RESEARCH ACTIVITIES
1 July through 30 September 1961
Edited by
June G. Pattullo

Progress Report No. 4
October 1961
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Office of Naval Research
Contract Nonr 1286 (02)
Project NR 083-102

National Science Foundation
Grant No. G 15070

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October 1961

Wayne V. Burt
Chairman
INTRODUCTION

This report summarizes the research conducted during the third quarter of the calendar year 1961 by the Department of Oceanography, Oregon State University, under contract No. Nonr 1286(02) Project NR 083-102 with the Office of Naval Research, and Grant No. G 15070 with the National Science Foundation.

RESEARCH IN PROGRESS

Hydrographic Survey of Oregon Coastal Waters -- Bruce Wyatt and Norman Kujala

The observational pattern has been expanded: all station lines now extend 165 miles offshore, and a fourth line (off Brookings) has been added to the existing lines off Astoria, Newport, and Coos Bay. The stations will be visited bimonthly. To monitor more rapid variations in properties, the line west of Newport will be occupied each month.

On 25 July, five oceanographic stations (consisting of plankton tow, BT cast, Nansen bottle cast and drift bottle release) were occupied west of Newport, Oregon. From 21 August to 1 September, lines of stations off Astoria, Newport, Coos Bay and Brookings were completed.

In addition to oceanographic surveys, short term drogue current measurements were made during 5 to 9 September in conjunction with Scripps Institution of Oceanography's "West Wind Drift Study."

A report is being prepared, summarizing oceanographic data collected on cruises taken off Astoria, Newport and Coos Bay from July 1960 to June 1961. This report should be ready for distribution by December 1961.

Plankton Inventories -- Herbert Frolander

Weekly sampling in Yaquina Bay, Oregon, from 1 July to 30 September 1961 consisted of 13 sampling days during which the following samples were taken at two stations.

Physical data:

Surface and bottom water samples at each station, total of 48 measurements each of temperature, salinity, and dissolved oxygen.
Biological data:

Two quantitative net tows at each station:

- #6 mesh net: 24 tows
- #12 mesh net: 28 tows
- Qualitative half-meter net: 24 tows.

Accessioning -- Herbert Frolander

All zooplankton samples have been accessioned into continuous collections in ledger, card file, and catalogued in collection cases.

The following volumetric analyses of zooplankton have been made:

1. Completed volumetric analyses #6 mesh samples: 64 samples taken 19 August 1960 - 24 November 1961
2. Completed volumetric analyses #12 mesh samples: 67 samples taken 19 August 1960 - 24 November 1961
3. Completed volumetric analyses CB #6 and #12 samples of 24 hour time study 11-12 August 1960: 46 samples

Total volumetric samples analyzed: 177


Nekton Studies -- William Pearcy, Donald Day, Lyle Hubbard

During the past quarter 36 midwater trawl collections have been made, including (1) replicate collections to 200m at a single station during the night, (2) collections along a transect of stations perpendicular to shore, and (3) collections at the same station to different depths down to 1000m.

A total of 12 oblique tows during the night, to the same depth (200m), at the same station, and retrieved in the same manner, permitted a comparison of the catch variation of the animals collected with the Isaacs-Kidd midwater trawl. The coefficients of variation \( (C = s/X) \) of the four dominant species of bathypalagic fishes; via, \( \text{Diaphus theta} \).
Lampanyctus leucopsarus, Tarletonbeania crenularis, and Tactostoma macropus, for collections during individual nights averaged 77% (range 17-258%). There were no indications that the tows closest to dusk or dawn caught significantly fewer fishes than tows at midnight. Such a high degree of variability in the catch of these species is believed to be largely due to "patchy" or "contagious" spatial distribution, probably related to the schooling behavior of these animals.

The variation in catches of the above four species along the transects of stations, located 20, 30, 40, and 50 miles off the Columbia River, Newport, and Coos Bay, Oregon, showed only slightly more variation (C = about 100%). In general, the similarity in the number of these species at the stations of a transect, and the large variation, precluded any apparent differences in the abundance of these species from inshore to offshore waters. Bathypelagic species which are typical of oceanic conditions were found 30 and 20 miles from shore, with the notable exception of the Newport transect where the water is shallower and no bathypelagic fishes were captured.

Diaphus theta was the predominant myctophid in both shallow water tows (to about 30m) offshore and in the nearshore collections (20 to 30 miles from shore) whereas L. leucopsarus was predominant in the tows to 200m in offshore waters.

Oblique tows to 200, 500, and 1000m depth revealed differences in the depth distribution of certain fishes: Cyclothone signata was common in tows to 500m as well as large Chauliodes and bathylagids. Tows to 1000m included Cyclothone microdon, Lampanyctus nannochir, melamphaids, searsids, and a cetomimid.

More than 30 collections of demersal fishes and epibenthos were made with the small otter trawl and biological dredge from depths of 50 to 1800m. The species composition of these collections, which is presently being analysed, is diverse and appears to be more variable than that of the mid-water trawl. Fishes such as certain species of Pleuronectiformes, Macruridae, Scorpaenidae, or Myxinidae sometimes completely dominated the catches.

Benthic Fauna -- James E. McCauley

An inventory of bottom invertebrates has been initiated as a preliminary investigation to a quantitative study of the ecology of the ocean floor. Seven collections with a biological dredge from depths of 50 to 1000 meters, and 14 otter trawls ranging in depth from 70 to 2200 meters have yielded a wide variety of animals. Identification of the invertebrates from these collections is underway. Preliminary examinations reveal that echinoderms constitute the major group of bottom invertebrates.
A reference collection of invertebrates has been started as an aid to identifying the forms. To date, 58 species have been added to the collection. The collection includes 25 species of molluscs, 19 species of echinoderms, 11 species of crustaceans, and three species of annelids.

**Water Masses off the Oregon Coast** -- Donald Rosenberg and June Pattullo

Data collected during the August cruise of the ACONA are being analyzed to determine the characteristics of offshore water during this period.

Current directions and velocities are being compiled from drift bottle data, drogues, and computed geopotential flow, to help track the origin of the water masses.

Drift bottle data indicate a surface current near the coast flowing north during the winter months and an indistinct current flowing south during the summer months.

Computations for geopotential flow are not yet complete.

**Seasonal Heat Storage in the Pacific Ocean** -- June Pattullo

Comparisons between the observed heat storage during IGY and the computed local heating were completed early in the quarter, and charts showing the advection during each season were prepared. The results were discussed in a paper presented at the Pacific Science Congress in Hawaii. A paper on this work is being prepared for publication.

**Shipboard Chemical Analysis** -- Kilho Park, L. W. Latimer and W. A. De Ben

During cruise 6108D of Research Vessel ACONA, pH, alkalinity, inorganic phosphate, and dissolved oxygen were determined off the Oregon coast, up to 165 miles offshore in conjunction with the regular hydrographic survey.

Preliminary data reveal that both pH and inorganic phosphate distributions are similar to the "upwelling" pattern which is frequently observed in temperature and salinity structure near the Oregon coast. The upwelled water contained approximately 1.1 μg-atoms/L of inorganic phosphate concentration at the surface.

Dissolved oxygen distribution at the upwelling region did not show as clear a pattern as that of the inorganic phosphate and pH, probably because of the atmosphere-sea oxygen transfer and possible biological activities in the euphotic zone.
Geology of the Oregon Continental Terrace -- J. V. Byrne.

Samples of sediment and rock were collected from 129 different positions on the continental shelf and upper slope between 40°20'N and 45°00'W offshore to 124°45'W. Collections were made at three mile intervals (primary grid) by means of a Dietz-Lafond sampler and rock dredge.

Sedimentary rocks, mainly siltstone and shale, are common as nearshore reefs, on Stonewall Bank and its extension toward Heceta Bank, and on the numerous sea knolls which characterize the upper slope. To date no igneous rocks have been collected.

Visual examination of the sediment samples reveals that fine and very fine sand are most common on the shelf, and that clay and silty clay characterize the upper slope.

The geomorphology of this area is being developed from Coast and Geodetic Survey "Smooth Sheets" and P.D.R. fathograms made during various cruises of the ACONA.

Coastal Erosion and Deposition -- J. V. Byrne, L. D. Kulm, and N. J. Maloney

Evaluation of coastal erosion from aerial photographs shows that fracture pattern, attitude of sedimentary and volcanic strata, and lithology are the most important factors affecting erosion along the Oregon coast north of Coos Bay. Areas where each of these factors is dominant are being mapped from the photos and will be studied in more detail in the field.

The investigation of coastal deposition has been extended south of Yaquina Bay to the Klamath River in northern California. Forty-two beach, 9 dune, and 14 river sand samples have been collected between the Siuslaw and the Klamath River, and size distribution and per cent heavy minerals have been determined for each.

A total of 73 beach, 23 dune, and 14 river samples have now been collected along the Oregon coast. The petrographic analyses of these sands will not only provide an inventory of the coastal sands, but will be helpful in determining the source of the continental shelf deposits.

Estuarine Sedimentation -- J. V. Byrne, L. D. Kuln, and N. J. Maloney

Detailed mechanical, petrographic and chemical analyses of 24 cores and 106 grab samples from Yaquina Bay and associated environments have been completed.
On the basis of mechanical and petrographic analyses, it is tentatively concluded that the sands in the estuary below Oneatta Point have been brought into the bay from the littoral zone by wind or tidal action, and that the sands above Oneatta Point have been contributed from the Yaquina River drainage system. The finer grained deposits on the tidal flats are believed to have been derived from the drainage system.

A comparison of recent and older charts and U. S. Corps of Engineer records and predredge surveys for the past ten years indicates that the areas of shoaling have been constant, but that the rate of shoaling has been influenced by meteorologic and hydrographic variations.

Generic identification of Foraminifera from 40 of the bay samples reveals a faunal distribution greatly affected by salinity patterns within the bay. The lower channel or bay mouth fauna, with high percentages of Elphidie1la, Cibicides and Discorbis, is similar to the nearshore marine fauna south of the bay. The inner bay fauna is dominated by Buccella and lacks Cibicides and Discorbis. The channel in the vicinity of Oneatta Point contains a transition fauna consisting of the bay and nearshore calcareous forms and the upper estuary arenaceous Formainifera Trochammina and Haplophragmoides. In general, the Foraminifera are most abundant in the channel and along the channel margins; the tidal flat fauna is sparse.

Proposed Phytoplankton Research Program -- Herbert Curl, Jr., and Lawrence F. Small

The proposed program in phytoplankton research will be an investigation into the production rates, distribution, ecological succession, taxonomy, nutrient, metabolism, and chemical composition of the phytoplankton algae. Insight into these phases of "primary ecology" will eventually lead to quantitative clarification of the role of phytoplankton, collectively and specifically, in the dynamic production process, or "food web," in the ocean.

The program can be separated effectively into four divisions: (1) seasonal succession and distribution, (2) estimation of primary production, (3) physiological ecology and (4) biochemistry and cellular physiology.

Phytoplankton will be examined in sedimentation chambers under the inverted microscope, on cleared millipore filters, and by fluorescence microscopy. Analysis of species composition and standing crop will indicate which organisms are most likely to be of importance as food for higher trophic levels, and if any recurring associations of certain species are present (as possible indicators of certain water masses or special environmental conditions). Mr. Carl Lehman, a student working toward a doctorate, is studying the taxonomy of the plankton algae off the Oregon coast. We also hope to build up a permanent phytoplankton reference collection with detailed drawings and/or photomicrographs.
The estimation of primary production is extremely important in that understanding of the photosynthetic process and interconversion of energy and nutrients is closely allied with production rate. A variety of rate measurement techniques will be employed to estimate primary production because there is some doubt as to what is being measured by each of the methods.

$^{14}$C uptake, both in situ and aboard ship in lighted incubation aquaria, will be measured from surface to depth of the euphotic zone at all stations throughout the year. Oxygen evolution measurements in "light" and "dark" bottles will be taken concurrently with the radiocarbon measurements, using the Kanwisher-Carritt oxygen electrode. Pigment extraction, with especial reference to chlorophyll "a" (thought to be rough indicators of potential gross photosynthesis), will also accompany the radiocarbon data at each station. Later a fully automatic system may be developed to monitor community photosynthesis and respiration at selected stations.

Factors affecting primary production, seasonal succession, and distribution of phytoplankton will be evaluated concurrently with measurements of production rates and standing crops. Besides more conventional nutrient analyses, bioassay methods will be used to determine the presence of vitamins, iron, and divalent sulfur. The grazing of zooplankton on phytoplankton will be studied in the laboratory using single-species, bacteria-free algae cultures labelled with radiophosphorus, and a "representative" copepod as the consumer. The experimental scheme used will be one that can be expanded easily.

The physiological ecology approach will involve the duplication of natural conditions in the laboratory, insofar as possible, and subsequent variation of one environmental factor at a time. From the responses of single-species, bacteria-free cultures to varying experimental conditions, and with knowledge of the natural conditions, we hope to predict the seasonal occurrence and abundance of experimental species. Dr. Curl already has had initial success along these lines.

Our ignorance of metabolic pathways in photosynthesis and respiration contributes to confusion on the significance of various ways of measuring organic production. Catabolic pathways of a common and usually abundant marine diatom, such asSkeletonema, will be systematically mapped, and this information used to interpret changes in cellular respiration of starving and nutrient-sufficient cells in light and dark. Previous work by Dr. Curl has already indicated that some of the most common phytoplankton algae do not possess the classical Krebs cycle of intermediary metabolism.

To date, most of the endeavor has centered around the ordering and construction of large amounts of specialized equipment, the identification and taxonomy of phytoplankton species off the Oregon coast, and the training of personnel in the various techniques to be employed, and in use of the equipment.
Investigations have been made as to procedures for extracting the salts and organic material from ocean sediments using 5 different solvents: (1) Acetone, (2) Diethylether, (3) H₂O, (4) Isopropylalcohol and (5) water extraction by electrodialysis. All samples were vacuum dried at 80°C after extraction. Extractions 1 through 4 were performed by means of a Soxhlett extraction apparatus. The solvents were selected to investigate the extraction ability in relation to their polarity. Samples of each method of extraction were ground until the material would pass through a 200 mesh screen.

B.E.T. (Brunauer, Emmett and Teller) surface area determinations were made on the above samples by the gravimetric method with nitrogen and water vapor. Nitrogen isotherms were made at liquid nitrogen temperature (-196°C.) and water vapor isotherms at 25°C. These preliminary investigations show surface areas from 14 to 35 m²/g for nitrogen adsorption and from 39 to 55 m²/g for water vapor adsorption. The samples electrodialyzed consistently showed the highest surface area. In general, for an individual sample, surface area by water vapor adsorption is about 2.5 times the surface area calculated from nitrogen adsorption indicating the probability of many micropores that require a polar molecule for penetration.

The data obtained up to this time indicates the necessity for multiple extractions for consistent results. This will be the next step in the investigation.

FACILITIES

Research Vessel ACONA

The ACONA has operated fifty-six days between 23 May and 12 September, and has travelled 5500 miles. Routine observations included 105 Nansen bottle casts, 197 bathythermograph casts, 95 Clarke-Bumpus plankton tows, 53 midwater trawl tows, 127 geological bottom samples, 26 Otter trawl tows, 7 biological dredge hauls, tracking of 11 parachute drogues, and release of 767 drift bottles.

The bow propulsion unit and hydraulic "A" frame, deep sea winch boom, deep sea winch, and hydrographic winch have proven very successful in improving the efficiency and accuracy of sampling. The bow propulsion enables the ship operator to maneuver the ship to maintain the desired wire angle. The deep-sea winch boom and hydrographic "A" frame have minimized the handling of equipment over the side of the vessel. The deep-sea winch and hydrographic winch, which are both remotely operated, provide precise control needed in working gear over the side.

The deep-sea winch with a capacity of 6000 meters of 5/8 inch wire rope has been used in making deep trawl tows (using a 20 foot shrimp trawl) as deep as 2200 meters. To reach the bottom with the net, required 5200 meters of wire rope.
Dr. Joseph W. Berg, Jr. has joined the staff as Professor of Geophysical Oceanography. Dr. Berg has a distinguished record of research and teaching in seismology. His many publications report on a wide range of field studies as well as experimental and theoretical researches on seismic waves, gravity and physical properties of crustal materials.

Until joining the Oregon State University staff, Dr. Berg was with the Institute for Defense Analysis. He had been serving as a geophysicist on a program concerned with basic and applied research and systems development of importance in detection of underground and underwater nuclear detonations. Dr. Berg also has a rich background of university experience. He has been an academic member of the staff of four institutions of higher learning and served for five years as an associate professor of geophysics at the University of Utah. He holds Ph.D. and M.S. degrees in geophysics from Pennsylvania State University; his undergraduate work was at Armstrong College and the University of Georgia.

Dr. Berg plans to develop a strong program of seismic and gravity research in the nearshore and offshore region. He has a particular interest in tracing crustal structures from land to sea across the continental shelf. He also plans to develop several courses in his field.

Dr. James E. McCauley has joined the staff with the rank of Associate Professor. Dr. McCauley returns to his interest in marine zoology after a year at Montana State College applying his special knowledge of trematodes to a study of liver fluke in cattle. He also returns to Oregon State, where he completed his doctorate in 1954 and later was, for four years, Research Associate in the Department of Zoology.

Dr. McCauley's research has touched upon such diverse fields as shellfish ecology and the morphology of a marine tectibranch; he is best known for his work on trematode parasites. He has numerous publications and is co-author of a catalogue of trematodes of the Pacific Northwest. He also has taught a wide variety of courses in biology, including zoology, botany, bacteriology and physiology.

Dr. McCauley received his B.S. in zoology from the University of Washington, although his education was interrupted by four years in the Navy during World War II. He received his M.S. in invertebrate zoology, from the University of Washington, and his Ph.D. from Oregon State with a major in parasitology and invertebrate zoology.

Dr. McCauley has initiated a study of the benthic fauna on the shelf and slope off the Oregon coast, and plans to extend this to deeper waters offshore.
Dr. Lawrence F. Small has joined the staff with the rank of Assistant Professor. Dr. Small came to Oregon State from Iowa State University, where he studied the interrelationships between the phytoplankton and zooplankton populations of a lake. In the course of the work he developed a rapid chlorophyll extraction technique that made it possible to analyze efficiently a large number of samples in order to follow the seasonal variation in phytoplankton standing crop.

Dr. Small received an A.B. from the University of Missouri with a major in wildlife management. His graduate work at Iowa State University led to an M.S. in fisheries biology, and his Ph.D., also from Iowa State, was with a major in zoology and minors in statistics and botany. He served for two years as a First Lieutenant in the United States Army.

In collaboration with Dr. Herbert Curl, who will soon arrive on campus, Dr. Small is developing a program on the primary ecology of the marine plankton in offshore waters (see Proposed Phytoplankton Research Program, elsewhere in this report).

PUBLICATIONS AND PAPERS

Papers Published


Papers Submitted for Publication


Pearcy, William G., Distribution and ecology of the fishes of the Mystic River estuary, Connecticut. Accepted by Ecology.


Technical Reports Distributed

Kujala, Norman and Bruce Wyatt, Surface temperature and salinity observations at shore stations on the Oregon coast, Data Report No. 6, Ref. 61-4, Dept. of Oceanography, School of Science, Oregon State University, June 1961.

Papers Presented at Scientific Meetings


Pattullo, June G. Seasonal heat advection in the Pacific Ocean during the IGY. Given 26 August 1961 to the Tenth Pacific Science Congress, Honolulu, Hawaii.