoplankton species in the tangled bank might be was explored using network analysis by **Ferenc Jordan**, who showed that the bottom of the marine food web, where HABs occur, and the top, where overfishing happens, can be surprisingly close to each other functionally; in agreement with Jackson *et al*. [37], he argues that overfishing may have substantial effects on phytoplankton species abundance.

Karlodinium micrum was first described by Braarud from Walvis Bay [38], and subsequently off southern Norway and in the North Sea, in the Swan and Canning estuaries in western Australia, in the Chesapeake system, and elsewhere. It is thus estuarine and 'cosmopolitan', and is linked to fish kills. It can be confused with *Pfiesteria*, *Gymnodinium estuariale*, and other taxa. Ballantine's *Gymnodinium veneficum*, isolated from Plymouth waters by Parke, is identical to *Karlodinium micrum* (**T. Bergholtz**), and since it was described one year before, the name to use from now onwards for both is *Karlodinium veneficum*. As we learned in Hobart (Tengs), *Karlodinium* shares a unique feature with *aureolum* and *breve*, namely plastids which contain chl1 + chl2 + fucoxanthins; these plastids distinguish this group from other dinoflagellates, and link them to haptophytes by tertiary endosymbiosis.

The *Ludi Saeculares* (secular games) of ancient Rome were celebrated at long but irregular intervals, and the word secular is sometimes used for events which occur every century or so. Maybe the most difficult question we can ask about domoic acid (DA) poisoning is, given what we now know about the widespread occurrence of toxic *Pseudo-nitzschia* species, why has there only been one recorded outbreak of poisoning in humans (caused by mussels from PEI, Canada, in 1987 [39]). DA in seaweed extracts (*Digenea*) has been used as anthelminthic in oral doses of 0.5 mg DA/kg body wt, but doses in the 1987 event ranged from 31 to 128 mg DA/100g muscle, much higher. Deaths of sea birds in Monterey Bay, California in 1991 led to the identification of domoic acid on the US West Coast, and since then several other mortalities of marine vertebrates have been attributed to DA. It is not always easy to identify sources of DA when it is detected, and, while nearly monospecific *Pseudo-nitzschia* blooms do occur (**Brian Bill**), mixtures seem to be the norm (e.g., **Keri Baugh**, NE Pacific; **Eileen Bresnan** and **Johanna Fehling**, Scottish waters; **C.I. Churro**, Aveiro, Portugal; **Roberta Congestri**, Tyrrhenian Sea), and toxic and nontoxic species can be dominant at different seasons (**Keith Davidson**). Cryptic diversity, already referred to, is widespread in *Pseudo-nitzschia*, and could partially explain variability in toxin content.

Christian Gottfried Ehrenberg, one of the 'fathers' of microscopy and micropalaeontology, witnessed a luminescent bloom in the waters of Sorrento (Gulf of Naples) in 1860; he called the organism responsible *Peridinium splendor-maris*, but in 1873 he made a new genus for the species, which became *Blepharocysta splendor-maris*; Stein in 1883 mixed everything up by illustrating *Blepharocysta splendor-maris* with images of a different organism, the one with no cingulum well known to taxonomists; **Malte Elbrächter** has now rediscovered Ehrenberg's material and demonstrated that it is an *Alexandrium* species, *A. balechii*, perhaps the same species as that which has been known to form massive, luminescent blooms in the neighbouring Gulf of Salerno in the

1980s [40]. How can a species given such a lustrous name escape detection for 120 years? [41].

On the lighter side, we have a new way to collect cysts – melt sea ice (**Janne-Markus Rintala**), a new definition of the sea bed: «The bottom is the solid surface where distance between parts is smaller than a man's foot.» (**Dolors Blasco**), and an example of how competitive HABs are - **Else Hegseth** told us of HAB species *under the midnight sun*, in the Lofotenfjord (in 68-70 degrees N latitude), but was upstaged by **Kin-Chung Ho** with his HAB species in Svalbard (in about 78 degrees N).

HAB2004 attracted about 400 participants from nearly 60 countries. The programme guide contains 428 abstracts, of which 320 were presented as posters. Apart from the seven plenary talks, other oral presentations were inevitably divided between parallel sessions. So, we could only listen to half the orals, and at a nominal five minutes for each poster, one would need 27 hours or approximately three working days to read them all. The preceding notes dwell on about 20% of these contributions, and large areas of the conference are not mentioned at all; no attempt has been made to include the many interesting presentations dealing with physiology, toxins, monitoring, public health, etc, and the editors would welcome contributions on these aspects from other participants. For a review of some of the contributions on cyanophytes, see the accompanying article by **Ian Falconer**.

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41. This is a relatively easy *Alexandrium* to identify, yet it has only been recorded from the South Tyrrhenian Sea, Greece and Florida, where it was re-described by Karen Steidinger. The nomenclatural implication of Malte's finding is that the name of the genus *Alexandrium* should rather be *Blepharocysta*, but happily the ICBN (International Code of Botanical Nomenclature) allows *nomina conservanda* (names to be kept despite the priority rule) in such special cases. But what we have called *Blepharocysta* for ages has to be renamed, and *Alexandrium balechii* should probably become *Alexandrium splendor-maris*.

· **Indonesia**

Mass Fish Mortality in Jakarta Bay: HAB organisms as the culprit?

National HAB Task Force Needed

SATURDAY, May 8th, 2004 seemed to be a bad day for local tourists when they went to Ancol Bay (or Jakarta Bay) for recreation and/or family gatherings. Instead of having fun with their family and breathing fresh sea air after a hard working week, they found thousands of dead fishes lying on the beach [2]. It was not only bad for the tourists, but also for the fishermen who live near the beach.

A week after the incident, people were starting to point at the culprit. The fishermen, because they were afraid to catch and sell the dead fish, would have no income for days, and accused the National Oil Company (Pertamina) of being responsible for the disaster, while some environment NGOs concluded that the main groups responsible were the industries that were discharging their wastes into the bay. A local government officer, however, told the press that the incident happened because local fishermen's boats spilled oil in the bay's water. Later, some research groups from reputable institutions such as the Oceanographic Research Institute – National Science Institute (P2O – LIPI), Oceanography Study Program – University of Indonesia (PSK – UI), and Oceanography Study Program – Bogor Agricultural Institute (PKSPL – IPB), found that the *causa prima* of the fish mortality was non-toxic HAB organisms such as *Noctiluca scintillans*, and *Trichodesmium erythraeum* [3, 7].

The main questions aired in the Indonesian atmosphere for almost a week were: «What is (or are) the cause(s) of the incident?» and «Who will take the responsibility?» No single answer found widespread support. Each group «stubbornly» maintained it had the best results and findings.

These disputes simply aggravated the situation. People became confused by the conflicting conclusions of the different groups. Local fishermen were not going to catch fish, while people were afraid to buy and eat fish as well as other seafood captured from the surrounding waters. Meanwhile, the government remained silent, as usual. Furthermore, it took more than a week to clean fish debris from the bay, and the odours as well.

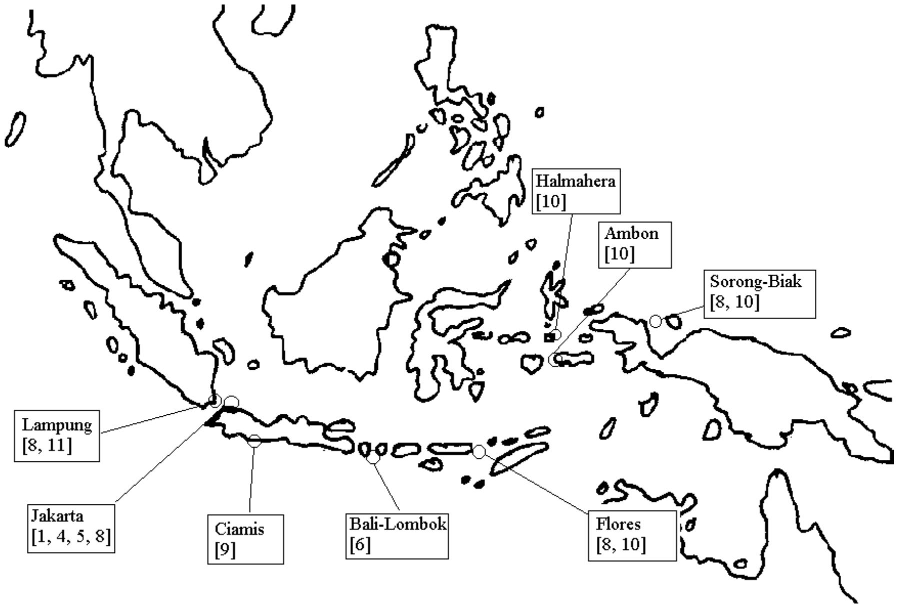

Figure. Map of Indonesian waters. Circles show the position of HAB organisms reported by the researchers. Numbers indicate the source cited.

Why did such a situation arise? Probably the most important reason is that, up to the present time, Indonesia has no official or National HAB Task Force as other Southeast Asian Nations (ASEAN) do, for instance, in the Philippines and Vietnam. Therefore, there were no official statements to keep the public informed of the official findings on such an incident. A HAB Task Force is assumed to comprise interdisciplinary expertise, such as marine biologists, fishery scientists, marine oceanographers, fishermen, NGOs, medical practitioners, politicians, government officers, and other group committed to HAB issues. Such a National HAB Task Force should receive a full mandate from the government to do monitoring and other activities related to HAB nationwide.

Why does Indonesia need such a Task Force? Some researchers in the field have reported that Indonesian waters are not free from HAB organisms (see Figure). Some HAB microalgae such as *Dinophysis* spp., *Alexandrium* spp., and *Pseudo-nitzchia* spp. are found off the coast of Jakarta [5], and others such as *Gymnodinium gracile* and *Dinophysis ovum* occur in the Bali-Lombok Strait [6], *Pseudo-nitzschia* spp., *Coscinodiscus* spp., and *Chaetoceros* spp. occur in Ciamis Bay [9] and the cyst of *Pyrodinium bahamense* var. *compressum* in Hanura Bay, Lampung [11]. Twenty years ago, *Pyrodinium bahamense* var. *compressum* was reported to cause the death of some fishermen who ate fresh shellfish captured at Lewotobi Bay, Eastern Nusa Tenggara and Kao Bay, Ambon [10]. The same organism is often found in the waters around Halmahera Island [8]. See also the table below.

What are the obstacles to establish such a Task Force in this country? First of all must be the government's political will, which has no strong policy for its national marine aspects. Second, Indonesia that has a very long coastline, about 81,000 km, a difficulty in term of management and monitoring activities. Third, there is still a dearth of researchers in this field in the country, and they live mainly in Java, the main and most populated island in the country. Fourth, *Table. HAB species reported from Indonesian waters*

HAB Species	Location	Source
Pyrodinium bahamense var. *compressum*	Lewotobi, east Flores	[8, 10]
	Kao Bay, Halmahera	[10]
	Ambon Bay	[10]
	Kotania Bay	[8]
	Sorong and Biak Bays	[8, 10]
	Hurun Bay, Lampung	[8]
P. bahamense var. *compressum* cyst	Hanura Bay, Lampung	[11]
Noctiluca scintillans	Off Jakarta Bay	[1, 4, 5]
Trichodesmium erythraeum	Off Jakarta Bay	[4]
	Eastern coast, Lampung	[8]
Pseudonitzchia spp	Ciamis Bay	[9]
P. pungens	Jakarta Bay	[4]
Prorocentrum spp	Jakarta Bay	[4]
Peridinium sp	Jakarta Bay	[1, 4]
Skeletonema costatum	Jakarta Bay	[1, 4]
Tintinnopsis sp	Jakarta Bay	[4]
Dinophysis spp	Off Jakarta Bay	[5]
	Bali-Lombok strait	[6]
D. caudata	Jakarta Bay	[4, 8]
Alexandrium spp	Off Jakarta Bay	[5]
Gambierdiscus toxicus	Lewotobi, east Flores	[8]
Gymnodinium spp	Jakarta Bay	[4]
	Bali-Lombok strait	[6]
Ceratium furca	Jakarta Bay	[4]
Coscinodiscus spp	Ciamis Bay	[9]
Chaetoceros spp	Jakarta Bay	[1, 4, 8]
	Ciamis Bay	[9]

the regional monetary crisis of 1998 still affects the government's budget for research and development (R & D) for its huge marine resources. Fifth, up to the present time, there was no official and formal group of researchers in this field at the national level.

One good thing with regard to HAB issues in the country is that there is an informal mailing list group namely Indonesia_HAB@yahoogroups.com that has more than 20 members nationwide and actively discussing and exchanging information about issues related to HAB, both in the country and abroad. But the group still needs assistance to develop, and open for support from and joint-programmes with other groups.

The latest mass fish mortality in Jakarta Bay is an appropriate moment for the Government to take action. Through the Department of Marine and Fisheries, government can help people to prevent arguments such as those that followed the abovementioned incident. A National HAB Task Force is evidently the better choice in this regard than an independent group or two of researchers from research and/or academic institutions doing research and monitoring on HAB related cases in the country. Because their results, findings, and conclusions, more often than not, might still confuse and frustrate people.

Other than that, Jakarta Bay, which is assumed to be the front door of this country, badly needs continuous monitoring, not only for HAB organisms but also for other aspects as one-whole ecosystem. Jakarta Bay since 1981 has become the most frequent place in the country not only for HABs, but also for mass fish mortalities . Thus, government should prepare the supporting infrastructures including regulations, experts, and the most important thing is their will (especially their political will to do so).

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· USA

Cochlodinium polykrikoides in the Peconic Estuary

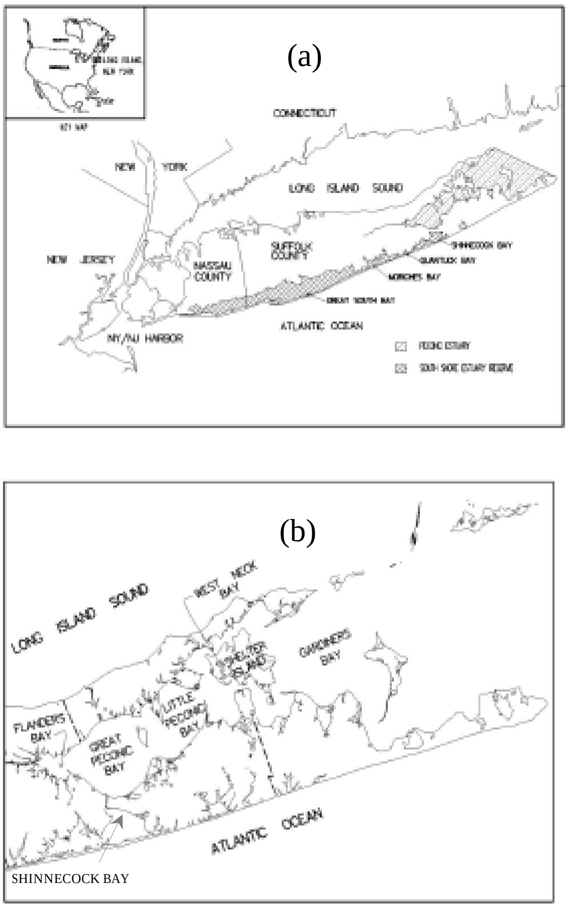

Fig. 1. (a) Long Island, NY. (b) Peconic Estuary.

A bloom of the dinoflagellate, *Cochlodinium polykrikoides* (syn. *C. heterolobatum*) has been identified in the Peconic Estuary, Long Island, NY, USA (Fig. 1), an area undoubtedly more familiar as the original focus of the «brown tide», *Aureococcus anophagefferens* [1]. The bloom occurred in late September-early October, 2004, when patches of red water were noted in Flanders Bay, extending into Great Peconic Bay and, ultimately, into neighboring Shinnecock Bay, through a one-way (south) flow canal.

The organism was found in chains of two to eight cells, with an occasional single cell noted. Cell size ranged from 25 – 40 µm, with the terminal cells somewhat longer than wide. The hyposome of the chain's terminal cell was bi-lobed. Cells within the chain were either spherical or slightly depressed dorso-ventrally. A large nucleus, and numerous chloroplasts were present, and the cingulum (girdle) made almost two turns around the cell. A stigma was contained within the episome (Fig. 2). As a live sample was not available, identification was made from lugol-preserved samples.

This had been thought to be the initial *Cochlodinium* bloom in the area, however, review of previous files and photomicrographs revealed the occurrence of a similar bloom in West Neck Bay, a sub-embayment of the Peconic Estuary, in early September, 2002. Cell numbers during the 2004 bloom were estimated, by counting all cells within a Palmer-Maloney counting chamber, to be over 2 x 10^6 per liter. No population estimate was made of the 2002 bloom, but it was noted that the waters, contained within a very poorly flushed area, were quite red.

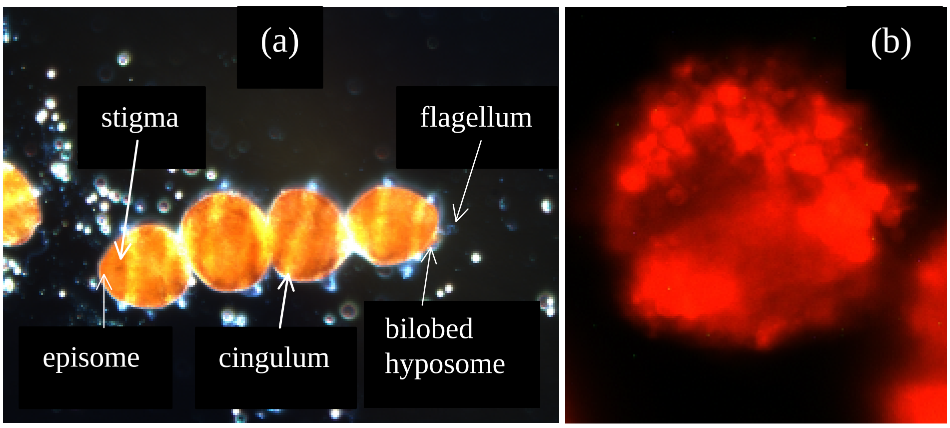

Fig. 2. (a) 4-cell chain illustrating the various structures. (b) Chloroplasts within a single cell visible under fluorescent microscopy.

Although *C. polykrikoides* has been implicated in kills of impounded fish in Japan [2], China and Korea [3] and, more recently the west coast of Canada [4], the Gulf of California [5], and the Philippines [6], no incidents of dead fish were reported during or after either bloom in the Peconic Estuary where motile species were free to leave the area. Hargraves and Maranda [7] reported a bloom in Pt. Judith Pond, Rhode Island, USA approaching 10^7 cells per liter, but also did not observe any fish mortality. *C. polykrikoides* (identified as *C. heterolobatum*) has also been reported to form intense blooms in the mouth of the York River, a tributary of Chesapeake Bay [8] and, beginning with a bloom in 1992, spreading into the lower bay [9].

Because *C. polykrikoides* is myxotrophic [10], engulfing phytoplankton species with equivalent spherical diameters of < 12 µm, its place in the food web, and its effect on estuarine ecology, regardless of its fish-killing potential, is difficult to determine. While larvae of the mussel *Mytilus galloprovincialis* have been shown to be capable of preying upon *C. polykrikoides* [10], its nutritional value relative to other species that may have been displaced has not been determined. Other studies have indicated that metamorphosis of oyster (*Crassostrea gigas*) trochophore larvae is retarded [11], and calcium uptake by larvae of the American oyster, *Crassostrea virginica*, is depressed, and mortality elevated by exposure to *C. polykrikoides* [12].

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XI th International Conference on Harmful Algal Blooms, Cape Town Nov 2004

Cyanobacterial news

Those of us researching into toxic cyanobacteria were offered two excellent conference choices this year. The first was the International Conference on Toxic Cyanobacteria in Bergen, Norway in June, and the second the HAB conference in Cape Town in November. Few could afford both! Fortunately this coincidence does not occur in 2006, when the HAB conference is in Copenhagen, as the Toxic Cyanobacteria conference is in Brazil in 2007.

Among the cyano papers at the HAB conference was a fascinating account by **Karen Arthur** of tumours in green turtles feeding on seagrass covered by the filamentous *Lyngbya*. This organism is well known for causing severe skin burns on bathers rubbing against the filaments, but had not previously been recognised as an ecological problem. The turtles were exposed to *Lyngbya* toxins through feeding on the seagrass, and also through physical contact with the filaments. The tumours appear at the flipper junctions and on the face. The increased dominance of *Lyngbya* is attributed to nutrients from fertiliser and sewage increasing in the shallow coastal bays of southern Queensland. Karen received the award for best student presentation for this paper.

Two other papers also focussed on the carcinogenic effects of algal toxins, **Valerie Fessard** evaluated the genotoxic effects of okadiac acid (the toxin of diarrheic shellfish poisoning) on cultured mammalian cells, showing that it caused chromosome loss and therefore potential cancer. To identify whether this is a real risk will require epidemiological studies of people who were sick in past outbreaks of this shellfish poisoning.

In my paper on the health impacts and carcinogenicity of the cyanobacterial toxin cylindrospermopsin, both the acute poisoning and potential carcinogenicity were discussed. Preliminary data on cancer rates in a population known to have been acutely poisoned and whose water supply was contaminated by this toxin for several years, indicated an increase in gastrointestinal cancers.

The majority of research on cyanobacteria was located in the poster sessions, and included several studies of *Microcystis* and *Cylindrospermopsis* and their toxins. The sophistication of new techniques applied to these studies was impressive, with increased use of genetic markers for toxin gene detection coupled with chemical or immunological toxin measurement. One interesting ecological aspect was the generally toxic North American, South African, Indian and European strains of *Microcystis*, compared to tropical African lakes with huge *Microcystis* populations with negligible toxicity.

The increasing data on *Cylindrospermopsis* and cylindrospermopsin in Europe is fascinating. In an extensive survey of German lakes by **Claudia Wiedner**, **Jutta Fastner** and colleagues, no *Cylindrospermopsis* strains were found that produced cylindrospermopsin. However many lakes tested showed cylindrospermpsin in the water. It is apparent that some other species is producing the toxin in European waters, whereas in North America, Asia and Australia the most frequent source is *Cylindrospermopsis*. This implies that the presence of cylindrospermopsin in water supplies may be a much wider risk than was anticipated.

On Wednesday morning the cyanobacterial researchers gathered for a round-table discussion on research priorities, and the particular problems faced by southern Africa. The Global Water Research Coalition earlier in 2004 did a similar exercise, meeting in Australia. The key areas of the toxicity of cylindrospermopsin, management of reservoirs and on-line or direct monitoring techniques for toxicity were discussed. The need for very basic detection methods and drinking water treatment technology in less developed countries was highlighted.

Overall a good conference, well organised and in a delightful setting.

Ian R. Falconer, University of Adelaide, Australia.

NOTE:

NEW HAB SPECIES IDENTIFICATION GUIDE TO SOUTH EAST ASIA

A guide to potentially toxic microalgae of Vietnamese waters has been published as Opera Botanica No. 140. Although the guide builds on Vietnamese material it will be of interest to anyone working with harmful algae in the South East Asian region.

Larsen, J. & Nguyen, N.L. (eds), 2004. Potentially toxic microalgae of Vietnamese waters. Opera Botanica 140: 5-216. Copenhagen.

ISBN 87-88702-85-5.

Future events

MARCH 2005

GEOHAB: OPEN SCIENCE MEETING ON HABS AND EUTROPHICATION. March 7-10, 2005. Baltimore, Maryland, USA.

The conference topics include:

- Global trends in eutrophication and HABs
- Physiology of HABs with respect to nutrients
- Comparative studies on HABs in eutrophic areas
- HAB programs in global eutrophic areas
- Modeling of nutrients and HABs
- New methodologies for nutrient and HAB monitoring

Further information at: http://www.jhu.edu/scor/GEOHAB-OSM3.htm

APRIL 2005

MARINE AND FRESHWATER TOXINS ANALYSIS: FIRST JOINT SYMPOSIUM AND AOAC TASK FORCE MEETING. April 11-14, 2005. Baiona, Spain .

Convener: Department of Analytical and Food Chemistry. Universidade de Vigo, Spain.

The symposium will address new developments and validation efforts in the analysis of marine and freshwater toxins, and is held as a joint meeting with the AOAC Task Force on Marine and Freshwater Toxins.

The conference program is planned to maximize interaction between the Symposium and the Task Force: Presentations will address special needs of the community from toxin monitoring to new concerns in the intentional contamination of food and water.

Further information at: http://www.aoac.org/marine_toxins/task_force.htm

HARMFUL ALGAE NEWS

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