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REPORT OF THE WORKING GROUP ON PHYTOPLANKTON ECOLOGY

HELSINKI, FINLAND
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REPORT OF THE WORKING GROUP OF PHYTOPLANKTON ECOLOGY

Helsinki, Finland, 4 - 7 July 1989

1. OPENING OF THE MEETING

- 1.1 The meeting was opened at 10:00 hours on 4 July 1989 and was hosted by J.-M. Leppanen, Finnish Institute of Marine Research, Helsinki. S. Demers acted as the Chairperson of the Working Group in the absence of K. Richardson, the formal Chairperson. K. Richardson was, however, in daily contact with the acting Chairperson via telephone.
- 1.2 The agenda was adopted and is attached in Annex I.
- 1.3 A list of participants is given in Annex II.
- 1.4 S. Bates was appointed as Rapporteur.
- 1.5 The Chairperson asked F. Colijn to summarize the Lund meeting on toxic algae. There was a general opinion at that meeting that there is no firm evidence that the occurrence of harmful phytoplankton blooms is increasing world-wide, although many felt that this was a possibility that should be investigated further. There was also concern of a possible connection between mariculture and the occurrence of harmful blooms.
- 1.6 The Chairperson advised the Working Group of C.Res. 1988/2:37 which established the following terms of reference:
 - a) specify the types of data to be incorporated into a data bank on primary production,
 - b) define an ICES standard method for measuring primary production,
 - c) initiate an analysis of available data that will provide information on as quantitative a basis as possible on conditions (physical, chemical and biological) relevant to the potential development of harmful algal blooms, with particular reference to the Baltic area,
 - d) review the report on possible trends in the occurrence of algal blooms and/or harmful events, under preparation by the Working Group on the Harmful Effects of Algal Blooms on Mariculture and Marine Fisheries,
 - e) discuss the report of the Chrysochromulina polylepis Workshop (C.Res. 1988/2:38),
 - f) consider terms of reference for expanded activities of the Working Group for 1990.

2. ICES STANDARD METHODS FOR MEASURING PRIMARY PRODUCTION

During the last Working Group meeting, F. Colijn, G. Kraay and M. Veldhuis agreed to construct a simple, inexpensive incubator, and to develop a standard protocol for measuring primary production for ICES monitoring programmes. They presented their protocol and an inexpensive incubator

which can be adapted to provide several irradiance intensities. The Working Group recommended that at least 5 irradiance levels be used to define roughly a P vs I curve for a given area in order to be able to obtain an estimate of a P_{max} value. The sampling depth should correspond to the mid point of the mixed layer. The type of filter used for chlorophyll filtration should be the same as that used for primary production filtrations. The final draft of the manuscript describing this method and the recommended protocol will be submitted by October 1, 1989. The Working Group agreed that the recommendation for the primary production data bank and the standard ICES method be presented together.

During an oceanographic cruise on board the new Finnish R/V Aranda, a first intercomparison was made between the ICES incubator and the incubator recommended by the Baltic Marine Environment Protection Commission. The results are very promising and will be included in the final report on the ICES incubator.

3. DATA BANK ON PRIMARY PRODUCTION

The Working Group discussed the importance of establishing a primary production ICES data bank. The Chairperson asked F. Colijn to prepare a first draft of parameters which should be included in such a data bank.

The working Group felt that the methods used should be clearly defined with reference to the guidelines for the measurement of ^{14}C incorporation (K. Richardson, ed. 1987). All members of the Working Group agreed that obtaining appropriate irradiance measurements is probably one of the most important aspects of primary production studies and that the method requires standardization.

4. DISCUSSION OF THE CHRYSOCHROMULINA REPORT

The Working Group felt that it was impossible to make final comments on the report since it is not yet completed, but agreed that the draft of the report contains a great deal of useful information. Several important gaps in the information reported and/or required were noted. For example, the nitrogen and phosphorus ratios data and the section on the effects of water column stability are missing. More culture work is required to understand the physiology and life history of the alga. Moreover, there should be more discussion on physical/biological interactions. The nutrient ratio section should be rewritten to be less speculative and provocative. The Working Group also felt that the authors should indicate that this is a case study and that it could be generalized to other harmful algae events, with added recommendations that are more general for other types of potential bloom-forming algae. This specific case is well documented and the approach could be used to investigate causes of blooms in general. The Working Group felt that continued international cooperation to study such blooms should be encouraged.

5. CONSIDERATION OF THE RESEARCH PRIORITIES IDENTIFIED BY THE WORKING GROUP ON HARMFUL EFFECTS OF ALGAL BLOOMS

The Working Group agreed with the research priorities identified by the Working Group on Harmful Effects of Algal Blooms on Mariculture and Marine Fisheries. Research could be focused on the hypothesis that anthropogenic inputs of selected nutrients, resulting in changes in nutrient ratios, could both increase the abundance of phytoplankton in general and alter the species composition of natural populations towards harmful species. An additional concern in this respect is the potential physiological enhancement of toxicity due to limitation of a particular nutrient such as phosphorus.

The Working Group discussed the role of governments with respect to the relative priorities of monitoring programmes and basic scientific research. Long-term time-series obtained by monitoring programmes of toxicity and of phytoplankton and associated hydrographic, meteorological and chemical variables should be coordinated by governments and institutions using methodologies standardized by ICES. This, in combination with strict quality control, is necessary if such data are to be used in efforts to assess long-term trends and to predict the appearance and development of blooms. Statistical methods such as risk analysis should be applied to manage mariculture operations and to make decisions about effluent discharges. Moreover, the Working Group felt that development of tools such as flow cytometry and image analysis could be evaluated for the study and the monitoring of harmful species.

6. INITIATION OF ANALYSIS OF AVAILABLE DATA (Point "c" in C.Res. 1988/2:37)

The Working Group felt that this is a major task that requires more information and experience than was present in this Working Group. This point should therefore be included in the terms of reference of the new Working Group. Some of the many issues involved in the development of blooms were discussed.

7. DRAFT A PROPOSAL FOR A SYMPOSIUM ON THE MEASUREMENT OF PRIMARY PRODUCTION

As unanimously concluded in last year's report of the Working Group on Primary Production, the present Working Group felt strongly that such a symposium should take place in 1991. The Chairperson asked M. Veldhuis to write a rationale for the symposium and a list of suggested topics (Annex III). The final form and content of the symposium will be the responsibility of Dr. Trevor Platt, who has already agreed to act as chairperson of this symposium.

8. DISCUSSION OF TERMS OF REFERENCE FOR THE NEW WORKING GROUP

In accordance with C.Res. 1988/2:37, the new Working Group on Phytoplankton Ecology proposes the following expanded terms of reference. Many of these are taken from the 1989 report of the Working Group on Harmful Effects of Algal Blooms on Mariculture and Marine Fisheries.

- a) Exchange and analyze data derived from monitoring and research programmes in order to identify possible trends in the occurrence of harmful algae, and to evaluate, improve and expand such programmes.
- b) Identify probable causes or mechanisms (e.g. meteorological, hydrographic, chemical and biological) responsible for the occurrence of harmful and non-toxic phytoplankton blooms, and recommend specific measurements and procedures to be incorporated into monitoring programmes.
- c) Report and discuss information on harmful algal blooms collected during the year by members of the new Working Group and by the ICES National Coordinating Centres for Exchange of Information on Exceptional Algal Blooms.
- d) Review, evaluate and report on the toxicological information available on known and newly-discovered algal toxins, and on the methods for their detection and quantification.
- e) Exchange and assess information on new techniques for measuring phytoplankton standing stock and primary production and organize a symposium on the measurement of primary production.
- f) Standardize methods for measuring primary productivity, irradiance and chlorophyll a concentration used for ICES monitoring studies.
- g) Encourage the development of long-term monitoring programmes for phytoplankton blooms and toxic events in key areas, and suggest standardized parameters to be measured.
- h) Evaluate information and recommend research priorities relating to the effects of nutrients and nutrient ratios on the species composition of natural phytoplankton populations and on the toxicity of harmful species.
- i) Exchange information and recommend research priorities relating to the culture and physiology of harmful algae.
- j) Continue an analysis of available data that will provide quantitative information on conditions (physical, chemical and biological) relevant to the potential development of harmful algal blooms, with particular reference to the Baltic area.

COMMENT

There was considerable discussion in this Working Group and in the Working Group on Harmful Effects of Algal Blooms on Mariculture and Marine Fisheries concerning the mechanism to continue the study of phytoplankton ecology and harmful bloom issues within ICES. C.Res. 1988/2:37 states that harmful algal bloom issues and topics in general phytoplankton ecology be combined in one new Working Group on Phytoplankton Ecology.

The positive aspects of such a combination include increased exchange of information among disciplines and economies of time, efforts and funds since some members presently participate in both Working Groups. However, certain negative aspects of such a combined group must be emphasized. The first concern is that the new Working Group must necessarily focus on a wide range of topics in a variety of disciplines, several of which are not considered "phytoplankton ecology" e.g., toxicology, mariculture management). This is exemplified by the long list of terms of reference that are recommended here. Second, the size of the group of experts needed to address these issues will necessarily be large (i.e., 35 or more members).

The Working Group felt that in order to carry out the tasks in our expanded terms of reference, the new Working Group on Phytoplankton Ecology should be composed of two subgroups, each with a chairperson and a defined list of tasks. Three alternative interaction between these subgroups are recommended:

- (1) All members could convene at the same time and place, but given the proposed terms of reference and expected time restraints, we feel that much of the meeting would involve separate meetings with limited exchange in a plenary session.
- (2) The two subgroups could meet at the same location in succession such that some members could participate in both meetings. This could be especially effective if the two agendas were coordinated to permit maximum overlap.
- (3) The subgroups could meet independently as is the case presently, but would occasionally meet concurrently once every few years to exchange information formally. There would of course continue to be communication among members of the two subgroups.

The choice among these alternatives would depend on the final terms of reference and general priorities adopted by ICES. The Working Group feels that all of the recommended terms of reference in this report are of high priority and are diversified such that it would be difficult to make adequate progress without choosing either option (2) or (3). Option (2) is preferred for our next meeting.

The meeting was closed at 12:00 hours on 7 July.

9. RECOMMENDATIONS

The Working Group on Phytoplankton Ecology recommends that:

1. There be held a symposium on the measurement of primary production in 1991 and that Dr. Trevor Platt be nominated as Chairperson of this symposium (see Annex III).
2. The data bank on primary productivity and associated parameters be implemented.
3. The incubator developed by F. Colijn and M. Veldhuis to measure primary productivity be used by ICES monitoring programs, and that data collected by this method be incorporated into the ICES data bank.
4. The diversity of disciplines present in the previous Working Groups be maintained in the new Working Group, and that the new Working Group be comprised of toxicologists, taxonomists, fisheries scientists, mariculturists, and biological and physical oceanographers.
5. The attendance of physical oceanographers be encouraged in the new Working Group, as the development of blooms is under the influence of hydrodynamical/physical as well as biological processes.
6. In view of the Council's 1988 decision to deal with phytoplankton issues in one Working Group, and the proposal of the Working Group on Harmful Effects of Algal blooms on Mariculture and Marine Fisheries to be re-established and to meet in Oban, Scotland, April 3-6, 1990, it is difficult for the Working Group on Phytoplankton Ecology to set a time and location for our next meeting. If only one Working Group is maintained by ICES (option 1, above), we propose to meet in Oban from April 2-7, 1990 with one agenda and several subgroups. If option (2), above, is adopted, we propose two successive meetings, one from April 2-5 and the other from April 5-8. If Oban is unable to extend an invitation to our enlarged group or to the successive groups, then the meetings can perhaps be held at ICES Headquarters in Copenhagen during the above proposed dates.

AGENDA

1. Opening of the meeting.
2. Nomination of a chairperson.
3. Adoption of the agenda.
4. Appointment of a rapporteur.
5. Chairperson's introduction.
6. Discussion of ICES standard methods.
7. Discussion of specific types of data to be incorporated into a databank on primary production.
8. Discussion of the Chrysochromulina report.
9. Consideration of the research priorities identified by the Working Group on Harmful Effects of Algal Blooms.
10. Initiation of analysis of available data (point "c" of our terms of reference).
11. Draft a proposal for a Symposium on the Measurement of Primary Production.
12. Discussion on the terms of reference for the new Working Group.
13. Discussion of recommendations from this meeting.
14. Discussion and date for the next meeting.
15. Closing of the meeting.

ANNEX II

ICES Phytoplankton Ecology WG 4-7 July

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PROPOSAL FOR A SYMPOSIUM ON THE MEASUREMENT OF PRIMARY PRODUCTION

The term "primary production" can be easily defined in a formal way and has a fundamental place in the conceptual basis of biological oceanography. On the other hand, operational definitions are ambiguous and difficult to reconcile with each other. Comparisons between measurements of primary production by different techniques have led to controversy that could have been avoided if the limitations of the operational definitions had been admitted. Discussion of the magnitude and variation of primary production cannot be divorced from consideration of the experimental methods used. We have no absolute standard for measurement of this important ecological quantity.

On the other hand, all the methods proposed until now consider the phytoplankton community as a global assemblage of particles which respond in the same way to the environmental conditions. In the marine environment, particles and phytoplanktonic cells play a dominant role in the global carbon fluxes. For the most part, cells, whether occurring as solitary units or as multicellular organisms, are in a wide size range from less than 1 micron up to more than 100 microns. The properties of cells in different size groups are not normally distributed which mean that the use of bulk analyses to estimate average properties and characteristics of populations has not given us insights needed to understand the ecology and the importance of the marine microbial systems. Moreover, Remote Systems operated from space or from small aircraft are increasingly used to provide information on marine primary production on a global scale. Until recently, no technique was available to study the ecosystem on individual particle and cell basis. Measurements of the assimilation of ^{14}C and ^{15}N provided tools to study the dynamics of total aquatic systems but the taxa-to-taxa aspects of the phytoplankton community were unapproachable. It is possible to assign the dynamics to size class, if filters, screens, or nets of different pore sizes are used, however the treatments can introduce artifacts due to cell breakage. Additionally, there is potential error in the cells retention on the filters and it is impossible to obtain a quantitative separation between autotrophs and heterotrophs or between groups of species and detritus.

This is an issue of continuing interest in view of its fundamental position in all biological oceanography. It is especially important now given the impetus of new international programs such as JGOFS and IGBP.

It is therefore proposed that ICES convene a symposium on Measurement of Primary Production to be held in 19XX. The scope would be much greater than the merely methodological. The meeting would aim at a review of existing methods to elucidate the commonality of their operational definitions in the light of current views on the structure of the pelagic food web. Against this background, the viability of new methods would be evaluated, and the prospects for future assessed. A major symposium on an important topic is envisaged. Considerable interest outside the normal ICES family could be expected.

PROPOSAL FOR ICES: PRIMARY PRODUCTION SYMPOSIUM 199X

MEASUREMENTS OF PHYTOPLANKTON PRIMARY PRODUCTION: FROM A MOLECULAR BASE UP TO THE GLOBAL SPACE

Convener: Trevor Platt (Can.)

General themes:

General introduction: Presentation of problems inherent to measurement of primary production.

Standard methods: ^{14}C , O_2 ; incubation type, light measurements, fluorescence induction, etc.

New production and regenerated production versus total production.

Size-fractionated production: Filtration problems, significance

New approaches: Individual cell analysis: Flow cytometry, image analysis,

Remote sensing: Light absorption, light scatter, effect of composition