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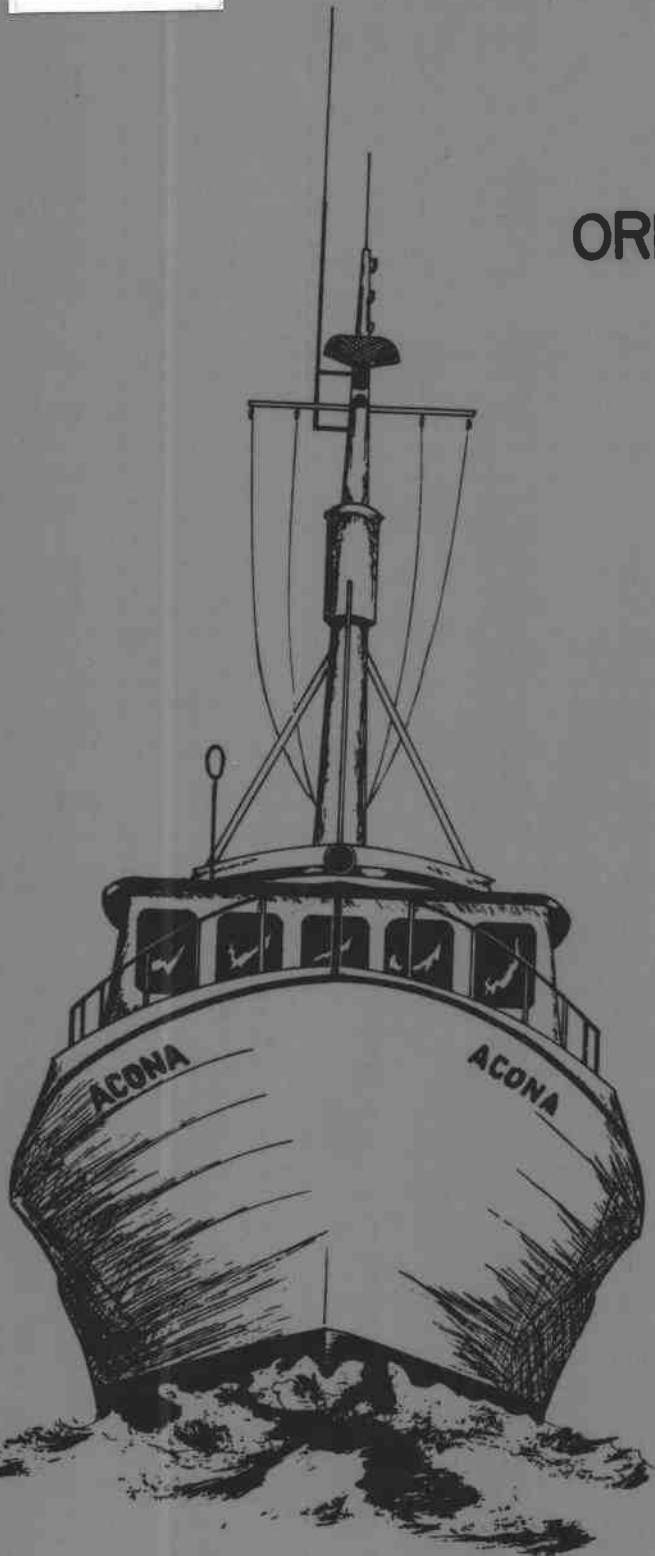
SIUSLAW R.

UNPQUA R.

COOS BAY

COQUILLE R.

ROGUE R.



**Energy Conversion
and Element Transfer
In Lower Trophic Levels
In the Marine Environment**

by
Lawrence F. Small and Herbert Curl, Jr.

AEC Progress Report Reference 63-2
April-December 1962 January 1963

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ENERGY CONVERSION AND ELEMENT TRANSFER IN
LOWER TROPHIC LEVELS IN THE MARINE ENVIRONMENT

by

Lawrence F. Small
and
Herbert Curl, Jr.

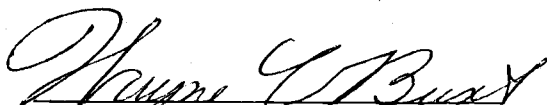
Department of Oceanography
Oregon State University

Progress Report

1 April through 31 December 1962

Submitted to the
U. S. Atomic Energy Commission
under Contract AT(45-1)1751.

Approved:



Wayne W. Burt, Chairman
Department of Oceanography

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Reference 63-2
January 1963

ENERGY CONVERSION AND ELEMENT TRANSFER IN
LOWER TROPHIC LEVELS IN THE MARINE ENVIRONMENT

Progress Report for 1962-63

Studies on elemental and energy transfer in lower trophic levels in the marine environment were initiated in July 1962 after receipt of AEC contract AT(45-1)1751. It should be pointed out that this report covers only a six-month period, because for bookkeeping purposes the contract was made retroactive to 1 April 1962, at the request of the contractor.

The major equipment described in the original proposal has been obtained. The gamma scintillation spectrometer has been calibrated for Cs¹³⁷ and Zn⁶⁵ and is being calibrated for Fe⁵⁹ and Cr⁵¹ shortly. An analytical ratemeter has just been obtained for use with the spectrometer. This device permits instantaneous calibration checks and provides a separate power supply for the gamma scintillometer, freeing the scaler for simultaneous use in counting.

The single-channel spectrometer can be converted to a recording multichannel instrument by adding an externally-driven, precision, ten-turn potentiometer for base-level voltage control. Such modifications would make it possible to check the instrument calibration for a mixture of isotopes, to discriminate mixtures of isotopes with close energy levels, and, in future experiments, to determine the half-lives and energy levels of unidentified isotopes. This modification will also be valuable in the routine counting of background, particularly in multiple-isotope work.

In compliance with regulations of the University Radiation Committee, an office-laboratory has been converted into an isotope preparation room and the cement floors of our main laboratory and instrument room were covered with asphalt tile.

A final design of the "aquastat" was decided upon and construction is under way. A careful study was made to select the best sources of illumination to simulate conditions in the sea with respect to both intensity and spectral composition. A combination of standard and high-output lamps, in several "colors," appears to be the most appropriate. We are exploring the possibility of replacing the lamp ballasts with magnetic frequency multipliers in order to decrease substantially the weight of the equipment, to provide greater flexibility in intensity control, and to remove a source of waste heat. We are using a 1-horse-power, water-cooled condensing unit for the cooling end of the "aquastat" and a "cal-rod" type heating element. Aluminum egg-crate dividers will diminish light leakage and thermal convection currents between compartments.

At present, five genera of phytoplankton organisms are being maintained in uni-algal, bacteria-free culture. The organisms are: Skeletonema costatum, Melosira sp., Fragillaria oceanica, Euglena sp., and four

species of Chaetoceros. A number of other species have been in culture for a short time. We are investigating the possibility of improving growth characteristics of cultures by using cellulose gums as inert suspending media.

Nutrient enrichment cultures are being brought back from all hydrographic cruises so that in the future additional species of phytoplankton will be available as food for herbivores. We expect to have cultures of algal species representing a wide range of cell dimensions and environmental preferences.

Artemia salina is being used as the initial grazer, but we are attempting to maintain some of the larger pelagic copepods in the laboratory. Work at other marine laboratories indicates that it is feasible to maintain copepodite stages and adults in the dark at low temperatures, without feeding, for several weeks. We have been successful in this regard with Calanus finmarchicus, a fairly abundant species off the coast of Oregon in winter. We are investigating the possibility of working with Calanus cristatus, which is abundant in Oregon waters in the spring and summer. This species is quite large and apparently is important as a second trophic level grazer and concentrator of radionuclides.

Artemia was originally selected as the experimental grazer because of its availability and large size. However, it was recognized that the feeding behavior of Artemia might differ in some respects from that of natural marine zooplankton. If experiments indicate that feeding or metabolic behavior are different in the two taxa, then copepods may be used to "calibrate" Artemia. However, we will still attempt to find a true marine herbivorous zooplankton that can be either cultured or maintained throughout the year. A literature search relating to the culturing of marine copepods is under way.

After preliminary work with Artemia, it was found necessary to revise the experimental technique for studies testing direct uptake of radionuclides from solution, because a "salt effect" was encountered. The erratic counts obtained in early experiments comparing radionuclide counts per unit weight of Artemia (cpm/mg) suggested that something in addition to the animals was affecting the results. The erratic counts occurred when the organisms were removed from the radioactive solution and counted dry.

Subsequent experiments comparing cpm/mg in rinsed and non-rinsed samples showed that over a range of sample weights, counts per unit weight were more uniform and always higher in the rinsed samples than in the non-rinsed samples. Dry weights of non-rinsed samples apparently included the weight of varying amounts of salt crystals adhering to the animals and to the filter used to separate the Artemia samples from solution. Expression of results as cpm/mg was actually an expression of cpm/mg of radioactive Artemia plus non-radioactive salt crystals. Rinsing, on the other hand,

removed the salt from the animals and the filter and gave a true expression of cpm/mg of Artemia. Covariance analysis on series of rinsed and non-rinsed samples showed a true difference between the two treatments.

In addition to the laboratory work started, we have undertaken the species analysis of zooplankton collections made off the Oregon coast. A knowledge of species composition and distribution will allow meaningful extrapolation of laboratory data to natural situations. These data will also be used later for analysis of population diversity and species associations. This information is of considerable theoretical interest with regard to energy-flow ecosystems.

The succinoxidase enzyme activity of muscle tissue and whole organisms of bathypelagic fish and large zooplankton is being analyzed in conjunction with work on oceanic nekton under the direction of Dr. William Pearcy AT(45-1)1726. The measurement of such activity provides a method of determining respiratory metabolism which can be used instead of the oxygen uptake experiments. This technique will be used in measuring the respiration of organisms employed in our "aquastat" experiments.

Major modifications in the original method have been made to correct for absorption by carotenoids and to produce data which will be reliable on the basis of weight. Work has also begun on an examination of alternative pathways to the succinoxidase system, since low activity may be a result of shunts rather than inherent low respiration. Instrumentation is being designed to measure gaseous (O_2) respiration before the enzymatic method is applied to a specimen.