

lines, in applying the flotation principle in the laboratory we may have found a useful way of evaluating our products, and perhaps of predicting the quality of proteins in fish meals. Much work remains to be done on this particular point.

6. In 1864 Dana reported to the Maine Board of Agriculture, that cattle are an effective means of converting objectionable fish residues to a readily useable form of manure. He was ingenious in recognizing a double objective of supplying nutrient and of obtaining a valuable fertilizer. Fortunately, there are now more economical ways of processing and using raw fish, but Mr. Dana's point was well taken. The use of natural processes continues to offer vast possibilities. Menhaden materials are excellent nutrients and organisms have been grown upon them to increase their feeding value. It is believed that mushrooms can be nurtured in menhaden stick water. It is known that it can be used to improve range land. It is hoped to work out nutrients suitable for bacteriological processes resulting in important chemicals and pharmaceuticals. In fact, the range of possibilities seems bounded only by the limits of imagination.

Tomorrow's By-Products

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Any discussion of the "by-products" of the menhaden industry would be brief since the industry does not currently produce anything that is strictly a by-product. All of its products are primary. However, because fish meal, solubles and body oils are so classified by other producers as well as the U.S. Fish and Wildlife Service, this term will be used in the present paper.

The basic products of the menhaden industry have been the same for 100 years, with the exception of the stickwater. This long record of stability would seem to indicate that no abrupt changes should be expected. However, we may be approaching just such a time.

In almost every field of science, engineering and industry research and developmental activity is at a high pitch. Since we have an economy that is responsive to new products and methods, as the findings of the various groups are made known to each other, the effects are far reaching and rapid. Because of this ferment in the scientific world it is important that every manufacturer be alert to trends and that he actively plan to adjust his process to take advantage of new discoveries.

Here are a few examples of recent developments that may have an effect on the menhaden industry, adverse or beneficial.

1. Agriculture provides the largest market for menhaden products, and agriculture is being revolutionized. By the addition of about one twentieth of one per cent of a chemical soil conditioner the tilth of some soils is semi-permanently improved to the extent of increasing crop yields 20 to 80 per cent.
2. The Carnegie Institution is engaged in research on a process for the

cultivation of algae as a source of proteins and oils. One method which seems to have promise is to expose the algae to sunlight in plastic bags through which water and fertilizers are circulated. This project is in its infancy, but it indicates the possibility of producing huge quantities of protein and fat by a factory process rather than by planting a crop, feeding an animal or operating a fishery.

3. Man can now make rain. This suggests the possibility of being able to change the climate of a region.
4. There is now a successful formula for synthetic sow's milk, which is making practical the operation of pig hatcheries. One potential of this system is to make possible three litters per year per sow instead of two. Incidentally, it is said that 5 to 10 per cent of fish solubles are a necessary ingredient in these synthetic pig starters.
5. By the use of chemical growth regulators, such as 2-4-D, the life processes of plants can be altered to produce more desirable results. About one millionth of an ounce applied to a small part of a plant will make that part grow faster than the untreated part, about 2,000 times this amount will stimulate the plant to burn up its food supply and die in 1 to 3 weeks. The use of chemical growth stimulators may also produce some spectacular results in the fields of poultry and animal husbandry.
6. It is estimated that the total damage to agriculture by insects, fungi, plant and animal diseases and weed infestation was equal to about 42 per cent of the value of the 1951 production. More efficient and versatile drugs, insecticides, fungicides and hormones are bringing these factors under control. More than 6,500 airplanes are now in use seeding, dusting, spraying, fertilizing and defoliating field crops. Several of these developments are yet in an early stage. However, the accumulated effect on agricultural productive efficiency has amounted to a reduction of 10 per cent in man hour requirements since 1941.
7. The six billion dollar investment in the field of atomic energy is commencing to provide new knowledge in nuclear physics, chemistry, biology and medicine. Hundreds of scientists have been trained under the-fellowship programs to pursue methods of applying this knowledge to the general welfare. More than 300 patents have been made available for licensing to industry. The radioactive elements are providing a clearer view of what happens in living processes. In the past five years radio phosphorus has provided more information about phosphate fertilizers than had been learned from the previous 50 years of study. Probably the most spectacular boost to the economy by atomic science is its promise to reduce greatly costs of heat, light, manufacturing and transportation by providing power at a fraction of present cost.

It is too early to predict the impact of these new technological advances on the menhaden industry. There is no immediate cause for alarm and probably the long-range effects will be beneficial. The developments are to encourage a closer observation of them on the part of menhaden products so that they may be better enabled to adapt themselves to the changing pattern.

There is a great deal of reason for optimism to be derived from an examination of what is taking place in the fishing industry, and of the fundamental economics on which it is based. We are commencing to develop methods for

farming the sea. In Scotland, fiords have been successfully fertilized, greatly increasing the yield of fish. In San Francisco Bay, in conjunction with the evaporation of sea water for salt, algae are being grown at one stage in the basins. Copepods are then introduced to feed on the algae and later harvested for protein. Preliminary investigations hint that we may learn how to attract fish up from the depths or herd them by means of a controlled electronic technique, and further that this method may permit selectivity as to size and, consequently, species. Here is great promise of a cost-reduction that would make the menhaden industry an even more competitive producer of nutrients and oil. Underwater photography, including television, is rapidly adding to our knowledge of marine life.

Recent preliminary work indicates that fish oils may be more valuable as a source of energy in poultry rations than for some of its present uses. Hence, the future of the industry appears to be even more allied to our food industry than in the past and the market potential in the food field is very bright.

Our population is increasing at the rate of 4 people per minute, or 6,000 per day. By 1975 this will amount to 38 million more people at the table, equal to the present population of all the southern states of Virginia, North and South Carolina, Georgia, Florida, Kentucky, Tennessee, Alabama, Mississippi, Louisiana, Arkansas, Oklahoma and Kansas.

To feed this population as we did in 1950 we will have to increase milk production by an amount equal to the total present output of Wisconsin, Michigan and New York; the additional pork that will be needed is equal to the present tonnage from Nebraska and Iowa; the extra beef will be equal to the present output of Minnesota, Texas, and Oklahoma; lamb and mutton equivalent to Nevada, Utah, Montana and Wyoming; and for eggs an amount equal to the present capacities of California, Kansas, Missouri, Pennsylvania and Illinois.

The basis of all vegetable and plant life on this planet is photosynthesis, which is the ability of green plants, in the presence of sunlight and chlorophyll, to manufacture complex organic chemicals from carbon dioxide, water and other simple materials. Man cannot yet duplicate this process. The source of energy for this process is solar radiation and 70 per cent of the earth's solar energy goes into the oceans. It has been estimated that the oceans contain about one million times as much carbon as our atmosphere and that the average carbon fixed per year per square kilometer of ocean surface is estimated to be 375 tons as compared to 130 tons per square kilometer for land surfaces. The photosynthetic activity of the ocean is estimated to be ten times that of all the plants growing on land surfaces. Millions of acres of our submerged coastal areas are covered with dense submarine forests of seaweed, and these marine plants are unusually rich in the trace elements so deficient in most land plants. Obviously the oceans are low-cost "conversion vats" of enormous capacity. The fishing industry has a head start in the development of these great resources and should be able to produce useful commodities that will be competitive to other sources far into the future.

As to what tomorrow's products will be we cannot be certain, but we do know they will have to be useful to our economy and at practical costs. The menhaden industry has a great stake in the success of the future development of marine products. Because of its seasonal nature, it is a logical group to de-

vote time to the necessary research and, considering the talent and imagination with which it is endowed, there is little doubt that it will help pioneer in this last great frontier.

Finally some remarks should be made about today's products. Competition from synthetics is very real and tends to lower the relative market prices of oil, meal and solubles. It is, therefore, highly important that this industry continue to increase its degree of quality control so its products will be less vulnerable to substitutes.

In the two years the writer has worked as a representative of the menhaden industry, few complaints have been received concerning its products or services. However, there is one characteristic of the industry that does not please the average customer. This is that most of the meal, scrap and solubles must be sold almost as soon as they are produced. Unfortunately, the season of the highest production does not correspond with the season of highest consumption and, as a result, most of the tonnage is sold in a buyer's market during which most producers are distress sellers. It is not known what this costs the industry, but it would not be surprising to learn that its mounted to as much as \$10 per ton on meal and scrap and one half to one per cent per pound on solubles. No solution is apparent now, but when it is found it will pay dividends in higher average sales income, greater customer satisfaction and a reduced vulnerability to competition.

"Quality Control" in the Fisheries

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Quality has come a long way in the last 50 years. Fifty years ago fish canning was a rather crude operation. Cans were hand-made and hand-sealed and there was only a small pack as a consequence. Sale of even this small pack was difficult, partly because of low quality. Cans of tuna would sometimes explode on the grocer's shelf and spray the ceiling and shelves with spoiled fish, resulting in a very angry grocerman. Tuna canning was unsuccessful for a long time, until through experimentation and general cleaning up of plants it became a profitable industry. Cannermen began to learn about sanitation and its effects upon the keeping quality of foods.

By now the Food and Drug Administration had come into being. Public confidence in the Administration was bolstered by backing given it by the "Good Housekeeping," which had become a household by-word for guidance in quality in foods.

Then, as now, the public knew that "Food and Drug" was taking care of food quality.

All of this leads to the conclusion that enforced quality control is what brought quality along so fast during the past half century. But the prohibition amendment of the twenties, taught that the Federal Government was not so infallible as had been supposed. Doubts were created as to the necessity of quality control.

A "What is good enough for Father, is good enough for me," attitude was prevalent. Laziness also has a deal to do with poor quality, and some of the