through a fritted glass dispersion tube at the bottom of the aeration column, providing a continuous, vigorous foam; bubbles adhere to the increased surface area provided by the balls. Seawater flowing out from the top of the column to the large reservoir is oxygen-saturated, a condition that is maintained by the mixing and aerating action of two more dispersion tubes placed in the reservoir.

Contamination. The CCS is constructed so that the danger of contamination by metallic ions is reduced to what is regarded as a negligible level. Most construction is of acrylic resin, polyethylene, glass, or hard rubber; copper heating elements are covered with seven coats of polyvinyl chloride; the conductivity electrodes in the salinity control stage are made of platinized, gold-plated nickel, and membrane filter parts are either plastic or Type 316 stainless steel. During two years of use, no evidence, either physical or biological, of contamination has ever been observed.

Although the CCS was built for, and satisfies the requirements of, studies of marine invertebrate olfaction, its applications are numerous. It has been used for studies of the respiration of large aggregates of filter-feeding animals under conditions of constant temperature, salinity, and flow, and of the metabolic effects of feeding these animals different species of phytoplankton. Some other possible areas of applicability are studies of toxicity, growth, excretion, dissolved metabolite absorption, and feeding rates.

LANGLEY WOOD

Virginia Institute of Marine Science, Gloucester Point, Virginia.

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FRACTIONATION OF PHYTOPLANKTON COMMUNITIES OFF THE WASHINGTON AND OREGON COASTS[1]

Fractionation of phytoplankton communities into different size groups has been carried out in several previous studies. The seasonal changes in the distribution of various size groups have been measured in inshore marine waters (Yentsch and Ryther 1959; Holmes and Anderson 1963) and in lakes (Rodhe, Vollenweider, and Nauwerck 1958). Saijo (1964) reported on the size distribution of phytoplankton in the Indian Ocean at different depths and areas. All of these studies have emphasized the importance of the contribution of the nanoplankton to the total photosynthesis of phytoplankton communities. The present study shows the seasonal and annual changes in the size distribution of phytoplankton in areas of the northeast Pacific Ocean ranging from coastal waters to the open ocean.

Fractionation of surface phytoplankton communities was carried out routinely as part of a continuing oceanographic investigation concerning the effects of the Columbia River effluent on the northeast Pacific Ocean. The information is pertinent to food chain considerations and to studies of the turnover of radionuclides introduced into the Columbia River by operations of the Hanford Laboratories. During 25 cruises from 1961–1963, 307 separate fractionations were made. Daily, at a station taken near noon, a 500-ml sample of sur-

[1] Contribution No. 348 from the Department of Oceanography, University of Washington. The assistance of Miss Ann Helander is gratefully acknowledged. Financial support was provided by U.S. Atomic Energy Commission Contract No. AT(45–1)-1725 and Office of Naval Research Contract Nonr-477 (10), Project NR 083 012 and Contract Nonr-477 (37), Project RR 004-03-01.

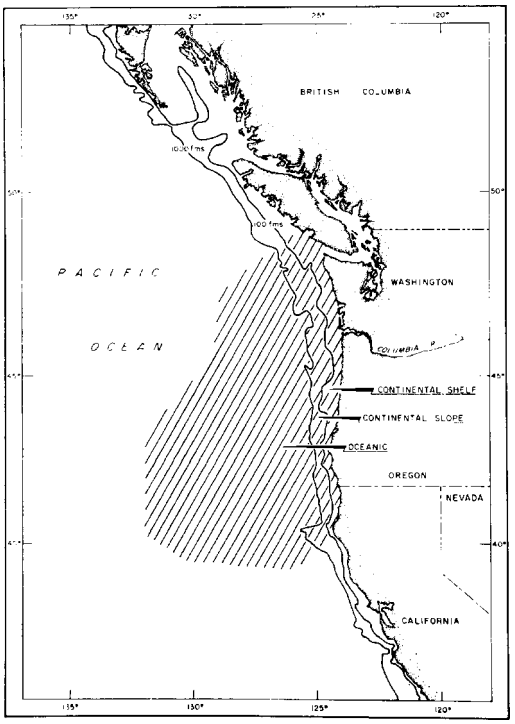

FIG. 1. Index map showing the area of investigation along the Washington–Oregon coast. The shaded area indicates the combined coverage of all cruises.

face water was inoculated with approximately 5 μc ^{14}C as Na_2CO_3 and incubated under artificial illumination (9,150 lux) at sea surface temperature. The ^{14}C-labeled population was fractionated by passing aliquots through a series of filters (nylon net–35.0 μ; Millipore®[2] filters: SM–5.0 μ, AA–0.8 μ, HA–0.45 μ, PH–0.3 μ, GS–0.22 μ) with a vacuum of 375–500 Torr. Radioactivity was measured with a gas flow counter with a micromil window. The mean value of the HA, PH, and GS filters was taken as 100% retention because each of these filters retained about the same activity when less than 500 Torr of vacuum was used.

The data are grouped into three areas, continental shelf, continental slope, and oceanic waters (Fig. 1), because it is known that the species composition is quite different in coastal and in oceanic areas (Hobson 1964) and that phytoplankton population size and productivity are generally much greater in the coastal area (Anderson 1964). In the oceanic area, phytoplankton productivity is characterized by a spring bloom and a lesser autumn pulse, but the standing crop of phytoplankton as measured by chlorophyll *a* shows little seasonal variation with the exception of a distinct summer minimum. In coastal areas, both phytoplankton productivity and standing stock are sustained at high levels throughout the summer because of an abundant nutrient supply from upwelled waters.

The variations in retention by each filter pore size were erratic but presumably reflect the changes in size composition of the community (Fig. 2, Table 1). As would be expected, coarser filters retained less activity than finer filters. The retention by the 35-μ net was small in most cases but ranged from 2 to 39% retention. Usually rather large fractions of the phytoplankton passed through the 5-μ filter (42–100% retention), whereas the amount passing through the 0.8-μ filter was generally small (76–100% retention). In view of the large variations in short intervals of time and lack of apparent trends, annual or seasonal mean values for retention by filters of pore size greater than 0.45 μ have little significance and therefore will not be reported.

There were no regular seasonal trends exhibited by any cell-size group nor were there any great annual or geographic differences. Over the continental shelf, there was a greater preponderance of larger organisms (> 35 μ) during the summer months. The water over the continental slope also showed a slight trend towards larger organisms during summer, but this trend in oceanic waters was not evident. However, the oceanic area apparently had, at most times, more fragile cells or possibly smaller cells than did coastal areas, especially in 1961 and 1963, as evidenced by the amount of material passed by the 0.8-μ filter.

The material passing through the 5-μ filter might be expected to be the small

[2] Registered trademark, Millipore Filter Corporation, Bedford, Massachusetts.

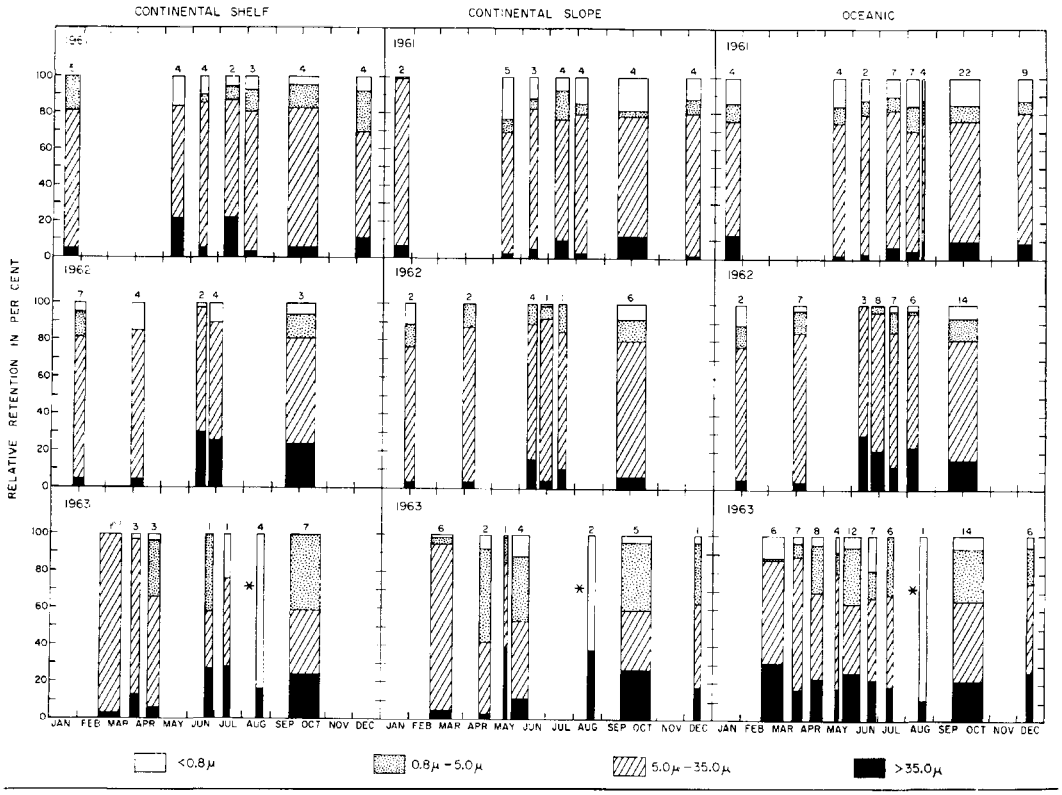

FIG. 2. The relative retention of ^{14}C-labeled phytoplankton by a graded series of filters from areas off the Washington–Oregon coast during 1961–1963. The number above each histogram designates the number of separate fractionations made during each cruise. The width of the histogram is proportional to the duration of the cruise. *—35- and 0.45-μ filters only were used during this cruise.

microflagellates and possibly small elongate diatoms that happened to be oriented in the proper direction. Because all phytoplankton cells are larger than 1 μ, as far as is known, phytoplankton material that passes a 0.8-μ filter would apparently be either fragments of cells or possibly small pliable cells that have been squeezed through the pores by suction pressure. Direct evidence for the existence of whole cells in the filtrate is not available, but significant photosynthetic activity has been measured in samples inoculated with ^{14}C after filtration through a 0.8-μ filter. In four experiments carried out in 1960 at the Friday Harbor Laboratories, ^{14}C uptake measurements in seawater samples previously filtered through 0.8-μ filters ranged from 1.2 to 6.3% of total ^{14}C uptake in raw seawater samples after correction for dark uptake. However, considerable fragmentation of cells could have taken place during filtration because in these experiments a vacuum as high as 685 Torr was used.

TABLE 1. *The range of relative retention (%) of ^{14}C-labeled phytoplankton by a graded series of filters from areas off the Washington–Oregon coast during 1961–1963*

		Continental shelf	Continental slope	Oceanic
35 μ	1961	4–23	2–13	2–12
	1962	4–30	3–16	3–29
	1963	3–28	3–39	11–31
5 μ	1961	70–87	70–99	70–82
	1962	81–98	76–92	76–100
	1963	58–100	42–97	63–87
0.8 μ	1961	84–100	77–100	83–90
	1962	86–98	76–92	89–100
	1963	76–100	88–99	81–100

Microscopic examination of the phytoplankton during January 1961, showed the microflagellates to be an important part of

the community and were as much as three times greater in biomass than the diatom population in some areas (Hobson 1964). The significant loss of material through the 5-μ filter at that time suggests that the difference between the SM (5.0 μ) and HA (0.45 μ) filters gives some idea of the abundance of microflagellates in the community, although the estimate is not as great as that shown by microscopic examination. A large fraction of particles smaller than Millipore filter pore size is retained by secondary valence forces of the filters (Millipore Filter Corp. 1964) and as a result would lead to minimal estimates for the smaller particles. Because it is not known what fraction of particles is held by secondary valence forces, fractionation with Millipore filters is not quantitative. However, the amount of phytoplankton activity generally passed by the 5-μ and 0.8-μ filters suggests that microflagellates at most times may be much more important in the ocean than has been previously thought.

GEORGE C. ANDERSON
University of Washington,
Department of Oceanography,
Seattle.

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OBSERVATIONS ON *GIGANTOCYPRIS* (CRUSTACEA: OSTRACODA) IN THE ANTARCTIC OCEAN

Although subtleties of marine biological relationships require analysis of populations or aggregations of planktonic organisms (*see* Glover 1961), single species indicators are of importance for shipboard work. Russell (1936) recognized that to be useful, indicator species must be comparatively abundant, large, and easy to identify. The necessary abundance depends on the size and speed of the collecting device employed.

Cruises 10 and 11 (October 1963 through February 1964) of the National Science Foundation's multidiscipline research vessel, the *USNS Eltanin,* were carried out largely in the southeastern Pacific Antarctic Basin area between 75° and 115° W long and 55° and 71° S lat. The cruise area was in deep water (generally 3,300 to 5,125 m; average 4,400 m at stations occupied). Sampling was done with an Isaacs-Kidd mid-water trawl (Isaacs and Kidd 1953) towed at about 4½ knots (8.3 km/hr). Most of the trawls were for 2 hr. Approximate depths trawled were determined by wire angle readings and pressure gauges. The size and speed of the trawl allow filtration of large amounts of water in comparison with plankton nets of practical size. Thus, organisms rare in usual plankton samples may appear in numbers in the Isaacs-Kidd trawl collections. In the area sampled, *Gigantocypris* was not more abundant than about one specimen per 3,000 to 8,000 m^3 (average 6,000 m^3) of seawater, but it was taken in sufficient numbers (12