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REPORT OF THE WORKING GROUP ON PHYTOPLANKTON AND THE MANAGEMENT OF THEIR EFFECTS

Vigo, Spain, 18 - 21 March 1991

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1. OPENING OF THE MEETING

1.1 The meeting was opened at 0930 on the 18th March, by Mr. S. Fraga, who was Acting Chairman in the absence of Dr. R. Gowen. The meeting was attended by 31 scientists from 12 countries and IOC. The list of participants is given in Annex II.

1.2 The agenda was adopted and is attached as Annex I.

1.3 Dr. K.J. Jones was appointed as Rapporteur.

1.4 The Chairman informed the working group of the Council Resolution C. Res. 1990/2:27:6 which established the following tasks:

a) Evaluate and report on the results of trend analysis on the occurrence of phytoplankton-related harmful events and assess the utility of using the data collected for inclusion in a data base of harmful events. If such a data base is considered desirable, advise on the relative merits of this being based in ICES or IOC.

b) Assess and prepare a report on the role of nutrients in stimulating the formation of phytoplankton-related harmful events, paying special attention to the role of nutrient ratios in the stimulation of the bloom and appreciation of the problems caused.

c) Discuss, evaluate, and report on case histories of new management techniques to carry stocks though phytoplankton-related harmful events.

d) Evaluate available different methods with a view to the development of a standard method for measuring ^{14}C uptake that could be adopted for monitoring purposes in relation to studies of the relationship between changes in nutrient inputs and concentrations and phytoplankton activity.

e) Report on the state of development and routine applicability of methods for the detection and quantification of phycotoxins that affect man or marine organisms and, if appropriate, recommend particular methods on the basis of their accuracy, sensitivity, ease, and speed of use, and, as appropriate, make specific recommendations for demonstration workshops.

2. SUMMARY

2.1 The working group requests advice and assistance from the Working Group on Statistical Aspects of Trend Monitoring for identification of trends in existing data sets and in planning the collection of new data which may be used in the future for trend analysis.

2.2 The Working Group concludes that further progress in understanding the role of nutrients in harmful algal blooms requires a much deeper understanding of the dynamics of phytoplankton blooms than we have at present.

2.3 Since the last meeting of the WG in 1990, no new management techniques to carry stocks through phytoplankton-related harmful events have been reported.

2.4 The WG suggests that ICES should seek cooperation with experts in the field of primary production outside the ICES area (through the auspices of IOC and SCOR), with the aim of establishing a globally-acceptable standard method for primary production measurement for monitoring purposes.

2.5 Advances in DSP analysis were discussed and sources of new standards and reference material noted.

3. PRESENTATION OF NATIONAL REPORTS ON HARMFUL EVENTS

A recommendation was made by the Working Group at the previous meeting in Oban that members should continue the practice initiated by the former Working Group on the Effects of Harmful Blooms on Mariculture and Marine Fisheries by presenting annual reports of harmful events which had occurred in their countries during the past year. Accounts of harmful events had not been presented by all members last year because of the formation of the new working group therefore it was agreed that reports for the period 1989-90 should be presented at this meeting. Reports presented to the meeting are presented in ANNEX VI. The incidence of previously unrecorded species or patterns of occurrence of harmful events which are new to each country are highlighted below.

3.1 Summaries of new events since 1989:

United States

The general pattern of harmful toxic algal blooms throughout the U.S. was similar to past years with closure of shellfisheries due to PSP toxicity caused by *Alexandrium tamarense* and *A. catenella*) occurring in Maine, Massachusetts, Washington and Alaska. 1SP and fish kills associated with *Gymnodinium breve* were reported along the coasts of the Gulf of Mexico and reports of low concentrations of *G. breve* were received from North Carolina. The non-typical events occurring in 1990 were:

a) A continuation of the recently detected PSP toxicity in surf clams and scallops from offshore waters of Georges Bank and Nantucket Shoals. This PSP remained above quarantine levels throughout the year presumably due to slow depuration *Spisula*.

b) The bloom of *Aureococcus anophagefferens* was reported in several embayments in Long Island NY, but no harmful effects were reported. Also, a survey of the US coast from Massachusetts to Maryland using an immunofluorescent assay for *A. anophagefferens* detected this species in 30 of 60 stations sampled, including more than 10 where "brown tides" have not been reported. These areas are at risk from future outbreaks of *A. anophagefferens*.

c) A large bloom of *Heterosigma akashiwo* resulted in mortality of farmed Atlantic salmon in central Puget Sound. This species is suspected to have caused fish kills in 1976 and was confirmed to have caused mortalities in 1989 in Puget Sound.

d) One human mortality was reported due to PSP in Alaska.

e) Significant levels of PSP (>500 μg/100 g) have been detected in the hepatopancreas of lobsters for the first time.

Canada

a) East Coast

The first proven case of Diarrhetic Shellfish Poisoning in North America was reported. In early August 1990, at least 16 people developed symptoms of DSP shortly after eating cultured mussels from Mahone Bay, N.S. Extracts of raw and cooked mussels were toxic to mice. Ionspray-MS and proton NMR spectroscopy established the presence of DTX-1, but no OA was found. The most toxic mussels contained up to 1000 ng/g whole tissue. Mussel digestive glands contained remnants of *Dinophysis norvegica*. When biologists sampled the water column in mid-August to mid-November, *D. norvegica* ? was still present (e.g. 1,600 cells/L on Sept. 28). Samples of the plankton concentrated by net tows showed no DTX-1 or OA.

b) West Coast

A non-toxic bloom of *Gonyaulax spinifera* (ca. 400 x 100 km in extent) mixed with other species was responsible for substantial shellfish mortality off the west coast of Vancouver Island. Cell concentrations were greater than 3.5×10^6 cells/L, but as many as 9×10^7 cells/L were also found.

Toxic blooms of *Heterosigma akashiwo* resulted in extensive losses of cultured fish in British Columbia. According to Dr. Ian White (DFO, Pacific Biol. Station, Nanaimo,B.C.), the bloom killed salmon within 200 min in Barkley sound, and within 60 min in Seshelt Inlet. No mucoid material was found on the gills; fish lost their equilibrium, turned on their side and sank. Ongoing research indicates the possible involvement of toxic compounds.

Non-toxic blooms of *Chaetoceros convolutum* and *C. concavicorne* continued to be a problem in British Columbian waters.

Norway

Prymnesium parvum bloomed in western Norway in the summers of 1989 and 1990 killing 750 tonnes of salmon and rainbow trout in 1989 and about 15 tonnes of caged salmon in 1990. The 1989 bloom was the first recorded of this species in Norway, although it had been observed before in water samples.

Sweden

In June and July 1990 large blooms of *Noctiluca miliaris* occurred in many regions of the Skagerrak and Kattegat. Blooms of an unidentified green gymnodinean dinoflagellate occurred along the coast of Bohuslän in the Skagerrak. DSP toxins were detected in August at Bohuslän (Skagerrak).

Finland

In June 1990 a bloom of *Prymnesium parvum* caused fish mortalities in a coastal inlet in SW Finland. Though this species has been detected in the whole Baltic Sea and caused fish kills in Denmark, this was the first time that the phenomenon took place on the Finnish coast. As compared to the outer archipelago the nutrients (P,N) as well as N:P ratios were considerably higher, indicating the stimulating effect of nitrogen. In August 1990 an exceptionally intense bloom of *Nodularia spumigena* took place in the Bothnian Sea.

Germany

A bloom of a green dinoflagellate probably identical with *Lepidodinium viride* was observed around the island of Helgoland. It reached a concentration of 6.5×10^6 cells/l. It is not certain whether this is a new species introduced in the German Bight or whether it was present before but overlooked. This bloom was not toxic.

United Kingdom

a) England

The high levels of PSP in mussels in 1990 from the annual bloom of *Alexandrium* off the N. East coast of England was noted. Mortalities of lugworm (*Arenicola marina*) in S. Wales were probably due to a combination of factors including spawning stress, high temperatures and anoxia as a result of a bloom of *Gymnodinium* species.

b) Scotland

From May to October 1990, the first detected case of PSP in the west coast of Scotland was recorded. The causative species was not known and the maximun level of toxin measured was 16480 MU (3023 μg/100 g) in both scallops and mussels.

France

Dinophysis occurred in 1989 and 1990 in the same regions where it had developed the two years before (e.g. Normandy, Southern Brittany, Western Mediterranean coast). A remarkably long depuration time was observed in 1989 along the Languedoc coast: up to 8 weeks. Developments of *Alexandrium minutum* have taken place since 1989 in Morlaix Bay, near the site where it was observed for the first time (1988). The PSP toxicity levels were not very high (160 μg/100 g of flesh in 1990). *A. minutum* also occurred in Toulon road-stead (Mediterranean Sea), with very great cell counts: up to 180 million cells/l.

Spain

a) Atlantic coast

There has been a remarkable extension in the temporal occurrence of *Dinophysis acuta*, a DSP agent, in the Rías Bajas (Galicia, NW Spain). This species used to appear in September-October. In the last two years (1989-1990), it has appeared in July or early August and persisted until November-December.

b) Mediterranean coast

A bloom of *Alexandrium minutum* reaching concentrations up to $28x10^6$ cells/l was observed for the first time in the bays of Ebro River delta in May 1989. PSP was detected in mussel reaching 110 μg STX/100 g meat. In February 1989, *Gymnodinium catenatum* was observed in Málaga with concentrations up to 3000 cells/l. PSP toxins were detected up to 100 μg STX/100 g meat in *Calliostoma chione*. This is the first time that *G. catenatum* is reported from this area, although PSP toxins were already detected in November 1987.

Portugal

The first records of persistence of DSP were recorded between May and July, on the Algarve coast, in Portimão and Aredo River regions. The causative species were *Dinophysis acuminata, D. sacculus, D. caudata* at a maximum detected concentration of 1600 cells/l. Detection of DSP is now occurring earlier on the north coast in the Aveiro and Matosinhos region. This year DSP was detected in early April.

4. DETAILED DISCUSSION OF THE TERMS OF REFERENCE

It was agreed that the most effective means of discussing the tasks would be to divide the working group into four sub-groups. A list of participants in each sub-group is given in Annex III.

4.1 Trend Analysis

a) It is useful for scientists and managers to have some indication of whether trends exist.

b) Several reports/data sets from members of the sub-group were submitted with, where appropriate, possible trends identified. These documents are listed in Annex IV. The sub-group did not feel that it was competent to perform analysis of these data at the meeting and therefore discussed the relative merits of different types of data for identification of trends and the results of this discussion is given below.

c) Many people concerned with algal blooms problems have intuitively concluded that there has been an increase in the frequency and severity of such events on time scales of years to decades. Such intuition can be tested by various statistical techniques if adequate time series exist. The group recognized that although such perceived trends may be real, we have no idea of their mathematical form, and cannot therefore know in advance what analytical techniques would be valuable.

d) This group began by listing the potentially relevant time series which exist in the ICES member states. This list is appended (Annex V). The data fall into four obvious categories, which are:

1. PSP,
2. fish and invertebrate mortalities,
3. plankton, and
4. DSP.

The value of these four categories is unequal, and we list them in descending order of value as perceived by the group, together with considerations on which this opinion is based.

1. PSP

It was concluded that time series of PSP-tests are the most valuable existing resource in the current context for trend analysis, for these reasons:

i) The method of determining PSP-levels has been standardized for a long time, and is accepted in all countries;

ii) PSP-levels are known for long periods in some regions, such as the English NE coast since 1968; Oslofjord since 1962; E and W coasts of Canada (> 40 years); and

iii) PSP is due to a rather small number of recognized phytoplankton species or morphotypes.

2. Fish and invertebrate mortalities

Mortalities are commonly associated with harmful algal blooms (of cultured fish, salmon and trout, in ICES member countries) and of benthic invertebrates. The changing magnitude of cultured fish deaths, in absolute terms, or as a proportion of cultured stock, could provide the basis for a trend analysis, but regionally different and often flexible management strategies, designed partly to avoid such mortalities, as well as the withholding of commercially sensitive information, degrade such time series, so that the normal assumption of homogeneity will never be realized. Invertebrate mortalities, except in a few cases, are not reported with sufficient accuracy to provide useful time series. But if this were remedied, they would not be degraded by management. Both categories of mortalities may also be affected by other stress-related factors such as disease.

3. Plankton

Quite long quantitative phytoplankton time series (>20 years) exist for a few localities (e.g. Helgoland, Germany; Plymouth, U.K; Narragansett Bay, USA; Gulf of Finland, Finland) as well as many shorter term but continuing smaller scale monitoring programmes. The Narragansett and Helgoland series in the longer term category are particularly valuable, since sampling is frequent (weekly in Narragansett, and 5 times weekly in Helgoland) and include chemical and physical parameters, as well as phytoplankton species composition. Such data are, however, more difficult to deal with, since in many cases the collection and preservation techniques vary over time, taxonomic judgments change, etc.

4. DSP

Estimates of DSP are still not fully quantitative, and the existing time series are also very short, so these data sets are not at present likely to yield useful results in this context.

Categories (1) and (2) have the added advantage that they integrate much of the biological variability and thus avoid some of the problems associated with spatial variability. This would also be true for the DSP data if the methodology were improved.

e) Monitoring for trend analysis

Most monitoring programmes in existence are 'target' orientated, e.g. for public health (PSP, heavy metals,..) or aquaculture (phytoplankton). An exception is the Baltic Monitoring Programme. The stations chosen are therefore not necessarily ideal for 'trend' monitoring, and mapping of coastal areas can provide a more rational basis for the location of stations suitable to the latter. A 3-year project, the Ocean Monitoring Centre (HOV-senteret) of the Norwegian Meteorological Institute, provides a model for such an exercise, and a projected Spanish programme in Galician waters (to be initiated this year by the autonomous government of Galicia) will be following similar procedures. Routine mapping can allow the identification of geographical trends, e.g. in species distributions over time (such as those of *Gyrodinium aureolum* in Norwegian waters or *Dinophysis* in French Atlantic and Mediterranean waters), as opposed to temporal changes at single locations.

Some geographical trends, such as shifts in species boundaries, are likely to emerge from sampling programmes already in existence. Although methods differ, it is nevertheless felt that some standardization of procedures would assist in the pursuit of potential trends of this type, and attention was drawn in particular to the value of integrated pipe sampling for phytoplankton counts.

f) Need for centralized database.

The relative merits of centralized and dispersed databases were discussed, and the group favored the latter. The main reason for this opinion was the general inaccessibility of highly centralized data-banks and the increased cost of gaining access to them. In following the latter option, the group felt that ICES should provide a list of what is available, along the following lines:

Directory of Databases

Sources of data potentially suitable for trend analysis should be listed under the following headings:

1. Nature of Data (PSP, DSP, ASP, NSP, Phytoplankton, Mortalities)

2. Parameters (e.g., Mouse units, species, chlorophyll, cell counts, temperature, salinity, nutrients)

3. Methods

4. Country, data collection area

5. Time period and sampling frequency

6. Contact with address

7. Publications.

4.2 The Role of Nutrients in Phytoplankton Related Harmful Events

In assessing the role of nutrients in enhancing phytoplankton-related harmful events, two types of events should be distinguished: a) those caused by toxic algal species, which may or may not be present at high levels of biomass; and b) those involving non-toxic species which cause harm as a direct result of their high biomass. Toxic events include episodes of paralytic shellfish poisoning (PSP), diarrhetic shellfish poisoning (DSP), neurotoxic shellfish poisoning (NSP), amnesic shellfish poisoning (ASP), and a variety of fish and marine fauna mortalities caused by known or suspected algal toxins.

Non-toxic species can cause harm as a result of high biomass. Perhaps the most common harmful event caused by non-toxic species is anoxia and its associated mortality of benthic and planktonic organisms due to the decompositional oxygen demand from decaying phytoplankton bloom biomass. Impacts can also be aesthetic, due to the sight and smell of bloom decomposition products on beaches (e.g. *Phaeocystis*). Non-toxic effects can also be mechanical, whereby bloom biomass clogs fishermen's nets or coats the nets and makes them visible to fish. A different type of mechanical problem occurs when some phytoplankton species (notably certain species in the diatom genus *Chaetoceros*), irritate fish gills, causing mucous secretions that limit oxygen uptake and cause suffocation. Fish mortalities may also result from changes in the seawater viscosity due to non-toxic polymer secretions from certain species of algae.

Despite this highly diverse spectrum of harmful bloom events, certain common features can be identified. Here the focus will be on the importance of nutrients, especially anthropogenic inputs, to the frequency and magnitude of the harmful events.

a) Toxic Species

Many species of toxic or harmful algae have thrived for thousands of years in waters free from human influence. These species can bloom in "clean" waters (e.g. *Alexandrium* spp. in the Gulf of St.Lawrence or in the Aleutian Islands of Alaska), achieving high biomass sufficient to cause dangerous levels of toxicity using naturally supplied nutrients. Although eutrophication is often invoked to explain the expansion of certain toxic episodes in recent years, convincing evidence linking increased frequency or magnitude of toxic blooms to pollution is lacking. In most cases where a toxic species has increased its geographic range or the frequency or severity of its impacts, mechanisms other than growth stimulation through nutrient enrichment can be invoked as alternative explanations. For example, the expansion of the PSP problem within southern New England during the last two decades can be attributed to *Alexandrium* species dispersal through natural bloom advection and cyst deposition just as easily as to nutrient enrichment of Gulf of Maine waters from coastal development. Likewise, the expansion of aquaculture activities may increase the reports of toxic episodes due to the initiation of commercial operations in waters where toxic species are indigenous or to the high level of regulatory scrutiny of the commercial product. One example of how toxic blooms may not be enhanced by nutrient enrichment or eutrophication is seen along the west coast of Sweden where the concentration and duration of okadaic acid toxicity seem to vary in proportion to the amount of water exchange with the open coast.

Nevertheless, it is evident that coastal pollution provides the macro- and micronutrients which can increase the growth rates and standing stock of toxic species. As with all other aquatic plants, high levels of inorganic macronutrients in pollution such as PO_4 or NO_3 can be directly stimulatory to toxic species if those nutrients are the first to be depleted during normal growth; likewise, some toxic species are known to utilize organic N or P as macronutrient sources. Micronutrients such as trace metals, vitamins, or chelators are also potentially stimulatory constituents of domestic and industrial effluents. One example where a link between toxic blooms and pollution has been demonstrated is in Finland. A decrease in the abundance of toxic bloom-forming, mostly fresh-water cyanobacteria algal species was observed in eutrophic bays within the city of Helsinki following removal of phosphorus from sewage effluents. In contrast, in the outer archipelago areas and open sea, other harmful open sea species have become more abundant and blooms more intense.

These nutrients can stimulate or enhance the impact of toxic species in several ways. For example, toxic phytoplankton may increase in abundance due to nutrient enrichment but remain as the same relative fraction of the total phytoplankton biomass (i.e. all phytoplankton species are affected equally by the enrichment). Alternatively, the nutrient enrichment can differentially enhance either the relative dominance of a toxic species within an assemblage or the level of toxicity of individual cells of that species. In each of these three examples, the net result of nutrient enrichment would be the same - an increased incidence of toxic episodes.

The non-selective stimulation of toxic and non-toxic species alike through nutrient enrichment would result in an elevation of toxicity superimposed on a general background of non-toxic blooms that are more frequent and that reach higher biomass levels. No special mechanisms need to be invoked to explain this pattern of development.

Differential enhancement of the biomass or toxicity of algal species by anthropogenic inputs could occur through several mechanisms. One possibility that is frequently cited relates to the different requirements that phytoplankton classes or species may have for certain nutrients, such as the silicon requirement of diatoms. Since other classes of algae do not share this requirement, diatoms could be silicon limited when supplies of N and P are sufficient to allow other species to grow and accumulate. An excellent example of this type of "nutrient ratio" effect (reviewed in Smayda, 1990) is found in the long-term monitoring records of Helgoland. Nearly 30 years of very detailed data document a steady increase in the N:Si and P:Si ratios, accompanied by a striking change in the composition of the phytoplankton assemblage as the relative proportion of diatoms decreased and flagellates increased. Changing nutrient supply ratios, which presumably reflect the abundance of P and N and the relatively low levels of Si in polluted waters, may thus have had a profound effect on the coastal ecosystem. Since a common assumption has been that diatoms are rarely harmful, the effect of nutrient enrichment may have enhanced the relative abundance and thus the impacts of harmful species.

Another example of the importance of nutrient ratio effects is in certain areas of the Baltic Sea where decisions are ongoing concerning the nature of proposed sewage treatment (e.g. N versus P removal). A controversial and unresolved issue is whether the removal of N will create N:P ratios that favor the growth and dominance of toxic cyanobacteria that possess the unique ability to fix nitrogen (N_2). Here again, the special nutritional characteristics of one group of harmful algae may permit them to take advantage of favorable nutrient supply ratios and dominate the phytoplankton.

Another mechanism by which nutrient ratios can influence toxic species relates to the effects of different limiting nutrients on the levels of toxicity in certain species. One example is *Alexandrium tamarense*, which can be about 5 times as toxic when grown in P-limited cultures than in nutrient-replete cultures. Severe N-limitation of this species can reduce toxicity several-fold compared to nutrient replete controls. The net effect is that cells limited by these two different nutrients in natural waters could differ in toxicity by an order of magnitude. This has obvious management implications with respect to nutrient loadings to coastal waters since efforts to reduce P concentrations, for example, might result in higher toxicity cells than before the nutrient control. In this case, even though there may be fewer cells overall, more toxin would be present.

A related phenomenon has been reported in *Chrysochromulina polylepis* cultures, where levels of toxicity were considerably enhanced in P-limited cultures relative to nutrient replete controls. This is consistent with the field data from the 1988 bloom of that species, which caused extensive benthic mortalities when dissolved N:P ratios were very high in the Skagarrak and there was a possibility of P limitation of the algae. Recent preliminary observations indicate that N limitation can also enhance *C.polylepis* toxicity (E. Paasche, unpublished). A related series of observations demonstrate that the toxicity of *Gyrodinium* cf *aureolum* is enhanced in P-limited cultures (Gentien *et al.*, 1991). A possible explanation is that since the toxins from these two species are glycolipids and lipid synthesis proceeds both under N or P limitation, toxin accumulation would continue after other metabolic pathways for growth have ceased.

Another example demonstrating how nutrient ratios may affect algal toxicity is with the pennate diatom *Nitzschia pungens* f. *multiseries*. This species begins to produce the neurotoxin domoic acid when cell division ceases during the stationary phase. However, domoic acid production occurs only when nitrogen is in excess and some other nutrient (e.g. silicon or phosphorus) limits the cell yield at that time (Bates *et al.*, 1991).

In the case of *Gymnodinium catenatum* cultured on K media, changes in the concentration of nitrate (and therefore in the N:P ratio) induce important qualitative and quantitative changes in the production of toxins (Reguera and Oshima, 1990). Femtomoles of toxin produced per cell can be more than one order of magnitude higher in cultured cells than in wild populations, and GTX6 can be the predominant toxin in cultures, whereas GTX5 is the more abundant in wild *G. catenatum*.

These observations from cultures raise the important issue that changing nutrient ratios in coastal waters may induce higher levels of toxicity in cells of some species than was the case previously.

b) Non-toxic, Potentially Harmful Species

Occurrences of red tides due to intense growth or accumulation of algae predate anthropogenic pollution; such growth results from natural processes of enrichment such as seasonal upwelling, land run off, etc. However, it is also evident that a common result of coastal eutrophication due to pollution has been to increase the occurrences of massive algal blooms.

In March 1990 an International Conference on Marine Coastal Eutrophication was held in Bologna (Italy) to discuss the response of marine transitional systems to human impacts. Many examples have been presented at this conference.

In contrast to the blooms of toxic algal species, for which the link to pollution remains speculative, there are several examples of increasing red tides or high biomass blooms of non-toxic algae coincident with coastal development. Examples are the red tides from Hong Kong Harbor, which increased in parallel to the trend of human population growth in that city, and the red tides in the Inland Sea of Japan, which decreased when effluent inputs with chemical oxygen demand were lowered through regulatory controls.

As discussed above for toxic algae, the species composition of the blooms can be dependent on the relative supply rates of the major nutrients (i.e, phosphorus, silicon and nitrogen) due to the differential uptake capabilities and growth requirements of individual bloom species. An important example of the potential role of nutrient ratios in the relative dominance of non-toxic species concerns the *Phaeocystis* blooms in the German Bight and the southeastern North Sea, which now last 2-3 times as long as was the case prior to 1973.

Phaeocystis blooms develop after the depletion of silicate by the diatom spring bloom, taking advantage of the high levels of nitrogen and phosphorus which the diatoms are unable to utilize due to silicate limitation. Here again, the relative inputs of N, P, and Si from domestic and industrial effluents may be affecting the dominance of certain species or classes of algae, while providing the additional nutrients required to enhance the biomass of non-toxic species to harmful levels.

Harmful effects from non-toxic blooms are thus controlled in part by the chemical characteristics of the nutrient enrichments. In theory, management strategies for the coastal zone could be developed that minimize the likelihood of harmful effects from non-toxic algae or that minimize the magnitude of those impacts. In practice, however, this requires detailed scientific understanding of the nutrient requirements, uptake capabilities, growth potential and grazing susceptibility of many indigenous species. The task is somewhat simpler in cases where harmful effects are largely due to one or two target species or when a general phenomenon (e.g., anoxia) occurs following blooms of a variety of different non-toxic species. In the former case, knowledge of the growth requirements and bloom mechanisms for those species can be used to design bloom mitigation strategies or to evaluate the potential for other activities to stimulate those species. When the impact is a more general phenomenon not linked to a particular algal species (e.g., anoxia), efforts to reduce effluent inputs can be expected to have a predictable effect by lowering the overall phytoplankton biomass and eliminating some of the oxygen demand responsible for the anoxia.

c) Other factors

It is important to note that many toxic and non-toxic blooms occur without any direct stimulation from anthropogenic nutrients. Mechanisms for population development through physical or hydrographic concentration can take a variety of forms. Some blooms are associated with specific hydrographic features such as fronts (e.g., Ushant Front) and coastal upwelling (e.g., Galician and northern Portuguese coast).

Long distance transport and delivery of established bloom populations to their impact sites via buoyant plumes, wind-driven flow, etc., are well-established mechanisms that may lead to toxic episodes.

The regular eastward development of the *Phaeocystis* bloom along the southeast coast of the North Sea is another situation where advective processes contribute to bloom development.

Another situation in which the geographic expansion of a toxic species or even the magnitude of bloom populations can be influenced by factors other than nutrient supply concerns species which form dormant resting cysts. The geographic dispersal of cyst-forming species (e.g. *Alexandrium tamarense*, *Gymnodinium catenatum*) is mainly governed by the advection and deposition of cysts, either during bloom events or during winter months prior to bloom development. Species dispersal via this mechanism would thus be unrelated to eutrophication. Although field evidence remains weak, advection and resuspension of cysts immediately prior to bloom events can be a major factor in bloom development independent of ambient nutrient levels.

A final consideration in the context of factors that can cause harmful events without linkage to nutrient enrichment is that some algal species are highly toxic. This means that very low concentrations can result in toxicity, i.e., that no enhancement is needed. The best example is *Dinophysis*, which has been shown to cause toxicity in shellfish at concentrations of 200 cells/liter.

Finally, it is important to note the effect that physical processes such as mixing, dilution, dispersion and light transmission have on the observed response of algal populations to nutrient enrichment in the sea. Algae require both light and nutrients to grow. If light becomes limiting, the full growth potential of any nutrient enrichment may not be achieved. Vertical mixing and turbidity in the surface layers reduce the availability of light to phytoplankton. Consequently, in strongly mixed or turbid environments there may be no algal bloom response to nutrient enrichment. Similarly there is unlikely to be the local development of algal blooms, even if nutrient enrichment is present, in environments where the growth rate of the phytoplankton cannot produce new cells faster than they are removed by dispersion and dilution (or any other loss) processes. Such factors are particularly important in fjords and estuaries where water exchange with coastal seas is controlled by tidal flushing and circulation driven by freshwater input.

d) Conclusions

1. There is clear evidence that some non-toxic but potentially harmful blooms in the ICES area are associated with nutrient enrichment (e.g. *Phaeocystis* in Dutch coastal waters).

   However, there are also many harmful algal blooms that show no obvious link to nutrient enrichment due to the dominance of physical concentration factors or the high toxicity of small numbers of cells. There are thus no generalizations that apply to all types of harmful algal events.

2. There is surprisingly little evidence directly linking toxic algal blooms to anthropogenic nutrient enrichment, although this may only reflect a lack of both data and attempts to demonstrate such a relationship.

3. Nutrient supply ratios can affect harmful blooms in several ways: a) selection of dominant species (e.g. replacement of diatoms by *Phaeocystis* as silicon is depleted); and b) by altering the toxicity of some species. Evidence supporting the latter mechanism is available from laboratory studies, but field verification is lacking.

4. **The biggest constraint in understanding the role of nutrients in harmful algal blooms is our lack of understanding of the dynamics of phytoplankton blooms.**

4.3 New Management Techniques

Since the last meeting of the WG, no new management techniques to carry stocks through phytoplankton-related harmful events have been reported.

4.4 Evaluation of Available Different Methods with a View to a Standard Method for the Measurement of Primary Production

The rationale for developing a standard method for measuring ^{14}C uptake of phytoplankton for monitoring, and the description of an incubator for such purposes have been discussed in previous documents (ICES C.M.1987/L:27; Richardson 1987; Colijn *et al.*, 1989; 1990 WG report C.M.1990/Poll:7; Anon. 1990 Cooperative Research Report No. 170). The sub-group noted the efforts made by the previous Working Group on Phytoplankton Ecology to arrive at a standardized procedure and accepted that the information from its activities provided a good basis for method selection. Repetition of this exercise was, therefore, not deemed necessary by the present sub-group. Although the 1990 meeting of the Working Group on Phytoplankton and the Management of their Effects could not recommend adoption of the protocol and apparatus of Colijn *et al.*, (1989) to be used as a standard method for use throughout the ICES community, the Working Group report pointed out that with minor, though important, modifications to the protocol it would be generally acceptable.

The main criticisms arising from the 1990 meeting of the present sub-group were: 1) samples would be collected at only one depth; and 2) only one irradiance level would be used for the incubation. In 1990, the Working Group stressed the importance of obtaining information on the physiological state of phytoplankton by measuring the photosynthetic parameters, P^Bm and α (Platt and Jassby, 1976), from P vs I curves. If supported by measurements of the vertical distribution of irradiance and chlorophyll, this approach, in addition to providing an estimate of P^Bm, would allow the estimation of depth-integrated water column production. The latter might be used more effectively and reliably as an indicator of changing phytoplankton activity resulting from nutrient enrichment than an imperfectly derived estimate of P^Bm in a sample taken from a single depth and measured at a single irradiance level. Furthermore, the additional information could be obtained with little extra effort and only minor modification to the method of Colijn *et al.*, (1989).

With regard to the first criticism, the sub-group recognized that while a sample collected at one depth may not be adequate for research purposes, it could be sufficient for monitoring purposes provided that associated measurements of the vertical distribution of chlorophyll and irradiance within the water column are made so that an estimate of integrated production could be determined. Under normal circumstances, samples should be taken from the middle of the surface mixed layer, as determined by CTD profiles. However, the sub-group identified circumstances where the choice of a sampling depth would have to be left to the discretion of the operator (e.g. in the presence of an extremely reduced mixed layer relative to the depth of the euphotic zone; where a sub-surface chlorophyll maximum was observed; or where complex stratification of the water column existed), or where it might be beneficial to determine photosynthetic parameters for samples from more than one depth. In any event, the sampling depth should be reported and the reasons for its choice stated.

With regard to the second criticism, the incubator could easily be modified to provide up to 11 irradiance levels plus one dark bottle by covering the sample bottles with suitable neutral density filters.

It was noted that the fluorescent light source recommended provides a maximum of only ca. 360 μmol photons $m^{-2}s^{-1}$ irradiance and therefore may not be sufficient to saturate photosynthesis in certain circumstances (e.g. unpublished data provided to the sub-group showed that ^{14}C uptake in samples from the Ria de Vigo, Spain in September 1990, saturated at irradiances greater than 800 μmol photons $m^{-2}s^{-1}$). The manuscript of Colijn *et al.*, (1989) was further revised during the current meeting to reflect the above concerns of the sub-group, and these revisions will be forwarded to the authors.

Before the protocol and incubator are adopted by ICES as a standard method, the sub-group recommend that further assessment of the suitability of the irradiance source be carried out to determine how generally applicable the present maximum achievable irradiance level is to the diverse conditions that are found within the ICES area. This might be done by field trials in a range of geographical areas or by reference to published literature or unpublished data sets which provide P vs I relationships from a range of geographical locations. If necessary, appropriate modification of the light source should be made (e.g., by the use of incandescent rather than fluorescent lamps).

The sub-group is aware of the ICES symposium on "Measuring Primary Production: From the Molecular Base to the Global Scale" to be held at the Centre de Recherche en Ecologie Marine et Aquaculture de L'Houmeau, France in April 1992, and noted its relevance to Task 4, addressed by the present sub-group. One objective of the symposium is to "examine the various approaches that can be used to measure marine phytoplankton production, to state their limits of applicability, and to discuss the extent to which the different methods can be said to give consistent results". Because of this objective, it was thought inappropriate that the sub-group should attempt to evaluate other methods in advance of this symposium, particularly since it was felt that a sufficient critical mass expertise was not present in the Working Group.

It was noted by the sub-group that the need to identify the relationship between nutrient inputs and phytoplankton activity is not a problem that is restricted to the ICES area. Neither is the necessity to obtain measurements of primary production limited to the discrimination of effects of nutrient inputs.

It is, therefore, recommended that ICES should seek cooperation with experts in the field of primary production outside the ICES area (through the auspices of IOC and SCOR), with the aim of establishing a globally acceptable method for primary production measurement for monitoring purposes.

4.5 State of Development and Routine Applicability of Methods for the Detection and Quantification of Algal Toxins

The former ICES WG on Harmful Effects of Algal Blooms on Mariculture and Marine Fisheries documented the methods for detection and/or quantification of different phycotoxins which were available up to 1989. These are reviewed comprehensively in the Cooperative Research Report produced by the Working Group which is now awaiting publication.

Due to the rapid development of new analytical techniques in this field, it was thought advisable that the new Working Group on Phytoplankton and the Management of their Effects, established in late 1989, should discuss and report new advances in methodology for the detection and quantification of marine phycotoxins at frequent intervals. The sub-group therefore discussed current topics of relevance to methodology for some of the major phycotoxins causing problems within the ICES area. However because of the absence of several members of the Working Group who are key workers in the field of NSP and ASP detection, the sub-group considered that this remit could be addressed with only limited competency.

a) Diarrhetic Shellfish Poisoning (DSP)

Most ICES countries which experience serious DSP problems are using the HPLC technique by Lee *et al.*, (1987) to detect the toxins. There is evidence that the extraction and preparation procedures may give rise to problems of variability in results. Some of these problems can be attributed to the use of the reagent ADAM (9-anthryldiazomethane). Until recently this has not been commercially available and, consequently, it has been necessary for individual laboratories to synthesize it. This can result in variability in the quality of the reagent between laboratories. Furthermore, its degradation during storage may create a serious problem. Finally, the presence of a high concentration of certain algal pigments in the extracts can affect the extraction procedure.

To avoid those problems, an improved technique which includes a modified purification, using a different eluent composition from that reported by Lee *et al.*, (1987), and ultrasonification during esterification with ADAM has been developed by Stabell *et al.*, (1991). The technique also permits the use of deoxycholic acid as an internal standard, which was not possible with the older method.

The sub-group were also aware that a new method had been proposed by Shen *et al.*, (1991) in which dichloromethane extracts of DSP toxins are cleaned by passage through a C-18 cartridge before derivatisation with a new reagent, BrMmC (4-bromo-methyl-7-methoxycoumarine) in the presence of a catalyst (18-crown-6) in alkaline solution. In contrast to the ADAM reagent, the new reagent and catalyst are stable. However insufficient information is available on the effectiveness of this procedure at present and thus the sub-group is not able to make recommendations regarding its use. The sub-group were also aware of a method involving the application of a combined Liquid Chromatography - Mass Spectrometry method (LC-MS), using ion-spray ionization to the detection and quantification of DSP toxins (Pleasance *et al.*, 1990).

b) Paralytic Shellfish Poisoning (PSP)

The sub-group did not identify any significant advances in the routine methods for the detection and quantification of PSP toxins over those outlined in previous reports. However the availability of a PSP kit, using polyclonal antibodies against STX, neoSTX, GTX1 and GTX3, must be mentioned. This "STX test Kit" is assumed to be more sensitive than HPLC and more specific than mouse bioassays (Cembella and Lamoreux, 1991), but results of intercalibrations are not yet available. The sub-group discussed a protocol used in Galicia, Spain, for routine PSP assay which attempted to reduce the number of mouse bioassays carried out. By using the fluorometric technique (Bates and Rapoport, 1975; Bates *et al.*, 1978) for initial detection of the toxin and the mouse bioassay for quantification of its concentration once its presence is established, the number of mouse bioassays can be reduced to a minimum. In Galician bivalves affected by *Gymnodinium catenatum*, the toxin complex has a high percentage of the highly fluorescent and low potency toxin, GTX5, previously detected by HPLC. In comparative analyses of such samples by both the fluorometric method and by mouse bioassay, higher levels of toxin concentration were always given by the former method. Consequently the fluorometric method gives positive results before the mouse bioassay and provides earlier detection. Once positive results are indicated by the fluorometric method, the mouse bioassay must be used to quantify the toxin (Martínez *et al.*, 1991). The protocol is faster, cheaper, and more sensitive than the mouse bioassay and reduces animal sacrifice. However, the sub-group could only recommend the use of this procedure when the toxin profile is previously known.

c) Availability of Standard Material

The sub-group noted that okadaic acid standard is now commercially available from Moana Bioproducts in the USA (>97% pure), and from Boehringer Mannheim Ltd. in Europe (with a purity >97%). NRC (Halifax, Canada) will be producing purified STX, neoSTX, GTX1 and GTX4 for sale before the end of 1991, as well as a certified reference mixture prepared from mussel tissue for HPLC calibration. The EEC Bureau Communitaire de Reference (BCR) is promoting the financing of a project leading to the production of toxin standards (PSP and DSP) and the provision of reference toxic material for intercalibration exercises.

5. ANY OTHER BUSINESS

5.1 Cooperative Research Report

The WG expressed its great concern about the long delay of the publishing of the Cooperative Research Report on the Management of the Effects of Harmful Algae on Mariculture and Marine Fisheries compiled by the ICES WG on Harmful Effects of Algal Blooms on Mariculture and Marine Fisheries. Since this document contains important review information on the current status of toxin detection methodology which serves as a baseline against which new developments can be assessed, the Working Group suggests that steps necessary to ensure rapid publication be taken as a matter of urgency.

5.2 IOC Programme on Harmful Algal Blooms (HAB)

The Intergovernmental Oceanographic Commission (IOC) is developing a programme on Harmful Algal Blooms under its joint programme with FAO on Ocean Sciences in Relation to Living Resources (OSLR). The objective is to foster development of the scientific and management aspects of the harmful algal bloom problem and to prepare the intergovernmental support network necessary to carry out the programme. A general outline of an appropriate programme was developed at a meeting in Takamatsu (1987) and Paris (1990). The programme overview will be prepared in 1991, with the components identified and appropriate committees selected to develop in detail the full programme. Once the programme plan is developed, an implementation plan will be prepared and resources identified in conjunction with an IOC ad-hoc Intergovernmental Panel for Harmful Algal Blooms which will meet in 1992. The programme will be done in cooperation with regional bodies (e.g. ICES, GCFM) and international scientific organizations (e.g. SCOR, ICSU).

5.3 The Working Group expressed concern that ICES documents relevant to the terms of reference of the Working Group had not been made available to the Chairman prior to the meeting. In particular it was noted that a Cooperative Research Report, No. 170, on the ICES ^{14}C primary productivity intercomparison exercise had been published in May 1990, but was only available to the working group because one member had fortunately brought a personal copy with him. This document contained material which was highly significant to task 1.4d and it was felt that it should have been forwarded to the Chairman prior to the meeting.

6. RECOMMENDATIONS

6.1 That, wherever possible, it is desirable that standard monitoring methods should be followed so that in the long term it will become possible to identify regional or broader scale patterns than is presently possible. However, changes sufficiently radical to destroy the relative homogeneity of time series should not be followed indiscriminately.

6.2 That every effort should be made to maintain the present series of monitoring programmes so as to ultimately provide long-term data series for tenable trend analysis.

6.3 ICES should encourage member countries to analyze their national data sets so that identified trends can be examined at the next working group meeting.

6.4 National reports of bloom events in the long term have the potential to provide a data-series suitable for trend analysis and should continue to be collected by this working group and published by ICES. It is emphasised that these reports should include null reports stating that there have been no known incidents of harmful events, when it is appropriate.

6.5 The ICES Statistics Committee should be asked to examine the time-series listed in Annex V and advise on suitable methods of trend analysis for identifying temporal patterns at individual monitoring sites and geographical changes.

6.6 Working Group members should review the programmes and plans within the ICES countries in order to assess their adequacy with respect to understanding the dynamics of phytoplankton blooms.

6.7 The WG should meet in Belfast in February 1992 to undertake the following tasks:

a) Working Group members should review the programmes and plans within the ICES countries in order to assess their adequacy with respect to understanding the dynamics of phytoplankton blooms.

b) Discuss, evaluate, and report on case histories of <u>new</u> management techniques to carry stocks through phytoplankton-related harmful events.

c) Report on the state of development and routine applicability of methods for the detection and quantification of phycotoxins that affect man or marine organisms and, if appropriate, recommend particular methods on the basis of their accuracy, sensitivity, ease, and speed of use, and, as appropriate, make specific recommendations for demonstration workshops.

d) Examine and analyze the value of temporal or geographical trends identified by WG members during the intersessional period.

e) Discuss and review new ideas and developments in primary production methodology arising from the proceedings of the ICES Symposium on "Measuring Primary Production: From the Molecular to the Global Scale", which might be appropriate to determining relationships between nutrient inputs and phytoplankton activity.

7. ACTION LIST

7.1 All National representatives to submit Tables, as described in the report, of time-series data sets held, for the Directory of Databases.

7.2 All National representatives to continue to submit National Reports on Harmful Algal Bloom events, including null reports, as these may, in the long term, provide a data series suitable for trend analysis.

7.3 Members should collect information during the intersessional period suitable for inclusion in a Directory of Databases.

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ANNEX I

WORKING GROUP ON PHYTOPLANKTONAND THE MANAGEMENT OF THEIR EFFECTS

18 - 21 March 1991

Instituto Español de Oceanografía

Vigo, Spain

AGENDA

1. Opening the meeting (9.30 Monday March 18th).
2. Adoption of the Agenda.
3. Election of Rapporteur.
4. General discussion of tasks of the working group.
5. Discussion of the National Reports on incidence and effects of harmful algal blooms in 1989 and 1990.
6. Establishment of subgroups for detailed discussion of the different tasks of the Working Group.
7. Any Other Business
8. Action List for members of the working group.
9. Recommendations to ICES.
10. Adoption of the Working Group Report.
11. Close of meeting.

ANNEX II

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ANNEX III

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ANNEX IV

DOCUMENTS SUBMITTED IN COMPLIANCE WITH RECOMMENDATIONS OF PREVIOUS WORKING GROUP MEETING

Anderson, D.M. and A. White. U.S. data sets relevant to harmful algal blooms.

Belin, C. Synthesis of harmful effects of humanly toxic phytoplankton species in France.

Dahl, E. Data on harmful events and monitoring activities in Norway.

Gentien, P. and C. Belin. Marine fauna mortalities associated with algal blooms in France.

Kononen, K. Events of mortality among fish and other organisms in Finland.

Kononen, K. and H. Viljamaa. Long-term data on the abundance of harmful cyanobacterial and dinoflagellate species in the Gulf of Finland, 1968-1990.

Laing, I. U.K. data summary of PSP in mussels, N.E. Coast of England, 1968-1990.

Mariño, J. *D. acuta* and *G. catenatum* data in Ría de Arosa, Spain, 1985-1990.

Reguera, B., I. Bravo and S. Fraga. *D. acuminata*, *D. acuta* and *G. catenatum* in Ría de Pontevedra, Spain, 1985-1989

Sampayo, M.A. Portugal monitoring data, 1986-1990. PSP

Sampayo, M.A. Portugal monitoring data, 1986-1990. DSP

Valcarcel, J.A. PSP data in Ría de Arosa, Spain, 1987-1990

Wyatt, T. PSP in the British Isles, 1990.

ANNEX V

TIME SERIES DATA AVAILABLE

Country	Area	Data	1st year
Norway	Oslofjord	PSP	1962
	Rest of coast	PSP	1982
	All	Mortalities	1966
		Gyrodinium	1981
		Dinophysis	1984
		DSP	1984
Sweden	West Coast	PSP	1982
		Phytoplankton	1989
		DSP	1984
Finland	All	Mortalities	1984
	Gulf of Finland	Phytoplankton	1968
Germany	German Bight	Phytoplankton	1962
U.K.	N.E. England	PSP	1968
France	All	PSP	1984
		Mortalities	1976
		Phytoplankton	1984
		Gyrodinium	1980
		DSP	1983
Spain	Galicia	PSP	1976
		Phytoplankton	1977
		Dinophysis	1985
		DSP	1982
Portugal	All	PSP	1986
		Phytoplankton	1987
		DSP	1987
U.S.A.	Maine	PSP	1958
	Mass.	PSP	1972
	Calif.	PSP	1962
	Washington	PSP	1978
	Oregon	PSP	1980
	Florida	NSP	1978
	Florida	Mortalities	1980
	Washington	Mortalities	1989
	Naragansett Bay	Phytoplankton	1958
Canada	East coast	PSP	1942
	West coast	PSP	1950
HELCOM	Baltic Sea	Phytoplankton	1979

ANNEX VI

NATIONAL REPORTS FOR 1989 AND 1990

ALGAL BLOOM REPORTS - UNITED STATES 1990

. **Locations:** Georges Bank -- offshore waters of the northeastern U.S.

. **Date of Occurrence:** May, 1990. Not determined how long the bloom lasted, although a few plankton samples made in June did not reveal many Alexandrium tamarense cells.

. **Effects:** Filter-feeding shellfish (surf clams, ocean quahogs, blue mussels, scallops) accumulated paralytic shellfish toxins. The toxins were still present in these animals in the late fall of 1990, although at reduced levels.

Eight fishermen were poisoned (PSP) in late May, 1990, after eating blue mussels taken as by-catch from the southern part of Georges Bank ("Little Georges"). Two became seriously ill and were hospitalized; one nearly died.

. **Management Decision:** Shellfishing was banned from U.S. waters south of 49°20'N and east of 69° W. The sea scallop fishery remained open because the only item marketed was the adductor muscle which remains toxin-free or nearly so.

. **Causative Species:**
All circumstantial evidence points to Alexandrium tamarense, which is the toxic dinoflagellate responsible for PSP in the coastal waters of New England and eastern Canada and which grows in those coastal waters each year.

. **Environment:** Georges Bank is an open ocean environment 100-200 miles from the nearest land (Cape Cod). Much of the Georges Bank area is very shallow (10-15 m) and the region is a very rich fishing grounds for both shellfish and finfish. In May the surface waters in this area are about 10-12° C and some parts of the Bank are becoming stratified.

. **Advected population or in situ growth:**
It is not known whether A. tamarense cells are transported to Georges Bank from coastal blooms or whether the offshore bloom develops in situ.

. **Previous Occurrences:**
Similar shellfish contamination with paralytic shellfish toxins occurred in 1989, apparently for the first time, although there were no reported cases of PSP. Shellfishing was banned in 1989, as it was in 1990.

. **Additional Comments:**
Shellfish toxicity on Georges Bank appears to be a new phenomenon, at least at toxin levels as high as occurred in the past two years, although this offshore region was not investigated for paralytic shellfish toxins routinely.

.0. **Individual to Contact:**

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ALGAL BLOOM REPORTS - UNITED STATES 1990

1. **Locations:** Coast of Maine : Winter Harbor to Robbinston(Canadian Border).

2. **Date of Occurrences:** June - November 1990

3. **Effects:** Paralytic Shellfish Poisoning in shellfish. (*Mytilus edulis*, *Mya arenaria*, *Modiolus modiolus*, *Arctica islandica*, *Placopecten magellanicus*)
Shellfish extracts and mouse bioassays prepared and performed at the Department of Marine Resources, West Boothbay Harbor, Maine. Toxicity ranged from <40 to 3060 ug/100 g meat in *Mytilus*, <40 to 1145 ug/100g in *Mya*, <40 to 1280 ug/100g in *Modiolus*, <40 to 2480 ug/100g in *Placopecten*, and <40 to 590 ug/100g in *Arctica*.

4. **Management Decision:** Effected areas closed to the harvest of specific species.

5. **Causative Species:** *Alexandrium tamarensis*

6. **Environment:** Data not available

7. **Advected population or in situ growth:** Seems to be in situ populations along the Maine coast.

8. **Previous Occurrences:** Every year since 1958; this area has been affected beginning in mid-July of each year.

9. **Additional Comments:**

10. **Individual to Contact:**

John W. Hurst, Jr.
Maine Department of Marine Resources
W. Boothbay Hbr., ME 04575
(207) 633-5572

ALGAL BLOOM REPORTS - UNITED STATES 1990

1. **Locations:** Coast of Maine : Kittery to Spruce Head

2. **Date of Occurrences:** May - November 1990

3. **Effects:** Paralytic Shellfish Poisoning in shellfish. (*Mytilus edulis*, *Mya arenaria*, *Ostrea edulis*, *Spisula solidissma*, *Modiolus modiolus*, *Lunatia heros*)

   Shellfish extracts and mouse bioassays prepared and performed at the Department of Marine Resources, West Boothbay Harbor, Maine. Toxicity ranged from <40 to 1500 ug/100 g meat in *Mytilus*, <40 to 600 ug/100g in *Mya*, <40 to 860 ug/100g in *Spisula*, <40 to 46 ug/100g in *Ostrea*, <40 to 110 ug/100g in *Modiolus*, and 300 to 1140 in *Lunatia* .

4. **Management Decision:** Affected areas closed to the harvest of specific species.

5. **Causative Species:** *Alexandrium tamarensis*

6. **Environment:** Data not available

7. **Advected population or in situ growth:** Seems to be in situ populations along the Maine coast.

8. **Previous Occurrences:** Every year since 1972; different areas of the coast affected in different years.

9. **Additional Comments:**

10. **Individual to Contact:**

John W. Hurst, Jr.
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HARMFUL ALGAL BLOOMS IN THE UNITED STATES - 1990

1. **Locations:**
   Massachusetts Coast
   North Shore and South Shore of Boston
   Southern Extent - Cape Cod Canal

2. **Date of Occurrence:**
   Last 2 weeks of May through mid-July

3. **Effects:**
   Shellfish closures
   Toxic levels 200-300 µg/100 g shellfish (mouse bioassay: MA Division of Marine Fisheries)
   No human deaths or illnesses known

4. **Management Decision:**
   Mytulis edulis, Mya arenaria and other species closed to shellfishing from late May to mid-August

5. **Causative Species:**
   Alexandrium fundyense and/or *A. tamarense* (variety not determined)
   Cell numbers 500-2500 cells/liter

6. **Environment:**
   - Temperature 8-11°C
   - Salinity front along coast (29-31‰) caused by freshwater plume from further North (i.e., Merrimac and Kennebec Rivers
   - Slightly stratified due to buoyant plume; waters 1-2°C warmer and 2‰ less saline than surrounding ambient waters

7. **Advected Population or In Situ Growth:**
   Advection from the North is the most likely cause of toxicity. Population originated near Kennebec River in Maine during early April. Growth probably also occurred during transit to the South

8. **Previous Occurrences:**
   Annual event in most years since 1972, usually in May/June

9. **Additional Comments:**
   - *Spisula solidissima* closed to shellfishing year-round due to retention of the toxins
   - Salt ponds of Cape Cod were free of toxin for second year in a row
   - Nearshore bloom may be related to offshore bloom event on Georges Bank

10. **Individual to Contact:**
    Dr. Donald M. Anderson
    Woods Hole Oceanographic Institution
    Woods Hole, Massachusetts 02543
    Telephone: (508) 457-2000, Ext. 2351

ALGAL BLOOM REPORTS - UNITED STATES 1990

1. Locations: Fordham Canal, Greenport NY

2. Date of Occurrence: June 8, 1990

3. Effects: Water discoloration - reddish brown. While no health effects were noted, this species has been implicated as a possible cause of respiratory distress under certain conditions.

4. Management Decision: None necessary; bloom short-lived.

5. Causative Species: Prorocentrum minimum - 8.2 x 10^5 cells/ml.

6. Environment: Tributary of minor embayment of Peconic Bay System. No ancillary samples collected.

7. Advected population or *in-situ* growth: *in-situ* growth.

8. Previous Occurrences: None recorded for Fordham Canal, however, blooms of P.minimum have routinely occurred in similar tributaries to embayments in the area, usually during May and June.

9. Additional Comments:

10. Individual to Contact: Dr. Robert Nuzzi
Bureau of Marine Resources
Suffolk County Department of Health Services
Riverhead, New York 11901

(516) 548-3330

ALGAL BLOOM REPORTS - UNITED STATES

1. Locations: West Neck Bay, Shelter Island NY

2. Date of Occurrence: April - July (> 5.6×10^5 cells/ml on 7/10/90) September - October (> 1.8×10^4 cells/ml on 10/10/90)

3. Effects: Primarily aesthetic - water discoloration (brown) and reduced transparency - secchi readings of less than 1 meter were recorded during peak concentrations. Effects on various shellfish species have previously been reported for other embayments.

4. Management Decision: Continue weekly monitoring program.

5. Causative Species: Aureococcus anophagefferens

6. Environment: Temperature: 11.4 - 27.2 degrees C
   Salinity: 25.93 - 28.23 ppt
   Dissolved Oxygen: 6.1 - 8.8 mg/l
   Water column stability: mixed

7. Advected population or *in-situ* growth: *in-situ* growth.

8. Previous Occurrences: The bloom was present throughout the entire Peconic Bay system during 1985 and 1986, with cell numbers exceeding 10^6 cells/ml. West Neck Bay, however, was not sampled until 1987, when counts ranged from 1×10^5 to 8×10^5 cells/ml. Cell numbers declined through 1988 (ranging from undetectable to 2×10^5 cells/ml) and 1989 (less than 3×10^3 cells/ml), before increasing in density during 1990.

9. Additional Comments:

10. Individual to Contact: Dr. Robert Nuzzi
    Bureau of Marine Resources
    Suffolk County Department of Health Services
    Riverhead, New York 11901

    (516) 548-3330

ALGAL BLOOM REPORTS - UNITED STATES

1. Locations: Moriches and Shinnecock Bays. Although present throughout both bays, the bloom was mainly concentrated in eastern Moriches Bay (including Quantuck Bay) and western Shinnecock Bay (the two are contiguous), where cell densities ranged from 10^4 to 9.6×10^5 cells/ml. Other areas of both bays ranged from < 10^3 to 10^5 cells/ml.

2. Date of Occurrence: July through December, with peak concentrations occurring on 12/6/90.

3. Effects: Its effects are primarily aesthetic - water column discoloration (brownish), and reduced transparency. Secchi depth readings were less than 0.5 meters during peak bloom periods. Effects on various shellfish species have previously been reported.

4. Management Decision: To increase the frequency of monitoring activities.

5. Causative Species: Aureococcus anophagefferens

6. Environment: Temperature: 2.1 - 26.0 degrees C.
Salinity: 25.39 - 30.81 ppt.
Dissolved Oxygen: 5.3 - 13.2 mg/l.
Water column stability - mixed

7. Advected population or *in-situ* growth: Probably *in-situ* growth in Quantuck Bay, eastern Moriches Bay, and western Shinnecock Bay, with other areas containing advected populations. Both bays are subject to significant tidal flow through ocean inlets.

8. Previous Occurrences: These bays were not monitored for Aureococcus until 1989. During that year, counts were < 1.3×10^5 cells/ml in Moriches Bay and < 2.3×10^4 cells/ml in Shinnecock Bay.

9. Additional Comments: Significant blooms of Aureococcus have also occurred in previous years in Great South Bay. During 1990 it was present throughout much of the bay from May through December, but in much lower concentrations (< 10^4 cells/ml).

10. Individual to Contact: Dr. Robert Nuzzi
Bureau of Marine Resources
Suffolk County Department of Health Services
Riverhead, New York 11901
(516) 548-3330

ALGAL BLOOM REPORTS - UNITED STATES

1. Locations: Raritan and Sandy Hook Bays (Staten Island to Sandy Hook), i.e., southern half of the Hudson-Raritan estuary. NJ, NY

2. Date of Occurrence: a) June 13-18, 1990
   b) June 25-30, 1990

3. Effects: a) Orange to red water in Sandy Hook Bay, locally intense at Atlantic Highlands (south shore);

   b) Red to reddish-brown water throughout Raritan and Sandy Hook bays; slight hypoxia (as low as 3.3 mg/l) subsequent to bloom; no fauna kills reported as occurred in 1988; toxicity not suspected.

4. Management Decision: Joint surveillance by NJ DEP/US EPA: continuation of the estuarine phytoplankton - dissolved oxygen survey initiated in 1989; New York Bight and coastal monitoring by these agencies ongoing.

5. Causative Species: a) In eastern Sandy Hook Bay, *Olisthodiscus luteus* (phytoflagellate) and *Cyclotella* sp. (diatom) dominant (each to 1.5 x 10^4 cells/ml^{-1}); at Atlantic Highlands, *Katodinium rotundatum* (dinoflagellate) dominant to 2 x 10^4 ml^{-1}; *Euglena*/*Eutreptia* spp., *Chlorella* sp. (chorophyte), *Cyclotella* sp. and several other diatoms abundant.

   b) *K. rotundatum* dominant throughout with maximum concentrations about 4 x 10^4 ml^{-1}, *Eutreptia lanowii* (euglenoid) abundant; surface and bottom samples by Kemmerer from the US EPA helicopter; chlorophyll *a* in bloom from 25 to 120 ugl^{-1} on June 29.

6. Environment: Temperature range 22.5 to 23.2 C (surface), 20.5 to 22.3 C (bottom), slight stratification, salinity 21.9 to 24.0% (surface), dissolved oxygen 3.36 to 9.9 mgl^{-1} (surface); 3.79 to 8.55 (bottom).

7. Advected population or *in-situ* growth: *in-situ* population.

8. Previous Occurrences: Chronic annual blooms

9. Additional Comments: The red tides were preceded in May and early June by intense spring deatom blooms dominated by *Skeletonema costatum*; surface temperature in the estuary peaked during the bloom and subsequently

fell as the bloom rapidly declined, probably due to weather conditions; a period of widespread diatom abundance occurred during late summer with local flagellate blooms in the estuary. The chlorophyte, Nannochloris atomus also bloomed at times during the season.

10. Individual to Contact: Paul Olsen
New Jersey Department of Environmental Protection
Division of Water Resources, CN029
Trenton, NJ 08625

ALGAL BLOOM REPORTS - UNITED STATES

1. Locations: Sandy Hook Bay, NJ especially the south shore area; Shrewsbury River, especially in the vicinity of Branchport Creek tributary.

2. Date of Occurrence: a) June 18, 1990
b) July 19, 1990
c) August 2, 1990

3. Effects: a) Localized green water in Branchport Creek (concurrent with developing red tide in the bay), kill of small fish observed coincident with green water.

b) Red water in vicinity of Branchport and Oceanport creeks.

c) Red to brown water in Sandy Hook Bay, Port Monmouth vicinity, in Shrewsbury River at Sea Bright and at Branchport Creek.

4. Management Decision: Increased surveillance by the Monmouth County Health Department in liaison with NJ DEP.

5. Causative Species: a) In Branchport Creek, diatoms *Cyclotella* sp. dominant (1.6×10^4 ml^{-1}) *Phaeodactylum tricornutum* subdominant, chlorophytes abundant; concurrent bloom in Sandy Hook Bay at Atlantic Highlands dominated by *K. rotundatum*.

b) *K. rotundatum* to 8×10^4 ml^{-1} at Branchport Creek. Also abundant, *Euglena*/*Eutreptia* spp. (*lanowii*), *Protoperidinium trochoideum* and several other species.

c) Diatoms abundant in all areas; *S. costatum*, *Thalassiosira nordenskioldii* dominant exceeding 2×10^4 ml^{-1}, *Chaetoceros* and *Cyclotella* sp. abundant, several other diatom and phytoflagellate species present.

6. Environment: Water turbid, flocculent; no other measurements taken.

7. Advected population or *in-situ* growth: Primarily an *in-situ* population; diatoms possibly of neritic origin.

8. Previous Occurrences: Chronic annual blooms.

9. Additional Comments: Localized blooms in the estuary and tributaries both preceded and followed the major red tide which occurred June 25-30 in Raritan-Sandy Hook Bays.

10. <u>Individual to Contact:</u> Paul Olsen
New Jersey Department of Environmental Protection
Division of Water Resources, CN029
Trenton, NJ 08625

ALGAL BLOOM REPORTS - UNITED STATES

1. Locations: Barnegat Bay, NJ

2. Date of Occurrence: Mid June to mid September, 1990.

3. Effects: Summer-long bloom, yellowish-brown water discoloration; mats of dead eelgrass on shores coincident.

4. Management Decision: Ongoing surveillance as part of NJ DEP/US EPA coastal monitoring program; eutrophication study by NJ DEP Division of Science and Research still underway.

5. Causative Species: Chlorophyte *Nannochloris atomys* predominant; cell concentrations exceeding 10^6 ml^{-1} during bloom peaks in late July and again in late August; chlorophyll *a* ranged from 15.71 to 24.26 ugl^{-1} between June 12 and September 12.

6. Environment: Other measurements may be available from the NJ DEP Division of Science and Research.

7. Advected population or *in-situ* growth: *in-situ* population.

8. Previous Occurrences: Chronic summer blooms, at least since 1985.

9. Additional Comments: The bay is shallow and not well flushed, thus stratification would be minimal; the shoreline is extensively developed; there is considerable freshwater influx.

10. Individual to Contact: Paul Olsen
    New Jersey Department of Environmental Protection
    Division of Water Resources, CN029
    Trenton, NJ 08625

ALGAL BLOOM REPORTS - UNITED STATES

1 Locations: Florida

Pinellas to Lee County

2. Date of Occurrence:

February 23 to March 22, 1990

3. Effects: Reports of disoriented and sick sea birds (particularly cormorants)
Some respiratory irritation on Siesta and Lido beaches (3/3-3/4)
Reports of dead birds and a few fish off Clearwater (2/9)
Reports of dead birds and dolphin at Egmont Key (2/9)
Shellfish harvesting ban

4. Management Decision:

Shellfish ban - 2/26 - 3/23 - Longboat Key (Sarasota County)

5. Causative Species: *Gymnodinium breve*

coastal surface water samples ranged from negative to 233,000 cells/l; offshore (3 to 5 miles out) surface water samples ranged from negative to 163,000 cells/l

6. Environment:

Occurred in coastal and nearshore waters with wide salinity (>30°/oo) ranges and nearshore surface water temperatures from 15.5 to 23.5°C.

7. Advected population or in situ growth:

Advected population from offshore waters

8. Previous Occurrences: March-May 1989, Oct.-Dec. 1988, Jan./Feb., May-July, Sept./Oc 1987, Sept.-Dec. 1986, Sept.-Dec. 1985, Jan.-March, May-Aug. 1984, Jan./Feb., Oct. Dec. 1983, Jan.-April, July-Oct. 1982, Sept./Oct. 1981, Jan./Feb., June-Nov. 1980, and before

9. Additional Comments:

10. Individual to Contact:

Dr. Karen Steidinger
Florida Marine Research Institute
100 Eighth Avenue S.E.
St. Petersburg, FL 33701-5095
(813) 896-8626

ALGAL BLOOM REPORTS - UNITED STATES

1. Locations: Florida
Sarasota to Collier County

2. Date of Occurrence: October 18 to November 22, 1990

3. Effects: Dead fish - offshore about 20 miles off Lee County and "massive fish kill" reported by SEAMAP cruise between 10 - 20 nautical miles offshore from Venice to Sanibel.
Respiratory irritation and dead fish on Gasparilla Island

4. Management Decision: Shellfish ban - 10/26 - 11/22 - Lemon Bay and Gasparilla Sound

5. Causative Species: *Gymnodinium breve*
coastal surface water samples ranged from negative to 6,300 cells/l; offshore (up to 20 nm out) surface water samples had a few live cells and immobile but potential cells (samples got too warm before observation)

6. Environment: Occurred in coastal and nearshore water with wide salinity (>32°/oo) ranges and nearshore surface water temperatures from 28°C to 30°C.

7. Advected population or in situ growth:
Advected population from offshore waters

8. Previous Occurrences: Feb.-March 1990, March-May 1989, Oct.-Dec. 1988, Jan./Feb., Ma July, Sept./Oct. 1987, Sept.-Dec. 1986, Sept.-Dec. 1985, Jan.-March, May-Aug. 1984, Jan./Feb., Oct.-Dec. 1983, Jan.-April, July-Oct. 1982, Sept./Oct. 1981, Jan./Feb., June-Nov. 1980, and before

9. Additional Comments:
Occurred soon after Tropical Storm Marco which had landfall in Sarasot
Pine Island Sound shellfish harvesting was closed due to the tropical storm

10. Individual to Contact:
Dr. Karen Steidinger
Florida Marine Research Institute
100 Eighth Avenue S.E.
St. Petersburg, FL 33701-5095
(813) 896-8626

ALGAL BLOOM REPORTS - UNITEL STATES

1. Locations: Texas
in ship channel running off Laguna Madre near Brownsville

2. Date of Occurrences:
November 1990 through March 1991 (continuing)

3. Effects:
Fish Kills and limited reports of aerosol (respiratory irritation)

4. Management Decision:
Shellfish harvesting bans south of Port Mansfield from November 1990 to present (March 1, 1991 - continuing)

5. Causative Species:
Gymnodinium breve
cell counts ranged up to 300,000 cells/l

6. Environment:
End of ship channel farthest from coastal access. In November, temperatures were around 19°C

7. Advected population or in situ growth:
Probably advected - Satellite imagery of November 18, 1990 showed a "slug" of 20.7°C water at mouth of Laguna Madre which may have affected ship channel, but nothing positive

8. Previous Occurrences:
1986 - G. breve bloom extended along much of Texas coast, although unsure if bloom occurred in the ship channel at that time

9. Additional Comments:
A recent Noctiluca bloom is concurrent. Speculation about the possibility of Noctiluca preying on G. breve because week of 2-17-91 G. breve counts appeared to be decreasing while Noctiluca increased. However, trend is not still occurring.

10. Individual to Contact:

Tony Reisinger
Texas Sea Grant (Near Brownsville)
512-399-0125

Dr. Elenor R. Cox
Texas A & M University
Department of Biology
College Station, TX 77843

HARMFUL ALGAL BLOOMS IN 1990 - UNITED STATES

1. Locations: SONOMA COUNTY, CALIFORNIA areas affected: Bodega Head, Goat Rock, Salt Point State Park, Sea Ranch

2. Date of Occurrence: August, November

3. Effects: High levels of paralytic toxin assayed by the mouse method in wild sea mussels. Detectable levels below the alert were assayed throughout the year.

4. Management Decisions: The annual mussel quarantine was in effect and no other decisions were made.

5. Causative Species: Protogonyaulax catenella

6. Environment: No data available

7. Advected Population or In Situ Growth: This appears to be an in situ growth.

8. Previous Occurrences: 1927, 1929, 1930, 1932, 1937, 1954, 1968, 1976, 1980, 1981, 1987, 1989

9. Additional Comments: In August the level of paralytic toxin in the wild sea mussel reached 380 ug/100 g of meat. No samples were submitted to the State Health laboratory for assay in September. In October high detectable levels just below the alert (72 ug) and in November concentrations above the alert level (99 ug) were assayed.

10. Individual to Contact: Dr. Maria R. Ross
Biology Department
University of California at Los Angeles
405 Hilgard Avenue
Los Angeles, California 90024
(213) 206-3528

HARMFUL ALGAL BLOOMS IN 1990 - UNITED STATES

1. Locations: MARIN COUNTY, CALIFORNIA areas affected: Drakes Bay Chimney Rock, Drakes Estero Beds #12, #38, Kehoe Beach, Tomales Bay Clam Island and Lawson's Landing.

2. Date of Occurrence: Two separate episodes occurred. March-April, and August through November. PSP concentrations detected were well above the alert levels, however, the rest of the year detectable levels below the alert were recorded. Maximum toxin concentration for March-April was 160 ug per 100 g shellfish and for August through November 580 ug/100 g shellfish meat.

3. Effects: Presence of Partalytic Shellfish Toxin activity in wild sea mussels, sentinel sea mussels, bay wild mussels, gaper clams, cultured pacific oysters as assayed by the State of California Department of Health Services mouse method.

4. Management Decisions: Emergency quarantine issued for March and April on sport harvested mussels; persons collecting clams and scallops advised to discard viscera or dark parts and only white meat be prepared for human consumption. Annual mussel quarantine in effect May 1 through October 31 at which time it was officially lifted.

5. Causative Species: Protogonyaulax catenella

6. Environment: Obserbvation of a toxic dinoflagellate bloom, however, no other data available.

7. Advected Population or In Situ Growth: Most likely in situ growth. No visible red tide conditions reported.

8. Previous Occurrences: 1927, 1929, 1932, 1954, 1962, 1963, 1964, 1965, 1980, 1982, 1984, 1986, 1988, 1989

9. Additional Comments: During the entire year 1990 Marin County shellfish exhibited measurable levels of paralytic toxins. Unfortunately, environmental data is not available.

10. Individual to Contact: Dr. Maria R. Ross
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HARMFUL ALGAL BLOOMS IN 1990 - UNITED STATES

1. Locations: MENDOCINO COUNTY, CALIFORNIA areas affected: Anchor Bay

2. Date of Occurrence: August

3. Effects: Paralytic toxin level in wild sea mussel reached 100 ug/100g meat. The rest of the year measurable concentrations below the alert level were recorded.

4. Management Decisions: The annual quarantine was in effect no further decisions were made.

5. Causative Species: Protogonyaulax catenella

6. Environment: No data available

7. Advected Population or In Situ Growth: Most probably this was the advected population from the 1989 blooms that may have deposited cysts which created the in situ growth.

8. Previous Occurrences: 1932, 1966, 1967, 1969, 1975, 1989

9. Additional Comments: No human cases of paralytic shellfish poisoning reported.

10. Individual to Contact: Dr. Maria R. Ross
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HARMFUL ALGAL BLOOMS IN 1990 - UNITED STATES

1. Locations: SAN LOUIS OBISPO COUNTY, CALIFORNIA areas affected: Moonstone Beach Cambria

2. Date of Occurrence: Beginning of January

3. Effects: Concentration of paralytic toxin in wild sea mussel assayed at 82 ug per 100 g shellfish meat. Measurable but below alert levels were recorded during January throughout the coastal areas of the county.

4. Management Decisions: Emergency mussel quarantine from December 1989 was still in effect. It was lifted on February 13, 1990

5. Causative Species: Protogonyaulax catenella

6. Environment: No data available

7. Advected Population or In Situ Growth: Most probably this was an in situ growth population from the late 1989 bloom.

8. Previous Occurrences: 1979, 1989

9. Additional Comments: The shellfish in this area were quite free of toxins.

10. Individual to Contact: Dr. Maria R. Ross
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405 Hilgard Avenue
Los Angeles, California 90024
(213) 206-3528

HARMFUL ALGAL BLOOMS IN 19~~89~~90 - UNITED STATES

1. **Locations**: Central Puget Sound, Samish and Bellingham bays, Port Angeles harbor, Port. Townsend Bay, northern Hood Canal, Washington

2. **Date of Occurrence**: 1-14 July 1990

3. **Effects**: Killed Atlantic salmon in net pens in central Puget Sound; large fish (brood stock) were affected first
   Also killed brood stock of White River spring chinook salmon in net pens

4. **Management Decision**: Fish growers harvested fish; two growers towed their pens to clear water after receiving contingency permits from the State Department of Fisheries

5. **Causative Species**: Heterosigma akashiwo
   Cell counts ranged from less than 50,000 to about 4,000,000 cells per liter at pen sites
   One patch in Port Angeles harbor had more than 12,000,000 cells per liter

6. **Environment**: sunny, calm weather
   water temperature: 11.5-17 C
   salinity: 27.9-29.8
   Secchi disk depth: .5 in patches - 5.3 m

7. **Advected Population or In Situ Growth**: in situ growth: started in shallow back bays that warmed up quickly, then moved into more open water

8. **Previous Occurrences**: suspected in fish kill at Lummi Island in 1976
   possibly occurred in central Puget Sound in 1976
   massive fish kills of salmon in net pens in northern Puget Sound, September 1989

9. **Additional Comments**: Although Heterosigma was present, this outbreak did not affect Atlantic salmon in net pens at Cypress Island, northern Puget Sound, that were hit in September 1989.
   Cells of Heterosigma were still around in all of Puget Sound into October 1990

10. **Individual to Contact**:

Rita Horner
School of Oceanography, WB-10
University of Washington
Seattle, WA 98195

90

HARMFUL ALGAL BLOOMS IN 1989 - UNITED STATES

1. **Locations:** Liberty Bay, Washington

2. **Date of Occurrence:** September 19-24 1990

3. **Effects:** Recall of commercially harvested oysters from 17 states
No illnesses reported

4. **Management Decision:** Product recalled; Liberty Bay closed to all commercial and sport harvesting of shellfish until further notice

5. **Causative Species:** presumably *Alexandrium catenellum*; toxin levels ranged from 226-358 ug toxin/100 g shellfish meat

6. **Environment:**

7. **Advected Population or In Situ Growth:** not known

8. **Previous Occurrences:**

9. **Additional Comments:**

10. **Individual to Contact:**

Rita Horner
School of Oceanography, WB-10
University of Washington
Seattle, WA 98195

90

HARMFUL ALGAL BLOOMS IN 1989 - UNITED STATES

1. **Locations**: Pacific coast of Washington, Vancouver Island, B.C., throughout San Juan Islands, WA

2. **Date of Occurrence**: mid to end of August 1990

3. **Effects**: No harmful effects reported; fish growers worried about effect on net-pen fish

4. **Management Decision**:

5. **Causative Species**: *Gonyaulax spinifera*
   1.5-4.5 million cells per liter in patches; formed cysts

6. **Environment**: calm, clear weather

7. **Advected Population or In Situ Growth**: probably both; occurred as huge, reddish-brown patches that moved with tides, currents

8. **Previous Occurrences**: None known

9. **Additional Comments**:

10. **Individual to Contact**:

    Rita Horner
    School of Oceanography, WB-10
    University of Washington
    Seattle, WA 98195

90

HARMFUL ALGAL BLOOMS IN 1989 - UNITED STATES

1. **Locations:** Dabob Bay, Washington

2. **Date of Occurrence:** October 1990

3. **Effects:** None, only fish grower in the area did not have fish in the water

4. **Management Decision:**

5. **Causative Species:** *Chaetoceros concavicornis*

   In the top 10 m, cell numbers ranged from 40,000 to 74,000 cells per liter

6. **Environment:** Series of wind-mixed events

   Sea surface temperature ranged from ca. 11-14°C
   Salinity: 29.2-30
   Nutrients were high, with nitrate always above 10 uM

7. **Advected Population or In Situ Growth:** In situ growth

8. **Previous Occurrences:** Not known

9. **Additional Comments:**

10. **Individual to Contact:**

Rita Horner
School of Oceanography, WB-10
University of Washington
Seattle, WA 98195

ALGAL BLOOM REPORTS - UNITED STATES (1990)

1. **Locations:** Between Homer, Alaska (59°38'40"N; 151°33'00"W) and unnamed Russian Village (59°45'N; 151°10'W).

2. **Date of Occurrence:** 6/24/90.

3. **Effects:** Water coloration.

4. **Management Decision:**

5. **Causative Species:** Suspect *Noctiluca.*

6. **Environment:**

7. **Advected Population or In Situ Growth:**

8. **Previous Occurrences:**

9. **Additional Comments:**

10. **Individual to Contact:**
Michael J. Ostasz
3601 "C" Street, Suite 1324
Anchorage, Alaska 99503
(907) 563-0318

ALGAL BLOOM REPORTS - UNITED STATES (1990)

1. **Locations:** Between Clam Gulch (60°14'30"N; 151°24'00"W) and Kasilof (60°23'15"N; 151°17'45"W)

2. **Date of Occurrence:** 6/26-27/90.

3. **Effects:** Water coloration.

4. **Management Decision:**

5. **Causative Species:** Suspected *Noctiluca.*

6. **Environment:**

7. **Advected Population or In Situ Growth:**

8. **Previous Occurrences:** None

9. **Additional Comments:**

10. **Individual to Contact:**
Michael J. Ostasz
3601 "C" Street, Suite 1324
Anchorage, Alaska 99503
(907) 563-0318

ALGAL BLOOM REPORTS - UNITED STATES (1990)

1. **Locations:** Tutka Bay, Kenai Peninsula, Alaska.

2. **Date of Occurrence:** 6/26/90.

3. **Effects:** Water coloration.

4. **Management Decision:**

5. **Causative Species:** Suspected *Noctiluca.*

6. **Environment:**

7. **Advected Population or In Situ Growth:**

8. **Previous Occurrences:** Not uncommon to have *Noctiluca* sitings as previously reported, analyzed and identified by Alaska Department of Fish and Game.

9. **Additional Comments:**

10. **Individual to Contact:**
Michael J. Ostasz
c/o ADEC
3601 "C" Street, Suite 1324
Anchorage, Alaska 99503
(907) 563-0318

ALGAL BLOOM REPORTS - UNITED STATES (1990)

1. **Locations:** Volcano Bay (SW end of), Aleutian Peninsula, 3 miles across, 28 miles E of village of Cold Bay (55°13'N, 162°00'W)

2. **Date of Occurrence:** On or about 6/27/90

3. **Effects:** One death - male, 47 years-old. Consumed 35-40 butter clams. PSP results showed:

1. Gastric fluids	-----	370 psp/100 grams
2. Butter clams	-----	7750 psp/100 grams
3. Clam broth (On board boat)	-----	2650 psp/100 grams

4. **Management Decision:** Two press releases stating risk of harvesting from unapproved areas (recreational beaches).

5. **Causative Species:** Suspected *Protogonyaulax.*

6. **Environment:**

7. **Advected Population or In Situ Growth:**

8. **Previous Occurrences:** Previous occurrences N.E. at Perryville, Alaska with mussels.

9. **Additional Comments:**

10. **Individual to Contact:**

General Program:
Michael J. Ostasz
3601 "C" Street, Suite 1324
Anchorage, Alaska 99503
(907) 563-0318

Laboratory Contacts:
Dick Barrett or
Chris Allison
500 S. Alaska Street
Palmer, Alaska 99645{
(907) 745-3236

ALGAL BLOOM REPORTS - UNITED STATES (1990)

1. **Locations:** Kodiak Island, Alaska (57°47'20"N, 152°24'10"W).
   Bayside Park, Monashka Road, Kodiak

2. **Date of Occurrence:** 6/23/90

3. **Effects:** One individual sought medical assistance after experiencing numbness in face and later had spread to his legs. Doctor's diagnosis was either PSP or hypertension. Five others who had concurrently eaten mussels with him were not sick. Individual consumed 20 mussels.

   Follow-up sampling on or about 6/26/90 revealed mussel PSP concentrations of 2026 and 1925 micrograms per 100 grams taken in duplicate samples.

4. **Management Decision:** Press release warning about harvesting in uncertified areas.

5. **Causative Species:** Suspected *Protogonyaulax.*

6. **Environment:**

7. **Advected Population or In Situ Growth:**

8. **Previous Occurrences:** Area around and near this area has had repeated PSP episodes and epidemiology.

9. **Additional Comments:**

10. **Individual to Contact:**

General Program:
Michael J. Ostasz
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Anchorage, Alaska 99503
(907) 563-0318

Laboratory Contacts:
Dick Barrett or
Chris Allison
500 S. Alaska Street
Palmer, Alaska 99645{
(907) 745-3236

1990 CANADA

Location: Bay of Fundy

Effects: No shellfish areas were closed due to the accumulation of unacceptable levels of domoic acid.
Domoic acid extractions were conducted at Black's Harbour, New Brunswick and analysis in Halifax, Nova Scotia, Department of Fisheries and Oceans.

Management Decision:
None

Causitive Species: *Nitzschia pseudodelicatissima*

(1.5×10^5 cells/L) - determined by surface water samples preserved in 2.5% formalin acetic acid and counted with an inverted microscope.

Environment:

Temperature range:	9-13° C
Salinity:	32 ‰
Water volume:	mixed

Previous Occurrences:
N. pseudodelicatissima occurs annually in the Bay of Fundy, although shellfish areas were only closed to harvesting during 1988.

Individual to Contact:
Jennifer Martin
Department of Fisheries and Oceans
Biological Station
St. Andrews, N.B.
EOG 2X0

HARMFUL ALGAL BLOOMS IN 1990 - CANADA

1. Location: East coast of Prince Edward Island: Cardigan Bay region.

2. Date of Occurrence: June

3. Effects: None

4. Management Decision: None

5. Causative Species: *Dinophysis norvegica*. Cell concentrations: 22,000 cells/L.

6. Environment: Temperature during the bloom period: 13°C. Salinity ranged between 27 and 31. The water column was moderately stratified.

7. Advected Population or In Situ Growth: Not known.

8. Previous Occurrences: 1989

9. Additional Comments: Samples of the plankton were concentrated and sent to the Institute for Marine Biosciences (National Research Council of Canada, Halifax, Nova Scotia) for analysis. No toxin was detected in the sample, using ionspray-MS (Sciex).

10. Individual to Contact:
Dr. John C. Smith
Department of Fisheries and Oceans
Gulf Fisheries Centre
P.O. Box 5030
Moncton, New Brunswick
Canada E1C 9B6
(506) 851-3827
(506) 851-2079 (Fax)

HARMFUL ALGAL BLOOMS IN 1989 - CANADA

1. Location: East coast of Prince Edward Island: Cardigan Bay region.

2. Date of Occurrence: Early August to late November.

3. Effects: The domoic acid levels in shellfish reached 16 µg/g.

4. Management Decision: The affected areas were closed to harvesting of shellfish.

5. Causative Species: *Nitzschia pungens*. Cell concentrations reached 780,000 cells/L in late November (Brudenell River).

6. Environment: Temperature range during the bloom period: 24°C in August, 4°C in November. Salinity ranged between 29 and 32. The water column was well mixed.

7. Advected Population or In Situ Growth: Most probably, *in situ* growth.

8. Previous Occurrences: First recorded in autumn 1987, and has recurred during the autumn of 1988.

9. Additional Comments: Early August populations were solely composed of *N. pungens* f. *pungens* (the form that does not produce domoic acid), and no domoic acid was detected. The proportion of f. *multiseries* increased to 50% in late August, then to nearly 100% during the major autumn bloom when mussels quickly accumulated the toxin.

10. Individual to Contact:
Dr. John C. Smith
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(506) 851-2079 (Fax)

HARMFUL ALGAL BLOOMS IN 1989 - CANADA

1. Location: East coast of Prince Edward Island: Boughton River.

2. Date of Occurrence: September

3. Effects: None

4. Management Decision: None

5. Causative Species: *Dinophysis acuminata.* Cell concentrations: 10,000 cells/L.

6. Environment: Temperature during the bloom period: 17.5°C. Salinity ranged between 29 and 30. The water column was weakly stratified.

7. Advected Population or In Situ Growth: Not known.

8. Previous Occurrences: None reported.

9. Additional Comments: Samples of the plankton were concentrated and sent to the Biotechnology Research Institute (National Research Council of Canada, Montreal, Quebec) for analysis. The sample was positive for DTX-1 according to a phosphatase inhibition assay, but the validity of this technique must still be confirmed.

10. Individual to Contact:
Dr. John C. Smith
Department of Fisheries and Oceans
Gulf Fisheries Centre
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QUEBEC FISHERIES REGION (CANADA)
Paralytic Shellfish Poisoning, 1990

1. Locations: Mid-northern shore (49° 14′N 68° 09′W) and lower southern shore (48° 39′N 68° 10′W) of the St. Lawrence estuary and the southwestern Gulf of St. Lawrence (48° 49′N 64° 26′W)

2. Dates: late June - early July, 1990

3. Effects:
   - no human illness reported
   - PSP toxicity detected in soft-shell clams (*Mya arenaria*) and blue mussels (*Mytilus edulis*): maximum scores of 2,218 and 5,468 µg STX eq/100 g, respectively, according to the AOAC mouse bioassay

4. Management Decisions: Periodic closures of recreational and commercial shellfish harvesting zones

5. Causative Species: *Alexandrium excavatum*, maximum recorded concentration 4.5 X 10^5 cells/L

6. Environment:
   - temperature range: 2-21°C (9-17°C during the bloom)
   - salinity range: 15-31 ‰ (21-31 ‰ during the bloom)

7. Advected population or in situ growth: Based upon circumstantial evidence from known water circulation patterns and benthic cyst distributions, it likely that the *Alexandrium spp.* blooms found along the northern shore of the St. Lawrence estuary represent endemic populations. The blooms along the southern shore of the estuary and the southwestern gulf probably represent exogenous transport by the Gaspé current.

8. Previous Occurences: Toxic blooms reported annually since 1984; PSP toxic incidents known for more that 100 years in the region

9. Additionnal Comments: Mid-north shore of the estuary appeared to be most affected by PSP toxicity; high PSP levels were extremely persistent and shellfish harvesting zones in this area were open for only three weeks (March to October) in 1990

10. Individual to contact:

Béatrice Huppertz
Maurice Lamontagne Institute
Dept. of Fisheries and Oceans
P.O. Box 1000
[illegible]
Mont-Joli, Québec, Canada.

HARMFUL ALGAL BLOOMS IN 1990 - CANADA

1. Location: Mahone Bay, southern Nova Scotia.

2. Date of Occurrence: Early August.

3. Effects: At least 16 people developed symptoms of nausea, vomiting and diarrhoea shortly after eating cultured mussels. Extracts of raw and cooked mussels were toxic to mice (IP injection). Ionspray-MS (Sciex) and proton NMR spectroscopy established the presence of DTX-1, but no okadaic acid was found. The most toxic mussels contained up to 1,000 ng/g whole tissue. Samples of the plankton concentrated by net tows in mid-August showed no DTX-1 or okadaic acid, but the plankton bloom may have already dissipated by the time of sampling.

4. Management Decision: None

5. Causative Species: Mussel digestive glands contained remnants of *Dinophysis norvegica.* When biologists sampled the water column in mid-August to mid-November, several *Dinophysis* species, including *D. norvegica*, were present. Representative cell concentrations: 1,600 cells/L on September 28; 100 - 200 cells/L by October 20.

6. Environment: Surface water temperature: 18 - 20°C.

7. Advected Population or In Situ Growth: Not known.

8. Previous Occurrences: None

9. Additional Comments: To our knowledge, this is the first proven case of diarrhetic shellfish poisoning in North America.

10. Individual to Contact:

Dr. Anthony de Freitas
Institute for Marine Biosciences
National Research Council of Canada
1411 Oxford St.
Halifax, Nova Scotia
Canada B3H 3Z1
(902) 426-8263
(902) 426-9413 (Fax)

QUEBEC FISHERIES REGION (CANADA)
Diarrheic Shellfish Poisoning, 1990

1. Locations: lower northern and southern shore of the St. Lawrence estuary
northern and southwestern Gulf of St. Lawrence

2. Dates: mid-June - early July, 1990

3. Effects: None observed

4. Management Decisions: No action taken

5. Causative Species: *Dinophysis acuminata* (dominant dinophysoid species), maximum concentration 1.5 X 10^4 cells/L; other *Dinophysis spp.* recorded: *D. norvegica* and *D. rotundata*

6. Environment: -temperature range: 1-20°C
(10-15°C during the bloom)
-salinity range: 16-31 ‰
(23-28 ‰ during the bloom)

7. Advected population or in situ growth: Based on information regarding the prevailing residual Gaspé current, it is probable that the *Dinophysis acuminata* bloom was transported into the Bay of Gaspé from the exterior

8. Previous Occurrences: Blooms of *Dinophysis spp.* are an annual summer event in these waters although no toxic episodes have ever been assotiated with their occurrence

9. Additionnal Comments: the presence of okadaic acid and an analogue of dinophysistoxin-1 were recently confirned from *Dinophysis* blooms in the Bay of Gaspé, by HPLC, immunoassay and ion-spray mass spectrometry

10. Individual to contact: Allan D. Cembella
Institute for Marine Biosciences
National Research Council of Canada
1411 Oxford Street
Halifax, Nova Scotia
B3H 3Z1
(902) 426-9501

1990 CANADA

<u>Location</u>: Bay of Fundy

<u>Dates of Occurrence</u>: Late June through early September

<u>Effects</u>: Marine organisms (mussels, soft shell clams, scallops, etc.) accumulated PSP toxins

PSP extractions were conducted at Black's Harbour, New Brunswick, Department of Fisheries and Oceans Laboratory

No water discolouration.

<u>Management Decisions</u>:
Affected areas were closed to the harvesting of shellfish.

<u>Causative species</u>: *Alexandrium fundyense* (6.8 X 10^4 cells/L) - determined by surface water samples preserved in 2.5% formalin acetic acid and counted with an inverted microscope.

<u>Environment</u>:

Temperature range:	9-13° C
Salinity:	32 ‰
Water Volume:	Mixed

<u>Physical Location</u>: Advected populations from well mixed offshore populations of *Alexandrium fundyense*

<u>Previous Occurrence</u>: Yearly.

<u>Individual to Contact</u>:

Jennifer Martin
Department of Fisheries and Oceans
Biological Station
St. Andrews, N.B.
E0G 2X0

HARMFUL ALGAL BLOOMS IN 1990 - CANADA

1. Location: East coast of Prince Edward Island: Cardigan Bay region.

2. Date of Occurrence: Mid-October to late November.

3. Effects: The domoic acid levels in shellfish never exceeded the 20 μg/g limit, and for the first autumn since 1987, no estuaries were closed to mussel harvesting.

4. Management Decision: None

5. Causative Species: *Nitzschia pungens*. Cell concentrations reached nearly 700,000 cells/L in early November (Brudenell River).

6. Environment: Temperature range during the bloom period: 15°C in October to 4°C in November. Salinity ranged between 27 and 31. The water column was well mixed.

7. Advected Population or In Situ Growth: Most probably, the population originated within the estuaries, as no *N. pungens* cells were found more than one km offshore of the mouth of Cardigan Bay.

8. Previous Occurrences: First recorded in autumn 1987, and has recurred during the autumns of 1988 and 1989, but to a lesser degree each year.

9. Additional Comments: The population was ca. 85% *N. pungens* f. *pungens* (the form that does not produce domoic acid) as determined by scanning electron microscopy. The bloom rapidly declined when a wind event swept the cells offshore.

10. Individual to Contact:
Dr. John C. Smith
Department of Fisheries and Oceans
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P.O. Box 5030
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Nóte on toxic algae in Icelandic waters

Several species, which are known to be toxic (harmful), have been found in Icelandic waters:

Alexandrium tamarense (Lebour)Balech
Alexandrium ostenfeldi (Paulsen)Balech & Tangen

Dinophysis norwegica Claparede & Lachman
Dinophysis acuta Eherenberg
Dinophysis acuminata Claparede & Lachman

Heterosigma akashiwo (Hada)Hada

Dictyocha speculum Eherenberg

Nitzschia pseudodelicatissima Hasle

Phaeocystis pouchetii (Hariot)Lagerheim

Scrippsiella trochoidea (Stein)Loeblich

Only two records are, however, known from these waters where phytoplankton species may have been involved in harmful events.

1. In late May 1987 Salmon salar kept in sea cages was killed in the inner part of Hvalfjörður, west Iceland. This event coincided with an increase in numbers of *Heterosigma akashiwo* (max. 570 cells/ml) at Hvítanes, a location on the other side of the fjord where phytoplankton monitoring was carried out (Thorarinsdóttir 1987, thesis).
2. On September 20th 1986, several people got diarrhea after eating *Mytilus edulis* from musselfields near Hvítanes. Bacteria tests showed negative results. At a station off Hvítanes 8 cells/ml of *Dinophysis norwegica* where found in samples taken this particular day whereas fourteen days earlier the numbers of *D. norwegica* were 177 cells/ml (Thorarinsdóttir loc.cit).

In the appendix of a recent publication "Toxic marine Phytoplankton" 1990 ed. by E.Granéli, B.Sundström, L.Edler & D.M.Anderson, we noted on a map on page 539, record of wild fish kills west of Iceland. To our best of knowlegde kills of wild fish have not occurred in Icelandic waters.

Reykjavík, Mars 15th, 1991.
Þórunn Þórðardóttir
Kristinn Guðmundsson

FAROE ISLANDS, 1989

Location:	Trongisvágsfjord
Dates of occurrence:	Late April to early May, 1989
Effects:	Mortalities of 22 tonnes farmed salmon
Management decisions:	Transport of the farms to the outhermost part of the fjord. After that the mortalities stopped.
Causative species:	Not known. In the water was a not identified flagellate(?). Size: 45-50 um. Maximum concentrations: 120 000 cells/l. Other species: *Thalassiosira gravida* (maximum conc.: 500 000 cells/l and *Leucocryptos sp.* (Croptophyceae)
Environment	Salinity: 35 °/oo Temperature: 6.0-6.3°C Water column: Mixed
Previous occurrences	Not known
Individual to contact	Eilif Gaard Fiskirannsóknarstovan Nóatún FR-100 Tórshavn Faroe Islands Tel.: (298)15092, Fax.: (298) 18264

FAROE ISLANDS, 1989

Location:	Trongisvágsfjord
Dates of occurrence:	May-June 1989
Effects:	PSP toxicity in shellfish. No fish mortality.
Management Decisions:	Warning
Causative species:	*Alexandrium excavatum.* Maximum conc.: 2.1 10^6 cells/l on June 8th
Environment:	Salinity: 30-35°/oo Temperature: 7.5-10.3°C Water column: Stratified
Previous Occurrences:	Every spring/summer since 1984 when the first investigations were made.
Additional comments:	The bloom developed in the innermost part of the fjord.
Individual to contact:	Eilif Gaard Fiskirannsóknarstovan Nóatún FR-100 Tórshavn Faroe Islands Tel.: (298)15092, Fax.: (298)18264

FAROE ISLANDS, 1990

Location:	Skálafjord
Dates of occurrence:	Late July to early August
Effects:	No effects were reported
Causative species:	*Heterosigma akashiwo* Maximum conc.: 1 mill. cells/l
Environment:	Salinity: 32-34°/oo Temperature: 9-10°C Water column: Stratified
Previous occurrences:	A bloom in 1988, small conc. in 1989
Additional comments:	In the innermost part of the fjord
Individual to contact:	Eilif Gaard Fiskirannsóknarstovan Nóatún FR-100 Tórshavn Faroe Islands

FAROE ISLANDS, 1990

Location:	Funningsfjord	
Dates of occurrence:	Mid May	
Effects:	Mortalities of 5 tonnes farmed salmon	
Causativa species:	*Gymnodinium sp.*	
Environment:	Salinity:	35°/oo
	Temperature:	7°C
	Water column:	Stratified
Previous occurrences:	None	
Individual to contact:	Eilif Gaard Fiskirannsóknarstovan Nóatún FR-100 Tórshavn Faroe Islands Tel.: (298)15092, Fax.: (298)18264	

HARMFUL ALGAL BLOOM IN NORWAY 1989
Paralytic Shellfish Toxins

LOCATION	Along the north-west coast.
DATES	April - May 1989.
EFFECTS	Toxins recorded above the action level according to mouse bioassay. Highest recording was 1821 ME.
MANAGEMENT DECISIONS	Harvesting was locally banned. The public was warned against picking toxic mussels.
CAUSATIVE SPECIES	Water samples were not collected, but most probably members of the genus *Alexandrium/ Protogonyaulax.*
ENVIRONMENT	No records.
ADVECTED POPULATION	Mainly due to *in situ* growth.
PREVIOUS OCCURRENCES	A few historical records and more or less regular occurrences the recent years, however, the the spatial extent and the duration of PSP-problems may vary significantly from year to year.
ADDITIONAL COMMENTS	The problem with PST in blue mussels seems to seems to be more frequent and serious in certain areas compared to others.
INDIVIDUAL TO CONTACT	Einar Dahl, Institute of Marine Research, Flødevigen Marine Research Station, N-4817 His tel. +47 41 10580, fax. +47 41 10515. O. Harbitz, Norwegian Food Control Authority P.O. Box 8187 Dep, N-0034 Oslo tel. +47 2 671585, fax. +47 2 199531.

HARMFUL ALGAL BLOOM IN NORWAY 1989
Diarrhoeic Shellfish Toxins

LOCATION	Nearly all along the coast of Norway. But some fjords and estuaries were less or nearly not affected.
DATES	More or less the year around along the southern coast of Norway.
EFFECTS	Toxins recorded above the action level according to mouse bioassay. Harvesting and consumption was banned.
MANAGEMENT DECISIONS	Harvesting was locally banned. The public was warned against picking toxic mussels.
CAUSATIVE SPECIES	*Dinophysis* spp. *D. acuta* has been shown to be the most potent toxin source among the *Dinophysis* spp. along the southern coast of Norway.
ENVIRONMENT	The problem may occur over a wide range of temperatures and salinities.
ADVECTED POPULATION	Along the southern coast there are some evidence that the algae and toxin problems are spreaded by advection.
PREVIOUS OCCURRENCES	A few more dubious historical records. A yearly, more or less large scale and long lasting phenomenon since 1984 according to mouse bioassay.
ADDITIONAL COMMENTS	The problem with DST in blue mussels seems to decrease from south to north along the coast. The "hot" period in 1989 was June-November, however, the frequency of the monitoring varied along the coast and throughout the year.
INDIVIDUAL TO CONTACT	Einar Dahl, Institute of Marine Research, Flødevigen Marine Research Station, N-4817 His tel. +47 41 10580, fax. +47 41 10515. O. Harbitz, Norwegian Food Control Authority P.O. Box 8187 Dep, N-0034 Oslo tel. +47 2 671585, fax. +47 2 199531.

HARMFUL ALGAL BLOOM IN NORWAY 1990
Gyrodinium cf. *aureolum*

LOCATION	The southern and southwestern coast of Norway.
DATES	August 1990.
EFFECTS	About 100 tonnes of salmon were killed in fish farms in the Flekkefjord area (southwest coast).
MANAGEMENT DECISIONS	Intensified local algae monitoring. Deep cages did probably save most of the farms in the area from large losses.
CAUSATIVE SPECIES	*Gyrodinium cf. aureolum*, up to 20 million cells per litre were recorded. But normally the recordings were from some hundred thousands to a few million cells per litre.
ENVIRONMENT	The temperature was mainly within 13-18 °C in waterbodies with high concentrations of *Gyrodinium*, and the salinity was in the range 30-34 o/oo. The water column had a high stability although not as high as observed during the most dense surface blooms observed in earlier years.
ADVECTED POPULATION	The bloom was due to a combination of advected populations and in situ growth.
PREVIOUS OCCURRENCES	*Gyrodinium* bloomed in the area in 1966, 1976, 1981, 1982, 1985, 1988.
ADDITIONAL COMMENTS	The bloom was first recorded as a subsurface population associated to the upper part of the pycnocline, and remained mainly a subsurface bloom with high cell concentrations recorded even at 50 m depth. Thus the integrated biomass in the upper 30-50 m of the water column was rather high.
INDIVIDUAL TO CONTACT	Einar Dahl, Institute of Marine Research, Flødevigen Marine Research Station, N-4817 His tel. +47 41 10580, fax. +47 41 10515.

HARMFUL ALGAL BLOOM IN NORWAY 1990
Noctiluca miliaris

LOCATION	The Skagerrak area
DATES	July 1990
EFFECTS	Patches of reddish sea were observed over large areas. Some small bays were temporarily unsuitable for swimming.
MANAGEMENT DECISIONS	A short information on the phenomenon was given to the public through massmedia.
CAUSATIVE SPECIES	*Noctiluca miliaris* caused patches of reddish water at the surface. The width of the patches was from only 1-2 metres to sometimes several hundred, while the length was up to kilometres. The concentration of *Noctiluca* in the reddish patches was not measured.
ENVIRONMENT	The temperature at the surface was 16-18 °C and the salinity 24-34 o/oo. The water column was strongly stratified with only low concentrations of nutrients in the surface layer.
ADVECTED POPULATION	The most dense patches were due to physical concentration mechanisms combined with the capacity of the algae to regulate its specific weight.
PREVIOUS OCCURRENCES	This phagotrophic dinoflagellate has now and then caused patches of reddish water in the Skagerrak area during summer, but this was probably the most extensive mass occurrence in recent years.
INDIVIDUAL TO CONTACT	Einar Dahl, Institute of Marine Research, Flødevigen Marine Research Station, N-4817 His, tel. +47 41 10580, fax. +47 41 10515.

HARMFUL ALGAL BLOOM IN NORWAY 1990
Paralytic Shellfish Toxins

LOCATION	Along the north-west coast.
DATES	April - June 1990.
EFFECTS	Toxins recorded above the action level according to mouse bioassay. Highest recording was 1616 ME.
MANAGEMENT DECISIONS	Harvesting was locally banned. The public was warned against picking toxic mussels.
CAUSATIVE SPECIES	Water samples were not collected, but most probably members of the genus *Alexandrium/ Protogonyaulax*.
ENVIRONMENT	No records.
ADVECTED POPULATION	Mainly due to *in situ* growth.
PREVIOUS OCCURRENCES	A few historical records and more or less regular occurrences the recent years, however, the the spatial and temporal extent may vary significantly from one year to another.
ADDITIONAL COMMENTS	The problem with PST in blue mussels seems to be larger in the Oslofjord area and along the north-west coast of Norway than along the rest of the coast.
INDIVIDUAL TO CONTACT	Einar Dahl, Institute of Marine Research, Flødevigen Marine Reseach Station, N-4817 His tel. +47 41 10580, fax. +47 41 10515. O. Harbitz, Norwegian Food Control Authority P.O. Box 8187 Dep, N-0034 Oslo tel. +47 2 671585, fax. +47 2 199531.

HARMFUL ALGAL BLOOM IN NORWAY 1990

Diarrhoeic Shellfish Toxins

LOCATION	Nearly all along the coast of Norway.
DATES	More or less around the year.
EFFECTS	Toxins recorded above the action level according to mouse bioassay. Harvesting and consumption banned.
MANAGEMENT DECISIONS	Harvesting was locally banned. The public was warned against picking toxic mussels.
CAUSATIVE SPECIES	*Dinophysis* spp. *D. acuta* has been shown to be the most potent toxin source among the *Dinophysis* spp. along the southern coast of Norway.
ENVIRONMENT	The problem may occur over a wide range of temperatures and salinities.
ADVECTED POPULATION	Along the southern coast there are some evidence that the algae and toxin problems are spread by advection.
PREVIOUS OCCURRENCES	A few more dubious historical records. A yearly, more or less large scale and long lasting phenomenon since 1984 according to mouse bioassay.
ADDITIONAL COMMENTS	The problem with DST in blue mussels seems to decrease from south to north along the coast. The "hot" period in 1990 was June-November, however, the frequency of the monitoring varied along the coast and throughout the year.
INDIVIDUAL TO CONTACT	Einar Dahl, Institute of Marine Research, Research Station Flødevigen, N-4817 His tel. +47 41 10580, fax. +47 41 10515. O. Harbitz, Norwegian Food Control Authority P.O. Box 8187 Dep, N-0034 Oslo tel. +47 2 671585, fax. +47 2 199531.

PRYMNESIUM PARVUM BLOOMS IN RYFYLKE, WESTERN NORWAY

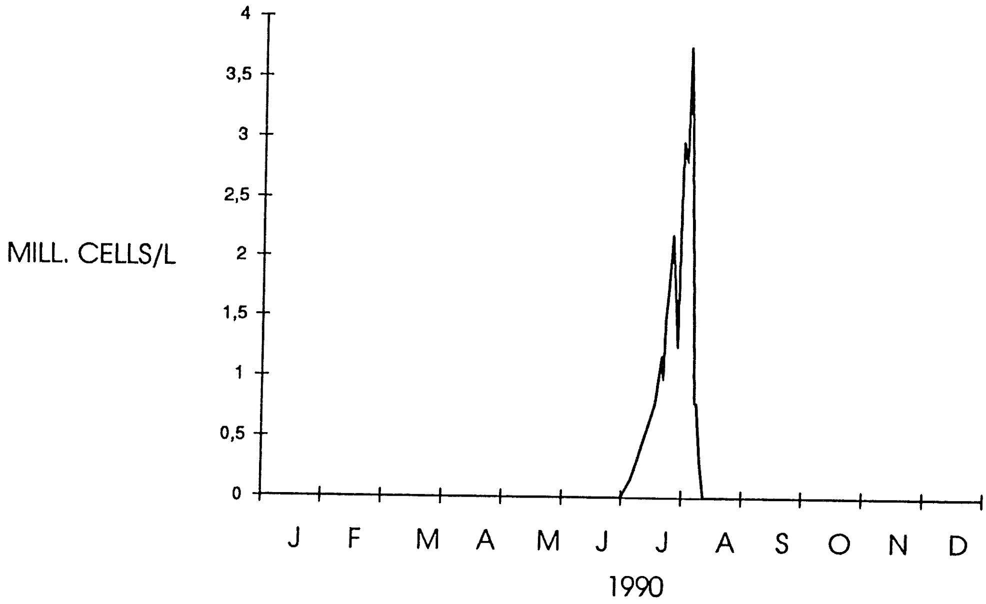
NORWAY 1989-1990

LOCATION	The Sandsfjord system, Ryfylke, Rogaland, western Norway
DATES	1989: July to September 1990: July to mid August
EFFECTS	1989: 750 tonnes of salmon and rainbow trout died in fish farms 1990: About 15 tonnes of caged salmon died
MANAGEMENT DECISION	Inside the fjord system: Movement of fish cages from brackish to marine environment. Outside the fjord system: Pumping of deep water to prevent toxic brackish water moving into the fish cages.
CAUSATIVE SPECIES	Prymnesium parvum (maxima, 1989: 2,3 million cells/L 1990: 3,8 million cells/L)
ENVIRONMENT	Salinity 4-9‰, temperature 12-18°C
PREVIOUS OCCURENCES	Found in water samples, but 1989 the first year with a bloom registration in Norway
ADDITIONAL COMMENTS	Prymnesium parvum was found associated with substrate. First record of attachment to a fish net; later large concentrations especially on Cladophora sp. Low losses of caged fish in 1990 as a result of monitoring. The fish farmers were alarmed when the Prymnesium bloom started and had time to move out of the area before the bloom reached its maximum.
INIDIVIDUAL TO CONTACT	Torbjørn M. Johnsen, Evy R. Lømsland University of Bergen, Department of Fisheries and Marine Biology, Thormøhlens gt.55, N-5008 Bergen, Norway

Evants of mortality among fish due to Prymnesium parvum

YEAR	MONTH	AREA (code)	COMMENTS
1989	July/August	Ryfylke (3)	750 tonnes of cages salmon died
1990	July/August	Ryfylke (3)	15 tonnes of cages salmon died

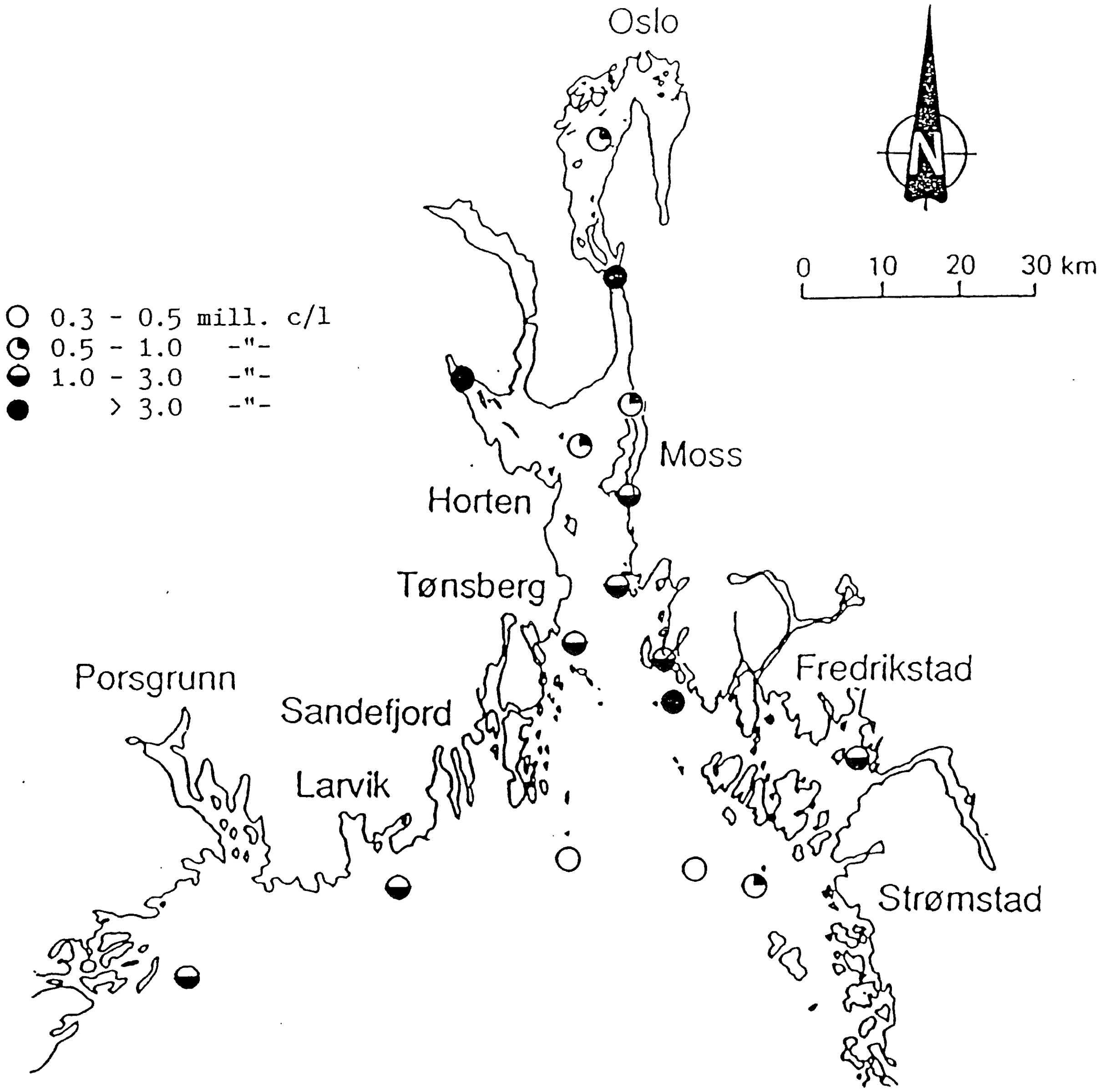
PRYMNESIUM PARVUM



GYRODINIUM AUREOLUM BLOOM IN THE OUTER OSLOFJORD

NORWAY 1990

LOCATION	The Outer Oslofjord
DATES	August
EFFECTS	Dead fish (flatfish and trout)
MANAGEMENT DECISION	Monitoring the region to know the desitribution of G. aureolum
CAUSATIVE SPECIES	Gyrodinium aureolum (max. records 11.5 million cells/L. Common consentration 1-3 million cells/L.
ENVIRONMENT	Present in salinities of 22-33 $^{0}/_{00}$ and temeratures of 16-19 ^{0}C
PREVIOUS OCCURRENCES	Common in the region with several blooms since 1966
ADDITIONAL COMMENTS	This bloom affected other parts of the Norwegian coast
INDIVIDUAL TO CONTACT	Gunnar S. Larsen, Østfold County, Environmental Administration, P.O. Box 325, N-1501 Moss, Norway. tel. 47-9-254100, fax. 47-9-253832.



Figur 2. Lokaliteter hvor Gyrodinium aureolum ble observert i relativt store mengder i august 1990.

HARMFUL ALGAL BLOOMS IN 1990 - FINLAND

1. Locations: A small coastal inlet in Dragsfjärd, Southwest Finland

2. Date of occurrence: end of June, 1990

3. Effects: dead and dying fishes of many different species.

4. Management decisions: The authorities were informed quite late. Thus sampling was performed when many rotten fishes were still observed. The media was informed.

5. Causative species: *Prymnesium parvum* ca. 50.000 cells cm^{-3}.

6. Environments: water slightly brownish. Before the bloom chlorophyll a 5-10 ug dm^{-3}, total phosphorus 30-36 ug dm^{-3}, total nitrogen 710-810 ug dm^{-3}, pH 9.2-9.5, all values higher than in the archipelago outside the canal

7. Advected population or in situ growth: in situ population

8. Previous occurrences: *P. parvum* occurs in low cell numbers in the Baltic Sea flora. First observation of mass occurrence and toxicity in Finnish coastal waters

9. Additional comments:

10. Individual to contact: Dr. Tore Lindholm, Dept. of Biology, Åbo Akademi University, SF-20500 Turku
tel. -358-921-654311

HARMFUL ALGAL BLOOMS IN 1990 - FINLAND

1. Locations: central Bothnian Sea, western coast of Finland

2. Date of occurrence: beginning around August 15, persisting 1-2 weeks

3. Effects: Algal flocks floating in the open sea, algal masses concentrated on the souh-western coasts of Finland. Maximum Nodularin-toxin concentrations 18 mg g^{-1} dry weight

4. Management decision: media informed

5. Causative species: *Nodularia spumigena* max. 55 ugC dm^{-3}

6. Environment:

7. Advected population or in situ growth: in situ population in the open sea. On the coast possibly advected from open sea areas.

8. Previous occurences: Blooms of *Nodularia* occur in the sea area. Mass occurrences this high have not been reported in the sea area before.

9. Additional comments:

10. Individual to contact: Kaisa Kononen
Finnish Institute of Marine Research
P.O.Box 33, SF-00931 Helsinki
tel. -358-0-331044
fax. -358-0-331376

ALGAL BLOOM REPORTS - POLAND

Location: Gulf of Gdańsk (Southern Baltic)

Dates	Effects General features	Causative species	Concentrations (cells/ml^{-1})	Environment (temp.)
17.04.90 to 24.04.90	Green water	*Eutreptiella sp.*	6480 to 5230	7.5 to 9.5 °C
24.04.90 to 27.04.90	Brownish water	*Gonyaulax catenata*	420 to 2000	10.0 °C
08.05.90 to 10.05.90	Brown water	*Heterocapsa triquetra*	8000 to 13700	15.5 to 17.5 °C
28.06.90 to 11.07.90	Greenish water	*Eutreptiella sp.*	6490 to 3000	19.0 to 17.5 °C

Previous occurrences:

Eutreptiella sp.; Not known in this area

Gonyaulax catenata; May 1987

Heterocapsa triquetra; Annually in June/July

Individual to contact:

Tomasz Mackiewicz
Sea Fisheries Institute
Al. Zjednoczenia 1
81-345 Gdynia, Poland

ICES WG 'Phytoplankton and the Management of their Effects'

FRG Country Report 1989/90

Monitoring Programmes (Algal Watch) and Exceptional Blooms in the coastal area of the North Sea and Baltic Sea

Compiled by Jürgen Lenz
Institut für Meereskunde
23 Kiel, Germany

The report is based on information provided by

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Forschungs- und Technologie-Zentrum Westküste, Hafentörn, 2242 Büsum

Dr. J. Voss
Landesamt für Wasserhaushalt und Küsten Schleswig-Holstein, Saarbrückenstr. 38, 23 Kiel

Fig. 8. 9, 10, 11, 13 and 16 were prepared during a national workshop in Hamburg in January 1991 for the 'Working Group on Nutrients' within the framework of the Paris Convention (PARCOM) for the Prevention of Marine Pollution from Land-Based Sources.

Monitoring Programmes

N o r t h S e a

1) Island of Helgoland

Since 1962 phytoplankton abundance and species composition together with environmental data (temperature, salinity, nutrients) are regularly recorded 5 times a week from Monday to Friday at the station Helgoland Road between the main island and the Dune (Fig. 1). Starting from 1989, the Wednesday sample is taken as representative for the week in order to obtain a quick picture of phytoplankton development and species succession during the main vegetation period from April to October. The results are presented in weekly diagrams showing phytoplankton biomass of main components (diatoms, flagellates etc.) expressed as µg C/l based on cell counts (Fig. 2 and 3).

2) Island of Norderney and East Frisian Wadden Sea

Since 1982 phytoplankton abundance and species composition, chlorophyll a, physical and chemical data are regularly recorded once a week at 2 permanent stations south of the Island of Norderney (Fig. 4).
Special emphasis is laid on the occurrence and bloom formation of *Phaeocystis* which produces large foam accumulations along the beaches.

In 1987 an algal watch programme (Informationssystem für Algenblüten und toxische Algen) was established in cooperation with the Veterinary Office in Oldenburg for monitoring mussel toxins. This algal watch was intensified during the last years and now includes 10 stations along the East Frisian coast which are visited at fortnightly intervals between March and the beginning of November (Fig. 4). The sampling programme corresponds to that off the island of Norderney.

3) North Frisian Wadden Sea

In 1989 a similar algal watch (Algenfrüherkennungssystem) was established along the North Frisian coast with originally 14 and now 15 stations

(Fig. 5). These are visited once in March and October and from April to September at weekly or fortnightly intervals. Phytoplankton abundance and species composition, chlorophyll a, physical and chemical data are recorded. Samples are taken by helicopter, ensuring a quasi-synoptical survey during one tidal period. A further advantage is the possibility to map bloom patches (discoloured waters) and to take additional samples there.

B a l t i c S e a

4) Baltic Sea Coast of Schleswig-Holstein

Since 1989 a similar algal watch (Algenfrüherkennungssystem) as held in the North Frisian Wadden Sea is carried out along the Baltic Sea coast (Fig. 6). It covers 23 stations which are visited at weekly to fortnightly intervals from May to September (Fig. 7). Algal abundance and main species composition are recorded and reports for the public prepared.

Algal blooms in 1989 and 1990

N o r t h S e a

Phaeocystis

Phaeocystis blooms (presumably Ph. globosa) occur regularly along the East and North Frisian coast (Fig. 8). In May 1989, the most intensive bloom ever recorded at the island of Norderney was observed there with 30-40000 colonies/l. The water was tinged brown and an acrid odour (probably dimethylsulphide) was noticed up to the inland. Secchi depth was reduced to 0.5 m. In 1990, two blooms occurred there, a lesser one in April (max. 5400 colonies/l) and a more marked one in May/June (max. 13000 colonies/l).

Chrysochromulina spp.

Chrysochromulina, for which species identification is not possible on a routine basis, was observed in higher concentrations of more than 100000 cells/l (up to 400000 cells/l) only in 1989 in June at station VII to IX and at the beginning of July at station II and III along the East Frisian coast.

Dinophysis spp.

Dinophysis, specially D. acuminata, which is made responsible for DSP production, occurs regularly along the coasts of the German Bight (Fig. 9). Mussels containing DSP (Mytilus edulis) are found mainly in 3 areas (Fig. 10). In 1989, DSP was detected in a single mussel sample from the North Frisian Wadden Sea south of the Island of Sylt. A HPLC analysis, however, of another sample from the same area was negative.

In 1990, higher concentrations of Dinophysis (more than 1000 cells/l) with a maximum of 25000 cells/l were observed in August at station V to X along the East Frisian coast. DSP was detected in mussel samples and led to fishing being temporarily closed. In the North Frisian Wadden Sea, too, higher concentrations of Dinophysis were recorded and mussel fishing consequently closed. No cases of human DSP poisoning were recorded in both years.

Ceratium spp.

Ceratium species form blooms in summer every year in the German Bight, occasionally exceptionally concentrated ones which then may lead to severe oxygen deficiencies in areas with stratified water masses (Fig. 11 and 12).

Leptocylindrus

In 1990 an untypical bloom of Leptocylindrus danicus and minimus with cell concentrations over a mill./l and extending over several months from the end of May to the middle of August was observed at the island of Norderney and other stations along the East and North Frisian coast as well.

Noctiluca scintillans

Noctiluca blooms (red patches and streaks) are a common phenomenon in the German Bight between June and August (Fig. 13). Concentrations within the patches may reach 1 mill. cells/l as was recorded in 1989 off the North Frisian coast.

Lepidodinium viride (Gymnodinium Y-100)

The most spectacular bloom in 1990 was a 'green tide' around the island of Helgoland in August. It was caused by a green Gymnodinium which is probably identical with the new species first described for Japanese waters by Watanabe et al. 1987 as Y-100 and now named Lepidodinium viride (Watanabe et al. 1990, Fig. 14). This dinoflagellate was observed for the first time at Helgoland although it was recorded in small quantities a year before on the North Frisian coast. It is not certain whether this is a new species introduced into the German Bight perhaps with ballast water or whether it was present before, but in such small numbers that it was overlooked or confused with the similar species Gymnodinium aureolum.

The bloom developed in the second half of August and reached a peak on 29. August with an average of 6.5 mill. cells/l. In surface samples as many as 100 mill. cells/l were recorded. A survey from the North Frisian Coast to the island during the following 2 days revealed a maximum chlorophyll concentration of 145 µg/l at the island (Fig. 15). The water there was bright green and during calm weather the algae tended to form slimy aggregates. Later on, the bloom extended further north but cell numbers decreased (Fig. 16). At the beginning of October the alga was still present, although in lower concentrations, at the island of Sylt. The 'green tide' was not toxic.

According to a personal communication by Honsell, University of Triest, there was a bloom of the same species in the Adriatic Sea in the mid-eighties with concentrations of up to 600 mill. cells/l. This was the most intense algal bloom ever recorded in that area.

Baltic Sea

Heterocapsa triquetra

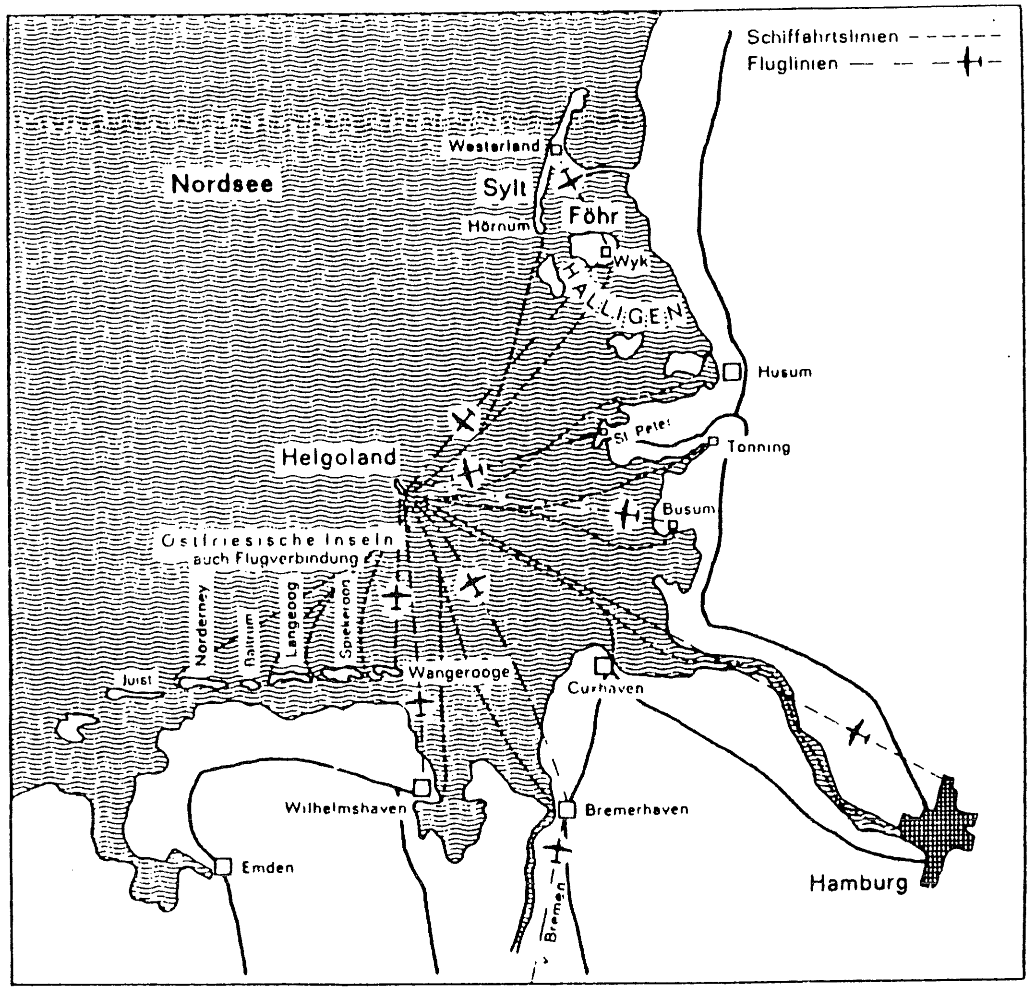
This small dinoflagellate formed a bloom in May 1989 in the inner part of Flensburg Fjord with 4-6 mill. cells/l and a maximum of 16 mill. cells/l in a surface sample. Dead jelly-fish (Aurelia aurita) were drifting in the water. Toxicity tests, however, carried out with sticklebacks exposed to the water and crabs which were injected with a water solution of the alga were negative. It is presumed that the jelly-fish died because of low oxygen content in the underlying water layer. In 1990, there was another bloom in Kiel Fjord in June with 8-10 mill. cells/l which produced a reddish water colour.

Prorocentrum minimum

A bloom of Prorocentrum minimum was observed in Kiel Fjord for the first time in 1983. Since then it has reoccurred every year with changing intensity. In 1989 there was an extended bloom from the beginning of July up to the middle of September along the entire coast of Schleswig-Holstein with peaks in Flensburg and Kiel Fjord. In the latter 10 mill. cells/l were recorded and in the inner part up to 58 mill. cells/l. Prorocentrum blooms are recognizable by a reddish-brown water colour. In 1990 only minor blooms occurred over short periods.

Chrysochromulina spp.

In 1990 a short but intense bloom of Chrysochromulina was observed at the beginning of June. It was restricted to the inner part of Kiel Fjord where it reached concentrations of up to 27 mill. cells/l. The water was tinged a greenish yellow.



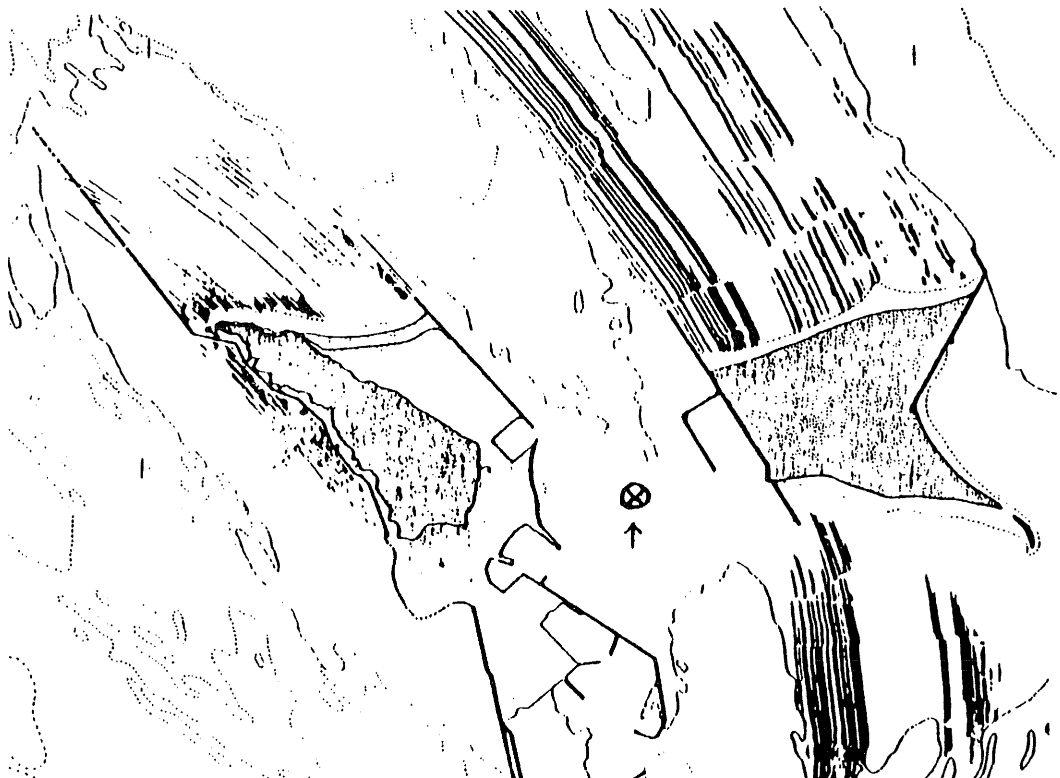
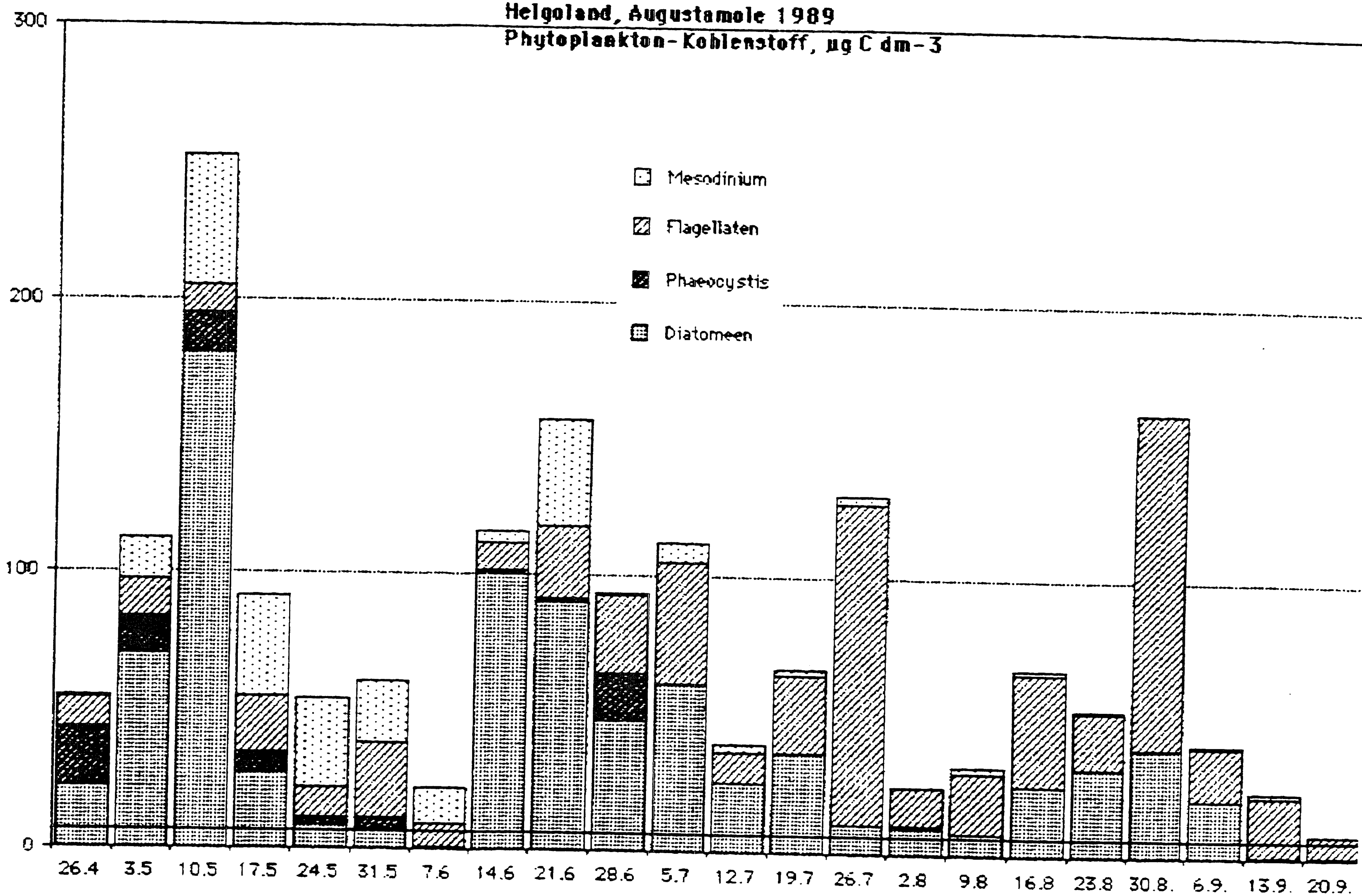


Fig. 1 Station Helgoland Road between main island (left) and Düne (right)



Helgoland, Augustamole 1989
Phytoplankton-Kohlenstoff, µg C dm-3
300
200
100
0
Mesodinium
Flagellaten
Phaeocystis
Diatomeen
26.4
3.5
10.5
17.5
24.5
31.5
7.6
14.6
21.6
28.6
5.7
12.7
19.7
26.7
2.8
9.8
16.8
23.8
30.8.
6.9.
13.9.
20.9.

Fig. 2

Mikroplankton, Helgoland-Reede 1990

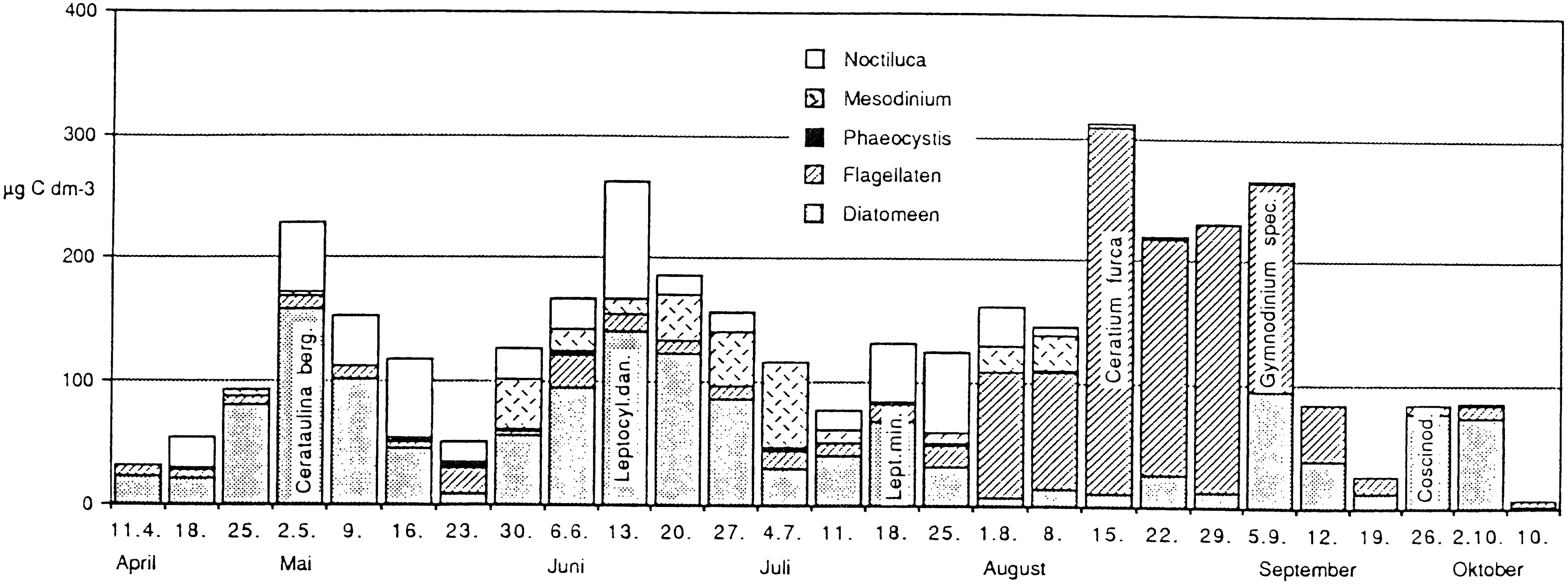


Fig. 3

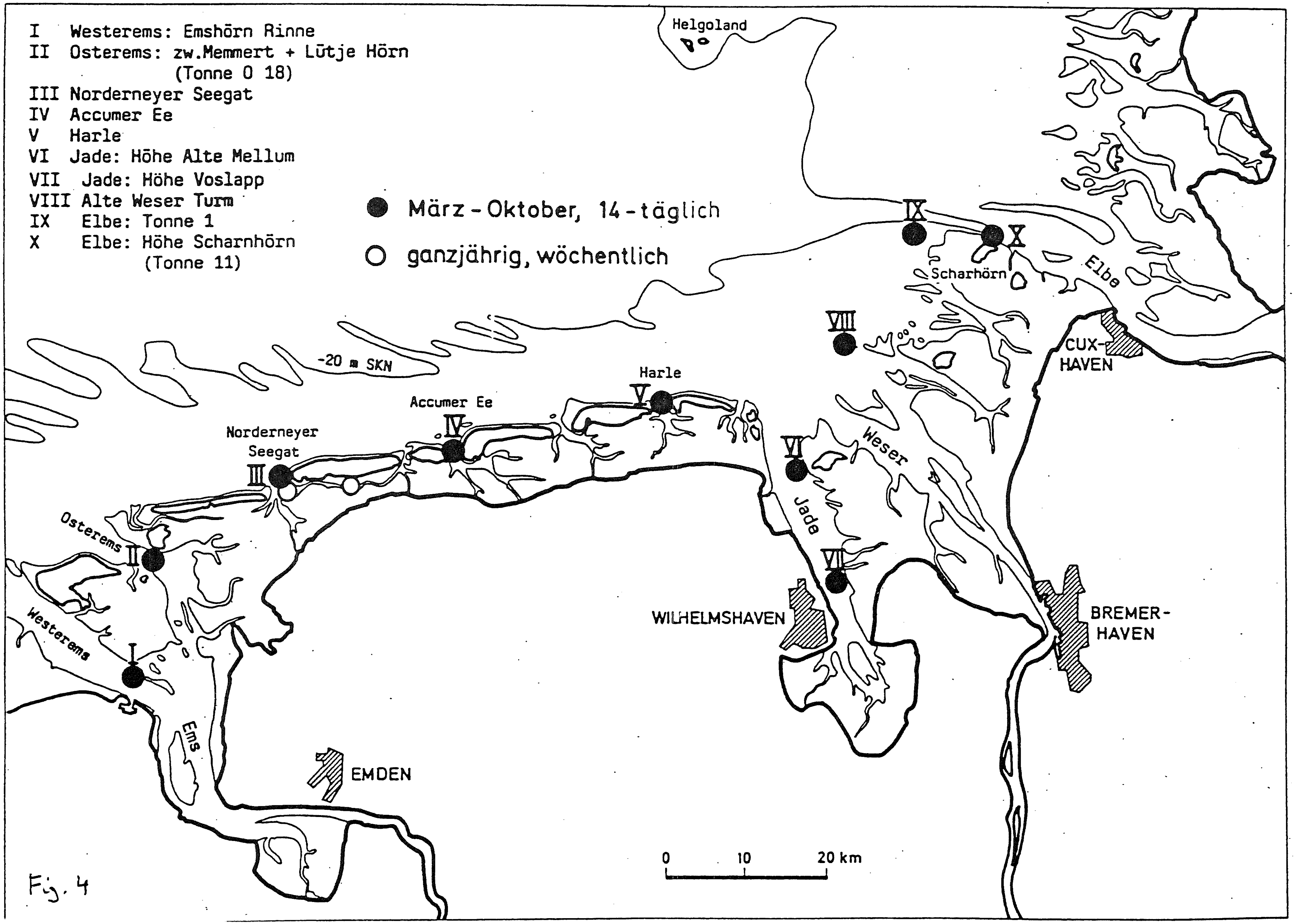

I Westerems: Emshörn Rinne
II Osterems: zw.Memmert + Lütje Hörn (Tonne O 18)
III Norderneyer Seegat
IV Accumer Ee
V Harle
VI Jade: Höhe Alte Mellum
VII Jade: Höhe Voslapp
VIII Alte Weser Turm
IX Elbe: Tonne 1
X Elbe: Höhe Scharnhörn (Tonne 11)
● März - Oktober, 14 - täglich
○ ganzjährig, wöchentlich
Helgoland
Scharhörn
Elbe
CUX-HAVEN
-20 m SKN
Harle
Accumer Ee
Norderneyer Seegat
Osterems
Westerems
Ems
EMDEN
WILHELMSHAVEN
Jade
Weser
BREMER-HAVEN
0 10 20 km

Fig. 4

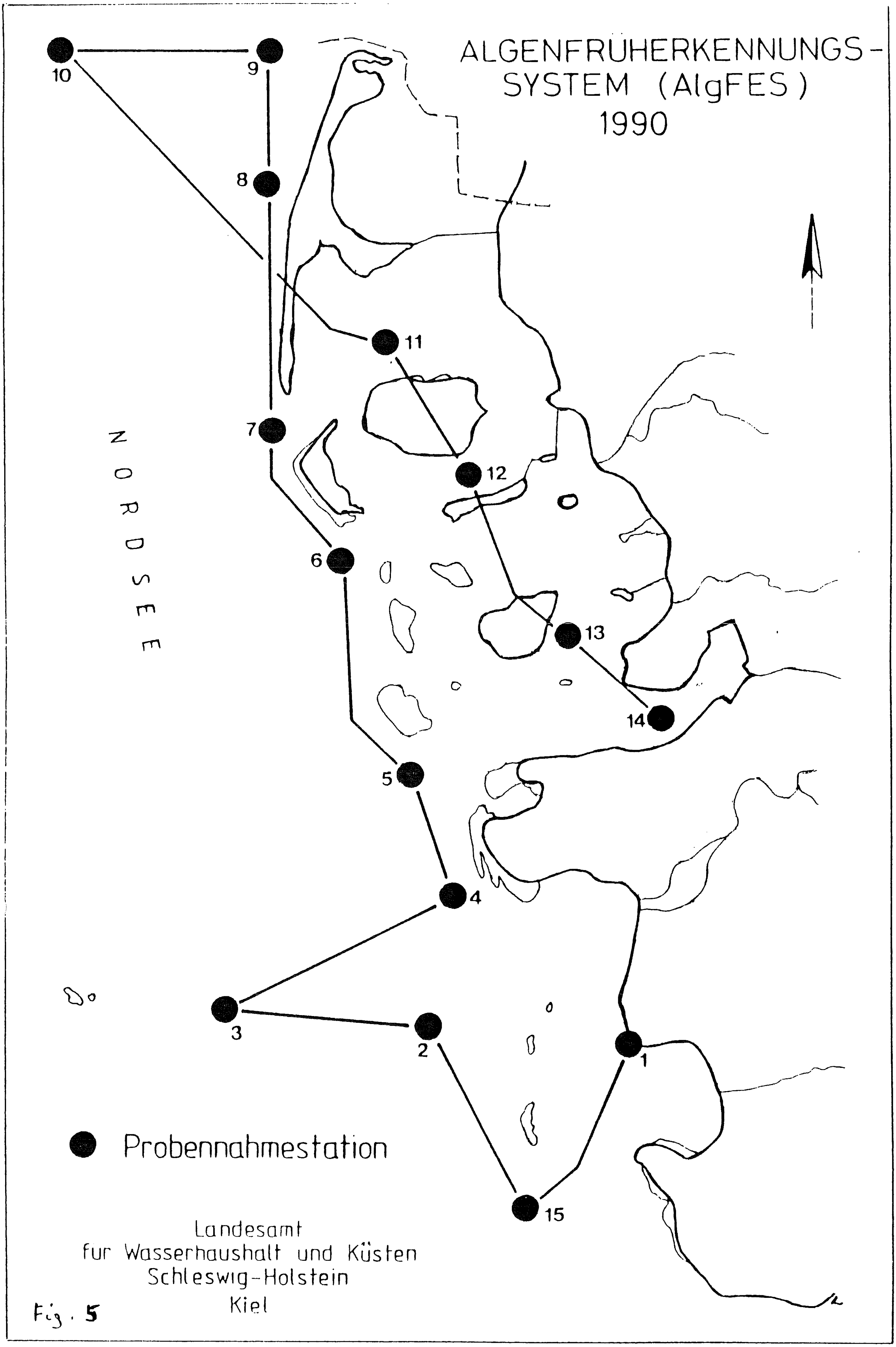

ALGENFRÜHERKENNUNGS-SYSTEM (AlgFES)
1990
NORDSEE
10
9
8
11
7
12
6
13
14
5
4
3
2
1
15
Probennahmestation
Landesamt
für Wasserhaushalt und Küsten
Schleswig-Holstein
Kiel

Fig. 5

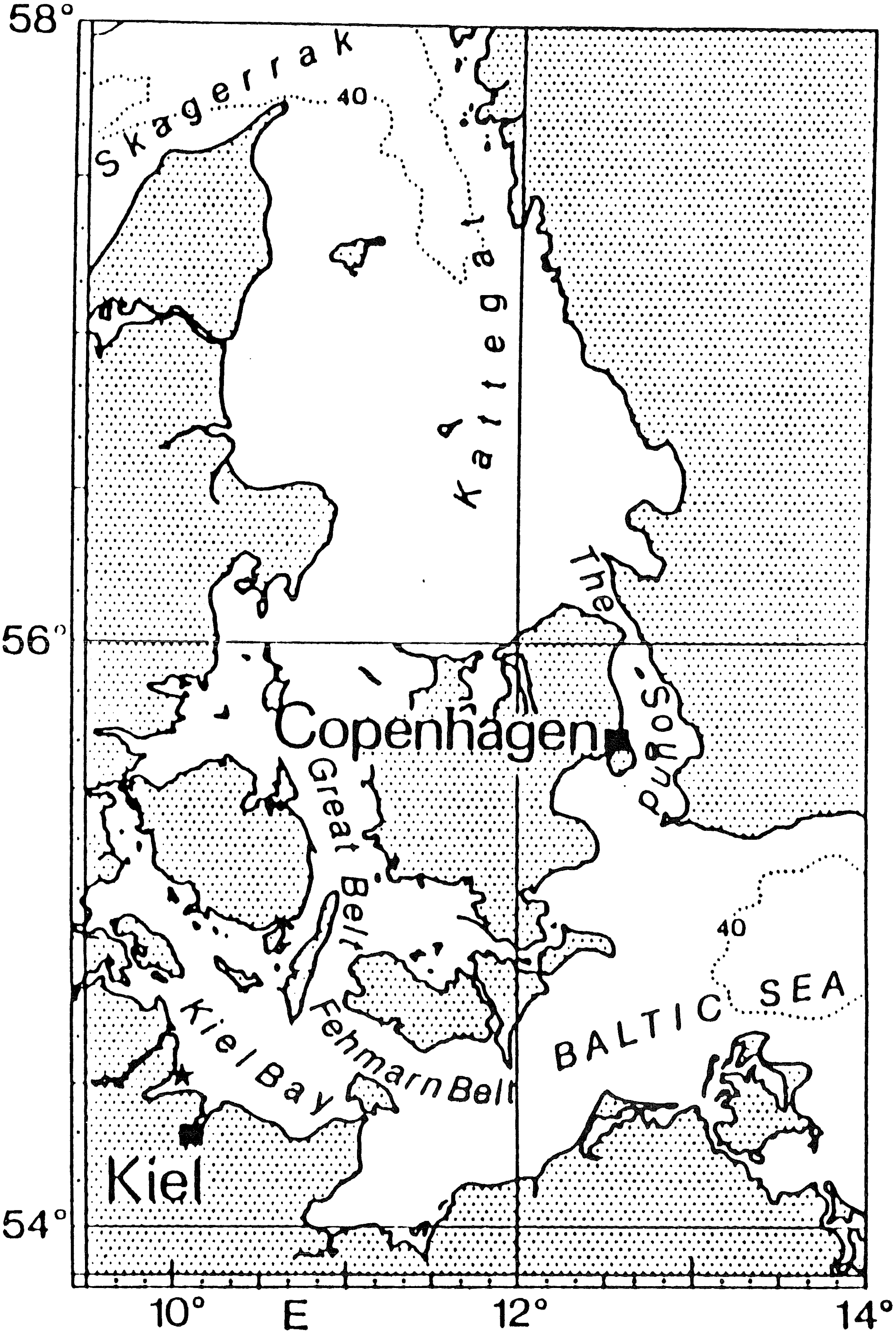

58°
Skagerrak
40
Kattegat
56°
Copenhagen
The Sound
Great Belt
Fehmarn Belt
Kiel Bay
Kiel
BALTIC SEA
40
54°
10°
E
12°
14°

Fig. 6

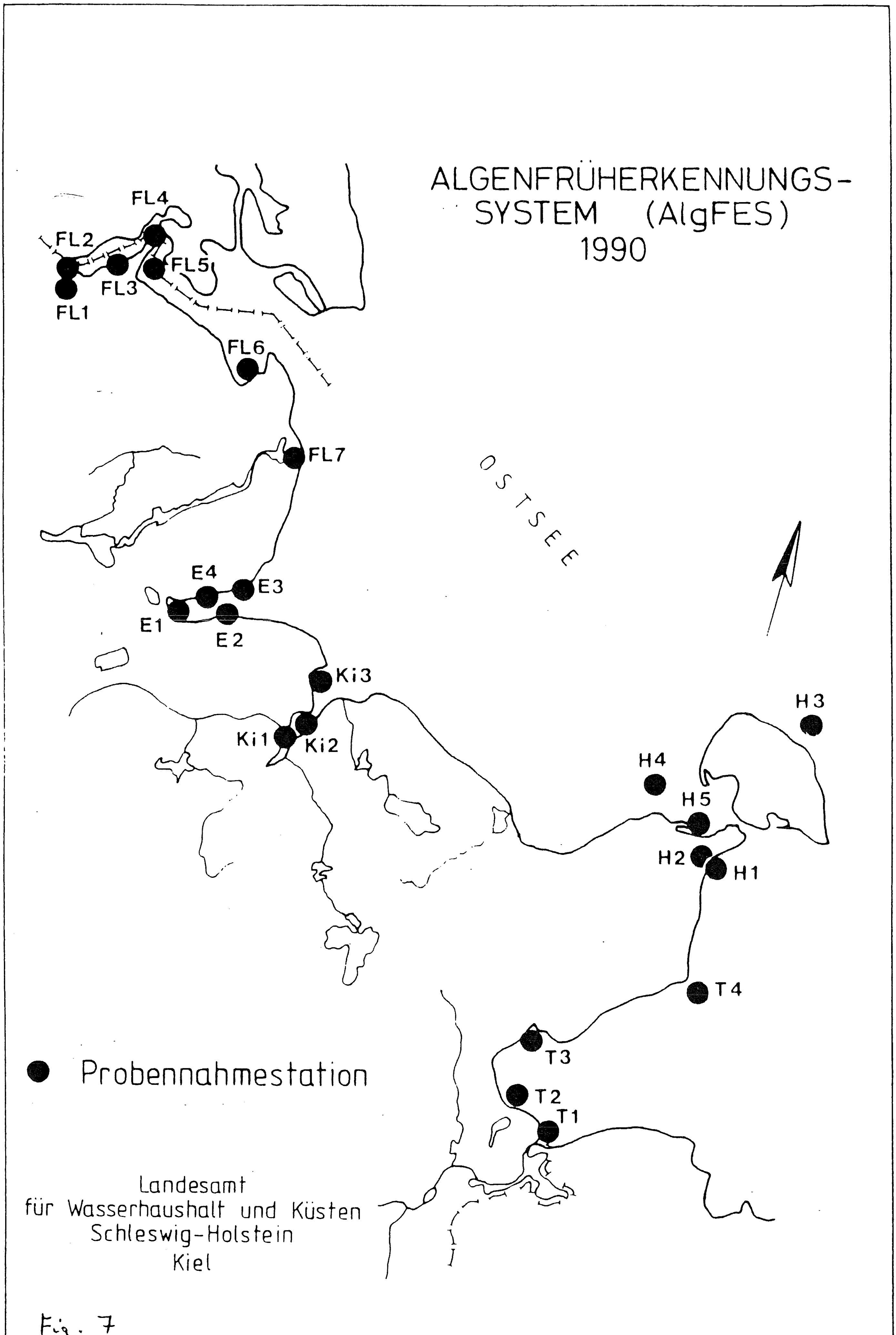

ALGENFRÜHERKENNUNGS-
SYSTEM (AlgFES)
1990
FL1
FL2
FL3
FL4
FL5
FL6
FL7
OSTSEE
E1
E2
E3
E4
Ki1
Ki2
Ki3
H1
H2
H3
H4
H5
T1
T2
T3
T4
Probennahmestation
Landesamt
für Wasserhaushalt und Küsten
Schleswig-Holstein
Kiel

Fig. 7

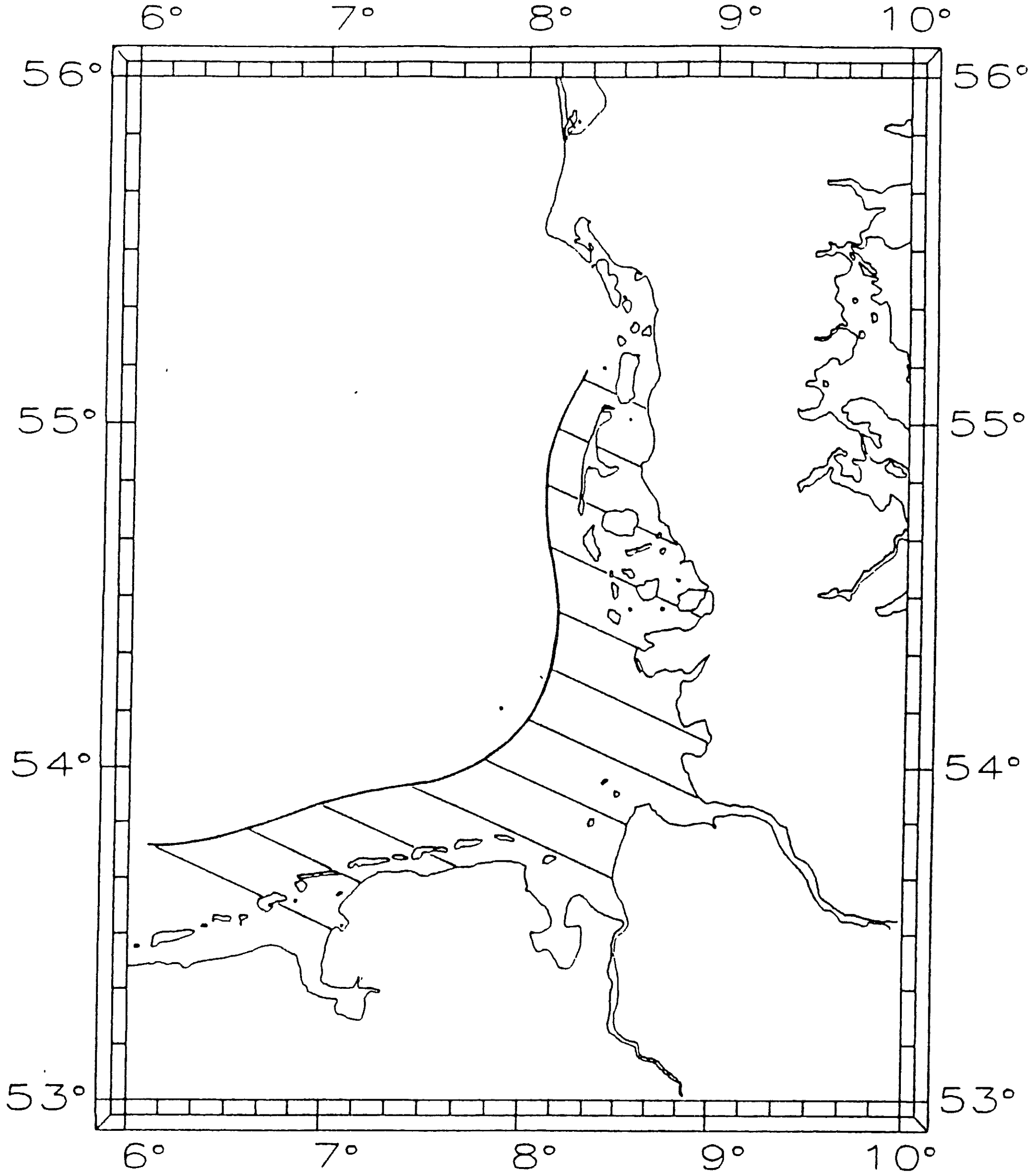


Figure 3: Area affected by exceptional algal blooms of *Phaeocystis sp.* from 1985 - 1990

During the period from 1985-1990 Phaeocystis sp. occurred regularly in exceptional densities in the East Frisian Wadden Sea and an area in front of the islands. In the North Frisian Wadden Sea an exceptional algal bloom was recorded solely in 1988 (Fig. 3).

Fig. 8

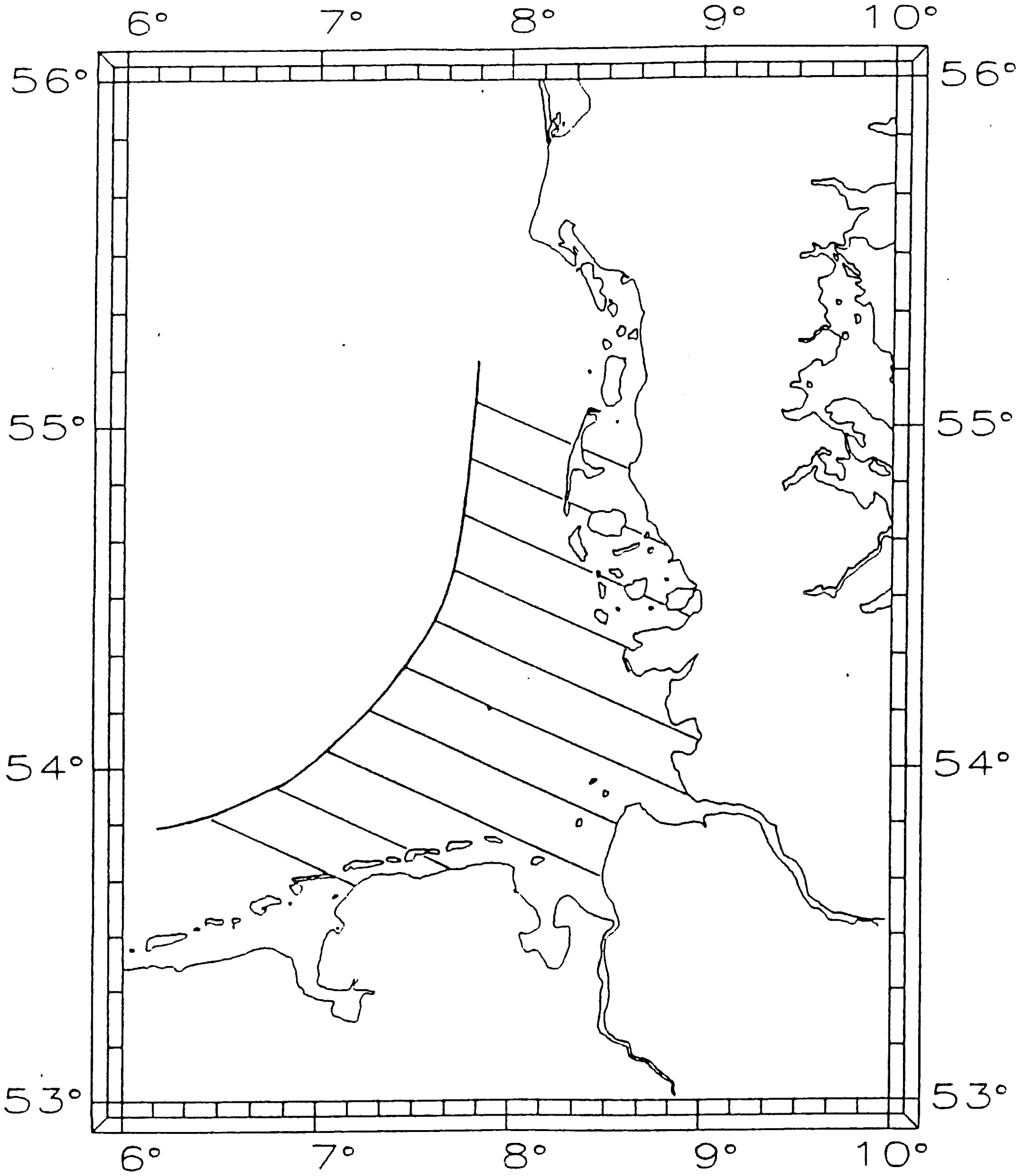


Figure 4: Area affected by exceptional algal blooms of *Dinophysis sp.* from 1985 - 1990

Figure 4 shows the potential occurrence of Dinophysis spec. in the German Bight. In the East Frisian Wadden Sea it has evidently been responsible for mussel infection since 1986.

Fig. 9

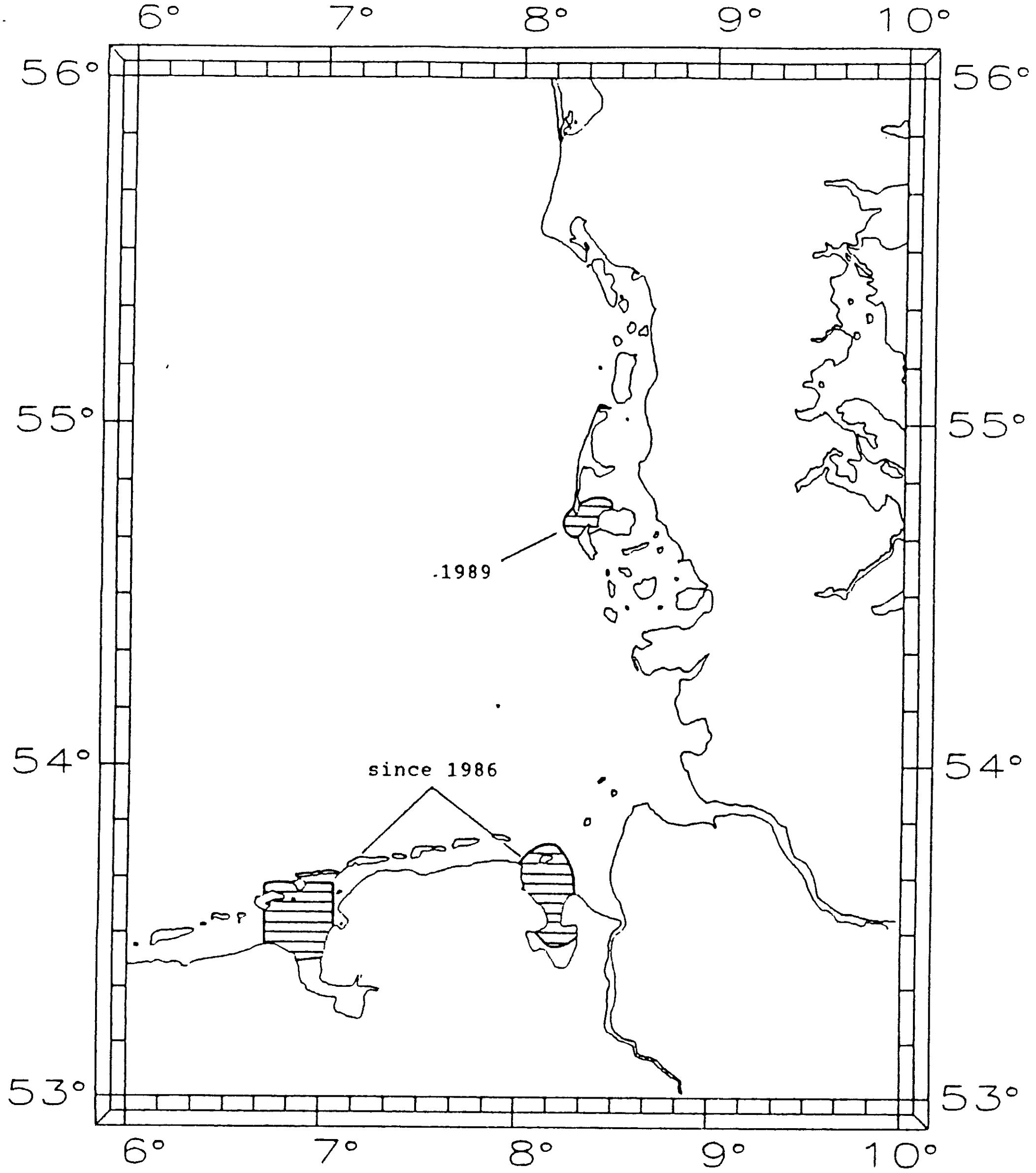


Figure 5: Occurrence of Diarrhetic Shellfish Poisoning (DSP) in *Mytilus edulis* from 1985 - 1990

Figure 5 shows the occurrence of DSP (Diarrhetic Shellfish Poisoning). In the East Frisian Wadden Sea it has occurred regularly since 1986, in the North Frisian Wadden Sea it was recorded in 1989.

Fig. 10

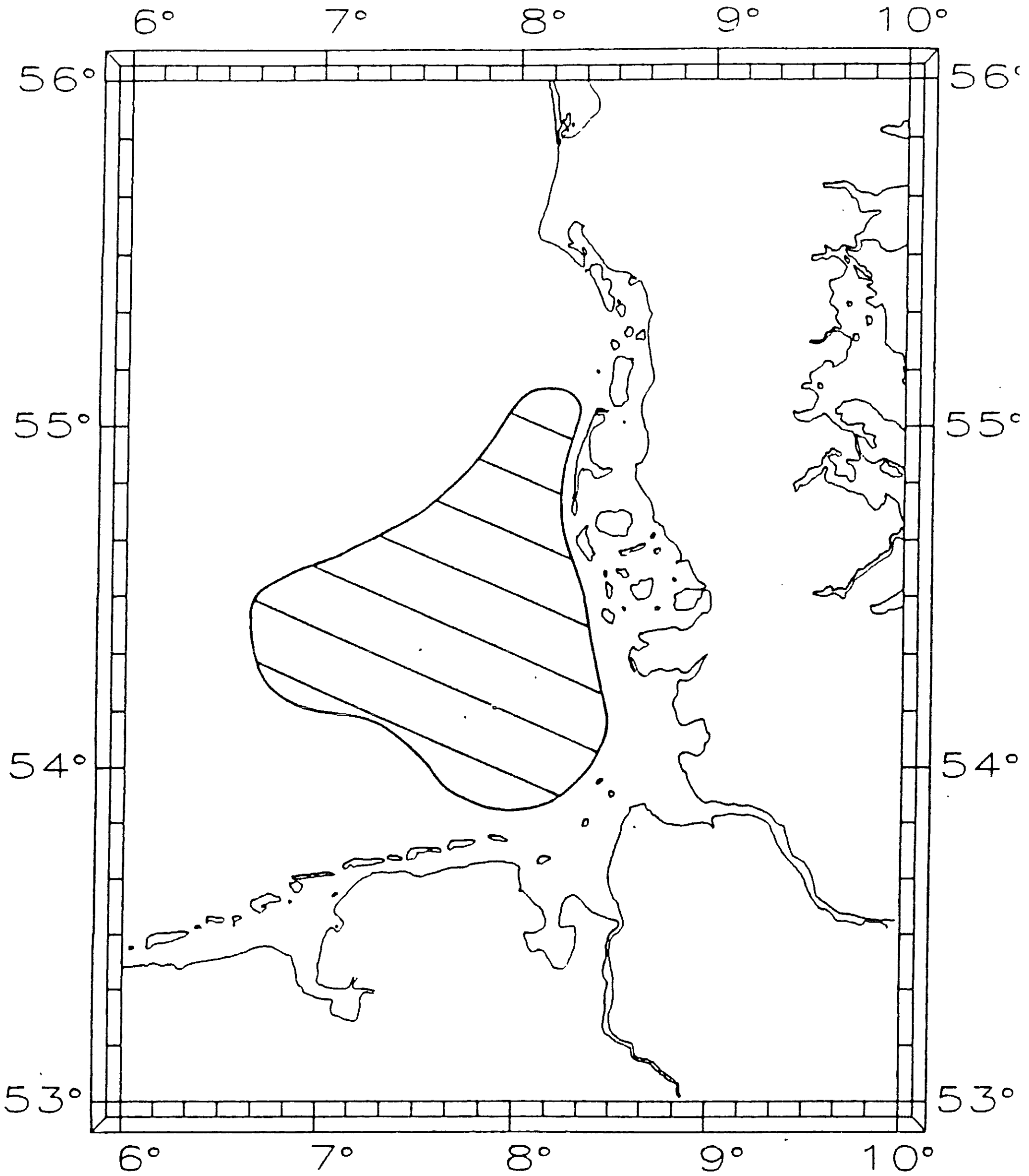


Figure 6: Area affected by exceptional algal blooms of *Ceratium sp.* from 1985 - 1990

In figure 6 one can see the area where exceptional algal blooms of Ceratium sp. have taken place every year. We mention this non-toxic alga because exceptional algal blooms can generally cause oxygen deficiency if certain hydrographic conditions such as stratification exist.

Fig. 11

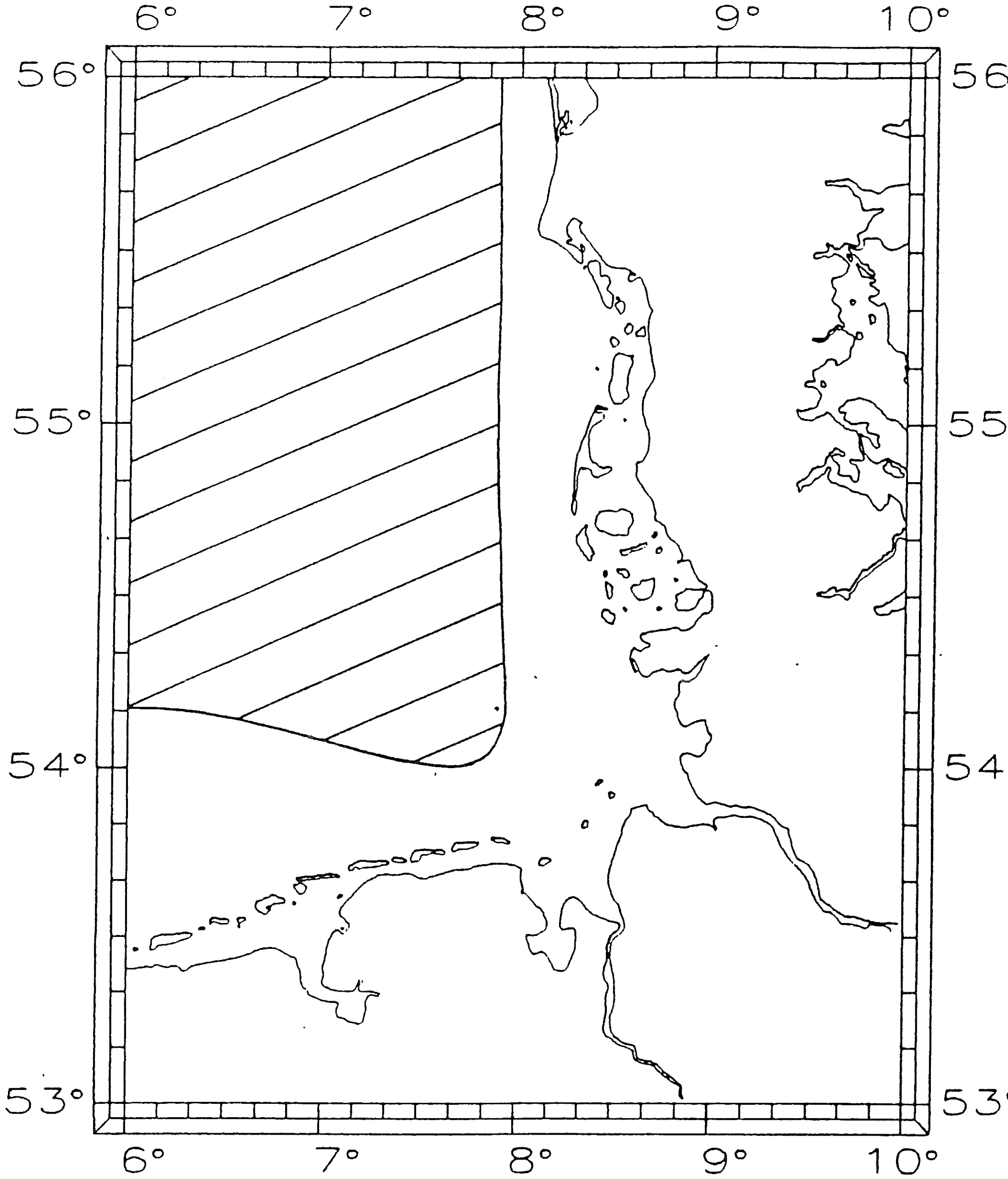


Figure 9: Area affected by oxygen deficiency in water from 1981 - 1990 (1 m above bottom: < 2 mg/l O_2; 1985 - 1990 only detected west of 7° E)

Fig. 12

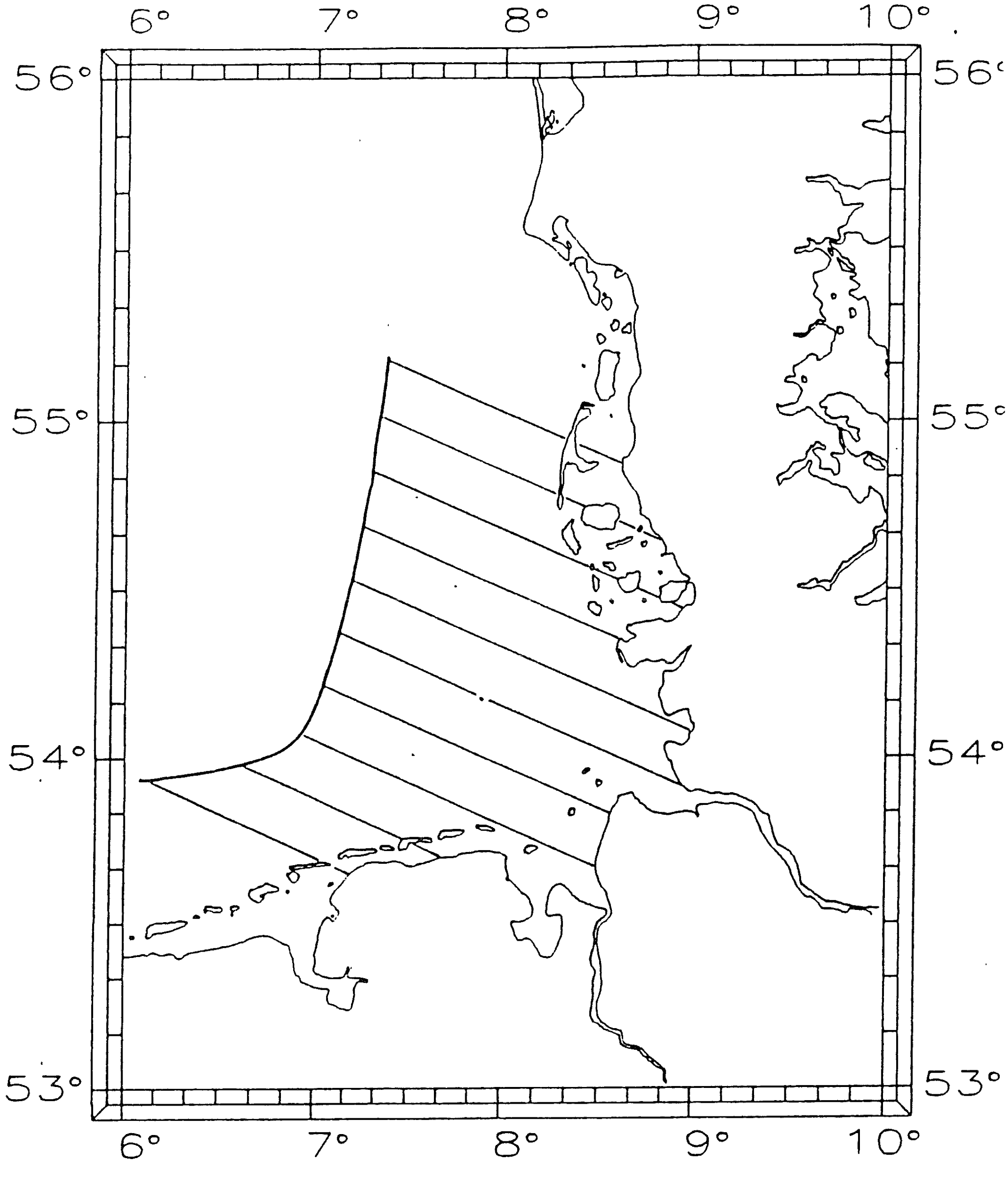


Figure 8: Area affected by exceptional blooms of *Noctiluca scintillans* from 1985 - 1990

It is a "normal" phenomenon for Noctiluca scintillans to form exceptional blooms in the German Bight every year (Fig. 8). It occurs in high abundances probably because its food resources have increased due to eutrophication. This species is mentioned here because it is able to release ammonia in concentrations which may be harmful for fish (PAERL, 1988). Furthermore its mucus affects animals in the upper water layers, e.g. fish larvae.

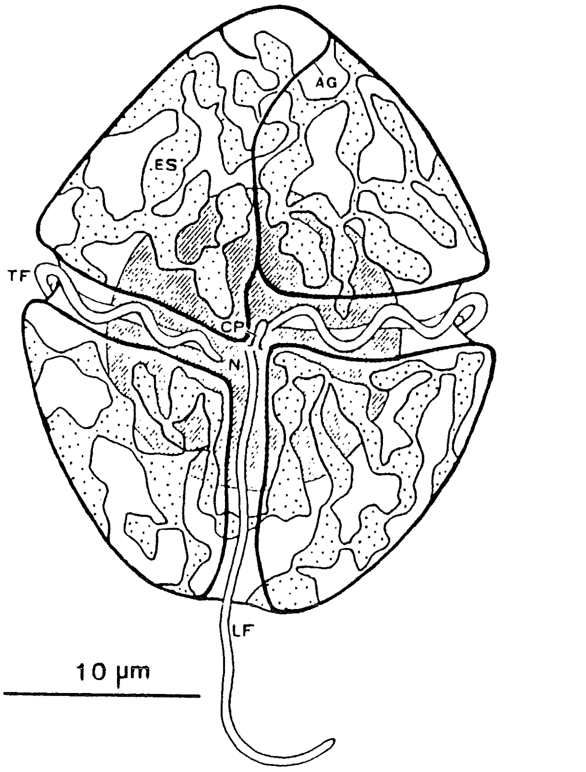
Fig. 13

J. Phycol. 26, 741–751 (1990)

LEPIDODINIUM VIRIDE GEN. ET SP. NOV. (GYMNODINIALES, DINOPHYTA), A GREEN DINOFLAGELLATE WITH A CHLOROPHYLL A- AND B-CONTAINING ENDOSYMBIONT[1,2]

Makoto M. Watanabe[3], *Shoichiro Suda*[4] et al.

National Institute for Environmental Studies, 16-2 Onogawa, Tsukuba, Ibaraki 305 Japan



NOTE: Abbreviations used in figures. AG: apical groove, C: chloroplast, CH: chromosome, CP: cytoplasmic projection, DL: a dense layer underlying the thecal vesicle, ES: endosymbiont, G: Golgi apparatus, IVM: innermost membrane of thecal vesicle, LF: longitudinal flagellum, M: mitochondrion, MC: mucocyst, ML: mucilaginous layer, MS: membranous sheet, MT: microtubule, N: nucleus, OM: outer membrane, OVM: outermost membrane of thecal vesicle, P: pellicular layer, PC: pusular collar, S: starch body, SC: scale, T: trichocyst, TF: transverse flagellum.

FIG. 1. *Lepidodinium viride*. Holotype.

Lepidodinium Watanabe et al. gen. nov.

Alga unicellularis, dinoflagellata gymnodinoides. Tabula thecae abest. Epiconus leviter quam brevior hypoconus. Extrema cinguli per spatium sui latitudinis disposita. Sulcus apicalis adest. Theca ex membrana externa, vesicula thecae et microtubulo consociato constans. Patella thecae abest. Protoplastus ab squama tectus. Squama capsi-formis cum arcum, in corpore Golgii producens.
Habitatio: marinus.
Types generis: Lepidodinium viride Watanabe et al.
Lepidodinium: Gr. *lepido-*, scaly + Gr. *dinein*, to whorl.

Alga unicellular, a gymnodinoid dinoflagellate. Epicone slightly shorter than hypocone. Cingulum displacement ca. one times its own width. Apical groove present. Theca composed of outer membrane, thecal vesicles and associated microtubules. Thecal plates absent. Protoplast covered by scales. Scale hand basket-shaped, produced in the Golgi apparatus.
Habitat: marine.
Type of the genus: *Lepidodinium viride* Watanabe et al.

Lepidodinium viride Watanabe et al. sp. nov.

Cellula subglobosae, dorsiventraliter complanata, 22.2–52.5 µm ($\bar{X}$ = 32 µm) longa, 18.9–38.3 µm ($\bar{X}$ = 26.6 µm) lata. Epiconus plus minus conicus. Hypoconus plus minus obtusatus. Sulcus ab cingulum ad antapicem extensus. Sulcus apicalis angusti et vadosi, ab extremo antico sulci ad apicem celluli extensus, circa apicem sinistrum ambiens. Projectura cytoplasmatis clavata ad parsem extremum sulci disposita. Flagellum transversum aequue longum ac cingulum; flagellum longitudinale leviter quam brevius corpus cellulae. Nucleus dinokari magnus, subsphaericus vel ovoideus, a centro ad apicem dispositus. Endosymbiontos vestigialis adest; numerus endosymbionti varians. Endosymbiontos a duobus membrana definitus, chloroplastus capiens. Chloroplastus chlorophyllis a *et* b, *a duobus membrana definitus, forma irregularis, peripheralis. Pyrenoid in chloroplasto inclusa.*
Holotypus: Figura 1.
Locus typicus: Lat. 40°40′N; Long. 141°55′E, in Oceano Pacifico.

Cell subglobular, dorsi-ventrally flattened, 22.2–52.5 µm ($\bar{X}$ = 32 µm) long, 18.9–38.3 µm ($\bar{X}$ = 26.6 µm) wide. Epicone slightly conical. Hypocone slightly obtuse. Sulcus extending from cingulum to antapex. Apical groove narrow and shallow, extending from the anterior end of the sulcus to the cell apex, veering to the left and surrounding the apex counterclockwise. Cytoplasmic projection club-shaped, situated at anterior sulcus region. Transverse flagellum as long as cingulum. Longitudinal flagellum slightly shorter than body length. Dinokaryotic nucleus large, subspherical or ovoid, and located from center to apex. Vestigial endosymbiont present, bounded by double membranes. Chloroplast of endosymbiont double-membrane bounded, with chlorophylls *a* and *b*, irregularly shaped and peripherally located. Pyrenoid embedded in chloroplast.
Holotype: Figure 1.
Type locality: Lat. 40°40′N; Long. 141°55′ E, Pacific Ocean.
Habitat: The specimens examined were isolated from the seawater sample collected from a depth of 0–20 m, off Miyako, Iwate Pref., 23 August 1985.
Type culture: NIES-Collection No. Y-100 (Microbial Culture Collection, National Institute for Environmental Studies).

Light Microscopy

Micrographs showing general light microscopical features have already been presented in a previous paper (Figs. 1–5 in Watanabe et al. 1987). Details which were not mentioned before are given below along with a line drawing of the cell (Fig. 1).

The cells of *Lepidodinium viride* are subglobular, dorsi-ventrally flattened, and with an average length of 32 µm (range 22.2–52.5 µm) and an average trans-cingulum width of 26.6 µm (range 18.9–38.3 µm). Although no delicate thecae were ever observed surrounding the active cells, a rigid peripheral coat without a plate pattern was observed on rounded up or lysed cells settled on the bottom of the culture vessel in an old culture (Fig. 13, see below). This coat seems to be identical to the pellicular layer *sensu*

Fig. 14

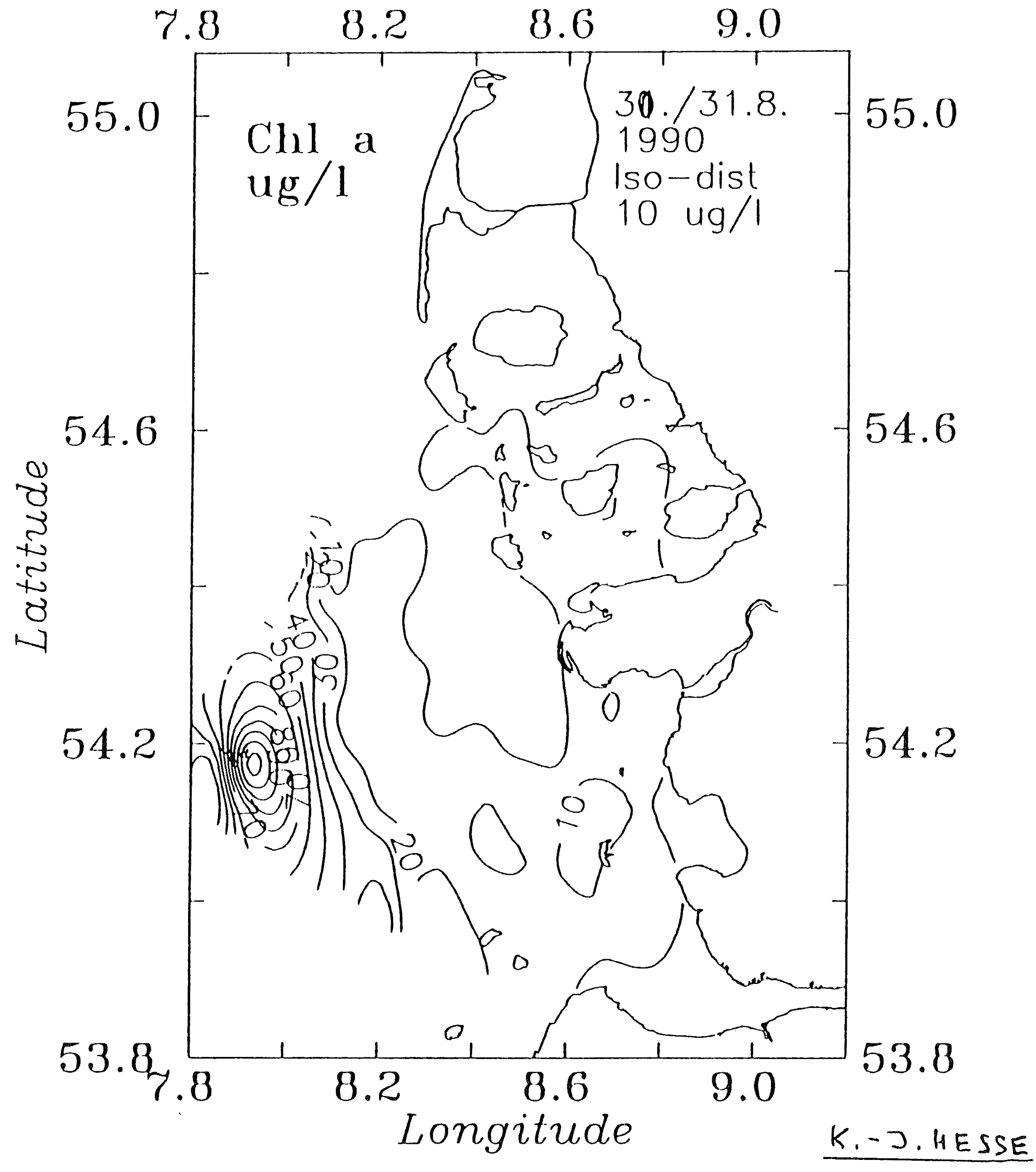


Figure 15. Mapping of a "green tide" in summer 1990. The green dinoflagellate responsible is presumed to be the newly discovered Lapidodinium viride (Watanable et al 1990)

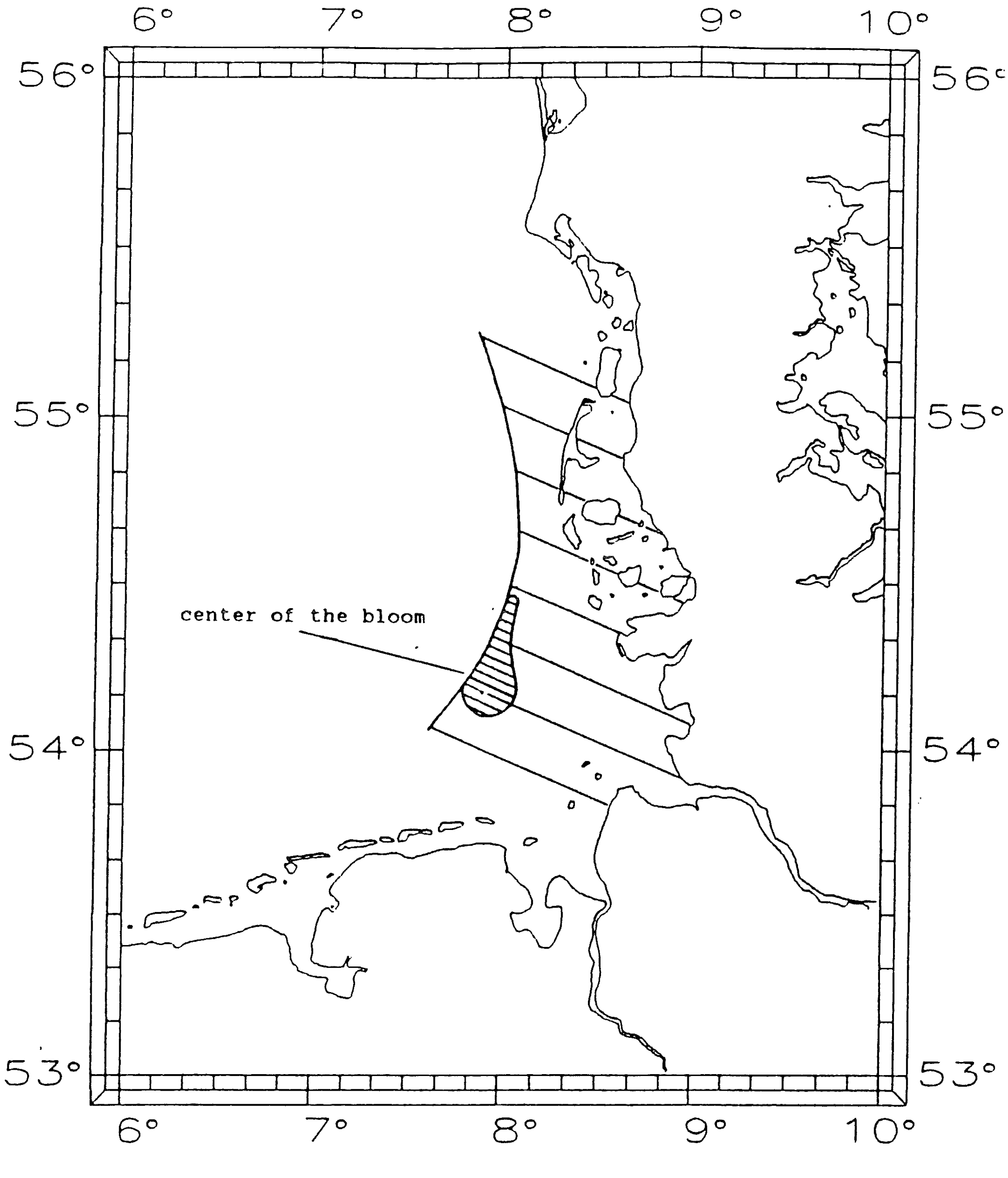


Figure 16. In 1990 the occurrence of an exceptional algal bloom of "Y-100" in the German Bight was reported for the first time. Figure 7 shows the area where this bloom had been observed for several weeks (TF5/Info 32-E). In the waters in front of Lower Saxony this species did not occur.

"Y - 100" Lepidodinium viride (Watanabe et al. 1990)

Occurrence of Dinophysis acuminata (A) and phytoplankton monitoring (B) in Dutch coastal and offshore waters in 1990.

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P.O. Box 8039,
4330 EA Middelburg,
The Netherlands.

P. van Banning,
Netherlands Institute for Fishery Investigations,
P.O. Box 68,
1970 AB IJmuiden,
The Netherlands.

A. In 1990 the monitoring of Dinophysis acuminata in phytoplankton samples and the employment of rat bioassays for the detection of DSP in mussels (Mytilus edulis) were continued.

Phytoplankton surface samples and mussels were taken from the two main commercial mussel-producing areas the Oosterschelde in the south-west and the western Wadden Sea in the north; sampling frequency was weekly during the period July-October. In the North Sea (coastal and offshore waters) phytoplankton surface samples were taken from the end of June until November.

In the Oosterschelde D. acuminata was observed in low numbers in the period 13/8 to 24/9, in the western Wadden Sea from 10/7 to 29/10 and in the North Sea from 11/7 to 24/10 (Table 1).

From the rat bioassays no occurrence of DSP in mussels from the Oosterschelde and the western Wadden Sea was measured.

Table 1. Number of Dinophysis acuminata cells l^{-1} in phytoplankton samples from the Oosterschelde, the western Wadden Sea and the North Sea (data from the Netherlands Institute for Fishery Investigations).

Oosterschelde		Western Wadden Sea		North Sea			
9/7	0	10/7	2	26/6	56°10'N	03°10'E	0
16/7	0	17/7	0	11/7	55°10'	03°10'	4
23/7	0	23/7	3	11/7	51°39'	03°13'	2
30/7	0	31/7	8	12/7	52°52'	04°34'	1
6/8	0	6/8	19	17/7	53°22'	04°54'	0
13/8	19	13/8	29	17/7	53°08'	04°26'	0
20/8	4	21/8	33	27/8	53°47'	05°40'	10
27/8	2	27/8	135	28/8	54°19'	05°27'	1
3/9	2	30/8	126	28/8	53°58'	05°54'	30
10/9	0	3/9	41	29/8	53°48'	05°53'	181
17/9	3	10/9	17	4/9	55°10'	03°10'	4
24/9	0	17/9	34	11/9	51°38'	03°19'	1
1/10	0	24/9	2	18/9	53°38'	04°51'	55
8/10	0	1/10	2	25/9	53°28'	05°13'	5
15/10	0	8/10	4	3/10	53°23'	05°01'	26
22/10	0	15/10	3	24/10	55°08'	04°29'	0
29/10	0	22/10	3				
		29/10	0				

B. In 1990 a phytoplankton monitoring network in all Dutch marine waters, comprising 29 sampling stations, became operational; sampling frequency was bi-weekly during the period April-September and monthly during the rest of the year. In addition to the phytoplankton samples also environmental (chemical and physical) variables have been determined. Results will be reported from 1992 onwards.

ALGAL BLOOM REPORTS - ENGLAND AND WALES

1. Location: South Wales coast from Burry inlet/Swansea Bay to Fishguard.

2. Date of occurence: Late August to mid September 1990.

3. Effects: Large mortalities of Lugworm (*Arenicola marina*) - estimated to be in excess of 70% in some areas. Some dead cockles (*Cerastoderma edule*). Patches of brown scum (dead phytoplankton) on some areas of beach. Secondary blooms of bacteria (Pseudomonads and Vibrios).

4. Management decision: Samples of mussels, cockles and lugworm taken for analysis of PSP toxins (mouse bioassay). No PSP toxins detected. Blood samples from worms negative for botulism.

5. Causative species: *Gymnodinium* spp ? (10,000 cells per ml). Effects possibly due to creation of anoxic conditions.

6. Environment: Weather very hot and settled.

7. Advected population or in situ growth: Mortalities commenced off Pembrokeshire coast and spread eastwards along S.Wales coast during incident.

8. Previous occurrences: none recorded in this area in living memory (40 years).

9. Additional comments: Bait digger complained of skin rash.

10. Individual to contact:

I.Laing
M.A.F.F.
Fisheries Laboratory
Benarth Road
Conwy
Gwynedd LL32 8UB

ALGAL BLOOM REPORTS - ENGLAND AND WALES

1. Location: North-east coast of England, from Humber estuary northwards (to Scottish border).

2. Date of occurence: 18th May to 20th July 1990.

3. Effects: PSP toxin detected in shellfish samples. Maximum of 19,881 mouse units per 100 g sample (*Mytilus edulis*). Bioassays carried out at the M.A.F.F. Fish Diseases Laboratory, Weymouth, Dorset, England (contact: Dr. D.J.Alderman).

4. Management decision: Affected areas closed for the harvest of all shellfish species (mussels, scallops, winkles, whelks, oysters, crabs, lobsters, shrimps and prawns) on May 26th. Further sampling allowed lifting of restrictions on winkles, whelks, lobsters, shrimps and prawns in early June. Sampling increased as bloom progressed. All remaining restrictions lifted on July 17th.

5. Causative species: *Alexandrium tamarensis*.

6. Environment: Weather very warm and settled.

7. Advected population or in situ growth: Data from previous events suggests mainly advected population, with the possibility of in-situ growth at some sites.

8. Previous occurrences: Annual event, although intensity varies. Highest recorded PSP levels since 1968.

9. Additional comments: Responsibility for routine monitoring to be transferred to Torry Research Station, P.O. Box 31, 135 Abbey Road, Aberdeen, AB9 8DG, U.K. from March 1991.

10. Individual to contact: I.Laing
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ALGAL BLOOM REPORTS - SCOTLAND

1. Location: Coast of North East England and East Scotland from the Humber to the Tay.

2. Date of Occurrence: Late May until mid July 1990

3. Effects: High levels of PSP toxins found in mussels *Mytilus edulis* and also in crabs. Maximum level recorded was 19881 MU (3647 μg/100 g) in mussels from Trow Rocks, South Shields.

4. Management Decisions: 26th May - blanket ban on all shellfish from the Humber to the Tay.
   1 st June - ban lifted for lobsters and prawns.
   5th July - ban lifted for everything except scallops.
   16th July - ban fully lifted for NE England.

5. Causative Species: Unknown.

6. Environment: No data available

7. Advective Population or in situ Growth: No firm data available, but possibly in situ growth.

8. Previous Occurrences: Similar event in 1968 led to monitoring program, which revealed presence of dinoflagellate toxins in littoral mussels annually, but extent and levels varied greatly.

9. Additional Comments: Blanket ban caused economic losses - approx 1000 boats tied up and 3000 people out of work.
   Environmental data would be useful.

10. Individual to contact:

ALGAL BLOOM REPORTS - SCOTLAND

1. Location: Coast of North East England and East Scotland from the Humber to the Tay.

2. Date of Occurrence: Late May until mid July 1990

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6. Environment: No data available

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9. Additional Comments: Blanket ban caused economic losses - approx 1000 boats tied up and 3000 people out of work.
Environmental data would be useful.

10. Individual to contact:

ICES WORKING GROUP ON PHYTOPLANKTON

AND THE MANAGEMENT OF THEIR EFFECTS

VIGO, SPAIN, 18 th – 21 st MARCH 1991

FRANCE – ALGAL BLOOM REPORTS – 1989

by Catherine BELIN

LOCATION	DATES	EFFECTS GENERAL FEATURES	CAUSATIVE SPECIES	CONCENTRATIONS (cells.l^{-1})	ENVIRONMENT
North of France Dunkerque	30.05.89 to 06.06.89	Many large sheets of green to brown water	Asterionella glacialis (japonica)	200.10^6 to 300.10^6	?
North of France From Belgian border to Somme bay	Beginning of April to beginning of June	Very brown water	Phaeocystis pouchetii	200.10^6	?
High Normandy Fécamp-Etretat	17.08.89 to 14.11.89	Ban of shellfish marketing. High toxicity DSP in mussels	Dinophysis Cf. acuminata	?	?
High Normandy From Antifer cap to Hève cap	13.07.89 to 14.11.89	Ban of shellfish marketing. Very high toxicity DSP in mussels	Dinophysis Cf. acuminata	max : 158 000 often more than 10 000	Tempér.: 16,2 to 21°C
Seine Estuary	07.09.89 to 14.11.89	Ban of shellfish marketing. High toxicity DSP in mussels	Dinophysis Cf. acuminata	?	?
Low Normandy Cabourg	19.07.89	Brownish water	Prorocentrum balticum and Eutreptiella sp.	$2\ 200.10^3$ $1\ 900.10^3$	?
	13.09.89	Green water	Gymnodinium sp.	130.10^6	?
Low Normandy From Orne to Seulles river	06.09.89 to 22.09.89	Ban of shellfish marketing. Middle toxicity DSP in mussels.	Dinophysis Cf. acuminata	max : 12 600 generally more than 1 000	Tempér.: 18 to 20,4°C
Northern Brittany Rance estuary	28.09.89	Reddish water	Oxyrrhis marina and Detonula confervacea	$7\ 200.10^3$ $1\ 800.10^3$	Tempér.: 19.2°C Salin. : 12.10^{-3}
	05.10.89	White water	Oxyrrhis marina	$13\ 440.10^3$	Tempér.: 18°C Salin. : $10,5.10^{-3}$

Northern Brittany St Brieuc Bay	20.03.89 to 10.04.89	Rust-colored water	Detonula confervacea and Plagiogramma sp.	674 400 228 800	Salin. : $32,4.10^{3}$
Northern Brittany Lannion Bay	10.07.89 to 19.07.89	Pink water	Oxyrrhis marina	?	?
Northern Brittany Morlaix Bay	14.07.89 to 28.07.89	Red water. Ban of shellfish marketing for risk of toxicity PSP. (But no toxicity has been detected in shellfish)	Alexandrium minutum and Alexandrium sp.	160 000 to $2\ 936.10^{3}$	Tempér.: 17 to 28,9°C Oxyg. : 86 to 183 %
West of Brittany Iroise sea	31.05.89 to 15.06.89	Ban of shellfish marketing. Middle to high toxicity DSP in Donax trunculus	Dinophysis (several species, including D. cf. acuminata and D. sacculus)	5 300	?
West of Brittany Camaret	01.08.89 to 02.08.89	Green water	Gymnodinium sp.	?	?
	09.08	Green water	Gymnodinium sp.	690 000	?
	28.08.89 to 29.08.89	Very green water	Gymnodinium sp.	37.10^{6}	?
West of Brittany Douarnenez Bay	25.05.89 to 29.06.89	Ban of shellfish marketing. Middle to high toxicity DSP in mussels and Donax trunculus	Dinophysis (several species, including D. cf. acuminata and D. sacculus)	max : 2 700 generally less than 200	Tempér.: 15,4 to 20,4°C Salin. : 34,5 to $35,4.10^{-3}$ Turb. : 0,6 to 4 NTU
	10.08.89 to 07.09.89	Ban of shellfish marketing. High toxicity DSP in mussels and Donax trunculus	-idem-	max : 300	Tempér.: 15,3 to 18°C
Southern Brittany Audierne Bay	01.04.89 to 03.04.89	Green to brownish water	Chaetoceros armatum	510.10^{6}	Tempér.: 9,6°C Salin. : $31,8.10^{-3}$
	10.04.89 to 17.04.89	Yellow-brownish water	Chaetoceros armatum	$5\ 980.10^{3}$ to $18\ 430.10^{3}$	Tempér.: 11,4 to 11,9°C Salin. : 32,6 to $33,3.10^{-3}$ Turb. : 2,25 to 5,25 NTU
Southern Brittany Lorient roadstead	19.05.89 to 16.06.89	Ban of shellfish marketing. High toxicity DSP in mussels	Dinophysis (several species, including D. cf. acuminata and D. sacculus	max. : 1 900	Tempér.: 15,4 to 21°C Salin. : $34,3.10^{-3}$ Turb. : 1,7 NTU

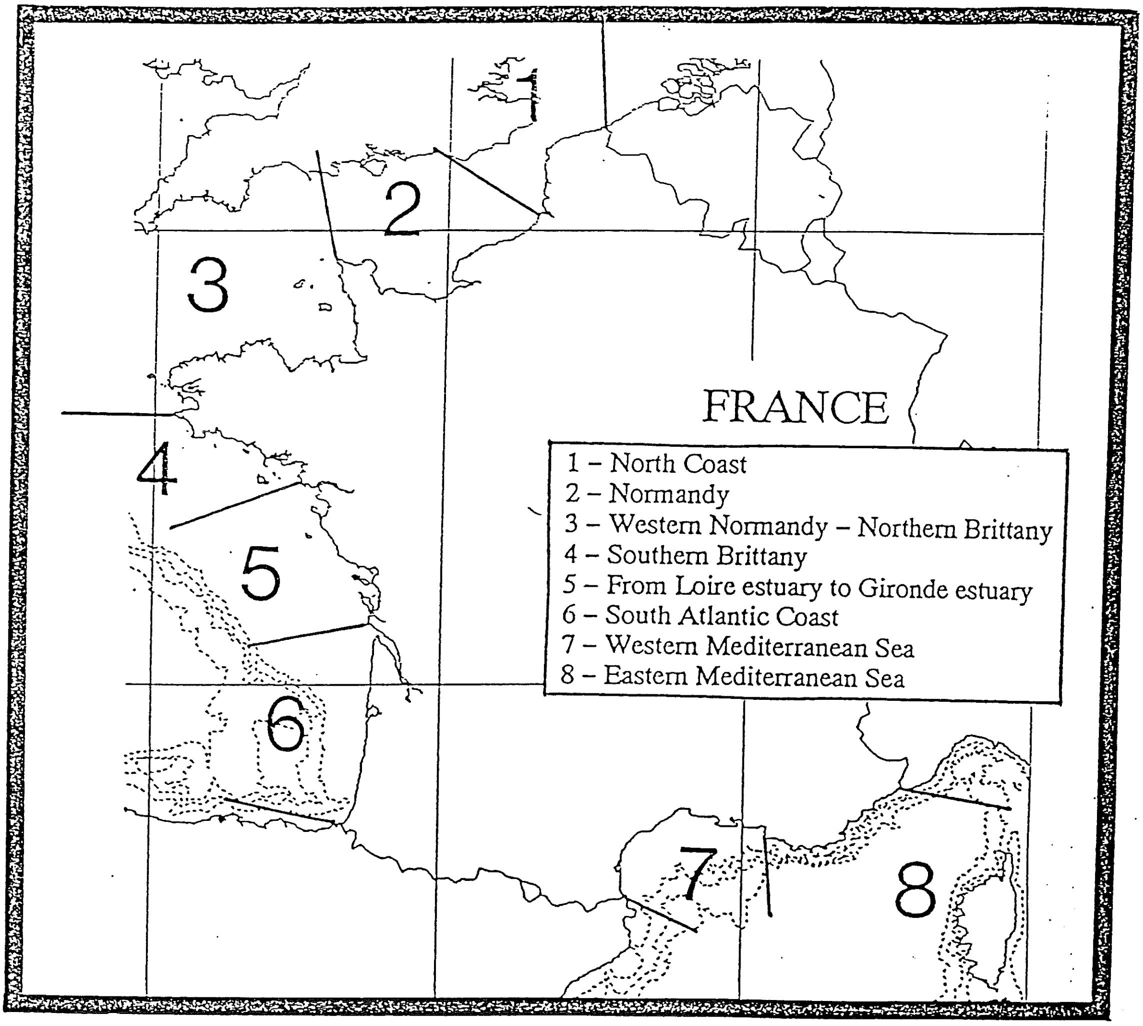
Vilaine Bay	12.07.89	Brown water	Katodinium sp.	6.10^6	Tempér.: 24,1°C Salin. : $26,3.10^{-3}$
	17.07.89 to 16.08.89	Very green water	Gymnodinium sp.	2.10^6 to 8.10^6	Tempér.: 17,8 to 22°C Salin. : 35,4 to $36,8.10^{-3}$ Turb. : 0,38 to 5,7 NTU
Northern Loire Estuary Le Croisic roadstead	29.04.89	Dark red water	Phaeocystis sp.	?	?
	31.05.89	Very red water	Mesodinium rubrum	440.10^3	Salin. : $33,3.10^{-3}$ Turb. : 4 NTU
	28.07.89 to 30.07.89	Very green water	Gymnodinium sp.	?	?
Atlantic coast Yeu Island	07.08.89 to 08.08.89	Green water ?	Gymnodinium sp.	670 000	Tempér.: 12°C Salin. : $33,4.10^{-3}$
Atlantic coast Les Sables d'Olonne	30.06.89	Orange-colored and "thick" water	Noctiluca scintillans	1.10^6	?
Atlantic coast – West and South Ré Island - West Oléron Island	17.05.89 to 24.05.89	Sheet of very red water (about 5 kms long)	Noctiluca scintillans	875 000 to 900 000	Turb. : 120 NTU
Atlantic coast East Oléron Island	31.07.89 to 01.08.89	Pale green water	Gymnodinium sp.	40 000 to $4\ 200.10^3$	Tempér.: 17,9 to 22°C Salin. : 33,7 to $33,8.10^{-3}$ Turb. : 7 to 14 NTU Oxyg. : 111 to 122 %
	09.08.89	Dark green water	Anabaena spiroïdes ?	$x.10^6$	?
Southern atlantic coast Cap Ferret	06.09.89	Dark red to brown water	Rhizosolenia styliformis	21 200	?
Southern atlantic coast Biscarosse	06.09.89	Red-brown water	Rhizosolenia styliformis	?	?
Southern atlantic coast Capbreton river	06.06.89 to 11.06.89	Yellow-brown to orange-colored water	Scenedesmus sp.	?	?
Southern atlantic coast Biarritz	14.05.89 to 20.05.89	Yellow to orange-colored water	Noctiluca scintillans	32 000 to 406 000	?
Mediterranean sea Pyrénées orientales department	02.06.89 to 17.08.89	Ban of shellfish marketing. Very high toxicity DSP in mussels.	Dinophysis (several species, including D. cf. acuminata and D. sacculus	max. : 300	Tempér.: 15,5 to 24°C Salin. : 38 to $38,5.10^{-3}$ Turb. : 1 to 1,5 NTU Oxyg. : 100 to 120 %

Salses-Leucate Lake	15.06.89 to 07.07.89	Ban of shellfish marketing. Very high toxicity DSP in mussels.	Dinophysis (several species, including D. cf. acuminata and D. sacculus	max. : 2 200 generally less than 300	Tempér.: 21,5 to 25°C Salin. : 36,5 to 38,5.10^{-3} Turb. : 0,7 NTU Oxyg. : 100 to 126 %
Mediterranean Sea Aude department	02.06.89 to 22.09.89	Ban of shellfish marketing. Very high toxicity DSP in mussels.	Dinophysis (several species, including D. cf. acuminata and D. sacculus	max. : 2 600 generally less than 1 000	Tempér.: 14,5 to 24°C Salin. : 37,8 to 38.10^{-3} Turb. : 1 NTU Oxyg. : 100 %
Lapalme pond	23.02.89 to 25.02.89	Red water ? Mortalities in mussels spats	Gymnodinium sp. (a different species from the Atlantic one)	?	?
Mediterranean sea Herault department (including mussels on suspended rope culture off Sète)	18.05.89 to 22.09.89	Ban of shellfish marketing. Very high toxicity DSP in mussels	Dinophysis (several species, including D. cf acuminata and D. sacculus)	max. : 6 800 generally less than 1 000	Tempér.: 14,5 to 25°C Salin. : 36,5 to 38,5.10^{-3} Turb. : 0,3 to 1,4 NTU Oxyg. : 98 to 122 %
Mediterranean sea Gard department	02.06.89 to 10.08.89	Ban of shellfish marketing. High toxicity DSP in mussels	Dinophysis (several species, including D. cf. acuminata and D. sacculus)	max. : 600	?
Prevost pond	23.06.89 to 11.09.89	Ban of shellfish marketing. Very high toxicity in mussels	Dinophysis (several species, including D. cf. acuminata and D. sacculus)	max. : 300	?
Aigues-Mortes Gulf	15.06.89 to 19.06.89	Pink water	Noctiluca scintillans	37 200 to 40 000	?
Camargue coast Saintes Maries Gulf	13.06.89 to 20.09.89	Ban of shellfish marketing. Very high toxicity DSP in mussels	Dinophysis (several species, including D. cf. acuminata and D. sacculus)	max. : 1 650	Temper.: 16,4 to 25,5°C Salin. : 33 to 36,5.10^{-3} Turb. : 1 to 12 NTU Oxyg. : 89,9 to 133,6 %
Fos gulf	13.06.89 to 23.08.89	Ban of shellfish marketing. Very high toxicity in mussels	Dinophysis recurva and Dinophysis cf. acuminata	max : 9 800 generally less than 1 000	Temper.: 18 to 25°C Salin. : 28,3 to 35,9.10^{-3} Turb. : 1 to 4 NTU Oxyg. : 73,2 to 140 %

Berre lake	19.04.89 to 22.04.89	Orange-colored to brown water	*Prorocentrum minimum*	$9\ 950.10^3$ to $24\ 722.10^3$	Temper.: 13,4 to 16,1°C Salin. : 15,4 to $16,6.10^{-3}$ Turb. : 3,8 to 12 NTU Oxyg. : 102,7 to 108,4 %
	08.12.89 to 13.12.89	Red to dark brown water	*Skeletonema sp.* and *Prorocentrum micans*	206 200 46 600 to 151 000	?

FRANCE – ALGAL BLOOM REPORTS – 1990

Catherine BELIN *



The French coast is separated into 8 areas for description of harmful events caused by phytoplankton.

* IFREMER, B.P. 1049, 44037 Nantes cedex, France

ALGAL BLOOM REPORTS - FRANCE

1990

1. Locations :

NORTH COAST (area 1)
zone affected : The whole area.

2. Date of occurence : April and early May, 1990

3. Effects :

Green–brown water discoloration over an extensive area. Some foam at beach.

4. Managment Decisions :

Continued Surveillance.

5. Causative Species :

Phaeocystis globosa. Highest observed count : 50.10^6 cells. l^{-1}.

6. Environment :

Temperature : between 14°C and 18°C.

7. Advected population or in situ growth :

Both.

8. Previous occurrences :

Before 1973 : probably.

Since 1973 : every year.

9. Additionnal comments :

It seems there is a global increasing of the phenomenon, which is related to the increasing nutrient levels.

10. Individual to contact :

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(National contact)

and

Hubert GROSSEL
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B.P. 699
62231 BOULOGNE SUR MER
FRANCE
(Regional contact)

ALGAL BLOOM REPORTS - FRANCE

1990

1. Locations :

NORTH COAST (area 1)
zone affected : The north of Seine estuary.

2. Date of occurence : Mid July to the end of September, 1990

3. Effects :

DSP toxicity above safety level (maximum recorded toxicity : very high)

4. Managment Decisions :

Ban of shellfish marketing.

5. Causative Species :

Dinophysis spp (dominant *Dinophysis* cf *acuminata*) maximum cell counts : 68100 cells l^{-1} (Antifer harbour).

6. Environment :

7. Advected population or in situ growth :

Advected population from Seine plume.

8. Previous occurrences :

1983 (1.10^6 cells l^{-1}), 1984 (6.10^5), 1986 (71000), 1988 (55800), 1989 (15800).

9. Additionnal comments :

10. Individual to contact : Catherine BELIN
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(National contact)

ALGAL BLOOM REPORTS – FRANCE

1990

1. Locations :
NORMANDY AND NORTHERN BRITTANY (areas 2 and 3)
zone affected : The whole areas.

2. Date of occurence : March, 1990

3. Effects :

White and green–brownish water discoloration. The bloom probably started around Ouessant front, then spread out offshore Normandy coast.

4. Managment Decisions :

5. Causative Species :

Most likely a coccolithophoridae species.

6. Environment :

No data available.

7. Advected population or in situ growth :

No data available.

8. Previous occurrences :

Not since 1984.

9. Additionnal comments :

10. Individual to contact : Catherine BELIN
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ALGAL BLOOM REPORTS – FRANCE

1990

1. Locations :

NORMANDY (area 2)
zone affected : Calvados coast, near Orne estuary

2. Date of occurence : August 22 to September 5, 1990

3. Effects :

Green water discoloration – offshore extent : about 3 kms.

4. Managment Decisions :

Continued Surveillance

5. Causative Species :

Gymnodinium sp maximum cell counts : 5.10^8 cells l^{-1} (August 23), 23.10^7 cells l^{-1} (August 28), 50.10^6 cells l^{-1} (August 30).

6. Environment :

Temperature : 19 to 22°C

7. Advected population or in situ growth :

No available data

8. Previous occurrences :

1989 (130.10^6 cells l^{-1})

9. Additionnal comments :

10. Individual to contact :

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ALGAL BLOOM REPORTS - FRANCE

1990

1. Locations :

NORMANDY (area 2)
zone affected : Calvados coast, between Orne and Seulles estuaries.

2. Date of occurence : End of July to the end of August, 1990

3. Effects :

DSP toxicity above safety level (maximum recorded toxicity : high)

4. Managment Decisions :

Ban of shellfish marketing, from July 30 to August 27.

5. Causative Species :

Dinophysis spp (dominant Dinophysis cf acuminata) maximum cell counts : 19800 cells l^{-1} .

6. Environment :

7. Advected population or in situ growth :

Probably both

8. Previous occurrences :

1984 (56.10^3 cells l^{-1}), 1985 (2100), 1986 (40600), 1987 (17800), 1988 (13100), 1989 (12600).

9. Additionnal comments :

10. Individual to contact : Catherine BELIN
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FRANCE
(National contact)

ALGAL BLOOM REPORTS – FRANCE

1990

1. Locations :

NORTHERN BRITTANY (area 3)
zone affected : Penzé river, Morlaix river.

2. Date of occurence : Late June to late July, 1990

3. Effects :

PSP toxicity above safety level (maximum recorded toxicity : 159 $\mu g/100$ g.flesh in Penzé river, 151 $\mu g/100$ g.flesh in Morlaix river).

4. Managment Decisions :

Ban of shellfish marketing from June 26 to July 06 (Penzé river), from July 20 to July 27 (Morlaix river)

5. Causative Species :

Alexandrium minutum. Maximum cell counts = 25.10^5 cells. l^{-1} (Morlaix river), 133400 cells l^{-1} (Penzé river)

6. Environment :

7. Advected population or in situ growth :

In situ growth

8. Previous occurrences :

1989 (3.10^6 cells l^{-1}).

9. Additionnal comments :

10. Individual to contact :

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ALGAL BLOOM REPORTS - FRANCE

1990

1. Locations :

WESTERN NORMANDY - NORTHERN BRITTANY (area 3)
zone affected : Morlaix river.

2. Date of occurence : June 13 to June 22, 1990

3. Effects :

Reddish and brown water. The sheet of discolored water was located at first at the mouth of the river, then spread out into the river.

4. Managment Decisions :

Increased Surveillance

5. Causative Species :

Gonyaulax spinifera (highest count : 2300.10^3 cells l^{-1}) and Alexandrium minutum (2500 000 cells l^{-1})

6. Environment :

Temperature : 15 to 18°C
Salinity : 22 to 32.10^{-3}
Turbidity : 2,5 to 3,5 NTU

7. Advected population or in situ growth :

Probably in situ growth for Alexandrium minutum, which has developped in the river since 1989 (presence of cysts in silt). No data for Gonyaulax spinifera

8. Previous occurrences :

Alexandrium minutum : 1989 (3.10^6 cells l^{-1})

Gonyaulax spinifera : not since 1984

9. Additionnal comments :

No PSP toxicity at this time

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ALGAL BLOOM REPORTS - FRANCE

1990

1. Locations :

WESTERN NORMANDY - NORTHERN BRITTANY (area 3)
zone affected : Aber Benoit.

2. Date of occurence : June, 1990

3. Effects :

Yellow-brown water

4. Managment Decisions :

Continued Surveillance

5. Causative Species :

Chaetoceros socialis (observed count : x 10^6 cells l^{-1})

6. Environment :

Temperature : 18°C
Salinity : 31.10^{-3}
Turbidity : 2 NTU

7. Advected population or in situ growth :

No data available

8. Previous occurrences :

Not since 1984

9. Additionnal comments :

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ALGAL BLOOM REPORTS - FRANCE

1990

1. Locations :

WESTERN NORMANDY - NORTHERN BRITTANY (area 3)
zone affected : Elorn river.

2. Date of occurence : August 19–20, 1990

3. Effects :

Pinkish water discoloration

4. Managment Decisions :

Continued Surveillance

5. Causative Species :

Prorocentrum micans

6. Environment :

Salinity : $28–33.10^{-3}$
Turbidity : 2.9 to 9.1 NTU

7. Advected population or in situ growth :

Probably in situ growth

8. Previous occurrences :

1987 (10.10^6 cells l^{-1}), 1988 (2.10^6 cells l^{-1})

9. Additionnal comments :

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ALGAL BLOOM REPORTS - FRANCE

1990

1. Locations :

NORTHERN BRITTANY (area 3)
zone affected : Sein island and Douarnenez bay.

2. Date of occurence : Mid August to mid September, 1990

3. Effects :

DSP toxicity above safety level (maximum recorded toxicity : high)

4. Managment Decisions :

Ban of shellfish marketing, from August 10 to August 24 (Sein island), and to September 20 (Douarnenez bay).

5. Causative Species :

Dinophysis spp (including D. sacculus) maximum cell counts : 1100 cells l^{-1} .

6. Environment :

7. Advected population or in situ growth :

Probably in situ growth

8. Previous occurrences :

1983, 1984 (1600 cells l^{-1}), 1985 (8900 in Douarnenez bay), 1986 (Sein : 200, Douarnenez : 18300), 1987 (Douarnenez : 6100), 1988 (Douarnenez : 2800), 1989 (Sein : 5500, Douarnenez : 2700).

9. Additionnal comments :

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ALGAL BLOOM REPORTS – FRANCE

1990

1. Locations :
SOUTHERN BRITTANY AND ATLANTIC COAST BETWEEN LOIRE AND GIRONDE ESTUARIES(areas 4 and 5)
zone affected : offshore, from Morbihan gulf to Yeu island.

2. Date of occurence : May, 1990

3. Effects :

Great sheets of yellow–orange discolored water.

4. Managment Decisions :

Continued Surveillance.

5. Causative Species :

Probably Noctiluca scintillans.

6. Environment :

No data available.

7. Advected population or in situ growth :

No data available.

8. Previous occurrences :

1984, 1985, 1988, 1989.

9. Additionnal comments :

10. Individual to contact :

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ALGAL BLOOM REPORTS - FRANCE

1990

1. Locations :
SOUTHERN BRITTANY (area 4)
zone affected : Audierne bay.

2. Date of occurence : February, 1990
and November, 1990

3. Effects :

Brownish water discoloration (a sheet of about 5 000 m^2 in February).

4. Managment Decisions :

Continued Surveillance.

5. Causative Species :

Chaetoceros armatum. Maximum cell counts : 2500.10^3 cells. l^{-1} (February), $x.10^6$ cells. l^{-1} (November).

6. Environment :

Temperature : 10°C (November)
Salinity : 35.10^{-3} (February)
Turbidity : 40 N.T.U. (February)

7. Advected population or in situ growth :

Probably in situ growth.

8. Previous occurrences :

1989 (510.10^6 cells l^{-1}).

9. Additionnal comments :

Chaetoceros armatum blooms are often associated to hydrocarbon presence in this zone.

10. Individual to contact :

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ALGAL BLOOM REPORTS - FRANCE

1990

1. Locations :
SOUTHERN BRITTANY (area 4)
zone affected : Audierne bay, Concarneau bay, Aven and Belon rivers.

2. Date of occurence : Early June to mid July, 1990

3. Effects :

DSP toxicity above safety level (maximum recorded toxicity : middle).

4. Managment Decisions :

Ban of shellfish marketing, from June 07 to June 28 (Aven and Belon rivers), to July 06 (Audierne bay, to July 12 (Concarneau bay).

5. Causative Species :

Dinophysis spp (including D. sacculus) maximum cell counts : 1000 cells.l^{-1} (Audierne bay), 6400 cells l^{-1} (Concarneau bay) and 7600 cells l^{-1} (Aven and Belon rivers).

6. Environment :

7. Advected population or in situ growth :

Probably both.

8. Previous occurrences :

1985 (400 cells.l^{-1} in Concarneau bay), 1986 (Audierne : 1000, Concarneau : 15300, Aven and Belon : 11400), 1987 (Concarneau : 1100), 1988 (Concarneau : 700, Aven and Belon : 2400).

9. Additionnal comments :

10. Individual to contact :
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ALGAL BLOOM REPORTS – FRANCE

1990

1. Locations :
SOUTHERN BRITTANY (area 4)
zone affected : Aven river, Belon river, Concarneau bay, Quiberon bay.

2. Date of occurence : March 19 to March 24, 1990

3. Effects :

Red or black water discoloration.

4. Managment Decisions :

Continued Surveillance.

5. Causative Species :

Mesodinium rubrum.

6. Environment :

No data available.

7. Advected population or in situ growth :

No data available.

8. Previous occurrences :

Not since 1984.

9. Additionnal comments :

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ALGAL BLOOM REPORTS – FRANCE

1990

1. Locations :

SOUTHERN BRITTANY (area 4)
zone affected : Groix island and Etel river

2. Date of occurence : Mid June to early August, 1990

3. Effects :

DSP toxicity above safety level (maximum recorded toxicity : very high)

4. Managment Decisions :

Ban of shellfish marketing from June 15 to July 06 (Etel river), and to August 10 (Groix island)

5. Causative Species :

Dinophysis spp (including D. sacculus) maximum cell counts : 6500 cells l^{-1} (Groix island) and 1300 cells l^{-1} (Etel river).

6. Environment :

7. Advected population or in situ growth :

Probably both

8. Previous occurrences :

1985 (300 cells l^{-1} in Groix island), 1986 (Groix : 4900, Etel : 1600), 1988 (Groix : 1300, Etel : 3900), 1989 (Groix : 67400).

9. Additionnal comments :

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ALGAL BLOOM REPORTS - FRANCE

1990

1. Locations :

SOUTHERN BRITTANY (area 4)
zone affected : Belle Ile island

2. Date of occurence : Early June to mid July, 1990

3. Effects :

DSP toxicity above safety level (maximum recorded toxicity : high)

4. Managment Decisions :

Ban of shellfish marketing from June 06 to July 12

5. Causative Species :

Dinophysis spp (including D. sacculus) maximum cell count : 3600 cells l^{-1} .

6. Environment :

7. Advected population or in situ growth :

Probably both

8. Previous occurrences :

1986 (200 cells l^{-1}), 1988 (500).

9. Additionnal comments :

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ALGAL BLOOM REPORTS - FRANCE

1990

1. Locations :

SOUTHERN BRITTANY (area 4)
zone affected : Quiberon bay, Morbihan gulf, and Morbihan coast

2. Date of occurence : Mid June to late July, 1990

3. Effects :

DSP toxicity above safety level (maximum recorded toxicity : very high)

4. Managment Decisions :

Ban of shellfish marketing, from June 22 to July 26 (Quiberon bay), from June 29 to July 12 (Morbihan gulf), from June 15 to July 19 (Morbihan coast).

5. Causative Species :

Dinophysis spp (including D. sacculus) maximum cell counts : 800 cells l^{-1} (Quiberon bay), 700 cells l^{-1} (Morbihan gulf) and 300 cells l^{-1} (Morbihan coast).

6. Environment :

7. Advected population or in situ growth :

Probably both

8. Previous occurrences :

1986 (200 cells l^{-1} on Morbihan coast).

9. Additionnal comments :

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ALGAL BLOOM REPORTS – FRANCE

1990

1. Locations :

SOUTHERN BRITTANY (area 4)
zone affected : Penerf river, Vilaine bay, Croisic roads.

2. Date of occurence : Late May to Mid July, 1990

3. Effects :

DSP toxicity above safety level (maximum recorded toxicity : high)

4. Managment Decisions :

Ban of shellfish marketing, from June 15 to June 29 (Penerf river), from May 31 to July 16 (at least one part of Vilaine bay, and Croisic roads).

5. Causative Species :

Dinophysis spp (including D. sacculus) maximum cell counts : 4800 cells l^{-1} (Penerf river), 24400 cells l^{-1} (Vilaine bay) and 2100 cells l^{-1} (Croisic roads).

6. Environment :

7. Advected population or in situ growth :

Probably both

8. Previous occurrences :

1983, 1984 (x. 10^3 cells l^{-1}), 1986 (Penerf : 2300, Vilaine : 2400, Croisic : 1300), 1987 (Vilaine : 10700), 1988 (Vilaine : 20400).

9. Additionnal comments :

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ALGAL BLOOM REPORTS - FRANCE

1990

1. Locations :

FROM LOIRE ESTUARY TO GIRONDE ESTUARY (area 5)
zone affected : North of Loire estuary, Yeu island, Gachère river

2. Date of occurence : Early June to Mid August, 1990

3. Effects :

DSP toxicity above safety level (maximum recorded toxicity : very high)

4. Managment Decisions :

Ban of shellfish marketing, from May 31 to July 16 (North of Loire estuary), from June 07 to July 19 (Yeu island), from July 06 to August 22 (Gachère river).

5. Causative Species :

Dinophysis spp (including D. sacculus) maximum cell counts : 2100 cells l^{-1} (Yeu island), and 100 cells l^{-1} (Gachère river).

6. Environment :

7. Advected population or in situ growth :

Probably both

8. Previous occurrences :

1988 (Yeu : 200 cells l^{-1}).

9. Additionnal comments :

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ALGAL BLOOM REPORTS – FRANCE

1990

1. Locations :

FROM LOIRE ESTUARY TO GIRONDE ESTUARY (area 5)
zone affected : Daire coast (Charente estuary).

2. Date of occurence : May 16–17, 1990

3. Effects :

Orange water discoloration

4. Managment Decisions :

Continued Surveillance

5. Causative Species :

Noctiluca scintillans maximum cell count : 350 000 cells l^{-1}

6. Environment :

Temperature : 17°C
Salinity : 34.10^{-3}
Turbidity : 6 N.T.U.

7. Advected population or in situ growth :

8. Previous occurrences :

Not since 1984

9. Additionnal comments :

10. Individual to contact :

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ALGAL BLOOM REPORTS - FRANCE

1990

1. Locations :

SOUTH ATLANTIC COAST (area 6)
zone affected : Gironde estuary, between Royan and Talmont.

2. Date of occurence : August 19–20, 1990

3. Effects :

Brown to dark water discoloration.

4. Managment Decisions :

Continued Surveillance.

5. Causative Species :

Heterocapsa triquetra (8 to 12.10^6 cells.l–1) and Peridinium trochoïdeum (3.10^6 cells.l–1).

6. Environment :

No data available.

7. Advected population or in situ growth :

No data available.

8. Previous occurrences :

Not since 1984.

9. Additionnal comments :

10. Individual to contact :

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ALGAL BLOOM REPORTS – FRANCE

1990

1. Locations :

SOUTH ATLANTIC COAST (area 6)
zone affected : Hossegor lake.

2. Date of occurence : September, 1990

3. Effects :

Red–brown water discoloration

4. Managment Decisions :

Continued Surveillance

5. Causative Species :

Prorocentrum minimum (664 000 cells l^{-1})
presence of Dinophysis reniformis (64 000 cells l^{-1})

6. Environment :

Temperature : 21°C
Salinity : 31.10^{-3}

7. Advected population or in situ growth :

In situ growth

8. Previous occurrences :

1987 (95 00 $.10^{3}$ cells l^{-1})

9. Additionnal comments :

10. Individual to contact :

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ALGAL BLOOM REPORTS - FRANCE

1990

1. Locations :

WESTERN MEDITERRANEAN SEA (area 7)
zone affected : Languedoc–Roussillon coast

2. Date of occurence : Early June to Mid July, 1990

3. Effects :

DSP toxicity above safety level (maximum recorded toxicity : high)

4. Managment Decisions :

Ban of shellfish marketing, from June 06 to July 12 (at least one part of Languedoc–Roussillon coast).

5. Causative Species :

Dinophysis spp (including D. sacculus) maximum cell counts : 2400 cells l^{-1}.

6. Environment :

7. Advected population or in situ growth :

No data available

8. Previous occurrences :

1987 (2400 cells l^{-1}), 1989 (6800).

9. Additionnal comments :

10. Individual to contact : Catherine BELIN
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ALGAL BLOOM REPORTS - FRANCE

1990

1. Locations :

WESTERN MEDITERRANEAN SEA (area 7)
zone affected : Thau lake

2. Date of occurence : July 30 to August 1, 1990

3. Effects :

Green water discoloration.

4. Managment Decisions :

Continued Surveillance

5. Causative Species :

Oscillatoria chalybea (650 000 cells l^{-1}).

6. Environment :

Temperature : 29°C
Salinity : 36.10^{-3}

7. Advected population or in situ growth :

Probably in situ.

8. Previous occurrences :

Not since 1984.

9. Additionnal comments :

Very rainy weather the days before.

10. Individual to contact :

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ALGAL BLOOM REPORTS - FRANCE

1990

1. Locations :

WESTERN MEDITERRANEAN SEA (area 7)
zone affected : Fos gulf

2. Date of occurence : Mid May to late June, 1990

3. Effects :

DSP toxicity above safety level (maximum recorded toxicity : very high)

4. Managment Decisions :

Ban of shellfish marketing, from May 16 to June 29.

5. Causative Species :

Dinophysis spp (including D. sacculus) maximum cell counts : 1200 cells l^{-1}.

6. Environment :

7. Advected population or in situ growth :

No data available

8. Previous occurrences :

1985 (4700 cells l^{-1}), 1987 (1400), 1989 (9400).

9. Additionnal comments :

10. Individual to contact : Catherine BELIN
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ALGAL BLOOM REPORTS - FRANCE

1990

1. Locations :

WESTERN MEDITERRANEAN SEA (area 7)
zone affected : Berre–Vaine lake

2. Date of occurence : May 12–14, 1990

3. Effects :

Red–brown water discoloration.

4. Managment Decisions :

Continued Surveillance

5. Causative Species :

Prorocentrum micans .

6. Environment :
Temperature : 23°C
Salinity : 19.10^{-3}
Turbidity : 1,2 N.T.U.
Dissolved oxygen : 6,7 mg l^{-1}

7. Advected population or in situ growth :

Probably in situ growth

8. Previous occurrences :

1989.

9. Additionnal comments :

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ALGAL BLOOM REPORTS – FRANCE

1990

1. Locations :

EASTERN MEDITERRANEAN SEA (area 8)
zone affected : Toulon roads.

2. Date of occurence : May, 1990

3. Effects :

Red water discoloration – PSP toxicity just at the safety level (80 μg/100 g.flesh)

4. Managment Decisions :

Increased Surveillance.

5. Causative Species :

Alexandrium minutum maximum cell counts : 18.10^7 cells l^{-1}.

6. Environment :

7. Advected population or in situ growth :

No data available.

8. Previous occurrences :

No.

9. Additionnal comments :

10. Individual to contact : Catherine BELIN
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ALGAL BLOOM REPORTS - FRANCE

1990

1. Locations :

EASTERN MEDITERRANEAN SEA (area 8)
zone affected : Urbino pond (Corsica)

2. Date of occurence : Late May to late June, 1990

3. Effects :

DSP toxicity above safety level (maximum recorded toxicity : high)

4. Managment Decisions :

Ban of shellfish marketing, from May 29 to June 22.

5. Causative Species :

Dinophysis spp (including D. sacculus) maximum cell counts : 600 cells l^{-1}.

6. Environment :

7. Advected population or in situ growth :

Probably in situ growth

8. Previous occurrences :

1988 (5300 cells l^{-1}).

9. Additionnal comments :

10. Individual to contact : Catherine BELIN
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HARMFUL ALGAL BLOOMS IN 1989 - SPAIN

1. Location : Ria de Ares (NW of Spain).

2. Dates of occurrence : July-August 1989.

3. Effects : No toxicity was detected.

4. Management Decisions :

5. Causative Species : *Alexandrium tamarensis* was observed on 28th July reaching 3200 cel/l on 4th August.

6. Environment :

7. Advected population or in situ growth :

8. Previous occurrences :

9. Additional comments :

10. Individual to contact : Joaquin Mariño, Instituto Español Oceanografia, Aptdo 130, 15080 La Coruña, Spain.

HARMFUL ALGAL BLOOMS IN 1989 - SPAIN

1. Location : Ria de Ares (NW of Spain).

2. Dates of occurrence : May-November 1989.

3. Effects : DSP toxicity was detected from 12 Setember until the end of October.

4. Management Decisions : Collection and sale of bivalves was forbidden.

5. Causative Species : *Dinophysis acuminata* was observed from 3 May to 13 November reaching 6700 cel/l on 26th Setember.

6. Environment :

7. Advected population or in situ growth :

8. Previous occurrences :

9. Additional comments :

10. Individual to contact : Joaquin Mariño, Instituto Español Oceanografia, Aptdo 130, 15080 La Coruña, Spain.

HARMFUL ALGAL BLOOMS IN 1989 - SPAIN

1. Location : Rias Bajas Gallegas (Vigo,Pontevedra,Arosa and Muros).

2. Dates of occurrence : Summer and autumn 1989.

3. Effects : DSP was detected in mussels cultivated on rafts on 8th August and it continued during the autumn until the first week of December, coinciding with a PSP episode during October and November.
Intraperitoneal mouse test.

4. Management Decisions : Collection and sale of bivalves was forbidden.

5. Causative Species : Several species of *Dinophysis* were observed during this episode. *D. acuminata* from 2 May to 2 November reaching 2360 cel/l on 13th July in Ria de Vigo. The most abundant species was *D. acuta*, which was observed from 13 July to 4 Dicember reaching 22760 cel/l on 31th August in Ria de Vigo. Other species of *Dinophysis* (*D.rotundata*, *D.caudata* and *D.tripos*) appeared in lower concentrations.

During the summer , *Dinophysis* cells represented only a small fraction of the total phytoplankton population.

Sampling was carried out with a hose-sampler (recommended by I.C.E.S., WG of 1986) at 0-5, 5-10 and 10-15 m.

6. Environment : Normal surface temperatures in the summer are 15-18°C due to upwelling, this year temperatures remained high and reached values above 21 C in August. Salinity is aproximatly 35 ‰. In July and above all in August there were strong thermal gradients between 0 and 20 m, in September the stratification varied depending on upwelling pulses and the water column was almost isothermal since the second half of October.

7. Advected population or in situ growth : Both mecanisms could occur. *Dinophysis acuta* concentrations are usually higher offshore, and they seem to be pushed into the rias when winds change from northerly to southerly. This mecanism is suggested for *D. acuta* in the autumn in the Rias Bajas. The summer populations of this species and *D. acuminata* seem to be growing autochthonusly in the outer parts of the rias. .

8. Previous occurrences : *D. acuta* and *D.acuminata* has been found in the Rias Gallegas since the begining of the monitoring programe in 1977 and sometimes linked to DSP episodes. In 1988,1989 and 1990 both species were associated with the presence of DSP episides.

9. Additional comments: More information in: Reguera et al, 1990. " Distribution of Dinophysis acuta at the time of a DSP outbreak in the rias of Pontevedra and Vigo (Galicia, NW Spain)". I.C.E.S. 1990. CM. 1990/L:14.

10. Individual to contact Isabel Bravo, Santiago Fraga, Joaquin Mariño and Beatriz Reguera, Instituto Español de Oceanografía.

HARMFUL ALGAL BLOOMS IN 1989 - SPAIN

1. Location : Rias Bajas Gallegas (Vigo,Pontevedra,Arosa and Muros).

2. Dates of occurrence : Autumn 1989.

3. Effects : PSP detected in mussels cultivated in rafts,reaching more than 80 ugr equiv. STX /100 gr. meat only during November. AOAC method.

4. Management Decisions : Collection and sale of molluscs was forbidden.

5. Causative Species : *Gymnodinium catenatum* was observed from 8 August to 13 December reaching 4800 cel/l on 26th October in Ria de Vigo.

Sampling was carried out with a hose-sampler (recommended by I.C.E.S., WG of 1986) at 0-5, 5-10 and 10-15 m.

6. Environment : Surface temperature were 15-16° C. Normal salinity in this area is aproximately 35 ‰. .At the begining of the season the stratification varied depending on upwelling pulses. The water column was almost isothermal since the second half of October.

7. Advected population or in situ growth : It is suggested that *G. catenatum* in this season is introduced into the rias when upwelling ceases and offshore surface waters are pushed onshore by the southerly winds.

8. Previous occurrences : In October and November 1976 the first PSP outbreak was detected in this area, it was caused probably by *G. catenatum* bloom. This species has appeared in the Rias Bajas Gallegas in association with PSP episodes every year since 1985.

9. Additional comments : The PSP episode coincided with a DSP outbreak on the same area associated with the presence of *Dinophysis acuta*.

10. Individual to contact : Isabel Bravo, Santiago Fraga, Beatriz Reguera, Instituto Español de Oceanografía, Aptdo 1552, 36280 Vigo, Spain. Joaquin Mariño, Instituto Español de Oceanografía, Aptdo 130, La Coruña, Spain.

HARMFUL ALGAL BLOOMS IN 1989 - SPAIN

1. Location : Ria de Pontevedra and Ria de Arosa.

2. Dates of occurrence : October and November 1989.

3. Effects : No toxicity was detected.

4. Management Decisions :

5. Causative Species : *Heterosigma akasiwo* was observed from October to November reaching 3000000 cel/l in Ria of Arosa on 9 November.

6. Environment :

7. Advected population or in situ growth :

8. Previous occurrences :

9. Additional comments :

10. Individual to contact : Isabel Bravo, Santiago Fraga, Beatriz Reguera, Instituto Español de Oceanografía, Aptdo 1552, 36280 Vigo, Spain. Joaquin Mariño, Instituto Español de Oceanografía, Aptdo 130, 15080 La Coruña, Spain.

HARMFUL ALGAL BLOOMS IN 1989 - SPAIN

1. Location: Bays of Ebro Delta

2. Dates of occurrence: May 1989

3. Effects: Red-coloured waters, PSP detected in mussels.
   Toxin (mouse bioassay method; AOAC, 1989) in mussels reached 110 µg/100 g meat.
   Not known human or animal illnesses.

4. Management Decisions: Extraction of shellfish was closed in all the Ebro Delta area until 25 May.

5. Causative Species: *Alexandrium minutum* Halim, concentration up to 28 x 10^6 cells l^{-1}. Co-occurring species: *Prorocentrum triestinum*, *Eutreptiella* sp.

6. Environment:
   Temperature of water at the begining of the detection 14-16 °C.
   Salinity range 34-37
   Water column stratificated

7. Advected population or in situ growth: ?

8. Previous occurrences: None. It is the first citation of PSP and the first known occurrence of *Alexandrium minutum* in the Catalan Coast.

9. Aditional comments: Delgado et al. 1990. Development of a toxic *Alexandrium minutum* Halim (Dinophyceae) bloom in the harbour of Sant Carles de la Rápita (Ebro Delta, northwestern Mediterranean). *Scientia Marina* 54(1): 1-7.

10. Individual to contact: Maximino Delgado
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    Pº Nacional S/N
    08039 Barcelona, Spain

HARMFUL ALGAL BLOOMS IN 1989 - SPAIN

1. Location : Coast between Malaga and Bahia de Algeciras.

2. Dates of ocurrence : January-February 1989.

3. Effects : PSP detected in shellfish. Toxin levels in the clam *Callista chione* reached 200 ugr. equiv. STX/100 gr. meat (mouse biossay method, AOAC).
No water colouration.

4. Management Decision : Collection and sale of bivalves was forbidden.

5. Causative species : Between 7 February and 10 March, samples were collected at 0, 5 and 10 m . *Gymnodinium catenatum* was suggested as the PSP agent. Cells of this species were not isolated nor cultured in order to confirm their toxicity. No other species were found which have been responsible for causing PSP toxicity elsewhere in the world. *Gymnodinium catenatum* reached 3000 cel/l , the dominant species was *Gonyaulax polygramma*, the rest of the phytoplancton composition was diatoms.

7. Advected population or in situ growth : It might be possible that this species enter through the Straits of Gibraltar. Atlantic surface water flows into the Mediterranean Sea through that straits, amd high salinity Mediterranean waters flows into the Atlantic below it. Thus, this area is an important mixing zone for these two water bodies.

8. Previous occurrences : In November 1987 PSP toxins were detected in samples of *Venus verrucosa* from the same area.

9. Additional comments : PSP toxicity was found in *Cerastoderma tuberculata* imported from Marrocco in February 1989. More information in: Bravo et al, 1990, " First report of *Gymnodinium catenatum* Graham on the Spanish Mediterranean Coast"

10. Individuals to Contact : Isabel Bravo, Santiago Fraga and Beatriz Reguera, Instituto Español de Oceanografia, Apdo 1552, 36280 Vigo. Ana Martinez Ministerio de Sanidad y Consumo, Apdo 90, 36280 Vigo, Spain.

HARMFUL ALGAL BLOOMS IN 1990 - SPAIN

1. Location : Ria de Ares (NW of Spain).

2. Dates of occurrence : June 1990.

3. Effects : No toxicity was detected. No water colouration.

4. Management Decisions :

5. Causative Species : Concentrations of 5000 cel/l of Alexandrium lusitanicum was observed on 11th June.

6. Environment :

7. Advected population or in situ growth :

8. Previous occurrences :

9. Additional comments :

10. Individual to contact : Joaquin Mariño, Instituto Español Oceanografia, Aptdo 130, 15080 La Coruña, Spain.

HARMFUL ALGAL BLOOMS IN 1990 - SPAIN

1. Location : Ria de Ares (NW of Spain).

2. Dates of occurrence : May-June 1990.

3. Effects : No toxicity was detected.

4. Management Decisions :

5. Causative Species : *Dinophysis acuminata* and *D. sacculus* were observed on 11 May (3000 cel /l) reaching 13200 cel/l on 5 May.

6. Environment :

7. Advected population or in situ growth :

8. Previous occurrences :

9. Additional comments :

10. Individual to contact : Joaquin Mariño, Instituto Español Oceanografia, Aptdo 130, 15080 La Coruña, Spain.

HARMFUL ALGAL BLOOMS IN 1990 - SPAIN

1. Location : Rias Bajas Gallegas (Vigo,Pontevedra,Arosa and Muros).

2. Dates of occurrence : Summer and autumn 1990.

3. Effects : DSP was detected in mussel cultivated on rafts on 9 July and it continued until October coinciding with a PSP episode which finished on 7 November.
Intraperitoneal mouse test.

4. Management Decisions : Collection and sale of bivalves was forbidden.

5. Causative Species : Several species of *Dinophysis* were observed during this episode. *D. acuminata,* from 5 June to 29 October, reaching 23000cel/l in Ria de Muros on 1 August. In the Rias of Vigo, Pontevedra and Arosa, the more abundant species was *D. acuta* from July to November (35500 cel/l on August). Other species of *Dinophysis* (*D.rotundata*, *D.caudata* and *D.tripos*) occurred in lower concentrations. *Dinophysis* cells comprised a small percentage of the total phytoplankton.

Sampling was carried out with a hose-sampler (recommended by I.C.E.S., WG of 1986) at 0-5, 5-10 and 10-15 m.

6. Environment : Normal surface temperatures in this area in summer and autumn are 15-18°C, in some ocasions may go above 21°C. Salinity is round 35 ‰. In July and in August there was an strong thermal gradient between 0 and 15 m with the most marked stratification at the end of July.

7. Advected population or in situ growth : Both mecanisms could occur. *Dinophysis acuta* concentrations are usually higher offshore, and they seem to be pushed into the rias when winds change from northerly to southerly. This mecanism is suggested for *D. acuta* in the autumn in the Rias Bajas. The summer populations of this species and *D. acuminata* seem to be growing autochthonusly in the outer parts of the rias.

8. Previous occurrences : *D. acuta* and *D.acuminata* has been found in the Rias Gallegas since the begining of the monitoring programe in 1977 and sometimes linked to DSP episodes. In 1988,1989 and 1990 both species were associated with the presence of DSP episides.

10. Individual to contact : Isabel Bravo, Santiago Fraga, Beatriz Reguera, Instituto Español de Oceanografía, Aptdo 1552, 36280 Vigo, Spain. Joaquin Mariño, Instituto Español de Oceanografía, Aptdo 130, La Coruña, Spain.

HARMFUL ALGAL BLOOMS IN 1990 - SPAIN

1. Location : Rias Bajas Gallegas (Vigo, Pontevedra, Arosa and Muros).

2. Dates of occurrence : From July to October 1990.

3. Effects : PSP values measured in cultivated mussels (rafts) and other bivalves from natural bancs (clams, cockles, etc) were more than 80 ugr equiv. STX/100 gr. meat from 29 Setember to 4 October. Mouse bioassay method, AOAC.

4. Management Decisions : Collection and sale of bivalves was forbidden.

5. Causative Species : Gymnodinium catenatum was observed between 3 July until 29 October, reaching 118000 cel/l on 2 October. Sampling was carried out with a hose-sampler (recommended by I.C.E.S., WG of 1986) at 0-5, 5-10 and 10-15 m.

6. Environment : Normal surface temperatures in this area during the summer and autumn are 15-18°C. Excepcionally , it can reach values of 21°C. Salinity is around 35 ‰. . In July and August there was a a strong thermal gradient between 0 and 15 m. Stratification was maximal at the end of July. The water column was well mixed from the begining of October onwards.

7. Advected population or in situ growth : The highest concentrations were found on the outermost stations and in the more southener Rias (Vigo and Pontevedra). It is suggested that warm offshore surface water was transported into the ria as the summer upwelling ceased pushing G. catenatum populations onshore.

8. Previous occurrences : In October and November 1976 was the first PSP outbreak detected in this area. It was probably caused by a G. catenatum bloom. This species has appeared in the Rias Bajas Gallegas in association with PSP episodes each year since 1985.

9. Additional comments : The PSP episode coincided with a DSP outbreak, associated with the presence of Dinophysis acuta and D. acuminata.

10. Individual to contact : Isabel Bravo, Santiago Fraga, Beatriz Reguera, Instituto Español de Oceanografía, Aptdo 1552, 36280 Vigo, Spain. Joaquin Mariño, Instituto Español de Oceanografía, Aptdo 130, La Coruña, Spain.

HARMFUL ALGAL BLOOMS IN 1990 - SPAIN

1. Location : Mediterranean coast of Spain (Valencia).

2. Dates of occurrence : August 1990.

3. Effects : No toxicity was detected.

4. Management Decisions :

5. Causative Species : *Gonyaulax cf turbiney* (15420 cel/ml), *Nitzschia sp* (19600 cel/ml) and others species of diatoms and dinoflagellates (*Gymnodinium catenatum* 1680 cel/ml)

6. Environment :

7. Advected population or in situ growth :

8. Previous occurrences :

9. Additional comments : The phytoplankton growth was accompanied by muccus production, therefore the bloom originated gelatinous aggregations that affected touristic beaches.

10. Individual to contact : Isabel Bravo, Instituto Español de Oceanografía, Aptdo 1552, 36280 Vigo, Spain.

HARMFUL ALGAL BLOOMS IN 1990 -SPAIN

1. Location: Coasts of the Ebro Delta area.

2. Dates of occurrence: August 1990

3. Effects: Brown-coloured waters near the coast line, clogging the fhising nets. Economic losses on fishing.

4. Management Decisions: Collection of samples in all the Ebro Delta area to asess the effects on shellfish cultures.

5. Causative Species: *Thalassiothrix mediterranea* Pavillard, reaching concentrations up to 10^6 cells l^{-1}.

6. Environment: Stratification of the water column.

7. Advected population or in situ growth:

8. Previous occurrences:

9. Aditional comments:

10. Individual to contact: Maximino Delgado
Instituto de Ciencias del Mar
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HARMFUL ALGAL BLOOMS IN 1990 - SPAIN

1. Location: Alfacs Bay (Ebro Delta)

2. Dates of occurrence: January 1990

3. Effects: PSP detected in mussels.
   Toxin (mouse bioassay method; AOAC, 1989) in mussels under 50 µg/100 g meat (permisive level in Spanish normative: 80 µg/100 g meat).
   Not known human or animal illnesses.

4. Management Decisions: To intensify the control.

5. Causative Species: *Alexandrium minutum* Halim

6. Environment: Abnormal calm wheather during this winter, resulting in stratification of the water column.
   Water temperature: 14-16 °C
   Salinity range: 34-37

7. Advected population or in situ growth:

8. Previous occurrences: May 1989 in the same area.

9. Aditional comments:

10. Individual to contact: Maximino Delgado
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    08039 Barcelona, Spain

HARMFUL ALGAL BLOOMS IN **1990** - SPAIN

1. Location: Ebro Delta

2. Dates of occurrence: February 1990 in Alfacs Bay and July 1990 in Fangar Bay.

3. Effects: DSP (mouse bioassay) toxitity in low levels (close to the detection level).

4. Management Decisions: To intensify the control.

5. Causative Species: *Dinophysis acuminata* and *D. acuta*, with maximal concentration of 13 cells ml^{-1} during the year.

6. Environment: Stratification of the water column.
Temperature range: 14-20 °C
Salinity range: 34-37

7. Advected population or in situ growth:

8. Previous occurrences: None

9. Aditional comments:

10. Individual to contact: Maximino Delgado
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HARMFUL ALGAL BLOOMS IN 1990 -SPAIN

1. Location: Beach of Benicasim (Castellón)

2. Dates of occurrence: July 1990

3. Effects: Accumulation of foam over the beach.

4. Management Decisions: To close the beach for recreative activities (tourism).

5. Causative Species: *Phaeocystis pouchetii* (Harriot) Laherheim

6. Environment:

7. Advected population or in situ growth:

8. Previous occurrences: None. It is the first known citation of this phenomenon in the area.

9. Aditional comments: Usual organism in the nearbouring marine area, but without previous notices to produce blooms in such area.

10. Individual to contact: Maximino Delgado
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ICES W.G. ON PHYTOPLANKTON AND THE MANAGEMENT OF THEIR EFFECTS

VIGO, SPAIN 18-21 MARCH 1991

PORTUGAL, ANNUAL REPORT 1989

PSP

1 - Locations:

a) Setubal - Coastal zone

b) Figueira da Foz - (Pranto river and Mondego estuary)

c) Aveiro: Vouga estuary

d) Matosinhos - Coastal zone

2 - Dates of occurrences:

a) September

b) Pranto river : January - December
Mondego estuary : September - October

c) Vouga estuary : August - September

d) Matosinhos : October

3 - Effects:

All bivalve molluscs affected
No human illnesses

4 - Management decisions:

a)	Shellfish	fisheries	closed	September
b)	"	"	"	Pranto river all year Mondego estuary May Nov. due to DSP
c)	"	"	"	May-November due to DSP
d)	"	"	"	June-October due to DSP

.../

5 - Causative species:

Gymnodinium catenatum in all areas

Max. concentrations:

a) 80 ug/100 g. - 3000 cells/l

b) 116 ug/100 g. - 7500 cells/l

c) 252 ug/100 g. - 25000 cells/l

d) 106 ug/100 g. - 28000 cells/l

6 - Environment:

Temperature 14 - 24° C

Salinity 24 - 36‰

7 - Advected population or in situ growth:

In situ growth

8 - Previous occurrences:

Common species since 1980.

First confirmed PSP problem 1986

9 - Additional comments:

10 - Individual to contact:

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ICES W. G. ON PHYTOPLANKTON AND THE MANAGEMENT OF THEIR EFFECTS

VIGO, SPAIN 18-21 MARCH 1991

PORTUGAL, ANNUAL REPORT 1989

DSP

1 - Locations:

a) Setubal (Coastal zone and Albufeira Lagoon)

b) Peniche (S.Martinho Bay and Obidos Lagoon)

c) Figueira da Foz (Pranto river and Mondego estuary)

d) Aveiro (Vouga estuary and coastal zone)

e) Matosinhos (Coastal zone)

2 - Dates of occurrences:

a) July - August

b) July - October

c) Pranto river January - October
Mondego estuary: May - November

d) Vouga estuary: May - November
Coastal zone: June - October

e) June - October

3 - Effects:

All bivalve molluscs affected
No human illnesses

.../

5 - <u>Causative species</u>:

Gymnodinium catenatum in all areas

Max. concentrations:

a) 80 ug/100 g. - 3000 cells/l

b) 116 ug/100 g. - 7500 cells/l

c) 252 ug/100 g. - 25000 cells/l

d) 106 ug/100 g. - 28000 cells/l

6 - <u>Environment</u>:

Temperature 14 - 24° C

Salinity 24 - 36‰

7 - <u>Advected population or *in situ* growth</u>:

In situ growth

8 - <u>Previous occurrences</u>:

Common species since 1980.

First confirmed PSP problem 1986

9 - <u>Additional comments</u>:

10 - <u>Individual to contact</u>:

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9 - Addicional comments:

10 - Individual to contact:

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ICES W.G. ON PHYTOPLANKTON AND THE MANAGEMENT OF THEIR EFFECTS

VIGO, SPAIN 18-21 MARCH 1991

PORTUGAL, ANNUAL REPORT 1989

PHYTOPLANKTON BLOOM WITH MORTALITIES

1 - Location:

Obidos Lagoon

2 - Dates of occurrence:

June 23-30

3 - Effects:

Some mortalities mainly cockles

4 - Management Decisions:

Fisheries closed

5 - Causative species:

Heterosigma akashiwo - Max. recorded concentration 15 x 10^6 cells/l

6 - Environment:

Temperature: 18 - 20^{o} C

Salinity : 33 - 36‰

Brown water, fish avoid the discoloured water

7 - Advected population or in situ growth

In situ growth

8 - Previous occurrences

Some red waters 1982, 1988 at coastal waters.

Mortalities in closed systems like aquaculture ponds 1987, 1988.

9 - Additional comments:

10 - Individual to contact:

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ICES W.G. ON PHYTOPLANKTON AND THE MANAGEMENT OF THEIR EFFECTS

VIGO, SPAIN, 18-21 MARCH 1991

PORTUGAL, ANNUAL REPORT 1990

PSP

1 - Location:

a) Figueira da Foz - Pranto river

b) Aveiro - Vouga estuary
Coastal zone

c) Matosinhos - Coastal zone

2 - Dates of occurrences:

a) May - October

b) Vouga estuary : September - October
Coastal zone : Augusto - October

c) August - October

3 - Effects

All bivalve molluscs affected
No human illnesses

4 - Management decisions:

a) Shellfish fisheries closed: May - November due to DSP

b) " " " : April - November due to DSP

c) " " " : April - November due to DSP

5 - Causative species:

a) Gymnodinium catenatum — Max. conc. 2000 cells/l
PSP - 91.9 ug/100 g.

b) " " — Max. conc. 106000 cells/l
PSP 1221.4 ug/100 g. at Vouga estuary

Max. conc. 4500 cells/l
PSP 254.1 ug/100 g. at coastal zone

c) " " — Max. conc. 14050 cells/l
PSP 364.9 ug/100 g.

6 - Environment:

Temperature 15° - 18° C

Salinity 30° - 35‰

7 - Advected population or in situ growth:

- At region a) Figueira da FOz, Pranto river in situ growth most probably
- At regions b) and c) Aveiro and Matosinhos probably a combination of processes.

8 - Previous occurrences:

Since 1986 there are PSP occurrences due to Gymnodinium catenatum.

9 - Additional comments:

This year although the problem was more restricted in affected coastal areas the highest recorded toxicity was higher than in 1987, 1988 or 1989.

10 - Individual to contact:

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ICES W.G. ON PHYTOPLANKTON AND THE MANAGEMENT OF THEIR EFFECTS

VIGO, SPAIN, 18-21 MARCH 1991

PORTUGAL, ANNUAL REPORT 1990

DSP

1 - Location:

a) Algarve - Portimão - Arado estuary

b) Setúbal - Coastal zone

c) Lisbon - Coastal zone

d) Peniche - Obidos Lagoon

e) Figueira da Foz - Pranto river and Mondego estuary

f) Aveiro - Vouga estuary and coastal zone

g) Matosinhos - Coastal zone

2 - Dates of occurrences:

a) May - June

b) May - September

c) July

d) August

e) Pranto river - May - August
Mondego estuary - June-October

f) April - October

g) April - October

3 - Effects:

All bivalve molluscs affected

No human illnesses

4 - Management decisions:

a) Shellfish fisheries closed: May-November due to *E. coli* high values

b) " " " : May - October

c) " " " : July - August

d) " " " : August

e) " " " : May - November

f) " " " : April - November

g) " " " : April - November

No human illnesses

5 - Causative species:

a) *Dinophysis spp* mainly *D. acuminata*, *D. caudata*, *D. sacculus*
max. concentration 1600 cells/l

b) " " mainly *D. acuminata*, *D. caudata*, *D. acuta*
max. concentration 600 cells/l

c) " " mainly *D. caudata*
max. concentration 1100 cells/l

d) " " mainly *D. caudata*, *D. rotundata*
max. concentration 1300 cells/l

e) " " mainly *D. acuta*, *D. rotundata*
max. concentration 1600 cells/l

f) " " Vouga estuary mainly *D. acuta*, *D. acuminata*, *D. caudata*
max. concentration 28400 cells/l
Coastal zone mainly *D. acuminata*, *D. acuta*
max. concentration 19900 cells/l

g) " " mainly *D. acuminata*, *D. acuta*
max. concentration 4900 cells/l

6 - Environment:

Temperature 14^{o} - 23^{o} C

Salinity 24^{o} - 36‰

7 - Advected population or *in situ* growth:

In situ growth

8 - Previous occurrences :

They are common species in portuguese waters, since 1987 DSP problems have been recorded in region b), c), d), e) and g).
First record of DSP at Algarve coast a).

9 - Additional comments:

Detection of DSP is happening each year early mainly at the North coast in regions f) and g) Aveiro and Matosinhos.

10 - Individual to contact :

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PORTUGAL MONITORING DATA 1986 - 1990

PSP Yearly periods of toxicity above safety action level

80µ/100g ·

MATOSINHOS

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Max. PSP µg/100g
1986										—	—		1595
87								—					95
88											—		127
89										—			116
90								—	—	—			364

AVEIRO

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Max. PSP µg/100g
1986										—	—	—	1436
87													
88								—	—	—	—	—	170
89								—	—				252
90								—	—	—			1221

FIGUEIRA DA FOZ

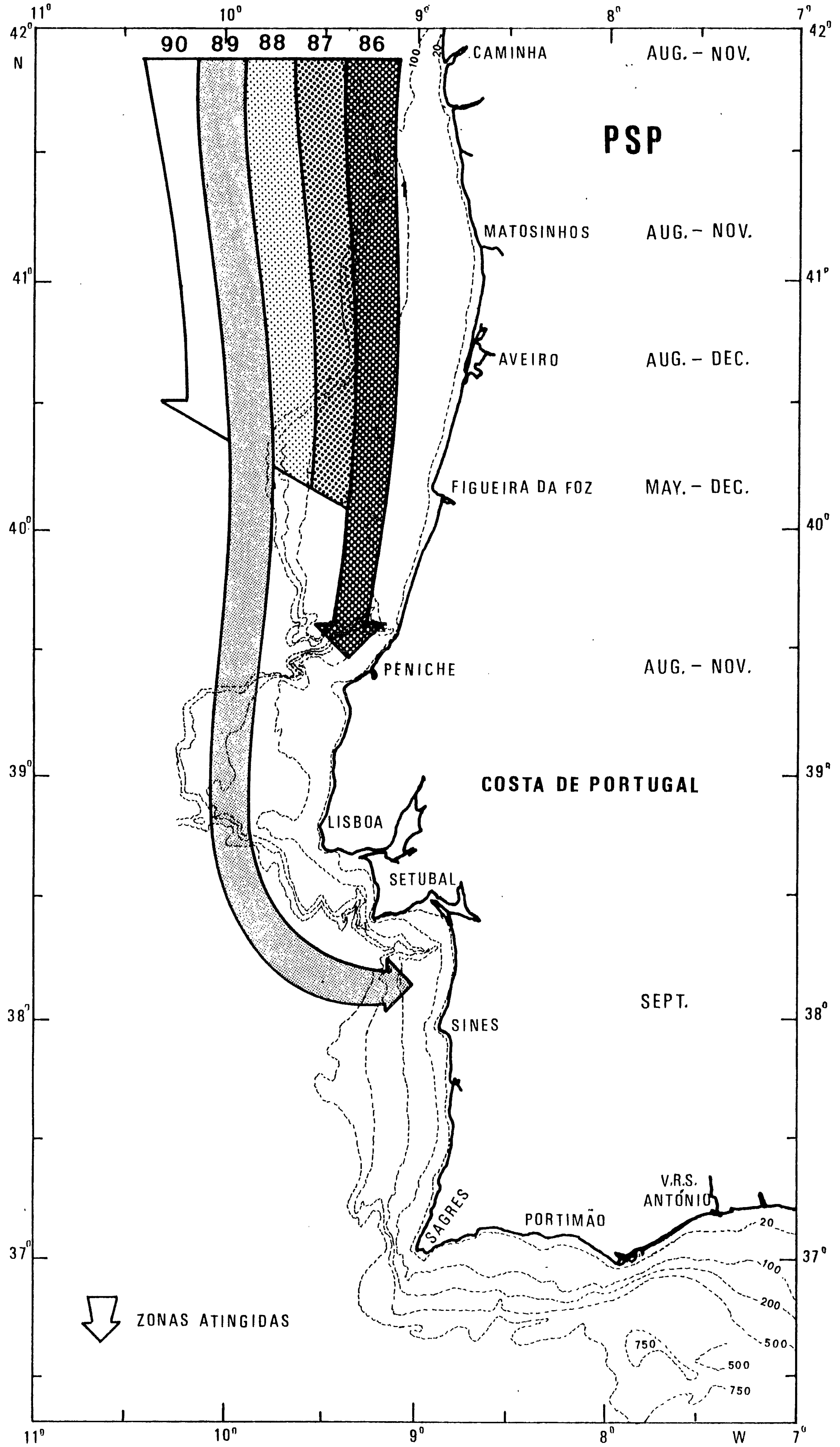
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Max. PSP µg/100g
1986										—	—		418
87									—	—	—	—	218
88								—	—	—	—	—	178
89	—			—	—	—		—	—	—	—	—	275
90					—								92

LAGOA DE OBIDOS

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Max. PSP µg/100g
1986										—	—		1100
87													
88													
89													
90													

SETUBAL

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Max. PSP µg/100g
1986													
87													
88													
89									—				80
90													



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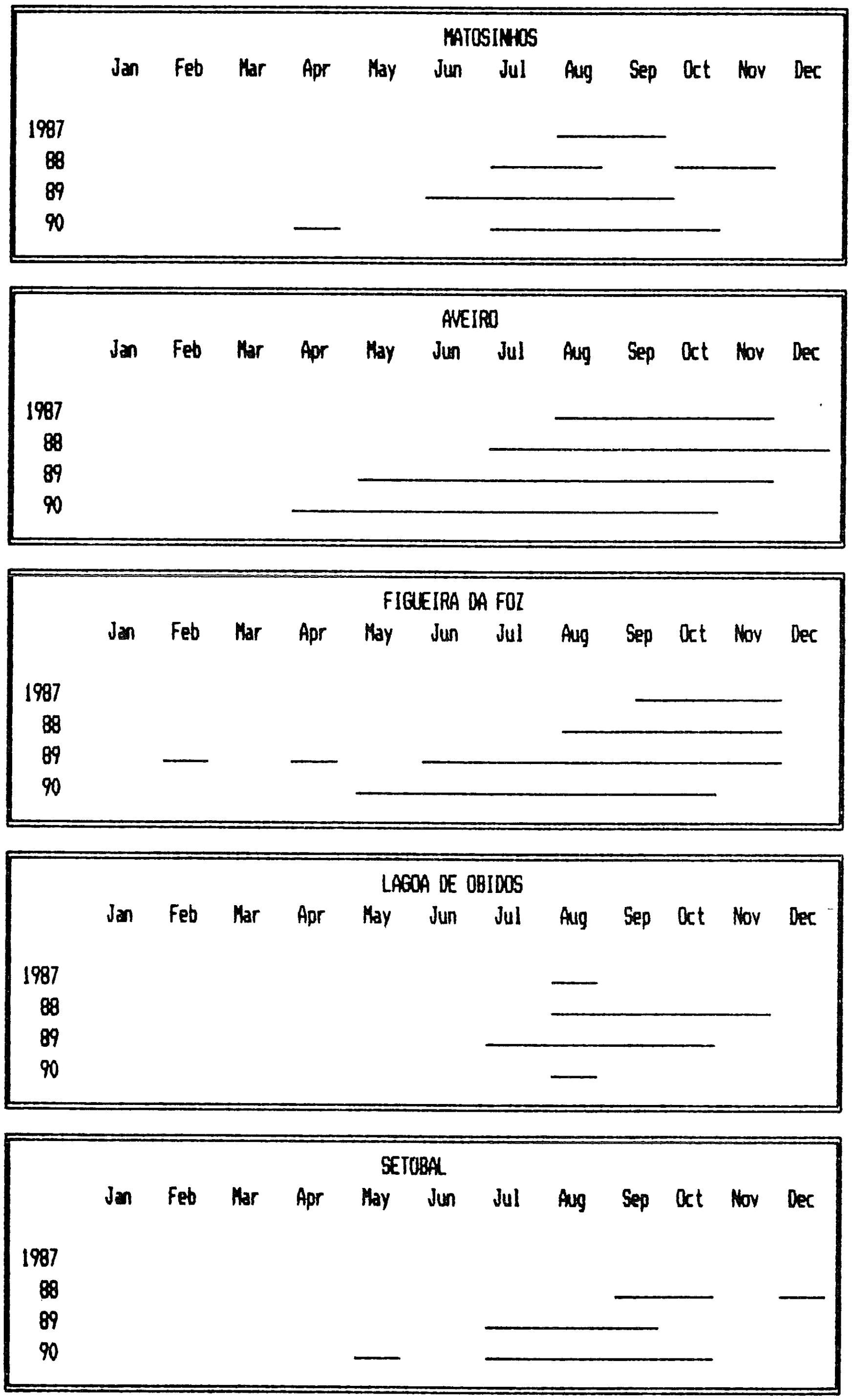
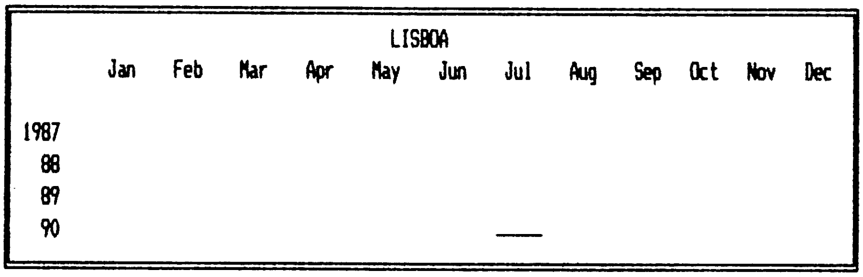
PORTUGAL MONITORING DATA 1987 - 1990

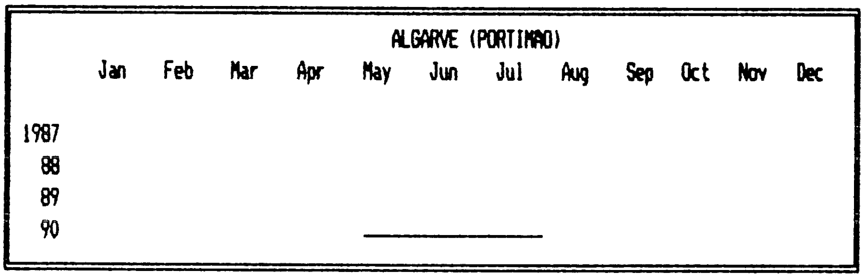
DSP Yearly periods of toxicity above safety action level

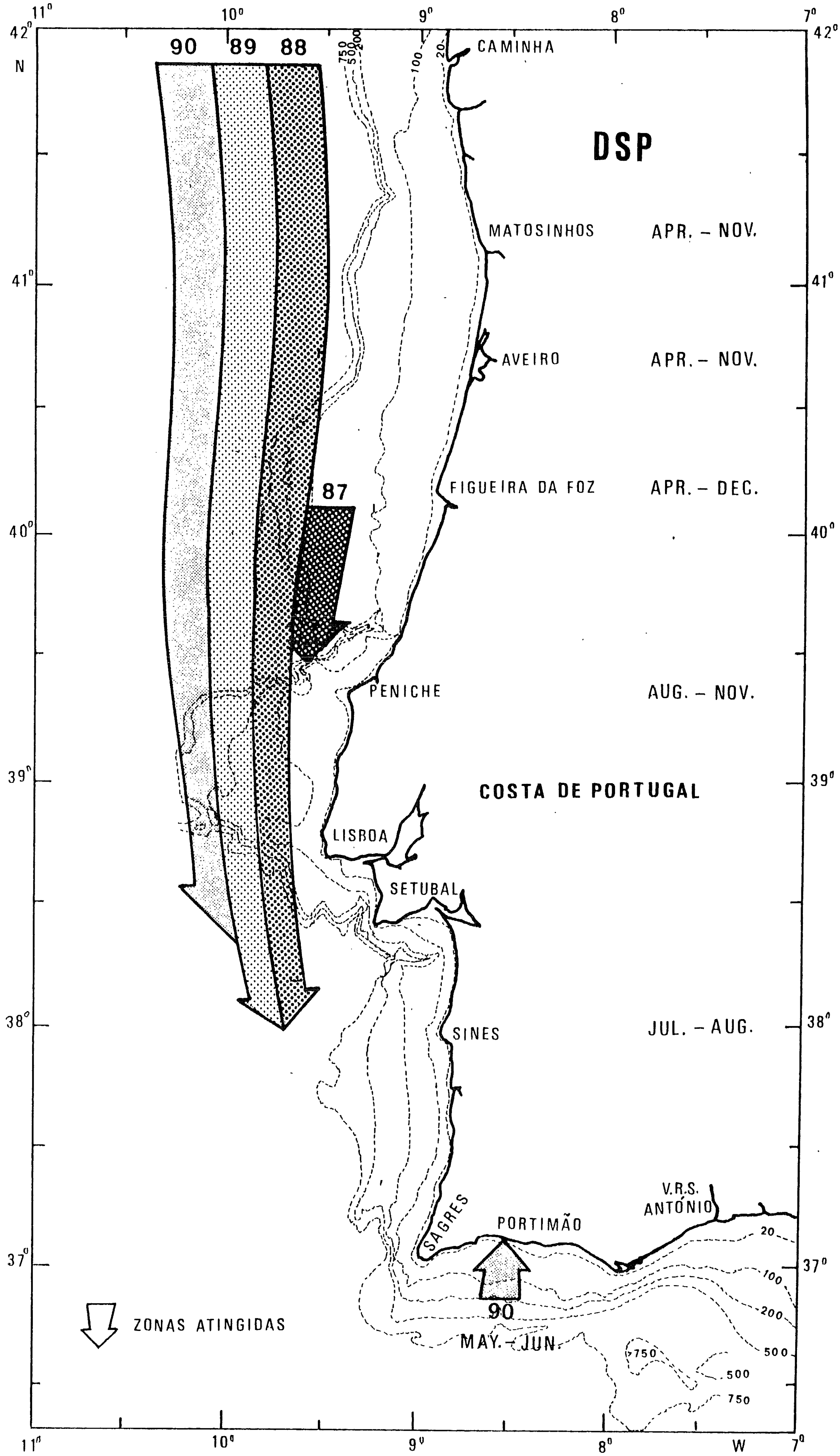


PORTUGAL MONITORING DATA 1987 - 1990

DSP Yearly periods of toxicity above safety action level







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