Trans-Pacific Cruise of CNAV ENDEAVOUR

by

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Introduction

During the past two years a cooperative program has been developed for the study of production processes in the subarctic North Pacific Ocean. The primary purpose of this program is to examine components of oceanic variability which may affect commercial fisheries (e.g. high seas salmon mortality) and further to assess the productivity and diversity of organisms having potential value as a food resource for man. The principal agencies in this cooperative program are the Fisheries Research Board of Canada, Nanaimo, and the Department of Oceanography, University of Washington, Seattle.

It was recognized that, in order to carry out the study, it was necessary to collect data over very large ocean areas. To this end, it was proposed that maximum use should be made of observational platforms which regularly cover the North Pacific. Weatherships, commercial vessels and satellites were therefore coordinated for the collection of such data as were specifically required for large-scale ocean surveys. In addition, however, it was considered necessary that research vessels should be occasionally employed in this program for the purpose of comparing protracted observations from established platforms with intensive but sporadic observations made from a research vessel. Thus the primary purpose of the trans-Pacific cruise of CNAV ENDEAVOUR was to investigate the waters of the subarctic Pacific, to examine plankton, small fish and other animals which form the primary food of secondary carnivores, including salmon, and to compare the results with theoretical predictions of biological productivity based on data collected from commercial vessels, weatherships and satellites.

Observations and Results

The cruise track (Fig. 1) was designed to follow the approximate route of American Mail Line vessels travelling on the great circle route, from Seattle to Yokohama. The cruise was carried out during the months of March and April, 1969, and was timed to coincide with the onset of the spring plankton bloom in the subarctic Pacific. Surface sampling included continuous underway monitoring of nutrients, carbon dioxide, pH, chlorophyll, turbidity, temperature, salinity, zooplankton and solar radiation. In addition, depth profiles for plankton, nutrients and small fish were taken each day, for a total of 39 stations.
Some data obtained from the continuous monitoring program, representing a coverage of approximately 8,000 miles of ocean surface, are shown in Fig. 1 and 2. These data show the degree of both small- and large-scale variability in the nutrient structure of the subarctic Pacific. The rate of nutrient utilization can be determined as the difference between values from the westbound and eastbound tracks, and the data used as a measure of the temporal and spatial characteristics of maximum productivity over the whole area. Long-term variations in these parameters, as measured from commercial vessels, will be used to assess time/space changes in the environment of the subarctic Pacific.

Primary productivity throughout the subarctic Pacific is shown in Fig. 3 for 5 months in 1969. The data have been taken from commercial vessels and have been evaluated in the light of more detailed studies conducted during the cruise of CNAV ENDEAVOUR. The figure shows that productivity in the spring was depressed in the vicinity of the Alaskan and Western Gyres, but that along the coast of North America, in the vicinity of the Aleutian Islands and off the coast of Japan, production increased steadily from February/March through June. Another significant aspect of these data is that the western subarctic Pacific is shown to be appreciably more productive than the eastern subarctic. Thus the average primary production for six months at longitudes East was 600 mg C/m²/day compared with the average, throughout the same period for longitudes West, of 310 mg C/m²/day.

Traces obtained from a 200 KHz (Furuno) echo sounder revealed the presence of an ocean-wide shallow scattering layer (Fig. 4 and 5). This layer varied in intensity but was seldom absent. Detailed sampling using a Longhurst recorder showed that the layer was composed of the large marine copepod, Calanus cristatus, at concentrations far exceeding any previously reported. This finding is both scientifically and economically significant. From a scientific point of view it is known that the amount of food a fish can acquire is related to the concentration of forage organisms and to their degree of aggregation or "patchiness". In previous studies of ocean environments only prey concentrations have been measured, since patchiness is generally difficult to evaluate. With the use of the 200 KHz sounder, however, patchiness has been shown to be readily measurable, thus permitting a better interpretation of plankton data with respect to fisheries. Furthermore, the finding should stimulate a reappraisal of the possible direct utilization of plankton as a commercial source of protein and oil.

Food organisms of secondary carnivores (e.g. salmon) and plankton which were collected during the cruise of CNAV ENDEAVOUR are being identified by various agencies as follows: Shrimp - Oregon State University; Squid - University of Victoria; Zooplankton - FRB, Nanaimo; Phytoplankton - University of British Columbia; Fish - National Museum, Ottawa, and FRB, Nanaimo.
Summary

The principal objective of the trans-Pacific cruise of CNAV ENDEAVOUR is being realized through analysis and comparison of the data with those collected by commercial vessels. The application of certain mathematical models to descriptions of production processes in the North Pacific has been found practical, and it is expected that some understanding of long-term changes in the oceanic environment of the subarctic Pacific will be achieved through the continuing program of observations from weatherships and commercial vessels. In addition, new information obtained on the trans-Pacific cruise will be utilized to modify mathematical representations of environmental processes. Finally, the cruise served to demonstrate that sophisticated experimental equipment could be operated under difficult conditions at sea; and this should encourage future widespread use of such instrumentation, especially in commercial vessels.
Fig. 1. (top) Cruise track of CNAV ENDEAVOUR; (bottom) silicate, nitrate and phosphate distribution.
Fig. 2. Partial pressure of carbon dioxide, pH and temperature collected during the trans-Pacific crossing of CNAV ENDEAVOUR (data supplied by Dr. P. Kilho Park, Oregon State University).
Fig. 3. Primary production (mg C/m²/day) as measured at different positions of longitude following a northern great circle route from Seattle to Yokohama (original data supplied by Dr. G. Anderson, University of Washington).
Fig. 4. (top) Portion of the shallow scattering layer (SSL) taken from the Furuno echo sounder on board CMAV ENDEAVOUR; (bottom) detailed vertical and lateral profiles through the SSL using Miller and Longhurst nets.
Fig. 5. Distribution of the shallow scattering layer across the North Pacific Ocean.