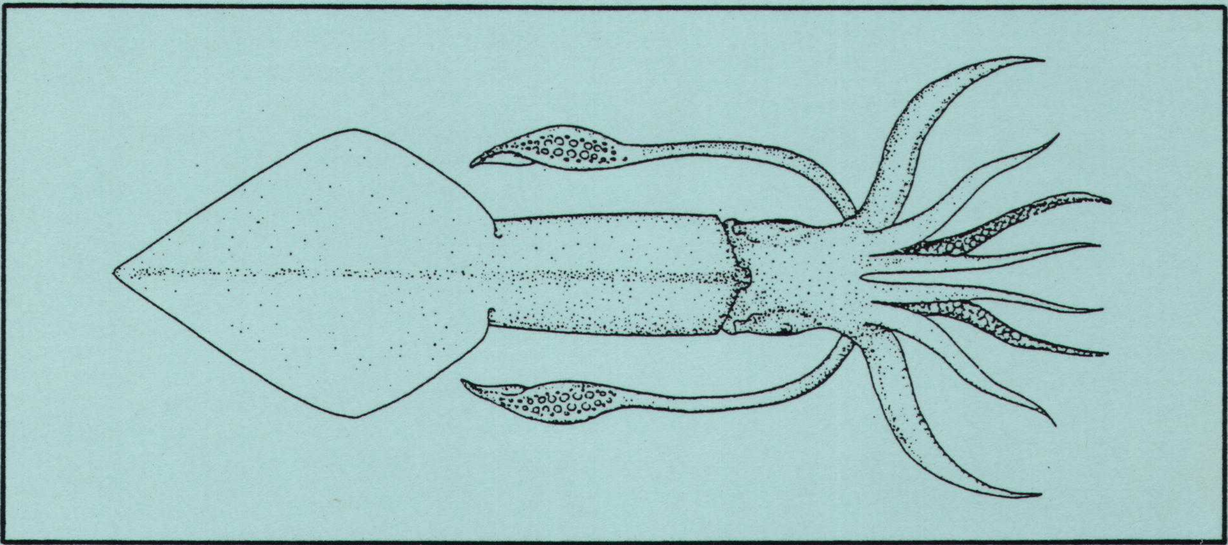
NOAA Technicial Memorandum
NMFS-SEFC-194



SPECIES PROFILE

LOLIGO PEALEI (LeSueur) - THE LONGFIN SQUID

Gladys B. Reese

MAY, 1987

U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary
National Oceanic and Atmospheric Administration
Anthony Calio, Administrator
National Marine Fisheries Service
William E. Evans, Assistant Administrator for Fisheries

NOAA Technical Memorandum NMFS-SEFC-194

SPECIES PROFILE: *LOLIGO PEALEI* (LeSueur) THE LONGFIN SQUID

Gladys B. Reese

May 1987

SOUTHEAST FISHERIES CENTER
MISSISSIPPI LABORATORIES
PASCAGOULA FACILITY
P.O. DRAWER 1207
PASCAGOULA, MS 39568-1207

U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary
National Oceanic and Atmospheric Administration
Anthony Calio, Administrator
National Marine Fisheries Service
William E. Evans, Assistant Administrator for Fisheries

Species Profile

Loligo pealei (LeSueur) - The Longfin Squid

by

Gladys B. Reese

List of Tables

List of Illustrations

SPECIES PROFILE

Loligo pealei (LeSueur) - The longfin squid

INTRODUCTION

Commercial squid fisheries exist along the California and northeastern Atlantic coasts of the United States. While the potential for a commercial squid fishery may exist off the southeastern United States and northern Gulf of Mexico, the size of available squid stocks in these waters is still unknown (Voss 1960, 1971, 1973; Rathjen et al. 1977, 1979.) Relatively little research has been directed specifically toward developing a squid fishery in the southeastern region. Whitaker (1980) conducted squid surveys off the southeastern United States (Cape Fear, NC to Cape Canaveral, FL). Other studies of *L. pealei* in this area were conducted by LaRoe (1967) and Cohen (1976). Hixon et al. (1980a) studied the commercial potential for a squid fishery off Texas. Cooperative U.S./Japan squid surveys were conducted in the northern Gulf of Mexico in 1984 and 1985 (NISSHIN MARU No. 201 Cruise Reports 1 and 2, 1984-1985). *In-situ* observations of squid distribution have also been made on the northwest Florida shelf (Vecchione and Gaston 1985). Although the studies were not optimistic for squid fishery development in these areas, Hixon (1980a) noted that the magnitude of the possible squid stocks is unknown. No comprehensive effort has been made to generate squid biomass or standing stock estimates for the northern Gulf of Mexico, and overall, squid stocks remain an uncertain Gulf fishery resource.

Market demands for squid are expected to increase. Loligo is the preferred genus on the world market, commanding a price two to three times that of Illex (Kolator and Long 1979). If future research into squid stocks in southeastern U.S. waters indicates a potential for a commercial squid fishery, Loligo pealei will most likely become one of the primary target species.

This species profile has been prepared to present information currently available for Loligo pealei. The profile represents a compilation of information from the literature and other sources. Special emphasis will be given to Loligo pealei in the northern Gulf of Mexico.

DESCRIPTION

Diagnostic Features (Figure 1) - Mantle long, moderately slender and cylindrical, with posterior end bluntly pointed. Eyes not usually large, but covered by transparent membrane. Fins rhomboidal, their sides nearly straight. Gladius long, rather wide, feather shaped, thin and translucent with edge of vane curved (sometimes straight in males) and rarely ribbed. Left ventral arm IV is hectocotylized in mature males, but modification does not extend to arm tip.

Fewer than 12 of the suckers in dorsal row usually smaller than half size of their counterparts in ventral row. Pedicel bases of some modified suckers rounded and narrowly triangular. Hectocotylization starts at about 20th pair of suckers and continues distally until near tip, where suckers reappear (Roper et al. 1984).

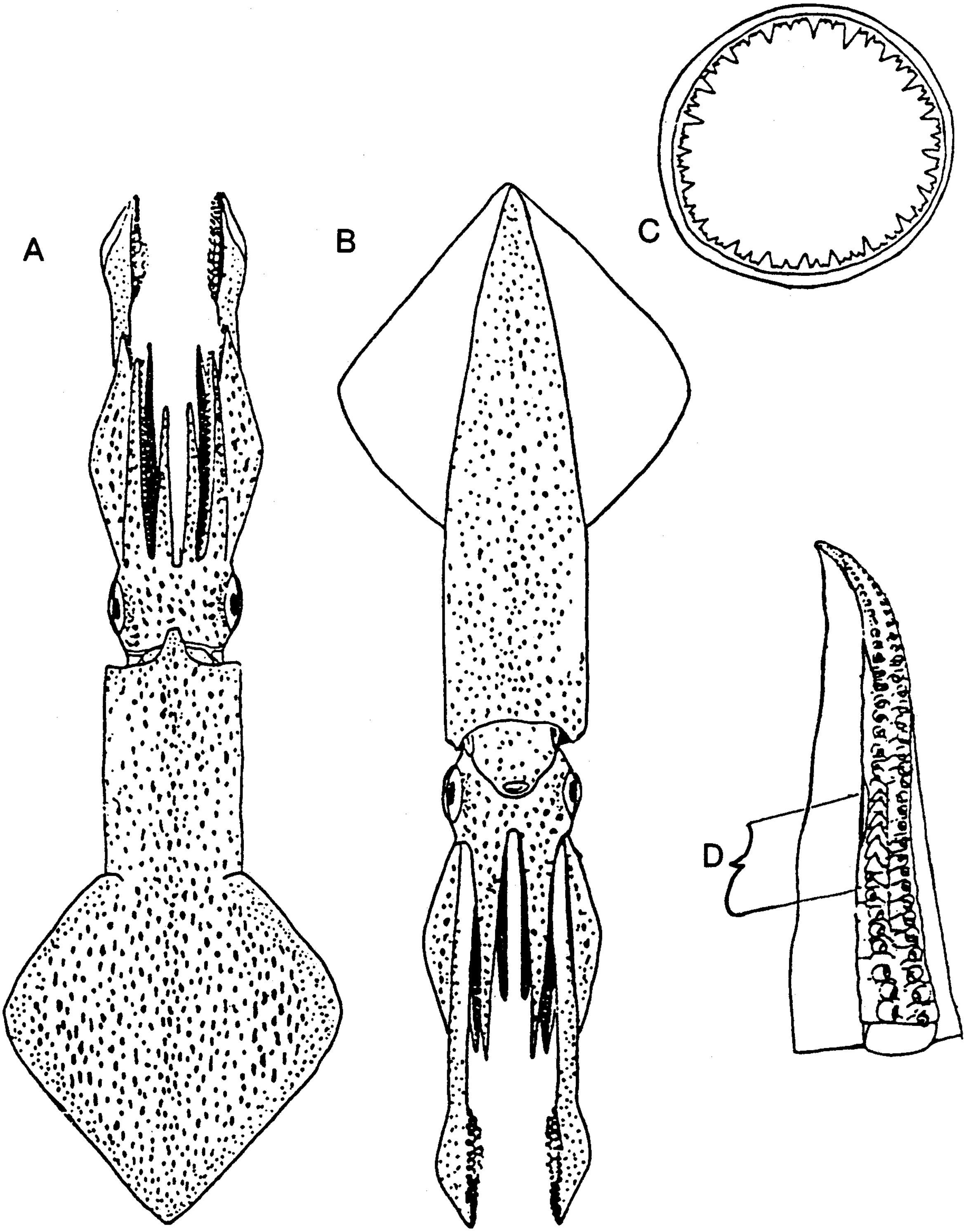


Figure 1. Loligo pealei--(A) dorsal view, (B) ventral view, (C) tentacular club sucker ring (teeth arrangement), (D) left arm IV of male, hectocotylized. (LSU-CFI 1985).

Color - Reddish brown chromatophores present on entire mantle, being larger and more closely spaced on dorsal side, particularly in mid-dorsal region. There is a dark crescent over the dorsal borders of eyes; and a reddish-brown anterior mid-dorsal longitudinal indentation (Cohen 1976).

Range - Western North Atlantic Ocean from Nova Scotia to Venezuela including the Gulf of Mexico and Caribbean Sea from 40 to 250 m depth.

Taxonomy

Loligo pealei LeSueur, 1821

Taxonomic Classification

Phylum	Mollusca, Cuvier, 1798
Class	Cephalopoda, Schneider, 1784
Order	Teuthoidea, Naef, 1928
Suborder	Myopsida, d'Orbigny, 1848
Family	Loliginidae, d'Orbigny, 1848
Genus	*Loligo*, Schneider, 1784
Species	*pealei*, LeSueur, 1821
Synonymy	*Loligo pallida* (Verrill, 1873).
Local Names:	USA - Longfin squid, Bone squid, Common squid, Winter Squid.
FAO Names:	Japan - Amerika kenasakiika
	England - Longfin inshore squid
	France - Calamar totam
	Spain - Calamar palido

Problems of Identification (*L. pealei* - *L. plei*)

Small specimens of *L. pealei* and *L. plei* are often difficult to distinguish especially in regions where they are sympatric (Voss 1956, 1971; LaRoe 1967; Cohen 1976). Immature males and females of both species often overlap in external characters and morphometric indices (LaRoe 1967; Cohen 1976).

Sexually mature males of both species may be distinguished by the hectocotylus (LaRoe 1967; Cohen 1976). In male *L. pealei*, the hectocotylus occupies only a small section of the middle portion of the left ventral arm, whereas in male *L. plei*, the hectocotylus occupies approximately 80% of the arm.

The species may be readily distinguished by examining the different shapes of the gladii (Whitaker 1978; Hixon 1980). In the gladius of *L. pealei* (Figure 2), the vane is relatively broad with thin curved margins; in *L. plei*, it is relatively narrow and straight with thickened margins. Hixon (1980a) used the configuration of the junction between the rachis and the vane to distinguish the species. In *L. pealei*, the junction is tapered, while in *L. plei*, the junction has a definite break. Greatest gladius width to greatest rachis width (GW/RW) ratio has also been used to separate the species (Cohen 1976; Whitaker 1978). A ratio between 2.4 and 3.7 (wide gladius) indicates *L. pealei*; a ratio between 1.5 and 2.4 (narrow gladius) indicates *L. plei*.

Dentition of the chitinous ring in the median manal (hand portion) suckers of the tentacular club has also been used to distinguish the two species (Adam 1937; Voss 1956). In *L. pealei*, the teeth are arranged in a tri-cusp pattern (large tooth, small

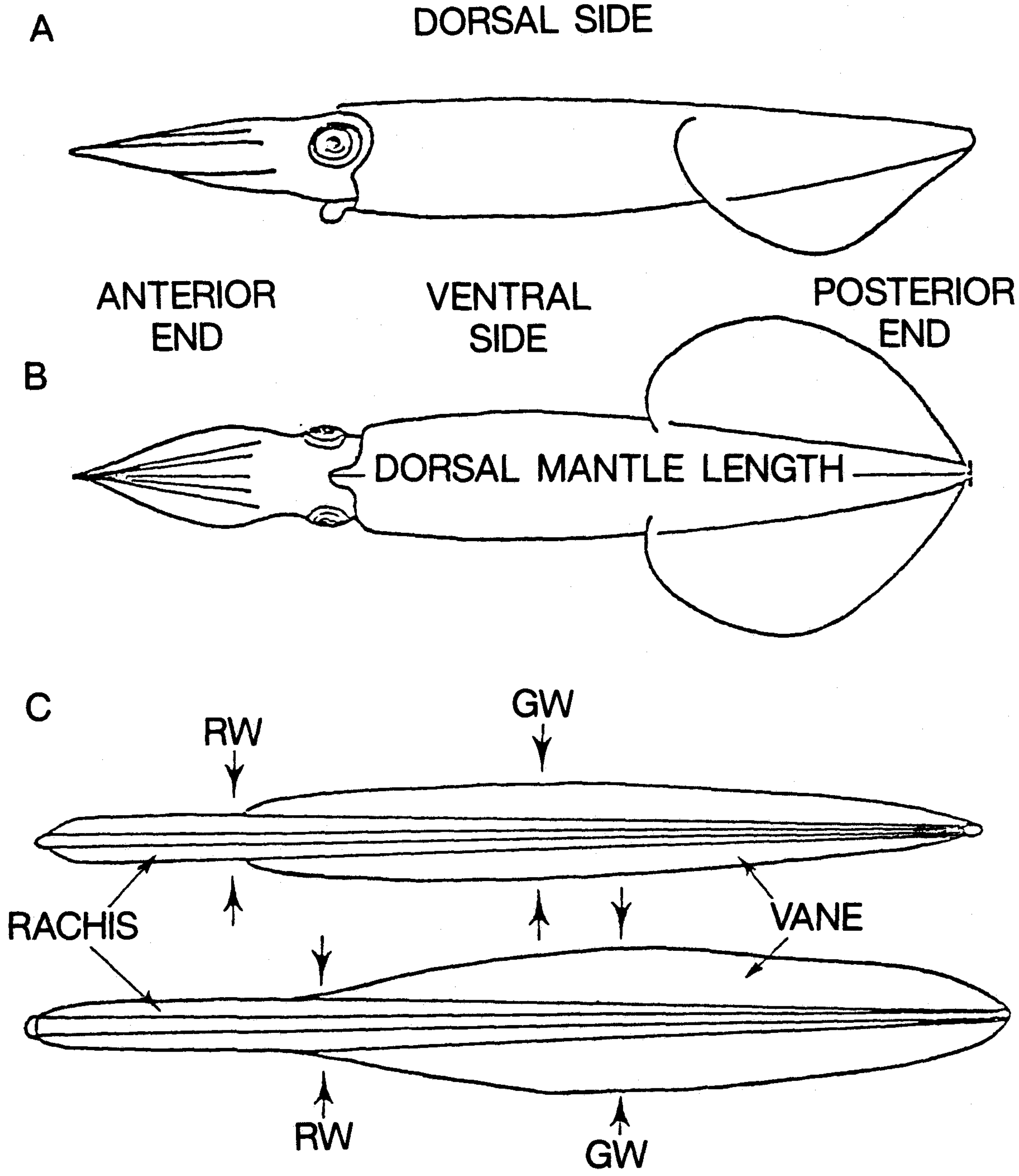


Figure 2. Terminology used to describe the orientation of a squid. (B) Dorsal view of squid showing measurement of dorsal mantle length. (C) Gladius of *Loligo plei* (top) with almost straight margins of the vane and a gladius width (GW)/rachis width (RW) ratio of 1.9. Gladius of *Loligo pealei* (bottom) with characteristic curved margins of the vane and a GW/RW of 2.6. Note the differences in the junction of the vane and the rachis (RW⟶), in *L. plei* there is a definite break between the two while in *L. pealei* the junction is more tapered.

tooth, mid-sized tooth, etc.). The teeth within the sucker rings of L. plei are similar in shape and size, with one small tooth between large teeth. This characteristic may not be very reliable (M. Vecchione, pers. comm.).

COMMERCIAL SPECIES

At least 84 species of cephalopods are known from the Gulf of Mexico (Voss 1956; Lipka 1975) and 12 of these have been identified as having potential for commercial exploitation (Voss 1960, 1971, 1973; Voss et al. 1973).

Loligo is an important commercial genus and is the basis of both local and worldwide fisheries (Arnold 1979). Loligo pealei is one of five western Atlantic species of the genus. It is the most important commercial species in the northwest Atlantic, where it makes up about 90 percent of the total squid harvest (Summers 1967; Arnold 1979). Species of Loligo are also fished in traditional, small-scale fisheries throughout the world (Voss 1973).

There are five potentially commercial squid species in the northern Gulf of Mexico: the loliginid squids (Loligo pealei, Loligo plei and Lolliguncula brevis) and the ommastrephid squids (Illex coindeti and Ommastrephes pteropus). The three loliginids occur over the continental shelf throughout the Gulf of Mexico. Each species occupies a primary depth range, but these depths vary seasonally and yearly. Their ranges thus overlap and it is not uncommon to catch the three loliginid squids in a single trawl (Hixon 1980a). The ommastrephid squids occur near or beyond the edge of the continental shelf. Loligo pealei is assumed to compose a single stock throughout the Gulf of Mexico.

BIOLOGY

Geographic Distribution

L. pealei is primarily found in temperate waters and is the most widely distributed loliginid in the western Atlantic, ranging from Nova Scotia to the Gulf of Venezuela (Cohen 1976). Its general range is given as the western Atlantic from 5^{o}N. - 50^{o}N. lat., including the Gulf of Mexico and Caribbean Sea (Voss 1971; Rathjen 1973; Roper et al. 1984). It appears to be most abundant in the mid-Atlantic Bight from Cape Hatteras to Cape Cod and Georges Bank (Kolator and Long 1979). Populations south of Cape Hatteras are less well known. The species appears to be evenly distributed throughout the northern Gulf of Mexico from Corpus Christi east to the Dry Tortugas (Voss and Brakoniecki 1985).

Bathymetric Distribution

Gulf of Mexico - In the northern Gulf of Mexico, L. pealei is occasionally captured in shallow water, but its primary depth range is 40 - 250 m (Hixon et al. 1980a), with an average depth of 56.4 m. It is found at bottom temperatures ranging from 7^{o}-26^{o}C, with an average bottom temperature of 19.5^{o}C (Hixon 1980a).

An approximate bathymetric distribution for species of commercially important squid from the Gulf of Mexico has been developed by Hixon et al. (1980a) and is shown as Figure 3.

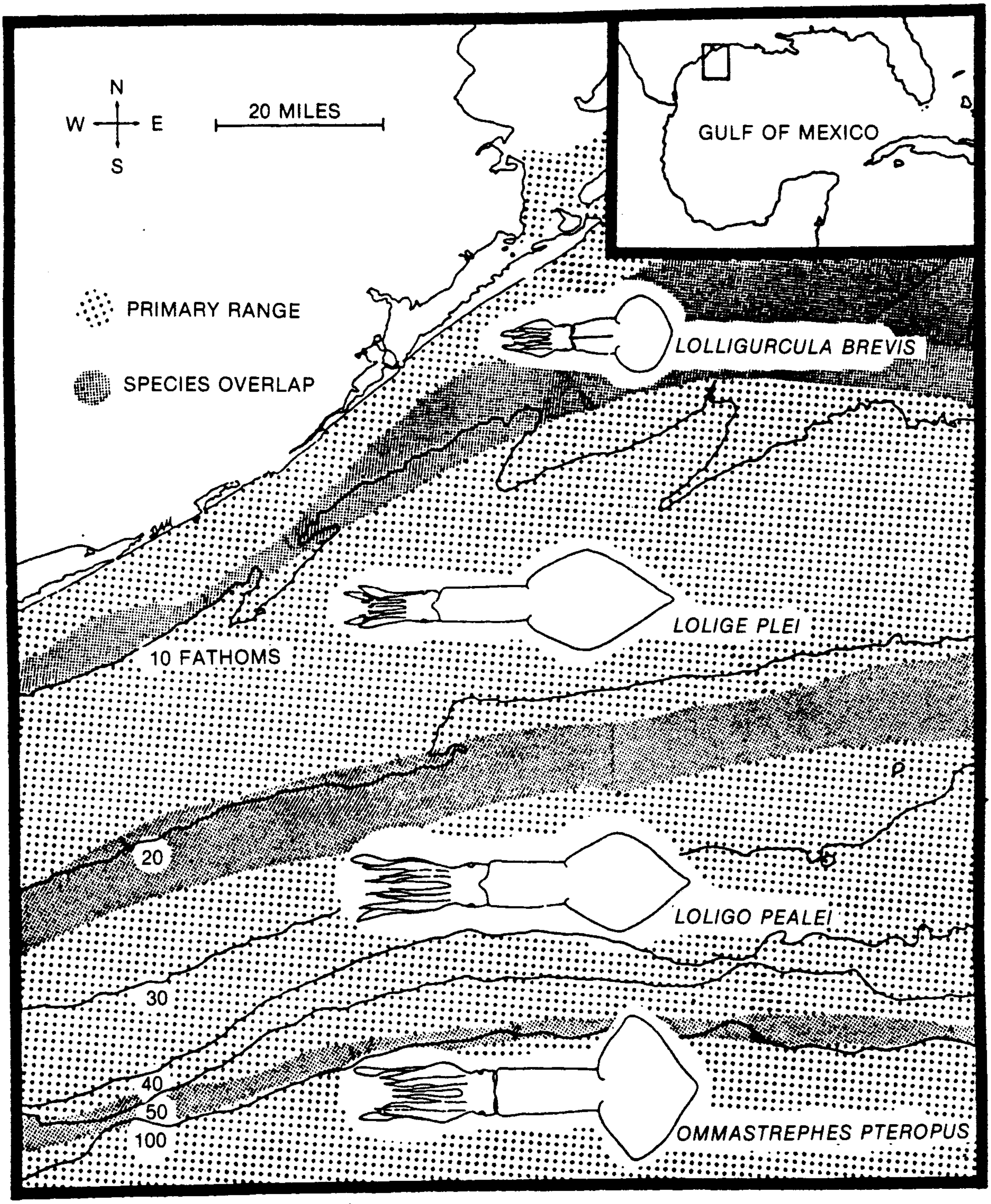


Figure 3. The approximate areal and bathymetric distribution in summer of four squid species of commercial potential on the Texas continental shelf south of Galveston Island, Texas (from Hixon, et al., 1980). The two other species (Illex illecebrosus/ coindeti and Onychoteuthis banksi) occur beyond the edge of the continental shelf (100 fathoms) as does Ommastrephes pteropus.

Seasonal Variations (Migrations)

Loligo pealei apparently undergo seasonal migrations off the New England coast in response to temperature conditions, and possibly, spawning activity. They usually overwinter in deeper offshore waters, then migrate inshore and aggregate by size, with the largest individuals moving inshore in spring and the smaller ones following in summer; they again retreat to deeper waters in late autumn (Summers 1969; Roper et al. 1984). However, in the northern Gulf of Mexico there is variation in the general areal and bathymetric distribution of squid both seasonally and yearly (Hixon 1980a).

Since *L. pealei* in the Gulf and Caribbean have been taken in shallow water in winter months as well as in summer, routine seasonal migrations to deep water may not occur in the warmer parts of their range (Cohen 1976). Summers (1969) linked seasonal migrations of *L. pealei* to avoidance of winter temperatures below $8^{o}C$ north of Cape Hatteras; temperatures as low as $8^{o}C$ seldom occur in the Gulf and Caribbean. While the average sea-surface temperature in the Gulf of Mexico is around $28^{o}C$ during the summer, winter temperatures are usually around 17^{o}-$19^{o}C$, with colder temperatures inshore during some years (Leipper 1954).

In the northwestern Gulf of Mexico, a general offshore-to-inshore movement in the spring, and inshore-to-offshore movement in the fall has been noted (Hixon 1980a). In spring, when temperatures are lower in deeper waters along the mid-shelf and outer shelf, *L. pealei* occur further inshore over the mid-shelf area of the Gulf. By late summer and fall, they are dispersed throughout the shelf area. It is not clear whether any of these movements are associated with spawning activity. The areal extent of the spring-summer inshore movement appears to be limited by the presence of high temperatures (above 22^{0} C) and/or low salinity (<32 ppt) (Hixon 1980a). Voss and Brakoniecki (1985) reported concentrations of L. pealei east and west of the Mississippi River Delta in April, July and November. However, seasonal patterns have not yet been determined for the species in the Gulf.

Age and Growth

Most squid species grow rapidly, are short-lived and are thought not to survive spawning (Arnold 1976). Although squid growth is most often estimated using mantle length measurements to determine length-frequency modal distributions, there are problems in using this method to identify age groups. At present, there is no generally accepted method to determine age in squid. The uncertainty of life span, the lack of reliable age markers and prolonged spawning season combine to produce a wide range of estimated growth rates (Hixon et al. 1981).

The maximal size attained by L. pealei is influenced by many factors, including geographic area, sex, season, and the size at which sexual maturity occurs (Hixon et al. 1981). Individuals attain a larger maximum size, grow slower and live longer in the cooler parts of their range (Thompson 1966; Ricker 1979). Cohen (1976) proposes that differences in maximaum sizes are related to temperature gradients and that the species is made up of morphologically variable populations. A comparison of the smallest size at sexual maturity of Caribbean and northern Gulf specimens suggests that the more southern populations do not reach as large a maximum size as do individuals from the northern Gulf of Mexico (Cohen 1976). Gulf of Mexico Loligo also do not attain as large a maximum size as their New England counterparts.

Age - Weight Relationships

The growth rate of larval loliginids probably does not exceed 4-8 mm/month mantle length (Fields 1965; Hurley 1976), increasing later to 10-20 mm/month; in some species later growth may increase to 30-40 mm/month (Araya and Ishii 1974; Holme 1974). The higher growth rates apply to summer months when growth is at a maximum (Arnold 1979). Growth rate is thought to be greatest during the first few days after hatching. Vecchione (1981) suggests a growth rate of 0.3 mm in six hours for larval L. pealei.

A historical summary of maximum size and growth rate estimates for L. pealei has been presented by Hixon et al. (1981) and is shown as Table 1. Growth rates obtained from the Hixon et al. (1981) summary suggests that the growth rate of L. pealei from the northwestern Gulf of Mexico is similar to those from New England waters. At present, an average growth rate of 1.0-1.5 cm/month is assumed for L. pealei (Summers 1971; Lange and Sissenwine 1980).

Hixon (1980) calculated growth rates for 12-month-old male and female L. pealei from the northwestern Gulf of Mexico as 16.5 and 12.5 mm/month respectively. This would suggest that at one year of age, these squid in the northern Gulf attain a size range of approximately 148-198 mm ML. Summers (1971) noted that northern individuals appear to increase in size evenly to 16 cm (females)

Table 1. Historical summary of maximal size and growth rate estimates for *Loligo pealei* (Hixon et al. 1981).

Maximal Size (mm ML) Males	Maximal Size (mm ML) Females	Growth Rate (mm/mo)	+ML Increase (mm)	Sex	Time (mo)	Period	Temp (°C)	Location	Reference
425	239	28-46	2 to 30- 48	M & F	1.00	Jun-Jul	15-19	Southern New England	Verrill (1882)
		20	30-48 to 50- 68	M & F	1.00	Jul-Aug	15-19		
		10-1	50-68 to 60- 82	M & F	1.00	Aug-Sep	15-19		
		2-10	60-82 to 79- 85	M & F	1.75	Sep-Nov	15-19		
		14-18	2 to 70- 90	M & F	5.00	Jun-Nov			
		9-14	2 to 62-100	M & F	7.00	Oct-May	8-15		
		13-16	2 to 152-188	M & F	12.00	Jun-Jun	8-19		
		7-9	2 to 175-225	F	24.00	Jun-Jun	8-19		
		8-11	2 to 200-275	M	24.00	Jun-Jun	8-19		
		8-12	2 to 300-425	M & F	36.00	Jun-Jun	8-19		
236	187							Jacksonville, FL to Columbia	LaRoe (1967)
465		11-28	2 to 45-110	M & F	4.00	Jul-Nov	?-19	Woods Hole, MA	Summers (1968)
465	230	11-18	2 to 250	M	18.00	*	8-19	Woods Hole, MA	Summers (1971)
		9-18	2 to 210	F	18.00	*	8-19		
200	128							"Warmer waters of range"	Cohen (1976)
		17-20	2 to 70- 90	M & F	4.00	Jun-Sep		Scotian Shelf, Georges Bank	Mesnil (1977)
		10-15	70-90 to 110	M & F	2.00	Sep-Nov			
		4-6	110 to 130-150	M & F	5.00	Dec-May			
		10	2 to 130-140	M & F	13.00	Sep-Oct			
262		11.4	88 to 138	M & F	4.40	Spr-Sum	10-22	Cape Hatteras to Cape Canaveral	Whitaker (1978)
		7.6	138 to 175	M & F	4.90	Sum-Win	10-22		
		10.9	88 to 138	M & F	4.60	Sum-Win	10-22		
413	303	16-24	32 to 116-148	M	2.70	Jul-Dec	12-22	Rhode Island	Macy (1980)
		15-23	32 to 110-136	F	4.30	Jul-Dec	12-22		
		14	2 to 397	M & F	28.00	*		Northwest Atlantic	Lange (1980)
		12	2 to 376	M & F	31.00	*			
		10-15		M & F				Northwest Atlantic	Lange and Sissenwine (1980)

*Actual time period differs between spring and fall broods.

+ML=mantle length

and 18 cm (males) at one year, and 27 cm (females) and 32 cm (males) at two years. The life span of Loligo in the northern Gulf is estimated to be approximately 1 year, with a few individuals surviving up to 18 months (Hixon et. al, 1980b).

A growth curve in weight has been proposed for three loliginid squid from the northwestern Gulf of Mexico (Hixon 1980a) and is presented in Figure 4. The growth in weight curves suggests that a one-year-old L. pealei in the northern Gulf should weigh approximately 50-70 g (wet wt.). Similar values were indicated in length weight plots of Lange and Johnson (1981). Based on winter samples, Summers (1971) suggests a weight doubling about every four months for L. pealei

Length-Weight Relationships

Length-weight relationships of L. pealei vary in relation to sex, year, season, and geographic area (Hixon 1980; Lange and Johnson 1981). Generally, females less than 13 cm weigh less than males of the same length, while females greater than about 17 cm are heavier than males of the same size (Lange and Johnson 1981). Hixon's (1980a) length-weight curve (Figure 5) for L. pealei tends to support this observation.

Whitaker (1978) indicates that L. pealei undergo an accelerated increase in mass after reaching 100 mm ML and shows the following length-weight relationship:

ML	Weight
50 mm	5 g
100 mm	30 g
150 mm	70 g
200 mm	140 g

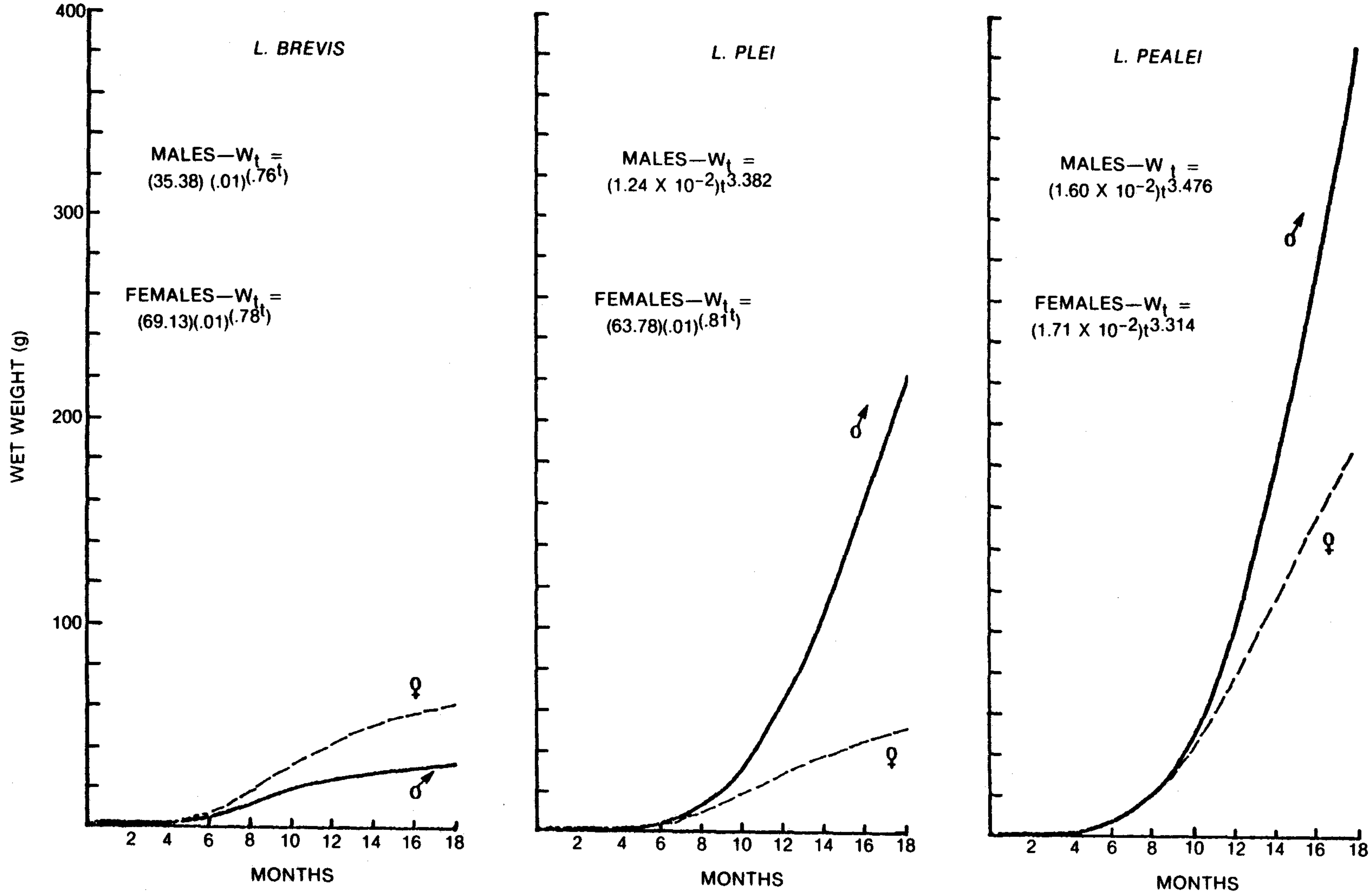


Figure 4. Proposed growth curves in weight for male and female *Lolliguncula brevis*, *Loligo plei* and *Loligo pealei* (Hixon 1980a).

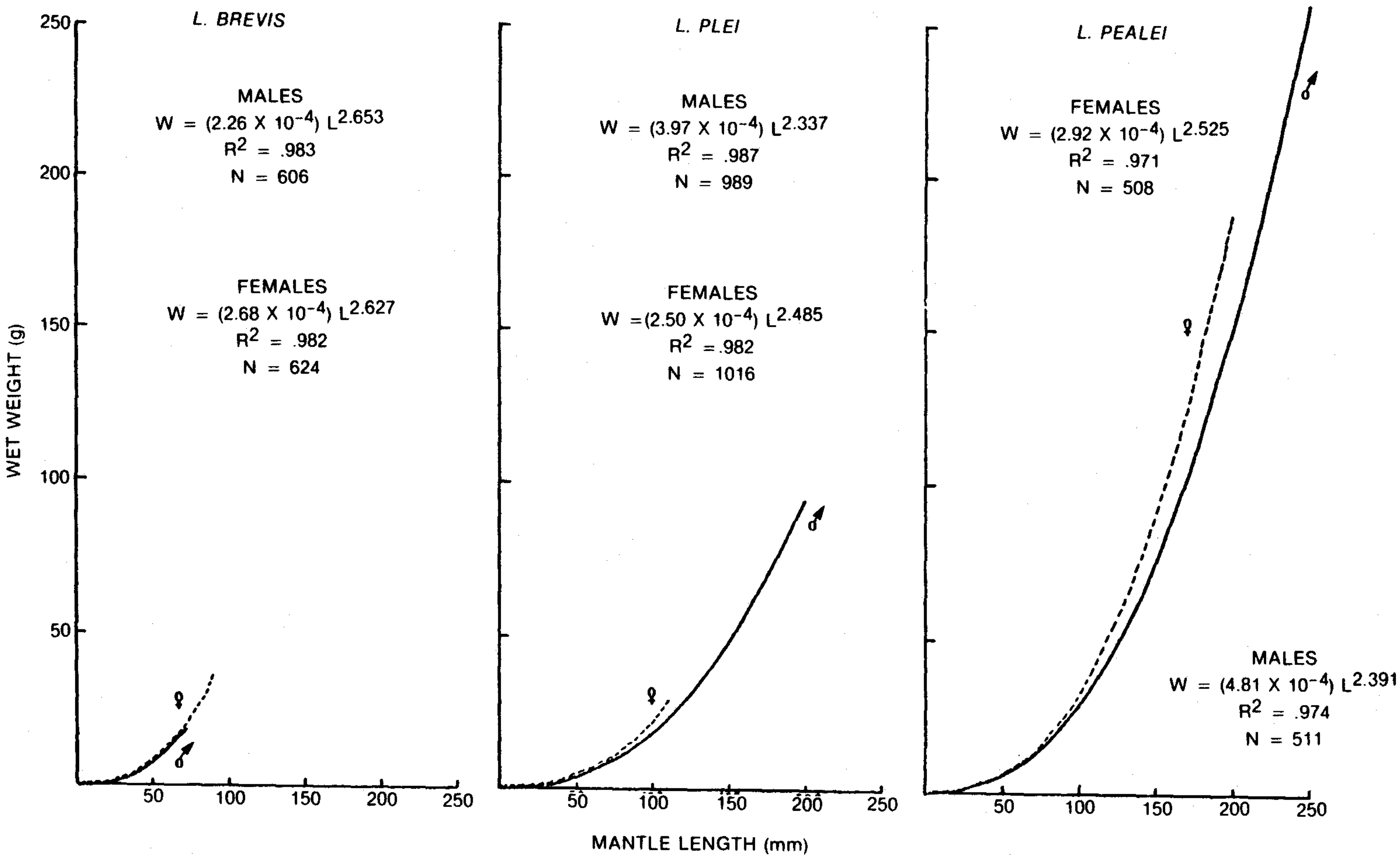


Figure 5. Length-weight relationships of male and female <u>Lolliguncula brevis</u>, <u>Loligo plei</u> and <u>Loligo pealei</u> (Hixon 1980a).

Fields (1965) noted a similar length-weight relationship for L. opalescens where a 150-mm ML male and a 140-mm ML female weighed approximately 70 and 50 grams, respectively. Whitaker (1978) developed a log-weight to log-mantle-length relationship for L. pealei (Figure 6).

Reproduction

Although spawning may occur year-round where temperatures are sufficiently warm (Summers 1971; Mesnil 1977), squid of the genus Loligo generally have a peak spawning period in the spring, with a secondary spawning in the summer or autumn in New England waters (Summers 1971; Holme 1974; Mesnil 1977). This apparently results from two reproductive cycles of alternating duration. Squid hatching in the spring from winter-spawned eggs mature during the first winter and spawn the following summer, thus having a short cycle. Squid hatching during the summer, on the other hand, are not sufficiently developed to mature during their first winter, and remain immature during summer and autumn when environmental factors inhibit maturation (Mesnil 1977; Mangold and Forsch 1977). They mature as larger squid during their second winter and have a long cycle (Arnold 1976). Typical reproductive cycles have not been established for Loligo from the Gulf of Mexico.

Age at Sexual Maturity

Several methods have been used to determine reproductive development stages in a variety of squid species. Juanico (1983) reviewed various of these maturity scales for squid, selected scales of which are presented as Appendix 1.

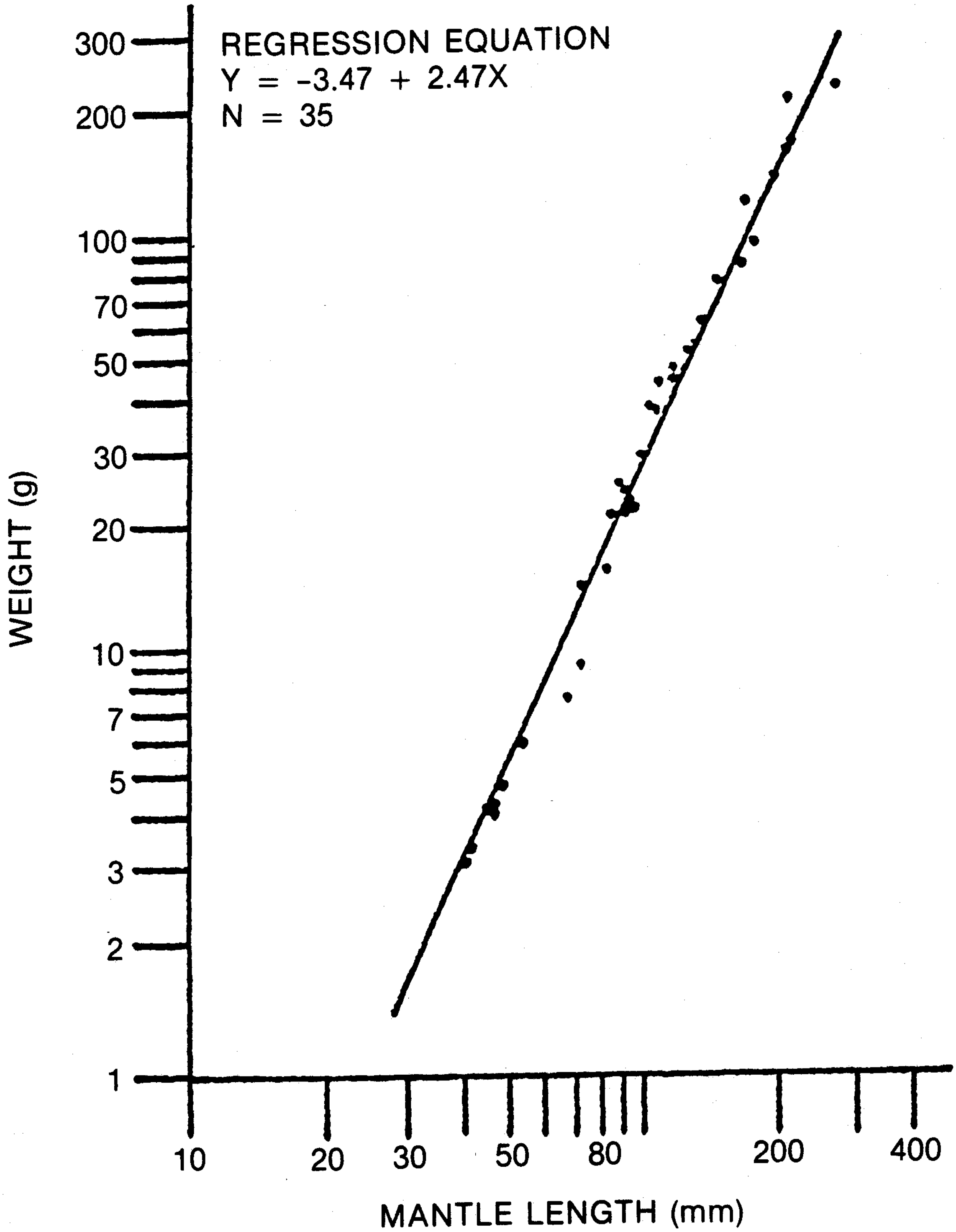


Figure 6. Relation of log weight (g) of squid to log mantle length (mm) for L. pealei (Whitaker 1978).

Considerable variation exists in the described age or size of _L. pealei_ at spawning (Summers 1971; Macy 1980). Dorsal mantle length, however, does not appear to be of primary importance in determining sexual maturity. The species has a wide geographic range and individuals in different parts of the range are exposed to varying environmental conditions throughout their respective annual cycles (Macy 1982). Such environmental variation is manifested by both spatially and temporally varying growth rates and gonad maturation (Hixon 1980a, Macy 1982b). Generally, however, squid spawn at about one year of age. Summers (1971) noted that sexual maturity and breeding were not observed in squid less than one year of age in the New England specimens he studied (average size 16-18 cm ML). _L. pealei_ appear to mature at a smaller size in warmer waters. Hixon (1980a) noted the smallest mature male and female from the Gulf of Mexico as 104 mm ML and 111 mm ML, respectively. His mantle length/maturation stage analysis for _L. pealei_ shows 50 percent of the male population mature at about 140 mm ML, at a proposed age of 10 months, whereas 50 percent of females were sexually mature at about 140 mm ML, when their proposed age was 11 months.

Sex Ratios

A 1:1 sex ratio is indicated for _L. pealei_ in the literature. Summers (1971) and Lange (1980) noted a 1:1 sex ratio for the species, and Whitaker (1978) noted a similar sex ratio in _L. pealei_ from the southeastern Atlantic. Hixon (1980a) also reported a 1:1 sex ratio for _L. pealei_ captured in the northwestern Gulf of Mexico.

Fecundity

Several estimates of *L. pealei* fecundity have been published (Haefner 1964; Summers 1971; Vovk 1972b). These estimates show a range of 980-1500 eggs per female. Although it is generally believed most cephalopods spawn once and die, recent investigations indicate that this may not be the case. Hixon (1980a) suggests multiple spawns. He has defined fecundity as the total number of eggs produced by a female squid in her lifetime. He notes that previous fecundity estimates for *L. pealei* may be too low. In the Hixon (1980a) study three *L. pealei* maintained in aquaria laid an estimated 21,315, 53,072 and 55,308 eggs respectively. Four to eight separate batches were laid by the female squid over a 7 to 29 day period. The total number of eggs was divided among the separate broods, which produced 6-110 capsules containing from 72-517 eggs per capsule (Hixon 1980a). Previous fecundity estimates are probably low because multiple broods were not known to occur in this squid. Once females begin to spawn, the ovary appears capable of producing additional oocytes and maintaining a large number of ripe mature eggs in the oviduct (Hixon 1980a), thus multiple spawns occur.

Spawning Seasons and Areas

Loligo pealei egg capsules have been collected in the northern Gulf of Mexico in the months of June, August, and December at depths of 20-60 m (Hixon 1980a). However, sexually mature male and female squid are found year-round in the Gulf. Presently, evidence for spawning times of *L. pealei* remains circumstantial (Hixon 1980a). Peak spawning most likely occurs in the fall with a second, smaller spawning in the spring (Hixon 1980a). Nursery and spawning areas are located throughout the northern Gulf although seasonality of the nursery areas is unknown (Hixon 1980b; Voss 1971, 1973). Although shallow water areas appear to be important to spawning, wintering and spawning areas have not been determined for Gulf squid. Hixon (1980a) states that the apparent lack of any well established spawning or wintering phases in L. pealei in the northern Gulf may be due to the relative annual uniformity of temperature and salinity near the outer shelf, and the lack of limiting low temperatures in shallow water.

Food Habits

Squid typically bite their food into small bits; therefore, identification of stomach contents is very difficult. Digestion is very rapid, normally 2-6 hours (Bidder 1950; Karpov and Cailliet 1978). They are voracious feeders, feeding when young on macroplankton and subsequently on small fish (Okiyama 1965). Loligo pealei is an opportunistic predator whose highly mobile existence allows it to utilize effectively a wide variety of potential prey species. Prey items, crustaceans and fish, change in relation to season and age, and size of the prey (Vinogradov and Noskov 1979). Cannibalism is exhibited in squid larger than 120 mm (Fields 1965).

Larval squid.

For an undetermined period, perhaps 10 days, L. pealei survive on their yolk sacs. Then they begin to stalk small planktonic organisms (Vovk, 1972a). Young Loligo readily attack prey as large as themselves within a few days of hatching, feeding on copepods, mysids, Artemia and larval crustaceans (Boletzky 1974; Hurley 1976).

Juvenile squid.

Juvenile *L. pealei* (70-100 mm) feed primarily on planktonic organisms, including copepods, euphausiids and decapods (Vovk 1972a). Chaetognatha, fish (including lanternfish), and squid have also been identified in the stomachs of small *L. pealei*. Common in the stomachs of these *L. pealei* are various bottom materials such as sand grains, vascular plant material, mollusk shells, various plankters, and polychaete worms (Whitaker 1978).

Adult squid.

In the adult *L. pealei*, fish and other squid are increasingly important food items (Williams 1909). The percentages of fish and squid increase with the size of the predator *L. pealei* (Armatunga 1983); *L. pealei* greater than 150 mm usually feed predominantly on fish and squid, and euphausiids decrease as a major food item (Vovk 1972a).

Many types of fish are eaten by *L. pealei*: sardines, herrings, mackerels, sauries and anchovies (Whitaker 1978). Other, less common foods are mysids, pandalid shrimps, chaetognaths, polychaetes, crabs, lobsters, and hyperiid and gammarid amphipods (Whitaker 1978). Representative genera of consumed fish groups reported by Vovk (1972a) as being important food items of *L. pealei* include: *Diaphus* (Myctophidae), *Anchoa* (Engraulidae), *Stenotomus* (Sparidae); *Clupea* (Clupeidae) and *Alosa* (Clupeidae). Large *L. pealei* also feed on small hake (*Merluccius* spp.).

Predators/Prey Relationships

Cephalopods are major prey of fish, birds and marine mammals (Clarke 1966). Among the known predators of *L. pealei* are various flatfishes, hakes, sharks, yellowfin tuna, toothed whales and most other large pelagic carnivores (Roper et al. 1984). Mackerels feed on squid at all growth stages, from larvae to adults (Roper, pers. comm.). Many predators of *L. opalescens* are associated with the bottom (Morejohn et al. 1978). Benthic species are also major predators of *L. pealei* (Lange and Sissenwine, 1980).

Very little is known, however about specific predators of squid at the larval stages (Vecchione, pers. comm.). They are probably eaten by such predators in the planktonic assemblages as ctenophores, chaetognaths and siphonophores (Fields 1963). The more agile benthic squid hatchlings are probably eaten by the more active predators, such as demersal fish (Armatunga 1983).

A list of fish predators of (*L. pealei* and *Illex illecebrosus*, as compiled by Lange and Sissenwine (1980), is shown in Table 2.

Early Life History

The life history of *L. pealei* from New England waters has been extensively studied. Few of these studies have focused on early life history (Vecchione 1981). Some investigators have studied *L. pealei* in the northern Gulf of Mexico (Voss 1954, 1956, 1960, 1971, 1973; Cohen 1976; Rathjen et al. 1977, 1979; Hixon 1980a, 1980b; Hixon et al. 1980a, 1980b, 1981). However, many aspects of the biology and early life history of *L. pealei* in the Gulf of Mexico remain obscure. A generalized life history is presented here.

Cephalopods lay eggs which are surrounded by a tough outer coating. This requires internal fertilization, with copulation preceded by proscribed courtship behavior (Arnold 1979; Packard 1972; Macy 1980; Griswold and Prezioso 1981). Loliginid squid lay their

Table 2. Fish predators on squid (*Loligo pealei* and/or *Illex illecebrosus*) from the Northwest Atlantic (Lange and Sissenwine 1980).

	Pelagic		**Benthic**
Atlantic bonito	*Sarda sarda*	haddock	*Melanogrammus aeglefinus*
bluefin tuna	*Thunnus thynnus*	Atlantic cod	*Gadus morhua*
skipjack tuna	*Euthynnus pelamis*	pollock	*Pollachius virens*
Atlantic mackerel	*Scomber scombrus*	red hake	*Urophycis chuss*
swordfish	*Xiphias gladius*	silver hake	*Merluccius bilinearis*
		spotted hake	*Urophycis regia*
	Semi-pelagic		
		white hake	*Urophycis tenuis*
alewife	*Alosa pseudoharengus*	Atlantic tomcod	*Microgadus tomcod*
butterfish	*Peprilus triacanthus*	northern searobin	*Prionotus carolinus*
scup	*Stenotomus chrysops*	four-spot	*Paralichthys oblongus*
bluefish	*Pomatomus saltatrix*	summer flounder	*Paralichthys dentatus*
striped bass	*Morone saxatilis*	windowpane	*Scophthalmus aquosus*
redfish	*Sebastes marinus*	witch flounder	*Glyptocephalus cynoglossus*
	Inshore		
silverside	*Menidia menidia*	barndoor skate	*Raja laevis*
rainbow smelt	*Osmerus mordax*	little skate	*Raja erinacea*
three-spine stickleback	*Gasterosteus aculeatus*	big skate	*Raja binoculata*
		clearnose skate	*Raja eglanteria*
weakfish	*Cynoscion regalis*	tilefish	*Lopholatilus chamaeleonticeps*
	Other	longhorn sculpin	*Myoxocephalus octodecemspinosus*
spiny dogfish	*Squalus acanthias*		
smooth dogfish	*Mustelus canis*	white perch	*Morone americana*
mackerel shark	*Lamna nasus*	oyster toadfish	*Opsanus tau*
thresher shark	*Alopias vulpinus*	black sea bass	*Centropristis striata*
barrelfish	*Hyperoglyphe perciformis*	goosefish	*Lophius americanus*
angel shark	*Squatina dumerili*	tautog	*Tautoga onitis*
roughtail stingray	*Dasyatis centroura*		

eggs in large strings or clumps, either directly on a sandy bottom (Kristensen 1959; Roper 1965; Fields 1965), or attached to submerged objects (Stevenson 1934; Packard 1972; Holme 1974; Griswold and Prezioso 1981). In some Loligo species, the clumps are constructed by the successive addition of egg capsules by different females (Stevenson 1934; McGowan 1954; Tardent 1962). During such mass spawning, egg clumps may reach 12 m in diameter (McGowan 1954).

The female loliginid can extrude 20-30 or more egg capsules in a spawning season. Each capsule contains approximately 70-300 or more eggs. Egg capsules vary in length from 5-20 cm and are about 1.2 cm in diameter (Fields 1967; Hixon 1980a; Jefferts 1983). At about 1.5 millimeters in diameter, the eggs undergo direct (non-larval) development. Hatching usually occurs in about three to five weeks depending on temperature (McGowan 1954; Fields 1965). At a temperature of 7^{o}-$8^{o}C$, it takes nearly three months for the eggs to hatch; at $13^{o}C$, it takes about a month, and at $16^{o}C$, it requires 12 to 23 days (Fields 1965; Jefferts 1983).

The young squid hatch at about 2.5 - 3 mm in length. They can live up to three days or longer on their yolk sac, and soon after hatching, assume a planktonic mode, swimming upward toward the light (Fields 1965). They then begin to stalk small planktonic crustaceans (Jefferts 1983). Young squid are pelagic and subject to drift by tidal (McGowan 1954; Fields 1965) or ocean (Okiyama 1965b; Araya 1967a, b) currents. During their early planktonic life, they remain immediately below the surface (Bigelow and Leslie 1930; Okutani and McGowan 1969). Cephalopods do not undergo true metamorphosis; there are no true larval stages and development is direct in Loligo.

During development, cephalopods experience a major ecological shift correlated with morphological changes. One aspect of this shift is from the planktonic niche to that of schooling demersal nekton (Vecchione 1985).

Spawner-Recruit Relationships

Very little is known about the location of L. pealei in the Gulf of Mexico from their hatching to spawning stages (Voss and Brackoniecki 1985). Most of the information on squid distribution and numbers in the Gulf has been taken from records of research vessels and bycatch information from shrimp trawlers.

Behavior

Squid must swim or maintain mantle movement to facilitate absorption of oxygen, so they remain in motion most of the time. They are powerful swimmers and capable of rapid acceleration, usually propelling themselves backwards through the water by means of water jet propulsion and undulation of the fin. However, they are capable of reversing direction quickly and swimming forward, usually during an attack on prey (Williamson 1965; Squires 1966).

Squid are sight feeders. Their behavior in feeding may be generalized as an active, visually controlled attack on fast-moving prey (Armatunga 1983). They may also use sight to avoid entrapment or ensnaring gear. They exhibit flight reactions to avoid trawls, but their stamina is limited (Amos 1982). Positions of squid in a school are maintained visually, each individual keeping station no more than two or three body lengths from its neighbor (Hurley 1978).

It has been suggested that *Loligo* feed chiefly upon actively swimming organisms and, less frequently, on bottom-living forms (Fields 1965). However, long-term observations of captive squid revealed a behavior pattern described by Williams (1909, cited by Bidder 1950), and Stevenson (1934) occurring in conjunction with feeding and spawning, where *L.* pealei remained on the bottom. This activity was reported as quite common, particularly during periods of bright illumination (Macy 1982a). The squid appeared to maintain a resting posture with their posterior ends and tips of the arms in contact with the substrate. Typically, the squid assumed a coloration pattern which blended well with the substrate (Macy 1982a). This behavior pattern was also reported by Hanlon et al. (1983), noting that *L. pealei* commonly remain on the bottom.

Schooling Relationships

Newly hatched squid appear to have no attraction to each other but after six or seven weeks, schooling is occasionally observed (Hurley 1978). Juvenile squid are found at the bottom (Vecchione 1985) of the water column and appear to spread throughout the water column as they grow.

Schooling squid are usually individuals of approximately the same size (Fields 1965; Hurley 1978). They aggregate in schools to spawn or to feed and sometimes in reaction to a disturbance. Squid fisheries are usually based on schools of spawning animals. Spawning may take place at any time of day but is chiefly at night (Fields 1965). Feeding schools are much less dense than the spawning schools, but are known to form large concentrations in the deep scattering layer, perhaps in pursuit of such food organisms as euphausiids (Serchuk and Rathjen 1974). Large concentrations of _L. opalescens_ in California group together for feeding or spawning (Kato and Hardwick 1976) No similar concentrations have been reported for _L. pealei_ in the Gulf of Mexico (Hixon 1980a).

Over a 24-hour period, squid demonstrate a variety of schooling and distribution patterns, occurring near the sea bed, in the midwater region, or scattered throughout the water column. When in these various distribution patterns, they present correspondingly varying echo sounder displays. A plume-like trace is seen when the squid are pelagic, continuous traces when they are along the sea bed line or in the midwater region, "splotches" scattered throughout the water column when they are dispersed, and a blackening of the entire water column with dense schools (Amos and DeMello 1982).

Association with other species

Myctophid fish are frequently associated with squid in the deep scattering layer, with the squid usually present in the middle and at the lower edge of the layer (Okiyama 1965). This association has not been documented for _L. pealei_. _Loligo pealei_ are found in association with various species of shrimp and bottom fishes, quite often taken as bycatch during bottom trawling. There is some recent evidence of _L. pealei_ association with butterfish _(Peprilus burti)_ in the Gulf of Mexico (NISSHIN Maru No. 201 Cruise Reports 1 and 2, 1984-1985). Roughly 5,000 lb of butterfish are caught with every 100,000 lb of _Loligo_ (Mid-Atl. Fish. Mgt. Council 1982). They are probably also associated with sardines, mackerels, herrings, sauries and anchovies since smaller specimens of these species have been reported as part of the diet of adult _L. pealei_ (Whitaker 1978). A list of organisms associated with squid and butterfish in the Gulf has been compiled by the Louisiana State University Coastal Fisheries Institute (Appendix 2).

Diurnal Patterns

Loliginid squid show a diurnal cycle of vertical migration, moving upward in the water column at night. They are demersal during the day and feed heavily during daylight hours (Vovk 1972a). Vertical migrations of L. pealei may be associated with the presence of such food organisms as euphausiids (Serchuk and Rathjen 1974). Trawl catches of squid are usually larger during the day than at night (Lux et al. 1974; Sissenwine and Bowman 1978). Sissenwine and Bowman (1978) reported daytime catches by weight to be 2.9 times larger than nighttime catches. Daytime catches in numbers, however, were 18.9 times the nighttime catches. These differences imply differential migration by size; Lange (1980) suggests that L. pealei may migrate vertically by size, with larger individuals remaining at the bottom at night and the smaller ones moving up into the water column to feed on plankton.

Diurnal patterns of feeding periodicity are also apparent, according to Vovk (1972a), who reports maximum stomach fullness of squid in the evening from 1600-2000 h. Other authors, however, note no clear diurnal pattern, although most intensive feeding by large squid was found to occur between 1800-2000 h (Vinogradov and Noskov 1979).

Habitat

L. pealei appear to prefer rough, rocky, or sand - and mud-bottomed areas with temperatures from 10°-22°C, and salinity greater than 33 ppt (Hixon 1980b). At various stages of development, the species may be found from the ocean surface to the bottom, at all depths over the continental shelf.

Squid are often found near outfalls from bays, areas of upwelling, and canyon areas (Voss and Brakoniecki 1985). *L. pealei* is generally a shelf species, however, and is usually found in areas where the shelf is broad (Cohen 1976). In the northern Gulf of Mexico, the species is captured primarily along the outer edge of the shelf, although *L. pealei* in the Gulf may occur in deeper depths (Hixon 1980b).

Environmental Relationships and Responses

Temperature and Salinity. Squid migrations are controlled largely by water temperature and to a lesser extent by salinity (Hixon 1980a). Mean preferred salinities average 36 ppt; squid are rarely captured in salinities less than 30 ppt. (Hixon 1980a). In the Gulf of Mexico, squid are generally more available where the bottom temperature is approximately 19°C. In recent Gulf surveys, *L. pealei* were captured where bottom temperatures averaged 19°C (NISSHIN MARU NO.201 Cruise Reports 1 and 2, 1984-85).

Moonlight.

Squid jigging operations are usually unsuccessful when the moon is full (Allen and Taber 1974). One reason for this may be that the distance at which a fishing light is perceptible decreases with increasing background illumination (Clarke and Denton 1962). The negative effect of the full moon is reduced, however, when a heavy overcast obscures the moon, or electric underwater lamps are used in deep water (Ben-Yami 1976). There are also within-month catch fluctuations with moon phases. The best fishing conditions appear to exist during dark nights and neap tides; the worst fishing conditions appear to be during full moon and spring tides (Ben-Yami 1976).

Artificial Light

L. pealei are generally believed to be positively phototactic and are often captured when using artificial light. However, experiments on the reaction of squid to light by the Marine Biomedical Institute at Galveston, Texas, resulted in findings that L. pealei may not be so phototactic as other species of squid (Smith 1979, cited by Amaral and Carr 1980).

Many squid are readily attracted to light at the surface. Catches increase with light intensity up to a certain limit (Ogura and Nasumi 1976). Most squid seem to prefer a certain light intensity, such as that cast by the shadow of a vessel just at the boundary of the illuminated zone. Squid aggregate close to, or directly in the illuminated zone, but are somewhat unpredictable in their coming and going (Ben-Yami 1976). The bright zones appear to attract squid, while the zone of shaded light encourages them to react to jigs. When a surfaced school of squid is illuminated with a powerful light feeding movements become slow, and in such a situation, jigging is not effective (Flores 1982).

Squid do not necessarily react to the color of lights, but are probably responding to the intensity of such light (Amos and DeMello

1982). Indoor laboratory experiments with *Todarodes pacificus* indicate that these squid do not possess color vision (Flores et al. 1978, Flores 1979).

Currents.

Some squid are known to congregate at the interfaces of currents and upwelling areas. The Japanese, in fact, use aerial locations of current rips to detect squid concentrations (Suzuki 1963).

Sound.

According to Voss (pers. comm.), squid do not react to sound and they are not very pressure sensitive.

FISHERIES

A commercial squid fishery has been in existence along the eastern U.S. coast from Maine to North Carolina since 1880 (Lyles 1968) and along the western U.S. coast at Monterey, California since about 1863 (Fields 1965).

L. pealei is caught by an international fleet offshore in the northwest Atlantic in winter, when the squid are concentrated on the outer edge of the continental shelf in the Mid-Atlantic Bight (Arnold 1979). Spawning *Loligo* also are taken inshore as bycatch of small trawlers (Lux et al. 1974). The major U.S. fishery for *Loligo* occurs in spring and summer off southern New England and Long Island (Rathjen 1983).

The southeastern United States, south of Cape Hatteras and extending to the Mexican border, has no significant fishery for squid. However, a small-scale directed fishery for *L. plei* has developed in the Gulf of Mexico near Progreso, Mexico (LaRoe 1967; Voss 1971). Loliginids are also taken in bottom trawls as bycatch of the Gulf shrimp fishery. Most of the squid are discarded, but a small amount is sold at a low price for bait or human consumption. Texas and Florida land 90 percent of these Gulf squid catches, with Louisiana, Alabama and Mississippi landing the remaining 10 percent. Squid landings for the Gulf States from 1960-1983 are shown in Table 3.

Hixon et al (1980a) described results of exploratory fishing off Texas and concluded that the development of a large scale squid fishery for Loligo in this area is "highly improbable". According to Hixon, the reasons for the present lack of development of a commercial squid fishery in the northern Gulf of Mexico are: 1) The magnitude of the possible stocks of each species is unknown; 2) no comprehensive effort has been made to generate squid biomass or standing stock estimates for the northern Gulf; 3) a major hindrance is the low price paid to fishermen for squid; and 4) a successful squid fishery would require quality products and demonstrated production. In spite of these hinderances, Rathjen et al. (1979) conclude that there are probably sufficient quantities of squid in the Gulf of Mexico to justify continued investigation of their exploitation.

Users

Foreign.

The Fishery Conservation and Management Act (FCMA) of 1976 (U.S. Department of Commerce 1977a) established exclusive fishery management authority for the United States waters of the sea adjoining territorial waters and extending offshore some 197 miles

Table 3. Volume (in thousands of pounds) and value (in thousands of dollars) of squid landings (unclassified) in the Gulf of Mexico by state. (Compiled by LSU-CFI, 1985)

Year	Florida (west coast)		Alabama		Mississippi		Louisiana		Texas	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1960	17	-	1	-	-	-	2.0	>0.5	12	-
1961	13	1	4	>0.5	-	-	2.0	>0.5	12	1
1962	25	2	3	>0.5	-	-	3.0	1.0	28	3
1963	26	2	4	>0.5	-	-	6.0	1.0	37	4
1964	15	1	4	>0.5	-	-	4.0	>0.5	24	-
1965	23	2	6	1.0	-	-	1.0	>0.5	24	3
1966	30	2	8	1.0	-	-	1.0	>0.5	22	2
1967	31	3	5	>0.5	-	-	1.0	>0.5	11	1
1968	66	7	9	1.0	-	-	1.0	>0.5	11	1
1969	42	7	7	1.0	-	-	2.0	>0.5	7	1
1970	36	5	8	>0.5	-	-	1.0	>0.5	10	1
1971	29	5	9	1.0	-	-	3.0	>0.5	9	2
1972	13	1	4	>0.5	-	-	>0.5	>0.5	5	1
1973	30	4	11	1.0	-	-	-	-	5	1
1974	47	9	4	1.0	-	-	-	-	15	3
1975	35	8	2	>0.5	-	-	-	-	6	1
1976	50	10	2	>0.5	-	-	>0.5	>0.5	20	5
1977	60	16	3	>0.5	4	1	>0.5	>0.5	14	4
1978	46	10	a	a	a	a	1.8	>1.0	a	a
1979	a	a	a	a	a	a	>1.0	>0.5	a	a
1980	a	a	a	a	a	a	>1.0	>0.5	a	a
1981	a	a	a	a	a	a	>1.0	>0.5	a	a
1982	a	a	a	a	a	a	-	-	a	a
1983	a	a	a	a	a	a	-	-	a	a

Sources: Fishery Statistics of the United States (1960-1978); Louisiana Landings, Annual Summary (1978-1983).

[a]Data not available.

-Not reported.

(Kolator and Long 1979). U.S. regulations (U.S. Department of Commerce 1977b) require that foreign vessels can be permitted to fish for squid within specified areas and at designated times (Kolator and Long 1979). As required by the FCMA, a Fisheries Management Plan (FMP) for Atlantic squid has been established, including the total allowable level of foreign fishing (TALFF).

The distant-water fishery for squid in the U.S. Fishery Conservation Zone (FCZ) has declined since 1982. *Loligo* squid catches by Japan, Italy and Spain totaled 11,795 mt in 1983, a 26% decrease from 1982 (Lange 1984). Joint venture (U.S. flagships/foreign interests) catches of *Loligo* squid also declined, from 2,332 mt in 1983 to 760 mt in 1984 (Lange 1984). Table 4 shows joint venture transfers of squid from 1981-1984.

Currently, Italy and Spain are the primary foreign vessels harvesting *Loligo* within the U.S. FCZ, with Japan participating to a lesser degree. Stricter regulations have caused the Japanese squid fishery to change the target species to the shortfin squid, *Illex illecebrosus*, in Canadian waters (Soto and Hatanaka 1983).

Domestic.

Traditionally, squid from the U.S. east coast fishery are taken incidentally in other directed fisheries (Lyles 1968). The fishery for longfin squid takes place primarily during the spring and summer (May-August) in inshore waters of southern New England and in the Mid-Atlantic area. Most of the *Loligo* harvested are from this inshore fishery. Nantucket Sound, Massachusetts is the site of intensive trawling for squid by vessels which make short trips (1-3 days), ice the catch, and deliver it to shore-based processing

Table 4. Joint venture catches by U.S. flag vessels 1982-1984 (Loligo).

Year	Volume (1,000 lb)	Value ($1,000)
1982	(1)*	(1)*
1983	5,142	1,646
1984	760	395

*Less than 1,000 lb and $1,000

Source: Fisheries of the U.S. 1985. Department of Commerce plants. There is also a significant trap fishery from Cape Cod, Massachusetts to Long Island, New York which produces a high-quality product for processing within hours of being caught (Kolator and Long 1979). Freezer trawlers also fish for squid (as an alternative to butterfish) out of Pt. Judith, R.I. (M. Vecchione pers. comm.).

Due to the strengthening of regulations for foreign fishing vessels operating within the U.S. FCZ, the Loligo fishery has now shifted toward a domestic fishery. Lange (1984) reports that in 1983, the U.S. domestic longfin squid harvest exceeded that of the foreign fishery for the first time since 1967. The 1983 U.S. catch, totaling 15,943 mt, represented a 192% increase from 1982. Table 5 shows annual longfin squid catches from the northwest Atlantic (Cape Hatteras to Gulf of Maine) by the U.S. and foreign fleets for 1963-1984 (Lange 1984).

U.S. Processors.

Approximately 29 Atlantic Coast processing firms presently participate in the squid fishery. Of these, 11 are located in Massachusetts, 8 in Rhode Island, 7 in Virginia, and 1 each in Maine, New York and New Jersey. All these firms handle other fish products in addition to their seasonal squid supply. The New England domestic supply of frozen and canned squid is produced by firms in New York and New Jersey (FMP Atlantic Mackerel, Squid and Butterfish Fisheries, MAFMC 1985). Although canned squid is commercially processed in the United States, most U.S. east coast squid is processed as a whole-frozen product (Learson and Ampola 1981). A listing of current U.S. squid processors is given in Appendix 3.

Table 5. Annual longfinned squid catches (in metric tons) from the Northwest Atlantic (Cape Hatteras to Gulf of Maine) by the U.S. and the distant-water fleets (DWF), 1963-1984 (Lange 1984).

Year	U.S.	DWF	Total
1963	1,294	0	1,294
1964	576	2	578
1965	709	99	808
1966	722	226	948
1967	547	1,130	1,677
1968	1,084	2,327	3,411
1969	899	8,643	9,542
1970	653	16,732	17,385
1971	727	17,442	18,169
1972	725	29,009	29,734
1973	1,105	36,508	37,613
1974	2,274	32,576	34,850
1975	1,621	32,180	33,801
1976	3,602	21,682	25,284
1977	1,088	15,586	16,674
1978	1,291	9,355	10,646
1979	4,252	13,068	17,320
1980	3,996	19,750	23,746
1981	2,316	20,212	22,528
1982	5,464*	15,805	21,269
1983	15,943*	11,720	27,663
1984[1]	10,000	10,000	20,000

[1]Projected.

*Includes joint venture catches.

Vessels

Foreign Vessels.

Currently, foreign vessels fishing U.S. waters average 130-200 ft in length, 300-2,000 gross tonnage, and of up to 3,000 or more hp. Most of the foreign vessels are factory freezer stern trawlers and carry a crew of 15 to 40 or more. These vessels process squid at sea.

Domestic.

Domestic vessels fishing for squid, butterfish, and mackerel are required by the FMP to have permits. For commercial vessels with squid permits, the average hold capacity is 63,000 lb, with a range up to 800,000 lb. Average crew size is approximately 4, with a range from 1 to 17. Table 6 shows characteristics of squid vessels operating in the domestic squid fishery during 1982.

Squid Detection Techniques

The most common method of locating schools of squid is the echo sounder. The best frequencies are above 70 khz, although lower frequencies also work (Amos 1983).

Remote-echo sounding.

Echo sounders have proven to be practical for finding squid. Most of the dual-frequency echo sounders currently available on the market have two transducers. The optimum sounder characteristics for squid detection are frequencies of 75-200 khz, with a narrow beam (half-power beam angles of 8^{0} and 3^{0}, at 75 and 200 khz, respectively) (Kawaguchi and Nazumi 1972; Suzuki et al. 1974). Tank measurements by Smith (1954) and Matsui et al. (1972) show that Loligo squid of approximately 12-cm mantle length have a target

Table 6. U.S. squid vessel characteristics, 1982.

Permit	Characteristic	Vessel*	Average	Minimum	Maximum
Squid (commercial) 892 vessels	Length	892	55	14	176
	Gross tonnage	892	61	1	560
	Hold capacity (lb)	750	62,838	1	800,000
	Year built	879	1967	1913	1982
	Crew size	879	4	1	17
Squid (party/charter) 46 vessels	Length	46	42	18	86
	Gross tonnage	46	27	2	137
	Hold capacity (lb)	36	7,514	200	90,000
	Year built	46	1970	1955	1981
	Crew size	45	3	1	7
Squid (incidental) 185 vessels	Length	185	55	14	166
	Gross tonnage	185	69	1	542
	Hold capacity (lb)	150	60,926	1	350,000
	Year built	185	1971	1917	1982
	Crew size	182	5	1	16

*=number of vessels with non-zero information.

Source: Unpublished NMFS data. (Cited, FMP-Atlantic mackerel, squid and butterfish fisheries, MAFMC 1983).

strength of between -42 and -48 db at frequencies of 15-200 khz. Squid produce distinct echo traces which can be detected from a stationary or a moving vessel (Arnold 1979).

Squid detection by multi-frequency, color depth recorders (chromoscope) is now widely practiced. The chromoscope is quite adaptable to locating and interpreting the characteristics of squid concentrations. It has the ability to color-code fish and seabed echos according to signal strength (Rathjen 1984).

Other Techniques

Photographic.

Photographic techniques have been employed by British researchers deC. Baker (1957) and Clarke (1966). Direct observations from a submersible vehicle have been described by Milliman and Manheim (1978) for waters adjacent to Cape Hatteras. A more recent innovation of fish detection by photographic technique includes the Manta system[1], an underwater television and computer-logging system.

Temperature.

Squid are highly sensitive to temperature variations, and as such, their movements are somewhat predictable relative to seasonal warming and cooling phenomena. Fishermen frequently utilize experience and recorded temperature information to help locate squid (Rathjen 1984).

Visual.

---

[1]The use of trade name does not imply endorsement of product by National Marine Fisheries Service

Visual sightings of such associated animals as birds, seals, and whales are sometimes indicators of prime fishing locations (Rathjen 1984).

The use of satellite imagery to locate water masses where squid may be anticipated is another technique which may prove useful (Rathjen 1973). The detection of current rips and luminescent squid schools by aerial observations are also useful in detecting squid (Suzuki 1963; Roithmayr 1970; Squire 1972).

Squid Capture (Gear and Methods)

There are four major harvesting methods used to capture squid: trawling, jigging, roundhaul (lampara) seining and high-seas gill netting (Amos 1983).

Bottom trawling.

A wide variety of net types is used in the squid fishery. Emphasis is placed on high-opening nets with head rope heights over the bottom ranging from 5-15 m. Mesh size in trawls varies from 60-400 mm (stretched mesh) in the wings and foreparts of the nets, to 45-60 mm in the cod end (Kolator and Long 1979).

According to Rathjen (1984), "Net configuration, mesh size and other characteristics are undergoing change, with increased interest in directed trawling for squid. Mesh size is quite variable, sometimes varying from very large (5' in the forepart of the trawl to 2" (50 mm) in the cod end. Bottom trawls used to capture squid are extremely variable and constantly evolving. Typically they are designed to be high opening with mesh size tapering from the foreparts to the cod end. The footrope is rigged to fish lightly over the bottom and the headrope is equipped with floats to increase the vertical opening. The trawls are usually towed at moderately fast speeds, 3-5 kn, over the bottom".

One of the most popular trawls currently used by vessels fishing for squid is the Shuman trawl (Figure 7). The trawl net used in a recent U.S./Japan Gulf of Mexico squid survey by the Japanese research vessel NISSHIN MARU No. 201 is shown in Figure 8. Information on other squid nets of the Mid-Atlantic has also been published (Cahill and Mansfield 1984)

Gill nets.

Gill nets are not currently used in the Loligo fishery.

Pelagic trawling.

Pelagic trawling is sometimes referred to as midwater trawling and is a technique in which the trawl net is operated in the water column between the surface and the substrate (Rathjen 1984). Amos (1983) suggests that when using a midwater trawl for squid, one should consider using a smaller size trawl than for finfish, in order to maintain high speeds. Speeds in excess of 3.5 kn seem to be most effective.

Automated squid-jigging (Arnold 1979).

Squid jigging is an important method of squid fishing, accounting for 95% of the Japanese catch. The squid jig is a type of grapple, usually 10-15 cm long. One or two rings of barbless hooks project from the end of the shaft, which may pass through a lead weight or bait fish. An example of a squid jig is shown in Figure 9. Traditionally, jigging is done by hand, but the Japanese have developed mechanical jiggers which can operate several lines simultaneously. Light attraction is necessary. The essential

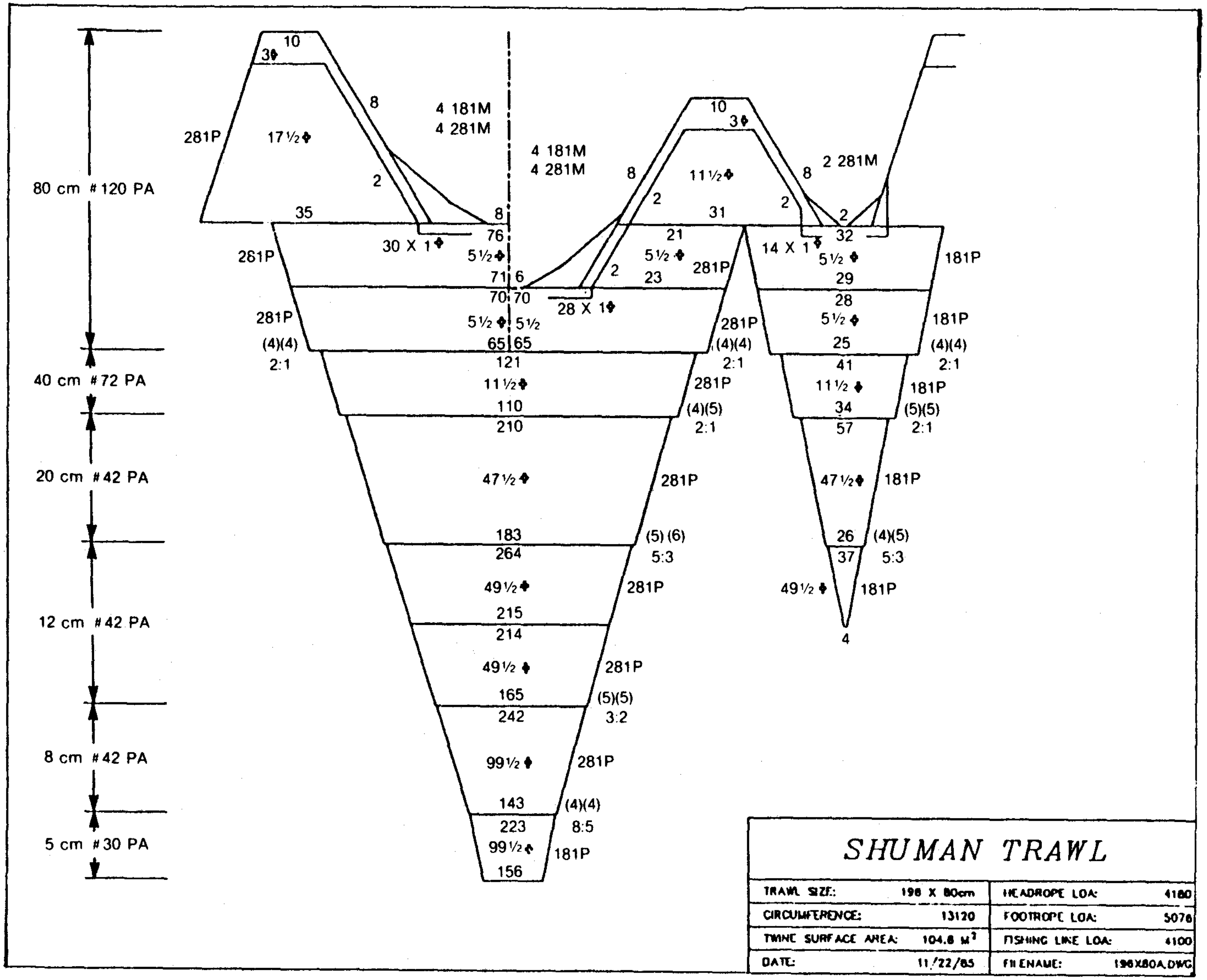


Figure 7. Shuman trawl (Shuman Trawl Co.).

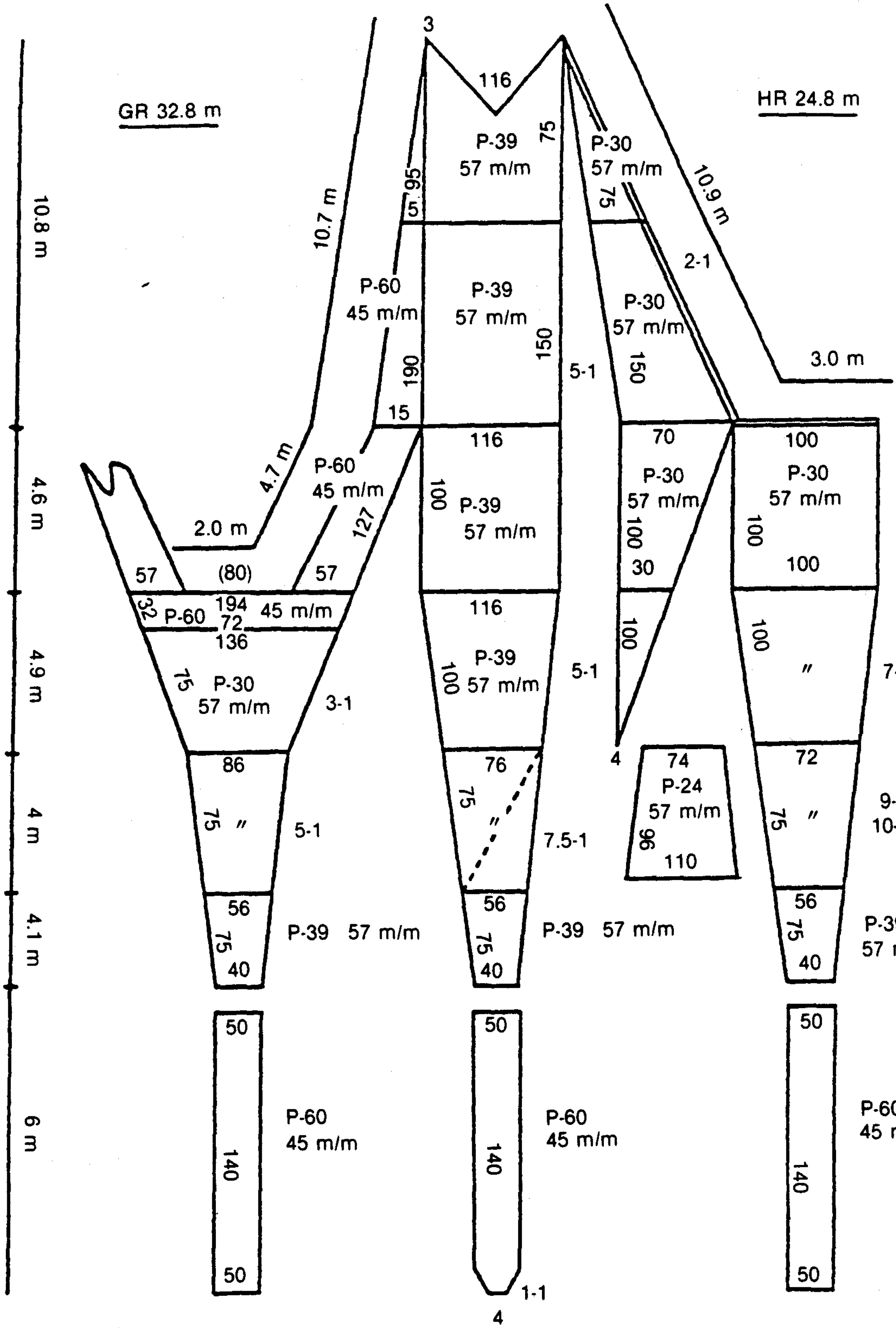


Figure 8. Single trawl net (Nichimo Co. Ltd.).

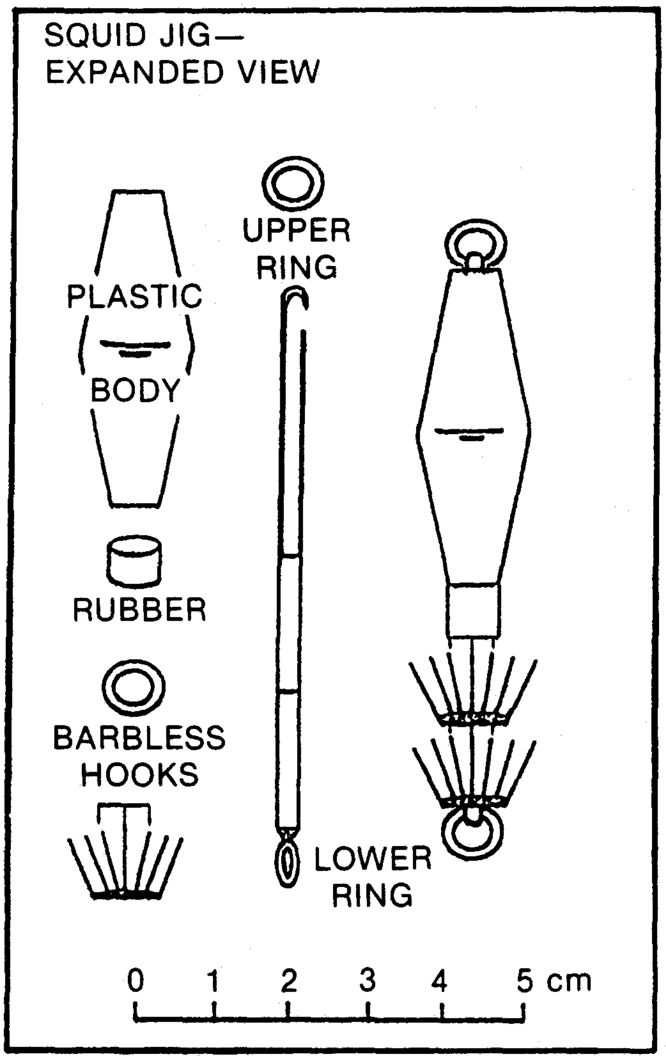


Figure 9. A typical squid jig (White Fish Authority 1976).

components of a mechanical jigger are a metal frame that supports a sheet of wire netting fitted outboard from the boat's gunwale, one or more rollers, and a hauling drum. A typical squid jigging vessel is shown in Figure 10.

Normally, fishing vessels engaged in squid jigging deploy a sea anchor to the windward side off the bow of the vessel. This is effective in steadying the motion of the vessel and slowing its drift. Such a procedure is very important in this fishing technique as the vessel should not be allowed to drift faster than the water mass in which it is operating. If the vessel drifts too rapidly (or not at all), the fishing lines may be at an angle which can cause tangles (Rathjen 1984). Some vessels also drift broadside to the wind without a sea anchor (M.Vecchione pers. comm.).

Light attraction (Arnold 1979).

Successful jigging depends on light attraction. The arrangement of the lamps consists of a row of lights attached to a pole or line stretched horizontally between the foremast and mizzenmast. The lights range in power from 1-5 kw and are commonly incandescent lamps, although mercury vapor lamps may be more efficient. Catches increase with light intensity up to a certain limit. A 100-ton vessel may have a generator with a capacity of 160-250 kw and as many as 40 5-kw lamps arranged in two parallel rows (Ogura and Nasumi 1976).

Lamps are positioned above the vessel rather than over the water as in other fisheries, due to the behavior of the squid, which aggregate in the boundary between the shadow of the ship's hull and the lighted zone (Flores 1981). The position of the boundary in

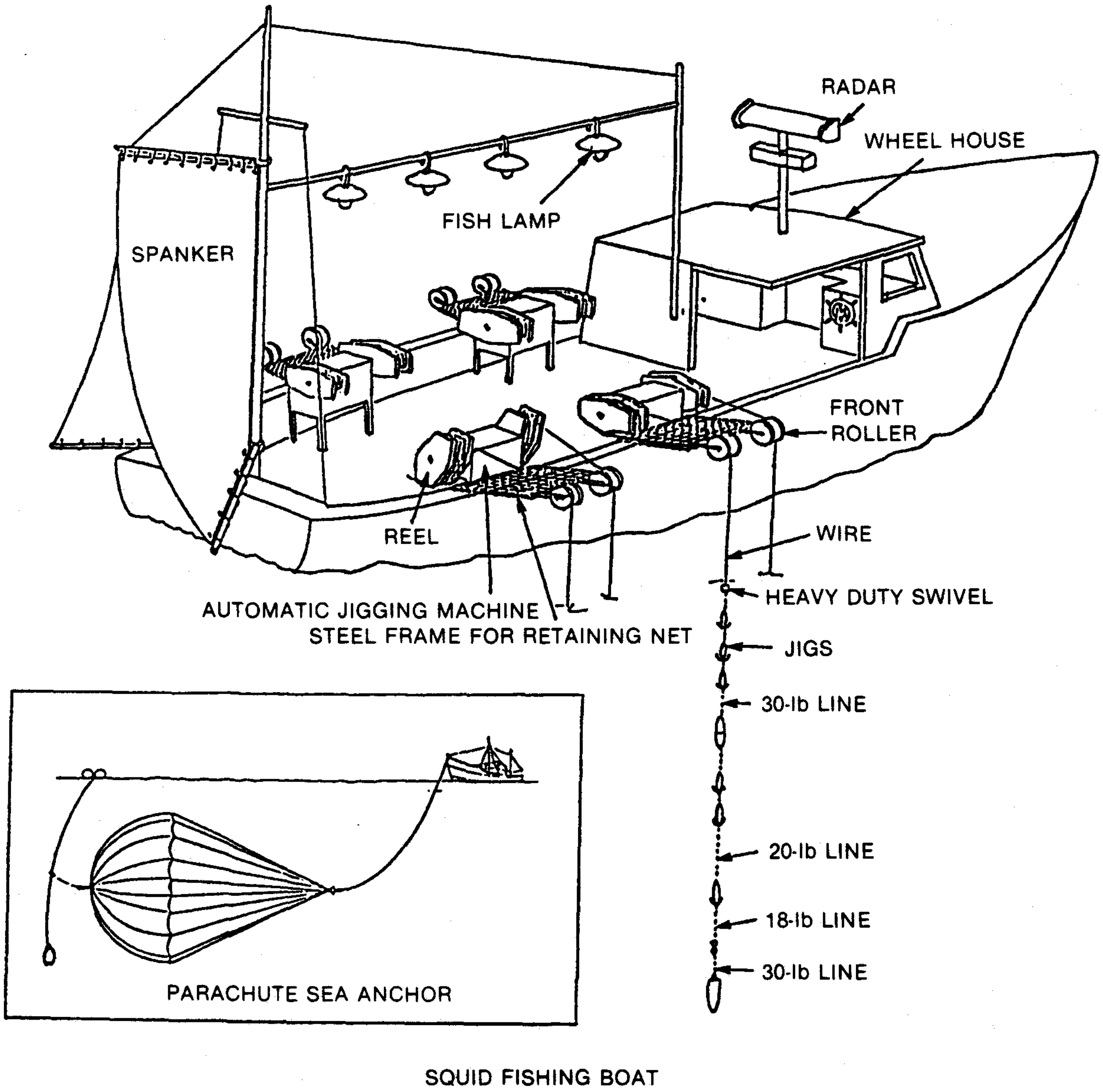


Figure 10. Automated jigging vessel (Rathjen 1984).

relation to the jigs depends on the height of the lamps and their position in relation to the center line of the vessel (Arnold 1979).

In practice, the height of the lamps ranges from 2.2-6.5 m. Underwater lamps attract more squid than surface lamps, but fishing efficiency is not improved, probably due to a lack of appropriate shadows. They may, however, be useful as an ancillary means of concentrating the squid (Ben-Yami 1976). An illustration of effective light configuration is shown in Figure 11.

Roundhaul nets (Arnold 1979).

The California squid fishery at Monterey employs a pelagic roundhaul (lampara) net to catch schooling L. opalescens. The essential features of a roundhaul net include a large central bunt, graduated mesh sizes, and no purse lines or rings. Both wings are hauled together (Scoffield 1951). A modern lampara net may have a central sack of small, 30-mm mesh, 55-73 m wide by 46-55 m deep. Each wing is 73-119 m long, tapering to a point, with meshes graduated from 10 cm nearest the main net to 40 cm at the extremity. The weighted lead line along the bottom of the net is shorter than the buoyant cork line at the top and as the wings are hauled simultaneously, the lower margins of the sack are drawn beneath the school.

PROCESSING AND ECONOMICS

At present, most New England squid packed for export are simply frozen whole. Although some packers have made substantial efforts to improve quality, foreign buyers complain that the typical U.S. squid

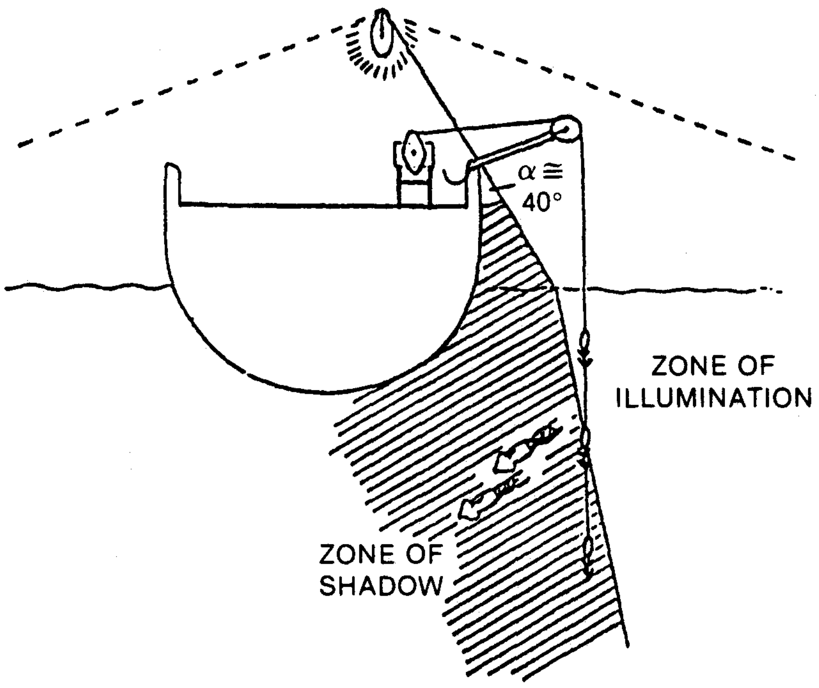


Figure 11. Light attraction for jigging (White Fish Authority 1976).

pack is inferior in both quality and workmanship (Learson and Ampola 1981).

OnBoard Handling Techniques

Japanese and European buyers are interested in "bloom" or body color of squid as a sign of freshness (Wilson and Gorman 1982). If not handled properly, squid undergo rapid spoilage. The time of the year the squid are harvested, as well as the amount of ice used during storage, has a definite beneficial effect on shelf life of squid (Ampola 1974).

Bulk icing, shoveling of the catch and dense packing of squid all lead to crushing, broken ink sacs, and broken (torn) skin, detracting from appearance as well as the overall organoleptic quality (Learson and Ampola 1981). Long-range operations require deep freezing and cold storage on board the fishing vessel (Arnold 1979).

Chilling Techniques.

(Japan Fisheries Workshop, Japan Fisheries Assoc; Deep Sea Trawlers Assoc.) To prevent loss of freshness, it is essential to lower squid temperatures immediately after capture by means of air or water cooling, or icing. There are two methods of icing: (1) the catch is cooled by dipping it in water which has been previously chilled; (2) the catch is cooled by spreading crushed ice over it, this method is the most commonly used by smaller vessels. To prevent damage from "piling on", squid should be carefully arranged in the fish box. After spreading crushed ice on top of the squid, the boxes should be stacked and covered. Ice is merely a means of retarding the loss of freshness relative to what would occur during storage at normal temperatures. The boxes should be stored in a refrigerated room ($3^{o}C \pm 1^{o}$).

As a general rule, freshness cannot be expected to last more than 1-2 days when ice storage is used. For icing efficiency, care should be given to the ratio of catch to ice weight, and to pre-handling of the catch (squid loses freshness quickly and if left more than 30 minutes on deck in normal temperatures, is no longer top quality). Ice should be applied in a 2:1 ratio to catch weight.

Shelf-life is increased with squid held in chilled seawater as compared to samples boxed at sea using ice. The average shelf-life for chilled-seawater-held squid is approximately five days (Learson and Ampola 1981).

Squid held in chilled-seawater and frozen immediately after landing are equivalent in quality to squid frozen at sea. Frozen-at-sea squid have a superior physical appearance after thawing, but sensory analysis of odor, flavor and texture show no substantial difference between chilled-seawater-held squid and frozen-at-sea squid (Learson and Ampola 1981).

Chilled-seawater systems aboard vessels have the potential of cooling squid rapidly and holding them at low temperatures with a minimum of physical damage. Holding chilled-seawater squid calls for about one-half ice and one-half seawater (by weight) and a 3:2 ratio of squid to chilled seawater. For commercial usage, a 3:1:1 squid to ice to water ratio is recommended (Learson and Ampola 1977).

Freezing at sea.

There is a major difference in freshness between on-board frozen (i.e., frozen aboard immediately after catch) and shore-frozen (frozen ashore after being transported in ice to the landing port). Sea-frozen squid are usually sorted by size and grade and then packed into 10-kg freezing trays. Freezing time varies according to species and type of freezing operation. For most squid, 5-8 hours are required for freezing, at a core temperature of -18°C. After freezing, squid are removed from the freezing tray and given a full glaze (two or three times), using clean water. The squid are then placed in plastic bags and packed in a box for freezer storage at -25°C or less, until they are unloaded (Japan Fisheries Workshop 1981).

Manual Processing (Ampola 1974)

To clean squid for further processing, each one must be washed in running water for removal of any foreign material or ink which could stain the meat. In heading and evisceration, the squid is laid flat, and the arms and tentacles are severed from the body by cutting through the head just in front of the eyes. The beak, which is located in a pouch at the base of the corona of appendages, is removed by squeezing the pouch from its attachment with thumb and forefinger.

To clean the body, the mantle is slit to the base of the tail and the visceral mass is removed. The mantle is laid flat and the visceral remnants, ink, and the pair of gills adhering to the mantle wall are scraped away. The pen (gladus) must then be removed. Some processors simply squeeze out or manually pull out the visceral mass and pen to leave the body intact. The cleaned parts are washed in running water. Removal of the skin from the mantle by hand is optional and laborious, and can be accomplished for some species by hand-peeling or scraping. Sometimes, blanching the animal in hot water (75^{o}-85^{o}C) for a few seconds will facilitate this process.

Iced squid--domestic processing.

Chilled squid transported to processing plants are rinsed with fresh water and placed in a brine tank containing ice. Squid are sized, graded and packed whole according to buyer specifications. Usually, a 10-kg net wt. carton is used, with sheets of cellophane between the layers of squid. Tentacles are packed underneath the mantle and the product is plate-frozen at -40^{o}C and stored at -20.6^{o}C (Learson and Ampola 1981).

Mechanical Processing (Learson and Ampola 1981)

A number of different physical, chemical and mechanical procedures have been used for skinning squid, including a warm-water dip, agitation, caustic acids, and enzyme solutions. Mechanical skinning and slicing machines are available to skin and split the mantles and to cut the squid into slices.

Preservation (Freezing and Canning)

Most of the U.S. squid harvest is exported to foreign countries in a frozen form. Upon arrival abroad, squid shipments may undergo any of several forms of processing and preservation (Wilson and Gorman 1982).

Freezing of squid should be done when the product is of top quality, as freezing will not mask a bad product. Slow freezing causes ice crystals to form in the flesh, which breaks down muscular tissue and renders a flabby product. If glazing is incomplete, the surface of the squid will dry, causing weight loss. Utmost care must be taken even during cold storage following freezing, since yeast, mold and some bacteria grow at temperatures between 0^{o} and $-10^{o}C$ (Japan Fisheries Workshop 1981).

Whole frozen squid, especially Loligo, have excellent freezing characteristics and can be stored whole or cleaned for periods up to 13 months. Whole squid, frozen for one year, can be thawed, cleaned and processed into breaded strips and refrozen, with an expected shelf-life of another 6-12 months (Learson and Ampola 1977). Storage temperatures of $-18^{o}C$ to $-30^{o}C$ are necessary.

Canned squid are usually processed as whole-boiled or minced-boiled products. Most of the U.S.-canned squid are produced in California, although a small amount is also canned by east coast processors. A summary of packaging standards, size grading, and quality requirements for squid has been produced by Veasey and Blaxall (1983). A list of U.S. squid processors is given in Appendix 3.

Nutritional Standards

The edible portion of squid, which consists of mantle, arms and tentacles, comprises 60-80% of the body weight and is greater than that of most finfish (20-50%) and shellfish (20-40%). Squid meat is equal to fish meat in protein content (16-20%) and amino acid composition (Ampola 1974) and has a food energy equivalent of about

85 calories per 100 grams of raw meat (Voss 1973; Ampola 1974; Stroud 1978).

The fat content of squid flesh has been reported as varying from 1-5% (Kitabayashi et al. 1963). This fat contains a considerable amount of cholesterol, but since the quantity of the fat is low, the amount of cholesterol present does not constitute a health hazard even to those on restricted diets (Korobkina et al. 1968). Nutrition information for raw Loligo squid is given in Table 7.

Product Acceptance

Many squid recipes have been formulated and tested for acceptability by taste panels, with excellent results. These include squid in chowder, thermidor-style and in other sauces (Ampola 1974). Squid meat has been used alone as an ingredient in stuffing and also in combination with clam meats and textured vegetable protein (Learson et al. 1971).

The sepia or ink of cephalopods has been refined and used by artists for many years. The pen and viscera can be processed to make a high-grade nitrogenous fertilizer or animal feed supplement (Ampola 1974). Many California, New York, and New Orleans restaurants note a widespread serving of stuffed squid (calamari) and breaded, whole, sauteed squid (N. Bane, per. comm.)

Although the U.S. market for squid exists largely within ethnic groups, squid flesh has many similarities to fish and shellfish products which are highly prized by U.S. consumers. Squid flesh, when it is processed and cleaned as skinless fillets, strips or rings, is white in appearance, boneless and relatively bland in

Table 7. Nutrition information - raw *Loligo* squid.

Content	Percent	Content	mg/100g	Content	mcg/100g
moisture	79.5	sodium	158	vitamin B1	20
protein	15.6	potassium	314	vitamin B2	70
fat	1.3	calcium	193	vitamin B12	1.3
ash	1.3	phosphorus	193		
carbohydrates	2.3	niacin	9		

(trace elements: iron 13.47 ppm; copper 7.02 ppm)

calories: 85/100g.

Source: Fact Sheet - Squid. National Marine Fisheries Service, Fisheries Development Division, P.O. Box 1109, Gloucester, MA.

flavor. Many squid products have been developed in the laboratory. The most preferred is as a "ring strip" (Learson and Ampola 1971).

Markets

Domestic.

The domestic market for squid in the United States is small and located primarily on the east and west coasts. Squid is sold in fresh fish markets of Boston, New York, San Francisco and other larger cities that have concentrations of people with Italian, Greek, Portugese, Hispanic, French or Asian backgrounds. At present, this ethnic market accounts for about ten million pounds of squid per year (Wagner 1985). In 1983, domestic fishermen along the east coast harvested well over 10,000 tons of *L. pealei* and at least 5,000 tons were utilized by U.S. consumers (Rathjen 1983).

Many U.S. wholesalers import frozen cleaned and whole squid from such countries as Taiwan, Korea, The People's Republic of China and Thailand. Very few wholesalers handle Gulf of Mexico squid (Wagner 1985).

Processors have shown a willingness to expand their production of squid in recent years because of increased demand by foreign countries for U.S.-caught squid (FMP, Atlantic Mackerel, Squid, and Butterfish Fisheries, MAFMC 1983).

The three main market forms of squid are frozen, fresh and canned. Table 8 presents various market forms for squid.

Squid are also widely used as bait for sportfishermen and commercial fishermen. A large portion of the incidental catch of squid is sold for this purpose.

Table 8. Market forms of squid.

Fresh	Semi Preserved
Whole ungutted	Pickled in vinegar after boiling
Split gutted	
Frozen	Dried
Whole ungutted	Sun dried meat
Split gutted	Smoked
Salted	Canned
Gutted	Whole ungutted
Pickled-salted in barrel	Split gutted
Hard-salted	Canned raw or precooked.
Split-gutted, salted in brine (sometimes after boiling)	Packed in own ink or oils (Market: Spain, U.S.).
Sprinkled with salt and dried in sun	Liver Oil (Market: Japan)

Source: -----"Seafood Exporter" fact sheet developed by the Fisheries Development Division, P.O. Box 1109, Gloucester, MA 01930.

Foreign.

Many countries of the world consume squid in large quantities as part of their regular diet. The larger consuming countries include Japan, China, Singapore, the Philippines, other Asian countries, Italy, Spain, and Portugal. Small amounts are also consumed in Greece, West Germany, France, Argentina, Chile and other parts of Latin America (Japan Fisheries Association Workshop 1981). Japan is the world's largest market for squid and draws supplies from a wide range of sources. Japanese demand for squid is of the magnitude of 500,000 mt per year, and this demand is increasing (Court 1980).

Species of squid exported to Japan from the U.S. are *Loligo pealei*, *Loligo opalescens* and *Illex illecebrosus*, augmenting the domestic supply with imports from other countries and Japanese fishing operations in foreign waters. To increase the domestic squid production, the Japanese have become involved with joint fishing ventures around the world. However, the number of joint ventures is expected to decline as participating countries move toward the development and harvest of their own fisheries resources (Kaczynski and Levieil 1980).

Spain is the second largest squid-consuming country in the world, with an estimated annual consumption of 75,000 mt per year of which 45,000 mt are *Loligo* spp. In 1980-84, the Spanish consumed approximately 28,000 mt of *L. pealei*, most of it being caught in U.S. waters by Spanish vessels; approximately 1,500 mt were supplied by U.S. producers (Wagner 1985).

Loligo entering the Spanish market is mostly two species: *L. vulgaris* (the European squid) and *L. pealei*. The *L. pealei* supply comes mainly from the northeastern United States in a sea-frozen form produced by Spanish trawlers. In addition, shoreside-frozen *L. pealei* is being exported to Spain by U.S. suppliers.

Strict import regulations imposed by Spain, and continuous quality problems, are concerns for U.S. suppliers (Wagner 1985). Greece and Italy are among the most promising new markets for U.S. squid. Other potential markets include Portugal, France, West Germany, Korea, Malaysia, Hong Kong, Mexico and Canada.

U.S. exports of frozen and canned squid for 1981-1984 are shown in Tables 9 and 10 and U.S. exports of squid by country of destination for 1983-1984 is shown in Table 11.

Future Trends (Milnes 1981)

The demand for squid in the future will be based largely on finished product quality and availability. Sea-frozen quality is becoming increasingly the only standard acceptable for squid in the whole form. It is now difficult to sell whole shoreside-frozen squid unless the squid is of a size which is in short supply. For shoreside-frozen squid, a profitable industry may depend upon converting to part-processed products, such as skinless tubes.

The demand for squid tubes, whether skinless or skin-on, is increasing rapidly. This is in part due to high import duties, making it cheaper to buy tubes rather than whole squids to avoid paying duties on the visceras and byproducts, which have little value, and partly because the tube is more convenient for handling in food factories.

Table 9. U.S. exports of frozen squid (1983-84).

Year	Volume (1,000 lb)	Value ($1,000)
1981	11,238	7,256
1982*	20,170	13,252
1983*	8,866	7,847
1984*	4,716	4,494

*Does not include joint venture landings.

Table 10. U.S. exports of canned squid (1981-84).

Year	Volume (1,000 lb)	Value ($1,000)
1981	10,287	4,120
1982	10,223	4,085
1983	683	379
1984	460	150

Source: Fisheries of the U.S. 1982-84. U.S. Department of Commerce.

Table 11. U.S. exports of squid by country of destination (1983-1984).

Country	1983 Volume (1000 lb)	1983 Value ($1,000)	1984 Volume (1000 lb)	1984 Value ($1,000)
Canada	1,403	799	2,376	1,002
Panama	7	7	(1)	(1)
Bermuda	88	64	9	8
Turks and Caicos Is.	-	-	(1)	(1)
Leeward and Windward Is.	-	-	21	18
Netherlands Antilles	(1)	(1)	7	18
French West Indies	56	46	2	2
Colombia	49	36	57	46
Venezuela	12	20	-	-
United Kingdom	322	255	294	176
Netherlands (Holland)	96	95	60	30
France	551	491	654	451
West Germany	217	144	129	44
Spain	3,889	3,359	503	282
Portugal	47	31	40	18
Italy	1,557	1,323	743	553
Greece	366	303	166	111
Cyprus	-	-	42	15
Hong Kong	-	-	414	250
Japan	5	7	240	158
Australia	-	-	148	120
Canary Is.	220	165	158	117
South Africa (Rep. of)	66	53	70	38
Puerto Rico	47	69	100	69
Mexico	-	-	164	130
Total	9,012	7,237	6,399	3,643

(1) less than 1,000 lb and $1,000

Source: Fisheries of the U.S., 1985. U.S. Department of Commerce.

RECREATIONAL USE

Over 67 species of fish are listed as being taken by marine anglers along the Atlantic and Gulf Coasts (U.S. Marine Recreational Fishery Statistics 1981-1982). Sportfishermen have voiced concern about the commercial utilization of *Loligo* in the Gulf of Mexico; their major concern is the lack of knowledge on the predator/prey relationships between *Loligo* and major food and game fish. A recent article in *Marlin* Magazine states, "Squid is an important forage species for food and game fish, sometimes forming the major food for tuna, marlin and swordfish. The level of abundance of forage species needed to support an abundance of food and game fish is not yet known by scientists. Although squid is currently commercially utilized on a world-wide basis, the schooling behavior of squid makes them vulnerable to human predation and overfishing".

A commercial squid fishery, however, would probably have little impact on recreational fisheries, since squid are short-lived and probably die after spawning. A commercial fishery would generally exploit only spawning individuals which are normally eliminated by natural mortality. However, the predator/prey impact of a *Loligo* fishery is an issue which should be considered if a commercial squid fishery is to be established in the Gulf of Mexico.

Currently, *Loligo* is one of the bait species utilized by recreational and commercial fishermen in the Gulf of Mexico. It is also used as bait aboard commercial longline vessels and private/charter boats, because of its attraction for tuna, marlin, or swordfish.

INFORMATION NEEDS

Taxonomy

Much work has been done on the taxonomy of *L. pealei* (Drew 1911, 1919; Voss 1956; LaRoe 1967; Cairns 1976; Cohen 1976; Roper et al. 1984). However, there remains some controversy concerning the distinction between the loliginid squids, *L. brevis*, *L. pealei* and *L. plei* in the early stages of development. The larger problem, however, lies in the distinction between *L. pealei* and *L. plei*. While it is generally agreed by most squid experts that the identification of species can be made with some difficulty (Voss 1956; Cohen 1976; Whitaker 1978); most problems are encountered when distinguishing the very small specimens of these two species. This becomes especially important when planning stock assessments for a single species.

Biology

Very little study has been done specifically on the biology of *L. pealei* from the northern Gulf of Mexico (Voss 1952, 1956, 1960; Hixon 1980a; Hixon et al. 1980; Vecchione 1985). More studies should be directed toward the understanding of the biology and population dynamics of this species. These include: (1) determination of spawning seasons, nursery areas, and migration patterns; (2) assessment of age and growth, reproduction, spawner-recruit relationships and mortality; and (3) enhancement of knowledge of predator/prey relationships, especially as they impact recreational fisheries.

Fisheries

If the potential development of a commercial squid fishery is to be considered in the Gulf of Mexico, serious thought must be given to the type of gear used to assess the stock, as well as the development of harvesting and assessment techniques for these squid.

Major fishery research needs include: (1) identification and development of harvesting gear, and detection and capture techniques most suitable for the assessment of Gulf of Mexico squid stocks; (2) implementation of systematic yearly surveys throughout the northern Gulf of Mexico to determine seasons and areas of squid concentrations; (3) determination of stock assessment models best suited for assessing squid; (4) stock assessments to obtain standing stock and biomass estimates; (5) determination of the effects of environmental factors on stock density; (6) catch/effort statistics to estimate *Loligo* yield potentials; and (7) determination of the feasibility of a potential commercial squid fishery.

Harvesting/Processing Techniques

Loligo tend to occur over rough-bottomed areas or near submerged obstructions where bottom trawling is hazardous. Major emphasis should be placed on more efficient capture techniques for the economical exploitation of Gulf squid. Harvesting techniques using the midwater trawl or lampara nets with lights may prove to be an effective capture technique for Gulf squid. Rathjen et al. (1979) notes that the refinement of light attraction and subsequent capture techniques may be desirable before any large-scale harvesting of squid at night can take place using this method.

Processing-freezing capacity or other quick-chilling methods aboard commercial vessels which harvest squid must be given prime consideration if a quality product is to be delivered. Lack of freezing or quick-chilling capacity aboard harvest vessels could prove a deterrant to the development of a squid fishery in the Gulf.

Bibliography

Bibliographic sources for squid are currently available and well documented in recent publications (Hixon 1980; Cohen 1984; LSU-CFI 1985). Additional bibliographic categories for squid are listed in the publications of Arnold (1979) and the 1983 FAO Fisheries Technical Paper 231. Other relevant bibliographic sources are cited by Summers (1983) species review of *Loligo pealei*, in P.R. Boyle (ed) *Cephalopod Life Cycles* Volume 1, Academic Pres. Literature cited in this profile will also constitute a sizeable bibliography on squid, with special emphasis on *Loligo pealei*.

Other sources of information:

E. Brian Veasey and Martha O. Blaxall. 1983. *Export Opportunities for United States Producers of Squid*. Prepared for the West Coast Fisheries Development Foundation by BBH Corporation, Washington, D.C.

Foreign Squid Imports Directory. Write:

Squid Directory
National Marine Fisheries Service
Utilization and Development Branch
P.O. Box 1109
Gloucester, MA 01931-1109.

Seafood Exporter Directory

Available from above NMFS address.

Squid Expertise (Gulf of Mexico Squid)

Mr. Warren Rathjen
Center for Fisheries Engineering Studies
Florida Institute of Technology
Melbourne, FL 32901

Dr. Gilbert Voss
Rosenstiel School of Marine and Atmospheric Science
University of Miami
4600 Rickenbacker Causeway
Miami, FL 35159

Dr. Gilbert Bane
Coastal Fisheries Institute
Center for Wetland Resources
Louisiana State University
Baton Rouge, LA 70803-7503.

Dr. Michael Vecchione
NMFS Systematics Laboratory,
Invertebrate Zoology
National Museum of Natural History
Smithsonian Institution
Washington, D.C. 20560

Dr. CFE Roper
Department of Invertebrate Zoology
National Museum of Natural History
Smithsonian Institution
Washington, D.C. 20560.

Dr. Roger Hanlon
Marine Biomedical Institute
University of Texas Medical Branch
200 University Blvd.
Galveston, TX.

References

Adam, W. 1937. Resultats scientifiques des croisieres du Navire-Ecole Belge "Mercator." IV Cephalopoda, Mem. Mus. Roy. Hist. Natur. Belg., Ser. 2, 1(9):43-82.

Allen, R.B. and R.E. Taber. 1974. Light attraction for squid in New England Waters. New England Fisheries Development Program. NMFS, Gloucester, MA. 14 p.

Amos, D. 1983. Squid - Finding and catching squid: A beginner's guide, p. 73-76. In National Fisherman 1983 Yearbook. Journal Publications Inc. Camden, MA.

Amos, D. and R. DeMello. 1982. Application of multi-frequency echo sounders to squid detection, p. 45-52. In Proc. of the International Squid Symposium, Aug. 1982, Boston, MA. UNIPUB New York, 390 p.

Armal, E.H. and H.A. Carr. 1980. Experimental fishing for squid with lights, in Nantucket Sound. Mar. Fish. Rev., 42(7-8):51-56.

Ampola, V. G. 1974. Squid--its potential and status as a U.S. food resource. Mar. Fish. Rev. 36(12):28-32.

Araya, H. and M. Ishii. 1974. Information on the fishery and ecology of the squid *Doryteuthis bleekeri* (Keferstein) in waters of Hokkaido. Bull. Hokkaido Reg. Fish Res. Lab. 40:1-30.

Araya, H. 1976a. Migration and fishing ground of winter subpopulations of the squid, *Todarodes pacificus* Steenstrup, in the northern waters of Japan. Bull. Hokkaido Reg. Fish. Res. Lab. (41):119-129.

Araya, H. 1976b. Distribution and migration of the winter subpopulations of Todarodes pacificus (Steenstrup) in the northern waters of Japan. Fish. Rep. F.A.O., (170, Suppl. 1:18-23.

Armatunga, T. 1983. The role of cephalopods in the marine ecosystem, p. 379-415 In Advances in assessment of world cephalopod resources. J.F. Caddy (ed) FAO Fish. Tech. Rep. 231; 452 p.

Arnold, G.P. 1979. Squid. A Review of their biology and fisheries. Lab. Leafl. MAFF Div. Fish. Res. 48:37 p.

Baker, deC. A. 1957. Underwater photographs in the study of ocean squid. Deep Sea Res. 4:126-129.

Ben-Yami, M. 1976. Fishing with light. FAO Fishing Manual. Fishing News Books Ltd., Farnham, U.K.; 121 p.

Bidder, A.M. 1950. The digestive mechanism of the European squids Loligo vulgaris, Loligo forbesii, Alloteuthis media, and Alloteuthis subulata. Q. J. Microsc. Sci. 91: 1-43.

Bigelow, H.B. and M. Leslie. 1930. Reconnaissance of the waters and plankton of Monterey Bay, July 1928. Bull. Mus. Comp. Zool. Havard Coll. 70(5):427-581.

Boletzky, S.V. 1974. The "larvae" of cephalopods: A review. Thal. Jugosl. 10:45-76.

Borderias, J.A. 1981. Technology of squid in Spain, p. 167-172 in: Proceedings of the International Squid Symposium. August 1982. UNIPUB Publ; 390 p.

Burukovski, R.N. and A.N. Vovk. 1974. Some questions on the oogenesis of the Atlantic longfin squid (Loligo pealei) of Georges Bank. Arkh. Anat. Gistol Embriol, 66(5):44-50. Issued also as Transl.Ser.Fish Mar. Serv. Can. (3711).

Cahill, P. and W.E. Mansfield. 1984. Squid nets of the Mid-Atlantic. Marine Resources Advisory Virginia Sea Grant, VIMS/William and Mary No. 27; 16 p.

Cairns, S.D. 1976. Cephalopods collected in the straits of Florida by the R/V GERDA. Bull. Mar. Sci. 26:233-272.

Clarke, G.L. and E.J. Denton. 1962. Light and Animal Life. 456-68 in: M.N. Hill (ed) The Sea Vol. 1. Physical Oceanography. Wiley Interscience. New York

Clarke, M.R. 1966. A review of the systematic and ecology of oceanic squids. Adv. Mar. Biol. 4:91-360.

Cohen, A.C. 1976. The systematics and distribution of Loligo (Cephalopoda, Myopsida) in the westearn Atlantic with descriptions of two new species. Malacologia 15:299-367.

Court, W. 1980. Japan's squid industry. Mar. Fish. Rev. 42(7-8):1-9.

Drew, G. 1911. Sexual activities of the squid, Loligo pealei (LeSueur) 1. Copulation, egg laying and fertilization. J. Morphal 22:327-359.

Fields, W.G. 1965. The structure, development, food relations, reproduction and life history of the squid Loligo opalescens Berry. Calif. Dept. Fish Game. Fish. Bull. 131:1-108.

Flores, E.E.C., S. Igarashii, and T. Mikami 1978. Studies on squid behavior in relation to fishing III. On the optomotor response of squid, Todarodes pacificus Steenstrup, to various colors. Bull. Fac. Fish. Hokkaido Univ. 29(2):131-140.

Flores, E.E.C. 1979. Studies on the maintenance and behavior of the

Japanese common squid, Todarodes pacificus Steenstrup, in relation to fishing. Doctoral dissert., Hokkaido Univ., Hokodate, Japan; 97 p.

Flores, E.E.C. 1981. Light attraction techniques in squid fishing p. 55-67 in: Proc. of the International Squid Symposium, Aug 1982, Boston, MA. UNIPUB, New York; 390 p.

Frost, N. and H. Thompson. 1934. Squid. Rep. Newfoundl. Fishery Res. Comm. 1(4):25-34.

Griswold, C.A. and J. Prezioso. 1981. In situ observations on reproductive behavior of the longfinned squid, Loligo pealei. Fish. Bull. 78:945-947 p.

Haefner, P.A. 1964. Morphometry of the common Atlantic squid Loligo pealei and the brief squid Lolliguncula brevis in Delaware Bay, Chesapeake Sci. 15:138-144.

Hanlon, R.T., R.F. Hixon, and W.H. Hulet. 1983. Survival, growth and behavior of the loliginid squids Loligo plei, Loligo pealei and Lolliguncula brevis (Mollusca:Cephalopoda) in closed sea-water systems. Biol. Bull. 165:637-685.

Hayashi, Y. 1970. Studies on the maturity condition of the common squid: 1. A method of expressing maturity conditions by numerical values. Bull. Jap. Soc. Sci. Fish. 36(10):995-99.

Hixon, R.F. 1980a. Growth, reproductive biology, distribution and abundance of three loliginid squid, (Myopsida, Cephalopoda) in the northwest Gulf of Mexico. Ph.D. dissertation, Univ. of Miami, Coral Gables, FL; 223 p.

Hixon, R.F. 1980b. Potential commercial squid resources of the Gulf of Mexico - An updated review, p. 51-73. in: Proc. of a Workshop for Potential Fishery Resources of the Northern Gulf of Mexico (MS-AL and LA Sea Grant) New Orleans, LA (USA) Mar. 4-5, 1980.

Hixon, R.F., R.T. Hanlon, S.M. Gillespie and W.L. Griffin. 1980a. Squid fishery in Texas: biological, economic and market considerations. Mar. Fish. Rev. 42(7-8):44-50.

Hixon, R.F., R.T. Hanlon and W.H. Hulet. 1980b. Growth, fecundity and estimated life span of three loliginid species in the northwestern Gulf of Mexico. J. Shellfish Res. (1):116.

Hixon, R.F., R.T. Hanlon, and W.H. Hulet. 1981. Growth and maximal size of the longfinned squid Loligo pealei in the northwestern Gulf of Mex. J. Shellfish Res. 1:181-185.

Hochberg, F.G. and W.G. Fields. 1980. Cephalopoda: The squids and octopuses, Chapter 17. in: R.F. Morris (ed) Intertidal Invertebrates of California, Stanford Univ. Press. Stanford, Calif.

Holme, N.A. 1974. The biology of Loligo forbesi Steenstrup (Mollusca, Cephalopoda) in the Plymouth area. J. Mar. Biol. Ass. U.K. 54:481-503.

Hurley, A.C. 1976. Feeding behavior, food consumption, growth, and respiration of the squid, Loligo opalescens, raised in the laboratory. Fish. Bull. 74:176-182.

Hurley, A.C. 1978. School structure of Loligo opalescens. Fish Bull. 76(2):433-442.

Ikehara, K., S. Kasahara, I.Okachi, T. Shumizu, and M. Hamabe. 1977.

(Ecology and maturity process in Loligo edulis budo WAKIYA et ISHIKAWA fished in the waters around the Oki Islets in the western Japan Sea.) (Engl. abstr.) Bull. Jpn. Sea Reg. Fish. Res. Lab. 28:29-49.

International Commission for the Northwest Atlantic Fisheries. 1978. Report of standing committee on research statistics, Part B: Special meeting on squid, Feb. 1978. Redbook Intl. Comm. N.W. Atlant. Fish; 21-33.

Ishii, M. 1977. Studies on the growth and age of the squid Ommastrephes bartrami (LeSueur) in: The Pacific of Japan. Bull. Hokkaido. Reg. Fish. Res. Lab. 42:25-36.

Jefferts, K. 1983. Squid distribution, biology and life history, p. 3-10. in: Proc. of the West Coast Squid Symposium, Newport, Oregon Feb; 1983. West Coast Fisheries Development Foundation and Oregon State Sea Grant Marine Advisory Program; 149 p.

Juanico, M. 1979. Contribuicao ao estudio da biologia dos Cephalopoda, Loliginidae do Atlantico sul occidental, entre Rio de Janiero e Mar del Plata. Ph.D. Dissertation. Univ. Sao Paulo, Sao Paulo, Brazil; 102 p.

Juanico, M. 1983. Squid maturity scales for population analysis, p. 341-78 in: J.F. Caddy (ed), Advances in assessment of world cephalopods. FAO Fish. Tech. Pap. (231);452 p.

Kaczynski, V. and D. Levieil. 1980. International joint ventures in world fisheries. Washington Sea Grant Tech. Report.

Kalikstein, P.H. 1974. The marketability of squid. Sea Grant Rep. MITSG 72-74, Mass. Inst. Tech., Cambridge; 108 p.

Karpov, K.A., and G.M. Cailliet. 1978. Feeding dynamics of Loligo opalescens. Calif. Dept. Fish Game Bull. 169: 45-65.

Kato, S. and J.E. Hardwick. 1976. The California squid fishery. Fish. Rep. F.A.O. 170:107-127.

Kawaguchi T. and T. Nazumi. 1972. Echo traces of the squid Ommastrephes sloani pacificus in the central waters of the Japan Sea. FAO Fish. Circ. 142:15-25.

Kitabayashi, K., K. Nakamura, K. Shudo and S. Ishikawa. 1963. Biochemical studies on squid (XXI): Re-examination on crude fat content of squid meat (in Jap., Engl. abst.) Hokkaido Reg. Fish. Res. Lab. Bull. 27:52-56.

Kolator, I.I. and D.P. Long. 1979. The foreign squid fishery off the northeast United States coast. Mar. Fish. Rev. 41(7):1-15.

Korobkina, G.S., E.H. Danilov, N.N. Kalinina, K.F. Tsurkova and N.A. Andreeva. 1968. Nutritive value of fresh-frozen squid (in Russ.) Rybn. Khoz 44(1):68-69.

Kristensen, I. 1959. The coastal waters of the Netherlands as an environment of molluscan life. Basteria 23 (supplement):18-46.

Lange, A.M.T. 1980. The biology and population dynamics of squids Loligo pealei (LeSueur) and Illex illecebrosus (LeSueur) from the Northwest Atlantic. M.S. Thesis, Univ. of Washington, Seattle; 178 p.

Lange, A.M.T. and K.K. Johnson. 1981. Dorsal mantle length - total weight relationships of squids Loligo pealei and Illex illecebrosus from the Atlantic Coast of the United States. NOAA Tech. Rept. NMFS. SSRF-745; 17 p.

Lange, A.M.T. and M.T. Sissenwine. 1980. Biological consideration relevant to the management of squids (*Loligo pealei* and *Illex illecebrosus*) of the Northwest Atlantic Mar. Fish Rev. 42(7-8):23-38.

Lange, A.M.T. and Sissenwine. 1983. Squid resources in the Northwest Atlantic, p. 21-54 in: J.F. Caddy (ed), Advancements in world cephalopod resources. FAO Fish. Tech Pap. (231);452 p.

Lange, A.M.T. 1984. An assessment of the longfinned squid resources of the northeastern United States, Autumn 1984. National Marine Fisheries Service. Woods Hole Laboratory Reference Document No. 84-37; 24 p.

LaRoe, E.T. 1967. A contribution to the biology of the Loliginidae (Cephalopoda: Myopsida) of the tropical Western Atlantic. Masters Thesis, Univ. of Miami; 200 p.

Learson, R.J. and V.G. Ampola. 1977. Care and maintenance of squid quality. Mar. Fish. Rev. 39(7):15-16.

Learson, R.J. and V. Ampola. 1981. The status of squid processing and preservation technology in the northeasternd United States; in: Proc. of the International Squid Symposium. Aug. 1981, Boston, MA. UNIPUB, New York; 390 p.

Learson, R.J. and B.J. Tinker and I.J. Ronsivalli. 1971. Fish proteins as binders in processed fishery products. Comm. Fish. Rev. 33(2):46-50.

Leipper, D. 1954. Physical oceanography of the Gulf of Mexico, p. 119-137 in: Gulf of Mexico, its Origin, Waters and Marine Life. Bull. U.S. Bur. Comm. Fish., 89(55).

Lipinski, M. 1979. Universal maturity scale for the commercially important squid. The results of a maturity classification of the Illex illecebrosus population for the years 1973-77. ICNAF Res. Doc. 79/21/38. Serial 5364;40 p.

Lipka, D.A. 1975. The systematics and zoogeography of cephalopods from the Gulf of Mexico. Ph.D. Dissertation. Texas A&M Univ, College Station; 347 p.

Louisiana State University, Center for Wetland Resources. 1985. Biology, Ecology and Economics of Squid and Buttterfish of the Northern Gulf of Mexico. LSU-CFI-85-24. LSU Baton Rouge, LA; 90 p.

Lux, F.E., W.D. Handwork and W.F. Rathjen. 1974. The potential for an offshore squid fishery in New England. Mar. Fish. Rev. 36(12):24-27.

Lyle, C.H. 1968. Historical statistics. The squid fishery. U.S. Bur. Comm. Fish. Cur. Fish. Stat. 4833; 19 p.

Macy, W.K.III. 1980. The ecology of the common squid, Loligo pealei LeSueur, 1821 in Rhode Island Waters. Ph.D. Thesis Univ. Rhode Island, Kingston; 249 p.

Macy, W.K. III. 1982a. Feeding patterns of the longfinned squid, Loligo pealei, in New England waters. Biol. Bull. (Woods Hole) 162:28-38.

Macy, W.K.III. 1982b. Development and application of and objective method for classifying longfinned squid, Loligo pealei, into sexual maturity stages. Fish. Bull. 80(3):449-459.

Mangold-Wirz, K. 1963. Biologie des cephalopodes benthiques et nectoniques de la Mer Catalane. Vie Milieu, Suppl. No. 13;285 p.

Mangold, K. and D. Forsch. 1977. A reconsideration of factors associated with sexual maturation. Symp. Zool. Soc. Lond. 38:541-555.

Matsui, T., Y. Teramoto and Y. Kaneko. 1972. Target strength of squid. F.A.O. Fish. Pap. 142:27-29.

McMahon, J.J. and W.C. Summers. 1971. Temperature effects on the developmental rate of squid (Loligo pealei) embryos. Biol. Bull. (Woods Hole) 141:561-567.

McGowan, J.S. 1954. Observations on the sexual behavior and spawning of the squid, Loligo opalescens at La Jolla, California. Calif. Fish. Game Bull. 40:47-54.

Mercer, M.C. 1969a. A.T. Cameron Cruise 130, otter-trawl survey from southern Nova Scotia to Cape Hatteras, March-April 1967. Fish. Res. Board Can. Tech. Rep. 103; 24 p.

Mercer, M.C. 1969c. A.T. Cameron Cruise 157, otter-trawl survey of the southwestern North Atlantic, February, 1969. Fish. Res. Board Can. Tech. Rep. 122; 47 p.

Mesnil, B. 1977. Growth and life cycle of squid Loligo pealei and Illex illecebrosus from the northwest Atlantic. ICNAF Sel. Pap. 2:55-69.

Mid-Atlantic Fishery Management Council. 1982. Incidental catch relationship among the foreign fisheries for the squids, Atlantic mackerel, butterfish, and the hakes. Revised; 69 p.

Mid-Atlantic Fishery Management Council. 1983. Amendment No. 1 to the Fishery Management Plan for Atlantic mackerel, squid, and butterfish fisheries.

Milliman, J.D. and F.T. Manheim. 1978. Observation in deepscattering layers off Cape Hatteras. Deep Sea Res. 15:505-507.

Milnes, J. 1981. Perspective on the Spanish squid market, p. 317-21 in: Proc. of the International Squid Symposium Aug. 1981, Boston, MA. UNIPUB, New York; 390 p.

Morejohn, G.V., J.T. Harvey and L.T. Krasnov. 1978. The importance of Loligo opalescens in the food web of marine invertebrates in Monterey Bay, California, p. 67-98, in: Recksiek, C.W. and H.W. Frey (eds.) Biological, Oceanographic and Acoustic Aspects of the Market Squid, Loligo opalescens. Calif. Dept. Fish Game, Fish. Bull. 169;185 p.

National Marine Fisheries Service. 1984. U.S.-Japan Squid Survey, NISSHIN MARU No. 201, Cruise Report 1, (Oct. - Nov., 1984); 18 p.

National Marine Fisheries Service. 1985. U.S.-Japan Squid Survey, NISSHIN MARU No. 201 Cruise Report 2 (Apr. - May, 1985); 18 p.

Ogura, M. 1981. Fishing gear and method for squids in Japan. Proceedings of the Biology and Resource Potential of Cephalopods. Proc. Natl. Mus. of Victoria, Melbourne, Australia.

Ogura, M. and T. Nasumi. 1976. Fishing lamps and light attraction for squid jigging. Fish. Rep. F.A.O. (120, Suppl. 1) 93-98.

Okiyama, M. 1965. On the feeding habits of the common squid, Todarodes pacificus Steenstrup, in the off-shore region of the Japan Sea. Bull. Japan Sea Reg. Fish Res. Lab., 14:31-41.

Okutani, T. and J.A. McGowan. 1969. Systematic distribution and abundance of the epiplanktonic squid (Cephalopoda, Decapoda) larvae of the California coast. April 1954 - March 1957. Bull. Scripps Inst. Oceanogr. 14:1-90.

Oliphant, M.S., and Marine Fisheries Statistical Staff. 1973. California marine fish landings for 1971. Calif. Dept. Fish Game Fish. Bull. 159:1-49.

Packard, A. 1972. Cephalopods and fish: the limits of convergence. Biol. Rev. 47:241-307.

Peterson, A.E. 1981. U.S. interest in the squid fishery, p. 3-50 in: Proc. of the International Squid Symposium Aug 1981, Boston, MA. New England Fishery Development Foundation. UNIPUB, New York; 390 p.

Pinkas, Leo. 1970. The California marine fish catch for 1969. Calif. Dept. Fish Game Fish. Bull. 153:1-47.

Rathjen, W.F. 1973. Northwest Atlantic squids. Mar. Fish. Rev. 35(12):20-16.

Rathjen, W.F. 1983a. Present Status of North American Squid Fisheries. Mem. of the National Museum Victoria 44: 255-260.

Rathjen, W.F. 1983b. East Coast Squid Fisheries p. 11-12 in: Proc. of the West Coast Squid Sympos. Newport, Ore., Feb. 1983.

Rathjen, W.F. 1984. Squid Fishing Techniques, NMFS Gloucester; Gulf and South Atlantic Fisheries Development Foundation Inc. Publ; 14 p.

Rathjen, W.F., R.T. Hanlon and R.F. Hixon. 1977. Is there squid in your future? Proc. Gulf and Carib. Fish. Inst. 29:14-25.

Rathjen, W.F., R.F. Hixon and R.T. Hanlon. 1979. Squid fishery resources and development in the Northwest Atlantic and Gulf of Mexico. Proc. Gulf and Carib. Inst. 31:145-157.

Ricker, W.E. 1979. Growth rates and models, p. 677-743 in: W.S. Hoar, D.J. Randall and J.R. Brett (eds.). Fish Physiology, Vol. VIII, Academic Press, Inc., N.Y.

Roithmayr, C.M. 1970. Airborne low-light sensor detects luminescing fish school at night. Comm. Fish. Rev. 32 (12):42-51.

Roper, C.F.E., M.J. Sweeney and C.E. Nauen. 1984. FAO species catalogue. Vol. 3. Cephalopods of the World. An annotated and illustrated catalogue of species of interest to fisheries. FAO Fish Synop., (125)3: 377 p.

Schwartz, J.W. 1972. Final report from FAO fellowship to Spain, Portugal and Italy. Rome: United Nations Food and Agriculture Organization; 44 p.

Scofield, W.L. 1951. Purse seines and other roundhaul nets in California. Calif. Dept. Fish Game Fish. Bull. 81:1-83.

Scott, J.W. 1978. Distribution of squid, *Illex illecebrosus*, on the Scotian Shelf 1970-76 Sel. Pap. Int. Comm. N.W. Atlant. Fish. (3):93-96.

Selman, K. and J.M. Arnold. 1977. An ultrastructural and cytochemical analysis of oogenesis in the squid *Loligo pealei*. J. Morphol. 152:381-400.

Serchuk, F. and W.F. Rathjen. 1974. Aspects of the distribution and abundance of the longfinned squid, *Loligo pealei*, between Cape Hatteras and Georges Bank. Mar. Fish Rev. 36(1):10-17.

Sissenwine, M.P. and E. Bowman. 1978. An analysis of some factors affecting the catchability of fish in bottom trawls. ICNAF Res. Bull. (13):8-17.

Smith, P.F. 1954. Further measurements of the sound scattering properties of several marine organisms. Deep Sea Res. 2:71-79.

Soto, T. and H.Hatanaka. 1983. A review of assessment of Japanese distant-water fisheries for cephalopods, p. 145-183. in: J.F. Caddy (ed), Advances in Assessment of World Cephalopod Resources. FAO Fish. Pub. (231):452 p.

Squire, J.L. 1972. Apparent abundance of some pelagic marine fishes off the southern California coast as surveyed by airborne monitoring program. Fish. Bull. 70(3):1005-1019.

Squires, H.J. 1957. Squid, Illex illecebrosus (LeSueur) in the Newfoundland fishing area. J. Fish. Res. Bd. Can. 14(50):693-728.

Stevenson, J.A. 1934. On the behavior of the longfinned squid Loligo pealei (LeSueur). Can. Fld. Nat. 48:4-7.

Stroud, G.D. 1978. Squid. Torry Advis. Note 77:1-6.

Suda, A. 1973. Development of fisheries for nonconventional species. J. Fish. Res. Bd. Can. 30:2121-2158.

Summers, W.C. 1967. Winter distribution of Loligo pealei determined by exploratory trawling. Biol. Bull. (Woods Hole) 133;489 p.

Summers, W.C. 1968. The growth and size distribution of current year class Loligo pealei. Biol. Bull. (Woods Hole) 135:366-377.

Summers, W.C. 1969. Winter population of Loligo pealei in the mid-Atlantic Bight. Biol. Bull. (Woods Hole) 137:202-216.

Summers, W.C. 1971. Age and growth of Loligo pealei, a population study of the common Atlantic coast squid. Biol. Bull. (Woods Hole) 141:189-201.

Summers, W.C. and J.J. McMahon. 1970. Survival of unfed squid, Loligo pealei, in an aquarium. Biol. Bull. (Woods Hole) 138:389-396.

Summers, W.C. and J.J. McMahon. 1974. Studies on the maintenance of adult squid (Loligo pealei). I. Factorial survey. Biol. Bull. 146:279-290.

Summers, W.C., J.J. McMahon and G.N.P.A. Ruppert. 1974. Studies on the maintenance of adult squid (Loligo pealei). II. Empirical extensions. Biol. Bull. 146:291-301.

Summers, W.C. 1983. Chapter 8. Loligo pealei p. 115-142. in: P.R. Boyle, (ed.) Cephalopod Life Cycles. Vol. 1. Species Accounts. Academic Press, London; 475 p.

Suzuki, T. 1963. Studies on the relationship between current boundary zones in water of southeast Hokkaido and migration of squid, Ommastrephes sloani pacificus (Steenstrup) Mem. Fac. Fish. Hokkaido Univ. 11(2):75-153.

Suzuki, T., Tashiro, M. and Yamagishi, Y. 1974. Studies on the swimming layer of squid Todarodes pacificus Steenstrup as observed by a fish finder in the offshore part of the Japan Sea. Bull. Fac. Fish. Hokkaido Univ. 25(3):238-246.

Tardent, P. 1962. Keeping Loligo vulgaris L. in the Naples aquarium. Bull. Inst. Oceanogr. Monaco. Spec. No. 1A:41-46 (Ier. Congr. Int. Aquarid, 1760).

Tinbergen, L. and J. Verwey. 1945. Zur Biologie von Loligo vulgaris

Lam. Arch. Neerland. Zovl. 7(1,2):213-286. (Transl. from Dutch) Fish. Mar. Ser., Halifax, N.S., Transl. Ser. No. 2733 (revised).

Thompson, D.W. 1966. On Growth and Form. Cambridge University Press. London; 346 p.

U.S. Department of Commerce. 1979a. Foreign fishing regulations Fed. Regist., February 11, 1977, Part IV.

______1977b. Fishery conservation and management - foreign fishing. Fed. Regist., November 28, 1977, Part III.

-----1982. Fisheries of the United States, 1981. Current Fishery Statistics No. 8120.

-----1983. Fisheries of the United States, 1982. Current Fishery Statistics No. 8300.

-----1984. Fisheries of the United States, 1983. Current Fishery Statistics No. 8320.

-----1985. Fisheries of the United States, 1984. Current Fishery Statistics No. 8360.

Veasey, E.B. and M.O. Blaxall. 1983. Export opportunities for United States Producers of squid. Prepared for West Coast Fisheries Development Foundation by BBH Corporation, Washington, D.C. 47 p.

Vecchione, M. 1981. Aspects of early life history of *Loligo pealei* (Cephalopoda: Myopsida). J. Shellfish Res. 1:171-180.

Vecchione, M. and G. R. Gaston. 1985. In situ observations on the small scale distribution of juvenile squids (Cephalopoda Loliginidae) on the northwest Folorida shelf. Vie Milleu, 35(3/4):231-235

Verrill, A.E. 1881. The cephalopods of the northwestern coast of

America II: The smaller cephalopods including the squids and the octopus with other allied forms. Trans. Conn. Acad. Sci 5:260-446.

Verrill, A.E. 1882. Reports of the cephalopods of the northeastern coast of America. U.S. Comm. of Fish and Fisheries for 1879:1-244.

Vinogradov, V.I. and A.S. Noskov. 1979. Feeding of short-finned squid, Illex illecebrosus, and longfinned squid, Loligo pealei, of Nova Scotia and New England, 1974-1975. Int. Comm. N.W. Atl. Fish. Sel. Pap. 5:31-36.

Voss, G.L. 1952. A revision of the loliginid squids of the western Atlantic. Masters Thesis, Univ. of Miami, Coral Gables, FL. 83 p.

Voss, G.L. 1954. Cephalopods of the Gulf of Mexico. Fish. Bull. 89:475-478.

Voss, G.L. 1956. A review of the cephalopods of the Gulf of Mexico. Bull. Mar. Sci. Gulf Carib. 6:85-175.

Voss, G.L. 1960. Potentialities for an octopus and squid fishery in the West Indies. Proc. Gulf Carib. Fish. Inst. 12:129-135.

Voss, G.L. 1971. The cephalopod resources of the Caribbean Sea and adjacent regions, p. 307-323. in: Symposium on investigations and resources of the Caribbean Sea and adjacent region papers on fishery resources. FAO, Rome.

Voss, G.L. 1973. Cephalopod resources of the World. FAO Fish Circ. 149:1-75.

Voss, G.L., L. Opresko and R. Thomas. 1973. The potentially commercial species of octopus and squid of Florida, the Gulf of Mexico and Caribbean Sea. Univ. of Miami Sea Grant Program Field Guide Series 2:1-33.

Voss, G.L. 1984. A review of the squid resources of the southeast (unpubl.).

Voss, G.L. and T.F. Brakoniecki. 1985. Squid resources of the Gulf of Mexico and Southeast Atlantic coasts of the United States, p. 27-37 in: NAFO Scientific Council Studies No. 9, Special Session on Squids, Sept. 1984, Dartmouth, Nova Scotia, Canada; 175 p.

Vovk, A.N. 1969. Prospects for a squid *Loligo pealei* (LeSueur) fishery. Rybn. Khox. 10:7-9, Bur. Comm. Fish., Off. For. Fish., U.S. Dept. Int: 1-3.

Vovk, A. 1972a. Feeding habits of the North Amnerican squid *Loligo pealei* (LeSeur). Transl. Atl. Sci. Res. Inst. Fish. and Oceanog. 42:141-151 (English Transl., Fish. Mar. Ser. Canada, Trans. 3304; 14 p.)

Vovk, A. 1972b. Method of determining maturing stages in gonads of the squid *Loligo pealei*. Zool. Zh., 51:127-132 (English transl.: Fish. Res. Bd. Canada, Trans. 2337; 9 p.)

Wagner, A.C. 1985. Squid market analysis, p. 51-69. in: Biology, ecology and economics of squid and butterfish off the Northern Gulf of Mexico - Quarterly Report July 1985. LSU-CFI-85-24; LSU Baton Rouge, LA.

Wenner, C.A., C.A. Barans, B.W. Stender and F.H. Berry. 1979a. Results of MARMAP otter trawl investigations in the South Atlantic Bight. I, Fall 1973. S.C. Mar. Res. Cent. Tech. Rep. 33; 79 p.

Wenner, C.A., C.A. Barans, B.W. Stender, and F.H. Berry. 1979b. Results of MARMAP otter trawl investigations in the South Atlantic Bight. II, Spring. 1974. S.C. Mar. Res. Cent. Tech. Rep. 33; 79 p.

Whitaker, J.D. 1978. A contribution to the biology of Loligo pealei and Loligo plei (Cephalopoda: Myopsida) off the southeastern coast of the United States. M.S. Thesis. College of Charleston, S.C.; 186 p.

Whitaker, J.D. 1980. Squid catches resulting from trawl surveys of the southeastern United States. Mar. Fish. Rev. 42(7-8):39-43.

White Fish Authority. 1976. Squid jigging trials aboard M.T. Artic Hunter. White Fish Authority, Industrial Develop. Unit. Hull, Field Rpt. (450);23 p.

Wilson, J.R. and A.H. Gorman. 1982. Alaska Underutilized Species. Vol. 1: Squid. Alaska Sea Grant Report 82-1; 77 p.

Williams, L. 1909. The anatomy of the common squid, Loligo pealei (LeSueur). E.T. Brill, Leiden publ; 92 p.

Williamson, G.R. 1965. Underwater observations of the squid Illex illecebrosus (LeSueur), in Newfoundland waters. Can. Fld. Nat. 79(4):239-247.

Appendices

I Sexual maturity scales for squid (Juanico 1983).

II Organisms associated with squid and butterfish - Northern Gulf of Mexico (LSU-CFI 1985).

III Processors of squid in the United States 1984 (NMFS Gloucester, Ma).

IV Importers of squid from east coast ports (NMFS Gloucester, MA).

V Listing of U.S. exporters (Veasey and Blaxall 1983).

Appendix 1

Sexual Maturity Scales for Squid

Source: Marcello Juanico, 1983. Squid maturity scales for population analysis. PP 344-378 In: J.F. Caddy (ed.), Advances in Assessment of World Cephalopod Resources, FAO Fish. Tech Pap., (231):452 p.

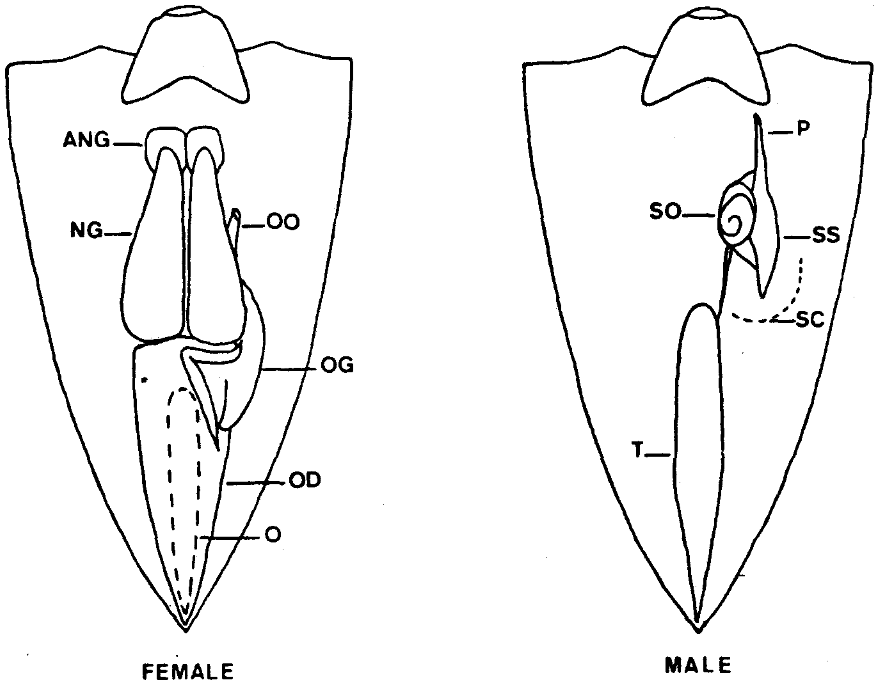


Figure A-1. Schematic drawings of squid reproductive systems. ANG: accessory nidamental glands. NG: nidamental glands. O: ovary. OD: oviduct. OG: oviiductal gland. OO: oviduct opening. P: penis. SC: spermatophoric complex. SO: spermatophoric organ. SS: spermatophoric sac. T: testis.

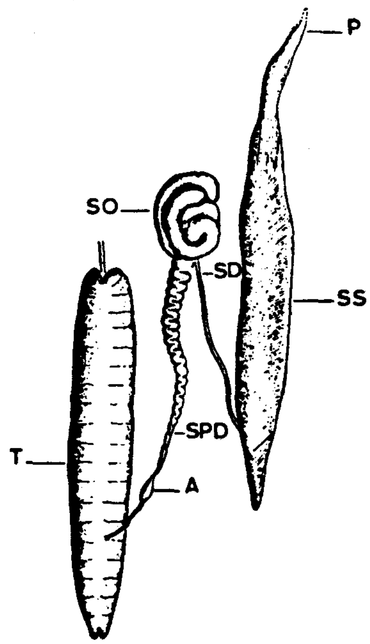


Figure A-2. Schematic drawing of male reproductive system. A: ampulla. SD: spermatophoric duct. SPD: sperm duct. Other references as in Figure A-1. (modified from Grieb, 1976).

Table 1.

Female maturity scale for *Loligo pealei* and *Dorytheuthis plei* (Whitaker, 1978)

Juvenille 0	*D. plei*, all specimens less than 40 mm ML *L. pealei*, all specimens less than 100 mm ML
I	No sexual development; no ova apparent; gonad very small; ANG showing no colour.
II	Gonad easily observed but small; gonad estimated as 1/2 or less of maximum size; some colour in ANG; NG small or Gonad very small (as in stage II) but ANG brightly coloured
III	Gonad appears greater than 1/3 but less than 2/3 of maximum size; ANG with colour tan to red.
IV	Gonad appears greater than 2/3 of maximum size; spermatophores often found on female's buccal membrane or spermatophore pad; spermatozoa in spermatheca; ANG dark to bright red; gonad and NG large and turgid; ovary often greenish-yellow.

Table 2

Male maturity scale for *Loligo pealei* and *Doryteuthis plei* (Whitaker, 1978)

Juvenile 0	*D. plei*: all specimens less than 40 mm *L. pealei*: all specimens less than 100 mm.
I	No sexual development; no spermatophores.
II	Gonad easily observed but small; gonad estimated as 1/3 or less of maximum size. or Gonad very small (as in stage I) but a few spermatophores present in spermatophoric sac.
III	Gonad appears greater than 1/3 but less than 2/3 of maximum size; several spermatophores present (more than 5) but spermatophoric sac not full; vas deferens is obvious.
IV	Gonad appears greater than 2/3 of maximum size; vas deferens very obvious and appearing silver or porcelain white; spermatophoric sac closely packed with spermatophores.

Table 3

Male maturity scale for <u>Loligo</u> <u>pealei</u>
(Vovk, 1972)

1	Testis not noticeable, or as small as a white disk; SO and SS noticeable left skewed. In some cases the hectocotylus begins to be formed in the left lower arm. The weight of the genital organs is almost 0.5% of total squid weight.
2	Testis clearly visible, filling almost 1/2 of the posterior part of mantle cavity. It is whitish-grey and flaccid. SO and SS well developed; the basis of the penis visible; hectocotylus visible too; weight or reproductive system: 0.5-5% of total squid weight.
3	Testis increases twice its volume, filling the posterior part of mantle cavity; it maintains its colour and is flexible. In the SS appears the first small S; S relative length is about 5% of mangle length. Length of hectocotylized part of hectocotylus: 15% of mantle length. Weight of genital organs: up to 7% of total squid weight.
4	Testis compact, pale yellow, filling the mantle cavity from stomach to the end of the gladius. SS pyriform, filled with S. S visible through the SS wall, inclined along the SS axis and densely packed. In some cases S are noticeable in the basis of the penis. A slight pressure on SS will let the S go through the penis to mantle cavity.
5	Testis rather rigid, covers part of the stomach filling all the posterior part of the mantle cavity. The packet of S dilates, making transparent the walls of the SS. S usually noticeable in the basis and tip of penis. Due to the fast growth of squid size and weight, a decrease of the relative length of hectocotylus and S. Hectocotylus length of 11.4%, S length 4.3% and reproductive system weight of 5.8% is characteristic.

Table 4

Female maturity scale for Cephalopoda (squid, cuttlefish and octopus)
(Egg measures refer to the most advanced ones)
(Mangold, 1963)

0 Juvenile	The sex cannot be distinguished externally
I Immature	The sex can be distinguished externally. Ovary always very small
II Very small eggs	Eggs less than 1/4 of its maximum length
III Small eggs	Eggs from 1/4 to 1/2 of its maximum length
IV Medium eggs	Eggs from 1/2 to 3/4 of their maximum length
V Big eggs	Eggs greater than 3/4 of their maximum length
VI Mature eggs	Eggs ready to be spawned; the "reticular system" on their surface disappeared.

Table 5

Female maturity scale for 17 species of squid
Lipinski's "Universal Scale"
(Lipinski, 1979)

I Juvenile	The sexual organs are very hard to find with the naked eye. The oviducts and NG appear (if at all) as very fine transparent strips. The ovary is translucent, membranous.
II Immature	The sexual organs translucent or whitish. The oviducts and nidamental glands from clearly visible translucent or whitish strips. The oviduct meander visible. NG small; all viscera behind them can be easily observed. The ovary clearly visible, in most cases without structures observable with the naked eye.
III Preparatory	The sexual organs are not translucent. Meander of the oviduct is extended. The NG enlarged, covering some internal organs. The structures inside the ovary (immature ova) clearly visible.
IV Maturing or mature	The NG large, also covers kidneys and distal part of the liver; the external glandular oviducts are fleshy and swollen. Plenty of eggs in the oviducts; the meanders hardly noticeable. The eggs not transparent (roughly 95%) and are pressed together at least in the proximal part of the oviduct. There may or may not be many different stages of eggs in the distal part of the oviduct.
V Mature or fully mature	As above, but the eggs are translucent (more than 60%) at least in the proximal part of the oviduct. Cut open, the NG secretes a viscous substance.

Table 6

Male maturity scale for 17 species of squid
(Lipinski, 1979)

Lipinski's "Universal scale"

Juvenile	The sexual organs are very hard to find with the naked eye. Spermatophoric complex appears (if at all as a transparent or translucent spot. The testis is transparent, membranous.
Immature	The sexual organs translucent or whitish; the separate parts of the spermatophoric complex are clearly visible; the testis small; its structure invisible.
Preparatory	The sexual organs are not translucent; the vas deferens whitish or white, SO with white streak; the testis in most cases is white or pink; its structure is invisible.
Maturing	The vas deferens white, meandering, enlarged; SS long with structureless whitish particles inside, but without formed S; the testis tight, crispy; the testis surface covered with structure.
Mature	As above, except that S are present in the SS.

Table 7

Female spent stage according to different authors

Tinbergen and (1945) <u>Loligo vulgaris</u>	The eggs are not as tightly packed in the ovary as Verwey described before, which gives the ovary a strikingly loose, disorderly aspect. These are probably the females which have just released their eggs.
Hamabe and Shimizu (1966) <u>Todarodes Pacificus</u>	Those females whose skin was stripped and in which a striking decrease in the content weight of the incubatory organs and liver was noted along with a shrunken mantle. Females in the process of dying from post-spawning exhaustion.
Barragan (1969) <u>Lolliguncula brevis</u>	Gonads small, 0.9-2.8 g; NG relatively large; oocytes small, whitish and pyriform; some specimens with no spawned mature ova which would be reabsorbed later; some females with many S.
Hayashi (1970) <u>Todarodes pacificus</u>	Ovary weight § oviductal weight (in mature animals the weights are approximately the same, and in immature ones on the contrary).
Vovk (1972) and Burukovski and Vovk (1974) <u>Loligo pealei</u> Burukovski et al. (1977) <u>Sthenoteuthis pteropus</u>	There is a small number of eggs in the ovary. Most often there are no mature eggs in the ovary. The ANG are of pale-rose colour. The NG and oviductal gland are softened and creembly and noticeably smaller in volume and weight. The mantle looses its previous density and elasticity and flabby. The weight of the reproductive system amounts to about 1/5 of the animal's weight. The dimensions of the not numerous females of this stage investigated by us are the same as of females of the fourth stage (mature).
Kashiwada and Recksier (1978) <u>Loligo opalescens</u>	NG large, greater than 20% of dorsal mantle length. Eggs large but few in number and opaque.
Lipinski (1979) species	There are almost no eggs in the oviduct, or only 14 squid degenerating ones. The NG are small, tissue slack and desintegrated. The condition of the animal is very poor; the hypothetical stage.
Juanico (1979) Loliginidae, 3 species	Spawning or spent: large females with NG flaccid or diminished. Ovary and oviduct flaccid with no or only a few mature eggs, but with immature eggs and tissue remains.

Table 8

Male spent stage according to different authors

Hamabe and Shimizu (1966) *Todarodes pacificus*	Males possessing S but whose feature and internal organs were deemed to be in a state of debility similar to that of the spent females.
Hayashi (1970) *Todarodes*	Testis weight § SS mass weight (in mature animals the weights are approximately the same, and in immature ones, on the contrary).
Grieb (1976) and Beeman (1978) *Loligo opalescens*	Animals in which only mature or very late mature Grieb and spermatids were found within the seminiferous tubules, and represents the final stage of maturation process in the spawning animals. These spent animals were undergoing a degenerative process. While the seminiferous tubules of some animals contained relatively large numbers of mature spermatids, the testituclar tissue of other specimens were composed of empty or collapsed tubules which contained only a very small number of relict sperm. In this latter stage, the lumen of the tubules sometimes contained large amounts of what appeared to be sloughed cytoplasm and sperical, vacuolated bodies. In all these animals the seminiferous epithelium was found to be thin and no visible sign of epithelial growth could be detected. Furthermore, the mantles of these animals were flaccid and their geenral condition was best described as emaciated. Finally, the SS contained very few S. The seminiferous epithelia of *L. opalescens* shows no sign of germinal cell growth or spermatogonia. This lack of any sign of a renewed gametogenic cycle, the degenerative condition of the seminiferous epithelia and the emaciated condition of spent animals leads to the conclusion that males spawn only once and die soon afterwards.
Kashiwada and Recksiek (1978) *Loligo opalescens*	Testis long and thin (in mature animals they were thick) S few in numbers and loosely packed or degenerating.
Lipinski (1979) 14 squid species	There are no S in the SS or only exploded, degenerating ones. Spermatophoric complex contains many membranous structures. The condition of the animal is very poor.

Appendix 2

ORGANISMS ASSOCIATED WITH SQUID AND BUTTERFISH IN THE NORTHERN GULF OF MEXICO

Source: Louisiana State University, 1985
Biology, and Economics of Squid and Butterfish
off the Northern Gulf of Mexico

Crustaceans

Aristeus antillensis	Purple-head shrimp
Aristeomorpha foliacea	Gamba prawn
Acanthocarpus alexandri	Calappidae crab
Calappa flammea	Calappidae crab
Caridea sp.	Caridean shrimp
Geryon quinquendens	Red crab
Hymenopenaeus robustus	Royal red shrimp
Heterocrypta sp.	Pentagon crabs
Libinia sp.	Spider crabs
Lyreidus bairdii	White frog crab
Majidae sp.	Spider crabs
Munida sp.	Black galitheid lobsters
Myropsis quinquespinosa	Leucosiidae crab
Munidopsis robusta	Blind galitheid lobster
Munida forceps	Galitheid lobster
Nephropsis rosea	Blind lobsterette
Neolithodes agassizii	King crab
Portunidae sp.	Portunid crabs
Penaeopsis megalops	Pink-speckled shrimp
Penaeidae sp.	Penaeid shrimp
Portunus spinicarpus	Portunidae crab
Penaeus aztecus	Brown shrimp
Paguridae sp.	Hermit crabs
Portunus sp.	Portunid crabs
Plesiopenaeus edwardsianus	Scarlet prawn
Penaeus setiferus	White shrimp
Rochinia crassa	Spider crab
Stereomastis sculpta	Flatback lobster
Squilla lijdingi	Mantis shrimp
Scyllarus delfosi	Bulldozer loster
Stenocionops spinosissima	Majidae crab
Solenocera sp.	Solenoceridae shrimp
Sycllaridae sp.	Bulldozer lobsters
Sicyonia typica	Kinglet rock shrimp
Squilla sp.	Mantis shrimp
Xanthidae sp.	Xanthidae crabs

Fish

Astroscopus y-graecum	Southern stargazer
Aulostomus maculatus	Trumpet fish
Antigonia capros	Deep-body boarfish
Antennarius radiosus	Singlespot frogfish
Argentinidae sp.	Porgies
Ancylopsetta dilecta	Three-eye flounder
Anchoa sp.	Anchovys
Aluterus schoepfi	Orange filefish
Antigonia combatia	Shortspine boarfish
Bembrops gobioides	Flathead goby fish
Bathygadis macrops	Rattail
Brosmiculus imberbis	Morid cod
Bembrops anatirostris	Duckbill flathead
Brotula barbata	Bearded brotula
Cyclopsetta fimbriata	Spot-fin flounder
Cynoscion arenarius	White trout
Coelorinchus caribbaeus	Blackfin grenadier
Coelorinchus carminatus	Shortsnoot grenadier
Caulolatilus intermedius	Gulfbareye tilefish
Chauliodus sloani	Viper fish
Centropristis philadelphica	Rock seabass
Centropristis striata	Black seabass
Centropristis ocyura	Bank seabass
Chaunax pictus	Angler fish
Decapterus punctatus	Round scad
Dasyatis centroura	Roughtail stingray
Dibranchus atlanticus	Offshore batfish
Diodon hystrix	Porcupine fish
Etrumeus teres	Round herring
Epinephelus flavolimbatus	Yellowedge grouper
Etmopterus pusillus	Dogfish shark
Etmopterus rus	Dogfish shark
Equetus umbrosus	Cubbyu
Epigonus sp.	Cardinal fishes
Gymnachirus texae	Fringed sole
Hoplostethus occidentalis	Soldier fish
Hoplunnis sp.	Congers
Hydrolagus alberti	Chimaeras
Hoplunnis diomedianus	Blacktail conger
Hoplunnis macrurus	Silver conger
Kathetostoma albigutta	Lancer stargazer
Lutjanus aquilo	Snapper
Leiostomus xanthurus	Flat croaker
Lophius americanus	Goose fish
Lutjanus campechanus	Red snapper
Lagodon rhomboides	Pinfish
Lagocephalus laevigatus	Smooth puffer
Lutjanus sp.	Snappers
Larimus fasciatus	Banded croaker

Monacanthus setifer	Pygmy filefish
Macrorhamphosus scolopax	Longspine snipefish
Myctophum obtusirostre	Lantern fish
Merluccius albidus	Offshore hake
Myctophum sp.	Lantern fishes
Mustelus canis	Smooth dogfish
Micropogon undulatus	Atlantic croaker
Malacocephalus occidentalis	Sculpin
Mugil cephalus	Striped mullet
Neopinula americana	Snake mackerel
Neomerinthe hemingwayi	Spinycheek scorpionfish
Nezumia sp.	Rattails
Ogcocephalus pumilus	Batfish
Ophichthus rex	Banded snake-eel
Ogcocephalus nasutus	Shortnose batfish
Ogcocephalus notatus	Batfish
Pristipomoides aquilonaris	Wenchman
Prionotus rubio	Blackfin searobin
Paralichthys squamilentus	Broad flounder
Peprilus burti	Gulf butterfish
Peristedion gracile	Slender searobin
Polymixia lowei	Beardfish
Priacanthus arenatus	Bigeye
Promethichtys prometheus	Snake mackerel
Pontinus longispinus	Longspine scorpionfish
Prionotus roseus	Bluespot searobin
Peristedion sp.	Searobins
Peprilus paru	Harvestfish
Prionotus stearnisi	Shortwing searobin
Parasudis truculenta	Longnose greeneye
Pomatomus saltatrix	Bluefish
Peristedion ecquadorense	Searobin
Peristedion truncatum	Searobin
Psychrolutes paradoxus	Tadpole skulpin
Paralichthys lethostigma	Southern flounder
Raja bullisi	Skate
Rhomboplites aurorubens	Vermillion snapper
Rhizoprionodon terraenovae	Sharpnose shark
Raja olseni	Spreadfin skate
Raja lentiginosa	Freckled skate
Rhinoptera bonasus	Cownose ray
Squatina dumerili	Atlantic angel shark
Synodus foetens	Inshore lizardfish
Stenotomus caprinus	Longspine porgy
Scomber japonicus	Chub mackerel
Selar crumenophthalmus	Bigeye scad
Squalus cubensis	Cuban dogfish shark
Steindachneria argentea	Luminous hake
Synagrops bella	Blackmouth bass
Setarches guentheri	Scorpion fish
Sternoptychidae sp.	Hatchet fishes

Sphyrna lewini	Scalloped hammerhead shark
Sphoeroides dorsalis	Marbled puffer
Schroederichthys tenuis	Cat shark
Seriola dumerili	Greater amberjack
Selar sp.	Scad
Synchiropus orgassizii	Sculpin
Synagrops spinosa	Cardinal fish
Trichiurus lathami	Rough scad
Trichiurus lepturus	Atlantic cutlassfish
Trichopsetta ventralis	Sash flounder
Upeneus parvus	Dwarf goatfish
Urophycis floridanus	Southern hake
Urophycis cirratus	Gulf hake
Xenolepidichthys dalgleishi	Spotted tinselfish
Zalieutes mcgintyi	Tricorn batfish
Zenopsis ocellata	American john dory

Invertebrates

Aurelia sp.	Stinging jellyfish
Asteroidea sp.	Starfish
Amusium papyraceus	Paper scallop
Anthozoa sp.	Sea anemones
Bathygnomus giganteus	Isopod
Doryteuthis plei	Arrow squid
Echinodermata	Starfish, sea urchins, sand dollars
Gorgonocephalus	Basket star
Holothuroidea	Sea cucumbers
Histioteuthis sp.	Webbed-arm squid
Illex coindetii	Shortfin squid
Illex sp.	Shortfin squid
Loligo pealei	Longfin squid
Lolliguncula brevis	Brief squid
Loligo sp.	Longfin squid
Murex sp.	Shells
Ommastrephes ephida	Flying squid
Octopodidae sp.	Octopus
Ophiode brevis	Sand dollar
Pholidoteuthis adami	Scaled squid
Peronella sp.	Sand dollars
Plutonaster rigidus	Sea starfish
Rosaster sp.	Big seastar
Spatangidae sp.	Heart urchin

Appendix 3

Processors of Squid in the United States
(1984)

Source: National Marine Fisheries Service
Utilization and Development Branch
Gloucester, MA

ARGO MARINE
62 HASSEY ST
NEW BEDFORD, MA 02740

AIELLO BROS INC
HOMERS' WHARF
NEW BEDFORD, MA 02740

ALIOTO WHOLESALE FISH CO
P O BOX 3325
MONTEREY, CA 93940

AMERICAN FREEZERS INC
756-28TH ST S
ST. PETERSBURG, FL 33701

AMERICAN SEAFOOD CO
FOOT OF "B" ST
PENSACOLA, FL 32502

AMERICAN TRAWLER CO
OLD DOVER RD
NEWINGTON, NH 03801

AQUACULTURAL RESEARCH CORP.
CHAPIN BEACH RD., BOX AC
DENNIS, MA 02638

ATLANTIS SEAFOOD
505 EAST B STREET
WILMINGTON, CA 90744

BUMBLE BEE SEAFOODS
P O BOX 60
ASTORIA, OR 97103

CANAL MARINE INC
SANDWICH, MA 02563

CAPE MAY CANNERS
P O BOX 158
CAPE MAY, NJ 08204

CAPEWAY SFDS INC
52 FRONT ST
NEW BEDFORD, MA 02740

CAPT JOE & SONS INC
EAST MAIN ST
GLOUCESTER, MA 01930

CUSTYS
7769 POST RD
NO KINGSTON, RI 02852

DEPOE BAY FISH CO
P O BOX 1650
NEWPORT, OR 97365

FAIRHAVEN FISH CO
UNION WHARF
FAIRHAVEN, MA 02719

GASKILL SEAFOOD CO.
BAYBORO, NC 28515

GENERAL FISH CORP
P O BOX 469
MONTEREY, CA 93940

GENERAL FISH CORP
BOX 31
MOSS LANDING, CA 95039

GOLDEN EYE SFDS
16 ANTONIA COSTA BLVD.
NEW BEDFORD, MA 02740

HALM'S ENTERPRISE
3171 WAIALAE AVE
HONOLULU, HI 96816

HUMENEME FISH & BAIT PROC
735 INDUSTRIAL AVE
PORT HUENEME, CA 93041

J REIS SFD
937 DODOCANESE BLVD
TARPON SPRINGS, FL 33589

JACKSON NO ATL PRODUCTS
P O BOX 146
ROCKLAND, ME 04841

KENNEBECK FISH CORP
FISH PIER
GLOUCESTER, MA 01930

KYODO FOOD PROCESSING
431 CROCKER STREET
LOS ANGELES, CA 90013

LA FISH & OYSTER CO
2212 SIGNAL PLACE
SAN PEDRO, CA 90731

LEGAL SEAFOODS
27 COLUMBUS AVENUE
BOSTON, MA 02210

MISTER FISH
246 WILMINGTON BLVD
WILMINGTON, CA 90744

MONTEREY FISH & BAIT
P O BOX 1875
MONTEREY, CA 93940

MONTEREY PACKING CO
P O BOX 1875
SAND CITY, CA 93955

MOORE & CO SOUPS INC
166 ABINGTON AVE
NEWARK, NJ 07107

N BEDFORD SFD COOP
GREEN & WOOD PIER
NEW BEDFORD, MA 02740

NATIONAL SEA PRODUCTS (US CORP)
1356 SHORELINE AVENUE
TAMPA, FL

NED'S SEA BRAND
1632 61ST STREET
BROOKLYN, NY 11204

NEWPORT SHRIMP CO
P O BOX 1301
NEWPORT, OR 97365

OCEAN CREST SEAFOOD INC
COMMERCIAL ST
GLOUCESTER, MA 01930

OCEANSIDE FISHERIES INC
95 EAST MAIN ST
GLOUCESTER, MA 01930

OLD RANCH CANNING CO
P O BOX 458
UPLAND, CA 91786

OLD SANTA BARBARA FISH INC
214 STATE ST
SANTA BARBARA, CA 93101

PAN PACIFIC FISHERIES #1
338 CANNERY STREET
TERMINAL ISLAND, CA 90731

PAN PACIFIC FISHERIES #2
338 CANNERY STREET
TERMINAL ISLAND, CA 90731

PARISI SFD CO
HOMER'S WHARF
NEW BEDFORD, MA 02740

PENINSULA FISH CO
40 FISHERMAN'S WHARF
MONTEREY, CA 93940

PENOBSCOT BAY FISH COLD STG
BOX 51
VINALHAVEN, ME 04863

PEOPLES FISH CO
565 HARBOR LANE
SAN DIEGO, CA 92101

PILGRIM FISH CORP
HASSEY ST
NEW BEDFORD, MA 02740

PILLAR POINT FISHERIES
P O BOX 881
MONTEREY, CA 93940

PLANTATION FISHERIES INC
P O BOX 374
TAVERNIER, FL 33070

POINT JUDITH COOP ASSO
GALILEE ROAD
NARRAGANSETT, RI 02882

QUALY-PAK SPECIALTIES FOODS INC
640 N FRIES AVE
WILMINGTON, CA 90744

R H GORR FISH PRODUCTS
768 PADILLA HGTS BOX 566
ANACORTES, WA 98221

RIVERSIDE FISH INC 384 ACUSHNET
AVENUE NEW BEDFORD, MA 02740

ROME PACKING CO. INC
375 PUTNAM PIKE
SMITHFIELD, RI 02917

ROYAL SEAFOODS
P O BOX 1347
MONTEREY, CA 93940

RUBENSTEIN FOODS, INC
P O BOX 687
DALLAS, TX 75221

SAN DIEGO FISH CO
585 HARBOR LANE
SAN DIEGO, CA 92101

SANTA CRUZ CANNING CO
P O BOX 3909
SAN FRANCISCO, CA 94119

SEA PACKERS, LTD
86 MACARTHUR BLVD
NEW BEDFORD, MA 02740

SEA PRODUCTS CO (TWO PLANTS)
BOX 1389
MONTEREY, CA 93942

SEA-PRIME FISHERIES CO
2208 SIGNAL PL
SAN PEDRO, CA 90731

SEAFOOD PRODUCTS
BEARSES WAY
HYANNIS, MA 02601

SEAFOOD SPECIALTIES
211 HELENA STREET
SANTA BARBARA, CA 93101

SO CALIFORNIA SQUID CO
200 N CENTER ST
LOS ANGELES, CA 90012

STAR KIST PLANTS 1 & 3
582 TUNA ST
TERMINAL ISLAND, CA 90731

STINSON CANNING CO
PROSPECT HARBOR, ME 04669

STINSON CANNING CO/ROCKLAND DIV
PROSPECT HARBOR, ME 04669

TAKE'S FISH MKT STALL 27
145 N KING STREET
HONOLULU, HI 96817

TICHON SFD CORP
7 CONWAY ST
NEW BEDFORD, MA 02740

TOMICH BROS FISH CO
2196 SIGNAL PL
SAN PEDRO, CA 90731

TOWER PROCESSING
6 HASSEY ST
NEW BEDFORD, MA 02740

TUPMAN THURLOW CO INC
2555 FLORES ST
SAN MATEO, CA 94403

U S FREEZER CO
595 FIGUEROA STREET
MONTEREY, CA 93940

UNIVERSAL PACKERS CORP.
P O BOX 627
OXNARD, CA 93030

USA FISH INC
P O BOX 3
LUBEC, ME 04652

VARIETY SFDS INC
4410 W CREST AVE
TAMPA, FL 33614

VENTURA ENTERPRISES
P O BOX 697
PORT HUENEME, CA 93041

WES STAN INC
MULLINS FREEZER
FAIRHAVEN, MA 02719

YOUNG'S MARKET-SEAFOOD DIV
620 SO GLADYS
LOS ANGELES, CA 90021

Appendix 4

Importers of Squid from East Coast Ports

Source: National Marine Fisheries Service
Utilization and Development Branch
Gloucester, MA

Importers of U.S. Fishery Products from East Coast Ports from 1/83 to 7/85

ACL CANADA INC
12E 74 OR NOTRE DAME
MONTREAL, CANADA
TELEX: 5268520 ATCON

AGROMARINA DE PANAM SA
APDO 64600 EL DORADO
PANAMA, PANAMA
PHONE: 97-4441
TELEX: 348-0001 ITT

ANAVAR S/A
JACINTIO BENAVENTE APTO 1047
VIGO, SPAIN
PHONE: 29-94-33/73
TELEX: 83277

ANTONIO CAPDEVILA FAGES
MERCADO CENTRAL DE PESCADOS
24 BARCELONA, SPAIN

ARTHUR ATKINSON
NEW ELLTON
SHELBURNE-NOVA SCOTIA
CANADA

BANCO DE COLOMBIA
SAN ANDRES ISLAS
COLOMBIA
TELEX: 40102 SAIB CO

BARRUFET S.A.
MERCAT CENTRAL DEL PEIX, 64-68
BARCELONA 4, SPAIN
PHONE: 336-29-11
TELEX: 97830 BRR E

BEN KOZLOFF
48 YONGE ST
TORONTO-ONTARIO
CANADA

BEOTHIC FISH PROCESSORS
C/O POST OFFICE
VALLEYFIELD-NEWFOUNDLAND
CANADA
TELEX: 1643589 BEOFISH

BLUE CONTINENT PRODUCT
P.O. BOX 56 PAARAEN
EILAND 7420
CAPETOWN, SOUTH AFRICA
PHONE: 021-51-0620
TELEX: 5727232, 5727355

BOOTH FISHERIES
6080 INDIAN LINE ROAD
MISSISSAGNA-ONTARIO
CANADA L4V IG5
PHONE: 416-678-9120
TELEX: 06-968807

BORDEN DE PEURTO RICO
RD 2 KM 15 HATO TEJAS
BAYAMON, PUERTO RICO
TELEX: 3170 BORDEN PD

BUTTERFIELD AND CO. LTD.
P.O. BOX H M 468
HAMILTON 5, BERMUDA
PHONE: 809-295-6688
TELEX: 3351 BUTT BA

C.J. NEWNES AND PARTNERS
11 BILLINGSGATE MARKET
LONDON EC3 6AL, ENGLAND
UNITED KINGDOM
PHONE: 515-0789, 0793, 0798
TELEX: 949885 WB

CANADA PACKERS
1243 ISLINGTON AVE
TORONTO, CANADA M8X 1Y9
TELEX: 06984598

CANADIAN SALT FISH CORP
P.O. BOX 6088
ST JOHN'S-NEWFOUNDLAND
CANADA
TELEX: 164599 CANSALPI

CAPE BALD PACKERS
C/O POST OFFICE
CAPE PELE-NEW BRUNSWICK
CANADA
TELEX: 1427519

CAPE PINES FISHERIES
C/O POST OFFICE WATER ST
WITLESS BAY-NEWFOUNDLAND
CANADA
TELEX: 164755

CHINA OVERSEAS INC LTD
LINDBERGHWEG #31
WILLEMSTAD CURACAO
NETHERLAND ANTILLES
TELEX: 3308 CONV NA

CLOUSTON FOODS
1560 BRANDON CRESCENT
LACHINE-QUEBEC
CANADA
PHONE: 514/634-6951
TELEX: 5821736 CLOUSTON

CLOUSTON FOODS CANADA LTD
10 CARY BAY DRIVE
TORONTO-ONTARIO
CANADA

COMCOR FROZEN FOODS PTY LTD
14 MARTIN PLACE
SYDNEY NSW 2000
AUSTRALIA
PHONE: (02) 233-5302
TELEX: 23891 COMCOR

COMMERCIAL ENGADE S.A.
SANTA ROSA DE LIMA 2
SANTA CRUZ
SPAIN
PHONE: 28-51-09
TELEX: 92392 ELECHE-E

COMMONWEALTH COLD STORAGE
CAPARRA HEIGHTS
SAN JUAN, PUERTO RICO
PHONE: 809-792-0740

COMPESCA S.A.
AVE CALVO SOTELO
19-4 SANTANDER
SPAIN
PHONE: 942-212362
TELEX: 35867 FOOD

COMPRA LTD.
P. O. BOX 739 WESTRAAT Z/N
WERFSTRAAT-ORANJESTAD
NETHERLAND ANTILLES
PHONE: 3025-3026
TELEX: 5046 VOCAR NA

CONNORS BROS LIMITED
BLACK HARBOUR
NOVA SCOTIA
CANADA EOG IHO

CORIMPEX
3 RUE DE LA CORDERIE
CENTRA 313
94586 RUNGIS CEDEX
FRANCE
PHONE: (1) 687 35 03
TELEX: 204847

DUBOIS EXPRESS MAREE
92 QUAI LOUIS PRUNIER
17000 LA ROCHELLE
FRANCE
PHONE: 46-41-21-60
TELEX: 790826

ECHO BAHAMAS LTD
P. O. BOX N-1038
NASSAU, BAHAMAS
PHONE: 809-32-53303

EUROFRIO S/A
AVENIDA SARDINEIRA 36
LA CORUNA, SPAIN
PHONE: 981-230967
TELEX: 82163

FISHERY PRODUCTS LTD
7 CRESCENT PLACE, SUITE 619
TORONTO, CANADA M4C SL7
CANADA
PHONE: 416-694-3765
TELEX: 016-3151

FLAMINGO FISCH GMBH & CO.
POSTFACH 290365 HALLE 8
D-2850 BREMERHAVEN 29
WEST GERMANY
PHONE: 0471-71094
TELEX: 0238614 FLAM

FOGO ISLAND CO-OP
P.O. BOX 70
SELDON-NEWFOUNDLAND
CANADA
PHONE: 709-627-3452
TELEX: 016-43531

FREIREMAR SA
PARCELAS 2-3
LAS PALMAS
SPAIN
PHONE: 34-82-272450
TELEX: 96100 MERE-E

FRIONOR A/G
PETER MERIAN STS 45
4002 BASEL
SWITZERLAND
PHONE: 0611/22/.28.30

GELAZUR SA
2 RUE DU CONGRESS
06000 NICE
FRANCE
PHONE: 93 82-22-40
TELEX: 460028, 461137

GIOLFO AND CALCAGNO SPA
CASELLA POSTALE 98
16158 GENOA-VOLTRI
ITALY

H.J. DE BRUINE B.V.
75 COOLSINGEL
3012 ROTTERDAM
NETHERLANDS
PHONE: 010-111830
TELEX: 22311

HANWA CO. LTD.
5-30 FUSHIMI-MACHI
HIGASHI-KU OSAKA 541
JAPAN
PHONE: 06-203-1301
TELEX: 63906

HOXIES SEAFOOD
P.O. BOX 2093
PRETORIA
SOUTH AFRICA
PHONE: (012) 261464
TELEX: 30551 SA

HUNTER FOODS PUERTO RICO INC
P.O. BOX 3905 URB INFO BECHARA
PUEBLO VIEJO
PUERTO RICO
TELEX: ITT0122HUNTERS

IFA FOOD
38 AVENUE DE L' OPERA
75002 PARIS
FRANCE
PHONE: 226-12-02
TELEX: IFA-210-598F

ITOMAN & CO. LTD.
1-30 MINAMI-AYOAMA 3-CHOME
MINATO-KU TOKYO
JAPAN

J.M. ALLUM S.A.
166 RUE VANHEECKHOET
F62205 BOULOGNE SUR
FRANCE
PHONE: 21-33-92-22
TELEX: 110053F

JACK TAR VILLAGE
PLAYA DORADA
PUERTO PLATA
DOMINICAN REPUBLIC
TELEX: ACR 2025JACKTAR

JACKSON BROS
P.O. BOX 150
WILSON'S BEACH
CAMPOBELLO-NEW BRUNSWICK
CANADA
PHONE: 506-752-2061

JARDINE JANES
R.R.2 LETREAU
DIPPER HARBOUR NB
CANADA
PHONE: 506-659-2890

M. GERTRUDE ALAIN
VOIE NO 2 ROUTE DE SCHOELCHER
97200 FORT DE FRANCE
LEEWARD AND WINDWARD ISL

MARUBENI CORP.
4-2 1-CHOME OHTEMACHI
CHIYODA-KU TOKYO 100
JAPAN
PHONE: 03-282-4760
TELEX: 23328, 22326

MINA SEAFOODS LTD
9 NIAGARA STREET
TORONTO
CANADA M5V IC2
PHONE: 416-363-5652
TELEX: 06-23781

MITSUBISHI CORPORATION
3-1 MARUNOUCHI 2 CHOME
CHIYODA-KU TOKYO 100
JAPAN
PHONE: 03-210-6523
TELEX: 2222063

NATIONAL SEA PRODUCTS
BOX 2130
HALIFAX-NOVA SCOTIA
CANADA B3J 3B7
PHONE 902-422-9381
TELEX: 019-21763

NATIONAL SEA PRODUCTS LTD
LOUIS MOROTE 6 3A
HALIFAX-NOVA SCOTIA
CANADA
PHONE: 902-422-9381
TELEX: 96842 ALIO E

NIPPON SUISAN CO. LTD
6-2 OTE-MACHI 2 CHOME
CHIYODA-KU TOKYO 100
JAPAN
PHONE: 03-244-7222
TELEX: 2222277

NISSHO IWAI CO
4-5 2-CHOME AKASAKA
MINATO-KU TOKYO 107
JAPAN
PHONE: 03-588-3527
TELEX: J-22233

OCEAN HARVESTERS LTD
P.O. BOX 310
HARBOUR GRACE-NEWFOUNDLAND
CANADA
PHONE: 709-726-4840
TELEX: 016-3111

ORIENTE COMMERICAL
GPO 2067 AVE
SAN MARCOS ESQ EL COMM
SAN JUAN
PUERTO RICO
PHONE: 809-752-9696
TELEX: ITT 04850RIENTE

P JANES 7 SONS
P.O. BOX 10
TRINITY BAY
CANADA A0B IYO
PHONE: 708-586-2252
TELEX: 016-4756

PESCAFINA SA
P PINTOR ROSALES 38
MADRID SPAIN
PHONE: 1-2416097
TELEX: 43141 IPEI

PESCLAUDIO SPA
VIA PONTE VETERO 18
MILAN 20121
ITALY
PHONE: (02) 80-14717
TELEX: 335 191 PESCLA

POULOS BROS WHOLESALE PTY LTD
1-3 LORD STREET
BOTANY NSW 2010
AUSTRALIA
PHONE: 666-9141
TELEX: 26464 POULOS

PUEBLO SUPERMARKETS INC
P.O. BOX 3288
SAN JUAN
PUERTO RICO
PHONE: 757-3103/3104
TELEX: 3859225 PUEBLO

QUALITY SEAFOODS CONCORD-ONTARIO
2781 HWY 7 SUITE 208
CANADA L4K 1BI PHONE: 416-663-1519
TELEX: 06-964620

RISTIC CMBH 7 CO
ACOMOSHOFER HAUPSTRABE 46-48
8500 NURNBERG 90
WEST GERMANY
PHONE: 345134
TELEX: 623254 SRTMP

S.A. PRIMEL
SIEGE SOCIAL, LE DIBEN
29228 PLOUGASNOU
FRANCE
PHONE: 95-67-81-22
TELEX: 940549

S.F. LEBENSMITTAL
HEMMERICHSWEG 4
6000 FRANKFURT/MAIN
WEST GERMANY
PHONE: 0611-752817
TELEX: 414322

SA MORAY FISH INTERNATIONAL
DESPACHOS 93-94
MERCABARNA 08004
BARCELONA
SPAIN
PHONE: 336-22-54
TELEX: 54609 MFIS E

SEA PRODUCTS INTERNATIONAL
67/67 HARBORNE RD
EDGBASTON-BIRMINGHAM B153BU
UNITED KINGDOM
PHONE: 021-454-9999
TELEX: 338168

SEAFOOD IMPORTS INC
P.O. BOX 5654
52 FERNANDES JUNCOS
OLD SAN JUAN
PUERTO RICO
PHONE: 721-1912

SHINYEI KAISHA
77-1 KYOMACHI CHUO-KU
KOBE
JAPAN
PHONE: 078-321-1121
TELEX: J78821

SOFANOR
4-10 RUE CONSTANTINE
BOULOGNE SUR MER
FRANCE
PHONE: 21-80-50-00
TELEX: 160311

SOFRIMAR (FRANCE)
RUE PAYAN D'AUGERY
13014 MARSEILLE
FRANCE
PHONE: 91-58-02-26

Appendix 5

Listing of U.S. Exporters - East Coast

Source: Brian Veasey and Martha O. Blaxall - Oct. 1983
Export Opportunities for United States
Producers of Squid.
Prepared for the West Coast Fisheries Development
Foundation, Portland, Oregon by BBH Corporation,
2301 M. Street N.W., Washington, D.C. 20037

Listing of U.S. Exporters of Squid

New Bedford, Massachusetts 02740

International Multifoods Inc.
72 North Water Street
Paul Wehrlin, V.P.,
Bert Foure,
David Gilbertson
617-990-1333

Coastal Fisheries, Inc.
P.O. Box F-822
2 Washburn Street
Ronald Nanfelt, Pres.
617-996-3191
(997-0391)

Pilgrim Fish Corp.
50 Hassey St.
P.O. Box E-735
Vincent Rugnetta, Pres.
617-999-2354

Tichon Seafood Corp.
P.O. Box H-3070
7 Conway Street
Everett H. Tichon, Pres.
Ronald D. Tichon, V.P.
Daniel E. Tichon, V.P.
Tom Dunn, Gen. Mgr.
617-999-5607
Telex: 92-9450

Golden Eye Seafoods
P.O. Box 231
Steve Boggess, Pres.
617-996-3321
996-3701, Freezer
Telex: 92-7628

Rhode Island

Capeway Seafoods, Inc.
100 Willard Avenue
Providence, RI 02905
401-274-9503
Robert D. Usen, Pres.
617-999-1940
Office: 997-4583
Telex: 92-9492

Stonington Seafoods
P.O. Box 748
3 State St.
Narragansett, RI 02822
Al Guimond
Peter Lindquist
Fred McGinnis
401-783-3319
Telex: 95-2051
FISHDEV

Point Judith Fishermen's
Cooperative Association
Gallilee Road,
P.O. Box 730
Narragansett, RI 02822
Jacob J. Dykstra
Leonard Stasiukiewick
Herb Wescott
401-783-3368

Town Dock
Noah Clark
401-294-6486

Boston Massachusetts 02110

Seamark Corporation
64 Long Wharf
Sidney Cohey, Pres.
Gere Munson
617-367-6400

Crocker-Windsor

Gloucester, Massachusetts 01930

Oceanside Fisheries International
P.O. Box 161
12 Kondelin Rd.
Cape Ann Industrial Park
Anthony Klos, Plant Mgr.
Wally Frontiera, Treas.
617-283-5206

Empire Fish Co., Inc.
11-13 Harbor Loop
James A. Bordinaro, Pres.
James, Jr., Gen. Mgr.
Thomas Morris, Sales Mgr.
617-283-0840

Prospect Harbor, Maine 04669

Stinson Canning Co.
Charles B. Stinson, Pres.
Ralph Stevens
K. Richard Trenholm, V.P. Sales
Calvin Stinson, Jr., Tres.
207-963-7331

Hampton, Virginia 23663

Fass Bros., Inc.
P. O. Box 3552
I. Luis Fass, Pres.
Arthur M. Fass, Exec. V.P.
Gary R. Propst, V.P., Whse., Sfd., Div.
804-722-9911
Telex: 82-3652

U.S. Exporters

West Bay Imports - East Greenwich, Rhode Island
Jones Seafoods - Boston, Massachusetts
F.W. Bryce Co. - Gloucester, Massachusetts
Marubeni America, New York, New York
Maritime Trading Co. - Hampton, Virginia
Slade Gordon - Boston, Massachusetts
Assateague Seafoods - Westburg, New York
Marketing Designs Inc. - Boston Masssachusetts
Joint Trawlers Ltd. - Gloucester, Massachusetts
Olmar Inc. - Miami, Florida
McRoberts Sales - Ruskin, Florida
Caribe Produce - Miami, Florida
Liberty Fish - Philadelphia, Pennsylvania
American Industrial Provisions - Miami, Florida
Coldwater Seafoods - Royaton, Connecticut

Nordic Industries - Gloucester, Massachusetts
Crocker & Windsor - Boston, Massachusetts
B.G. Lobster & Shrimp - New York, New York
Seafood Products - Hyannis, Massachusetts
Ocean Canyon - New Bedford, Massachusetts
Mass Bay Fisheries - Gloucester, Massachusetts
Ocean Clear - Gloucester, Massachusetts

Wholesalers

Achille Paladini Seafood Co.
500 Mendell St.
San Francisco, CA 94124
415-821-1900
Achille Paladini, Pres.

Alaska Shell, Inc.
4241 21st Ave. W.
Seattle, WA 98199
206-285-3350
Telex: 32-8785
Peter J. Marinkovich, Pres.

Alaskan Gourmet, Inc.
1130 W. International Airport Rd.
P. O. Box 6733
Anchorage, AK 99502
907-274-9508
Telex: 25-327
Paul L. Schilling, Pres.

Frank Spenger Co.
1919 4th St.
Berkeley, CA 94710
415-845-7771
Frank L. Spenger, V.P.
Buyer

Glacier Seafoods, Inc.
P.O. Box 686
Aptos, CA 95003
408-688-1399

1577 C St., Suite 216
Anchorage, AK 99501
907-274-0614
Telex: 25-170
Earl E. Blaser, Pres.