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Univ. Washington  
Oceanography

UNIVERSITY OF WASHINGTON - OCEANOGRAPHY

PROGRESS REPORT OF THE OCEANOGRAPHIC LABORATORIES

October 1, 1931 - 1932

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PROGRESS REPORT OF THE OCEANOGRAPHIC LABORATORIES  
FROM OCTOBER 1, 1931, TO OCTOBER 1, 1932

Building, Boat and Equipment

A. Laboratories on Campus

Occupancy of the new oceanographic laboratories began April 1, 1932. The installation of the laboratory furniture was completed during the summer, and the building was made available for scientific work on September 15, 1932.

In the interests of economy and in order to have as much money as possible for scientific equipment, twelve of the twenty-four private research laboratories were not completed or equipped. At the time this decision was made, it was thought that the space available for scientific work would be ample for at least two or three years, but this fall five applications for rooms had to be refused.

The circulating sea water system has been installed, which has a total capacity of about 48,000 gallons. The water is cooled to the average temperature of Puget Sound before circulating through the aquaria. The humidity of the building is regulated to prevent dilution of the sea water by condensation and sweating on the outside of the aquaria. Some trouble has been experienced with the breakage of the glass in the aquaria due to stresses, but this problem seems to have been solved by Professor May. At present fresh water is being run through the system to test the filters, pumps, and cooling equipment. About November 15, the sea water will be brought to the laboratories in a barge and pumped into the storage tanks.

Parts of the building need acoustical treatment, and some of the walls and ceilings need painting. This was sacrificed to insure ample funds for equipment.

#### B. The Boat

The research boat Catalyst went into operation June 20. It is 75 feet long, has an 18-foot beam, and is powered with a 120-horse power Washington-Estep engine. It has a cruising speed of 8 knots and a cruising radius of 3200 miles. The laboratory on the main deck provides space for seven scientists and is equipped with gas, alternating and direct current, Duriron drains, fume hood, compressed air and running sea water. The nature and extent of the work carried out on board has far exceeded our expectations. There is no vibration when the main engine is running, but considerable inconvenience is experienced when the auxiliary generator is in operation. This difficulty we hope to remedy when opportunity offers. The boat is equipped with about 1000 meters of half-inch cable for dredging and about 4500 meters of quarter-inch stainless steel cable for water sampling and net hauling. The winches are electrically operated.

During our cruise off the Washington coast this summer and in Alaskan waters, we had sixteen persons on board, twelve scientists and scientific assistants, the captain, engineer, cook, and deckhand. Since the boat was put in commission, it has cruised some 5000 miles and made approximately 11,000 observations.

The boat is absolutely seaworthy as shown this summer when we experienced a No. 11, Beaufort Scale, gale some fifty miles off Cape Spencer on the Alaskan coast.

Last spring, when asked by the Administration for an estimate of the cost of operation and maintenance of the boat, the figures of \$5,000 for the first year and \$8,000 for the remaining years, were given. The difference was due to (a) the first year the boat would be new and items for repairs and alterations would be small; (b) it was assumed that the money would be available January 1 (similar to original grant) and that the boat would only be in operation nine months of the first year. However, the Rockefeller Foundation gave us \$5,000 annually for a period of four years, and a budget has been prepared accordingly by curtailment of some of the work originally planned. The business office has charged the cost of insurance to the maintenance fund provided by the Rockefeller Foundation, but this has been protested by the staff. It is believed a readjustment will be made. (The insurance amounts to \$2677.50).

#### C. Friday Harbor Laboratories

The laboratories at Friday Harbor have functioned throughout the year, scientific observations being made continuously. During the summer session, only graduate students and advanced workers are accepted as residents.

A new salt water system has been installed in the laboratories, a cantilever observation pier constructed, and the curator's house has been remodeled. Scientific equipment has been considerably augmented.

There are two outstanding needs for the Friday Harbor laboratories at present. One is suitable living conditions for members of the staff, particularly those with children and those who are rather advanced in years and who find the living in tents during rainy weather a handicap

to health. The other need is suitable dockage facilities for the Catalyst. At present we maintain a float of logs and pontoons, which admirably serves the purpose of handling the live boxes and small craft but is far too light for the needs of the Catalyst. A small sturdy pier with trucking facilities would greatly facilitate boat operations and eliminate a source for accident that exists with the use of the present float by the Catalyst.

#### D. Establishment of Fellowships

The general retrenchment throughout the University has eliminated a number of teaching fellows, and the economic conditions have made it impossible for many good students to continue their graduate work. The establishment of fellowships would not only aid some worthy students but also materially advance the research program of the Laboratories.

#### Summary of Needs

1. Increased allowance for boat maintenance
2. Dockage facilities at Friday Harbor.
3. Better living conditions for staff at Friday Harbor.
4. Completion and equipment of unfinished portion of the campus laboratories and acoustical treatment and painting in certain parts of the completed structure.
5. Establishment of fellowships for worthy students.

REPORT OF THE SCIENTIFIC WORK  
OF THE OCEANOGRAPHIC LABORATORIES

Staff

Botany - Prof. George B. Rigg (Plant Physiology)  
          Dr. Lyman D. Phifer (Phytoplankton)

Chemistry - Prof. Thomas G. Thompson  
            Dr. Rex J. Robinson

Physics - Prof. Clinton L. Utterback

Zoology - Prof. John E. Guberlet  
          Prof. Robert C. Miller

Collaborating Scientists

Bacteriology - Dr. B. S. Henry

Biochemistry - Prof. Earl R. Norris

Fisheries - Dr. Leonard P. Schultz

Zoology - Prof. Trevor Kincaid

The members of the staff and collaborating scientists direct the various researches in progress in the laboratories, and the projects as outlined below have been prepared by the individual members. Reports from Prof. Kincaid and Dr. Schultz are not included, at this time, as their researches are dependent upon the circulating sea water which will not be in full operation for another month.

## INVESTIGATIONS IN PLANT PHYSIOLOGY

Prof. George B. Rigg

The early phases of all of these lines of work have been done at Friday Harbor. Later phases are being carried on at the laboratories on the campus.

### 1. Colloidal Materials in Kelps. (with Bernadine Dunsford)

Large amounts of these materials are present in kelps that are abundant near the Oceanographic Laboratories at Friday Harbor. Work has been in progress during 1931 and 1932 on the preparation of these materials and the determination of their properties. A paper was read at the meeting of the Botanical Society of America at Pullman, Washington, in June, 1932. This paper will be ready for publication early in 1933. Further work along these lines and also the relation of these materials to the metabolism of the plants is to be done. This is a pioneer field which has now been investigated at the Oceanographic Laboratories far enough to indicate its importance and open up definite biochemical and physiological problems.

2. Enzymes. Two papers on an enzyme in kelps were published a few years ago by graduate students (Sundquist and Platt) in plant physiology in the University of Washington. Some work has since been done (Rigg) which has not yet led to publication. Several definite problems now await workers who are prepared to attack them.

This work correlates with work that is now opening up on enzymes of marine animals and marine bacteria.

Investigations in Plant Physiology

3. Pigments in Marine Algae. (with Robert Tschudy)

4. Photosynthesis and Respiration in Marine Algae. Methods of investigating these processes and their relation to physico-chemical factors have been worked out at the Oceanographic Laboratories at Friday Harbor. A few problems are open to competent workers.

5. Red Pigments in Salt Marsh Plants. Considerable progress has been made in determining the physiological factors in the occurrence of these pigments. A paper will be ready for publication soon, and the investigation will be continued.

## INVESTIGATIONS OF PHYTOPLANKTON

Dr. Lyman Phifer

### Research Completed

1. Vertical Distribution of Diatoms in Strait of Juan de Fuca and San Juan Archipelago. Read before Western Society of Naturalists meeting at Berkeley, California, December, 1931. Unpublished.

2. Quantative Study of Occurrence and Distribution of Planktonic Diatoms at Friday Harbor, Washington, from May 1931 to May 1932. This has been accepted for publication in University of Washington Publications in Oceanography.

### Research Problems in Progress

1. The study of an annual cycle of productivity of a water body known as East Sound as to the phytoplanktonic, chemical, physical constituents of the water. Samples are collected semi-monthly by aid of Coast Guard boats and are worked up through the cooperation of various members of the staff.

2. A study of the taxonomy and distribution of the genus *Dinophysis* from plankton samples collected from the Catalyst.

3. The study of a "coffee"-colored water due to a very minute plant occurring off Cape Flattery and Vancouver Island during July and August, 1932. The plant is unknown and new. The phenomena must be further investigated next summer, because in corresponding with Dr. H. H. Gran of Oslo, he insists that this type of water is new.

Investigations of Phytoplankton

4. The identification and description of new phytoplankton organisms that have been found since April, 1931.

5. A continuous study of the sea water at Friday Harbor laboratories from samples collected every fourth day and worked up by various cooperating members of the staff.

6. Daily observations of meteorological and water temperatures at Friday Harbor laboratories which include the operation of tide gauge and pyrheliometer stations which are operated in cooperation with government projects.

Phytoplankton is an important group of organisms in the sea, since in their protoplasm chemical compounds are combined with radiant energy forming food. Therefore, phytoplankton are a primary source of food of the animal life of the sea. At the present stage of development of biological oceanography, I consider the study and description of the annual, geographic, and bathymetric occurrence and distribution of phytoplankton organisms to be fundamental. In this line of study we will derive an understanding of the productivity of various water bodies.

## INVESTIGATIONS IN CHEMISTRY

Dr. Rex J. Robinson

Determination of Organic Phosphorus in Sea Water. A method for the determination of organic phosphorus has been evolved which, when applied to marine analysis, will add materially, it is hoped, to our knowledge of the marine phosphorus cycle.

Kjeldahl Nitrogen and Albuminoid Nitrogen. (with Henry E. Wirth) Vertical distribution of albuminoid and Kjeldahl nitrogen has been studied in various localities near Friday Harbor the last two summers in an effort to obtain information regarding the role of nitrogen in marine life.

Micro-Analysis of Diatoms. This problem has included a study of the various micro-analytical procedures necessary for such an analysis. Methods are now available with which analyses may be made with speed and precision.

A seasonal study of the chemical and biological nature of Lake Washington (with V. Scheffer) will be begun in the immediate future.

A rapid method with which to study the distribution of potassium in fresh and marine waters (with A. Putnam) will be attempted.

## INVESTIGATIONS IN THE PHYSICS OF THE SEA

Prof. Clinton L. Utterback

The projects upon which work is now being done are listed here with a few statements concerning the progress and future developments contemplated.

### 1. Penetration of the Visible Solar Radiation Into Ocean Waters.

This work has been carried on during the past year to the extent that eight stations in the San Juan Archipelago have been studied to a depth of 50 meters. An apparatus, containing a photoelectric cell, has been constructed so that when submerged readings can be taken on seven different frequency bands, at a given depth, in four or five minutes. The selection of the filters, limiting the frequencies, is electromagnetically controlled from the boat laboratory. In addition, considerable data have been obtained in the waters of southern Alaska. This work is to be extended to measure scattering and, later, it is hoped to obtain some information of the polarization.

### 2. Relations Between the Total Radiation Intensity and the Illumination Intensity.

This work has proceeded only to a study of surface conditions - not to conditions beneath the surface. The Eppley pyrheliometer, installed at the laboratory, together with illumination measurements are used. A preliminary report of some of the past summer's work has been submitted to the literature.

### 3. A study of climatic conditions as affected by the total solar radiation as recorded by the pyrheliometer will be carried on as the radiation records accumulate. The instrument was placed in operation in August, 1932.

Investigations in the Physics of the Sea

4. A continuous record of tides is being kept for study.

It now appears that the tides at Friday Harbor, Washington, are a little off phase. The tidal gauge was installed through the cooperation of the United States Coast and Geodetic Survey, by courtesy of Captain Hardy.

5. The records of the pyrheliometer and the tidal gauge, as they accumulate, will furnish a basis for studies of other conditions pertaining to general oceanography.

6. The Radioactivity of Sea Water. This work has been in progress for two years. A report will be published in the December issue for 1932 of the Journal du Conseil. Apparatus of greater sensitivity is planned and when available will enable us to make more valuable studies.

7. The Radioactivity of the Material of the Bottom of the Sea. About fifty samples have been collected and are being prepared for analysis. These samples came from selected places in Puget Sound and in Alaskan waters. Apparatus for the analysis is to be built.

8. Relation Between the Refractive Index and the Chlorinity of Sea Water. More than 100 samples have been collected and most of them analyzed. This study is being made for water from the sea, sound waters, strait waters, waters diluted by drainage rivers, and waters of the sea in the region of glaciers.

## INVESTIGATIONS IN ZOOLOGY

Prof. John E. Guberlet

### 1. Studies on the Complete Life History of the Puget Sound

Annelid, Nereis Agassizi. (with Martin W. Johnson) This work was carried on experimentally for a period of two years. The eggs were taken in July from the spawning worms and fertilized in the laboratory. Studies were made of the hatching of the eggs and the larval development was followed throughout the entire year. All stages in the development were observed. The change from the "nereis stage" to that of the Heteronereis stage" was observed to take place during the latter part of March and early in April. Sexual maturity was reached in the laboratory worms during the latter part of June and in July. The life cycle is completed in one year. This work is being prepared for publication.

### 2. Continuation of Studies on Life Histories of Puget Sound

Annelids. The life cycle of *Nereis procera* was demonstrated experimentally in the laboratory at Friday Harbor in 1931-1932. Eggs were obtained from spawning worms in August 1931 and the larvae were reared through the winter. Sexually mature individuals appeared in the cultures in July 1932. This cycle is being duplicated and checked throughout the present year in order to clear up some points which could not be observed last year.

Similar experiments are being carried on with *Arenicola pusilla* and *Glycera rugosa*.

This line of work will undoubtedly require a period of several years for its completion.

Investigations in Zoology3. Studies on Some Fish Trematodes from Puget Sound Fishes.

(with Fred J. Kohlruss) This project has been in progress for two years and a small portion is nearing completion. Two genera of worms are being studied - *Genolinea laticanda* and some species of *Hemiurus*. These studies comprise the morphology, the various hosts attacked and geographical distribution of the parasites.

4. Notes on Morphology and Life Histories of Cestodes from Puget Sound Elasmobranchs. (with John F. Hart) This project has been under way about a year and large collections of the parasites have been made. Skates and various species of sharks have been taken in the Sound from Olympia to Point Roberts and their parasites were collected. This gives something of their distribution. Life history studies are being attempted through experimental feeding.

5. Morphology and Distribution of *Rajonchocotyle* from Puget Sound Skates. (with G. Ablan) This project treats of the ecto parasitic trematode on the gills of skates. All of the data are at hand and the material is being prepared for publication.

6. Studies on the Morphology and Distribution of *Microcotyle* of Puget Sound Fishes. (with Kelshaw Bonham) Work on the project has been under way for about a year and a half. It deals with the gill and skin trematodes of marine teleost fishes.

7. Morphology and Description of Two Species of *Acanthocotyle* from Puget Sound Skates. This work has been under way for nearly three years and is nearing completion.

Investigations in Zoology

8. Relationship of Physical and Chemical Factors in the Distribution of Animals from Puget Sound to Alaska. This project was started during the past summer and is cooperative research. This involves the distribution of animals from the southern part of Puget Sound up to southeastern Alaska. Records of animals were obtained by dredging and an attempt is being made to determine their distribution from physical and chemical data obtained from the same areas.

## REPORT ON RESEARCH IN PROGRESS IN ZOOLOGY

Prof. Robert C. Miller

1. Wharf-pile Organisms in Puget Sound. Ecology and seasonal distribution of shipworms, barnacles, etc. Factors affecting their settlement on piling. Period of survival in fresh water, and under other adverse conditions. The Pacific Biological Station at Nanaimo and the University of British Columbia are cooperating with us by starting a similar investigation in Canadian waters.
2. The Zooplankton of Puget Sound and Adjacent Waters. The work thus far has been largely testing of plankton nets of different types and the standardization of methods and equipment. Quantitative plankton samples from the trip of the Catalyst to Alaskan waters are now under investigation. Preliminary results indicate a much greater abundance of zooplankton at considerable depths (250-500 fathoms) than was anticipated. These studies are of considerable importance from the standpoint of the food supply of fishes.
3. The Physiology of Digestion in Invertebrates, especially the digestion of cellulose by oysters, clams, shipworms, etc. It is not definitely known whether this digestion is enzymic or bacterial. Mr. H. A. Hanson is now engaged on this problem, with the expectation of writing his doctor's thesis upon it.
4. Morphology and Ecology of the Moon-snails of the Genus Polinices. Miss Mary E. Russell is engaged in a comprehensive study of this group of large marine snails, as a basis for writing a doctor's thesis on the fossil representatives of the same group. A study of the living forms is regarded as

Report on Research in Progress in Zoology

fundamental to an interpretation of the conditions of life under which the fossil forms must have lived.

5. Factors Affecting the Rate of Division of Unicellular Organisms.

This is a general study of the physical factors influencing cell division. It is not only a problem of interest in connection with the reproduction of marine protozoa and protophyta, but is one of the fundamental problems of biology. Two students, John Roberts and Vance Tartar, are working on different aspects of this problem.

6. A project on which it is planned to embark in the immediate future is a study of the hydrobiology of Lake Washington. This large and deep lake presents a group of problems of very great scientific interest,-- the plant and animal organisms which occur in the lake, their seasonal cycle, their inter-relations with each other and with the chemical and physical conditions of the lake. No comprehensive study of this kind has ever been made in the Northwest. Mr. Victor B. Scheffer wishes to work on this as a problem for his doctor's thesis. Dr. Rex Robinson will collaborate on the chemical side, and Professor Kincaid on the limnological side of the work.

## BACTERIOLOGICAL INVESTIGATIONS

Dr. B. S. Henry

During the latter part of the past summer (1932) preliminary studies on the marine bacteria were undertaken at the Friday Harbor laboratories. As a basis for all future work, it was necessary to obtain information concerning the number and kinds of bacteria present in the waters of that particular area. Sufficient data has been collected to indicate that the bacterial population is relatively constant from day to day although seasonal variations have not been determined as yet.

Samples taken at depths varying from ten to one hundred meters have shown that the bacterial population increases with increases in depth. This is in agreement with the conditions found in other northern waters such as those adjacent to Norway, but contrary to the findings for southern waters.

A study of the intestinal flora of marine invertebrates has been begun, and a number of cultures have been obtained from individuals of the same species living under different environmental conditions. These cultures are being classified and studied at the present time.

Approximately 280 cultures, obtained from the various samples taken during the work outlined above, have been examined as to their ability to reduce nitrates. These cultures will be used in the work on nitrite formation outlined below.

The bacteriological work planned for the coming year includes a continuation of the survey of the bacterial population of the Puget Sound region. In this work determinations will be made of the numbers of anaerobes present as well as counts of aerobic bacteria.

Bacteriological Investigations

The role of cellulose digesting bacteria in the metabolism of marine invertebrates will be investigated as a supplement to work being done by another department.

Emphasis, however, will be placed on an attempt to determine the influences both direct and indirect, which the presence of bacteria may have upon the concentrations of nitrite ions in sea water. As the solution of this problem is unquestionably connected with the metabolism of the bacteria, dissociation which may occur in the bacterial species concerned will of necessity be investigated. The ability of variants of marine bacteria to lose or acquire the property of reducing nitrates will be studied in relation to this problem.

## INVESTIGATIONS IN BIOCHEMISTRY

Prof. Earl R. Norris

In biochemistry of marine life, we are interested in the nutrition, digestion and metabolism of organisms found in the sea. Studying the nutritional and environmental requirements for life, including the utilization of many of the less common elements found in sea water; the enzymes of digestion and the enzymes and hormones of metabolism, making a comparison of the chemical basis and processes of life of the various phyla and species found in the sea from the simplest forms, or plankton, to the more complex, or vertebrates. At the present time we have outlined problems studying some of the tissue enzymes of metabolism of the various phyla, also enzymes of digestion as found in or extracted from the alimentary tract with its accessory glands.

In studying the utilization of the less common elements we have been working for the past year upon the distribution of arsenic in marine life and are continuing a study of the occurrence of this element in the organism.

Arsenic Content of Some Marine Organisms of Puget Sound. (with Miss Bertha Boit)

Digestive Enzymes in Fish. (with Lewis Harris)

## INVESTIGATIONS IN THE CHEMISTRY OF THE SEA

Thomas G. Thompson

### Papers Completed

1. The Determination of Iron in Sea Water. (with Raymond W. Bremner) A method was devised for determining iron. It was shown that the concentration of iron compounds was the function of the depth and the extent of phytoplankton. The iron existed probably as an organic complex. Analytical Section of Industrial and Engineering Chemistry Vol. 4, 288, July 1932.

A second paper will shortly appear, describing an improvement in method whereby the sensitivity of the test has been increased tenfold and much additional data for true ocean waters will be included.

The Determination of Fluorides in Sea Water. (with H. J. Taylor) A constant relationship of fluoride ions with chlorinities has been demonstrated after the perfection of a reliable method for determining fluorides. However, there is a slight variation in the fluoride-chlorinity ratios in "inside" waters, that is, waters of estuaries, sounds, channels, and straits, especially those of the surface that have been subjected to dilution. This paper has been submitted to Analytical Section of Industrial and Engineering Chemistry for publication.

3. The Determination of Silicon and Its Occurrence in the Waters of the Puget Sound Region. A critical study was made of the method, and a number of determinations were made. River waters are high in silicon, and yet the sea waters at the mouths of rivers are considerably lower than those farther seaward. The sources of silicon in sea water are listed as an explanation.

Investigations in the Chemistry of the Sea4. The Determination of Alkalinity, or Buffer Capacity.

A field method has been developed and this property of sea water studied. Published in Analytical Edition, Industrial and Engineering Chemistry, Vol. 3, 393, October 1931.

5. In a recent bulletin of the National Research Council, No. 85, two chapters have been written on the physics and chemistry of the sea in collaboration with Dr. Robinson.

6. A Study of the Radioactivity of Sea Water. (with Mr. D. Devaputra and Dr. Utterback) A report of this study will appear in the Journal du Conseil for December, 1932.

Work Completed and Ready for Publication

1. A method for the determination and the distribution of iodine in sea water. (with Lacey H. Evans)

2. Determination of nitrates and nitrites and their distribution in the waters of Puget Sound region and off the Washington coast. (with Lacey H. Evans)

3. The occurrence of nitrates and nitrites in the waters of the inside passages of Alaska and off the coast of Vancouver Island, British Columbia, and Alaska. (with Raymond W. Bremner)

4. The first quantitative studies of lithium in sea water have been made and a method devised for its determination. (with Bertram D. Thomas)

Investigations in the Chemistry of the SeaResearch in Progress

1. The existence of free ammonia in sea water. (with Henry E. Wirth) A large number of analyses have been made, and the general opinion concerning free ammonia in sea water appears to be in error.
2. An investigation of the electrical conductivities of aqueous solutions of mixed electrolytes with determinations of their partial molal specific conductances at various concentrations and temperatures and an application of the results to the study of sea water and similar systems. (with B. D. Thomas)
3. Study of the concentration of sea water by freezing. Development of methods and apparatus for carrying out the concentration. Study of the equilibrium relationships of the different solutions and salts which are formed during the process. (with Iver Igelsrud)
4. A method for determining manganese in sea water and its distribution is being developed. (with Thomas L. Wilson)
5. A method for determining arsenic in sea water and its distribution is being developed. (with Clifford A. Barnes)

Probably the most interesting fact that the Laboratories have demonstrated from the chemical viewpoint thus far is the explanation for the extreme richness of the biological life in the Puget Sound region. It has been shown definitely this summer, by a vast number of analyses and temperature measurements off the coast of Washington, that there is a marked upwelling of the rich ocean waters from the depths to the surface at the

Investigations in the Chemistry of the Sea

mouth of the Strait of Juan de Fuca. This is caused by the tidal currents and the general rotation of the earth which causes the waters to be forced upward as they enter the submarine canyon at the mouth of the Strait. To further demonstrate the phenomenon, a similar canyon was found off Cape Spencer at the entrance to Icy Strait, off the coast of Alaska, and the same characteristics were likewise observed.

Another interesting fact which will need further amplification and study is the marked difference in the waters off the Washington, Vancouver Island and Alaskan coasts as compared with those found 200 to 250 seaward.

The results obtained on the summer cruises of the Catalyst will be worked up in the laboratories this winter.

Studies of the seasonal variations of the waters in parts of Puget Sound and San Juan Archipelago are being conducted.

The United States Coast and Geodetic Survey and the United States Coast Guard have been unusually kind in their cooperation with us.

A large number of bottom samples were collected on the summer cruises and will be subjected to a physical and chemical examination.

PROPOSED BUDGET FOR THE OPERATION  
OF THE CATALYST FOR ONE YEAR

The sum of \$5,000 a year has been allotted for operation for a period of four years, but this amount is not enough to cover the expenses if full use is to be made of the boat. The following budget itemizes the expenses before making the curtailment necessary to meet the amount available.

Note: The ten per cent reduction ordered by the Board of Regents in all salaries, has been deducted.

# BUDGET FOR CATALYST

<u>Salaries and Wages</u> . . . . .	\$3603.75
Captain, 12 mo. at \$157.50 per mo. . . . .	\$ 1890.00
Engineer, 175 days at \$4.50 per day . . . . .	787.50
Cook, 175 days at \$3.75 per day . . . . .	656.25
Deckhand, 120 days at \$2.25 per day . . . . .	270.00
<u>Food</u> . . . . .	1058.25
Board for captain, engineer and cook for 175 days at 85¢ per day . . . . .	446.25
Board for deckhand, 120 days at 85¢ per day . . . . .	102.00
Board for scientific assistants, 600 days at 85¢ per day . . . . .	510.00
<u>Fuel and Engine Room Supplies</u> . . . . .	723.05
Fuel oil, 10,000 gal. at 4-1/2 ¢ per gal. . . . .	450.00
Flamo, 20 cylinders at \$7.74 . . . . .	154.80
Gasoline, 100 gal. at 11¢ . . . . .	11.00
Lubricating oil, 150 gal. at 60¢ . . . . .	90.00
Valve oil, 5 gal. at \$1.25 . . . . .	6.25
Greases . . . . .	10.00
3-in-1 oil, 2 bottles . . . . .	1.00
<u>Paints and Varnishes</u> . . . . .	492.90
Drydocking, once a yr., 2 coats best copperpaint. . . . .	50.00
Caulking, all over, once in 4 yrs. . . . .	250.00
Paint:	
Battleship gray, 15 gal. at \$2.50 . . . . .	37.50
Outside white, 10 gal. at \$2.50 . . . . .	25.00
Inside white enamel, 5 gal. at \$3.50 . . . . .	17.50
Inside flat white, 5 gal. at \$2.50 . . . . .	12.50
Heat resisting gray enamel, 3 gal. at \$4.00 . . . . .	12.00
Mast color (buff), 1 gal. . . . .	3.00
Smokestack paint, purple, 1/2 gal. . . . .	2.00
Indian Red, quickdrying floor paint, 4 gal. at \$4.00 . . . . .	16.00
Light screen red paint, 1/4 gal. . . . .	1.00
Light screen green, 1/4 gal. . . . .	1.00
Dark buff, chocolate color enamel, 1 gal. . . . .	4.00
Black paint, 1/2 gal. . . . .	1.50
White brushing lacquer, 3 gal. at \$5.00 . . . . .	15.00
Aluminum paint, 3 gal. at \$5.50 . . . . .	16.50
Gold Bronze, 1/4 gal. . . . .	1.50
Spar Varnish, 3 gal. at \$5.00 . . . . .	15.00
Boiled linseed oil, 5 gal. at 70¢ . . . . .	3.50
Turpentine, 2 gal. at \$1.20 . . . . .	2.40
Japan Drier, 1/2 gal. . . . .	2.00
Stockholm Tar, 5 gal. . . . .	4.00

5877.95

Budget for Catalyst

Brought forward . . . . \$ 5877.95

Repairs and Replacements . . . . \$ 935.00

Engine Room . . . . .	400.00
Galley . . . . .	50.00
Laboratory . . . . .	125.00
Electric equipment . . . . .	50.00
Winches and windlass . . . . .	50.00
Meter wheels and water bottles . . . . .	100.00
Dredges, nets, etc. . . . .	100.00
Life boats, outboard motor, skiff . . . . .	50.00
Lamp globes . . . . .	10.00

Miscellaneous . . . . 860.00

Adjustment of compasses . . . . .	10.00
Navigation instruments, books and charts . . . . .	25.00
Scientific supplies and apparatus . . . . .	750.00
Customs fees, harbor fees, etc. . . . .	25.00
Rope, merlin, hardware, etc. . . . .	50.00

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Total . . . . . 7672.95