be off the Florida coast for the next season. Some companies have plants in several areas and move their boats to the area where fish are abundant. However, this is expensive and the fish may disappear again before good catches can be made. Information is obviously needed on methods of predicting abundance and on the behavior of the menhaden.

The high cost and shortage of labor has handicapped many menhaden plants and boat owners. Many former fishermen are taking steady jobs on shore where pay checks are more. To offset this some companies have installed suction pumps aboard the menhaden vessel for loading the fish aboard the ship from the nets. This operation, in addition to reducing the number of fishermen, enables the crew to make more sets, since fish can be loaded faster. In addition it reduces wear on the nets. More technological research is necessary to improve gear and fishing methods to reduce further the labor requirements on the vessels.

Lack of knowledge of how to preserve the fish until the boat arrives at the plant results in losses, especially to the plant owners located in warm climates. Stale or decomposed fish yield poorer quality products. Chemicals have been tried but to date none has proven successful. Much research is required in this question.

A thorough study of the food of the menhaden would be of tremendous value. The relationship of food to oil production has received no attention from scientists. Herring fisherman recognize that the food of the herring directly effects the quantity and quality of herring oil and this matter requires study in the menhaden fishery.

The past few years has seen the use of fishmeal change from that of a fertilizer to almost exclusively that of a high protein supplement in animal and poultry feeds. Expansion and modernization of plants is going forward in an effort to increase their capacity, and as a result the menhaden catch for the past four years has exceeded one billion pounds. Despite this importance little is known about the biology of the menhaden. Certainly knowledge of this fish's range, its spawning, factors effecting its abundance and its migrations are desirable.

Research has a big job to do for the menhaden industry,and it should start soon.

An Outline of the Manhaden Industry

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Considering that it is the most prolific fish in the waters of all the seas, and that it supports the biggest fishery in the United States in point of tonnage landed, the menhaden, or pogy, is as little known as a fish could be. Last year one billion one hundred million pounds of menhaden were caught in the nets of the purse-seiners. This figure is more than twice that of the next most numerous species of fish landed and accounts for about one quarter of all fish brought to the dock.

Of his love life and spawning habits we know nothing. From "whence he cometh and wither he goest" is likewise a mystery. We know that he has been recognized in seven different species, namely, *Brevoortia tyrannus B. brevicaudata, B. patronus, B. pectinata, B. aurea, B. smithi and B. gunteri.*

B. tyrannus is the most common species in the Atlantic Coastal waters and *B. patronus* is by far the most abundant in the Gulf of Mexico.

Menhaden vary in length from about 3 to 18 inches and in weight from an ounce or two to over a pound. The larger species are much less numerous than those running from 5 to 10 inches in length.

In physical appearance the menhaden has the characteristics typical of a small shad or herring. Just behind each side of the head there is a black spot on most species. The species that abounds in the Gulf is usually marked along the fins and the tails with a yellowish tint that sometimes blends into a greenish hue.

The history of the menhaden fishery goes back beyond the earliest colonial days of America when the Indians caught them and sowed one to each hill of corn for fertilizer. Its very name is derived from the Indian "Munnawhataug", which is roughly translated to mean "a thing which fertilizes".

The main reason for the early settlers' development of the menhaden fishery was for the extraction of oil. Although today only a negligible portion of the menhaden catch finds its way into fertilizers, this was the prime use of the solid end product for many years and is, no doubt, responsible for the erroneous but prevalent impression today that menhaden, or pogy, is used almost exclusively for fertilizers.

Menhaden is also known variously as pogy, shad, fatback, bunker, alewife, bugfish, hardhead, chebog, mossbunker, baitfish and many other aliases in different sections of the coastal areas.

The menhaden occurs in all of the coastal waters of the eastern and Gulf areas in this country with the possible exception of the Florida peninsula. Menhaden were first processed in the Maine and Rhode Island areas. The operations were not on a regular basis and the equipment, both for fishing and reduction, was of the crudest form. Later, along in the 1850's in Connecticut and Long Island, refinements in the process were made. The 1870's showed the first indication of the general trend of the menhaden industry southward. There has been only one major appearance of this fish north of Cape Cod since 1880. This was in Maine in 1950 and was of short duration. Today Long Island marks the northern boundary of commercial fishing for the menhaden. Although a few are caught in fish traps to the northward, they do not exist any more in commercial quantities in that area. In the south, the first commercial pogy fishing in North Carolina started at the beginning of the present century, and slowly moved southward until now there are plants in the Fernandina area on Florida's east coast.

Almost completely unexploited until the past several years, the Gulf coast now has active plants from Florida to Texas. Louisiana has four, two located at Empire and two at Cameron. Mississippi also has four, while Texas has two and one is located on the Florida Gulf coast.

Fishing for menhaden in the Gulf of Mexico is active from April through October, with the larger runs of fish with the highest oil content expected during the months of June, July and August. The season observed in the New Jersey-Deleware area, the Cheaspeake Bay area and to the southward to Florida starts the latter part of May and can be expected to last through September into October. The exception in this area is the central North Carolina coast,

where the fleet based in the Morehead City-Beaufort area usually expect large runs of the largest menhaden from October to January.

There are more than 30 menhaden reduction plants in operation in this country. There is no accurate estimate as to the number of boats engaged in this trade, as these purse seiners are shifted from plant to plant according to the season of the year and the run of the fish.

Menhaden run in schools consisting of several thousand individuals up to huge bodies of fish covering acres of the sea and containing millions of fish. Normally these fish swim at the surface or near it. At the surface they are distinguishable by a dark brown br reddish coloration on the water. When just below the surface they are located by "whipping" or "playing" of the fish. Another telltale sign is the sight of large numbers of gulls and pelicans feeding in a given area. In recent years electronic "fishfinders" have been developed to locate schools of fish not otherwise discernable. These instruments, called fathometers or echosounders, utilize the principles of electronics used in sonar, a development stimulated by submarine hunting during World War II. Another most effective means of spotting schools of menhaden is by use of airplanes. Both the airplane and the fishing boats are equipped with radiotelephone equipment. By this communication the pilot can accurately direct the boats to the schools of fish.

When a school is located, the crew, numbering 20 or more, takes to the two steel purse boats towed behind the mother boat. One is in the charge of the captain and the other in the charge of the mate. Each boat carries one-half of several hundred yards of purse seine.

Meanwhile a small skiff, known as the striker-boat, has marked the location of the head of the school. The purse boats move together to this point. The purse boats now separate and circle the school in opposite directions, paying off the net. When the school is circled the boats meet again and the net is "pursed" by drawing in the bottom with the purse line, hauled by a hand winch, until the fish are in a bag. Then, the crews in the purse boats take in net by hand and often to the cadence of ancient chanteys until the school is a compact mass of fish.

The big boat then comes up and the purse boats are made fast to her side to form a triangle enclosing the fish. The fish are then put into the hold of the mother boat by bailing (or "brailing", as the operation is technically known), or by means of a hydraulic conveyor. Each set will contain from a few thousand to several thousand fish. This procedure is repeated until the big boat is loaded with half million fish or more, or until darkness or the weather prevents further activity.

When the fish are brought to the factory they are sold by the thousand, each member of the crew receiving shares in accordance with his particular job. The arbitrary measure of 1,000 fish is that number which will fill 22,000 cubic inches, or 96 gallons. By actual count there are considerably more than a thousand fish in this space. This historic measure is constant throughout the industry however. It is considered that each 1,000 fish will weigh 666 ⅔ pounds, so, for conversion purposes it is figured that 3,000 fish equals one ton.

Fish are usually landed within 10 to 15 hours of the time they are caught. They are processed within the next twelve hours.

Boats were formerly unloaded by means of bucket elevators. Almost all un-

loading at the present is done by means of large pumps, either piston or centrifugal, which actually serve as hydraulic conveyors.

The fish pass from the measuring hopper into a storage compartment called the "raw box". From here the fish are drawn into cookers. These long, narrow chambers are equipped with a line of steam jets over which the fish are moved by means of a screw conveyor or revolving paddles. A steam pressure of about 10 pounds is maintained in the cookers. The fat must be separated from the tissue without overheating since excess heat is believed to damage the protein values of the meat and to interfere with the remainder of the reduction process.

Solids and liquors from the cooker pass into screw presses which squeeze out the "press liquor" and leave the "press cake". The press cake is carried into either flame or steam tubular dryers which reduce the moisture content to the vicinity of 10 per cent. The scrap, when discharged from the dryer, is placed in piles and turned several times to eliminate the residual moisture and latent heat. Fish scrap is ground to produce fish meal.

The press liquor is either passed through centrifuges or run into large settling tanks to separate the oil from the residue, known as stickwater, after having been passed over vibrating screens to remove any large particles of solid matter that may be present. The fish oil is drawn off into storage and shipped in tank car lots for use in industry in its crude form or to processors who treat it for specialized uses.

The stickwater is freed of its residual oil and much of the suspended protein by either centrifuging or by gravity separation. It is then concentrated approximately ten times, generally by means of triple effect vacuum evaporators. The 50 per cent solid syrup that results from this process is called condensed menhaden fish solubles. This is usually acidifid to stabilize it in storage, and shipped in tank car lots.

We see then, that the menhaden yields three products: (1) fish meal or scrap, (2) fish oil, and (3) condensed fish solubles.

The meal is valued as a feed ingredient for poultry, swine and other domestic animals for its high protein value, and its well balanced content of amino acids, its vitamin content and its content of trace minerals.

Menhaden fish solubles are used primarily as a feed ingredient. Its value lies in its wealth of vitamins, particularly the essential B-complex, and the unknown growth factors that are recognized as essential to the well-being and proper development of all animals including humans. This plentiful supply and even balance of almost all of the vitamins, plus the ability of various types of bacteria to thrive in this culture, indicates that solubles will become an excellent fertilizer. The menhaden feed on plankton and is thus an efficient machine for reclaiming the chemical nutrient wealth washed to sea each year from our soil.

It has been conclusively demonstrated that the catching of menhaden does not intefere with the catching of food fish nor sport fish. Only in rare instances have other species of fish been found in pogy nets.

It should be now evident that this little known pelagic creature, the menhaden, which exists in such large numbers, and about which so little is generally known, finds its place, in one way or another, into some phase of our lives every day.