

EQUIPMENT AND METHODS USED IN OCEANOGRAPHIC INVESTIGATIONS IN THE PHILIPPINES¹

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ABSTRACT

In the Philippines, oceanographic investigations are carried out with the equipment and instruments turned over to the Bureau of Fisheries by the American Government, following the termination in 1950 of the Philippine Fishery Program of the United States Fish and Wildlife Service. The methods and chemical procedures being followed are patterned after those in practice at the former Oceanographic Laboratories of the University of Washington, U. S. A. Slight modifications in carrying out the chemical determinations have been adopted to suit local needs. Nomenclature and units are in accordance with international standards.

The importance of conducting cooperative oceanographic investigations in the Indo-Pacific region emphasizes the need of using uniformly reliable and accurate equipment and instruments, standardizing methods, nomenclature, and units. The information herein offered is intended to stimulate interest in filling this need, and invite complementary information from different countries of the region.

The equipment and instruments now in use by the Philippine Bureau of Fisheries are not the latest in design and construction, nor are they complete to enable us to carry out a comprehensive research program. Our methods and procedures, on the other hand, are an adaptation of the standardized system followed by the defunct Philippine Fishery Program of the United States Fish and Wildlife Service.

EQUIPMENT

Boat.—The M/V *David Starr Jordan* of the Bureau of Fisheries was acquired in May, 1950, as part of the equipment and supplies turned over to the Philippines after the termination of the Philippine Fishery Program. Completely rebuilt by the Grandy Boat Building Company of Seattle, Washington, the boat was outfitted for otter trawling operation in Philippine

¹ Contribution of the Philippine Delegation to the Fourth Meeting of the I.P.F.C. at Quezon City, Philippines, October 23 to November 7, 1952.

waters by the United States Fish and Wildlife Service. Although its winch is not suitable for working high-speed oceanographic gear, the boat is stable, seaworthy and highly maneuverable. An after-deck affords ample space for the work-table used in the shipboard chemical work. The walls of this table serve as racks for a battery of 15 water bottles.

The principal dimensions of the vessel are: overall length, 16.2 meters; length at water line, 14.6 meters; breadth, 4.0 meters; and draft, 2.0 meters. The 30-ton vessel is driven by a 135-horsepower Murphy diesel engine, giving a cruising speed of six knots.

The sampling gear is made up of the starboard drum of the drag winch which can pay out the $\frac{5}{32}$ -inch hydrographic wire at the rate of two meters per second, and retrieve it at about one-sixth that rate. From the starboard drum the wire passes through a sheave fastened to the seaside of the gunwale, then to the meter wheel, and thence into the water. Shocks due to uneven motions of both boat and sea are absorbed by the accumulator which is suspended above the meter wheel. The accumulator is in turn hung from the free end of the davit used as boom. This sampling set-up, though not in accordance with standard practice, has met our requirements even under adverse sea conditions.

Thermometers.—The deep-sea reversing thermometers being used are a part of the 497 Japanese thermometers which were turned over to the Philippines as part of the reparations of World War II. Fifty-seven thermometers from this stock were used by the Philippine Fishery Program, and these are the same instruments being used by the Philippine Bureau of Fisheries at the present time. They were manufactured by the Watanabe Keiki Manufacturing Co., Tokyo, Japan.

These thermometers bore no calibration certificates; hence, the corrected temperatures based on headings taken from them are only relative. Personnel of the Philippine Fishery Program had calibrated these instruments against two Richter and Wiese thermometers, but the certificates of these two reference thermometers also are not available at present.

The performance of these Japanese-made thermometers has been, as a whole, thoroughly satisfactory. A comparison of the *Baird* temperatures with those of the *Snellius* for the deep water of the Sulu Basin showed good agreement (Graham, 1949). Two of these Watanabe thermometers were tested by the "Galathea" in the Mindanao Deep in August, 1951, and

they were able to withstand a pressure of 815 atmospheres. The thermometers give readings consistently reliable to 0.02° C.

Water bottles.—Water samples are taken using the two-plug valve-type Nansen bottle of liter capacity. This type of bottle has the advantage over the modified flap-type Nansen sampler in that its reversing mechanism can be tripped by a lighter messenger. Its drawbacks, however, are: it is apt to close prematurely, and samples taken at subsurface levels may get contaminated while in transit to the upper layers of the water column, due to malfunctioning of the valves caused frequently by rough sea conditions.

STATION POSITIONS

Stations are predetermined, arbitrary, geographic positions, where the boat stops to take water samples. The choice of station position is dictated by the need of representative sampling, and by such factors as topography, nature of water circulation, and type of survey desired. On account of the fact that almost all the areas now under investigation are littered with war debris, these snags are taken into consideration in laying out the stations.

In areas adjoining the open sea, the stations are invariably distributed grid-fashion, such that the line of stations so laid cuts across the expected current. In island-studded spaces, where pockets of topographically isolated areas indicate basin conditions, stations are established over the deepest portion of the area and also over the effective sill or deepest threshold.

PROCEDURE AT STATION

Once the station is fixed, sampling is immediately commenced. Where more than one cast is necessary, the deepest cast is made first. If wind or water current causes the wire to incline to more than 8°, the boat is maneuvered to set the wire in nearly vertical position. However, a protected and an unprotected thermometers are always paired at appropriate levels to insure, during reduction of the data, the application of displacement corrections on wire depths recorded in cases when the wire angle unavoidably exceeds 8°. Messengers have been clocked at a speed of 200 meters per minute; this rate of descent affords the basis for determining when to haul the cast. Five minutes for shallow casts and 10 minutes for deep casts are allowed for the bottles and thermometers to attain thermal equilibrium with their surroundings.

Once aboard, the thermometers are read first and then samples for the chemical determinations are drawn in the following order: oxygen, phosphate, silicate, pH, and chlorinity. Chlorinity samples are taken to the shore-based laboratory where the analyses are made.

Plankton tows are run in between stations. Vertical plankton samplings are done after the water samples are in.

Owing to the slow speed of the winch, bathythermograph measurements have not been made a regular part of the hydrographic routine. Bathythermograph observations, whenever made, always precede the hydrographic sampling.

SERIAL OBSERVATIONS

Water samples are taken at the surface, and at 2, 5, 10, 20, 30, 50, 75, 100, 150, 200, 300, and 500 meters below the surface. In deeper areas, the first five standard levels below the surface are omitted; samples at 25 meters are taken instead. In shallow areas bottom samples are taken at a few meters above the bottom.

Samples are not regularly taken at depths greater than 500 meters, because below this level, seasonal changes in Philippine waters are believed to be no longer operative or are at a minimum.

In the top layers, it is desirable to shorten the sampling intervals. These intervals are, however, limited by the length of the Nansen bottles, which cannot be operated in series at less than one-meter intervals on the line.

ANALYTICAL PROCEDURES

With the exception of the pH determination, all the analyses are based on unpublished mimeographed notes prepared by Thompson and Robinson of the Oceanographic Laboratories of the University of Washington. In the following discussions of the analytical procedures, no attempt has been made to describe the chemistry of the method, nor the details of the procedure. These are amply covered in relevant literature. Only such modifications as have been adopted to suit our purpose have been treated.

Chlorinity.—The amount of halogens in the sample is determined by a modification of the Oxner-Knudsen method using a Knudsen bulb, burette, and a 15-ml. automatic tap pipette. A bulb flask, filled with a weak solution of potassium chromate and set before an artificial light, has proved to be a handy

aid in sharpening detection of the end point of the titration. Standardization is against a secondary sea-water standard whose chlorinity has been fixed by Woods Hole standard sea-water. Copenhagen water will be used, after we have exhausted our present stock of secondary sea-water standard.

The preparation of a secondary standard sea-water is covered by Lyman's procedure. A slight modification that we have found highly desirable is the dipping of the tops of the citrate bottles containing the secondary standard sea-water in molten paraffin wax to insure their seal.

Chlorosity values are converted into chlorinities using the table for conversion of Cl/l at 20° C. to Cl‰ prepared by Thompson (1928, 1930). In line with standard practice, salinities are used in dynamic computations.

The chlorinity determinations are believed to be accurate to within 0.02‰.

Dissolved oxygen.—Dissolved oxygen is determined using the Winkler titration method. In line with more recent practice, however, we are using a standard potassium iodate solution of 0.01 normality. In order to get more significant figures for titration volumes, we have also adjusted the concentration of our sodium thiosulfate solution to about 0.005 normality. Sodium furoate is used in the amount of 0.1 per cent by weight to inhibit bacterial action. The buffering action of this chemical makes it unnecessary to boil out carbon dioxide from the water used in preparing the thiosulfate solution (Jentoft, 1949). As an inhibitor of the growth of mold in the starch indicator, we use a pinch of mercuric iodide regularly.

The routine precision of the determination is about 0.002 mg. atom, or 0.02 ml./l of sea-water.

Inorganic phosphates.—The method of Deniges is the basis of the determination of soluble phosphates in sea-water. To avoid applying the customary salt error correction on the phosphate values, synthetic sea-water of about 18‰ chlorinity is used in diluting the standards for comparison. This is prepared by dissolving 33.6 grams of sodium chloride in a liter of phosphate-free distilled water.

The accuracy of the determination is of the order of 5 per cent to 10 per cent.

Silicates.—Silicates are determined by using the method developed by Dienert and Wadenbulcke as applied by Atkins to oceanographic work. For comparison, we have been using the "preferred standard of potassium chromate", rather than the

"alternate method" of using picric acid as standard. The latter keeps unchanged in its chemical properties for a period of months, the former even longer. As in the colorimetric determination of inorganic phosphates, Nessler tubes are used in measuring the silicate content of water samples.

Hydrogen-ion.—The pH is measured with the Beckman pH meter.

NOMENCLATURE AND UNITS

The scheme of nomenclature and units adopted follows that of the *Baird*. Chlorinity and salinity are expressed in parts per mille of weight in accordance with the definition on which the Knudsen Hydrographic Tables are based. To-date our areas of investigations have been always confined to coastal and inland seas, and so dynamic computations of currents for these regions have not been deemed practicable. Therefore, except in cases when water masses are examined or oxygen values computed for degrees of saturation, we have always used chlorinity in expressing halogen concentration.

Oxygen values are expressed in milligram-atoms or in milliliters/liter at 27.5° C., a unit useful to physical oceanographers, and on the basis of percentage saturation, which is the more preferred unit in biological studies. The degree of saturation includes the effects of temperature and salinity, and provides a measure of availability to organisms.

The concentration of nutrient salts is expressed in microgram-atoms/liter of sea-water at 27.5° C.

For purposes of volume measurements, we have adopted 27.5° C. as our standard temperature, although the indicated temperature of calibration of our laboratory glassware is at 20° C. The error introduced in using this standard room temperature in the Philippines is insignificant, compared to the error in the determination of chlorinity, which has the highest accuracy of all the chemical analyses run on our water samples.

In all other cases involving measurement, the metric system has been adhered to in line with IPFC practices.

SUMMARY

1. The 30-ton combination fishing vessel, M/V *David Starr Jordan*, was rigged with a crude hydrographic sampling set-up which permitted the collection of water samples from moderate depths within a tolerably short time. A portable compact work table mounted on the after deck provided the facilities for the shipboard analysis of the water samples.

2. The Japanese-made, deep-sea reversing thermometers used, gave readings consistently accurate to within 0.02/C. The water bottles were of the Nansen plug-valve type of liter capacity.

3. Bathythermograph observations and vertical plankton sampling, whenever made, preceded and followed respectively, the hydrographic sampling. Plankton tows were run in between stations. Water samples were ordinarily taken at the surface, and at 2, 5, 10, 20, 30, 50, 75, 100, 150, 200, 300, and 500 meters below the surface.

4. Chlorinity was determined using the modified Oxner-Knudsen method. Standardization of the titer was against a secondary sea-water standard whose chlorinity had been determined, using Woods Hole standard sea-water.

5. Dissolved oxygen was determined by the modified Winkler method. The strength of the thiosulfate solution was adjusted to half the standard normality to gain more significant figures for titration volumes. Oxygen content was expressed in mg-atoms/l or ml/l.

6. Inorganic phosphates were determined using synthetic sea water of about 18‰ chlorinity for diluting the standards. For comparison, in the determination of silicates, a series of potassium chromate standard solutions were used. The concentrations of the chemical nutrients were expressed in microgram-atoms/l.

7. The standard temperature used was 27.5° C.

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