respondingly higher. This suggests the possibility that the distinction represents simply the use of one decolorant instead of another. Certainly coloration due to iron is often effectively suppressed in glasses of both compositions.

Glasses of this "Roman" composition have been reported in earlier analyses. Matson *(4)* pointed out the essential differences between this glass and early Egyptian glass, suggesting the possibility that the change from one composition to the other was occasioned by the advent of glassblowing. Now, however, it appears that at least in eastern areas the early glass was superseded by the antimony-rich composition several centuries before the appearance of mass-produced blown glass.

The early-Islamic group (introduced 8th–10th century A.D.) is the one comprising what might be called "Islamic soda-lime glass." It is marked by a return to the higher magnesium and potassium concentrations of the second millennium B.C. group but, in general, without showing the low manganese content of the early glass. The principal sources of these specimens included Nishapur, Susa, Quadrisia, Kish, Raqqa, Fostat, Sabrah, and various Iraqi sites represented in the collection of the Baghdad Museum.

This glass is so similar to that of the second millennium B.C. group that the assumption has been voiced that it represents an uninterrupted continuation of the same glassmaking tradition *(5)*. The present analyses, however, would suggest that a lapse of many centuries occurred between the production of these two categories of glass. Certainly glasses of both the antimony-rich and Roman groups were produced in some of the areas destined to become Islamic. The possibility, however, that the early formulation was used without interruption in certain regions (Mesopotamia, Parthia, or Central Asia) merits investigation.

The four preceding categories represent only relatively minor variations in the basic soda-lime glass of Western antiquity. The distributions of the major components, silicon, sodium, and calcium oxide, essentially overlap for the different categories with standard deviations of the order of 25 percent of the mean values.

The identification of the Islamic lead-glass group (introduced 8th–10th century A.D.?) is based upon only six analyses, but the six glasses came from a variety of sources and yet possess remarkably similar compositions. Glass of this composition has not been singled out previously. Islamic lead-glass contains considerably more lead and less alkali and lime than most New Kingdom high-lead glass. It is distinctly different from the lead-barium Chinese glass reported by Seligman and Beck *(6)* and also from the two main types of 11th–13th century A.D. Russian lead glasses described by Bezborodov *(3)*.

Out of the 26 elements determined, only the five that show the clearest differences between the major glass categories are listed in Table 1. Some of the other elements confirm these differentiations, others are present in the same range of concentration in all except the lead glasses, and some are present in small erratic concentrations that have not yet revealed a correlation with provenance. Indications of some regional correlations within the main categories have been noted and are being explored. For example, Islamic glass from Iraq and northwestern Iran appears to have significantly less manganese than other Islamic glass. Also, high-antimony glass found at Persepolis can be differentiated from fundamentally similar and contemporary glass excavated in Greece and Asia Minor upon the basis of its relatively low contents of titanium, zirconium, and lead. The possibility of determining the concentration of additional elements, which are present in concentrations below the limits of spectrographic sensitivity, by means of neutron activation analysis is being investigated. Also, it has been possible to determine without the consumption of sample the concentrations of the five elements of Table 1 by X-ray fluorescence analysis.

The initial and terminal dates of the main groups should eventually become more precise, and some of the main compositional changes in ancient glassmaking will probably be explainable in terms of the raw materials utilized, improved furnace designs, and other shop improvements. An ultimate objective will be to pin down individual deposits and to establish trade routes in raw materials *(7)*.

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Zinc-65 in Marine Organisms along the Oregon and Washington Coasts

Abstract. The concentration of zinc-65 in marine animals and plants near the mouth of the Columbia River is presented. Amounts of radiozinc found in the biota diminished rapidly with the distance from the river mouth. The highest levels were found in plankton, algae, and mollusks. Of the human foods, oysters exhibited the highest levels.

Zinc-65, a nonfission product commonly formed by nuclear detonations and nuclear reactors, was found in pelagic fish collected in 1954 near the Pacific Proving Grounds after the Castle series of weapon tests *(1)*. It was subsequently reported in tuna *(2)*, marine plankton *(3)*, mollusks *(4)*, and reef fishes *(5)* of the western Pacific. In these marine organisms Zn^{65} was responsible for up to 40 percent of the total radioactivity and in most instances was more abundant than any of the fission products. Radiozinc has also been found in marine shellfish from the Atlantic coast of the United States *(6)*.

This radionuclide is present in Hanford reactor effluents and is one of the dominant radioisotopes in aquatic organisms inhabiting the Columbia River downstream from reactors *(7)*. It is also found in agricultural products which are irrigated with river water taken from the Columbia at a point approximately 45 miles down river from the reactors *(8, 9)*.

The amounts of Zn^{65} which enter the Pacific Ocean through the Columbia River are dependent on several factors, including reactor-operating levels and river flow. Concentrations of 9×10^{-9} to 1.5×10^{-7} μc of Zn^{65} per cubic centimeter of Columbia River water were measured at Vancouver, Wash., located about 90 miles from the river mouth, during the last half of 1959 and the first quarter of 1960 *(9, 10)*. Total discharge of Zn^{65} based on these measurements ranged from 8 to 55 curies of Zn^{65} per day; this would result in an equilibrium value of about 7000 curies in the ocean. A recommended rate of release of noncontained Zn^{65} into the ocean is 1.4×10^4 c/yr or approximately 40 c/day (*11*).

The dispersion pattern of the Columbia River in the ocean is not well defined. In general the flow in summer, based on salinity measurements, is toward the southwest and may be detected for distances up to 200 miles from the river mouth (*12*). Flow in winter is generally toward the north along the coast of Washington. Factors such as wind direction and velocity, tidal amplitude and seasonal variation in volume discharge of other coastal streams in the area will affect the alongshore movement of Columbia River water.

To investigate the dispersion and accumulation of radioelements from the Hanford Atomic Products Operation in the marine biota, various kinds of plant and animal life were sampled along the coasts of Washington and Oregon during September 1957, April 1959, and April and July 1960. Early collections were made within 40 miles of the river mouth while later surveys included samples from locations up to 250 miles distant. Most of the material collected was obtained from the intertidal zone and included birds, fish, crustaceans, mollusks, algae, and plankton.

Samples were ashed at 550°C for approximately 24 hours before they were counted in a 256-channel gamma-ray analyzer, which was equipped with a 3-in. diameter by 3-in. high sodium iodide crystal.

Zinc-65 was the dominant gamma-emitting radioelement in all samples analyzed, and highest concentrations occurred in mollusks, algae, and plankton. Values for representative kinds of algae and mollusks are given in Fig. 1. The concentration of Zn^{65} in the biota was highest at the mouth of the river and decreased very rapidly with the distance from there. Mussels from locations 100 miles distant from the river mouth contained less than 10 percent of the amount of Zn^{65} found in mussels at the mouth. No appreciable differences in levels of radiozinc with respect to direction from the river mouth were noted, a possible indication of nearly equal distribution of river water to both Oregon and Washington coasts at the time of measurement.

Interspecies differences in concentration of radiozinc were most evident in the organisms collected near the river mouth with highest levels found in plankton, attached algae, and mussels. In 1959 the amount of Zn^{65} in these forms was 80, 110, and 100 $\mu\mu c$/g (wet weight), respectively. Both the algae and the plankton have high ratios of surface area to body weight, which possibly makes adsorption and entrapment of particulates an important factor in the amounts of Zn^{65} found in these forms. Mollusks are very rich in zinc (*13*), and oysters contain greater amounts than other bivalves (*13, 14*). As pointed out by Chipman *et al.* (*14*), the amount of zinc concentrated in the soft tissues of oysters is directly related to the amount available in the water in which they live. The concentration of radiozinc in crabs, fish, and marine birds was approximately one-tenth that found in algae or mussels.

Although it is rather difficult to evaluate the change in concentration of Zn^{65} with time because samples were not collected at the same season of the year, there has been an increase since the first measurements were made in 1957. Little change is apparent between 1959 and 1960, however.

Of the marine organisms from near the mouth of the Columbia River commonly used for food by man, oysters had the highest concentration of radiozinc, and razor clams were second highest in this respect. Willapa Bay, Washington, one of the major oyster-producing areas of the Pacific coast, is located approximately 40 miles from the mouth of the Columbia River.

On the basis of limits for persons outside a controlled radiation zone, as suggested in *Handbook 69* (*15*), and the concentration of 34 $\mu\mu c$ of Zn^{65}/g

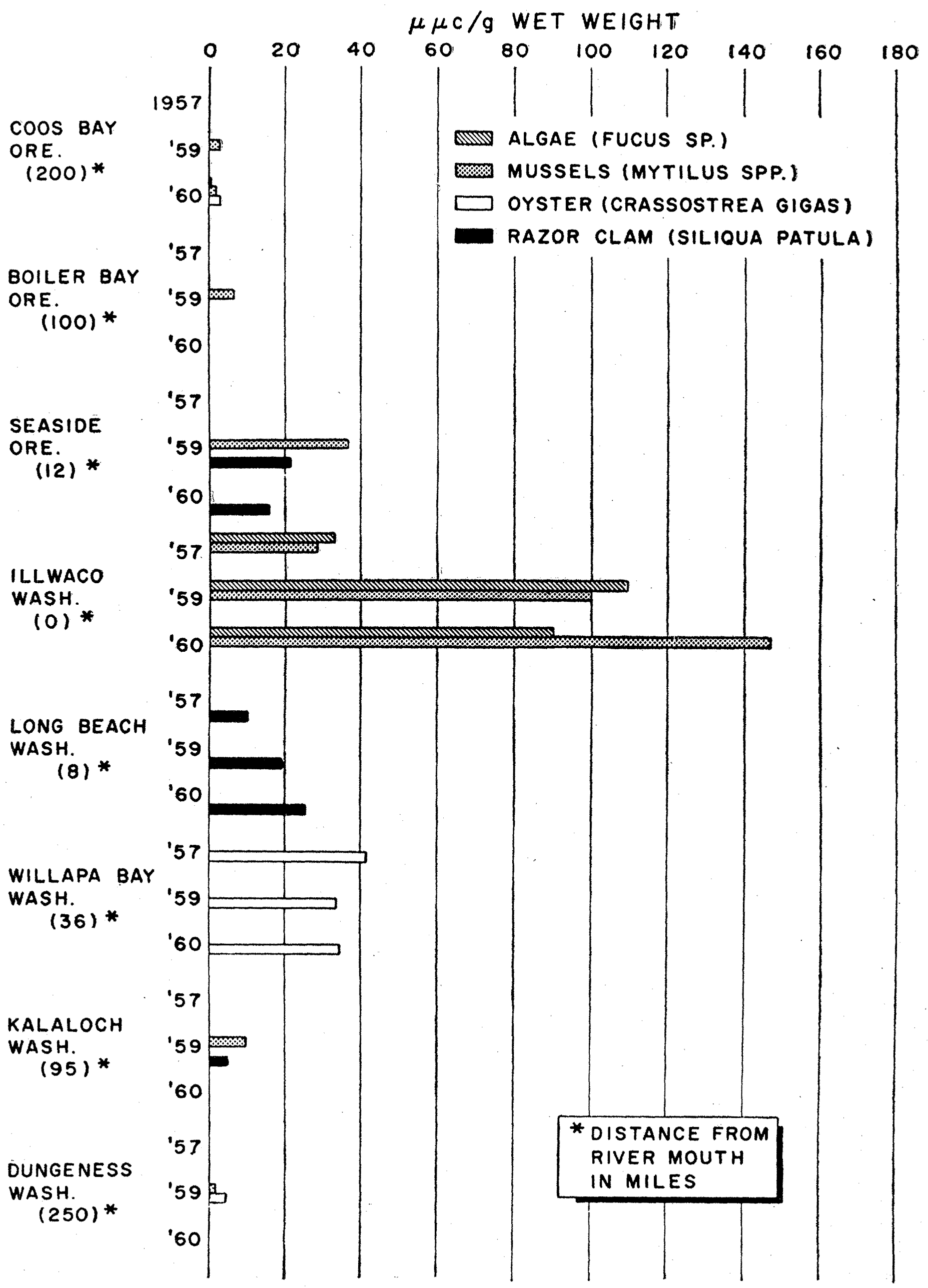

Fig. 1. Concentration of Zn^{65} in marine organisms near the mouth of the Columbia River.

found in Willapa Bay oysters, a consumption of this seafood at the rate of 100 lb/week would be necessary to produce a maximum permissible concentration of Zn^{65} (6 μc total body burden). Although this concentration of radiozinc is higher than that reported in other human foods in the United States [for example, 0.32 $\mu\mu$c/g in beef liver from Nevada (*16*), 0.18 $\mu\mu$c/g in Atlantic coast oysters (*6*), and 11 $\mu\mu$c/g in beef grazed on land irrigated with Columbia River water (*8*)], it is substantially below levels that would produce a maximum permissible concentration in man even if oysters were the sole source of animal protein in the diet (*17*).

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High-Rate Laboratory Filtration with Büchner Funnels

Abstract. A method is described for greatly increasing the efficiency of Büchner funnels by utilizing a much larger fraction of the filter paper surface. The method also makes it possible to use Millipore filters efficiently on Büchner funnels.

Büchner funnels, as commonly used, have the disadvantage that filtration is limited to those areas of the filter paper which lie directly over the holes in the porcelain plate. When these areas, which represent only a small fraction of the paper surface, become clogged, filtration stops. The filter paper disk studded with mounds of residue is a familiar sight.

A very simple but extremely effective way of fully utilizing the total area of the filter paper has been devised in this laboratory. It consists of interposing a disk of screening (Fiberglas window screening is good because it will not ravel) between the paper and the pierced porcelain plate of the funnel. The paper is centered over this disk (which is about ¼ to ½ in. smaller in diameter than the paper), is wet, and its edge is smoothed onto the porcelain surface. Thus the main portion of the paper is kept off the porcelain plate and rests instead on a surface having many openings. The holes in the porcelain serve only to carry off the filtrate.

The result is that the rate of filtration is speeded up greatly, the quantity of suspension which can be filtered by a single sheet of paper is increased markedly, and, instead of the paper surface being covered with mounds of residue, the whole surface is uniformly coated (Fig. 1).

Typical results include the filtering with an 11-cm funnel, of 500 ml of a turbid, opalescent bog water in 5 min by using the screen, compared with 42 min for the usual procedure; and the filtering of 1 liter of a silica suspension (5 g/lit.) in 2 min by using the screen, compared with 9 min for the usual procedure. On one occasion 900 liters of lake water were filtered with a 24-cm Büchner funnel, a feat which we would not even have contemplated earlier because of the time it would have taken.

Filtering efficiency in terms of removal of suspended matter is not substantially affected by the screen. A sample of turbid bog water (51 percent transmission of blue light) exhibited about the same degree of clarification when filtered with No. 42 Whatman

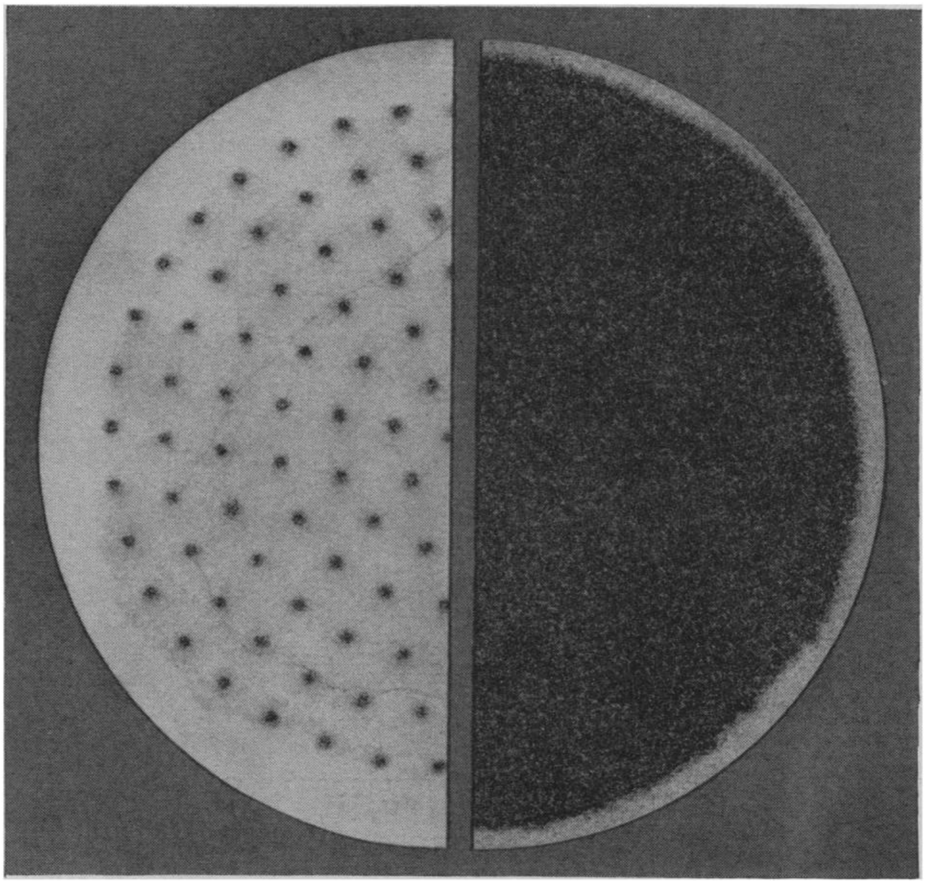

Fig. 1. Filtration of bog water with a Büchner funnel. Left, usual procedure; right, improved procedure.