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Short communication

Updating the Continuous Plankton Recorder: an improved tool for integrated plankton monitoring

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After providing unique records of plankton distribution for over 60 years, the Continuous Plankton Recorder survey needs to be updated in order to obtain improved information on vertical distribution and abundance of plankton, the physico-chemical environment, and on microplankton. To meet these requirements, a new body has been developed with the capability to undulate and carry a larger payload whilst retaining the ability to be deployed from ships of opportunity. To improve estimates of abundance, miniature current meters have been developed to quantify flow through the sampler mechanisms. An appropriate suite of environmental sensors has been identified and a suitable microplankton sampler mechanism has been developed. The new body (U-Tow) has been successfully deployed in undulating mode with the standard plankton sampler mechanism and a range of environmental sensors. The microplankton sampler prototype has been built. This system will be integrated with smart logger and sensor system allowing a sample to be taken dependent upon externally measured environmental conditions.

Key words: Continuous Plankton Recorder, CPR, monitoring, plankton sampler, towed body, spatio-temporal variability.

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Introduction

The Continuous Plankton Recorder (CPR) survey has provided a unique, 65-year data set on the distribution of plankton in European regional seas and the North Atlantic (Gamble, 1994). It has provided a yardstick against which changes in the planktonic ecosystem, perhaps the most sensitive indicator of environmental change, can be assessed (Aebischer *et al.*, 1990). The CPR programme has been successful but there is a need to modernize in order to meet new requirements of monitoring studies and to take advantage of new developments in sensor and sampling technology. There are a number of initiatives currently under way to update the programme and also develop an integrated monitoring programme using moorings. These two strategies will provide effective observational platforms for monitoring the planktonic ecosystem and in particular the distribution and biodiversity of the plankton in relation to their physico-chemical environment.

The programme

Starting in 1996, a 3-year collaborative venture between SAHFOS, CEFAS, and DANI has commissioned the development of a sampling and sensing system for an updated CPR for the determination of biomass and species composition of microplankton. This system will sample the smaller plankton which are not quantitatively sampled by the CPR standard mechanism and will be installed alongside a suite of environmental sensors. Information from such a system is not only essential for the interpretation of plant pigment data, but also for the

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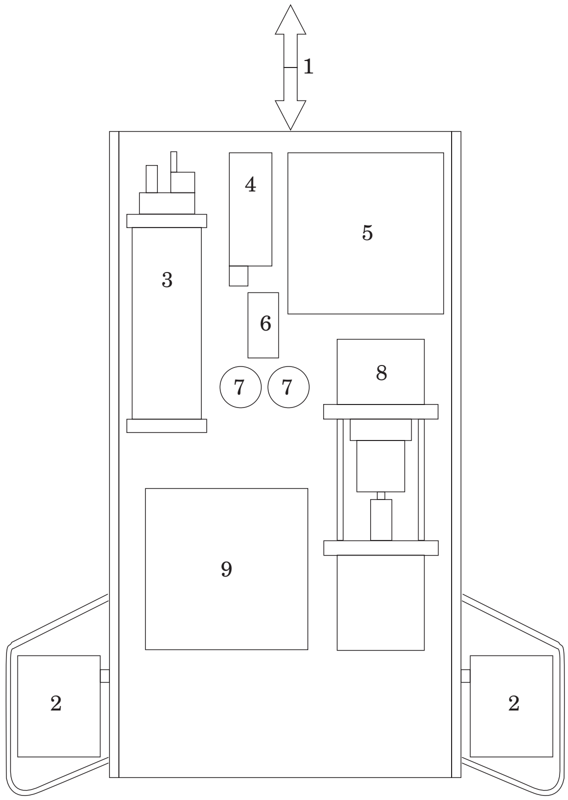

Figure 1. Schematic of "U-Tow" (W.S. Oceans Systems Ltd, Alton, UK). 1. Two-way communication. 2. Undulation control. 3. Marine Monitor logger with sensors for CTD, turbidity, and control systems for the body and conditional sampling. 4. Chlorophyll fluorometer. 5. Mesozooplankton sampler mechanism. 6. PAR irradiance. 7. Discrete band colour sensors (up and down). 8. Aqua-monitor phytoplankton sampler mechanism. 9. Stored phytoplankton samples.

identification of temporal and spatial changes in the composition of the tightly bound communities of auto- and heterotrophic organisms that constitute the microplankton. Only specific taxonomic analyses can give understanding of community variability, biodiversity, and its role in influencing ocean metabolism.

Progress to date

A new and potential replacement body ("U-Tow") for the CPR survey (Fig. 1) has been developed with the ability to undulate and to carry a comprehensive payload. Other developments have been to quantify the flow through both the towed body and the sample mechanism itself using miniature electromagnetic current meters and instrumenting the towed body with a range of environmental sensors. Examples of the kind of information that may be obtained are shown in Figure 2.

An "intelligent" phytoplankton sampler has been designed and a prototype built. It is able to collect and preserve up to 52 water samples of 150 ml each dependent upon environmental conditions and may be operated within the confined space of U-Tow (Fig. 1) The design is based on a programmable syringe system. A water sample is collected and stored temporarily prior to fixation and dispatch to permanent storage. This two-stage process permits a choice between rejecting the initial sample in favour of a second. Such an approach allows the use of a conditional sampling protocol where sample collection and permanent storage are decided by a predetermined set of user-defined conditions. These conditions will be based upon electronically measured environmental variables such as chlorophyll fluorescence, turbidity, and density. The particular advantage of this design is that in conditional sampling mode, for example, a sample is likely to be required at a maximum or minimum in signal strength from a sensor. The peak in sensor output may be defined as a shift from a positive to a negative slope in a record. Consequently, the sensor output recorded as a sample is taken may subsequently be compared with the next sensor reading and a decision reached whether to reject the sample and take a further one or store the current sample.

To set the trigger for conditional sampling, the user sends via the PC program a logical string such {(A or B or C) and D}. As an example of a potential protocol, the following string might be used: if [chlorophyll fluorescence in last sample burst >x, or turbidity in last burst >y] and time elapsed since last sample >z hours, then take a sample.

New technologies

A new towed body which incorporates the ability to undulate in combination with new sensor and sampling systems will strongly enhance the potential of the CPR survey to meet the requirements of modern large-scale monitoring programmes. By undulating the recorder, the information on plankton distribution can be integrated over the surface layer. By equipping the recorder with environmental sensors, changes in plankton can be related to their environment. New bio-optical and chemical sensors are emerging. Rapid development in sensor technology will in the near future allow measurement of many subtle features of the marine ecosystem, perhaps even the presence of particular phytoplankton species or specific algal toxins. In looking to the future we will need to evaluate these new technologies as they emerge in order to assess their possible role in a newly instrumented CPR.

Any proposal for updating of the CPR survey will have advantages and disadvantages. In order to maintain the integrity of the existing decadal data sets, both systems (original CPR body and U-Tow) need to be operated in parallel to allow a comparison of the

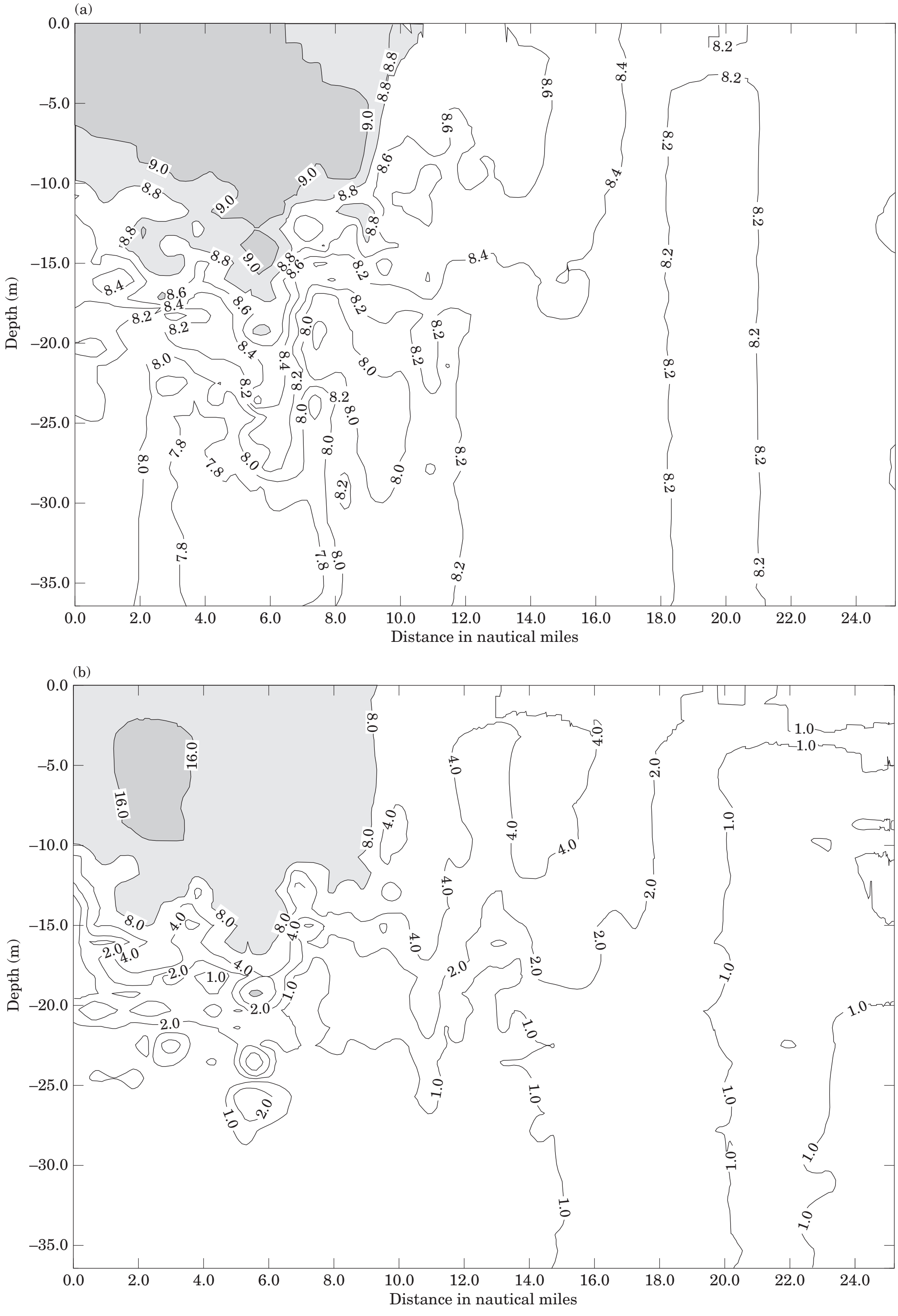

Figure 2. Vertical sections of (a) temperature (°C) and (b) chlorophyll (mg m − 3) concentration obtained with an undulating U-Tow equipped with a CTD and fluorometer and deployed for 2 h at 53.78°N 5.62°W in the Irish Sea on 23 April 1997. High concentrations of chlorophyll (Chelsea Instruments MkIII Aquatracka fluorometer calibrated with surface water) coincide with the temperature stratified surface layer (10–15 m) observed during the first part of the tow.

different sampling systems. In the short term, few routes will benefit from these advances but in future and for new routes these options will be available. These developments will create the need for greater technical support and shore-based analytical effort. Again new developments in automated image analysis and particle counting will play their part in ensuring that the survey and the CPR can meet the needs of modern ocean-monitoring programmes.

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