TECHNOLOGICAL STUDIES OF THE STARFISH

PART VI - ECONOMIC CONSIDERATIONS IN THE UTILIZATION OF STARFISH

By Charles F. Lee*

INTRODUCTION

Previous papers have discussed the relation of the common starfish (Asterias forbesi) to the oyster industry and the phases of starfish utilization which have been investigated by the U.S. Fish and Wildlife Service. The economic considerations involved in any practical utilization of starfish have been mentioned only briefly before. It is the object of this concluding section to investigate this important phase of the general problem of the utilization of starfish in the New England area.

SUMMARY OF POTENTIAL USES FOR STARFISH

Briefly, the investigations of the Fish and Wildlife Service have been confirmed by several other investigators with respect to the value of starfish meal as a feedstuff. It was found to be a valuable protein supplement in amounts up to 6 percent by weight of growing mashes for chicks. In addition, starfish meal satisfactorily supplied both protein and lime in laying mashes at a level of 8 percent. Raw starfish as well as meal dried at low temperatures were found to contain thiaminase, the thiamine-destructive enzyme. This added a new phylum of marine organisms to the list of those with members containing thiaminase. Raw starfish used as fertilizer supply about 1.3 percent available nitrogen and 3.5 percent of acid soluble calcium. Treatment with sulfuric acid does not, however, solve any of the problems involved in handling and storing large quantities of raw starfish.

The proximate analysis of starfish does not indicate any other way in which starfish might be used. Starfish oil must be solvent extracted as it averages about 2 percent and rarely exceeds 3 percent of the freshly caught material. The oil has been found to contain a complex mixture of virtually inseparable sterols (see Part II). So far as is known, none of these sterols shows promise as intermediates in the fields of vitamin or hormone chemistry. Only the existence of a high-priced byproduct would justify the costly solvent extraction of the small amount of oil available. Thorough investigation of the protein of starfish offers some promise of discovery of a product of high value. The protein is readily broken down and might prove to be a source of certain amino acids which have recently been in considerable demand for clinical studies and nutrition research.

*Chemical Engineer, Fishery Technological Laboratory, Branch of Commercial Fisheries, College Park, Maryland.

NOTE: Part I of this series, "Starfish Control--Its Economic Necessity and Methods Used," appeared in the January 1948 issue of Commercial Fisheries Review, pp. 1-6. Also available as Sep. No. 193.

Part II, "Chemical Composition," appeared in the February 1948 issue, pp. 11-18. Also available as Sep. No. 196.

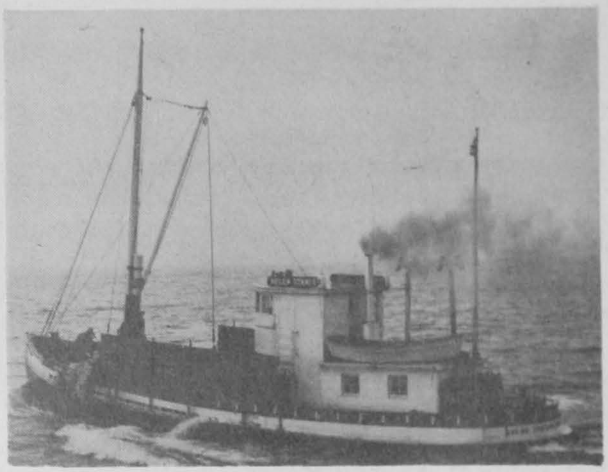
Part III, "Value of Starfish Meal--Protein Supplement for Growth of Rats and Chicks and for Egg Production," appeared in the March 1948 issue, pp. 8-19. Also available as Sep. No. 199.

Part IV, "Thiaminase in Starfish," appeared in the May 1948 issue, pp.12-19. Also available as Sep. No. 204.

Part V, "Starfish as Fertilizer," appeared in the June 1948 issue, pp.11-16. Also available as Sep. No. 206.

ECONOMIC FACTORS RELATING TO USE OF STARFISH FOR PROTEIN MEALS

Special handling of starfish in any quantity, large or small, would be justified if the material were to be used in preparation of amino acids or vitamin and hormone intermediates. However, at present, the only proven value of starfish is as a source of protein in poultry feed or in fertilizer. For these purposes, it is in direct competition with the other protein byproducts. Some of these are crab scrap meal, shrimp and lobster bran, and the "white fish" meal produced from New England groundfish fillet scrap. In fact, since starfish meal is merely a potential source of protein dependent on economic factors, other potential sources might be used under certain circumstances. Of these might be mentioned the enormous quantities of trash fish discarded by the North Atlantic trawl fisheries, as well as the smaller, but sizable, quantity of trash fish taken, but not utilized, by the shrimp trawlers in the South Atlantic and Gulf.



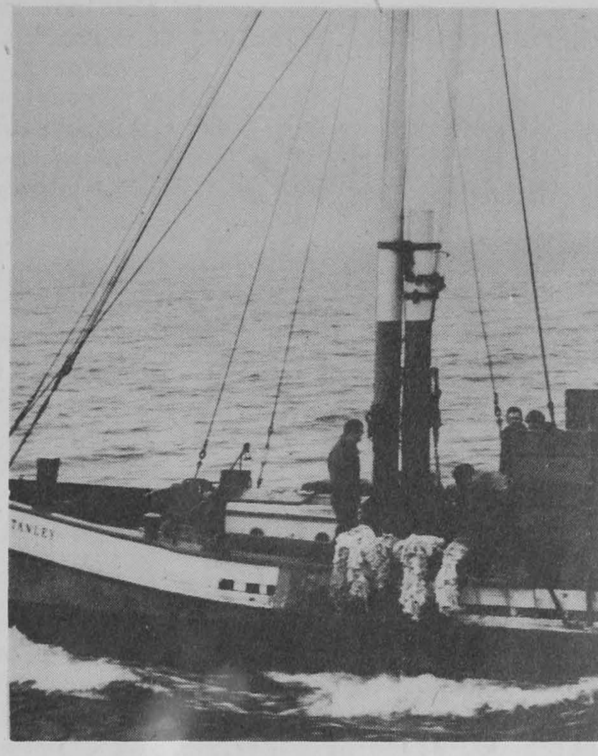
STARFISHING VESSEL

For this reason, the creation of an industry based on the use of starfish as a raw material for the production of protein meals is dependent upon a number of factors, each directly affecting its economic feasibility. To be considered are:

1. The amount of starfish available from present control efforts of the oyster industry, and costs thereof.
2. The regularity of supply from month to month and over a period of years.
3. The possible quantity of starfish to be obtained from a separate fishery and costs of such operations.
4. The cost of production, transportation and marketing of starfish meal.

It is virtually impossible to obtain data on the catch of starfish, cost of control operations, fluctuations in the number of starfish and other pertinent information (Galtsoff and Loosanoff, 1939 and Burkenroad, 1946). Starfish are regarded by oystermen as a necessary evil to be kept at the lowest level consonant with a reasonable expenditure of money and effort. Operating costs of vessels used for starfish control vary widely with the type and size of vessel used and the method of control. In 1947, these were estimated to be $35 to $50 per day at a minimum, while costs may exceed $150 per day per vessel when the large oyster dredge boats are transferred to cleaning grounds of starfish.

The amount of starfish taken by these control efforts is even harder to estimate. Generally, the starfish have not been brought to shore so that a quantitative estimate is not possible. The starfish are landed on deck only when the mops are hand-picked or during the uncommon occasions when starfish are dredged. Catch estimates of starfish taken by the mops which are dipped in hot water are, at best, rough estimates. The material taken by dredge may consist of more crabs, conchs, oysters, shells, and rocks, than of starfish. If the amount of starfish exterminated is not known, at least it is generally agreed that the quantities of starfish encountered show large variations from year to year and even from month to month (Sweet, 1946). At certain times, every available craft is working at starfish control, while during similar periods in other years so few starfish may be found that the only operations necessary are periodic surveys to detect any sudden increase in population which can then be checked before serious damage is done.



CLEANING MOPS ON STARFISHING VESSEL

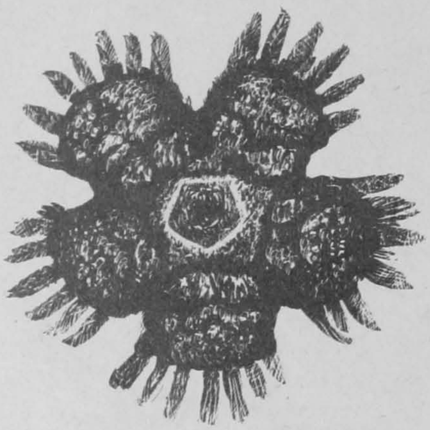
Unpublished work of Loosanoff suggests that the abundance of starfish for a given season can be predicted with some degree of accuracy from a study of larval forms in plankton samples taken in the preceding months. However, very little is known of the causative factors in the fluctuation in abundance of starfish. The opinion has been prevalent both among growers of seed oysters and the State agencies of Rhode Island and Massachusetts that the starfish population can be materially reduced for some years by intensive control efforts during periods of heavy infestations. This theory has been the basis for the limited appropriations which have been made several times in recent years paying a bounty on starfish caught, (Barnes, 1946 and Gibbs, 1941 and 1946).

On the other hand, the trend in recent years has been for biologists to attribute more and more weight to the effects of ecological factors on the size of populations. Many of these factors are still unidentified. The effect of human factors, such as, hunting, sport fishing, extensive commercial fishing, trapping, and even bounty payments for predators are often believed to be secondary in importance in their effect on future abundance.

Some of the species, the abundance of which is held to be greatly affected by these ecological factors, are certain of the game birds and smaller game animals, fresh-water game fish, and marine species of fish and shellfish, such as, the blue crab, haddock, mackerel, menhaden, and pilchard. This does not imply that too heavy hunting or fishing cannot significantly reduce a population, but in normal years, it has been estimated that, for some of the marine species with a short life cycle, a capture of as much as 80 percent of the population will not materially affect future abundance. Conversely, disease, drought, abnormal rainfall, and similar uncontrollable conditions may dramatically reduce a population, for many years in some cases. The well-known mystery of the disappearance of smelt in the Great Lakes is an illustration.

It is not too surprising, therefore, that Burkenroad (1946) found evidence of a large annual variation in his extensive, though hardly quantitative, survey of starfish abundance. In the course of fluctuations of a seemingly cyclic character, he estimated a decrease in the population of the order of one-twentieth of that found at the maximum. The nature of the information on which these conclusions were based does not permit quantitative comparison of the population density at the several maxima.

It was suggested, though also not subject to proof, that the fluctuations in starfish abundance coincided throughout the whole New England area. Since control efforts have been carried on by the oystermen throughout the period studied, it is of course impossible to separate their influence from that of natural factors. This is emphasized by the fact that most of the information comes from sources directly influenced by the reports of oystermen on starfish abundance, namely, trade journals and newspapers.



STARFISH ABOUT 1 MONTH OLD

Actually, for present purposes, it does not matter whether the fluctuation is man-made or from natural causes. The critical fact is that enormous variations in abundance do occur. One company encountered a range from 5 to 650 tons per year in its estimated catch of starfish. The supply of raw material from a fishery of this type does not permit the economical operation of a meal drying plant.

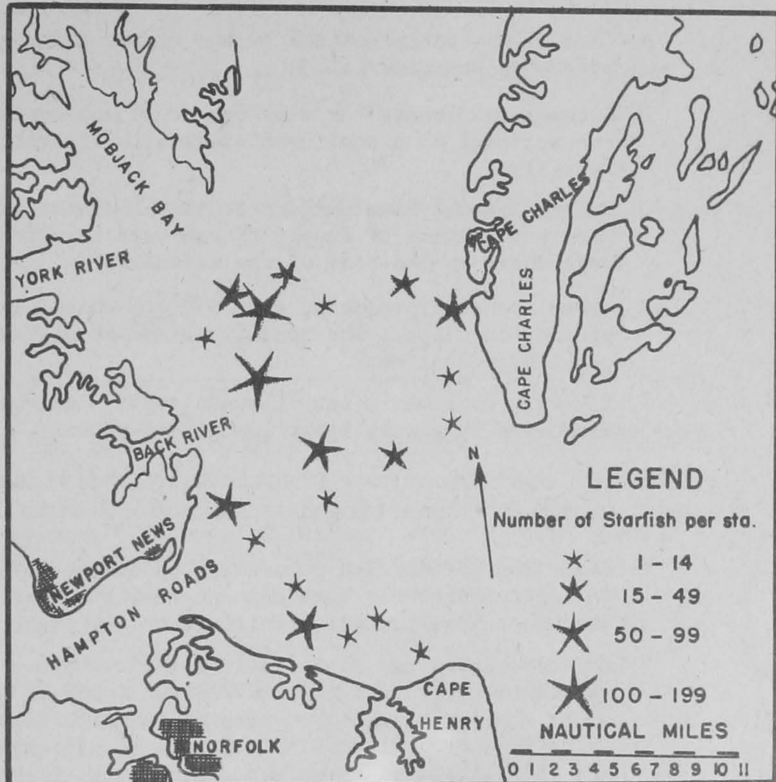
A rough estimate of the cost of starfish taken by the seed oyster companies may be made based on average costs of $50 per day to operate a vessel taking 8 bushels of starfish weighing approximately 500 pounds. A ton of raw starfish would cost $200, which is equivalent to a cost of $1,000 for raw material to produce a ton of meal. This figure probably would be at least doubled if the starfish were hand-picked. The drying plant, on the other hand, could not pay more than $3 to $4 per ton for raw material.

The establishment of a separate fishery for starfish comes somewhat nearer to the border of economic feasibility. A bounty was paid on starfish landed in Massachusetts from 1932 to 1936 (Barnes, 1946) and in Rhode Island in 1941 (Gibbs, 1941 and 1946). There was also one commercial plant at Mobjack Bay, Va., which made starfish meal for a short period in 1935-36 when starfish invaded the lower Chesapeake Bay. From these sources, an estimate of the cost of a separate fishery for starfish may be made. The starfish dredged from Chesapeake Bay were estimated by Burkenroad to have cost the Virginia meal plant from $2.50 to $4.00 per ton. Bounty payments have ranged from $10.00 to $15.00 per ton, the price being increased as the abundance of starfish decreased. Bounty payments were limited to starfish taken from small skiffs with hand dredges. With an organized fishery using much larger, powered fishing craft, costs could undoubtedly be reduced below these figures. However, with the high operating costs of the postwar period, it would be difficult even in periods of maximum abundance to land starfish at a drying plant for as little as $5.00 per ton. Over a period of years, the previously discussed uncertainty of supply would make the average cost of raw starfish several times this figure, or a far greater cost per ton of dry meal than its retail value.

MEAL PRODUCTION COSTS

A suggestion of possible merit would be the construction of a meal plant designed for processing starfish during periods of maximum abundance with the use of other raw materials, such as trash fish during periods when starfish are relatively scarce. The existence of such a standby source of unused raw material would have to be assured. The relatively small size of the Connecticut trawl and trap fishery up to 1947 has not offered the assurance of a reliable supply of trash fish.

With raw material costs inevitably high, transportation costs would of necessity have to be kept at a minimum. The drying plant would have to be located at the point of maximum starfish concentration. A floating dehydration plant would solve the problem of accessibility to a shifting and uncertain source of raw material. To operate efficiently, this type of plant would need a small fleet of "buy" boats to collect the starfish. Since operations of this type have not been carried out on the East Coast, cost estimates are difficult to make. It is certain that costs would be very high unless a supply of raw material of many times the quantity of starfish now available in 1947 were definitely assured.



DISTRIBUTION OF STARFISH IN CHESAPEAKE BAY IN MARCH 1937

The cost of drying, grinding, packing, and selling of starfish meal would be equal to or greater than similar costs of other byproduct meal. Personal observation, as well as the limited experiences of the Rhode Island Oyster Company in producing a trial lot of starfish meal, suggest that the tendency of raw starfish to mat together will lead to difficulties in maintaining an even feed to the driers. Special handling would be required to eliminate this difficulty, and grinding the dry meal might also present difficulties. The starfish skin is both tough and abrasive, and has a tendency to flake into sheets rather than to break into a uniform particle size. Reduction of moisture content below 3 percent would facilitate grinding but would add considerably to drying costs.

The most efficient type of drier operating continually at optimum capacity would add $19.00 to $20.00 to the cost of a ton of starfish meal. Total production costs were estimated by Burkenroad to total about $42.00 per ton for a steam dried meal. This value is, however, based on a regular year around supply of raw material to yield an annual production of 5,000 tons. This would mean 25,000 tons (50 million pounds) of raw material would be required and as indicated above there seems to be no possibility that the supply of starfish could regularly meet more than a small fraction of this total demand for raw material.

CONCLUSIONS

1. The production of starfish meal is not practicable for the following reasons:

   A. Control methods practiced by the oyster industry do not offer a reliable source of raw material.

   B. A separate fishery for starfish could not operate at present to yield raw material at a cost consistent with its value as a feedstuff or fertilizer.

   C. Extreme annual fluctuations in the abundance of starfish creates a very poor source of supply of raw material for a meal drying industry, regardless of the cost of raw material.

   D. There are no byproducts, such as oil, which might carry part of the production costs. The costs would be as high or higher than for any other byproduct meal.

   E. Starfish meal has a low nitrogen content and high ash content and therefore is a relatively low priced product.

2. Control operations now practiced by individual oyster companies appear to be the best means for combating the menace of starfish to the oyster industry.

   A. Reduction of starfish population by bounty payment is only temporary. It appears probable that abundance will normally decline from maximum through natural causes within one or two years.

   B. Further biological research is needed to prove the existence of an abundance cycle, and to study larval forms of plankton samples in order to predict the abundance of starfish in the immediate future. Reliable information of this nature should enable more efficient and intelligent planning and utilization of present control equipment by the oyster companies.

3. Future technological research on starfish should be directed to the development of high-priced preparations from starfish.

   A. The utilization of starfish for feed or fertilizer has been sufficiently explored to show that it is theoretically possible but not economically feasible.

   B. At the present time, it would appear that development of methods for the separation of the amino acids of the protein of starfish might produce products of sufficiently high price to encourage the establishment of a separate fishery.

LITERATURE CITED

BARNES, E. W.

1946. Starfish menace in southern Massachusetts in 1931. Bingham Oceanographic Collection, Bull. 9, Art. 3: 38-43.

BURKENROAD, M. D.

1946. General discussion of problems involved in starfish utilization. Bingham Oceanographic Collection, Bull. 9, Art. 3: 44-58.

GALTSOFF, P. S. and LOOSANOFF, V. L.

1939. Natural history and methods of controlling the starfish (Asterias forbesi, Desor), U. S. Department of the Interior, Bureau of Fisheries Bulletin 31: 1-132, illus.

GIBBS, H. N.

1941. Annual report of Office of Fish and Game. Department of Agriculture and Conservation of Rhode Island, pp. 11-2.

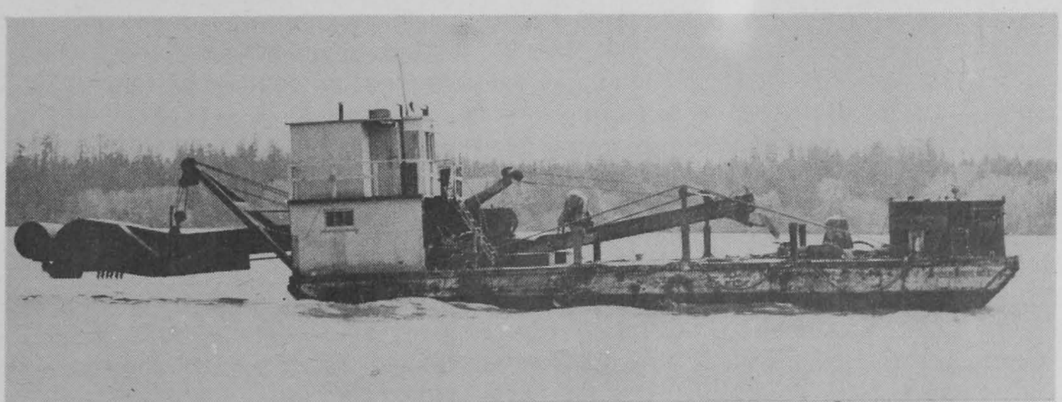
1946. The control and utilization of starfish in Rhode Island waters. Bingham Oceanographic Collection, Bull. 9, Art. 3: 28-30.

SWEET, H. G.

1946. Starfish prevalence and production problems. Bingham Oceanographic Collection, Bull. 9, Art. 3: 33-7.

PLANTING AND MARKETING OYSTERS IN THE PACIFIC NORTHWEST

Owing to the scarcity of help, dredging for oysters has largely taken the place of picking and tonging. Dredgers may be self-powered or towed behind another boat. They may be operated from one side only, or from both sides, or from the stern. If more than one drag is to be fished, a separate hoist is used for each drag so that one may be pulled in while the other is fishing. Some dredgers are merely boats with a long foredeck where the oysters are piled as dredged; others are power scows with side boards. As the latter have a more shallow draft they hold larger loads and may fish longer over the beds without going aground.



PACIFIC COAST OYSTER DREDGE

Oysters are delivered to the opening house from the dredges by means of a chain elevator or a bucket hoist. In some houses the oysters pass through a rotating cylindrical washing-screen which removes all sand and grit, and passes the oysters to the storage bins. These bins are built above the concrete-surfaced opening tables and are tapered toward the bottom. The oysters fall through the narrow opening at the bottom onto the opening table and, as the oysters are removed by the opener, the supply is continually renewed.

--Fishery Leaflet 52