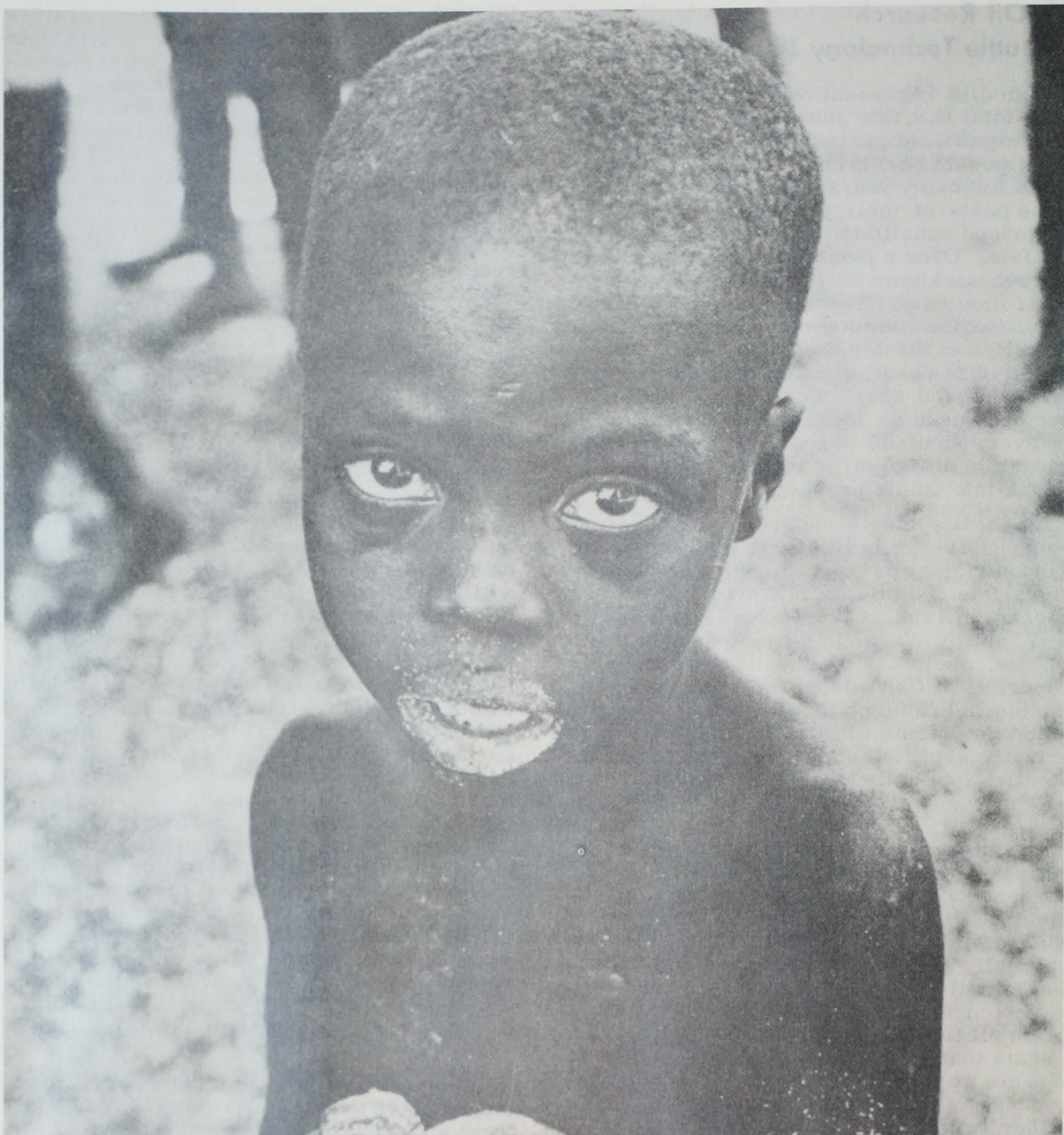

This African boy was so hungry that he could not wait for the flour to be baked. The flour was provided by the UN's Food and Agriculture Organization.

For him--and for hundreds of millions of other children around the world who go to bed hungry every night--fish protein concentrate may ensure a better tomorrow.

THE U.S. FISH PROTEIN CONCENTRATE PROGRAM

Roland Finch

The population explosion has led to worldwide nutrition problems. Food production has not kept pace with the rapidly increasing population. Many people, especially in less-developed countries, get less and less to eat every year. Not only is the amount of daily food insufficient, but the quality often is below that needed for proper growth and for leading a full and useful life. In many countries the average diet is low in protein--important in the formation of brain and muscle during the growing process. This affects especially babies and young children, and nursing and pregnant mothers. Protein deficiency has been shown to cause stunted growth and underdeveloped mental capabilities. In extreme cases, it leads to an illness called Kwashiorkor, especially serious in young children, and sometimes it leads to death. Terrible and dramatic evidence of this has been widely published recently in accounts of starvation in Biafra, but it is often not realized that such protein shortage is a daily fact of life in many parts of the world.

A great improvement could be made if more protein were added to the food of undernourished people. This would be especially valuable if the addition could take the form of animal protein. This is not only a very efficient form of protein in itself, but it also has the advantage of increasing the value of the vegetable protein in the food to which it is added.

Nutritionists concerned with the problem have considered many sources of protein. One of the best is fish, which contains 15 to 20 percent of a high-quality animal protein. There is evidence to show that the oceans of the world could provide much more fish than the 60 million tons now harvested each year, and some scientists believe four times as much. Just one-tenth the amount presently unused would, by this estimate, be 18 million tons of fish. This could provide about two ounces of fish containing one-third of an ounce of fish protein daily to the more than 750 million people believed to receive now insufficient protein. Two ounces of fish would not give all the protein needed each day--but would be enough, with the vegetable protein already eaten, to produce marked improvement in a typical protein-deficient diet. Therefore, increasing the world production of fish would seem to be a good way to meet at least a large part of this problem. The difficulty is that fish are often expensive and will only keep for a short time after being caught, especially in the tropics. Less developed countries cannot afford to instal and operate extensive systems of refrigerators, containers, freezers, and transport. In these countries, fish cannot be stored for long or shipped far from the coast. So even if more fish were landed, many people still would be unable to benefit.

Mr. Finch is Director, FPC Project, BCF.

FISH PROTEIN CONCENTRATE (FPC): THE CONCEPT

Scientists studied the problem of how to 'stabilize' fish inexpensively so the fish could be stored and shipped without refrigeration. They found that if the water and oil were removed, the remaining product would be largely protein. They called the product fish protein concentrate, or FPC. When properly made, FPC will keep for long periods without being canned, frozen, or otherwise specially treated. There are several ways oil and water can be extracted from fish, and BCF chemists examined these. They decided that one of the simplest and cheapest was to grind up the whole fish and extract the water and oil with isopropyl alcohol--an inexpensive, safe, solvent.

The dried product was a tasteless, odorless powder containing more than 75 percent protein. It could be added to many foods, such as bread, cookies, pasta, tortillas, soups, etc., at a 5- to 10-percent level without affecting appreciably the appearance and flavor. The foods containing FPC looked and tasted almost the same as those without, but the amount and quality of the protein were greatly increased.

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The next question was the safety of the process. Did the process have any undesirable effects ? Extensive chemical and feeding tests using FPC made from hake, first on animals and then on humans, showed FPC to be highly nutritious, as predicted, and free from any side effects. The National Academy of Sciences and the U.S. Food and Drug Administration reviewed the results of these tests and proclaimed FPC wholesome and nutritious.

THE PRACTICAL DEVELOPMENT STAGE

So far, FPC was only a laboratory product. Before it could become a practical reality, it was necessary to determine whether it could be made economically on a large scale. Scientists and engineers at BCF's College Park (Md.) Laboratory, using a model-scale unit, studied the technical problems and developed much basic information needed for larger-scale operation. At this point, BCF hoped that industry would take up the process. But, at meetings and privately, industry representatives said they did not believe sufficient information was yet available to be sure operation on a commercial scale was practical.

Members of the Marine Protein Resource Development Committee of the National Academy of Sciences, who were advising BCF, were concerned about this delay in developing a commercial FPC operation. They recommended that BCF construct a demonstration plant to develop the large-scale application of the process and to prove its feasibility. The plant would give reliable engineering and cost information needed by would-be investors. It also would provide considerable amounts of FPC to the U.S. industry and to the State Department's Agency for International Development (A.I.D.) to explore the best uses of FPC in many countries. And the plant would form a working demonstration center for the U.S. industry and foreign visitors. Several Congressmen became interested in the project. Bills were introduced to construct or lease varying numbers of plants. Different ideas were resolved. In November 1967, Public Law 89-701 authorized funds for BCF to construct an experimental and demonstration plant, to lease another, and to conduct necessary research. When BCF called for bids to construct and operate a plant that would process 50 tons of fish daily, it was found that the $1 million authorized was insufficient. It was hoped that an interested company might make up the difference in cost in return for the opportunity to be first. This did not happen. It became necessary to request Congress to increase the construction authorization. After considerable discussion, the existing law was modified to permit use of part of the funds already authorized for other purposes of the act for construction. In this way, it became possible to construct the plant without increasing the total amount to be spent.

THE FPC DEMONSTRATION PROGRAM

During this time, BCF had been negotiating with bidders to design, construct, and operate the proposed plant. It was considered important that the successful bidder be responsible for all these aspects of the program. On October 21, 1968, a contract was awarded to Ocean Harvesters, Inc., of Los Angeles, Calif. One subsidiary company, SWECO (formerly Southwestern Engineering Co.) will undertake design and construction. The other, Starkist Foods, Inc. (associated with H. J. Heinz Co.) will operate the completed plant.

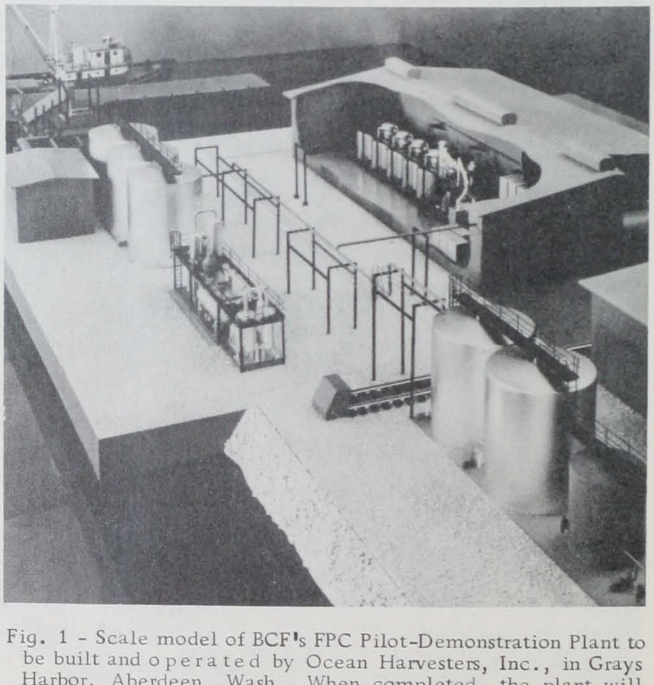


Fig. 1 - Scale model of BCF's FPC Pilot-Demonstration Plant to be built and operated by Ocean Harvesters, Inc., in Grays Harbor, Aberdeen, Wash. When completed, the plant will convert about 50 tons of raw fish a day into 8 tons of FPC.

The first 5 months will be occupied with predesign engineering studies to determine and demonstrate design factors needed in several stages of the operation--raw-fish grinding, deboning, extraction, drying, solvent removal, milling, and recovery of the solvent. Based upon this work, and on results previously obtained by BCF, a process design will be developed. This amounts to a series of flow sheets that will show exactly the types and sizes of equipment needed, and the flows and balances of materials at each stage. The next step will be plant design, an architectural plan showing dimensions and locations of equipment and building. Figure 1 shows one proposal for the layout, although the final design will not be completed for months. Following design approval, the plant will be constructed at Aberdeen, Wash., on land generously made available by the Port of Grays Harbor. The first start-up operation is due in March 1970. Two months later, after the initial shakedown, the plant will be examined, approved, and accepted by the Government. Ocean Harvesters will continue to operate the plant for 10 months more under the present contract.

THE PROCESS

A simplified outline of the process is shown in Figure 2. The plant will be designed to extract the groundfish with alcohol in stages. To achieve greatest efficiency, it will be a countercurrent system: the alcohol will travel through the stages in the opposite way to the fish. In each stage, the fish (sometimes partly extracted) will be mixed in a large tank with the solvent for a time, then separated. The extracted fish will pass to the next stage--and the solvent will pass in the reverse direction to an earlier stage. The later stages will probably be heated to increase the extraction of oil. The final moist

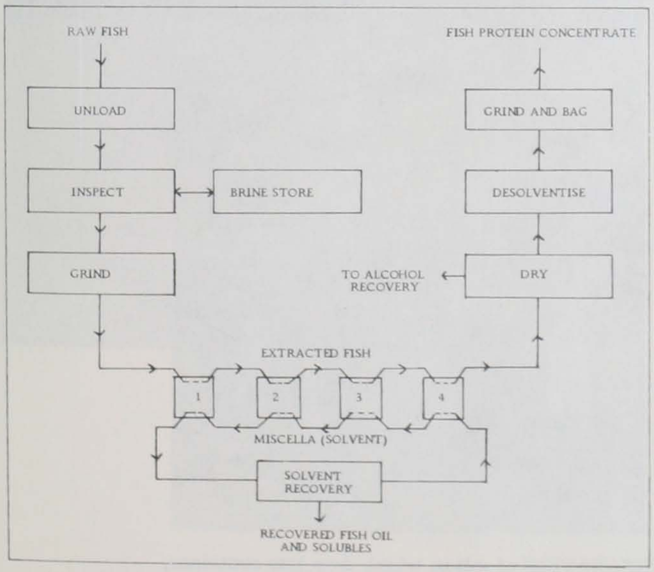


Fig. 2 - Simplified diagram of FPC demonstration plant.

cake of extracted fish will be dried so that most of the isopropyl alcohol can be recovered and reused. A very small amount of remaining alcohol cannot be removed by simple drying and must be driven off by treatment with steam. This process will also remove traces of fishy flavor which may be left in the product. Following this, the dry product will be ground to a very fine powder and filled into 50-pound bags for storage.

The plant will be able to process about 2 tons of fish per hour; this will produce slightly less than one-third ton of FPC. Because it is an experimental plant, it will be run mostly on an 8-hour basis, not continuously as would be necessary in a production operation. However, there will be some periods of continuous running to check the equipment's efficiency under these conditions. A control group of BCF employes will occupy a laboratory in the plant to examine the raw fish, control and measure the product quality, and to collect engineering and other data required for future designs and cost calculations.

THE FISH

The fish used for the first operations will be Pacific hake because only hake and hakelike species can be used for making FPC at present. Data are being collected to further petition the Food and Drug Administration to increase the number of species that may be used to make FPC. So other fish will be used for later runs in the plant to find out what changes, if any, are needed in design and operation to use the plant for different species, especially fatty fish. The use of fatty species, such as menhaden, anchovy, herring and thread herring, has a potential for making FPC at a lower cost than when hake is used. In many parts of the world, they can be landed for less money.

Moreover, experiments have shown it probable that natural oil these species contain in larger amounts can be recovered very cheaply in excellent condition. The oil can be sold to offset the cost of FPC.

Another byproduct is fish solubles, a mixture of soluble proteins, salts, and other compounds used to a limited extent in animal feeding. At present, this is not a high-value material and would not contribute much revenue to the operation.

(Contd. p. 30)

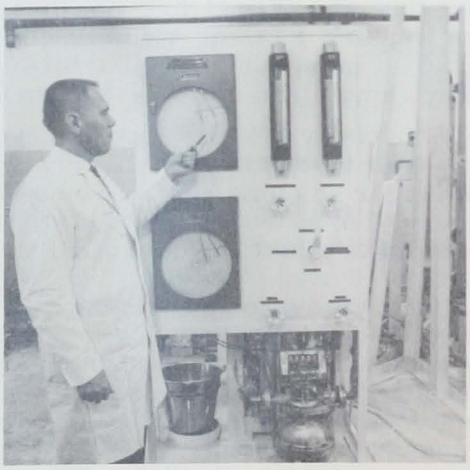
HOW BCF MADE FPC

GRINDING FISH: Operator drops hake into grinder, which produces . . . . .

. . . . a FISHBURGER.

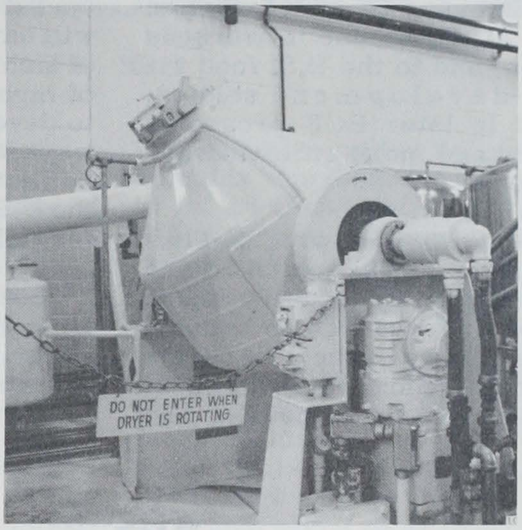
Fishburger is mixed with alcohol in unheated vessel to remove water and fats (they dissolve in alcohol).

HOT ALCOHOL is used to continue the extraction of fats and moisture from the fish.



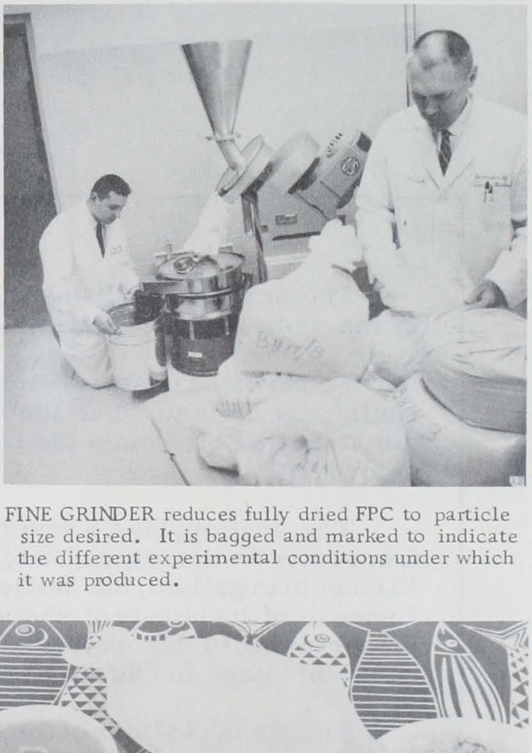
Processing of fish is conducted under carefully controlled conditions of time, temperature, and the completeness of each operation.

SEPARATION of solids, which drop into container, from liquids.

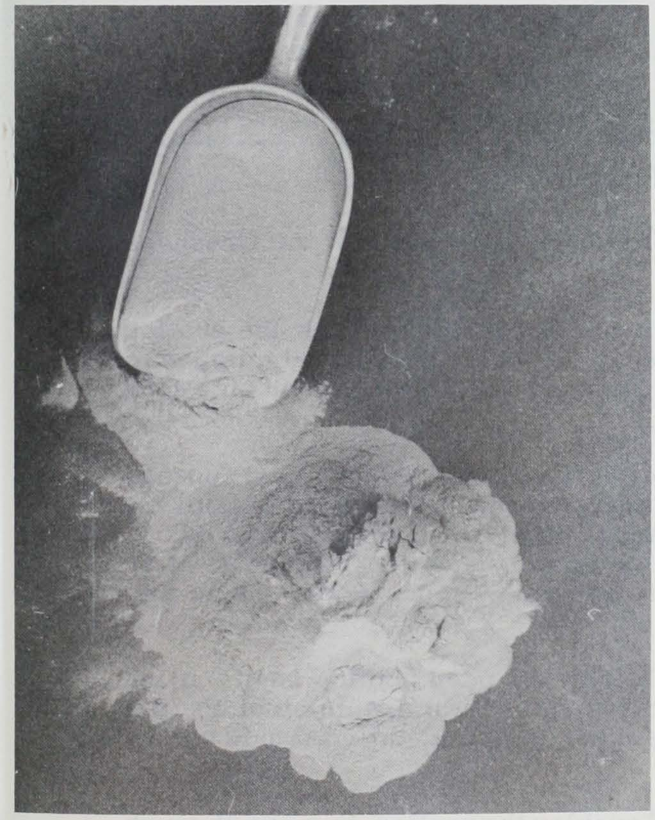


ROTATING VACUUM DRYER removes virtually all traces of the solvent (alcohol).

DISTILLATION COLUMN recovers alcohol, which is used again.



FINE GRINDER reduces fully dried FPC to particle size desired. It is bagged and marked to indicate the different experimental conditions under which it was produced.



FPC

All these foods contain FPC.

The FPC made during this demonstration will be available to A.I.D. for use in overseas feeding programs, and to the U.S. food industry for market-development studies. Some will be used in later BCF programs designed to find new and more efficient ways of applying it to foods.

Even when the demonstration program has proved the isopropyl-alcohol method and provided the data needed by industry, much will remain to be done before FPC can become a practical, working reality on the great scale necessary. It will require private investment and industrial experience to develop and operate full-scale production plants. These will have to be capable of processing 200 tons of fish or more daily, and ensuring a supply of high-quality product. Much must be done to develop markets for FPC, by investigating ways it can be fed to protein-deficient people. Some work already is being undertaken by the U.S. food industry and in studies conducted for A.I.D.

But the stage now is set for moving FPC from the laboratory to a full practical demonstration--an important step in bringing fish protein to needy people throughout the world.

DO YOU KNOW?

The scallop shell was the emblem of knights and monks of the Crusades in the ninth and tenth centuries.

Found in the coats-of-arms of many noble European families, the scallop shell may indicate that the bearer's ancestors went on a holy pilgrimage to the shrine of St. James the fisherman in Spain, to the Holy Land, or on a long sea voyage.

The scallop, long a favorite symbol of both writers and painters, appears frequently in literature, song and art. It is mentioned in the works of both the Elizabethan gallant, Sir Walter Raleigh, and the still-popular Sir Walter Scott. Because of its beauty of shape and color, the scallop was represented so often in portraits of the mythical Venus that the name "Venus-cocle" came into common usage in Old English.

The Makah Indians of the U.S. Pacific Northwest used scallop shell rattles in their ceremonial dances. One particularly beautiful specimen of Pacific scallop was an object of worship by natives of some South Pacific islands before the introduction of Christianity.

An oversized muscle called the "eye" enables the scallop to move through the waters and over the ocean floor by snapping its shell together. This nutritious, sweet-flavored muscle is relished by gourmets for its delicate flavor.

BCF conducts research programs on both the giant sea scallop of the North Atlantic and the small calico scallop of the South Atlantic to assure a continued supply of these tasty shellfish for U.S. tables.

--Catherine Criscione