SEA GRANT SESSION (Aquaculture)

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Chairman – George B. Gross, *Director of Purchasing, Red Lobster Inns of America Inc., Orlando, Florida*

Squid Processing Machine

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The race between the population explosion and the means to feed this growing mass of people has by no means been decided. The cost of meat is rising and will continue to rise in this and many other countries. It is urgently necessary to examine, develop and utilize to the fullest extent possible all food resources available and potentially available on land or in the water.

A project funded in part by the M.I.T. Sea Grant Program was launched 2 years ago in the Department of Nutrition and Food Science to determine the potential value of squid as food for the American Consumer. The project was designed to investigate: (1) the chemical characteristics of the squid muscle proteins, (2) methods for processing squid and (3) the acceptability of squid and squid products by the American consumer.

My remarks particularly concern a brief description of a prototype machine that we designed, constructed and tested at M.I.T. to eviscerate and skin raw squid. I shall give you a few basic data on the squid resource, the harvesting methods and a few other facts, to make the presentation more useful.

Taxonomy

The squid belongs to a group of animals called cephalopods, which are the most highly developed class of creatures of the phylum mollusca. The squid and the cuttlefish are active, strong swimmers and close relatives of the sluggish and sessile oyster and clam. The cephalopods as a whole and the squid in particular are probably the most abundant of the underutilized species of marine food animals and deserve much more serious attention by the U.S. fishing and food industries than they have received so far.

Of the five sub-divisions of the cephalopods, the squid belongs to one, Teuthoidea, containing the sub-orders Myopsida and Oegopsida. Among the former we find one of the commercially most important species of squid, *Loligo*, which seldom lives beyond the edge of the continental shelf; to the other sub-order belong the truly oceanic squid like the useful and palatable *Illex* and *Todarodas* which dwell usually beyond the edge of the shelf, though they come periodically inshore and are then caught by fishermen.

The Resource

According to Gilbert L. Voss, of the School of Marine and Atmospheric Science at the University of Miami in Florida, our present knowledge of cephalopod fisheries lacks many important data. It is almost impossible, also, to attribute much credance to estimates of catch or catch potential. According to Voss, we lack almost all reliable data on egg production and distribution, growth, longevity, stock sizes, fishing efforts and even landing statistics. However, some data are available and some rough estimates of potential harvest can be made. Table 1 summarizes the catch statistics available for a number of regions and the estimated harvesting potential as gathered from various sources.

It is not improbable, according to Voss, that at the present time the total cephalopod catch of the world lies somewhere between 1½ and 2 million metric tons. The estimated potential of the shelf and upper slope regions lies, according to him, between 8 and 12 million metric tons.

Table1. Landings and Potential Cephalopod Resources of the World

Regions	Landings (tons)	Estimated potential (tons)
Northeast Atlantic	12,000	> 100,000
Mediterranean Sea	42,000	100,000
Northwest Atlantic	27,000	500,000
Central Eastern Atlantic	300,000	1,000,000
Caribbean Sea	900	> 100,000
Southeast Atlantic	?	> 200,000
Southwest Atlantic	5,400	500,000
Northeast Pacific	15,000	600,000
Central Eastern Pacific	500	> 100,000
Southeast Pacific	1,000	500,000
Northwest Pacific	1,000,000	2,000,000
Western Central Pacific	40,000	500,000
Southwest Pacific	500	200,000
Oceania	500	500,000
Indian Ocean	500	500,000
Total	1,445,300	>7,400,000

Source: Gilbert L. Voss, *Cephalopod Resources of the World FAO Fisheries Circular NE 149*, FAO, Rome, April 1973.

Probably less than 10% of the ocean's surface is at present fished for cephalopods and from this area is taken almost all of our present cephalopod catch. At least, to continue to quote from Dr. Voss, 90% of the ocean's area is unexploited and yet is the home of very large numbers of species of cephalopods that seldom stray inshore and spend their entire life cycle on the high seas. Attempts to assess the potential productivity of the oceanic area have yielded a very wide range of estimates. Clarke told Voss in a personal communication that from his work on sperm whales he estimates that the southern hemisphere population of about half a million sperm whales consumes between 40 and 100 million tons of squid a year and that he thinks that 50 million tons is probably a reasonable estimate if one single figure were needed. If we accept Clarke's figure of 50 million tons, which seems conservative, we can make further estimates. Certainly, the present state of sperm whales represents no more than say one-fifth of its original size which may have been of the order of two and a half million for the southern hemisphere. It is, therefore, possible to say that the annual potential catch of oceanic squid lies within the range of from 100 million to 300 million tons and may be as high as 500 million tons.

Locating, Harvesting and Preserving the Catch

Almost no modern technology has been developed to locate schools of squid, but it is expected that acoustical methods will eventually be employed to facilitate the search operation. As far as harvesting the catch is concerned, a large number of methods is in use at the moment. (1) Spearing or hooking are probably the oldest and most successful of all small-scale methods. They are used at night with the help of lights. (2) In the Mediterranean, a female squid is slowly trolled at the stern of the boat to attract the males. In the Orient, weighted jigs or jig type lines are used. (3) Floating or anchored traps are used in Newfoundland. (4) Baited baskets and pots are used elsewhere. (5) Otter trawls seem to be the most productive of all harvesting implements. (6) Purse seines are in use in the Mediterranean, off the coast of Africa and Japan. Light is used to attract the squid and when the seine is pursed, the catch is brailed or pumped out.

As to the preservation of the catch on board ship, great care must be taken since the squid is extremely sensitive and bruises very easily; it is also important to avoid spilling the squid ink over the squid muscle. Research is needed to devise methods to keep squid fresh on board ship. Squid cannot be packed in large amounts of ice because the weight of ice and squid would squash the animals.

Mariculture

This brief sketch of the potential of squid as a food resource would be incomplete without mentioning that the artificial rearing of squid from the egg to commercially sized animals has been successfully accomplished and is particularly attractive on account of the extremely rapid growth of the animals and the short overall period of time required to fully grow individuals.

Processing of the Raw Squid

Squid is widely and abundantly available in the world's oceans, can be harvested by a number of means and represents a source of high quality protein.

Several important social, economic, and technological problems must, however, be addressed and resolved if squid is to enter the American diet, or if it is to be processed on a large scale for export. One of these problems concerns methods and equipment for eviscerating and skinning the raw material. These two operations, including the removal of the ink sack, are essential for esthetic reasons. Squid ink and the sack in which it is contained are integral parts of the animal's viscera. The ink has powerful dying properties. Should the ink sack burst and the ink spill, the animal's muscle tissue would become irreversibly discolored.

Removal of the skin enveloping the mantle is also important, since only when the skin has been peeled does the snow-white muscle become easily suitable for further processing into different food forms and attractive enough to compete with other similar raw materials such as clams and oysters.

In this country, evisceration and skinning of raw squid are performed manually. These are expensive and inefficient operations. In an attempt to improve this situation, Professor Berk developed the prototype of a simple automatic eviscerating and skinning machine which we have tried, tested and demonstrated. We are now looking for funds to develop the machine one step further, to bring it a little closer to industrial usefulness and application.

The machine, for which patent protection has been applied, operates on the basis of the old Maytag washing machine squeeze-wringing device. It consists of horizontally mounted, spring-loaded pairs of rollers of identical dimensions; the rollers are placed, one pair beneath another, the lower pairs rotating at slightly greater speed than the upper pairs, so that the squid is pulled downwards and the viscera and ink sack squeezed out of the mantle. In working the prototype the squid is fed by hand into the machine, tail first, the operator holding onto the head of the animal; the squid mantle is rapidly pulled downwards and through the rollers, at the same time that the viscera are squeezed upwards. In this way, the viscera attached to the head and tentacles are easily and quickly separated from the rest of the body. By hand feeding the prototype, the machine can process 10-15 squid per minute.

The second, skinning, operation is similar: the eviscerated mantles are washed, scalded in 160° F water for 2-3 minutes, and reintroduced into the machine, which now peels the skin from the muscle. This phase of the operation does not as yet function as well as the first: the peeling process is sometimes not quite complete and remnants of the skin have to be removed by hand. In this respect, the machine has to be improved.

Consumption

The edible parts of the squid containing 18% of highly valuable protein represent almost 80% by weight of the whole animal, an unusually large proportion if compared to the edible material of either finfish or crustaceans.

Squid have been consumed since antiquity and are presently eaten as regular dietary components in many parts of the world, especially in Japan, where several hundred thousand tons are annually consumed, and in the Mediterranean countries. In the U.S., only small quantities are consumed by certain ethnic groups; the American people as a whole have not yet learned to accept and appreciate this delicate and nutritious food.

Conclusion

The crisis in the world's natural resources has only just started in earnest for the industrialized countries. Today it is a shortage of energy in the form of oil that worries us. Tomorrow it will be a shortage of energy in the form of food. There are enormous unutilized and underutilized yet still finite food supplies that we have not yet really begun to husband and exploit wisely. Squid is one of them. This paper with its description of a modest prototype for the processing of the raw squid attempts to turn attention to this resource in the hope that more engineers and scientists may become interested in contributing to making it more widely available.