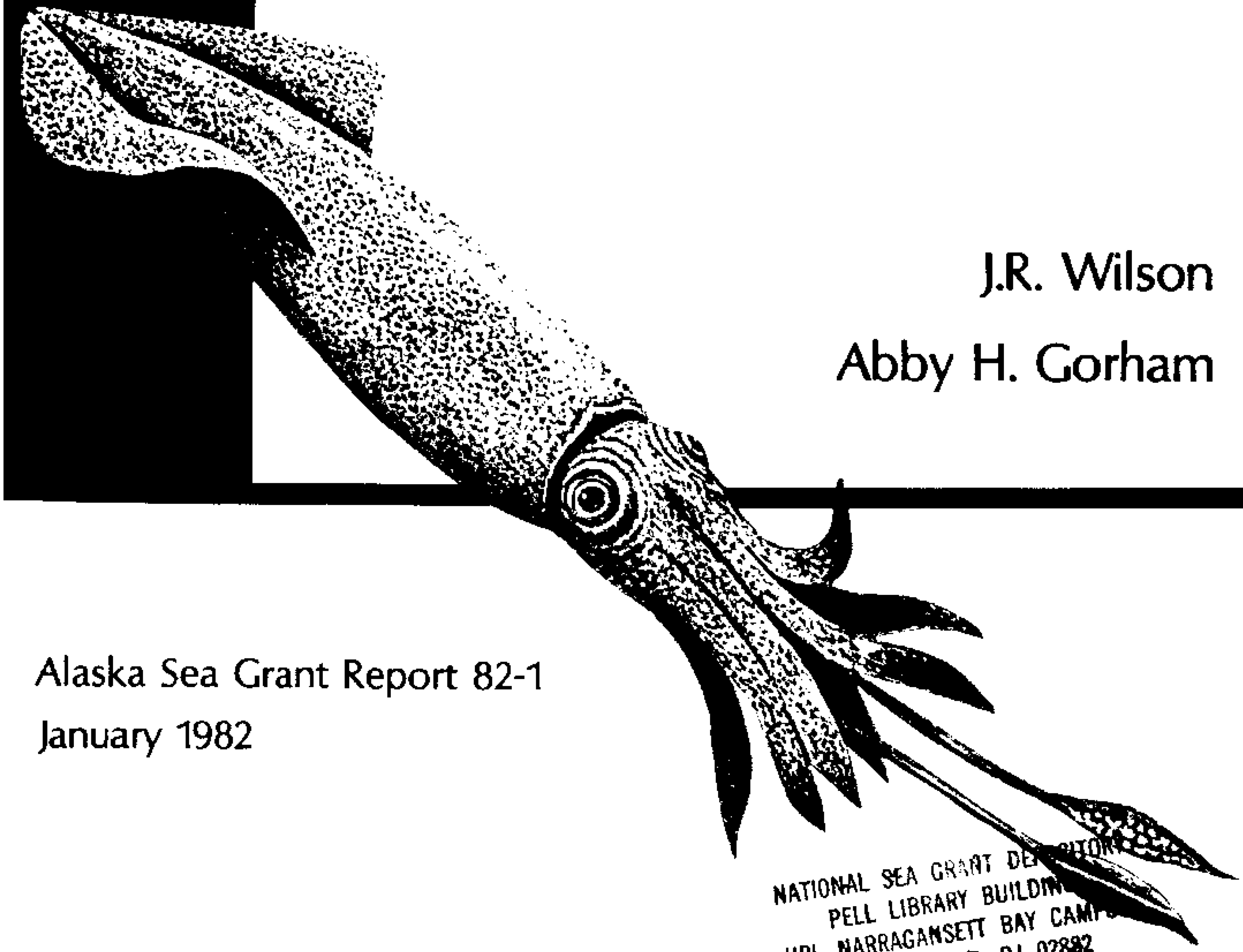
# Alaska Underutilized Species
## Volume I:

# SQUID



J.R. Wilson
Abby H. Gorham

Alaska Sea Grant Report 82-1
January 1982

Alaska Sea Grant Program
University of Alaska
Fairbanks, Alaska 99701

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## VOLUME I

## SQUID

by

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The appendices to this report have been published in a separate volume. They contain more detailed information relating to the various sections in this report. If you are interested in this additional information, request copies from:

Alaska Sea Grant Communications
307 Chapman
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The appendices are as follows:

| | |
|---|---|
| Appendix A: | Results of selected cruises of the National Marine Fisheries Service in the Bering Sea, and Gulf of Alaska, by statistical block, showing incidental catches of squid |
| Appendix B: | Japanese and Korean squid catch in the Bering Sea and Gulf of Alaska, by statistical block |
| Appendix C: | The estimated incidental squid catch by mothership and stern trawler, by statistical block, derived from NMFS foreign observer data |
| Appendix D: | Detailed results of the feasibility analysis of trawling operations for squid |
| Appendix E: | Survey questionnaire and background information |
| Appendix F: | Import and export statistics for countries reporting trade in squid |
| Appendix G: | A summary of major producers of the world's sea cucumber, sea urchin, squid, octopus, and cuttlefish resources with synopsis on the availability of import-export data from the country |

## ACKNOWLEDGEMENTS

**This report, the first in a series on underutilized species, is in part the result of research which used compiled data on file at the International Fisheries Analysis Branch, Office of International Fisheries, National Marine Fisheries Service. Special thanks are expressed to Milan Kravanja and his staff for their generous assistance in this task.**

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# TABLE OF CONTENTS

# FIGURES

FIGURES
(Continued)

FIGURES
(Continued)

FIGURES
(Continued)

## TABLES

# ALASKA'S UNDERUTILIZED SPECIES - SQUID

## GENERAL DESCRIPTION

### DISTRIBUTION OF THE RESOURCE

The squid resources of the world are diverse. There are numerous species of varying shapes and sizes which have their own regional consumer following. In this regard, squid possess the same barrier to traditional marketing methods that most finfish have: many types, most of which carry regional consumer preferences. The order of squid (Teuthoidea) contains about 270 species in 25 families (Lipinski 1973) and ranges in length from 2 cm to over 60 ft. Squid are also distributed worldwide with definite species distribution in certain areas. In addition to squid resources, cuttlefish distribution is also important. These cousins to the squid are heavily exploited and consumed by countries such as Japan.

### WORLD DISTRIBUTION

Table 1 and Figure 1 show the world distribution of cuttlefish (Sepiidae and Sepiolidae), Ommastrephid squid and Loliginid squid, as outlined by Briantais (1974), after Voss (1973). The starred areas by each species' name indicate an abundance of that species though they may not be heavily exploited. The two main families of cuttlefish are represented by about 100 species (Hotta 1976). Although only 29 species are shown here, these are the major part of the exploited population.

These general distributions should also give the reader an indication of where potential competition exists in the export market. However, Lipinski (1973), Hotta (1976), and Voss (1973) have described individual areas where exploitation is the greatest. Among these areas, the northwest Pacific is heavily exploited, with Japan taking roughly one-half of the world catch (Rathjen 1973). The predominant species caught in this area is <u>Todarodes pacificus</u> Steenstrup, although a number of other species are fished.

The northwest Atlantic has received much attention recently from foreign fishing fleets (including Japan, Spain, and the U.S.S.R.) as well as the U.S. and Canadian fisheries. This area has two species of commercial importance; the short-finned squid, <u>Illex illecebrosus</u>, found from Labrador through the Gulf of St. Lawrence and Newfoundland regions, along the Nova Scotia shelf and down to the south of Cape

Table 1. World distribution of Loliginid, Ommastrephid squid and cuttlefish (Briantais 1974, after Voss 1973)

| Espèces \ Régions | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Loligo vulgaris* | ★ | ★ |  |  | ★ |  |  |  |  |  |  |  |  |  |  |
| *L. forbesi* | ★ | ● |  |  | ● |  |  |  |  |  |  |  |  |  |  |
| *L. pealei* |  |  | ★ | ● |  |  |  |  |  |  |  |  |  |  |  |
| *L. reynaudi* |  |  |  |  |  | ● |  |  |  |  |  |  |  |  |  |
| *L. brazilensis* |  |  |  |  |  |  | ★ |  |  |  |  |  |  |  |  |
| *L. patagonicus* |  |  |  |  |  |  | ● |  |  |  |  |  |  |  |  |
| *L. ellipsura* |  |  |  |  |  |  | ● |  |  |  |  |  |  |  |  |
| *L. opalescens* |  |  |  |  |  |  |  | ★ |  |  |  |  |  |  |  |
| *L. gahi* |  |  |  |  |  |  |  |  |  | ★ |  |  |  |  |  |
| *L. japonica* |  |  |  |  |  |  |  |  |  |  | ● |  |  |  |  |
| *L. beka* |  |  |  |  |  |  |  |  |  |  | ● |  |  |  |  |
| *L. budo* |  |  |  |  |  |  |  |  |  |  | ● |  |  |  |  |
| *L. chinensis* |  |  |  |  |  |  |  |  |  |  | ● |  |  |  |  |
| *L. formosana* |  |  |  |  |  |  |  |  |  |  | ★ | ★ |  |  |  |
| *L. sumatrensis* |  |  |  |  |  |  |  |  |  |  | ● | ● |  |  |  |
| *L. edulis* |  |  |  |  |  |  |  |  |  |  | ● | ● |  |  | ● |
| *L. duvaucelii* |  |  |  |  |  |  |  |  |  |  |  | ● |  |  | ★ |
| *L. etheridgei* |  |  |  |  |  |  |  |  |  |  |  |  | ★ |  |  |
| *L. indica* |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ● |
| *L. hardwicki* |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ● |
| *Lolliguncula brevis* |  |  | ★ | ● |  |  | ★ |  |  |  |  |  |  |  |  |
| *L. panamensis* |  |  |  |  |  |  |  |  | ● |  |  |  |  |  |  |
| *Loliolus affinis* |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ● |
| *Loliopsis diomedeae* |  |  |  |  |  |  |  |  | ★ |  |  |  |  |  |  |
| *Alloteuthis media* | ● | ● |  |  |  |  |  |  |  |  |  |  |  |  |  |
| *A. subulata* | ● | ● |  |  | ● |  |  |  |  |  |  |  |  |  |  |
| *Doryteuthis plei* |  |  | ● | ● |  |  |  |  |  |  |  |  |  |  |  |
| *D. bleekeri* |  |  |  |  |  |  |  |  |  |  | ● |  |  |  |  |
| *D. kensaki* |  |  |  |  |  |  |  |  |  |  | ● |  |  |  |  |
| *D. singhalensis* |  |  |  |  |  |  |  |  |  |  |  | ● |  |  | ● |
| *Sepioteuthis sepioidea* |  |  |  | ● |  |  | ● |  |  |  |  |  |  |  |  |
| *S. lessoniana* |  |  |  |  |  |  |  |  |  |  | ● | ★ | ● | ★ | ● |
| Total = 32 | 4 | 4 | 3 | 4 | 3 | 1 | 5 | 1 | 2 | 1 | 10 | 6 | 2 | 1 | 6 |

| Espèces \ Régions | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Todarodes sagittatus* | ● | ● |  |  | ● |  |  |  |  |  |  |  |  |  |  |
| *T. pacificus* (1) |  |  |  |  |  |  |  | ★ |  |  | ★ | ● | ● |  |  |
| *Illex illecebrosus* | ★ |  | ★ |  |  |  | ★ |  |  |  |  |  |  |  |  |
| *I. coindetii* | ● | ● |  |  | ● |  |  |  |  |  |  |  |  |  |  |
| *Ommastrephes pteropus* |  |  |  | ★ | ● |  |  |  |  |  |  |  |  |  |  |
| *O. bartrami* |  |  |  |  |  |  |  |  |  |  | ● |  |  |  |  |
| *Todaropsis eblanae* |  |  |  |  | ● |  |  |  |  |  |  |  |  |  |  |
| *Onychoteuthis banksi* |  |  |  |  |  |  | ● |  |  |  | ● |  |  |  |  |
| *Pterygoteuthis giardi* |  |  |  |  |  |  | ● |  |  |  |  |  |  |  |  |
| *Moroteuthis ingens* (2) |  |  |  |  |  |  | ● |  |  |  |  |  |  |  |  |
| *Bathyteuthis abyssicola* (2) |  |  |  |  |  |  | ● |  |  |  |  |  |  |  |  |
| *Hensenioteuthis antarctica* (2) |  |  |  |  |  |  | ● |  |  |  |  |  |  |  |  |
| *Galiteuthis suhmi* (2) |  |  |  |  |  |  | ● |  |  |  |  |  |  |  |  |
| *Architeuthis sp.* (2) |  |  |  |  |  |  | ● |  |  |  |  |  |  |  |  |
| *Dosodicus gigas* |  |  |  |  |  |  |  | ● | ● | ★ |  |  |  |  |  |
| *Symplectoteuthis oualaniensis* |  |  |  |  |  |  |  |  | ● | ★ | ● | ● |  | ★ | ● |
| *Berryteuthis magister* |  |  |  |  |  |  |  |  |  |  | ● |  |  |  |  |
| *Nototodarus sloani* |  |  |  |  |  |  |  |  |  |  | ● | ★ | ★ | ● |  |
| *Watasenia scintillans* |  |  |  |  |  |  |  |  |  |  | ● |  |  |  |  |
| *Thysanoteuthis rhombus* |  |  |  |  |  |  |  |  |  |  | ● |  |  |  |  |
| Total = 20 | 3 | 2 | 1 | 1 | 4<br>4 |  | 8 | 2 | 2 | 2 | 8 | 3 | 2 | 2 | 1 |

(1) Longtemps référencié par erreur comme Ommastrephes sloanei pacificus.

(2) Tout à fait au sud de la Patagonie. Appartiennent déjà à la faune antarctique.

Table 1 con't.

| Especes \ Regions | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Sepia officinalis* | ★ | ★ |  |  | ★ | ★ |  |  |  |  |  |  |  |  |  |
| *S. orbignyana* | ● | ● |  |  | ● |  |  |  |  |  |  |  |  |  |  |
| *S. elegans* | ● | ● |  |  | ● |  |  |  |  |  |  |  |  |  |  |
| *S. bertheloti* |  |  |  |  | ● |  |  |  |  |  |  |  |  |  |  |
| *S. elobyana* |  |  |  |  | ● |  |  |  |  |  |  |  |  |  |  |
| *S. esculenta* |  |  |  |  |  |  |  |  |  |  | ★ | ● |  |  |  |
| *S. andreana* |  |  |  |  |  |  |  |  |  |  | ● |  |  |  |  |
| *S. pharaonis* |  |  |  |  |  |  |  |  |  |  | ● | ● |  |  | ★ |
| *S. latimanus* |  |  |  |  |  |  |  |  |  |  | ● |  |  |  |  |
| *S. lycidas* |  |  |  |  |  |  |  |  |  |  | ● |  |  |  |  |
| *S. aculeata* |  |  |  |  |  |  |  |  |  |  |  | ● |  |  | ● |
| *S. recurvirostra* |  |  |  |  |  |  |  |  |  |  |  | ● |  |  | ● |
| *S. tigris* |  |  |  |  |  |  |  |  |  |  |  | ● |  |  |  |
| *S. latimanus* |  |  |  |  |  |  |  |  |  |  |  | ● |  |  |  |
| *S. rostrata* |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ● |
| *S. arabica* |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ● |
| *S. braggi* |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ● |
| *S. murrayi* |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ● |
| *S. prashadi* |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ● |
| *S. trigonina* |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ● |
| *Sepiola rondeleti* |  | ● |  |  |  |  |  |  |  |  |  |  |  |  |  |
| *S. birostrata* |  |  |  |  |  |  |  |  |  |  | ● |  |  |  |  |
| *Sepiella cyanea* |  |  |  |  |  | ★ |  |  |  |  |  |  |  |  | ● |
| *S. japonica* |  |  |  |  |  |  |  |  |  |  | ★ |  |  |  |  |
| *S. inermis* |  |  |  |  |  |  |  |  |  |  |  |  |  |  | ● |
| *Rossia macrosoma* |  | ● |  |  |  |  |  |  |  |  |  |  |  |  |  |
| *R. tenera* |  |  |  |  |  |  | ★ |  |  |  |  |  |  |  |  |
| *Euprymna berryi* |  |  |  |  |  |  |  |  |  |  | ● |  |  |  |  |
| *E. morsei* |  |  |  |  |  |  |  |  |  |  | ● |  |  |  |  |
| Total = 29 | 3 | 5 |  |  | 5 | 2 | 1 |  |  |  | 9 | 6 |  |  | 10 |

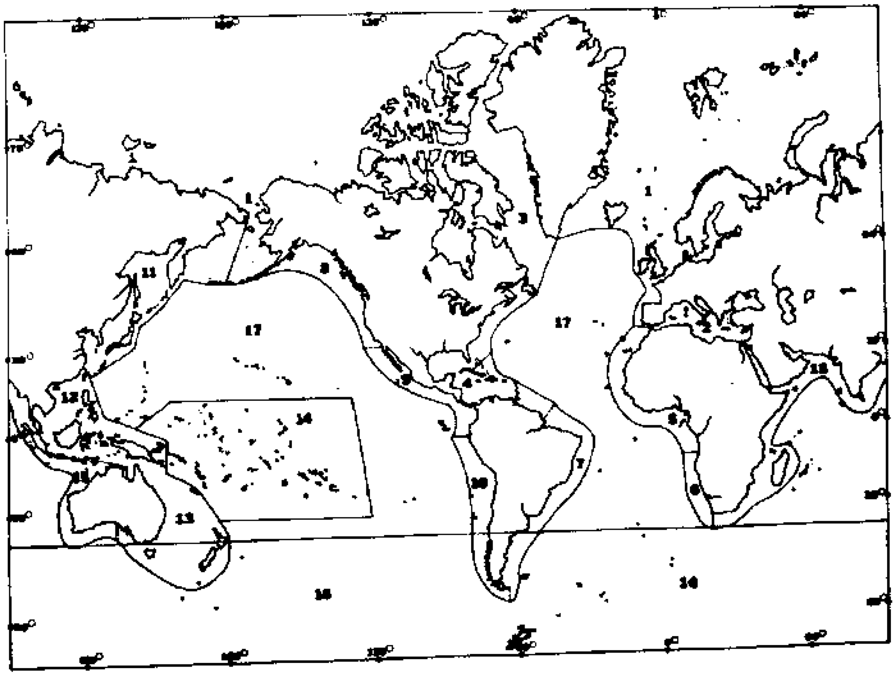


Figure 1. World distribution of cuttlefish, Ommastrephid squid and Loliginid squid (Briantais 1974, after Voss 1973).

Cod and Long Island; and the long-finned squid, *Loligo pealei*, found in greatest concentrations from Georges Bank to Cape Hatterns (Noetzell 1974).

Other species found in the west Atlantic and Gulf of Mexico include *Loligo pelei* (arrow squid) and *Lolliguncula brevis* (brief squid) on the continental shelf and *Pholidotheuthis adami*, *Ommastrephes peteropus* (orange back squid), and the giant squid, *Architeuthis*, found in the deep pelagic zone of the ocean (Rathjen 1973). It is not surprising that the most aggressive fisheries development activities in the United States have occurred in the New England and Middle Atlantic states with the help of the National Marine Fisheries Service (NMFS), and have been described in publications by Noetzell (1974), Rathjen (1973 and 1974), and Lux, Handwork and Rathjen (1974).

## DISTRIBUTION OFF ALASKA

Review of cephalopods in the northern North Pacific and Bering Sea have been made by Berry (1912), Sasaki (1929), Akimushkin (1963) and Clarke (1966). Okutani (1977) shows ten species of squid from the northern North Pacific, Bering Sea and Gulf of Alaska which occur in relative abundance. These include: *Rossia pacifica* Berry, *Onychoteuthis borealijaponicus* Okada, *Gonatopsis borealis* Sasaki, *Gonatus* sp. *Berryteuthis magister*, *Berryteuthis anonychus*, *Ommastrephes bartrami*, *Morotheuthis robusta*, *Histioteuthis dofleini* and *Eucleoteuthis luminosa* (Nishiyama 1979, Bernard 1980). With the exception of the last three species, which are not important commercially, Figures 2 to 5 give the reader some idea of the relative size and shape of these squid. *Todarodes pacificus* is also included. This species is the most desired by the Japanese, and there is some question about its distribution in the North Pacific. It is not found in Alaska, although an unpublished report by MacFarlene and Yamamoto (1976) suggests this species occurs off British Columbia.

The majority of cephalopods found in Alaskan waters are oceanic forms of the family Gonatidae. Studies indicate there are 16 known species of Gonatid squid belonging to three genera in North Pacific. However, little is known about the distribution, biology, or feeding habits of many of the major Gonatid species which inhabit these waters (Nishiyama 1979).

Most of the work on squid distribution results from stomach analysis of whale, seal and salmon. Some research has shown that in the North Pacific and Bering Sea, sperm whales feed

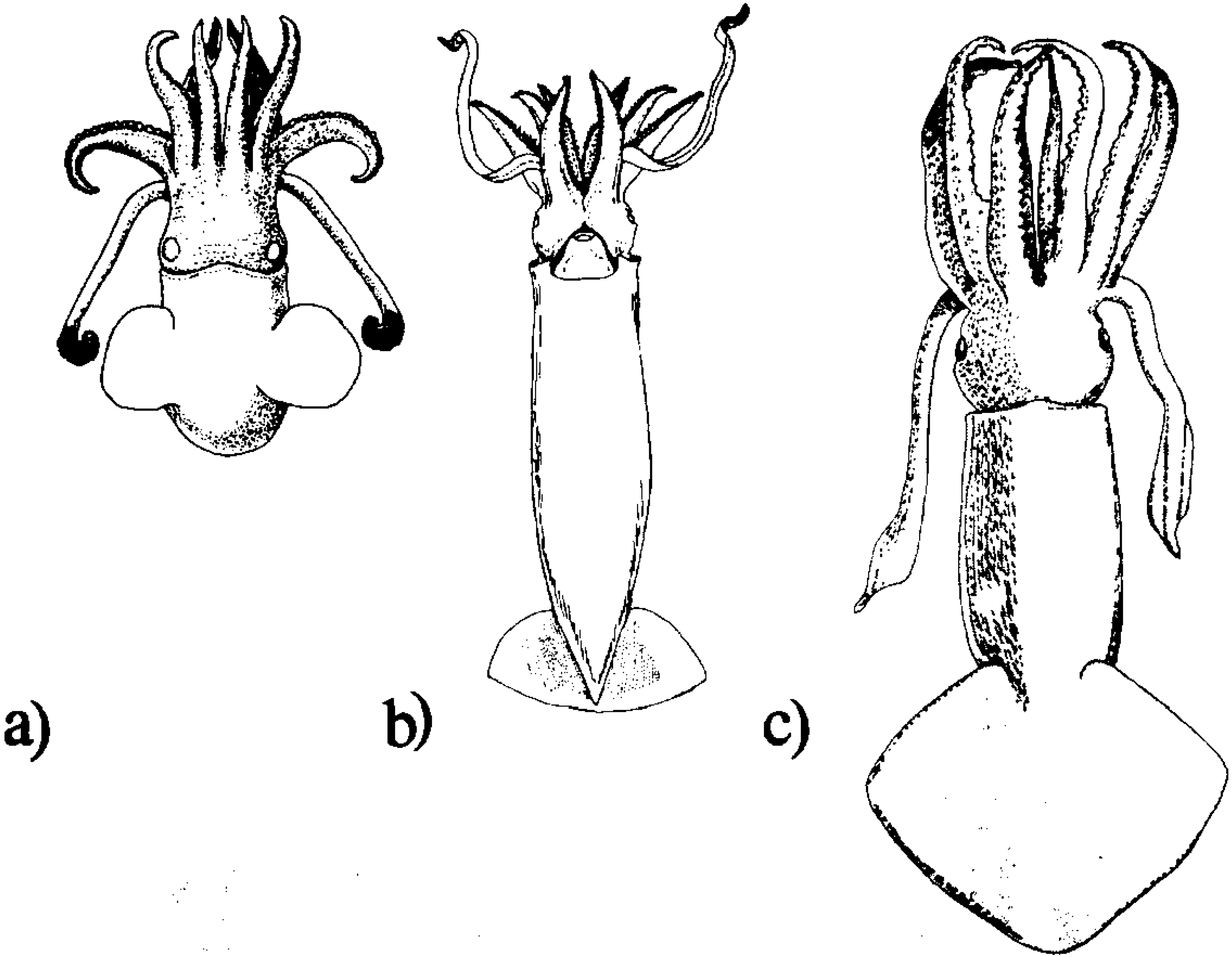


Figure 2. Some major squid species that occur in Alaska: a) *Rossia pacifica* Berry, b) *Berryteuthis anonychus*, and c) *Berryteuthis magister* (Okutani 1977).

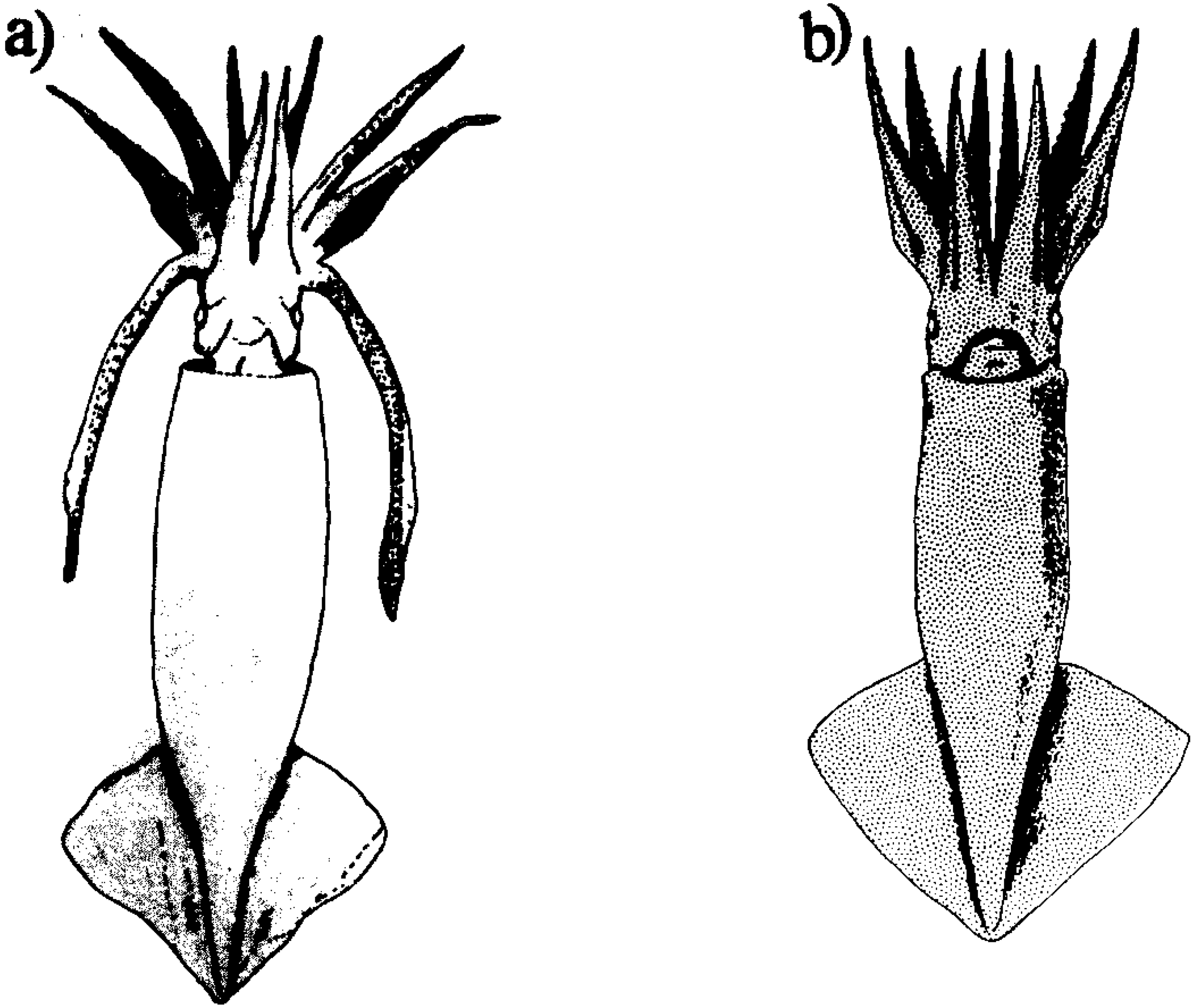


Figure 3. Some major squid species that occur in Alaska: a) *Todarodes pacificus Steenstraup*, and b) *Gonatopsis borealis* Sasaki (Okutani 1977).

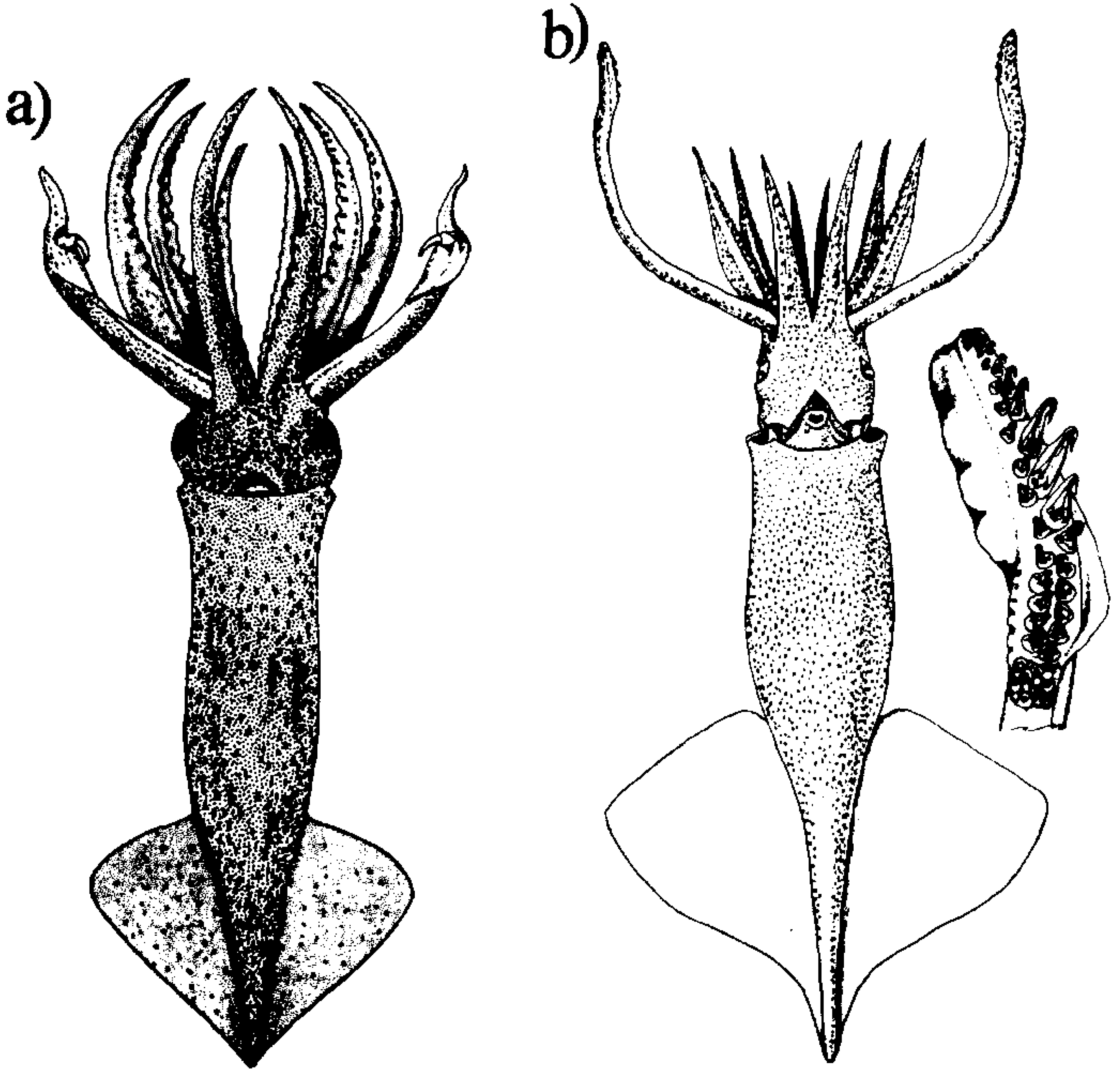


**Figure 4.** Some major species that occur in Alaska; a) *Gonatus* sp., and b) *Onychoteuthis borealisjaponicus* Okada (Okutani 1977).

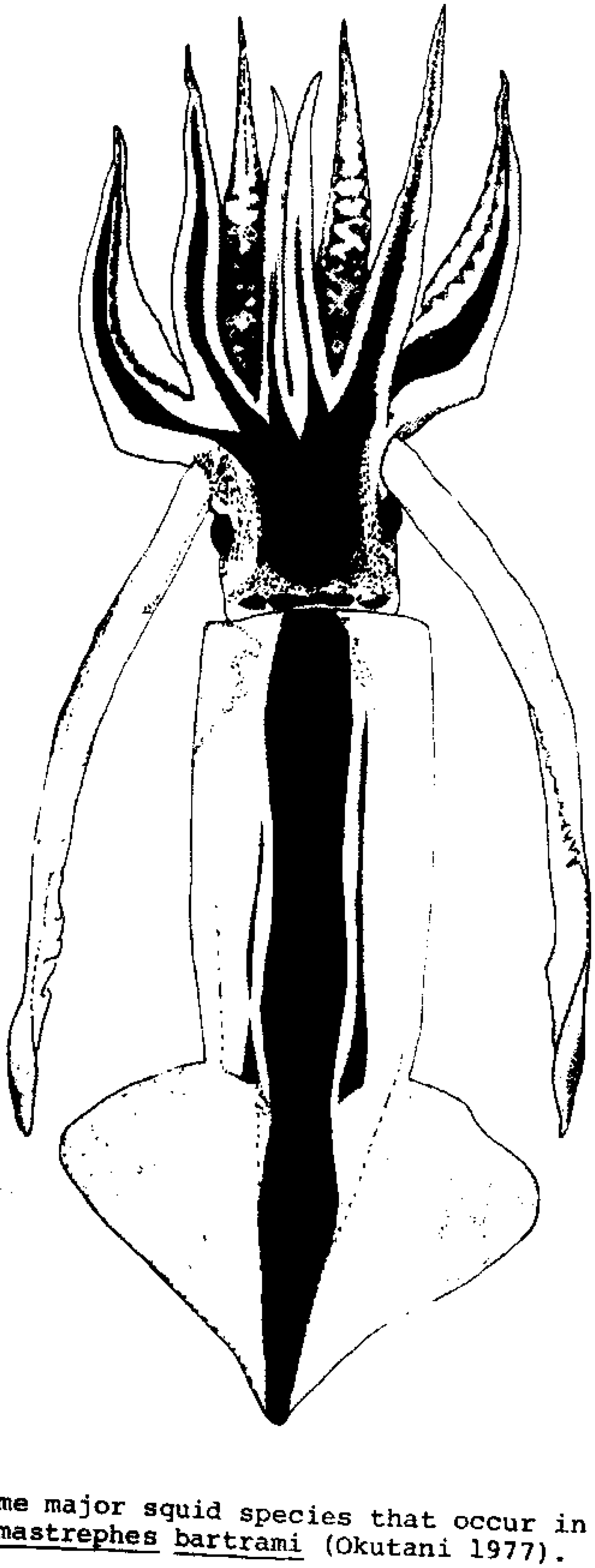


Figure 5. Some major squid species that occur in Alaska: <u>Ommastrephes</u> <u>bartrami</u> (Okutani 1977).

almost exclusively on Gonatid and Onychoteuthid squid. A single whale may have as many as 3,000 undigested squid and up to 28,000 beaks (indigestible mouth parts of squid) in its stomach. Whales, and the squid they prey on, concentrate in areas with an abrupt change in depth, areas of upwelling on the continental slope, above the slopes of underwater ridges near ocean islands, and in areas of convergence and divergence (Lipinski 1973, Okutani and Nemoto 1964).

The distribution and abundance of squid in Alaska is difficult to assess. Squid may not even be present in some areas. In order to make an estimate, readily available survey data was collected, mostly from the National Marine Fisheries Service (NMFS). This data was taken from periodic NMFS trawl surveys, from catch data supplied to them by foreign vessels operating in U.S. waters, and from their foreign observer program.

## TRAWL SURVEY DATA

During the trawl surveys, NMFS uses a variety of trawling gear and attachments for targeting species. A careful record is kept of incidental catches.

For this study we selected ten surveys, taken between 1973 and 1979. They covered the entire Bering Sea and Gulf of Alaska. Figures 6 and 7 show the general survey areas. Appendix A is a detailed, station-to-station summary of catch and catch rate data for the cruises.

Several cautions are in order about this data. First, most of the surveys were taken in deep water and the figures are good only for those depths. Second, most cruise samplings were not conducted in enough detail to identify the squid caught by species. In many cases, the crew members are not specialists. NMFS encourages interested scientists to take part in the cruises, however. This is an excellent opportunity for those who wish to conduct field work on squid. Third, almost none of the gear described in Appendix A is useful for harvesting squid. Mid-water trawls, for example, will produce a much different sampling from bottom nets with bobbin gear. Squid can move quickly and have a good sense of where nets are. They can often avoid bottom nets, and are more likely to be a larger component in trawl samples.

## FOREIGN CATCH DATA

Catch reports are collected by NMFS directly from foreign vessels fishing in U.S. waters. For selected species of commercial importance, NMFS processes the data into statistical blocks and uses it to manage the fishery.

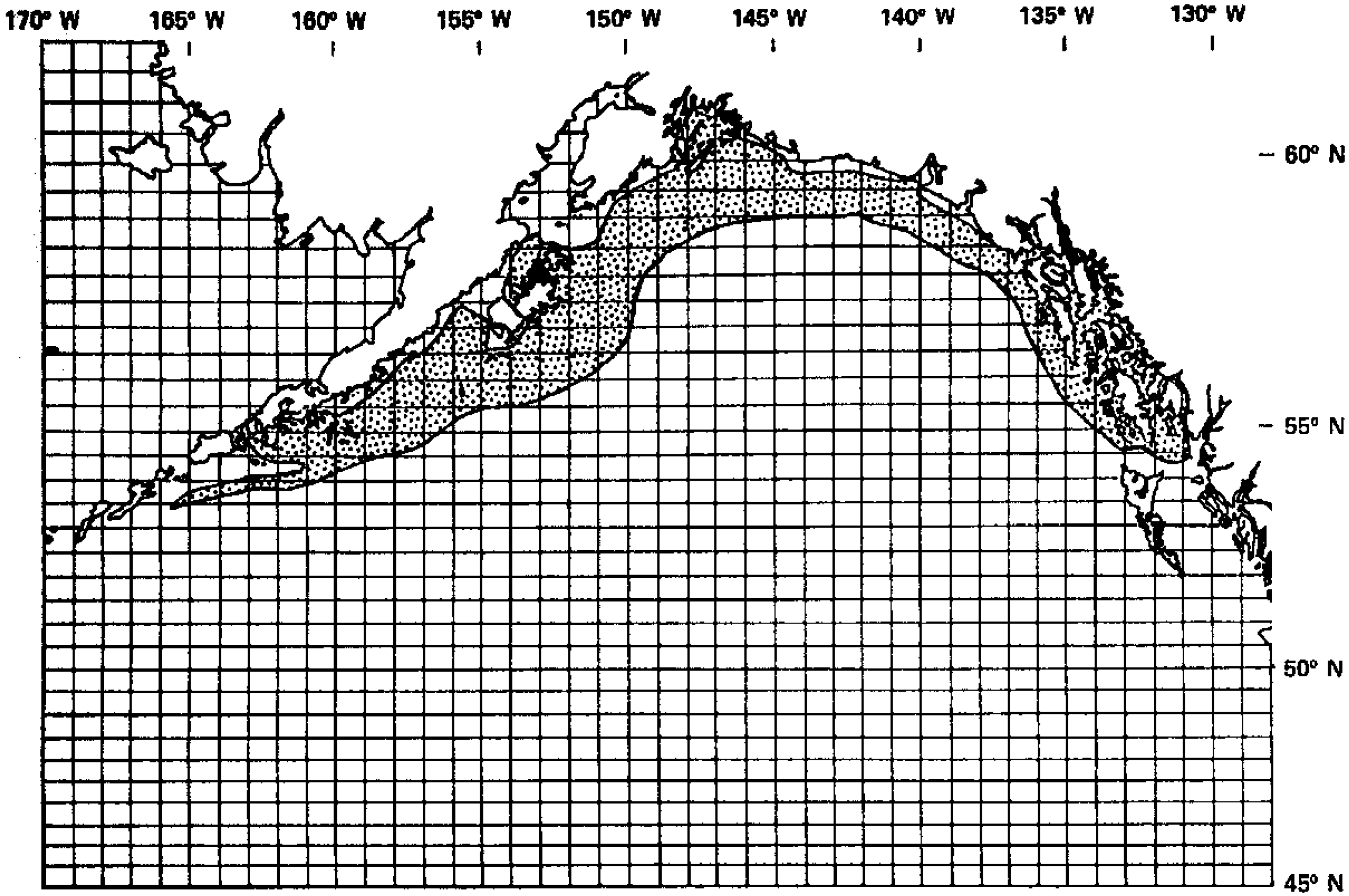


Figure 6. The area encompassed by selected NMFS Gulf of Alaska surveys, from 1973 to 1979 (NMFS 1973, 1975, 1976, 1977, 1978a, 1978b, 1979a, 1979c).

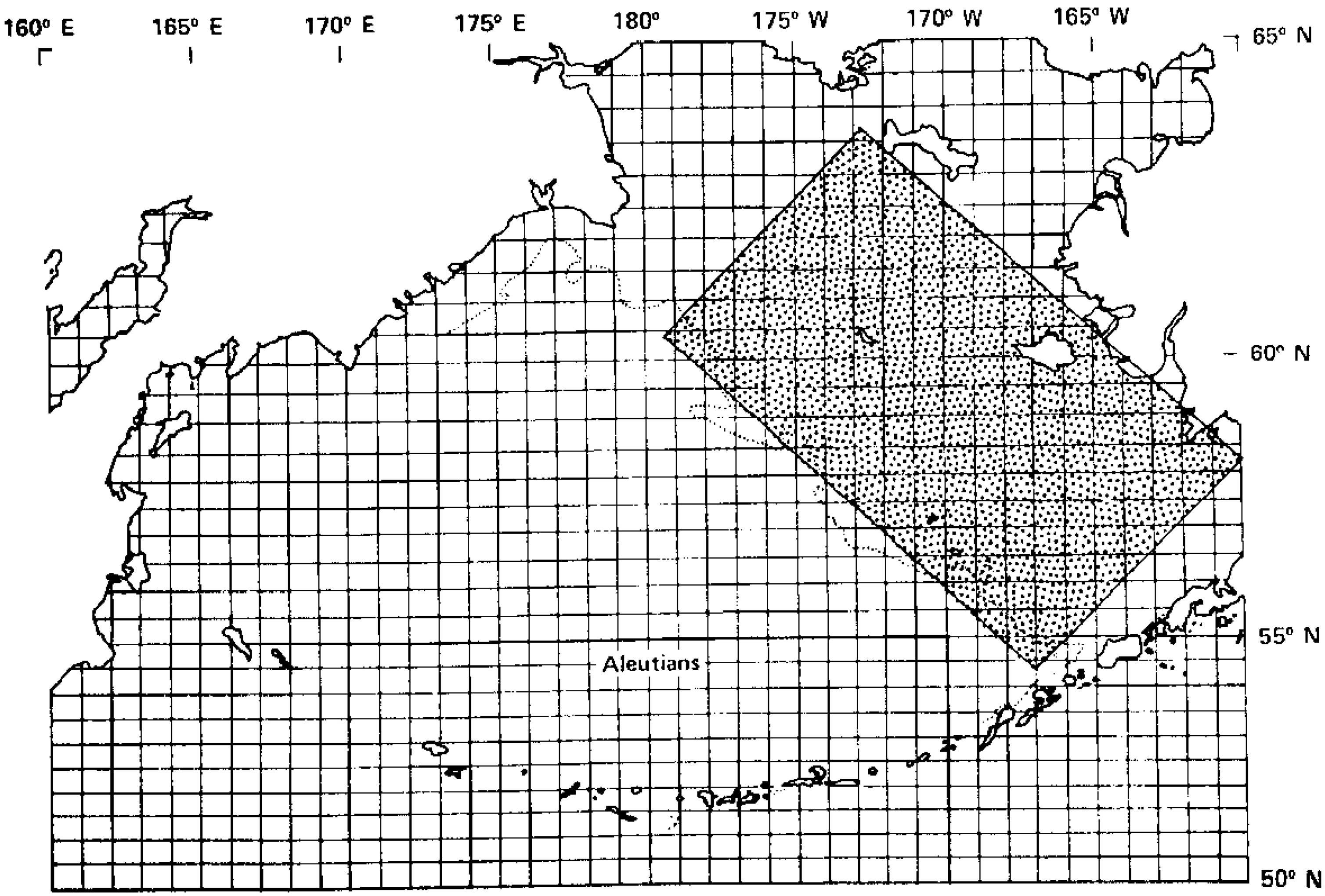


Figure 7. The area encompassed by the NMFS 1979 Bering Sea survey (NMFS 1979b).

Figures 8, 9, 10 and 11 show the 1978 catch rate per hour for Japanese and Korean efforts. The raw data used to create these figures appears in Appendix B.

Although we have no measure of their accuracy, these reports do have figures for catches of different squid species reported by the Japanese. Figures 8 and 9 describe the catch rate for *Berryteuthis magister*.

Figure 10 describes the catch rates for *Onychoteuthis banskii borealis*, probably corresponding to our *Onychoteuthis boreali-japonicus*. Korean and Japanese reports for unidentified squid appear in Figure 11.

The only way to validate these reports is to check them against the country's reported finished products. We expect their reports are fairly accurate, however, especially those from friendly nations like Japan and Korea.

## FOREIGN OBSERVER PROGRAM DATA

This program allows U.S. observers with quasi-enforcement powers to accompany foreign fishing vessels working in U.S. waters. Observers are placed on selected vessels and monitor catches of both targeted and incidental species.

Generally, random samples are taken from trawl hauls. The species mix for that trawl weight is recorded. The relative proportion of each species to the sample weight is inferred for the total catch in that haul.

Observers also note the areas fished, the number of days fished in an area, hours of actual trawling, weight of the sampled hauls (mt), weight of the whole catch (mt) and the estimated catch of a species in an area. Some other variables may be inferred from this data, but are not important to this study.

We used 1978 foreign observer data. It appears by statistical block (.5° lat. x 1° long.). Most of the observations were taken from Japanese mother ships or independent stern trawlers. In some cases we also have information from Soviet, Polish and Korean vessels, shown in Appendix C.

Figures 12 and 13 show estimated catch rates for squid (mt/hr) and the location of statistical blocks. The catch rates used in this data were extrapolated from raw data appearing in Appendix C. They represent the highest hourly catch rates yielded by this data.

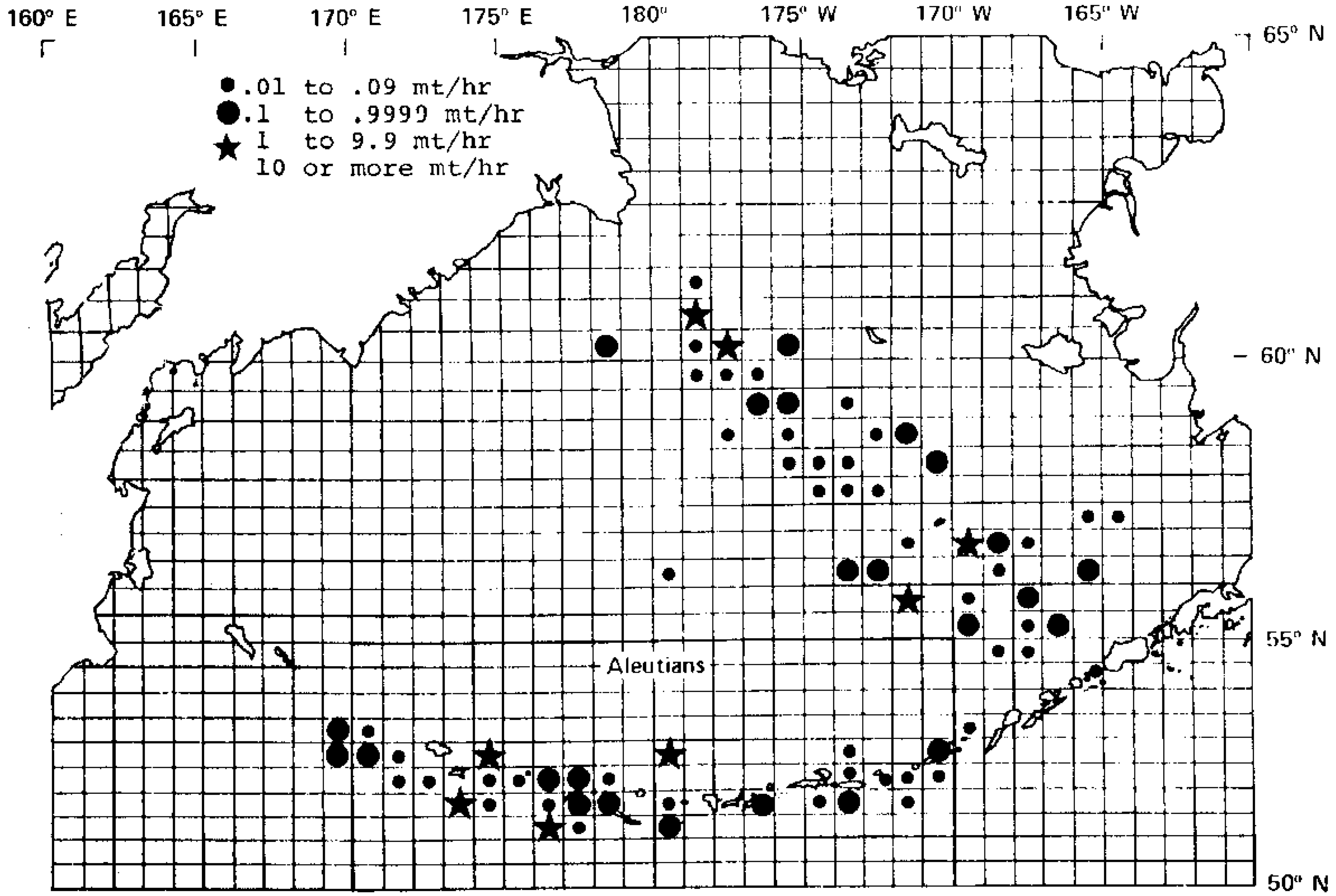


Figure 8. The distribution of the 1978 catch rates of *Berryteuthis magister* by Japanese stern trawl and pair trawl in the Bering Sea (NMFS 1978c).

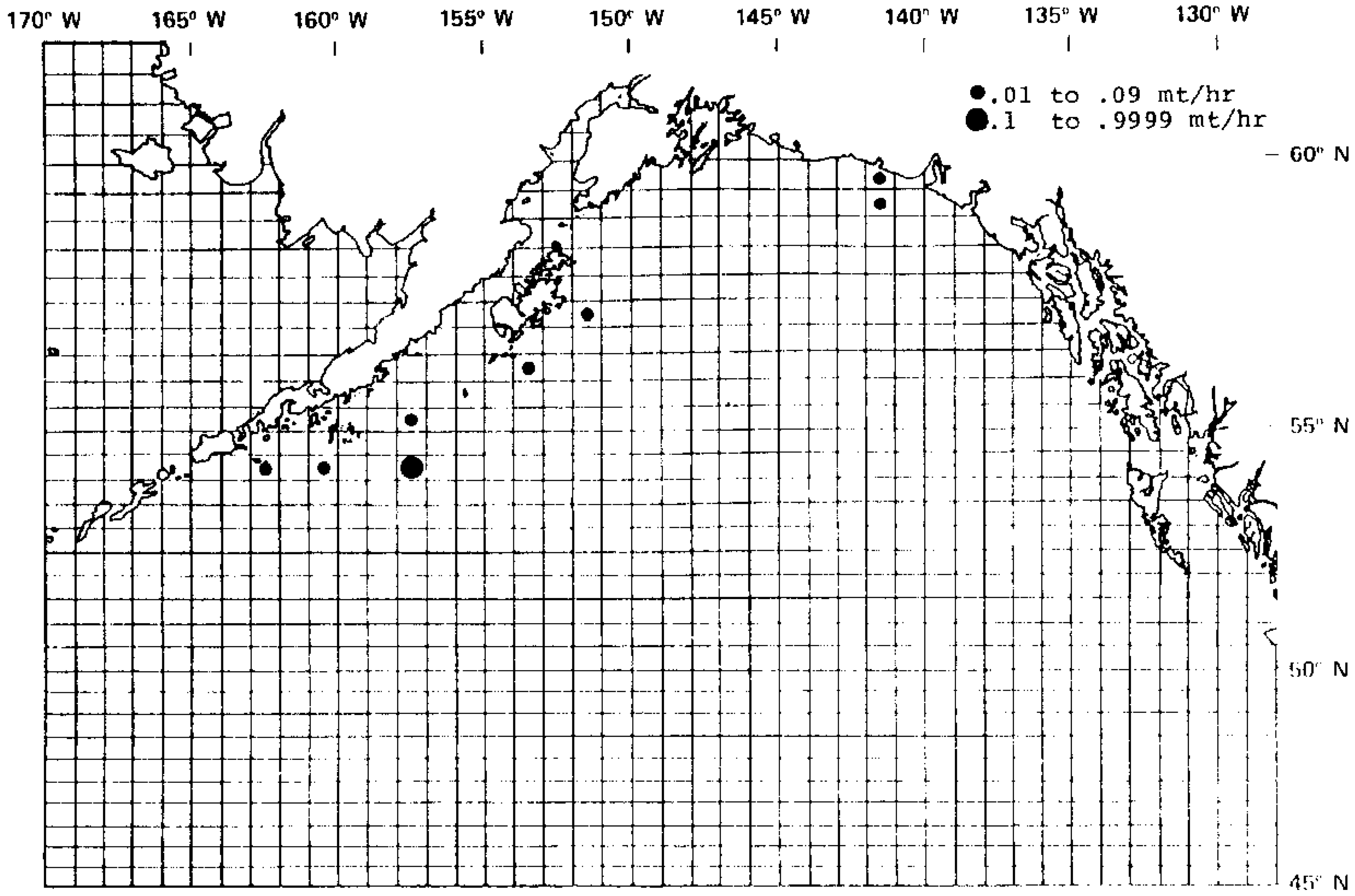


Figure 9. The distribution of 1978 catch rates of *Berryteuthis magister* by Japanese stern trawl in the eastern North Pacific (NMFS 1978c).

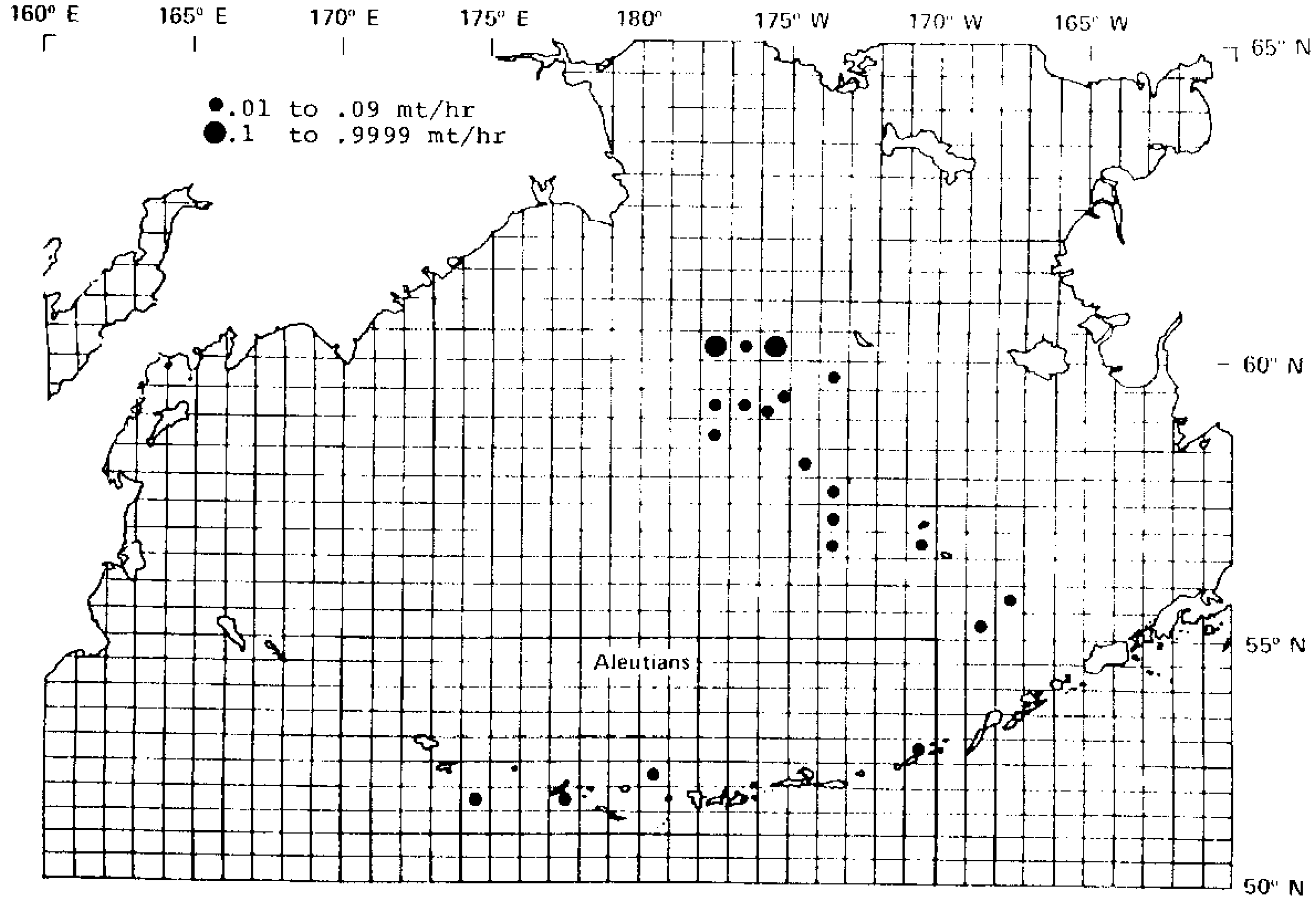


Figure 10. The distribution of 1978 catch rates of Onychoteuthis banskii borealis by Japanese pair trawl, stern trawl, and Danish seiners in the Bering Sea (NMFS 1978c).

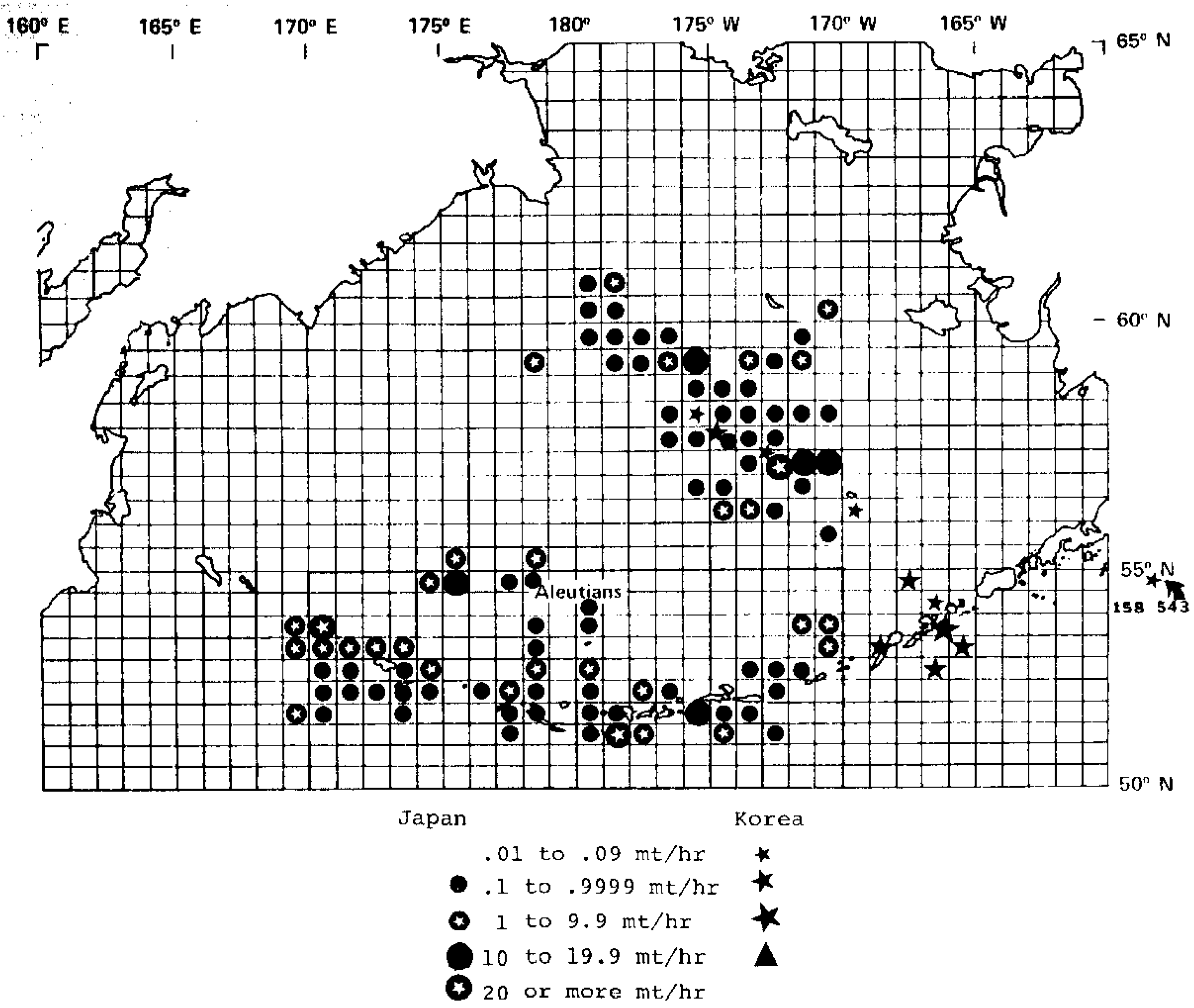


Figure 11. The 1978 Japanese and Korean catches of unidentified squid by stern trawl in the Northeast Pacific and the Bering Sea (land-based stern trawls only) (NMFS 1978c)

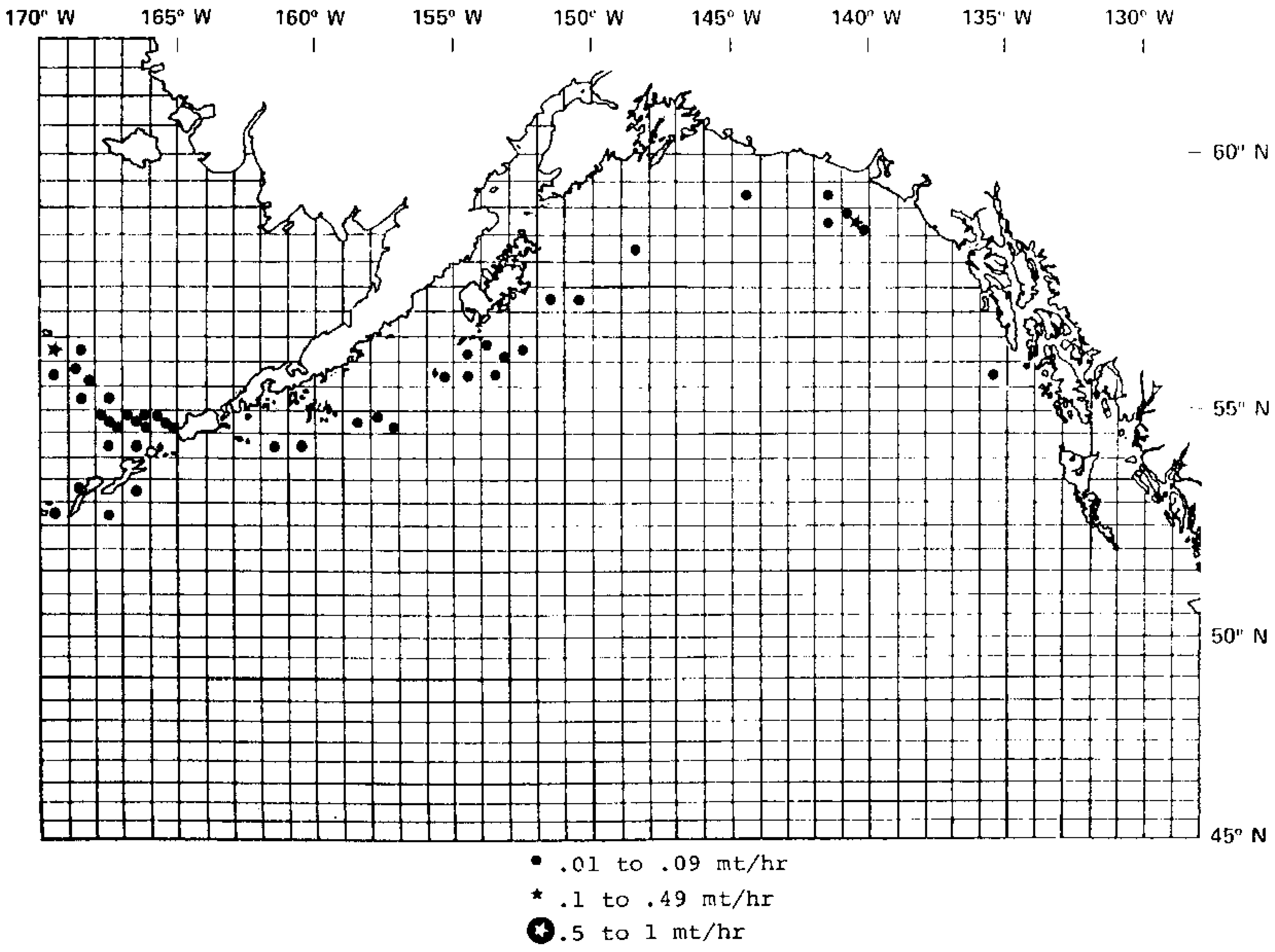


**Figure 12.** The distribution of incidental catch rates of unidentified squid from 128°W to 170°W long. as indicated by foreign stern trawl and mothership fleets (NMFS 1978d).

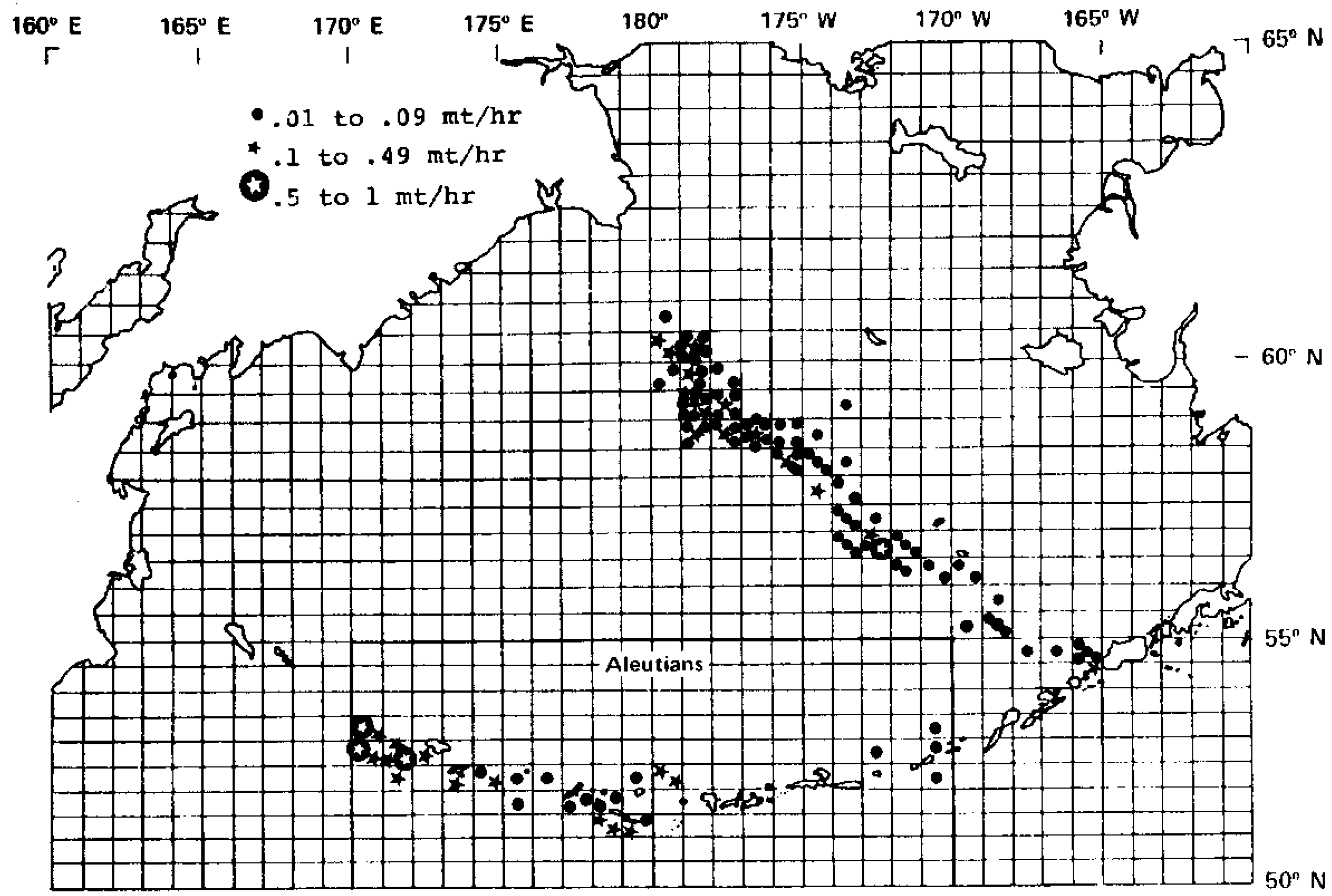


Figure 13. Distribution of incidental catch rates of unidentified squid in 1978 from 160°W to 160°E long. as indicated by foreign stern trawl and mothership fleets (NMFS 1978d).

Remember that the catch and catch rate figures are not absolute numbers but statistical inferences based on samples of a whole catch. It is impossible to assume that each observer sampled with the same efficiency or was treated with the same helpfulness by the crew. Also, the data does not reflect the type of gear used or the conditions under which catches were taken. It is therefore hard to use this data to compare efficiency of various harvesting methods.

## THE GENERAL BIOLOGY OF SQUID

There are two basic types of squid: the regular ten-armed squid and the eight-armed squid. In addition, there are squid which live over the continental shelves (neritic) and those that live far to sea (pelagic). The pelagic squid appear to be the most abundant in Alaska and will be discussed most often. Squid seem to have relatively short lives; few live beyond two years. Squid are at the peak of the food chain. When young, they feed upon small planktonic crustaceans and fish larvae. As adults most are active predators, both on other pelagic animals and upon each other. Figure 14 shows a general anatomy of the squid. The mantle and the tentacles are most important in processing.

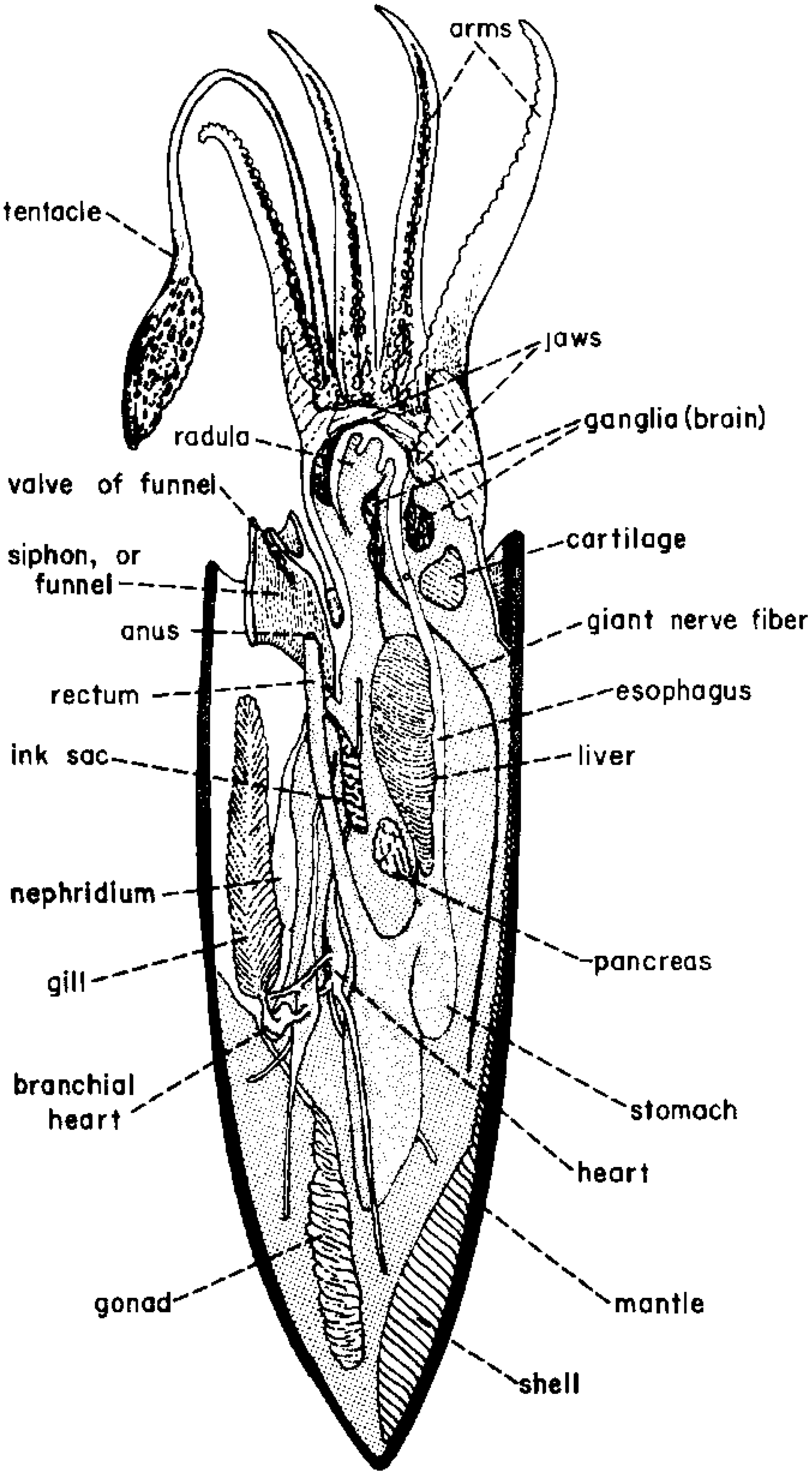


Figure 14. General anatomy of the squid (Ampola 1974).

## SQUID HARVESTING TECHNIQUES

Squid are commercially harvested using several different methods: jigging, trawling, suction funnels, lampara nets, and brailers. Methods of harvest are divided between those best suited for shallow water squid and those for deepwater squid. Suction funnels, lampara nets, and brailers are used for nearshore shallow-schooling squid found in Southern California and elsewhere. There is speculation on whether Alaska has any shallow-schooling squid. For this reason, the two major types of harvesting techniques for Alaska are squid jigging and trawling.

Large-scale squid jigging is almost exclusive to the Japanese and the Newfoundland fisheries. It is an extremely efficient way to capture the large pelagic Ommastrephid and Loliginid squid, well-liked in Japan. Trawling, on the other hand, may be effective for the capture of Gonatus and Gonatopsis borealis, deepwater squid found in Alaska. These two harvest techniques are discussed in detail, because they lend themselves to Alaskan fisheries of all sizes.

### SQUID JIGGING AND THE DEVELOPMENT OF THE JAPANESE FISHERY

The squid jigging fishery in Japan developed around the capture of Todarodes pacificus, a squid species popular with consumers. It has been heavily exploited around Japan and on the polar front zone in the Japan Sea. The fishery grew from one with small, wooden, non-motorized boats in 1945, to very large high seas vessels, between 100 and 300 gt in 1975 (Hamabe et al. 1975). The gear grew in sophistication too, until the development of the Ikatombo, the squid jigging machine (Figure 15). These machines have been modified so one fisherman can operate many machines at once.

The machine is relatively simple, consisting mainly of an electric motor, an axle with two eccentric spools, open to accommodate the squid jigs rolled on to them, and another spool that acts as a fairlead and line guide. The speed is variable, allowing more variety in retrieval. The line guide is positioned so that jigged squid pulled over the guide will slide off the barbless jigs into a trough. The trough either holds the squid or conveys them in a water medium to a holding pen for grading.

Squid jigs come in a variety of sizes (Figure 15), each having an optimum use for the size of squid to be taken (see also FAO 1975a). Bublitz (1979 personal communication) notes that many fisherman feel jig size and color combinations have much to do with the success or failure of a fishing expedition. This suggests that test fishing with spools of

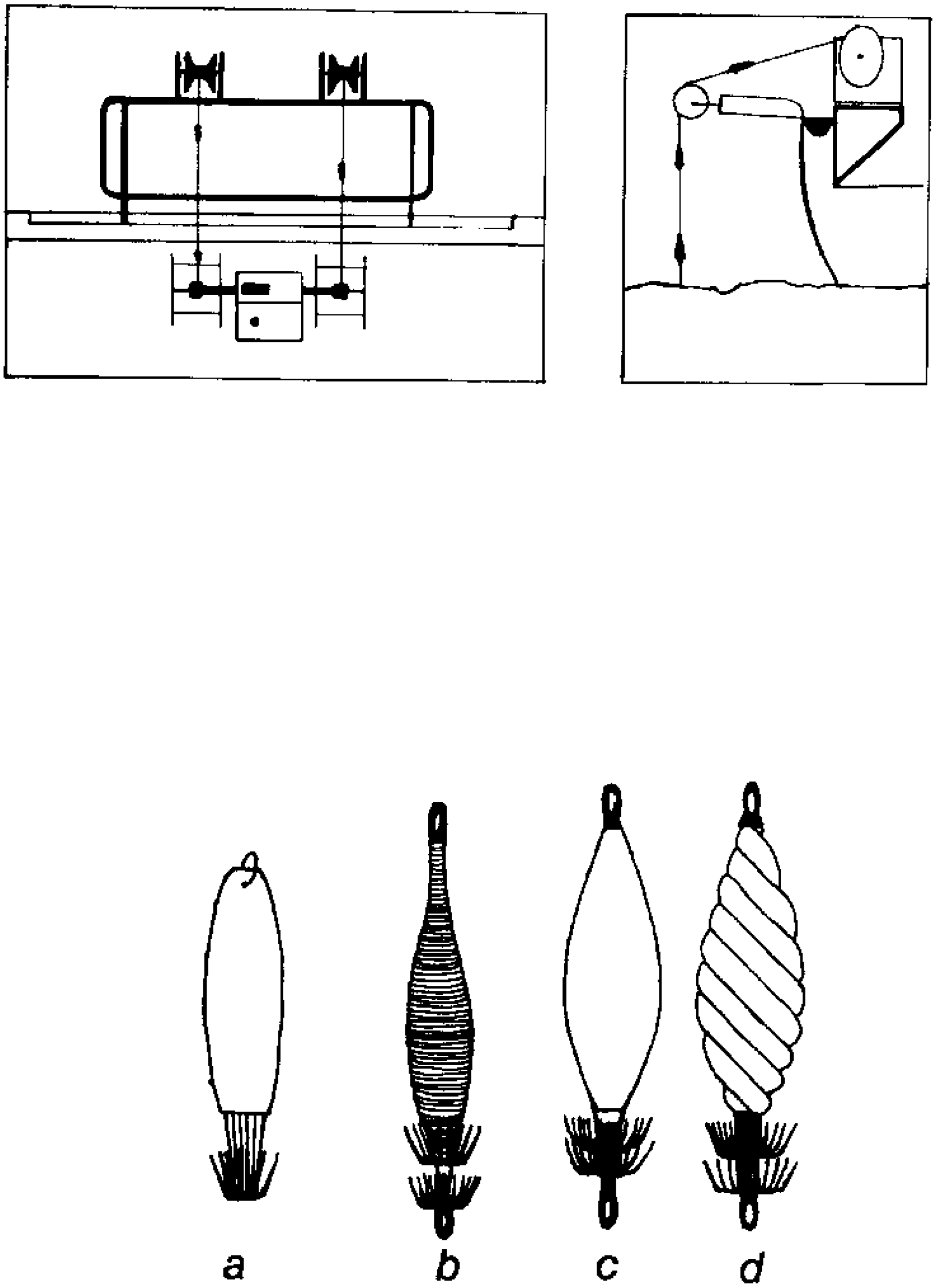


Figure 15. A Hamade type electric squid jigging machine set-up and the development of squid jigs: a) traditional bone or horn squid jig, b) squid jig wrapped in colored thread, c) plastic-bodied jig, and d) flexible plastic-bodied jig (Yajima and Mitsugi 1976).

different types of jigs may be called for. The most popular jig color seems to be red. However, simultaneous successful catches have been reported by boats using different color jigs. This indicates that jig color may not be critical. (Bublitz 1979, Allen and Taber 1974).

A small technological improvement with far reaching effect is the flexible jig (Figure 15). This is simply a jig with a pliable plastic body that will wind onto the spool easily. The jigging machine seen by the author used flexible jigs with monofilament line, with the jigs spaced about every meter.

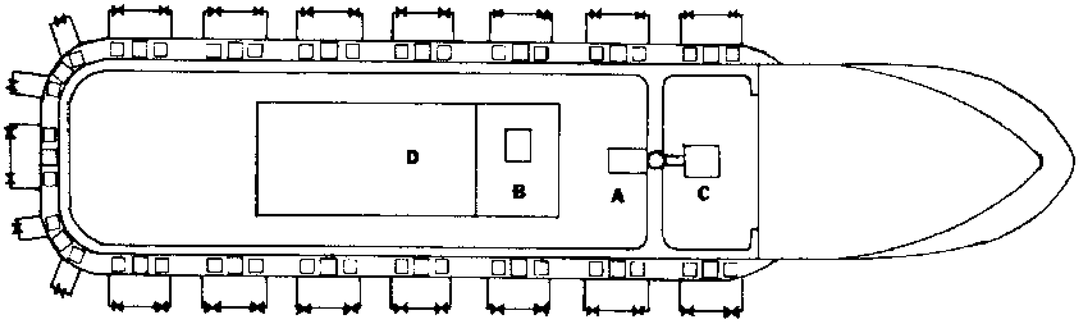
Allen and Taber (1974) describe the jigging spool set up on the Hoyo Maru No. 63 (MGI-737). Each reel of the jigging machine is rigged with 50 m of braided dacron, 50 m of monofilament, and another 25 m of monofilament with a jig spaced every meter.

Jigging may or may not be automatic. Automatic squid jiggers used on Japanese vessels pay out at a predetermined length of line (jigs in at whatever the desired rate is, usually 68 to 80 revolutions per minute). When the last jig is in, the reel stops at the 4 to 5 lb weight, then pays out all of the line and starts again.

The advisory committee on manpower saving was established in the Japan Fisheries Agency in 1967 to deal with problems of high labor intensity in different phases of the fishery. The committee, in response to the labor intense nature of the squid fishery, designed the 99 gt squid jigging vessel (Figure 16) (Hamuro and Mizushima 1975).

The Japanese developed the concept and design of squid jigging vessels and equipment in the early 1960s. Although these ideas may be obsolete compared with the present Japanese squid fleet (with jigging vessels over 300 gt in 1975), they are certainly a starting point for an American domestic squid fishery. The bulk of the following comments are taken from Hamuro and Mizushima, designers of the 99 gt vessel.

The guiding considerations on Hamuro's design were manpower use and product quality. These are attributes that U.S. fishermen can readily appreciate. The vessel had 21 automatic machines with 42 lines. These 42 lines were tended during the actual fishing operation by three to four persons. All machines were placed in line about 1.2 to 1.5 m apart, the same height off the deck. They suggested using the smallest possible jigging machines saving space and making room for as many machines as possible. The outrigger rollers and trays, which receive the squid, are connected to a trough and conveyor, as noted earlier, in order to move the squid to the grading pen.



Items

| | |
|---|---|
| Material | steel |
| Gross tonnage | 99 tons |
| Displacement tonnage | 269 tons |
| L (R) | 28.5 m |
| L (P) | 28.3 m |
| B | 6.07 m |
| D | 2.65 m |
| Number of crew | 12 (including 2 spares) |
| Main engine | one 4-stroke diesel |
| BHP | 450 hp |
| Propeller (diameter x pitch x no. of propellers) | C.P.P., 1,600 x 960 x 3 |
| Revolutions | 360 rpm |
| Auxiliary engine | one 2-stroke diesel |
| BHP | 140 hp |
| Generators | 225 V x kVA (main)<br>225 V x 12.5 kVA (aux.)<br>225 V x kVA (aux.) |
| Freezing machine | NH$_3$ 115 x 90 x 4, 1,200 rpm |
| Fish hold | 73.87 m$^3$ |
| Freezing room | 18.23 m$^3$ |
| Freezing capacity | 8 tons/day |
| Fuel tank | 31.54 m3 |
| Freshwater tank | 8.77 m$^3$ |
| Squid angling machine | 0.6 kW x 21 |
| Windlass | 1.5 tons/30 m/min. |
| Speed | 9.5 kn |

**Figure 16.** Main deck layout and vessel specifications for the 99 gt squiding boat: A) Squid portioning machine, B) Pre-freezing preparation room, C) Squid receiving and washing machine, and D) freezer. The quarter deck layout, not shown here, also has four more jigs, or eight additional lines. (Hamuro and Mizushima 1975).

The 99 gt vessel was equipped with 40 incandescent 3 kw lamps arranged in 14 interspersing groups, one-half of which are on a separate current system. Attracting squid with light consumed about 120 kw.[1] With this vessel, most of the crew worked handling the product rather than fishing. This reduced labor to one-half of that required in more conventional vessels. Since the size of the crew is so important to the viability of the business, it is interesting to note that on this vessel, Hamuro and Mizushima planned for only a nine man crew.

They conclude that normal fishing trips last 20 to 30 days with this vessel, about eight trips per year. The average catch per year is estimated at 250 tons, valued in 1975 dollars at $330,000. However species-catch for these calculations was not mentioned.

Squid jigging can be taken to even larger scales. Reports by Allen and Taber (1974) describe test fishing on the *Hoyo Maru*, an ex-tuna longline vessel of 422 gt equipped with 29 automatic squid jigging machines, each with two lines. A string of 3 kw bulbs was arranged overhead along each side of the vessel, and in about 6 ft from the rail.[2]

## Method of Squid Jigging

The object in all squid fishing is to find a school of pelagic squid like *T. pacificus* or *O. bartrami* using a sonar, and wait for them to get within about 50 m of the ocean surface. Several observations on squid behavior and anatomy may assist in their location (see also Arnold 1979):

1. Japanese fishermen have noticed that some squid, like *T. pacificus*, are found on the interface of cold and warm water masses. Following one of the large ocean streams (such as the Japanese Current), will probably bring success.

2. Moonless nights are reported to be the best for squid fishing, especially for neritic squid.

3. The type of sonar used is extremely important. Since squid have no air bladder it is hard for a low frequency scanner with mid-range power to give a good resolution of the squid on sonar paper. Experience indicates that squid will mark well on either a high frequency (125 to 200 H) low power sounder, or on a low frequency (50 H), high power (500 w) machine.

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[1] Kilowattage has decreased as fuel shortages have worsened.

[2] An excellent discussion of various fishing methods can be found in Bernard 1980 and FAO 1975b.

4. Since daily migration of squid is nearly always vertical, and horizontal travel seems to be with the current, a combination of a sea anchor and spanker sail may be appropriate in order to keep the vessel at a slow drift.

Aside from these considerations, squid jigging is surprisingly like the methods used for taking other species that migrate vertically through the water column through the day. In some cases, the upward migration may start in the late afternoon, and fishing begin in late evening.

## METHODS USED IN TRAWLING

Trawling for squid is carried on by Spain, Italy, Japan, France, Poland, and others. The trawling method is complex, because most squid, unlike other marine animals, are extremely fast if frightened and can avoid trawl nets. Also, specialized sonar equipment is necessary to pick up squid on a recorder. Some of the more sedentary squid, like Rossia and even some of the Gonatid squid are taken by trawl. The fast Ommastrephid squid are seldom taken. For purposes of comparison, both the Japanese and the Spanish squid fishing trawl methods will be discussed.

### Spain

The trawl net in Figure 17 was made for the Loligo and Illex fishery in the North Atlantic (Sullivan and Veiga 1976). Both of these squid genera have habits similar to Alaskan squid. The trawl discussed was made for the Spanish vessel Corba out of Vigo, Spain. Its overall length is 127 ft with a gross tonnage of 299.3 mt. Its maximum speed is 12 knots. The engine is a 1,235 hp Stork Werkespoor diesel.

The main winch is powered by a 170 hp engine. The winch has two main drums for the warp. The trawl warp is 22 mm (.86 in.) in diameter (although most boats in Spain have 24 mm (.89 in.) warp). The trawl warp scope is set up as follows: in 50 fathoms of water 450 m (1,476 ft) of warp is set out; at 60 to 70 fathoms, 500 m (1,640 ft) of warp is put out; for 70 to 80 fathoms, about 600 m (1,968 ft); and in 80 to 100 fathoms about 200 m (656 ft).

The steel otter boards are oval demersal type. Each weighs 900 kg (1,984 lbs), is 1.70 m (5.57 ft) high and 2.90 m (9.51 ft) long. The groundline is made of four wire cables twisted together and covered with nylon twine with a diameter of 46 (1.81 in.) to 48 (1.88 in.) mm. Dandy lines were 100 m (328.1 ft) long and attached at the end with a steel bobbin weighing 50 kg (110 lbs), to which a steel triangular bridle is shackled.

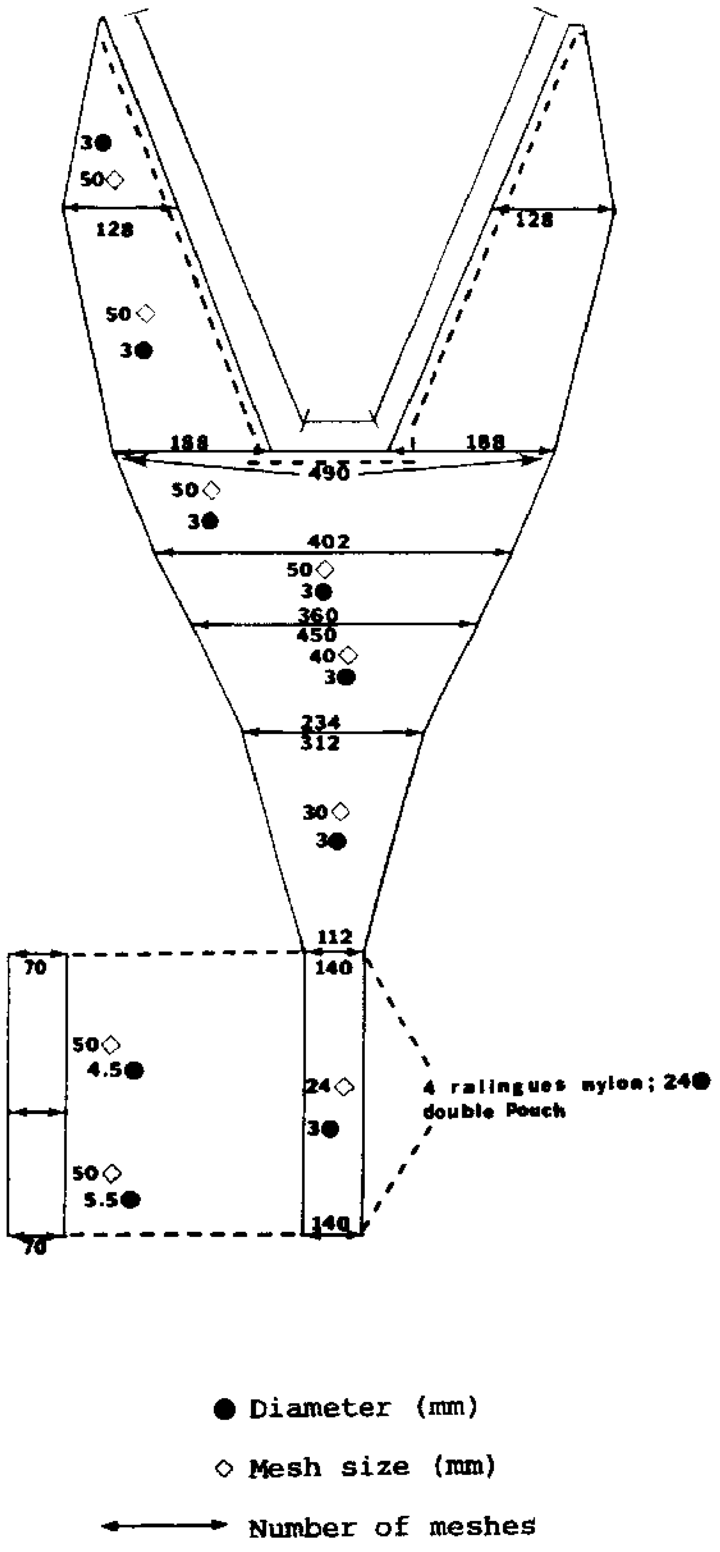


Figure 17. Trawl net Chalut De Fond, a grande ouverture verticale (large vertical opening). (Comptoir Fecampois De Materiel De Peche after Sullivan and Veiga 1976.)

The trawl nets are nylon, produced in France. The twine width is 3 mm. The mesh sizes are 50 mm (1.9 in.) in the wings and body, 40 mm (1.57 in.) in the cod end. The underside of the cod end is fitted with 50 mm mesh chafing gear. No floats are attached to the belly or cod end. The distance from headrope to cod end is 32.5 m (106.6 ft). The distance from the footrope to cod end is 22.5 m (73.82 ft). The cod end is 12 m (39.37 ft) long. The footrope is of the same construction as the groundlines, with a thin rubber covering.

Twenty aluminum floats, 200 mm in diameter, are attached to the headrope at the mouth. Floats are placed on the headrope as follows, from the center of the headrope to the wings: 5 floats, .5 m (1.64 ft) apart; 5 floats, 1 m (3.28 ft) apart; 5 floats, 1.5 m (4.92 ft) apart; and 5 floats, 2 m (6.56 ft) apart. The mouth opening at the headrope is about 6 m (19.68 ft), while the opening at the footrope is about 4 m (13.12 ft). Trawl height at the opening is about 1.5 m (4.92 ft).

### Japan

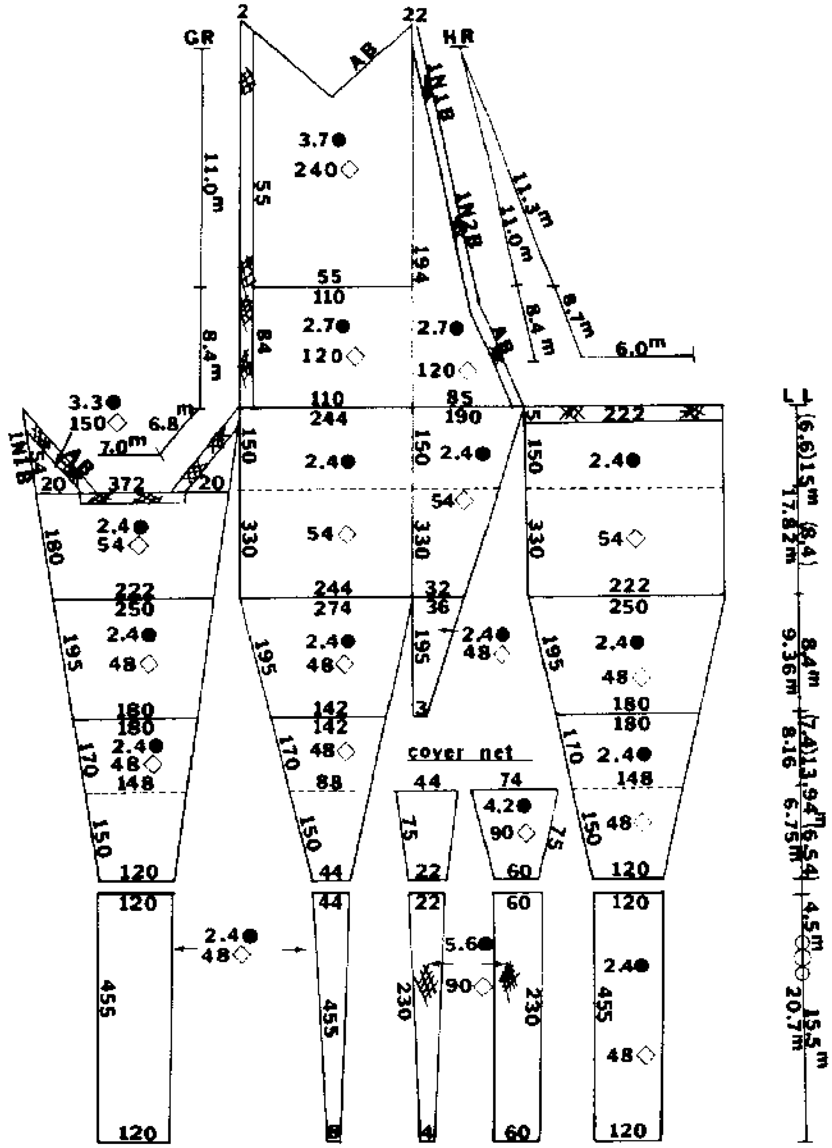
Japanese trawlers have fished for squid (mostly Loligo) in the northwest Atlantic with considerable success. The following design is a six panel trawl produced by Koyama (1976) of the Tokai Regional Fisheries Laboratory in Tokyo, Japan. The net shown in Figure 18 is designed to be towed by a 1,500 gt, 2,500 hp trawler. In this respect, this vessel and operation are considerably larger than the Spanish trawling vessels.

### Other Commercial Trawling Gear

Engel (1976) has described other trawl gear used for catching Loligo squid in the North Atlantic by Italy, Canada, France and the United States. Italian trawling is done with a French high opening bottom trawl (vertical opening 4 to 6 m, 13.12 to 19.68 ft) used with stern trawlers of about 3,300 hp with a towing speed of up to 4.5 knots. With this trawl, sweeplines of 50 fathoms, bridles of 15 fathoms and otter boards of 3.4 by 2.10 m (11.15 by 6.89 ft), each about 1,550 kg, were used. Bridle and sweepline lengths vary.

Canadian stern trawlers of 1,250 hp have used the Engel high opening bottom trawl with 145 ft of footrope designed for bottom species, with lower wings shortened for 60 ft bobbins in the footrope. Mesh size in the wings and square is 180 mm stretched mesh, decreasing to 120 mm in the cod end.

This trawl was modified for squid with lower wing extensions and an 80 mm (3.14 in.) stretched mesh squid liner, decreasing to 40 mm stretched mesh in the cod end. In general, it



● Twine diameter (mm)

◇ Stretch mesh (mm)

Unmarked numbers indicate the number of meshes.

HR = headrope of steel wire 18 mm (.07 in.) in diameter.
GR = groundrope.
LL = Lastrich line, combination rope 28 mm (1.1 in.) in diameter.
A = double braided.
(Koyama 1976)

Figure 18. Squid bottom trawl net, designed for approximately 1,500 gt vessel of 2,500 hp.

appears that high opening trawls designed for bottomfish, with appropriately small mesh size, will take squid.

The French trawlers use the same basic type of trawls described for the Italian trawlers. Further details were not revealed by Engel.

The United States east coast fishery out of Point Judith, Rhode Island has experimented with the use of trawl gear for squid. The 500 hp trawlers reportedly had good luck with the standard 41 Yankee trawls appropriately meshed for taking squid.

Although all of these trawl types are by and large made for fishing the Loligo and Illex population of the North Atlantic, much of the information on gear construction can be used to guide Alaskan trawlers. There may be significant squid bycatch already in trawling.

In the Loligo fishery, daytime is the most successful time to trawl for squid, when the squid have returned to the bottom. Towing speed is from 3 to 4.5 knots or more.[3] Towing time can be from 2 to 3.5 hours. Temperature, an important factor in determining fishing areas, is determined by a remote sensor attached to the net.

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[3] For more information, consult Warren F. Rathjen, NMFS, Gloucester, MA.

# SQUID PROCESSING

European countries rimming the Mediterranean Sea and Japan have the most experience in processing squid. Japan is the largest catcher and consumer of squid. Spain is second.

The difficulty is that the squid found in Alaska, (the genera *Gonatus*, *Gonatopsis*, *Berryteuthis*, *Ommastrephes*, and *Rossia*) differ somewhat from Japan's most popular squid, *Todarodes pacificus*. Alaskan squid is quite different from the European squid *Loligo* and *Illex*. Consumer taste for Alaska squid will be hard to discern.

The final marketing outcome will depend on the form of the squid when semi- and fully processed. Regardless of where one goes to find information on preliminary squid processing for shipment to wholesalers, the story seems to be the same: study the Spanish and Japanese methods. These two methods are similar.

Squid can be packed for shipment in one of two ways: fresh/frozen whole or fresh/frozen tubes. Processing starts, however, on the vessel. Squid kept raw and unfrozen needs to be adequately iced, preferably with a 1:1 squid to ice ratio (Learson and Ampola 1977, Rathjen 1974, Ampola 1974). Atlantic squid kept on ice in this ratio can be expected to last between two and six days, depending on physiological condition (Bernard 1980). One could probably expect the same results from North Pacific squid.

Japanese and European buyers are particularly interested in the "bloom" or body color of the squid, which indicates freshness. If squid are not handled as described, they spoil rapidly, the flesh yellows, eventually turns white and ammonia forms. Chilled sea water lengthens the time one can spend fishing to about eight days. There is some question about whether the "bloom" of the skin is adequately preserved, although the firmness of the flesh may be excellent.

Chilled sea water (CSW) squid holding calls for about half ice and half seawater (by weight) and a 3:5 ratio of product to CSW. Therefore, for a vessel with a 20 ton capacity of squid, 30 tons of ice and seawater should be used, based on Learson and Ampola (1977).

The other method of processing whole squid is onboard freezing. The advantages to this method are: it is widely accepted, it increases the length of time one can stay at sea by increasing shelf life, and the processing is virtually complete, requiring no shore-based processing.

The following processing method is used on the *Corba*, a large Spanish squid trawler built in Vigo, Spain in 1975. The *Corba* (one representative of a rather large Spanish squid fleet) is 127 ft in length overall with 21 ft beam, 12.4 ft depth and 10.5 ft trough. Tonnage of the *Corba* is 299.3 mt gross and 100.6 mt net. The Stork Werkespoor, as mentioned, diesel delivers 1,235 hp at 12 knots maximum speed. The fish hold capacity (freezer space) is 240 to 250 mt.

When the cod end is released, the catch is dumped into a holding pen. There is similar arrangement on Japanese squid jigging boats. Squid, through a series of conveyors, are deposited in a holding pen, graded by size and weight, then given a saltwater wash.

The four *Corba* crew members separate the squid by species. Since Spain has little experience in Pacific squid, size and species gradings can only be taken as a general indication of consumer preference. Grading is done by hand with a wooden ruler. The following are Spanish size classifications for *Loligo* and *Illex*:

Table 2. Spanish size classifications for *Loligo* and *Illex* squid.

| Loligo | | Illex | |
|---|---|---|---|
| Grade | Length (Mantle) | Grade | Length (Mantle) |
| #1 | >27 cm | #1 | >18 cm |
| #2 | 22-27 cm | #2 | 14-18 cm |
| #3 | 18-22 cm | | <14 cm |
| #4 | 14-18 cm | | |
| #5 | 10-14 cm | | |
| #6 | <10 cm | | |

Perhaps the most important aspect of freezing at sea is size separation and uniform product quality in blocks of 10 kg. Squid are placed into trays by size category. The trays used on board Spanish ships are 20 kg shallow trays divided down the middle, making it possible to produce two 10 kg squid blocks of different sizes and grades. These graded squid have a label attached to them, placed in the block to be visible after freezing, and are then taken to the freezer.

On the Corba, each of the two freezers holds about two tons. The two 36 hp Grenko compressors and two 235 hp Stork Werkespoor diesel engines hold the freezers at -32°C. Initial freezing lasts for six hours. Afterward, the blocks are broken loose, glazed with salt water, and placed in plastic bags. These bagged blocks end up in a main freezer powered by one 16 hp Grenko compressor, stored at -25°C to -30°C. These blocks can then be shipped to a number of places for secondary processing.

Squid frozen in this manner can keep up to six months (Schwartz 1972). Learson and Ampola (1977) state frozen storage tests on Illex revealed that frozen product, even after 13 months of cold storage at 0°F (-18°C), was still rated good by taste panels. Tests have been done on Loligo with similar results.

The other product preferred by Japanese and Spanish buyers is the skinned and gutted mantle or tube with the fins and tentacles removed. This is also the initial processing phase for sashimi (raw squid), surimi (diced squid strips) and for Spanish and Italian cuisine: stuffed squid, curried squid, or frozen squid portions and rings.

Squid tube processing is highly technical work. If gutting and skinning are done by hand, costs are nearly prohibitive in all but countries with comparatively low labor costs.

The squid are received by the processor iced, or frozen in blocks. Depending on the form, they are thawed and washed or simply washed. This is where the processing methods diverge significantly.

In Spain, it was common as late as 1972 to gut and skin by hand, under ample amounts of running water (Schwartz 1972). The head was usually extracted from the mantle with a swift pull. This took the main entrails out of the squid body rather neatly. Next, the pen was removed from the mantle, and the fins torn or cut off. Depending on whether the mantle was destined to be a steak or a tube, the mantle could be cut lengthwise to remove viscera. Removing the colored skin by hand is difficult and consumes a considerable amount of manual labor (Schwartz 1972).

The sloughing of the skin is helped along by blanching the cleaned mantle in hot water, 80° to 85°C, for 5 to 10 minutes. Research in the U.S.S.R. is slightly contradictory however, claiming that a blanch of 30 seconds is appropriate for saline water temperature of 80° to 85°C. Other methods of removing skin from the mantle involve alkalai solutions of sodium and potassium hydroxide in 2 to 4 percent concentrations. In a 2 percent solution, the blanch time is about 8 minutes. In a 4 percent solution, the blanch time is about 2 minutes.

During the evisceration process, the ink bags are removed and placed in a separate bag for producing squid in ink sauce, a favorite dish among southern Europeans. The tentacles and fins are usually left unskinned and sold either separately for minced products or included with the squid tubes.

Since this processing method is highly labor intensive, there has been much research on mechanizing squid processing. Review of literature shows several countries involved in alternative squid processing methods: Japan, the United States, and Poland. Japan is the leading producer of skinning, eviscerating and heading equipment.

Discussion by Jutkiewicz, Lipinski and Milanowski (1973) summarizes the problem of squid processing and skinning:

> The average output per man is one to two squids per minute (60 to 120/hour) (and) this is the bottleneck in squid processing methods... For this reason the world trend, including Poland, is toward mechanical initial processing of squids. Machines for the initial processing of squids can be divided in general into:
>
> 1. Machines to cut off the arms.
> 2. Machines to remove entrails, jaws and eyes:
>     a. with a longitudinal cut along the mantle;
>     b. removing the head and entrails without cutting along the mantle.
> 3. Skinning machines.
> 4. Multi-operational machines:
>     a. to cut off arms and remove entrails;
>     b. to cut off arms, remove entrails and skin;
>     c. others.

Jutkiewicz, Lipinski and Milanowski (1973) then describe several machines that they feel have the most promise among those that produce longitudinal mantle cuts. These authors reviewed the performance of the Japanese Ataka machines, the "Tova" and the "Taje". Comparisons of characteristics are shown on Table 3.

Ataka also produces a series of machines which remove entrails, jaws, eyes, and arms, if need be. The Ataka

Table 3. Comparison of three processing machines making longitudinal cuts for evisceration

| | Ataka[1] | Tova[2] | Taje[3] |
|---|---|---|---|
| **Capacity** | 50 squid/min | 20 squid/min | 30,40,or 60 squid/min |
| **Power Use** | 0.4 kw/hr | | |
| **Length** | 1,660 mm | 2,140 mm | 1,620 mm |
| **Width** | 700 mm | 480 mm | 710 mm |
| **Height** | 900 mm | 915 mm | 915 mm |
| **Weight** | 190 kg | 180 kg | 190 kg |

---

[1] Removes arms (optional).
[2] Cost 60,000 ¥, 1979.
[3] Improvements placed on removal of eyes and jaws.

processor (Figure 19) cuts the mantle longitudinally (Figure 19a, cut 2) and, for squid destined for drying, the arms are left on with only the single cut being made (Figure 20). The general mechanism for this type of squid processing is shown in Figure 21, with notations on each step. The resulting product is a flat pressed fillet of squid, with or without tentacles, skin and fins on (Figure 19d).

The other type of machine reviewed by Jutkiewicz, Lipinski and Milanowski pulls the head and entrails out of the body of the squid (Figure 22) through a series of roller-pullers that grasp the tentacles. So secured, the squid is conveyed under revolving rollers which draw up the arms and remove them with the head and entrails. The squid body or "tube" is then washed and packed. The resulting semi-processed product may have the fins on or off and the skin intact.

Squid skinning is one of the most time consuming-steps of processing and has been approached by many methods. One reason is that squid products are numerous. No machine yet can perform the initial processing and skinning. However, Jutkiewicz, Lipinski and Milanowski (1973), discuss a squid skinning machine that uses press rollers, slitting the skin with a divergent worm wheel pattern on the press rollers. This skinning technique apparently does not injure the mantle but is inappropriate for the production of tubes, since the mantle must be split and laid flat.

## SQUID PROCESSING RESEARCH IN THE UNITED STATES

An in-house paper from the Northeast Fisheries Center (NMFS), The Mechanization of Squid Processing, brings together the most recent body of literature on the U.S. experience (Learson 1979, personal communications). Most of the work on squid processing has been done by the Northeast Fisheries Center Laboratory at Gloucester, Massachusetts in response to a growing interest in selling squid to Japan and Spain. This work concentrated on the sizing and skinning problem.

The only unit that successfully sized squid was the MOBA weight grader which can separate different sized squid into 2 oz increments with 95 percent accuracy. There is a high correlation between weight and length in squid, so it is equally suited for grading by length. However, a letter from Ampola (1979) and talks with MOBA sales representatives, determined that the MOBA graders must be hand fed. They do not function well onboard ships unless they are very large and on calm seas. For more information on the MOBA grader contact:

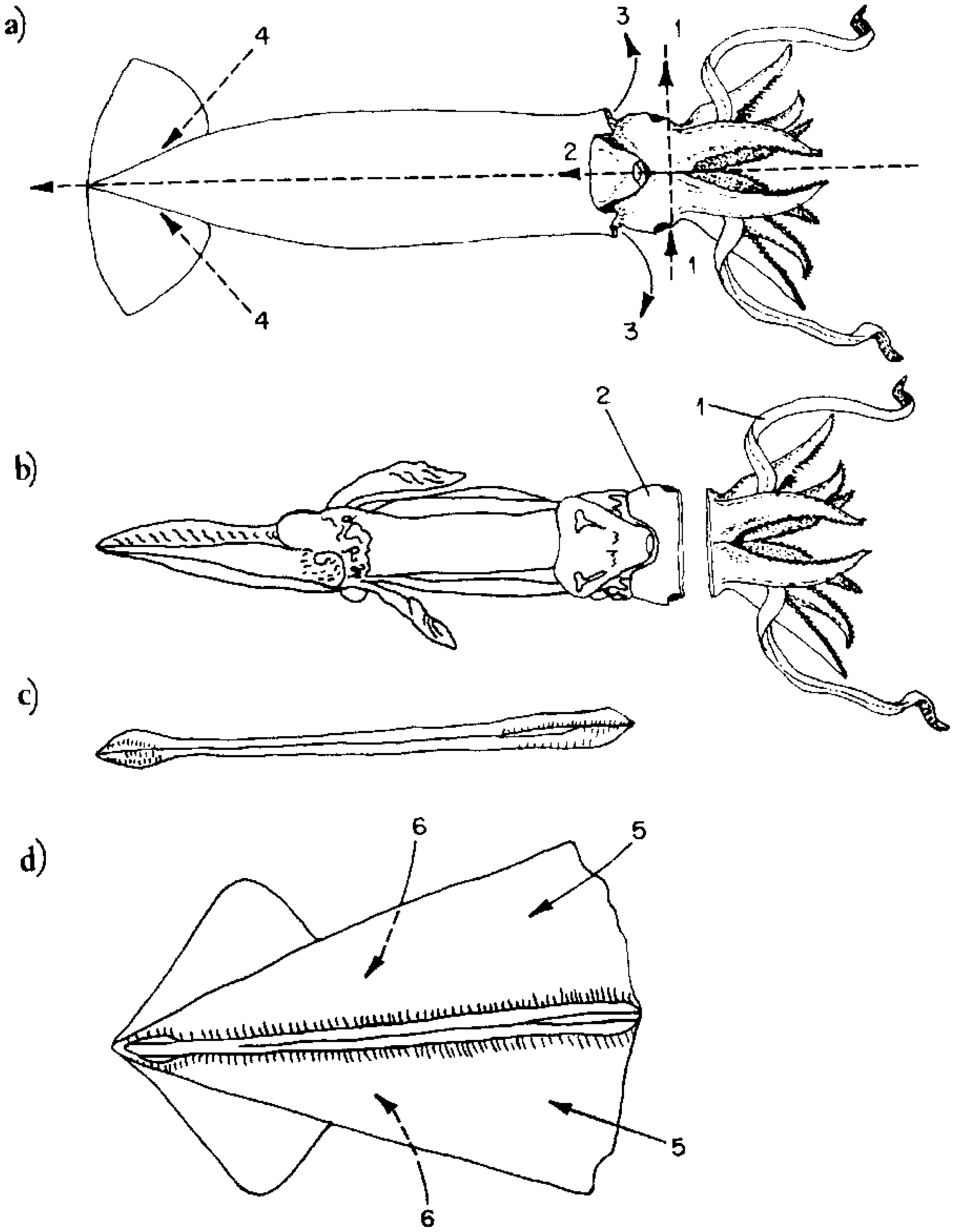


Figure 19. General methods of squid processing: a) tentacles cut(1), a longitudinal mantle cut(2) with splitting pressure(3) and fin removal(4); b) viscera pressed or pulled out with tentacles attached, then tentacles(1) removed from visceral mass (2); c) pen removed; and d) a squid steak, unskinned with fins intact. (Jutkiewicz, Lipinski and Milanowski 1973).

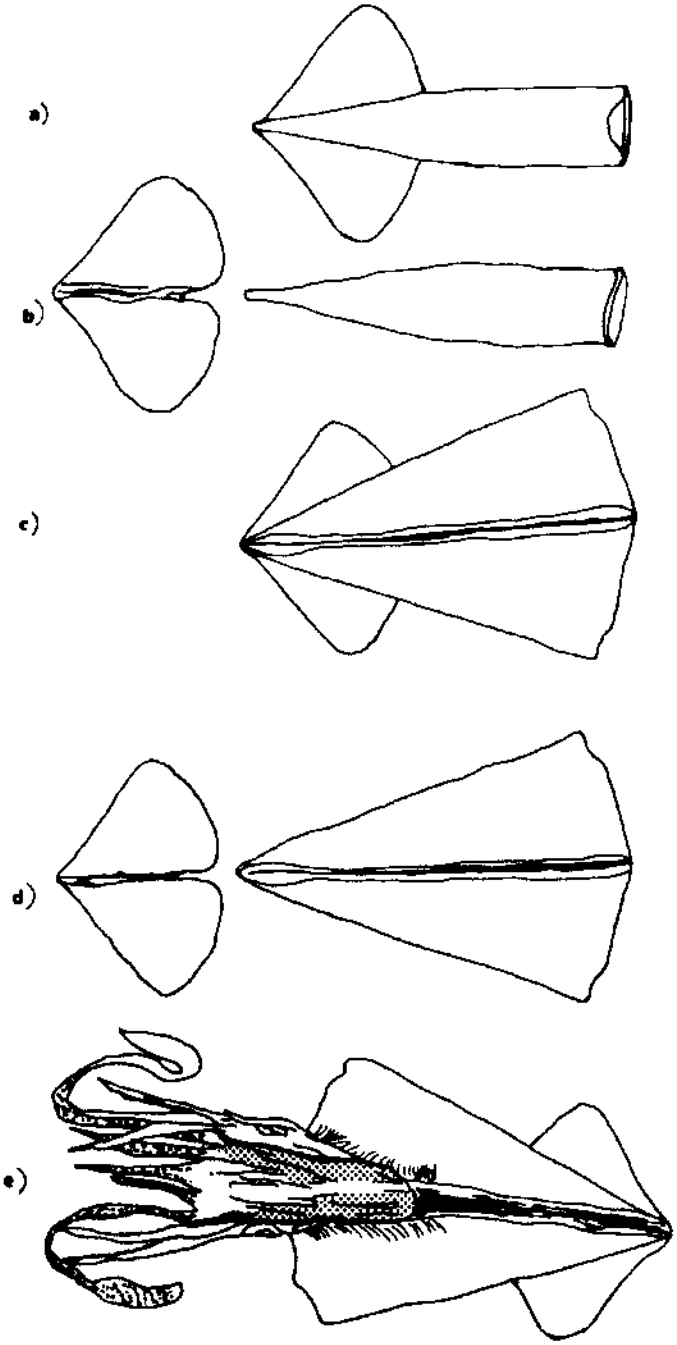


**Figure 20.** Processed squid mantle product forms: a) tube with fins, b) tube without fins (fins are kept for other products), c) squid steak with fins, d) squid steak without fins, e) squid horizontally split and eviscerated with tentacles and fins attached, destined for drying. There may be a final step, where the dried squid is shredded into strips. (Jutkiewicz, Lipinski and Milanowski 1973).

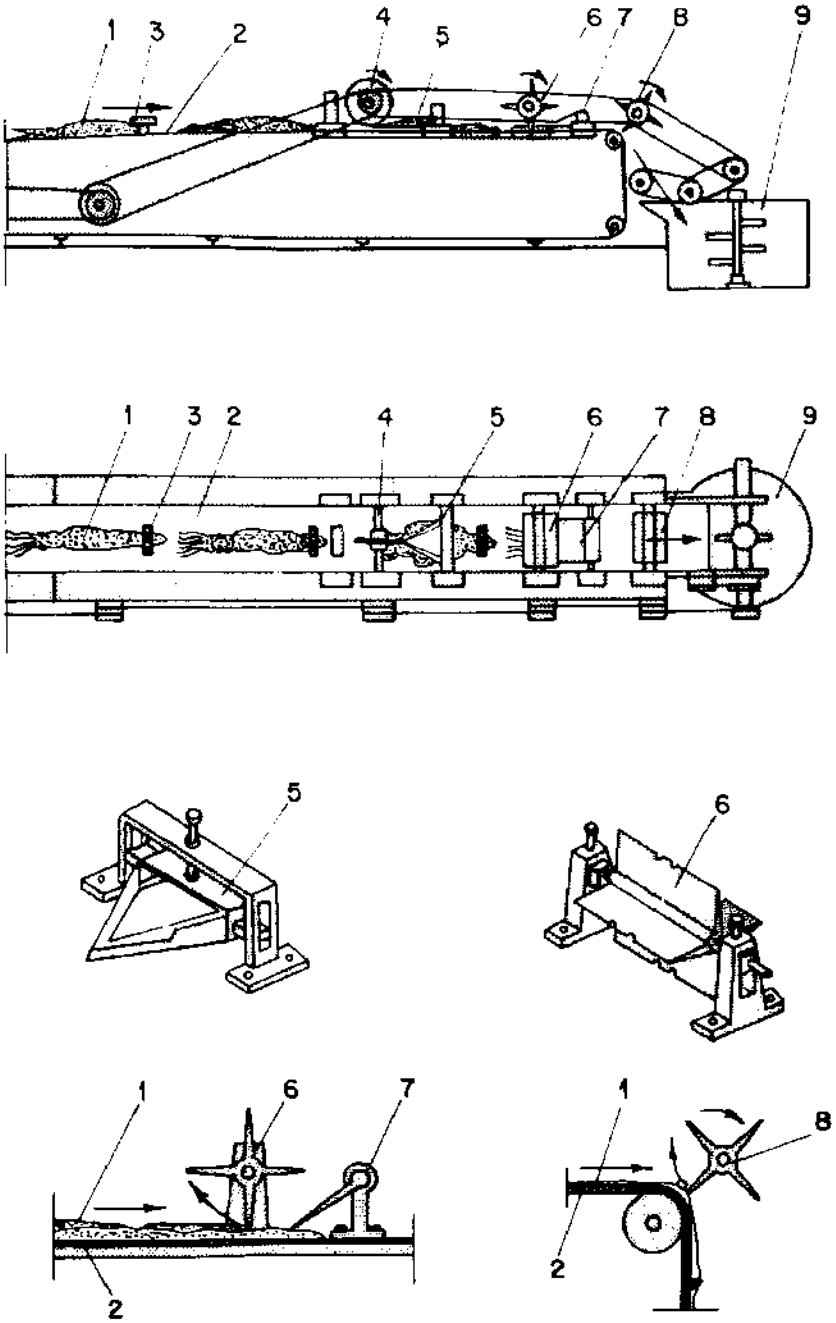


Figure 21. A Japanese squid eviscerating and splitting machine. (1) Squid placed dorsal side down with fins anchored by hooks (3) attached to conveyor belt (2). Squid move into circular cutter (4) and then to spreaders (5) which flatten the mantle, and rupture internal membranes. Entrails, mouth parts and eyes are removed by cruciform drivers (6) and (8) with undersprung plate in between (7) and is fed to the rinsing machine (9). (Jutkiewicz, Lipinski and Milanowski 1973).

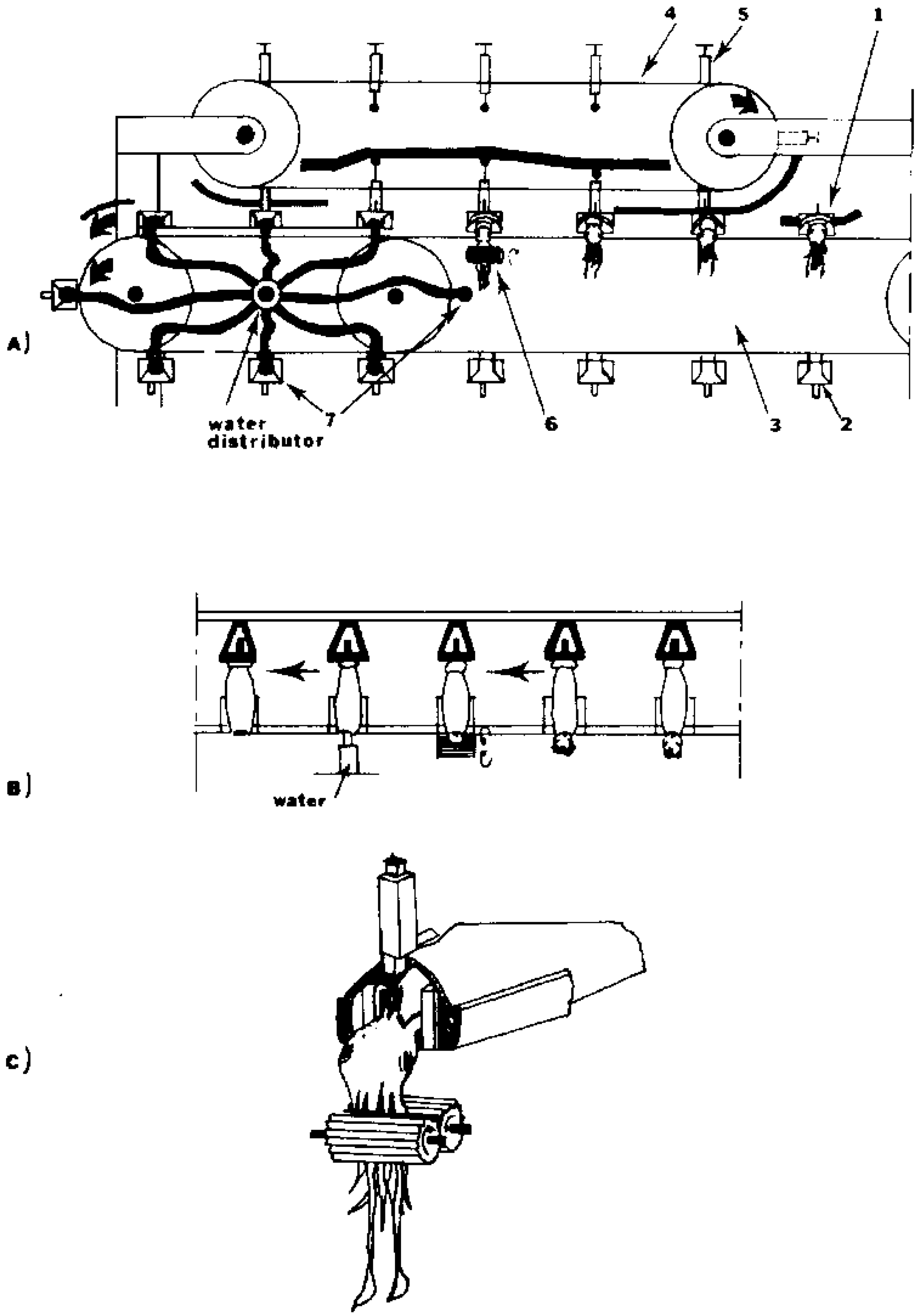


Figure 22. Japanese squid processing method for making intact mantles. A) Squid (1) are attached by the fins to clamps (2) located on conveyor (3), the clamped squid are conveyed past a second conveyor (4) that has attached to it devices for holding the mantle in place (5) while the roller extractors (6) take the head and entrails out. The squid then pass through washers (7). B) top view of conveyor belt with eviscerator and water jet. C) close up of the eviscerator. (Jutkiewicz, Lipinski and Milanowski 1973).

Apparatenbouw B.V.
Stations WEG 117 - P.O. Box 7
Barneveld,
Holland
Tel: 03420-3241
Telex: 47574
ATTN: Mr. A. J. Van Ginkel

There was little success with evisceration and beheading by high pressure rollers. The idea was to produce an intact "tube" by subjecting the whole squid to a roller-conveyor pressure of about 250 lbs with a 2:1 differential between the pressure roll and the conveyor belt. Invariably the evisceration was incomplete and the resulting entrails and head fouled the roller.

In the Japanese models described above, the head, tentacles, and viscera were pulled out, much the same as in hand evisceration. In this case, the visceral mass will have the ink sac intact. This ink sac may be an important bargaining factor, especially in sales to Spain.

Skinning techniques were also reviewed by the Gloucester Laboratory. Learson (1979, personal communication) indicates two skinning machines were successful: the Baader 50 (analogous to the Jensen skinner which was tested but discontinued), and the TRIO skinner. The Baader 50 is a rotating belt knife skinner with adjustable blades for thicker cuts. One person can operate this machine. The feed width is 14 in., large enough for most squid. The filleting capacity is 40 to 100 fillets per minute.

TRIO produces a skinner which freezes fillets on a refrigerated drum. The fillet is cut off the drum with a continuous band knife, leaving the skin behind. The fillet can then be picked up from the conveyor or further processed. Specifications suggest that between 100 and 150 small fillets per minute can be processed this way. The cooling medium is Freon 22. The machine consumes about 18 liters (4.75 gal) of water per minute, and weighs 900 kg (1,984 lbs) and is 117 m by 255 m by 140 m (3.8 by 8.36 by 4.59 ft). The 1979 price on this unit complete with options, freight and set-up costs is $36,800, not including taxes and duty.

The regional fisheries attaché in Tokyo supplied information on squid skinning machines from Yagi Sangyo Kikai Seisakusho, a company selling squid processing equipment. The addresses for Baader, TRIO, and Seisakusho are:

Nordischer Maschinenbau Rud. Baader
D - 2400 Luebeck-1
Geniner Strasse 249
Post fach 1102
Germany

TRIO Maskindustri
c/o Trans-Cold
Refrigeration, Ltd.
5485 Lane Street
Burnaby, B.C. V5H 2H4
Canada

Yago Sangyo Kikai Seisakusho
3, Kamigata-Cho, Himeji-shi
Hyogo Prefecture
Japan

### Fin Removal

The Northeast Fisheries Center tested two methods of fin removal. The first involved a pair of rollers set diagonally across a course carrier belt. It was supposed to pull the fins off by twisting but was unsuccessful. The best system tested was mechanical cutting, using a steel rule die to cut off the fins (Figure 23).

## CONCLUSIONS OF THE NORTHEAST FISHERIES CENTER STUDIES

Learson (1979, personal communication) indicated there has not yet developed a squid evisceration machine which kept the tube intact. In a paper given at the Squid Symposium in Gdynia, Poland, a machine was described (Japanese patent no. 41-1059), that produces a tube squid with the fins on. It is not known, however, if the tube still has the pen or whether pulling on the tentacles (which appears to be the sole method of evisceration) cleans the inner mantle.

Raw squid skinning requires two passes through a skinner if the mantle is a tube, and one pass if the mantle has been cut to stay flat. The alternative to mechanical skinning is blanching in conjunction with agitation and brushing. This appears to be common in Japanese processing, especially in production of diced and smoked squid strips.

Additional research has been conducted by Robert Price (food technologist, UC Davis) and John Richards (UC Santa Barbara). Their mechanical processing studies were conducted by University of California Sea Grant College Program.

Beyond tube production, fillet, or blocks of whole squid for export, processing becomes more complex and difficult. It

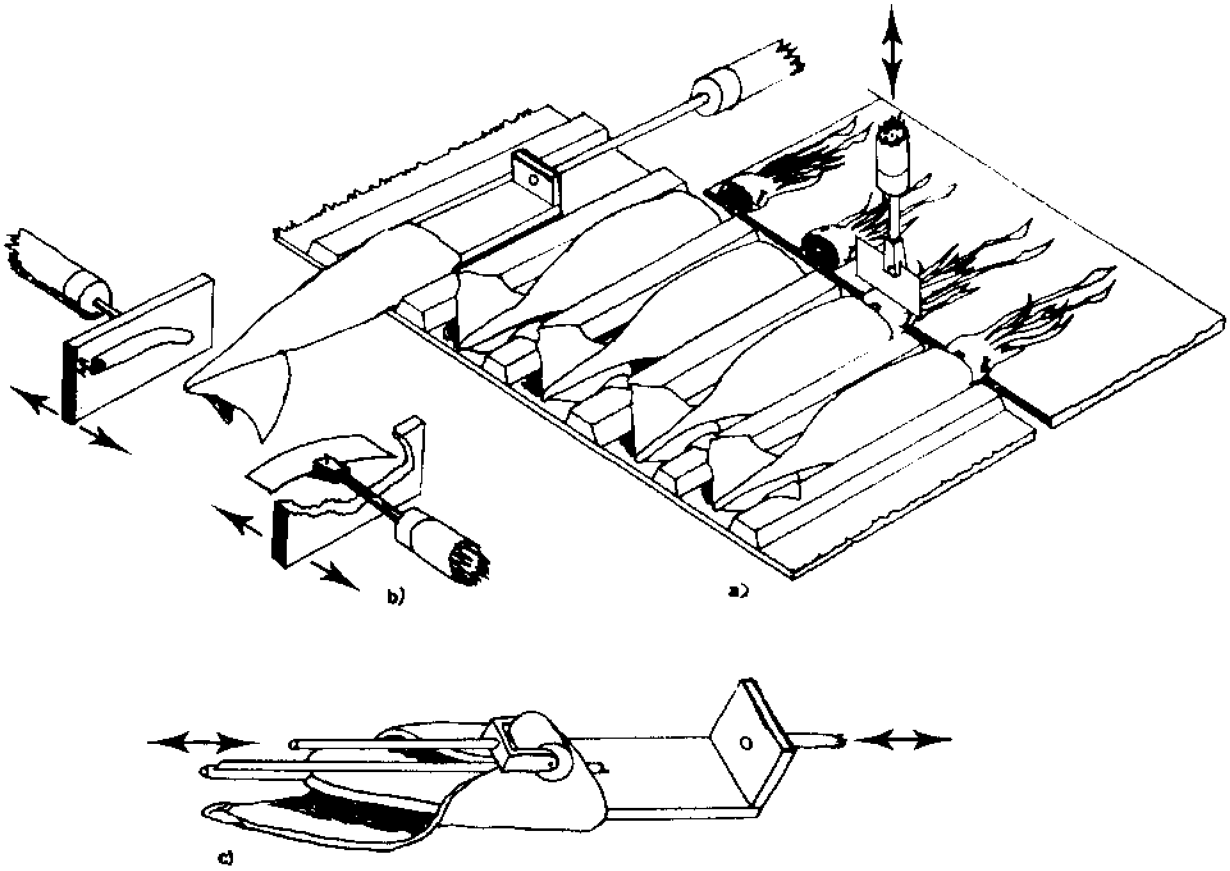


Figure 23. Test operations performed by Northeast Fisheries Center's Gloucester Laboratory. Squid are placed, dorsal side down, in conveyor trays and pass under synchronized guillotine and across transfer tongue a) which pushes the tube into optional fin removal b) or mantle splitter c).

may be to a processor's advantage to produce skinned squid fillets or tubes to minimize the more obvious differences in squid body type and so on. Producing, for instance, canned squid in olive oil and spices for Spain, or smoked squid for Japan, may be far too ambitious an undertaking for an initial marketing contact. Revenues to be made on the finished product, however, may be considerably greater.

# THE ECONOMIC FEASIBILITY OF A SQUID TRAWL FISHERY

## INTRODUCTION

This feasibility analysis used some responses from the Commercial Fisheries Entry Commission (CFEC) 1976 cost and earnings survey of the shrimp fishing fleet, to determine whether or not trawl fishermen will be able to fish squid at a profit, should a market and a fishery develop. The full results of the analysis and instructions on how to interpret the results are found in Appendix D.

We feel that this analysis of summarized responses from these representative members of the shrimp fleet can be a useful tool. It enables a fisherman to make an informed decision about when it would be most profitable for him to enter the squid fishery, given his own cost structure and crew payment setup.

As shown in previous sections of this report, the Japanese have been taking squid in the waters off Alaska for some time. NMFS trawl surveys indicate that squid do exist in some areas in commercial quantities. The problem is to develop a "reasonable market", small-scale or large-scale, for the squid using domestic processing capacity. At present, no one has even attempted to develop this fishery in Alaska, with the exception of a proposed demonstration fishery in Southeast Alaska.

The reader must assess for himself the possiblity of a sustainable long-term squid fishery. However, the squid resource seems so vast and the domestic trawl harvesting capacity so small, that there is not an immediate problem with sustaining a fishery. It seems likely that a small directed or incidental fishery for squid could be developed in the future without immediate adverse effects. However, we have not been able to assess, nor is it likely that we can determine, what it will cost each fisherman to gain enough knowledge on seasonal concentrations of squid to make harvesting feasible. We have determined where the Japanese catch most of their squid and have collected data on monthly catch of squid in statistical areas of the Gulf of Alaska and Bristol Bay. This will provide a good start for fisherman to determine where and when to go trawling for squid.

## ASSUMPTIONS USED IN THE ANALYSIS

We have assumed a five month fishery and a 12 hour trawling day. We arrived at five months by looking at the length of time that the Japanese had the most success at catching squid, from August to December. We used a 12 hour trawling day after talking with shrimp fishermen. During the season for shrimp, trawling operations usually go around the clock during hours of total daylight. Since squid trawling appears to be a late summer and fall fishery, 12 hours seemed to be about maximum for daylight trawling activities.

We maintained the crew sizes, food and fuel costs as they would have been in the shrimp fisheries, but adjusted them to reflect 1980 prices. Galley prices (PGALYE) were adjusted to 1980 prices by using a ratio of the February 1980 Anchorage Consumer Price Index and the May 1976 Index. This multiplier was calculated at 1.3547. Fuel costs (PFLOPE) were also adjusted to 1980 prices using a ratio of the combined wholesale price indexes of gasoline and diesel for commercial consumers in the Pacific states from June 1976 to February 1980. This multiplier was calculated at 2.1706.

We also maintained skipper and crew shares and crew costs at whatever amount was originally reported to the CFEC. Trips per year, trips per month and days per trip were also maintained at their reported levels, provided that they were internally consistent. For instance, if there were more days taken on trips per month than the number of days in a month, we had to adjust these. We also made adjustments in the number of days per trip to account for running time to and from grounds. If we encountered missing values for any of the variables, we substituted the mean value for that variable over the horsepower class.

We divided the shrimp fishing fleet up into two size classes according to horsepower of the main engine. The size of the nets we used realistically matched the size of the vessels (Table 4). All data on nets and net types was acquired from Nor'Eastern Trawl Co., Seattle. A "catch factor" was determined based on the average square footage of opening a net for this size range of vessel would have. This factor shows the catch rate as a function of the net size. We were assured the net equipment had a zero value after three years, which may be a slight overestimation of cost.

Another major change we made in the cost structure of all the vessels was adding a freezer system including storage. Based on our preliminary discussions with foreign squid buyers, worldwide squid markets use frozen blocks.

We used two different sizes of self-contained horizontal plate freezers manufactured by Dole Refrigeration (Harrington 1980, personal communication). For freezer storage space, we also consulted W. E. Stone and Company, Seattle; (Raynor 1980, personal communication) and obtained cost formulas for installing air hatch units in different size holds. A 20-year capital life was assumed for all freezing gear.

**TABLE 4.** Budget and specifications for squid trawling equipment

| Engine Horsepower Range | Doors | Tail Chains | Bridles | Net, Body & Cod end, 2" Stretch Mesh | Total Cost | Square Footage Range[1] | Mean Square Footage | Catch Factor |
|---|---|---|---|---|---|---|---|---|
| 200-400 | $2,400 | $500 | $ 600 | $2,400 | $ 5,900 | $4,298-8,595 | $ 6,447 | 1.000 |
| 400-800 | $4,200 | $800 | $1,000 | $4,000 | $10,000 | $8,617-1,791 | $12,904 | 2.0016 |

---

SOURCE: Nor'Eastern Trawl Co. (1980).

[1] These figures were computed from the following relationships supplied by Loverich (1980):

> A net made for a vessel with 1,000 hp in the main engine will have a vertical opening of 72 feet and a horizontal opening of 95 feet for the cod end, mesh size described. The area of an ellipse is $\pi AB$, where A and B are the principal and minor axes, respectively. The opening is therefore 21,488 square feet. Since square footage of opening is proportional to horsepower, the range of horsepower described in each scale size yield these optimum square footages. The mean square footage and catch factors are derived from these optimums.

We assumed the fishing trip would end if the hold were filled.

We have used what we believe to be three realistic ex vessel prices of squid in block form (the high end is far more realistic than the low end) to illustrate where these vessels will lose, breakeven and win in a squid fishery. The three ex vessel prices used in this analysis were: \$.05/lb, \$.15/lb and \$.25/lb.

Based on what we know of the Japanese fishery and its success over a season trawling for squid, we have suggested three seasonal catch rates per hour of dragging that are realistic for the size of the nets used. These average catch rates over the season are: 250 lbs/hr; 500 lbs/hr; 1,250 lbs/hr. For vessels with horsepower from 400 to 800, these catch rates are adjusted upward by a factor of 2.0016.

Finally, for this three-year fishery, we have chosen the discount rate in our net present value (NPV) equation (Appendix D) as 15 percent. This means that if the fisherman bought his net and gear with his own money, fished for three years and made a NPV of 0 in this analysis, he would make 15 percent on his investment. However, we have set up this analysis so that there will not be a distinct difference in what he can attribute to the use of his investment money and what he bankrolls for the boat.

No mention has been made about a payment to the boat for its services. We have tried to avoid this issue whenever possible. Different fishermen have different ideas about how much they need to keep their boat up. This depends on vessel age, mortgages, and average maintenance and repair. The point is, beyond the breakeven point where NPV = 0 and the fisherman makes 15 percent on his investment, it is entirely up to him how much more he will need to pay his boat. Therefore, he should look at net present values (Appendix D) that will allow him to pay his boat something. Of course, if he is borrowing money at a rate of interest, he will probably need to look at positive NPVs that cover not only his payments to the boat, but also the payments of interest on the loan, in order to get a 15 percent return on the use of that money.

We give general results for the whole fleet below. Also included is a more detailed description on how the analysis was performed. A discussion follows on interpreting the results and applying them for those who may be interested in seeing, beforehand, what his probable success would be over the different combinations of catch rates and ex vessel prices.

## RESULTS

We looked at vessels in two horsepower ranges according to the size and cost of nets. Vessels above these horsepower ranges could not be analyzed because of the small amount of data that was reported. More detailed information is found in Appendix D.

## VESSELS FROM 200 TO 400 HORSEPOWER

There were 16 observations in this group of vessels. Recall that our conclusions are based on statistics from the shrimp fishery. Those results are given in Table 5, which shows how many vessels would at least have broken even over a three year involvement in the squid fishery. Each variable (NPV) indicates a certain average ex vessel price and catch per hour. The first digit indicates pounds per hour and will be a 1, 2 or 5, standing for 250, 500 and 1,250 lbs per hour, respectively. The second digit stands for average ex vessel price and will be a 1, 2 or 3, standing for $.05, $.15 or $.25, respectively. Calculation of net present value is more clearly explained later in this section.

A catch rate of 1,250 lbs/hr over a season for this size range is probably optomistic, since a person starting in this fishery will have to do some hunting to get started. We feel far more comfortable with figures between 250 and 500 lbs/hr as a seasonal average. However, in this catch rate range there seems to be about a 50 percent success rate at $.25 given the respondent's cost structures and the gearing up costs we have defined. Unless your costs are, on the average, lower than the ones shown in Appendix A, and unless the ex vessel price is $.20/lb or higher, with a catch rate between 250 and 500 lbs/hr, squid fishing as we have defined it is not feasible. We feel that $.25/lb for well frozen blocks is not only a reasonable price to expect, it will put about half of the fishermen shown here in the red and the other half in the black. Proceed with caution, if a market can be developed.

## VESSELS WITH HORSEPOWER FROM 400 TO 800

There are 13 observations in this group of vessels. All of the catch rates have been adjusted by 2.0016 to reflect the larger net. The NPV variables work the same as those in Table 5, but in order to take the larger net into account, the first digits stand for more pounds per hour. The 1, 2 and 5 indicate 500, 1,000 and 2,500 lbs, respectively. The percentage of vessels that would have been successful in the three years of fishing, based on our calculations, are described in Table 6.

Table 5. Percentage of success in squid fishing by average catch per hour (lbs) and average ex vessel price (dollars).

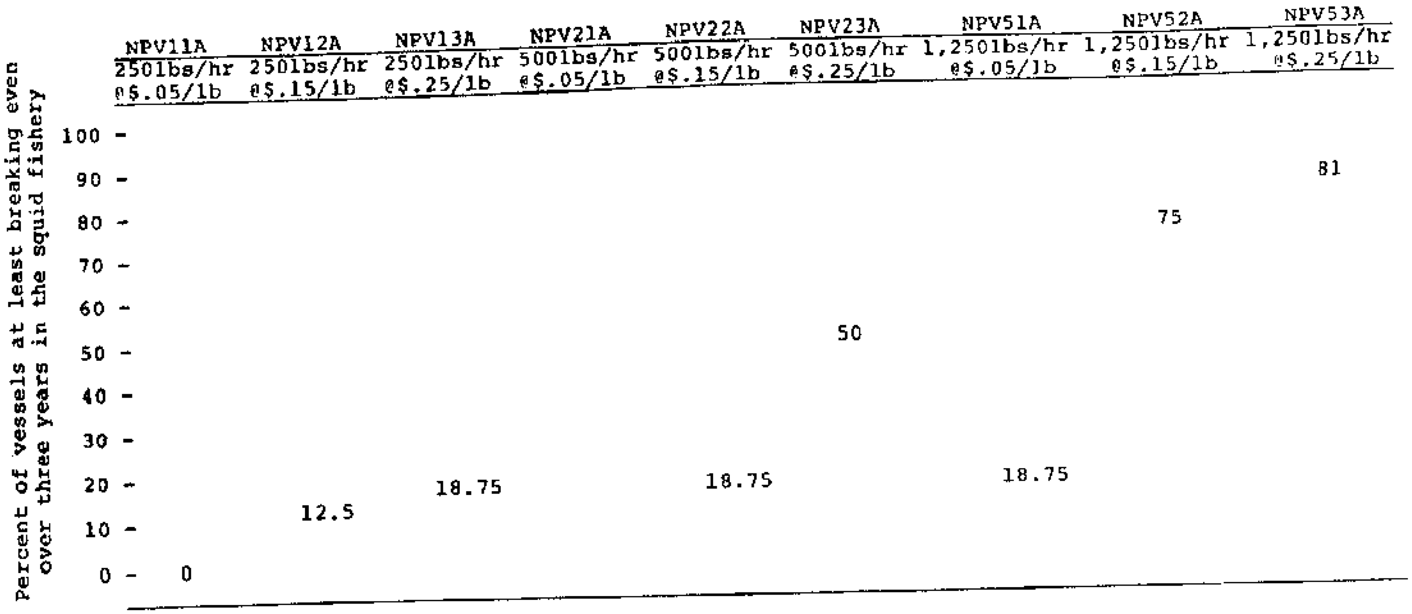
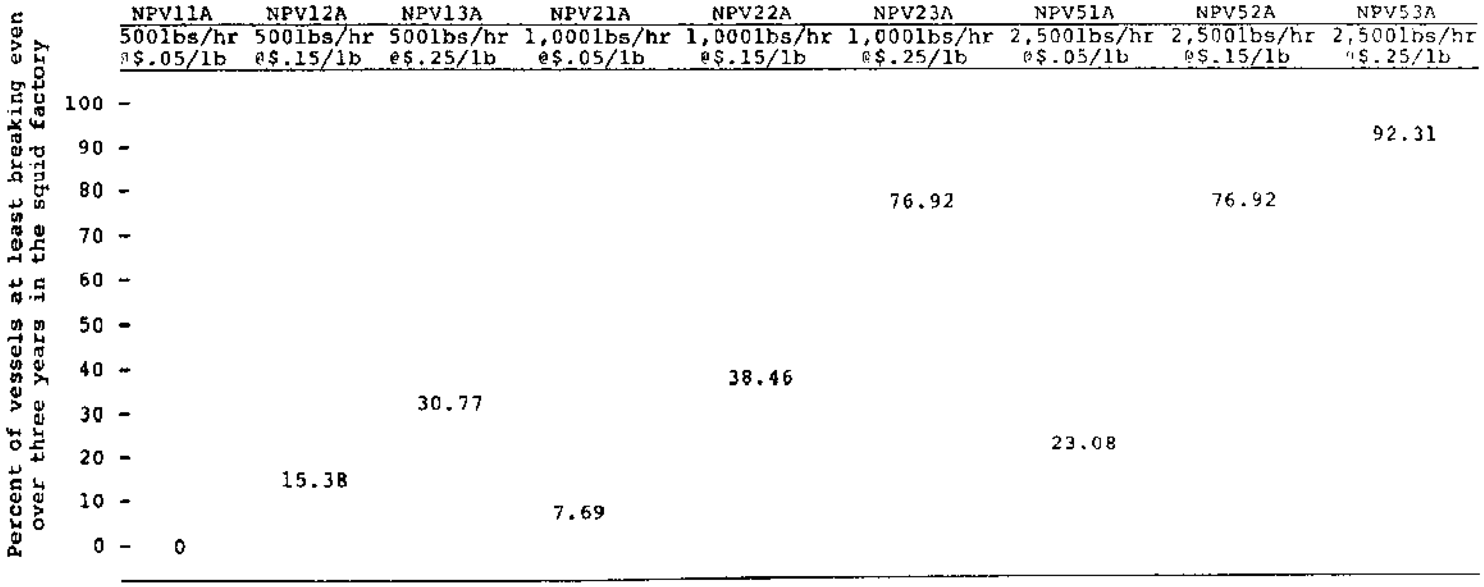


Table 6. Percentage of success in squid fishing by average catch per hour (lbs) and average ex vessel price (dollars).



As with 200 to 400 hp vessels, it is improbable that the catch rate per hour over the season will ever reach 2,500 lbs. But it is important to note that even at this unrealistic level, at the highest price we assigned, there was still one case that would have lost money over the three-year period (Case 1 at $70,909). (Appendix D)

We feel that a reasonable catch rate per hour for the season would lie between 500 and 1,000 lbs/hr. Depending on how each individual fisherman's cost structure is assigned, he may or may not be able to breakeven.

## CONCLUSION

If a fishery can be developed on the basis of supplying a world food market with Alaskan squid (this is possible with diligent work), we would recommend that a fisherman refuse an ex vessel price for frozen blocks of much less than $.25/lb, unless he is absolutely sure that he can catch at per hourly rates of greater than 500 lbs for vessels with 200 to 400 hp or greater than 1,000 lbs for vessels with 400 to 800 hp. The fisherman with mean variable costs that are higher than the norm must be very cautious about his ability to cover expenses. For fishermen with lower mean variable costs or those who are more satisfied with the amount of money that they could net for their boat over three years given our assumptions, these issues about minimum ex vessel prices become much less critical.

# WORLD TRADE OF SQUID

Our summary of squid world trade is based on responses we received to a questionnaire. Countries that might be interested in the squid trade were determined by consulting the FAO's Yearbook of Fishery Statistics. Using data for 1976 and 1977, and an elimination process described in Appendix E, we selected a number of countries to contact. The questionnaire went not only to government agencies, but also to companies interested in squid.

The questionnaire and details on how it was developed are contained in Appendix E. Essentially, it asked for two types of information:

1. General and topical data including descriptions of the fishing industry, which squid species they preferred, and descriptions of harvesting and processing techniques.

2. Marketing data, including import and export information, used to construct a model showing every relevant dealer on the world market. This model eventually included Eastern Europe, not explicitly contacted during research.

Fisheries ministers in each country were contacted and asked to supply the following information:

1. Production and value of harvest (defined or landed catch) from 1974 to 1977.

2. Import value for 1977 (or 1976, if 1977 not available).

3. Export value for 1977 (or 1976, if 1977 not available).

4. Trade barriers against the U.S. (tariff and non-tariff).

5. Names and addresses of importers that might be interested in U.S. trade.

This information is more fully detailed in Appendix E.

Processors, wholesalers and brokers were then sent a questionnaire to determine:

1. Interest in species offered by U.S. catches.
2. Desired harvesting techniques.
3. Desired processing techniques.
4. If they could be contacted by English speaking businessmen.
5. Specific quality control requirements.
6. Price quotes, buyer terms.

This is more entirely detailed in Appendices F and G.

## 1977 WORLD TRADE PICTURE FOR SQUID

The information in Appendix F (Import and Export Statistics for Countries Reporting Trade in Squid) has been summarized in Figure 24. In this trade diagram, an arrow pointing to a country indicates that it imports from the country where the arrow originates. A double arrow indicates a cross trade between two countries. Consult Appendix G to determine net trade flows.

Gesellschaft mib H
Postf. 290014
Elswerkestr
2850 Bremerhaven F
Germany

Interfrost is primarily interested in Loligo vulgaris, which does not inhabit Alaskan waters. They did not indicate whether other species might be acceptable. Business is conducted in English. They specify the following for onboard handling: freezing in fresh or seawater, or preservation in chilled seawater. They are interested in tubes with or without head and tentacles or in squid rings (cut from the cleaned tube). Packaging requirements are 2 kg or 5 lb blocks or I.Q.F. in 15 kg packages. For whole squid in 5 lb blocks, they offer a CFI (customs, freight and insurance) price of $2.50/lb. For tubes and rings in packages (5 kg), they offer a CIF price of $2.80/lb.

Standard Ubersee Handels GMBH
Rothenbaumchaussee 3
2000 Hamburg 13
Germany
ATTN: N.J. Ravenburg
Tel: 040-44-10-41
Telex: 0211596

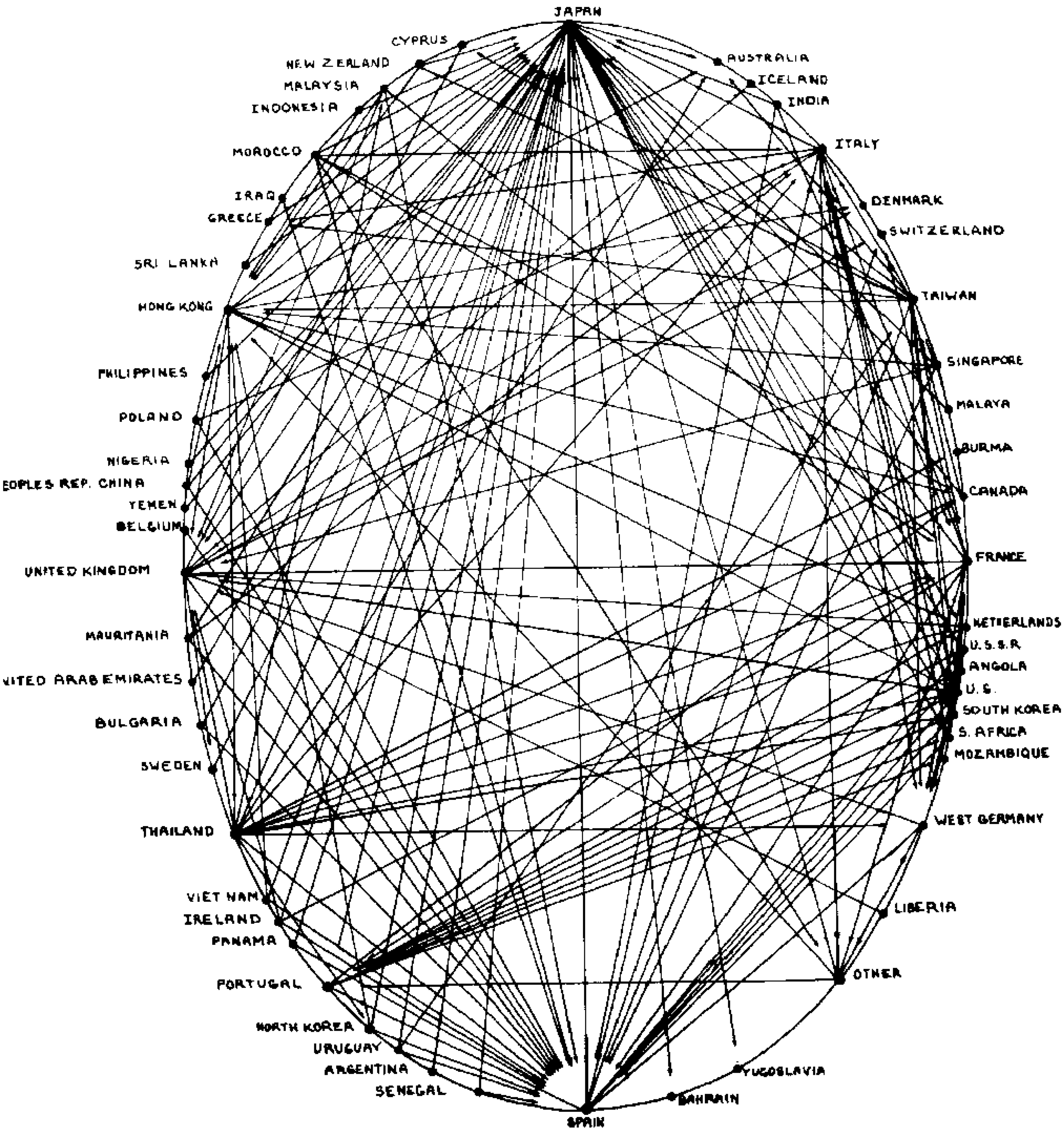


Figure 24. World trade picture for squid (Republic of China 1978, 1977; Department of Customs, Thailand 1977; Estatistica Del Commercio Exterior de Espana 1977; Acores E Madeira 1977, 1978; Japanese Import Statistics 1977; Mersil de Co-mercio con L'Estero, Italy 1977).

This company indicated interest in squid without further specifications. They were willing to answer inquiries in English and welcome visits to their offices. They prefer squid frozen onboard, particularly specifying *Illex*, in blocks of commercial sizes. No prices or weights were given.

Preparations followed that of Spanish and Italian dealers. This indicates that the largest volume dealers have gotten most buyers to use their specifications: 10 kg blocks, poly wrapped and placed two to three in a box or master carton. *Illex* and *Loligo* squid were mentioned. This should be taken as an indication of preferred type, not a specific request.

## Greece

Elamer, Ltd.
Import-Export
14, Xenofontos Str.
Athens 118
Greece
Tel: 323-2920
Cable: ELAMER
Telex: 214233 ELAN Gr.
ATTN: Spiro Georgeoglou

This company expressed interest in *Loligo* squid frozen in 2.5 kg blocks, packed in a master carton. Inquiries in English are accepted.

Veropolos Bros., S.A.
Orfeos and Kifissou Str.
Egaleo, P.O. Box 878
Athens
Greece

This company did not specify a type of squid. Inquiries in English and visits to their offices are welcomed.

## France

Paul Coutau-Begarie
P.O. Box 22
33029 Bordeaux Cedex
France
Tel: (56) 48.55.17.
Telex: 560853 AFTOM

This import/export agent is interested in importing squid. However, processing procedures and prices were not discussed. Visitors and English inquiries are accepted.

## Italy

P.A. Cornara
Rappresentanze
Via Giacomo Boni, 37
20144 Milano
Italy
ATTN: P.A. Cornara
Tel: 46-94-178
Telex: NORPES 333879

This importer/exporter expressed interest in *Loligo*, *Illex* and *Todarodes sagittatus*. Products should be frozen whole onboard in 15 to 25 kg blocks. In his response, M. Cornara indicated that those interested in more about grading and packing should provide him with information on the size and type of fish considered. Visitors are welcome. Samples are required. No prices were quoted.

Commercial Services International
International SRL
Via Vincenzo Monti, 56
20123 Milano
Italy
ATTN: J.D. Maranelli, Dir.
Tel: 469-1464
Telex: 332-078

This company represents Thomas Borthwick and Sons of Australia as importers and Conserviera Adratica of Offida (Italy) as exporters. The owner is American and inquiries in English are welcome. No specifications for preparation or processing of squid were given.

Eturia, S.P.A.
Piazza Bertarelli, 2
20122 Milano
Italy

This independent processor is interested in importing squid, although no details on preferred species were given. The questionnaire was answered in English and visitors are encouraged.

Giolfo and Calcagno, S.P.A.
Via Ovada 1
16158- Casella Postale 98
Genova Voltri
Italy

This independent processor is a nationwide distributor and a valuable contact. They replied in English and will receive visitors at their home office. They handle Illex illecebroces. Processing techniques follow those of Japan and Spain: capture by trawl net, freezing at sea, whole, hand laid, not pressed during freezing, size sorting, two frozen blocks of 10 kg per master carton, each block poly wrapped.

Japan

Co-Optrade Japan, Ltd.
Seikyo kaikan 1-13
4-Chome
Sendagaya
Shibuya-ku
Tokyo
Japan

ATTN: K. Miyasaka
Tel: 03-404-3251
Telex: J23393 COOPTR

Illex sp. are frequently handled by this firm. Acceptable harvest methods include jigging or trawl seining. Size grading is also listed as important, however no grading scheme was included. Catch must be frozen onboard in 8.5 kg blocks, poly wrapped and packed three boxes in a master carton. Quality of squid is determined by color (dark natural), smell (seawater freezing helps), taste and size. An Anchorage/Ketchikan FOB price of $900/mt was quoted along with a CIF Tokyo price of $1200/mt.

Hoei Trading Company
Mitsui Seimei Bldg.
2-3 Ohtemachi
1-Chome
Chiyoda-ku
Tokyo 100
Japan
ATTN: Mitsuharu Fujisawa
Tel: (214)-3981

This firm expressed interest in Ika squid. We believe this is a Todarodes species found in Japan. They are open to inquiry in English and welcome visitors. No additional pricing, processing or quality control information was provided.

International Marine Products Co.
1-17, 4 Chome
Tsukiji
Chuo-ku Tokyo 104
Japan
ATTN: Yoshio Tatsukawa, President
Tel: (542)-5241
Telex: J23384 IMPCOTOK

This independent processor has handled Todarodes pacificus. This appears to be their major interest. They welcome visits from businessmen and researchers.

Ito Yokado Co., Ltd.
5 Sanbancho
Chiyodaku
Tokyo
Japan
ATTN: S. Yoshimura, Trading department (food)
Tel: 03-264-2111
Telex: 23841

This is an independent processing and export company. They expressed interest in importing, but no specifications were given. Inquiries in English and visitors are accepted.

Kabushiki Kaisha Washington Fish
(Washington Fish, Inc.)
4th floor, Ikeda Bldg.
4-5-5 Tsukiji Chuo-ku
Tokyo 104
Japan
ATTN: Masataka Sueyoshi, Vice President
Tel: (03)-542-9301
Telex: J24234

This subsidiary of Washington Fish is that company's import/ export broker in Japan. They are interested in Todarodes pacificus, the most valuable squid species on the Japanese market. Squid should be pan frozen, preferably onboard. Each squid must be neatly hand laid. Size grades are given as small, medium and large, but no weights or measurements were provided. They also specify 7.5 to 10 kg blocks, two blocks to a master carton. Quality checks include color (blackish), firm entrails, easily removed without breaking. A CIF Tokyo price of $.60/lb was quoted.

Kanematsu Gosho, Ltd.
Central P.O. Box 141
Tokyo 100-91
Japan
TGS5

This independent processor apparently handles a variety of seafood. They suggest immediate quick freezing of squid to reserve color. Size classifications were based on Todarodes pacificus as a guide to onboard processing. Sizes begin at 6 to 10 cm. They continue at intervals of 4 cm, each interval a new size class (11 to 15 cm, 16 to 20 cm, etc.). Each size class should be frozen into 7.5 kg blocks. Those with the best preserved color receive the highest grade.

Nichiryo, Ltd.
No. 2-1, 2 Chome
Azabudai, Minato-ku
Tokyo
Japan
ATTN: K. Tanaka, Marine products section
Tel: (03)-584-0151
Telex: 242-2136 NICRYOJ

This company is primarily interested in crab, salmon and herring. However, they did mention some interest in squid. No details on processing or shipping were provided. They welcome visitors and inquiries.

Seiwa Trading Co., Ltd.
Rm. 215, Tsukishima-Heights
21, 4-Chome Tsukishima, Chuo-ku
Tokyo
Japan
Tel: (03)-533-5881
Telex: 252-4647 SEIWAJ

Although this independent processor and import/export company expressed interest in squid, they provided no specifics. They will conduct business in English and visitors are received.

Tokyo Commercial Co., Ltd.
Playguide Bldg.
6-4 Ginza 2-Chome Chuo-ku
Tokyo, 104
Japan
ATTN: Seiichi Takeuchi, Import section

This import/export company indicates squid harvest is usually by trawl. They prefer onboard sizing and freezing. Frozen blocks should be 5 to 10 kg, poly covered and placed in a 20 kg master carton. Prices quoted were CIF Tokyo or Yokahama $700 to $800.

## Portugal

Gama and Gomes, L.D.A.
Rua Formosa, 345
Porto
Portugal
Tel: 27462
Telex: 22419-AGOMES P

This is both a processing and an import/export firm. Squid specifications listed call for immediate freezing in 10 lb blocks. They will communicate in English and invite visits to their offices. Port of entry is Leixoes.

Sociedade de Fomento da Pesca, L.D.A. (SOFOPEL)
Avenida Duque de Loule, 86-1 Esq.
Lisboa 1
Portugal
Tel: 56-08-43
Telex: 13446-SOFOPE P

SOFOPEL is a diversified company with its own vessels fishing off Portugal, the Azores and the Newfoundland Bank. They are also involved in the import/export trade although we are not sure in which species. They indicated an interest in squid but gave no specifics. They will conduct business in English and are eager to make U.S. contacts for trade in squid and other fish products.

## Spain

Armour S.A.E.
Importacion-Exportacion
Plaza Urquinaona, 6
Planta 15b
Barcelona-10
Spain
Tel: 318-56-16
Telex: DELFO-E54749

This response was received in English. They indicated an interest in squid trade, but provided no additional information.

Carreras S/A
Consignaciones de Pescados Y Mariscos
Wellington, 52-70
Locales 3-4-5
Barcelona
Spain
ATTN: Sr. A. Moreno
Tel: 300-00-66-1654-1658
Telex: 54.122 RAPE E

This fish processing company is primarily interested in squid importation. Product specification included freezing in blocks, whole, including tentacles and skin. Blocks should be placed in cardboard boxes of 14 to 25 kg. Quality checks include white skin with a slightly salty taste. For *Loligo vulgaris*, they indicated a CIF price of $5,000/mt, about $2.27/lb. One should expect to get a lower price for other squid species.

CIEISA
Compania Internacional De
Exportacion E Importacion, S.A.
Alcala, 30-32
Madrid 14
Spain

This processing and import/export company is primarily interested in *Loligo* and *Illex* squid. They specify onboard I.Q.F. freezing. They caution trawlers to be sure the skin remains intact. They suggest freezing in 10 to 15 kg blocks, placed in a carton. Quality checks include natural color and flavor notwithstanding freezing. They also indicated price fluctuations prevented them from estimating an opening offer.

Commercial Vemora, S.A.
Importacion-Exportacion
Acalde Sainz de Baranda, 29
Madrid 9
Spain
Tel: 274-60-99

This company gave information on squid and octopus. They prefer products frozen in seawater. Squid are placed in pans and frozen into 5 kg blocks which are then wrapped in plastic and placed in a master carton of larger capacity (10 to 15 kg). The emphasis is on "sea fresh" squid with no additives. Immediate freezing is the major quality check.

Compesca, S.A.
Calvo Sotelo, 19
Santander
Spain
Tel: 212362
Telex: 35867 FOOD-E

This company answered the questionnaire in excellent English, saying they were most interested in squid, but giving no further details. They welcome inquiries and visits to their office in Santander.

CONSAJA, S.A.
P.O. Box 12
San Vicente de la Barquera
Santander
Spain
ATTN: Sr. Angel Aja M.
Tel: 71-01-00
Telex: 35.884 AJA E

This company responded in Spanish, but will conduct business in English. They specify Loligo squid which are generally trawled then frozen onboard after washing and size grading. They are frozen in the round in blocks, probably 5 to 7 kg, wrapped in plastic and placed in a 10 kg master carton. Dark natural color is a quality check. The CIF price at Santander was $1.36/lb. We suspect the price would be considerably lower for squid species other than Loligo vulgaris.

Eurofrio
Alimentos Congelados, S.A.
Aida de la Sardincina 35
La Coruna
Spain
Tel: 23-09-67

This company responded in Spanish, but indicated they could also conduct business in English. Although they are interested in squid, no further details were given.

Robert Gordon Maple
Apartado 596
Seville
Spain
ATTN: R.G. Maple
Tel: 61-41-47

This is a U.S. firm conducting business in Spain. They are interested in supplies and suppliers of all types of Alaskan seafood. They suggest they could act as an intermediary between Alaskan suppliers and Spanish, as well as U.S. buyers. They are interested in squid if someone is willing to send samples and photographs of equipment and processing techniques.

Mayorista Pesca del Sur, S.A.
Av. Garcia Morato, 6-8
2º-2ª Barcelona (1)
Spain
ATTN: Sr. L.D. Navarra

This company's primary interest is squid, concentrating on the traditional *Loligo vulgaris*. Onboard processing is recommended and follows other descriptions, adding "tunnel" or contact freezing. Size classifications break every 5 cm. The product should be stacked neatly to minimize air space in the frozen block. Each 5 kg block should be placed in a 20 kg master carton after individual wrapping in plastic. Quality checks include white meat, and natural skin color. The company deals in *Loligo pealei*, *Illex illecebrosus* and *Ommastrephes sagittatus*.

Pescanova, S.A.
Apartado 424, Vigo
Spain
ATTN: Juan A. Gallastequi, Manager, Foreign department
Tel: 21-57-91
Telex: 83072 Pesva E

This firm communicates in English and welcomes visits to their home office. They are familiar with marketing *Loligo* squid, and suggest freezing onboard. Their response was difficult to read, but it appears that they require grading by size and freezing in 5 kg blocks, three blocks to a master carton. No prices were quoted.

## SHIPPING THE PRODUCT

### Surface Shipping

Surface shipping companies in Alaska indicate that there are only two routes that operate continuously: Alaska to Seattle and Alaska to Tokyo. This makes it difficult to estimate freight rates and routes without specific product weight, destination and frequency of shipment. Those interested in shipping information should contact shipping companies with specific information for estimates. The two major surface shippers in Alaska are American President Lines and Sea-Land, Inc. Some specific information on freight rates and packaging is included in Appendix H.

Neither of these companies has much experience shipping to countries other than Japan and Korea. Surface shipment to Europe has offered little incentive in the past because customer interest has been small. If shipping through an Alaskan company is possible, there are three things to consider:

1. Almost all frozen products going to Europe will go through Seattle. Another alternative is to ship by rail to the east coast from Prince Rupert.
2. Companies which ship from the west coast to Europe are almost exclusively California based.
3. Truck and rail shipping routes to the east coast are well established. From eastern ports, products can be placed on ships for travel to Europe.

## Air Freight

Air freighting perishable foods is more expensive but may be the best way to insure product quality. Before deciding on how to send products, the following questions should be considered.[4]

1. How perishable is the commodity?
2. How valuable, by weight, is the commodity? Air freight rates are often quite high per pound, especially for small non-containerized shipments. If the CIF (customs, insurance, freight) quote agreed on by the buyer and seller is not substantial, the shipper may lose money on the margin to shipping costs.
3. What are the holding costs of the product? Because seafood is highly perishable and because finance charges on money lent to cover the cost of a transaction is often high in Alaska, the cost of handling and storage can be prohibitive.
4. How predictable is demand for the product? Successful trade with foreign countries requires assurance of a steady demand in large volume for a

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[4] The section on air freighting was developed after contacting representatives from Western Airlines, Japan Air Lines, Northwest Orient Airlines, Flying Tigers, Air France and Scandinavian Airlines Systems. Publications by Western Airlines, the Air Transport Association of America (1971) and the International Chamber of Commerce (1974) also proved useful.

product. With a new or volatile consumer market, air freight may be a good alternative to surface transportation.

5. What is the total cost of distribution? The Air Transport Association of America (1971) suggests the following elements be considered:

    a. Transportation charges
    b. Cost of capital tied up in inventory
    c. Warehousing expense
    d. Packaging
    e. Insurance (considerably higher for perishable items, estimated at two times the cost for nonperishables)
    f. Spoilage losses
    g. Theft losses
    h. Inventory taxes

In addition, the back haul charges must be considered, especially if one's own containers are being used. Most airlines will help a shipper determine the cheapest, most efficient way to send items. In most cases, they will also tell a shipper when air freight is too expensive.

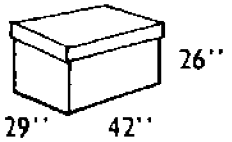
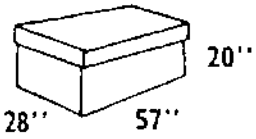
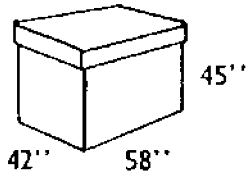
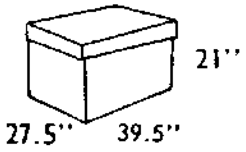
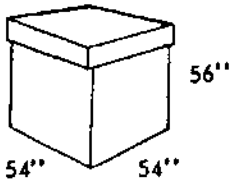
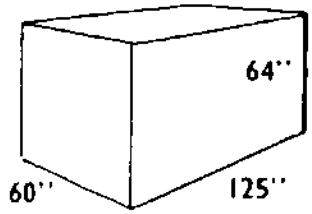
## Packaging

Once method of transportation is determined, packaging should be considered. There are three general categories:

1. Unit packaging, no container
2. Unit packaging, shipper owned containers
3. Unit packaging, carrier owned containers

Unit packaging with no container is the highest priced shipping. Only large quantities get a price break, so only large volume orders can be sent this way without considerable expense.

Price breaks are available for shipper owned containers that meet domestic and international air freight container regulations. Figure 25 shows the most commonly used containers. Types E, E-2, D, Q, and LN are corrugated cardboard and reusable. The D, E, E-2, and Q containers are collapsible, and entail back haul charges. LN boxes are made of Fiberglas and also carry a back haul charge. The L5 container is so large it is used only by the airlines for the return trip. The original shipper is not charged back haul fees. Varying discounts are given for packing large weights in the D, E, E-2, and Q boxes, for palleting small boxes and for loading or unloading at points other than the airport.

| CONTAINERS | AIRCRAFT | INTERNAL CAPACITY and DIMENSIONS | MAX. GROSS WT. | CONTAINER WEIGHT |
|---|---|---|---|---|
| TYPE E  | All aircraft | 17 cu. ft.<br>40" X 27.5" X 25" | 500 lbs. | 18 lbs. |
| TYPE E-2  | All aircraft | 17 cu. ft.<br>varies | 500 lbs. | 18 lbs. |
| TYPE D  | DC-10 | 60 cu. ft.<br>56" X 40" X 41" | 1200/2000 lbs.* | 63 lbs. |
| TYPE Q  | All aircraft | 12 cu. ft.<br>37.5" X 26" X 20" | 400 lbs. | 13 lbs. |
| TYPE LN  | DC-10 only | 90 cu. ft.<br>51.5" X 52" X 52" | 3100 lbs. | 100 lbs. |
| TYPE L5  | DC-10 only | 277 cu. ft.<br>121" X 58" X 60" | 5000 lbs. | Actual Empty Wt. |

* The maximum gross wt. for the Type D container on a 707 or 720 aircraft is 1200 lbs.; 2,000 lbs. on DC-10 aircraft.

Figure 25. Containers available to air shippers (Western Airlines 1977).

Using carrier owned containers can lead to some savings. These are usually rented at a flat fee for both the container and the load. Each type (Figure 26) has a maximum weight for the fee charged, called a pivot weight. If this weight is exceeded, a surcharge is assessed by the pound, kilo or centiweight.

Generally, airlines provide night and day rates for containers, pick-up and delivery, and free time for loading and unloading freight. Container rates are also regulated by the Air Freight Container Tariff.

Airlines and some freight forwarders have containers which can keep products cold with dry ice or refrigerator compressors. Self-contained refrigeration reduces the risk of loss if flight connections are delayed, but there are also substantial premium payments involved when using dry ice. Delays often occur because freight packed in dry ice is sometimes not compatible with other cargo.

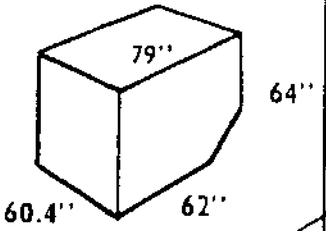
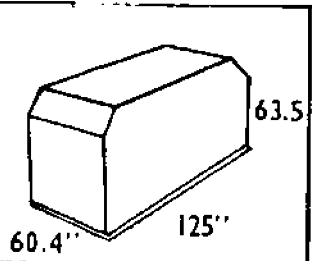
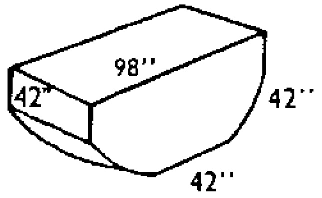
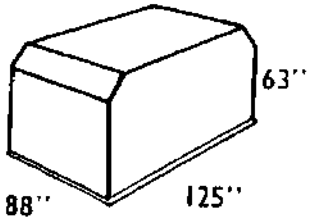
It may be best to consider a super-insulated container. This avoids refrigeration problems. These containers are available through independent container dealers in Anchorage.

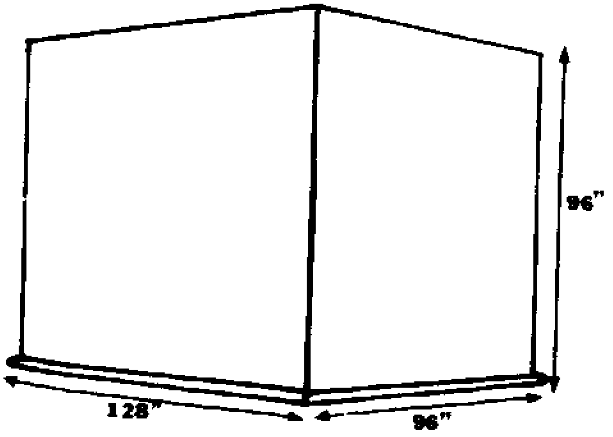
## Freight Rates

Freight rates, like container rates, are controlled by both regional and international tariffs. Comparing freight charges might not be a good way to choose among airlines, but the following considerations may help with the decision:

1. Directness of flight
2. Pick-up, delivery and loading services offered
3. Storage space and conditions at layover points
4. Airline policy on lost, damaged or misdelivered freight
5. Allowing shipper to travel with order
6. Ability of airline to plan logistics for handling and delivery
7. Accurate tariff interpretation for weight and type of shipment
8. Favorable terms of payment and cities served

Freight rates are divided into four categories: general commodity shipments, exception rating, priority reserved flight, and specific commodity shipments. General commodity tariffs are based on net weight or weight and volume estimations. As the weight increases, the per pound rate decreases. Exception rates are percentage surcharges to the general commodity rate for shipments requiring special handling. Priority reserve flight is a special service that reserves

| CONTAINERS | AIRCRAFT | INTERNAL CAPACITY and DIMENSIONS | MAX. GROSS WT. | APPROXIMATE CONTAINER WEIGHT |
|---|---|---|---|---|
| L3*  | DC-10 | 140 cu. ft.<br>75"–58" X 58" X 60" | 3,500 lbs. | 370 lbs. |
| L11*  | DC-10 | 265 cu.ft.<br>115" X 58" X 58"<br>*Has a separate pallet base that may be used for transporting shipments.* | 7,000 lbs | 400 lbs. |
| LW  | Boeing 720, 727 707 | 65 cu. ft.<br>96" – 40" X 40" X 40" | 1,200 lbs. | 180 lbs. |
| L7**  | DC-10 | 355 cu.ft.<br>115" X 58" X 81"<br>*Has a separate pallet base that may be used for transporting shipments.* | 10,400 lbs. | 500 lbs. |



The M-1 container and pallet are loaded onto the main deck of the 747 combi. The internal volume measures 600 cubic feet. The maximum gross weight is 15,000 pounds. The weight without cargo is 1,119 pounds.

Figure 26. Carrier containers (Western Airlines 1977; Scandinavian Airlines System 1979).

space for a shipment that must be on a certain flight. Specific commodity rates are the most used rates for very high volumes of specific product between cities. There is, for example, a special rate for fish between Anchorage and Tokyo (Appendix H). These rates are nearly always lower than general commodity rates.

Appendix H gives an example of general commodity rates by division and weight from Anchorage to different destinations in Europe, Asia and South America. Five of nine airline contacts responded with discussions on rates. It is interesting to note the difference between special seafood rates offered by Northwest Airlines to Tokyo and Japan Air Lines' general commodity rates for the same destination. It is also interesting to note the comparison between the general rates for container dimensions in the questionnaire and rates that apply to the carrier owned containers. This signifies a considerable savings over loose cargo.

## OTHER CONSIDERATIONS

Dimensional Rate Rule. For high volume, low weight shipments, the following rates are used:

1. For most domestic shipments, 1 lb = 250 $in.^3$
2. For international shipments, 1 lb = 194 $in.^3$

If dimensional weight exceeds measured weight, then rates are charged according to the dimensional rate.

Surcharge For Dry Ice Use. Almost all airlines give a flat charge for handling shipments packed in dry ice. A restricted article certificate is also required.

Compliance With U.S. Fish and Game Laws. Seafood must have a declaration for importation or exportation of fish or wildlife. This is U.S. Fish and Wildlife Department form 3-177.

Compliance With U.S. Export Laws. Export shipments must have two copies of the shipper's export declaration of shipments from the United States (form 7525-V). This declaration describes export district, port, city, transportation, name of carrier, exporters, agents, consignees, and the foreign port.

Shipping Arrangements. Arrangements with a carrier should be made well in advance of shipping date. You should discuss preservation (brine, ice, dry ice, self-contained refrigeration, ground cold storage), length of transit, rates for loading and unloading, terms of payment and so forth. If shipping to a foreign country, considerable lead time is required to determine the procedure for getting things into the country. It is important to know the buyer or his agent. Losses are often caused by when an agent is not available for the consignee, failure to give an agent power of attorney, or failure to notify the buyer that a shipment is en route.

The buyer may also refuse shipment at the point of destination. As a foreign national, the seller has little legal recourse if the product spoils on site. It is a good idea to have an alternative sale plan in case the buyer refuses shipment. For this reason it is also best for the seller, or his agent, to be with the shipment when it arrives until customers prove reliable.

Planning and confirming shipping logistics may prove profitable to many sellers, especially if they are able to use the plan many times. However, many find it is less expensive and more efficient to work through a broker, rather than setting up trade routes on their own.

Organizations. If you have more questions on the air freight industry, the following organizations should be able to help (Air Transport Association of America 1971):

International Air Transport Association of
America (IAIA)
1155 Mansfield
Montreal, 2
P.Q. Canada

The Air Cargo Tariff (TACT) (international)
P.O. Box 7627
1118 ZJ Schipol Airport
The Netherlands

Airline Tariff Publishers, Inc. (domestic)
1825 K Street
Washington, D.C. 20006

Air Cargo, Inc. (ACI) (domestic and Canada)
1730 Rhode Island Ave., N.W.
Washington, D.C. 20036

Official Airline Guide
P.O. Box 6710
Chicago, IL 60680

**A Note About Financial Arrangements.** There are a number of ways to arrange payment for the shipment which are less risky for the seller than consignment (where payment is made shortly after arrival). One possibility is letters of credit, which are arrangements between the seller's and buyer's banks offering payment to the seller immediately upon presentation of evidence that the product has been shipped. This is often an agreement that must be filled even if the buyer rejects the shipment.

Other alternative methods of receiving payment have been compiled and explained by the International Chamber of Commerce (1974) and the National Marine Fisheries Service and can be obtained by writing for the following publications:

> _Uniform Customs and Practice for Documenting Credit_
> _ICC Publication No. 290_
> United States Council of the International Chamber
> of Commerce
> 121 Avenue of the Americas
> New York, New York 10036
>
> _Export and Domestic Market Opportunities for Underutilized Fish and Shellfish: Study Report_
> Robert D. Nordstrom
> International Trade Specialist
> National Marine Fisheries Service
> NOAA, U.S. Department of Commerce
> Washington, D.C. 20235

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Briantais, A. 1974. L'exploitation des cephalopods. *La Peche Maritime* 1974:20 Jan:11-21.

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Lux, F.E., W.D. Handwork and W.F. Rathjen. 1974. The potential for an offshore squid fishery in New England. *Mar. Fish. Rev.* 2:1974:24-27.

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