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EXPLORATORY FISHING AND RESEARCH FOR DEVELOPMENT OF THE LOBSTER RESOURCE OFF NORTH CAROLINA: RELATIONSHIP TO SQUID AND BLUE CRABS

PART I: EXPLORATORY FISHING

By

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14 JANUARY 1976

Contract # 1054011 from
Coastal Plains Regional Commission

ABSTRACT

During the period 16 August through 27 September 1974, sampling for *Loligo pealei* was conducted aboard the R/V DAN MOORE in the oceanic waters of North Carolina and Virginia. *Loligo pealei* were most abundant in the southernmost portion of the study area. September was the month of maximum abundance. During both August and September, maximum abundance of *L. pealei* was found to be in the 40-100 fm (73-183 m) depth zone. Optimum $\log_e$ mean catches occurred at 13° C. Length frequency data showed that a 10 cm modal peak, representing squid less than one year old, dominated the offshore catches. A standard No. 41 Yankee trawl proved to be slightly more efficient than the experimental 151' (45.1 m) wing trawl.

INTRODUCTION

Recent investigations of the American lobster (*Homarus americanus*) aboard the Research Vessel DAN MOORE in North Carolina and adjacent waters during the period July, 1972 – December, 1973 resulted in significant incidental catches of long-finned squid (*Loligo pealei*). These catches, when evaluated along with data of other squid investigations in North Carolina (Serchuk and Rathjen, 1974; Summers, 1969), suggested that a potential resource for North Carolina commercial fishermen might exist. On this basis, a study of the squid population in oceanic waters off North Carolina and Virginia was undertaken. The objectives: (1) To collect ecological and biological data on the long-finned squid during the late summer offshore North Carolina, (2) To design and evaluate trawl gear suitable for the effective capture of the long-finned squid, were met during the period of August and September 1974.

METHODS AND MATERIALS

The R/V DAN MOORE made two ten-day cruises during the late summer 1974, one from 19 August through 30 August, and the other from 16 September through 27 September. Each cruise consisted of two five day segments. The first five days of each cruise was utilized to determine geographical and bathymetric distribution of *Loligo pealei*, and, for clarity, was termed Phase I. The second five-day segments of each cruise was utilized to compare gear efficiency and termed Phase II.

Sampling

Sampling was conducted in two phases. Phase I sampling occurred in three transects, latitude 35° 45'N, 36° 15'N, and 36° 45'N. Within each transect, four depth zones were sampled: 20-30fm (37-55m), 30-40fm (55-73m), 40-50fm (73-91m), and 50-100fm (91-183m) (Figures 1 and 2). The location of stations during Phase I insured stratification by depth and latitude. The Phase I sampling area consisted of 12 stations which were sampled once each month. The

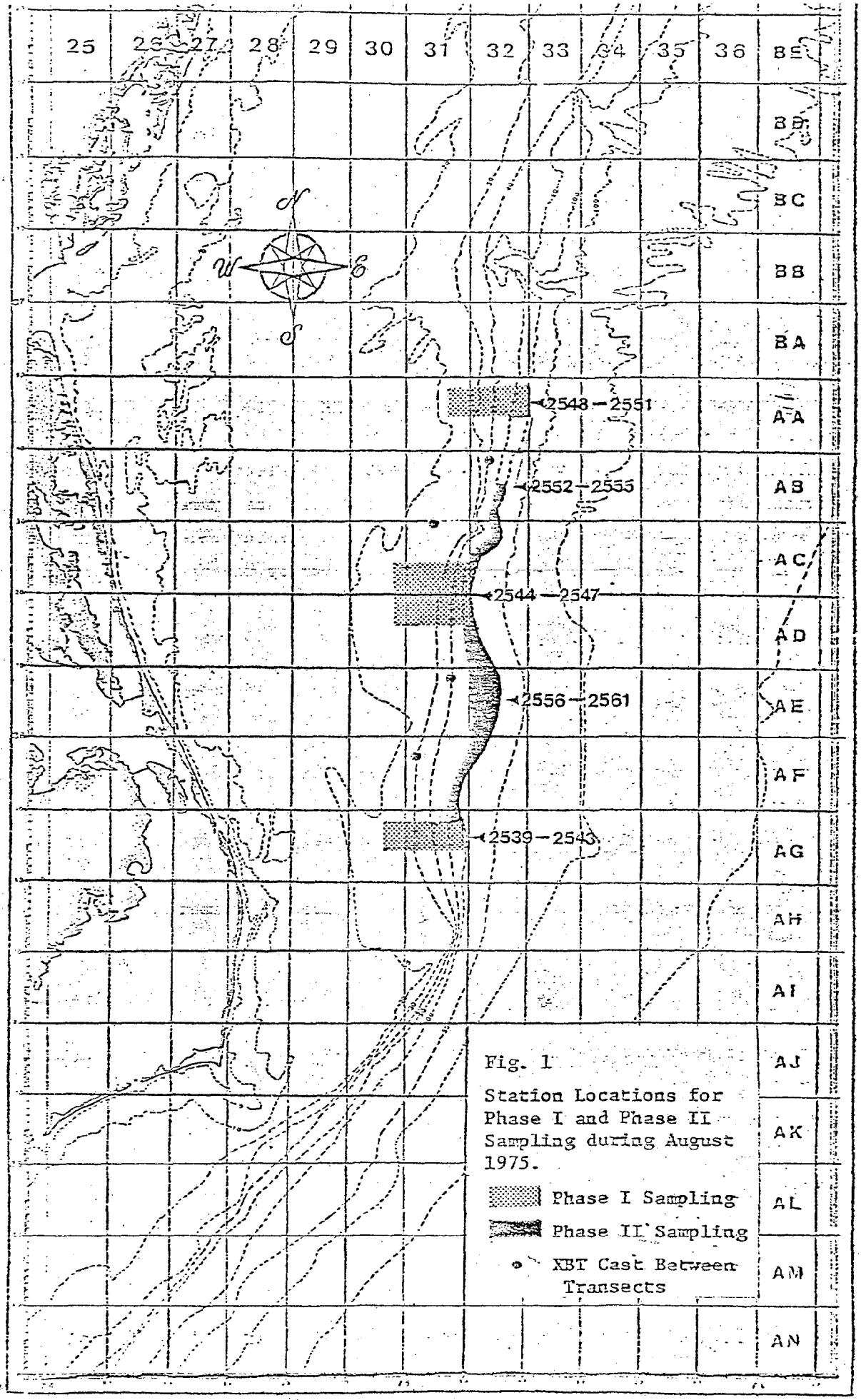


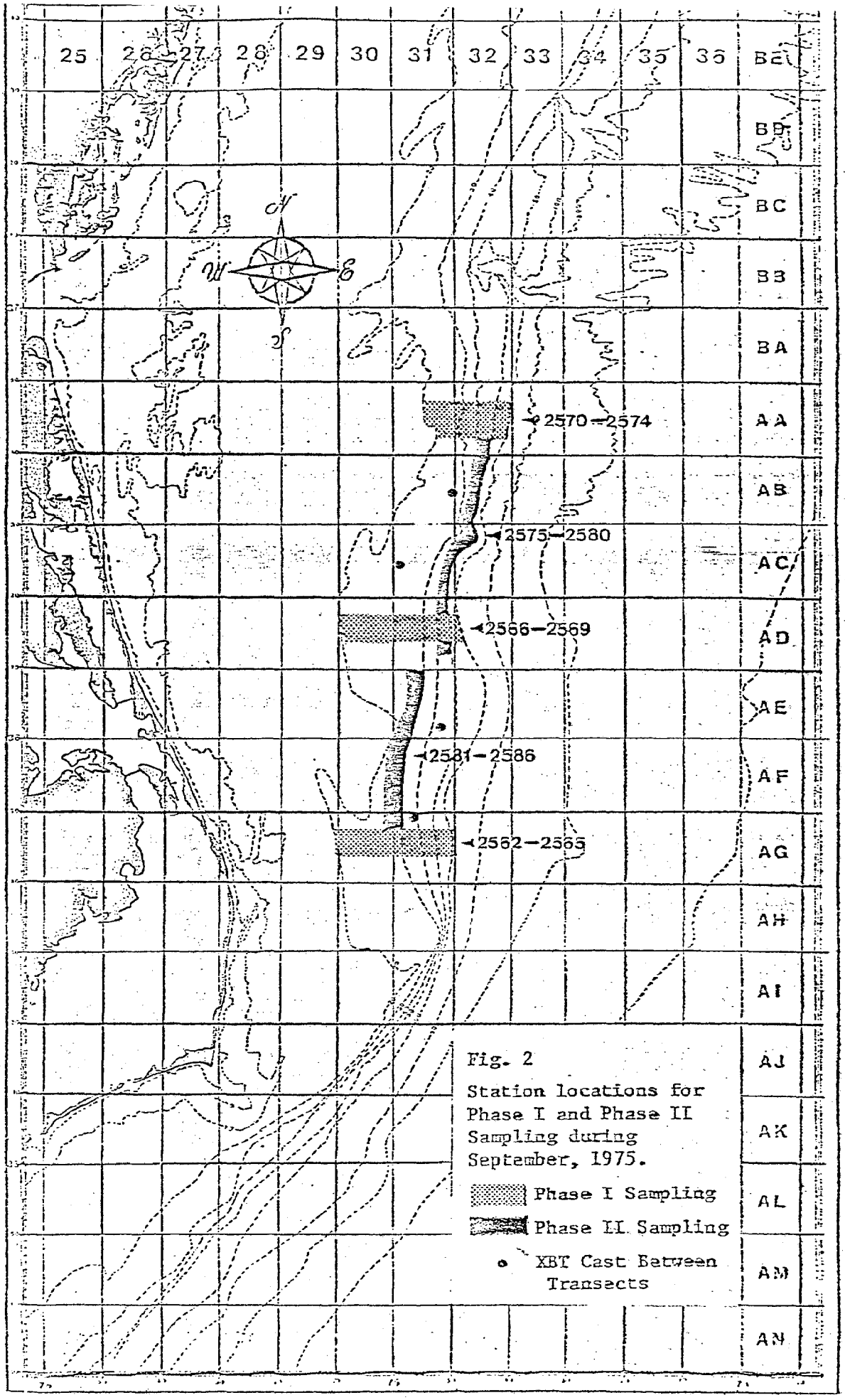
Fig. 1

Station Locations for Phase I and Phase II Sampling during August 1975.

Phase I Sampling

Phase II Sampling

XBT Cast Between Transects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2562—2565
Fig. 2
Station locations for Phase I and Phase II Sampling during September, 1975.
Phase I Sampling
Phase II Sampling
XBT Cast Between Transects

Phase II sampling area was determined from Phase I catches. The depth zone which produced the maximum abundance of *Loligo pealei* was sampled from the northern to the southern extent of the study area where the bottom type was suitable. During the August segment of Phase II, the 50-100fm (91-183m) depth zone was sampled from ca. latitude 36° 33'N to 35° 45'N. During the September segment of Phase II, the 40-50fm (73-91m) depth zone was sampled from ca. latitude 36° 45'N to 36° 13'N, and the 20-30fm (37-55m) depth zone from ca. latitude 36° 10'N to 35° 45'N. A complete list of station locations and pertinent data is shown in Table 1.

Two types of sampling gear were employed during this study: a standard No. 41 Yankee trawl and a 151' (46.1m) modified wing trawl, both having 1½" (3.8cm) stretch mesh in the cod ends. The latter was designed and constructed by Captain Fred Smith and the crew of the R/V DAN MOORE, and has shown to be highly efficient in the capture of pelagic anadromous fishes in previous investigations (Figure 3). All tows during Phase I were of 30 minute duration at ca. 4.5 knots towing speed with a No. 41 Yankee trawl.

Sampling during the Phase II segment consisted of successive alternate tows of one hour duration at ca. 4.5 knots towing speed with the No. 41 Yankee trawl and the 151' (46.1m) modified wing trawl. During the August segment of Phase II, five tows with the No. 41 Yankee trawl and four tows with the wing trawl were accomplished. Modifications of the wing trawl were necessary during this period because the net was "fishing" off the bottom. Six tows with the No. 41 Yankee trawl, and five tows with the modified wing trawl were achieved during the September segment of Phase II.

Collection of Material

Samples collected during both phases of the survey were treated similarly. Both *Loligo pealei* and *Ilex illecebrosus* were culled from the catch and weighed. A subsample of approximately 200 squid was retained when available. The species were separated, counted, and dorsal mantle lengths according to Haefner (1964) were obtained. Estimated weights of incidental organisms were recorded, and the presence of foreign fishing vessels was noted.

Table 1.--Station locations and other pertinent data

August Phase I Stations

Station number	Grid	Lat.	Long.	Loran bearings	Depth(m)	Bottom temp. (°C)	Total weight squid(kg)	Gear
2539	31AG	35°45'	74°51'	3H41552 3L14800	143	13	118	Yan.#41
2540	31AG	35°45'	74°52'	3H41547 3L14800	110	13	133	Yan.#41
2541	31AG	35°46'	74°53'	3H41551 3L14805	91	12	50	Yan.#41
2542	31AG	35°47'	74°57'	3H41534 3L14813	57	14	27	Yan.#41
2543	30AG	35°48'	75°00'	3H41520 3H52908	49	16	27	Yan.#41
2544	31AD	36°16'	74°49'	3H41872 3H52910	179	11	56	Yan.#41
2545	31AD	36°18'	74°51'	3H41879 3H52920	91	13	42	Yan.#41
2546	31AD	36°19'	74°53'	3H41883 3H52926	70	12	42	Yan.#41
2547	31AC	36°23'	74°57'	3H41907 3H52940	37	14	14	Yan.#41
2548	32AA	36°46'	74°41'	3H42232 3H52930	121	14	44	Yan.#41
2549	32AA	36°48'	74°42'	3H42238 3H52936	91	11	23	Yan.#41
2550	32AA	36°47'	74°45'	3H42213 3H52945	68	11	27	Yan.#41
2551	32AA	36°48'	74°51'	3H42197 3H52955	49	11	16	Yan.#41

August Phase II Stations

2552	32AB	36°32'	74°44'	3H42070 3H52921	278	11	12	Yan.#41
2553	32AC	36°28'	74°47'	3H42003 3H52922	132	14	9	WT
2554	32AC	36°24'	74°48'	3H41955 3H52919	117	14	167	Yan.#41
2555	32AD	36°19'	74°49'	3H41908 3H52915	135	14	0	WT
2556	32AD	36°15'	74°48'	3H41865 3H52911	121	14	54	Yan.#41
2557	32AE	36°09'	74°48'	3H41801 3H52905	130	13	1	WT
2558	32AE	36°03'	74°49'	3H41743 3H52900	124	13	155	WT
2559	32AF	35°58'	74°49'	3H41679 3H52896	124	13	128	Yan.#41
2560	31AF	35°53'	74°51'	3H41626 3H52894	154	12	116	Yan.#41
2561	31AG	35°48'	74°53'	3H41569 3H52894	88	15	0	Yan.#41

September Phase I Stations

2562	31AG	35°44'	74°50'	3H41543 3L14795	134	14	81	Yan.#41
2563	31AG	35°45'	74°53'	3H41540 3L14797	97	12	81	Yan.#41
2564	31AG	35°45'	74°56'	3H41520 3L1	68	13	63	Yan.#41
2565	30AG	35°44'	75°02'	3H41472	48	16	68	Yan.#41
2566	32AD	36°15'	74°48'	3H41859	152	12	52	Yan.#41
2567	31AD	36°14'	74°50'	3H41838 3H52915	86	12	122	Yan.#41
2568	31AD	36°15'	74°53'	3H41840 3H52922	57	14	30	Yan.#41
2569	30AD	36°15'	75°00'	3H41801 3H52937	37	15	72	Yan.#41
2570	32AA	36°45'	74°40'	3H42226 3H52924	146	12	57	Yan.#41
2572	32AA	36°45'	74°43'	3H42204 3H52933	86	19	72	Yan.#41
2573	32AA	36°45'	74°46'	3H42193 3H52941	64	11	25	Yan.#41
2574	31AA	36°45'	74°51'	3H42173 3H52953	44	15	10	Yan.#41

Table 1.—(Cont.)

September Phase II Stations

Station number	Grid	Lat.	Long.	Loran bearings	Depth(m)	Bottom temp. (°C)	Total weight squid(kg)	
2575	32AA	36°42'	74°44'	3H42172 3H52933	79	11	39	Ya
2576	32AB	36°36'	74°46'	3H42100 3H52930	77	11	4	W
2577	32AB	36°31'	74°46'	3H42047 3H52925	82	10	130	Ya
2578	32AC	36°26'	74°49'	3H41978 3H52921	84	21	108	WT
2579	31AC	36°21'	74°51'	3H41917 3H52919	82	11	206	Y
2580	31AD	36°15'	74°51'	3H41845 3H52918	79	11	189	W
2581	31AE	36°10'	74°55'	3H41780 3H52920	49	14	41	Ya
2582	31AE	36°05'	74°56'	3H41724 3H52917	53	14	32	W
2583	31AE	36°01'	74°59'	3H41663 3H52919	37	19	8	Y
2584	31AF	35°56'	75°00'	3H41607 3H52916	42	17	149	WT
2585	31AF	35°52'	75°00'	3H41564 3H52911	46	17	96	Y
2586	30AG	35°46'	75°01'	3H41507 3H52908	44	17	0	W

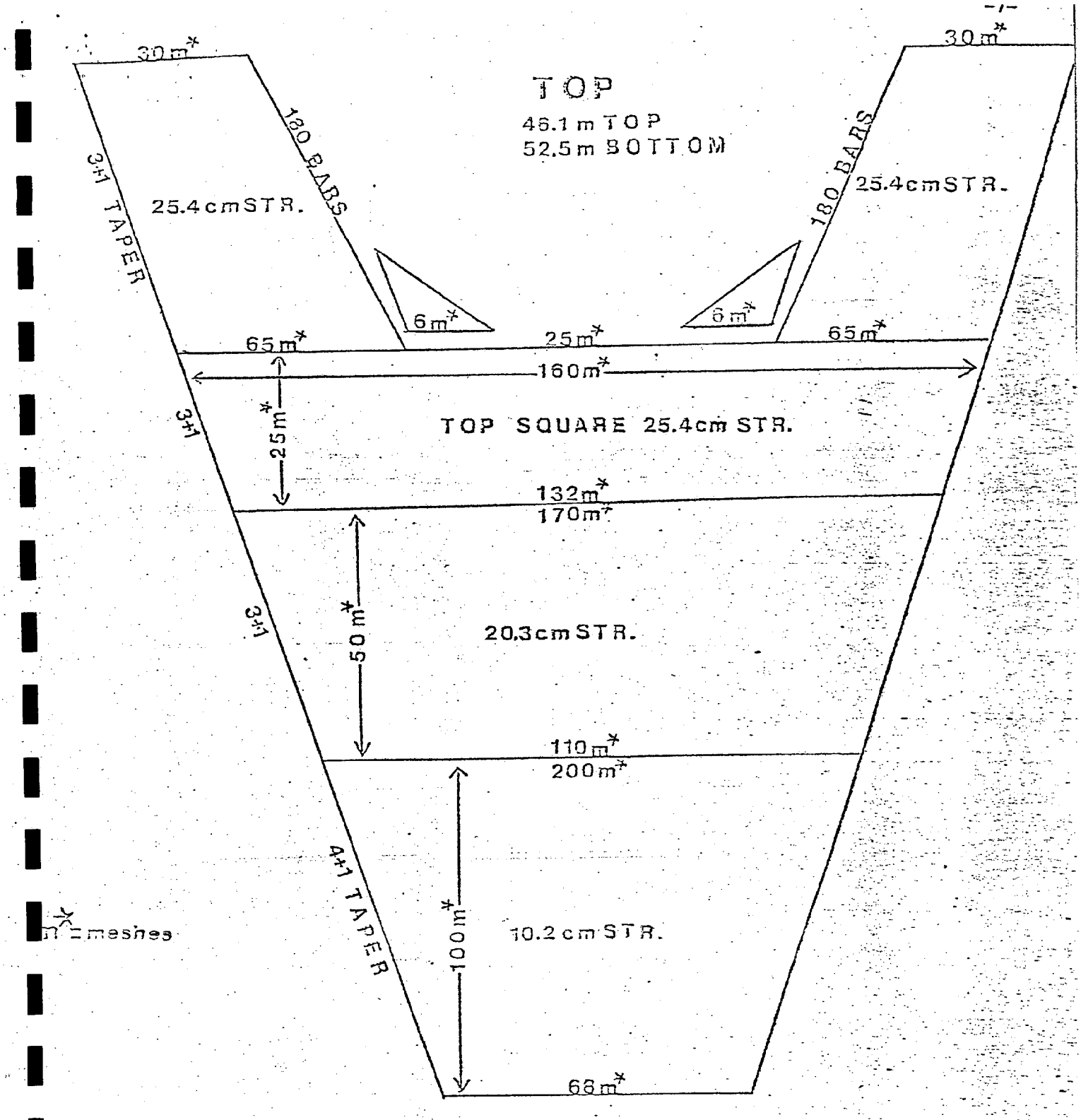

Figure 3.—Experimental wing trawl utilized during Phase II.

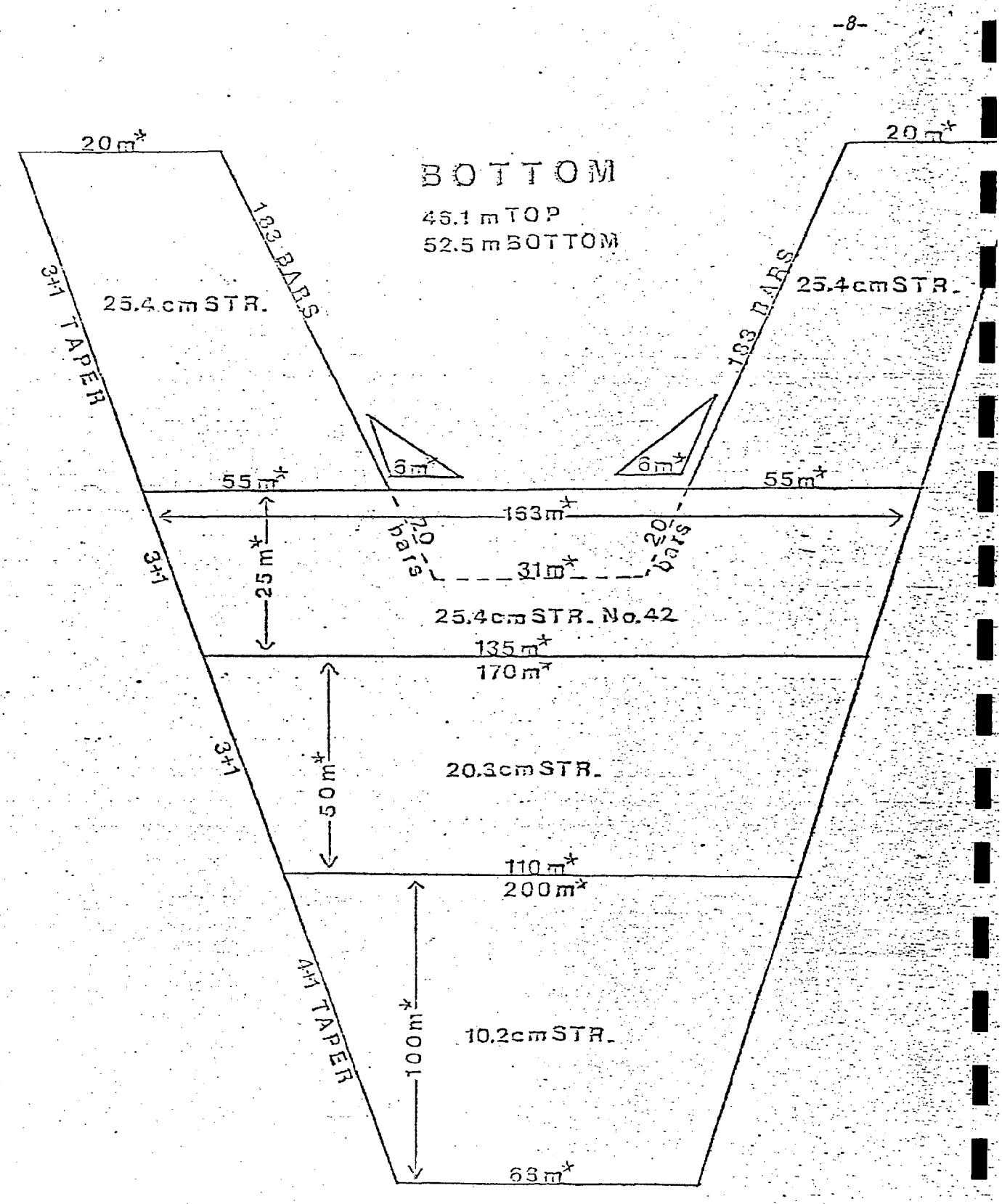

Figure 3.—Continued

At each station of both Phase I and Phase II, hydrographic data were obtained by an expendable bathythermograph (XBT). During the Phase I segment, when steaming between transects, additional XBT casts were made (Figure 1 and 2). The collection of these data afforded both the delineation of bottom isotherms and temperature profiles in the study area.

Analysis of data in relation to abundance required that a catch-per-unit-effort (CPUE) be defined. The stratified mean catch (kg) of *Loligo pealei* per 30-minute tow time, calculated after a $\log_e$ transformation, was utilized as an index of relative abundance. $\log_e$ mean catches of squid have been employed by Serchuk and Rathjen (1974) and Summers (1969) on the basis that the frequency distributions of catches were postively skewed due to the "patchiness" of squid distribution.

RESULTS AND DISCUSSION

Distribution

Maximum $\log_e$ mean catches occurred in the southernmost transect ($35^{o}45'N$) for both months (Figure 4). The $\log_e$ mean catches decreased steadily as latitude increased. September $\log_e$ mean catches were slightly higher than August at all transects with a maximum $\log_e$ mean catch of 4.16 (64 kg) in the southernmost transect when months were combined.

The distribution of *L. pealei* with relation to depth is shown in Figure 5. Long-finned squid were present in all depth zones sampled with maximum catches in the deeper zones (40-100fm) (73-183m). September was the month of maximum abundance in all depth zones except in the 50-100fm (91-183m) zones. Here, $\log_e$ mean catches for August were slightly higher. During the August cruise, a minimum value was obtained in the 20-30 fm zone. From this minimum value, the $\log_e$ mean catches of *L. pealei* increased with depth. The individual Phase I station $\log_e$ mean catches for each transect are shown in Figure 6.

The relative abundance of *L. pealei* in relation to bottom water temperatures was calculated. Although the temperature range in the study area was somewhat restricted ($11-16^{o}C$), optimum $\log_e$ mean catches occurred at $13^{o}C$. When

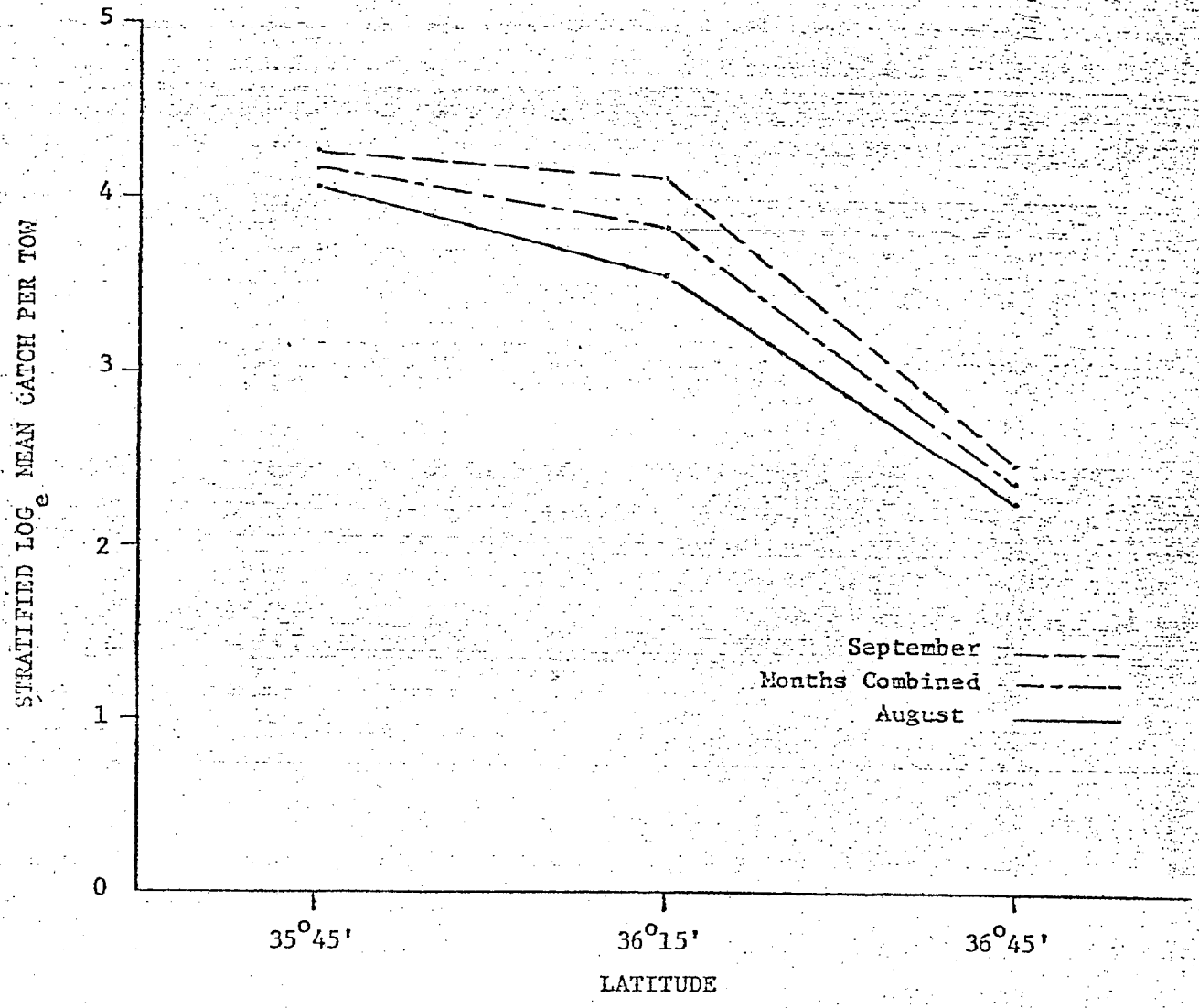

Figure 4.—Log$_e$ mean CPUE vs latitude

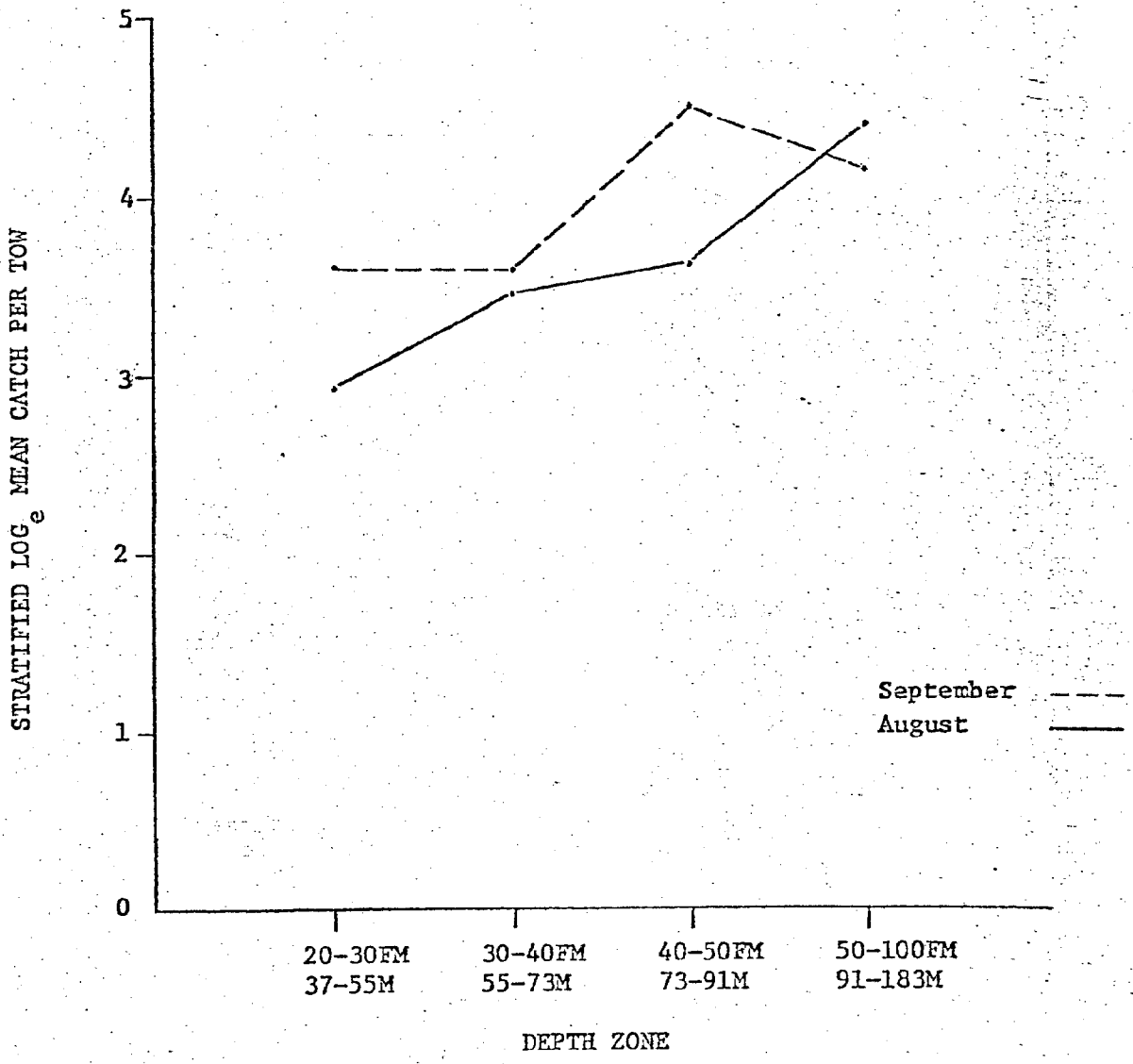

Figure 5.—Log$_e$ mean CPUE vs. depth

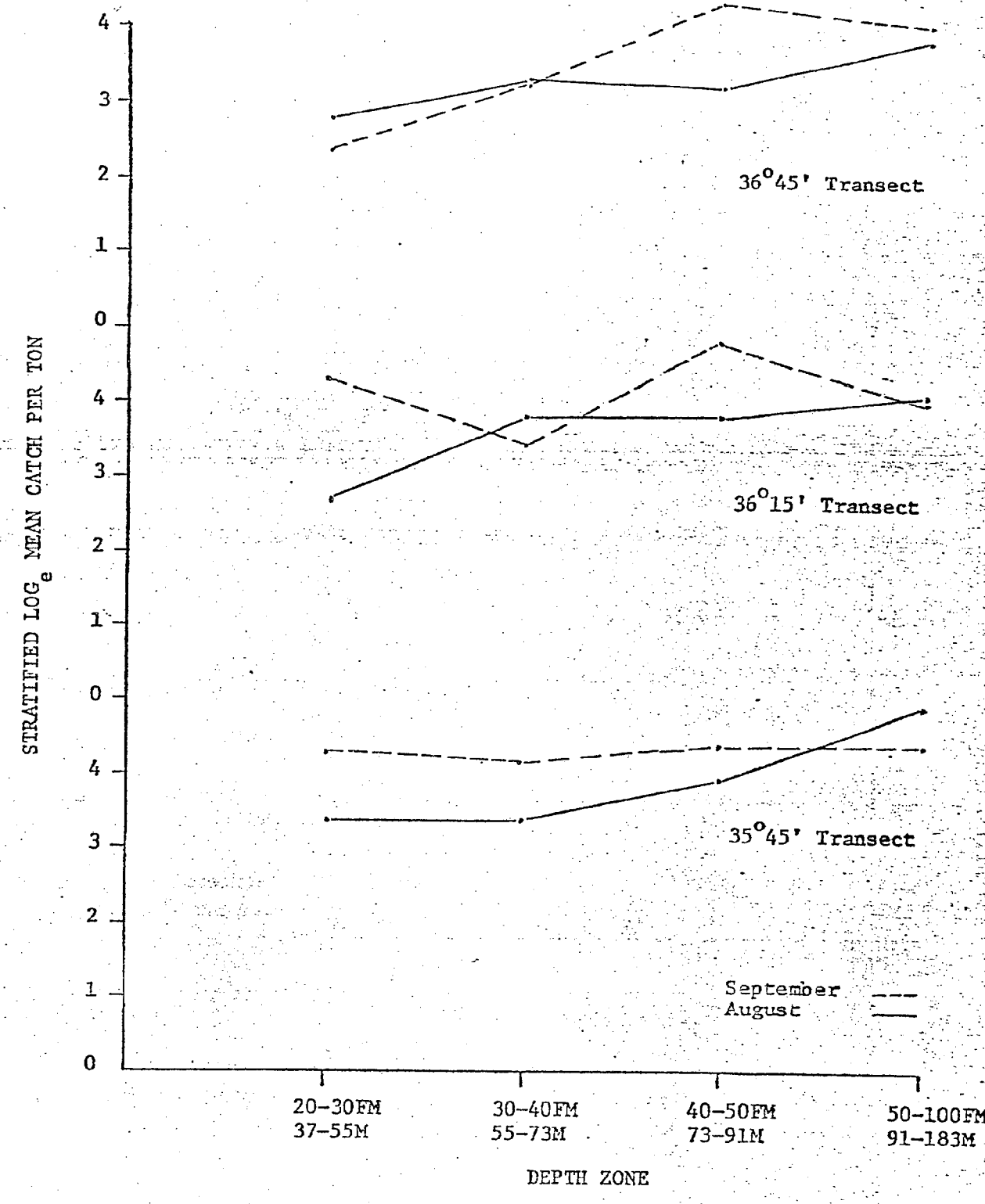

Figure 6.--Individual Phase I station log$_e$ mean catch for three transects comparing months.

mean temperature and catch values were combined by month according to depth zone, a correlation between temperature and catch was difficult to discern. Mean catch values increased with greater depths, yet mean temperatures were similar among the 30-100 fm (55-183m) zones (12.5 - 13.2° C). Notably, the highest recorded mean temperature of 14.5°C (20-30fm) (37-55m) produced the lowest catch.

Size Composition

The mean dorsal mantle length of *L. pealei* was slightly longer at each depth zone for specimens captured in September (Figure 7). During August, similar mean dorsal mantle lengths were observed for all depth zones. During September, larger *L. pealei* were noted in the 20-30 fm (37-55m) depth zone; then size decreased with increasing depths. The occurrence of squid eggs and relatively small squid (ca. 1 cm) during this study period suggested an extended breeding season in this portion of its range.

Dorsal mantle length frequency distributions for *Loligo pealei* were determined for both the August and September cruises (Figure 8). The data were analyzed in accordance with the findings of Summers (1968, 1971). It is apparent in Figure 8 that the 10 cm modal peak, representing squid less than one year old, dominated offshore catches. Two year olds were present, but were not a meaningful component of the catch.

Gear Evaluation

The Phase II segment of the study was used to evaluate gear. During the August Phase II cruise, modifications of the experimental 151' (46.1m) wing trawl were accomplished. Negligible catches of any benthic organisms during the first two tows required the addition of weight to the wings and the removal of floats from the headrope. Furthermore, 1/2" (1.27cm) chain leg lines were added just prior to the second cruise. The quantitative evaluation of this net in relation to standard gear was, therefore, only accomplished during the September Phase II segment.

The $\log_e$ mean catch of the standard No. 41 Yankee trawl was slightly greater than that obtained with the experimental wing trawl (4.04 and 3.96

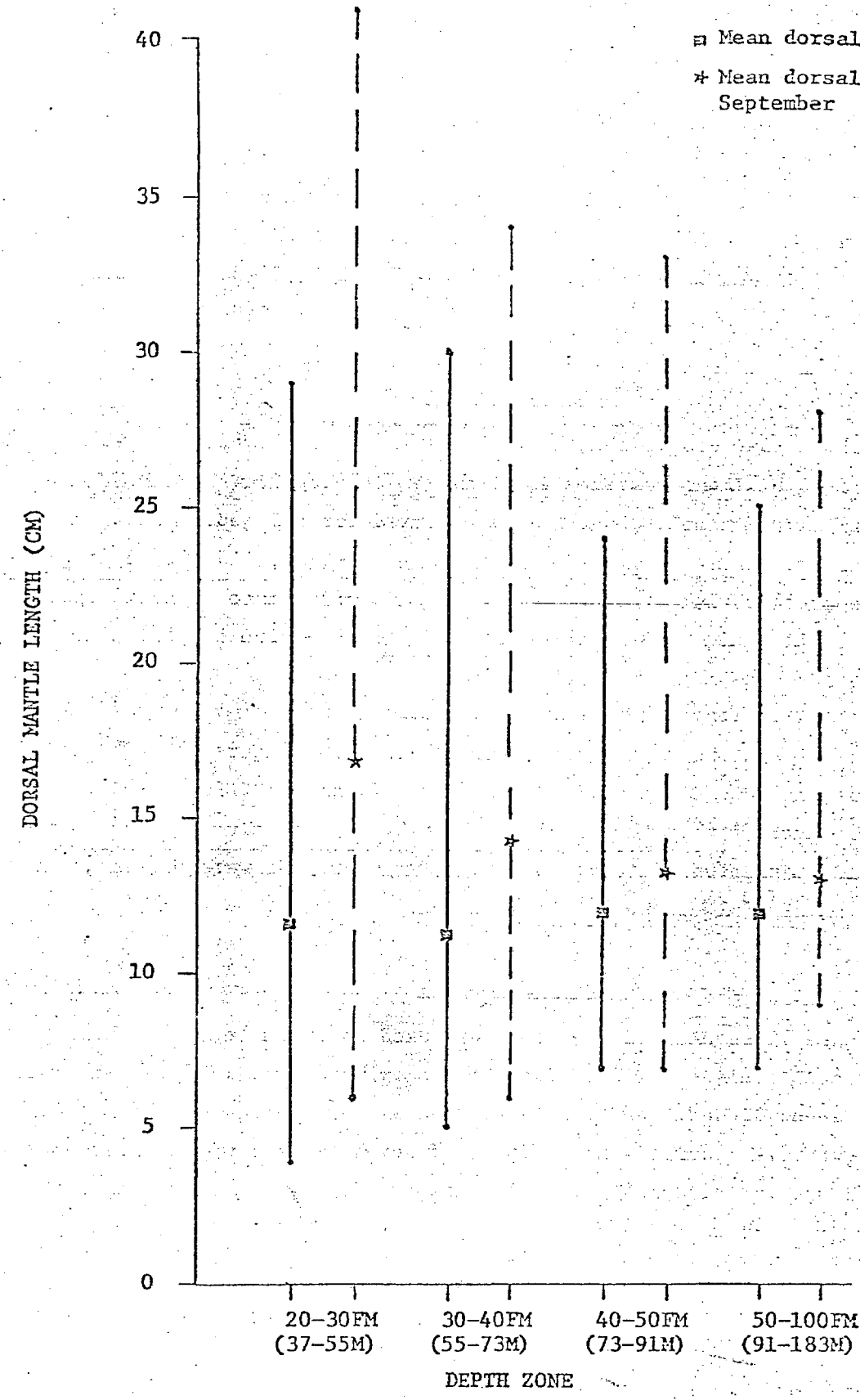

Figure 7.—Dorsal mantle length ranges and means by depth zone for August and September.

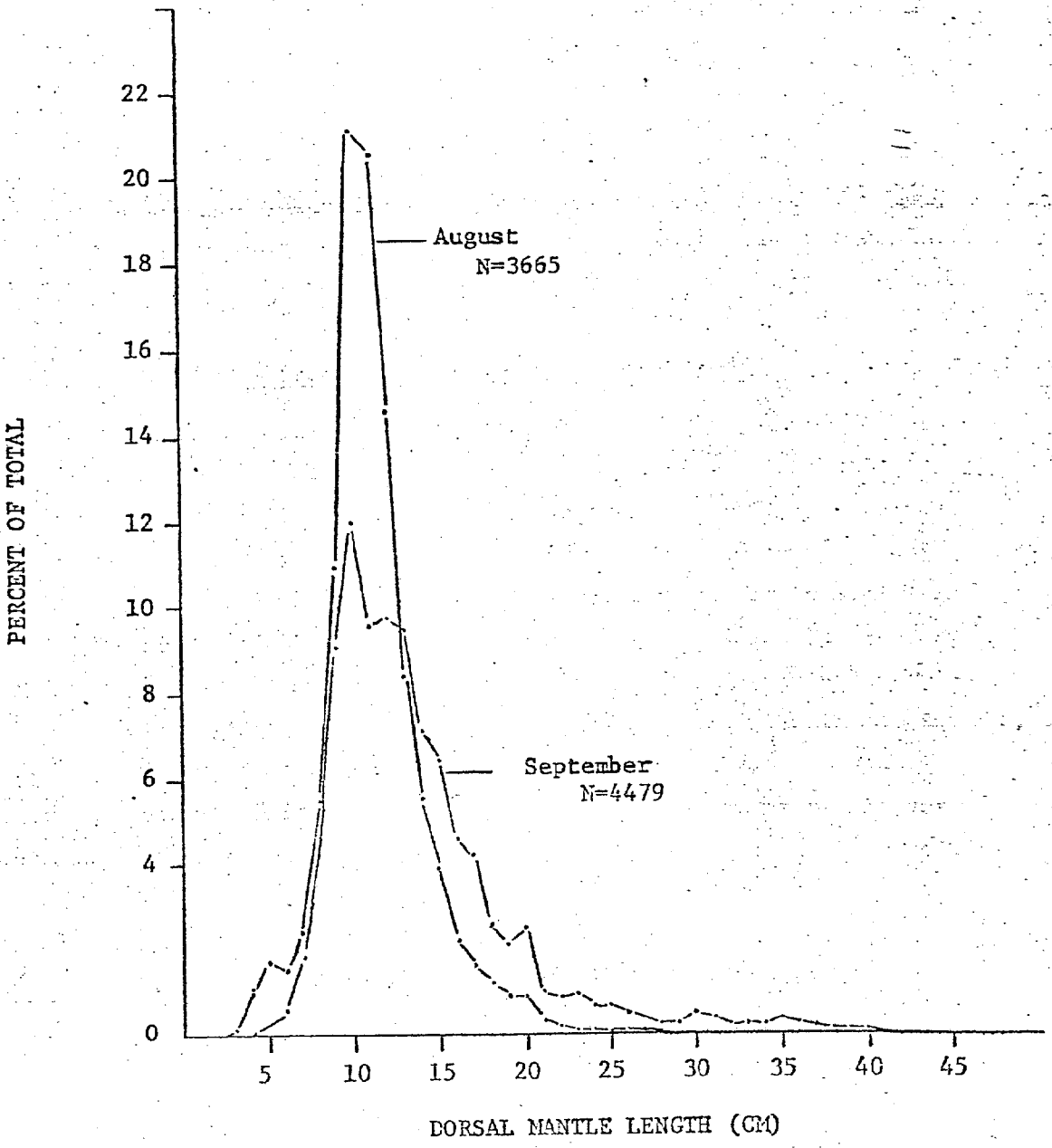

Figure 8.--Dorsal mantle length frequency distribution of *L. pealei* for August and September cruises.

respectively). Within the 40-50 fm (73-91m) depth zone, catches of squid were consistently greater with the standard gear. In addition, the weight of squid relative to the overall catch was significantly higher. On the other hand, the experimental trawl appeared to be at least as efficient as the standard gear within the 20-30 fm (37-55m) zone in both $\log_e$ mean squid catches, and in the weight of squid relative to the overall catch.

Foreign Fishing

Five foreign stern trawlers were sighted in the study area. Four were Spanish trawlers, and one not in the immediate vicinity was not identified. All of the trawlers were fishing the 50-100 fm (91-183m) depth zone, presumably for squid and butterfish.

Other Commercially Important Species

Two other commercially important species, butterfish (*Peprilus triacanthus*) and Atlantic deep sea scallops (*Plactopecten magellanicus*), were caught in commercial quantities incidental to squid. Butterfish were abundant and widely distributed throughout the study area. However, practically all were under 15 cm FL and of no commercial value in existing domestic markets. In the 40-50 fm (73-91m) depth zone at ca. latitude 36° 43'N, 150 pounds (67.6kg) of sea scallops were caught during a 60-minute tow. Other sea scallop catches were scarce, ranging from 5-50 pounds (2.3-22.6kg) per 60-minute tow.

A complete species list by depth zone is shown in Table 2. This list contains a number of commercially important or potentially important commercial species, however these species were not captured in commercial quantities or were of no commercial interest to domestic markets.

Additional Observations of *L. pealei* other than August and September, 1974

During the period October 1973 through May 1975, the R/V DAN MOORE was engaged in two projects, a study of flounder, and a project concerning pelagic anadromous fishes. A total of 161 stations of 30-minutes duration was sampled during this period from Cape Hatteras to Cape Henry in water of 3-20 fms (5.5-37m). *Loligo pealei* were present during every month in small concentrations (under 4.5kg) over the entire area, but the highest concentrations (over 22.7kg) were recorded off Cape Henry during April 1975.

Table. 2.--Species list

20 - 30 fm

Bonito, Atlantic *(Sarda sarda)*
Burrfish, striped *(Chilomycterus schoepfi)*
Butterfish *(Peprilus tricanthus)*
Cutlassfish, Atlantic *(Trichiurus lepturus)*
Filefish *(Alutera sp.)*
Filefish, planehead *(Monacanthus hispidus)*
Flounder, fourspot *(Paralichthys oblongus)*
Flounder, ocellated *(Ancylopsetta quadrocellata)*
Flounder, summer *(Paralichthys dentatus)*
Goosefish *(Lophius americanus)*
Hake, spotted *(Urophycis regius)*
Herring, round *(Etrumens teres)*
Jack, horse-eye *(Caranx latus)*
John dory *(Zenopsis ocellata)*
Octopus *(Octopus vulgarius)*
Porgy, longspine *(Stenotomus caprinus)*
Puffer *(Sphoeroides sp.)*
Scallop, Atlantic deepsea *(Plactopecten magellanicus)*
Scallop, calico *(Argopecten gibbus)*
Sea bass, black *(Centropristis striata)*
Seahorse, lined *(Hippocampus erectus)*
Searobin, northern *(Prionotus carolinus)*
Searobin, striped *(Prirotus evolans)*
Shark, angel *(Squatina dumerili)*
Skate, clearnose *(Raja elganteria)*
Skate, rosette *(Raja garmani)*
Squid, long-finned *(Loligo pealei)*
Squid, short-finned *(Ilex illecebrous)*
Stingray, rough-tail *(Dasyatis centroura)*
Weakfish *(Cynoscion regalis)*

Table 2.--(Con't)

Windowpane *(Scophthalmus aquosus)*
Crab, horseshoe *(Limulus polyphemus)*
Crabs, Jonah & Rock *(Cancridae)*
Crabs, portunid *(Portunidae)*

30 - 40 fm

Flounder, fourspot *(Paralichthys oblongus)*
Flounder, summer *(Paralichthys dentatus)*
Frogfish, ocellated *(Antennarius ocellatus)*
Goosefish *(Lophius americanus)*
Hake, red *(Urophycis chuss)*
Hake, spotted *(Urophycis regius)*
Herring, round *(Etrumens teres)*
John dory *(Zenopsis ocellata)*
Mackerel, frigate *(Auxis thazard)*
Octopus *(Octopus vulgarius)*
Puffers *(Sphoeroides sp.)*
Rag, silver *(Ariomma bondi)*
Scallop, Atlantic deepsea *(Plactopecten magellanicus)*
Sea bass, black *(Centropristis striata)*
Shark, angel *(Squatina dumerili)*
Skate, clearnose *(Raja elganteria)*
Skate, rosette *(Raja garmani)*
Squid, long-finned *(Loligo pealei)*
Squid, short-finned *(Ilex illecebrous)*
Starfish *(Echinoderma)*
Crab, horseshoe *(Limulus polyphemus)*
Crabs, Jonah & Rock *(Cancridae)*
Crabs, portunid *(Portunidae)*

Table 2.--(Con't)

40 - 50 fm

Boarfish, deepbody *(Antigonia capros)*
Butterfish *(Peprilus triacanthus)*
Cunner *(Tautogolabrus adspersus)*
Flounder, fourspot *(Paralichthys oblongus)*
Goosefish *(Lophius americanus)*
Hake, silver *(Merluccius bilinears)*
Hake, spotted *(Urophycisregius)*
Herring, round *(Etrumens teres)*
John dory *(Zenopsis ocellata)*
Mackerel, frigate *(Auxis thazard)*
Octopus *(Octopus vulgarius)*
Puffer *(Sphoerdides sp.)*
Rag, silver *(Ariomma bondi)*
Scallop, Atlantic deepsea *(Plactopecten magellanicus)*
Sea bass, black *(Centropristis striata)*
Sea turtle *(Cheloniidae)*
Skate, rosette *(Raja garmani)*
Squid, long-finned *(Loligo pealei)*
Squid, short-finned *(Ilex illecebrous)*
Starfish *(Asteroidea)*
Crab, horseshoe *(Limulus polyphemus)*
Crabs, Jonah & Rock *(Cancridae)*
Crabs, portunid *(Portunidae)*

50 - 100 fm

Boarfish, deepbody *(Antigoria capros)*
Butterfish *(Peprilus triacanthus)*
Dogfish, chain *(Scyliorhinus retifer)*
Flounder, fourspot *(Paralichthys oblongus)*
Goosefish *(Lophius americanus)*

Table 2.—(Con't)

Hake, red *(Urophycis chus)*
Hake, silver *(Merluccius bilinearis)*
Hake, spotted *(Urophycis regius)*
Herring, round *(Etrumeus teres)*
John dory *(Zenopsis ocellatus)*
Mackerel, chub *(Scomber japonicus)*
Puffer *(Sphoeroides sp.)*
Sea bass, black *(Centropristis striata)*
Searobin, armored *(Peristedion miniatum)*
Searobin, rimspine *(Peristedion thompsoni)*
Searobin, slender *(Peristedion gracile)*
Shark, angel *(Squatina dumerili)*
Skate, rosette *(Raja garmani)*
Snapper, glasseye *(Priacanthus cruentatus)*
Snipefish, longspine *(Macrorhamphosus scolopax)*
Torpedo, Atlantic *(Torepedo nobiliana)*
Crab, horseshoe *(Limulus polyphemus)*
Crab, walking *(Cancridae)*
Lobster, American *(Homarus americanus)*
Squid, long-finned *(Loligo pealei)*
Squid, short-finned *(Ilex illecebrous)*
Starfish *(Asteroidea)*

SUMMARY

1. Sampling for *Loligo pealei* was conducted in the oceanic waters of North Carolina and Virginia from ca. latitude 35° 45'N to ca. latitude 36° 45'N, and from 20 fms to 100 fms (37-183m) in depth, during August through September 1974.

2. The maximum $\log_e$ mean catches of *L. pealei* occurred at the southernmost transect of the study area. The $\log_e$ mean catches decreased with increasing latitude.

3. September was the month of maximum abundance. *L. pealei* was present in all depth zones sampled with maximum $\log_e$ mean catches in the 40-100 fm (73-183m) depth zone.

4. The distribution of long-finned squid in relation to bottom temperature was calculated. The temperature range was somewhat restricted (11° C - 16° C). The maximum $\log_e$ mean catches occurred at 13° C.

5. The mean dorsal mantle lengths were slightly longer during the month of September, and decreased with depth. During August, the mean dorsal mantle lengths were similar for all depth zones.

6. The length frequency distribution of *L. pealei* was determined. The data were analyzed and a 10 cm modal peak, representing squid less than one year old, dominated the offshore catches.

7. The $\log_e$ mean catches of the No. 41 Yankee trawl were slightly greater than the experimental 151' (46.1m) wing trawl. The No. 41 Yankee trawl was more efficient in the capture of squid in the 40-50 fm (73-91m) depth zone. The experimental wing trawl proved to be at least as efficient as the No. 41 Yankee trawl in the 20-30 fm (37-55m) depth zone.

8. Five foreign stern trawlers were sighted fishing in the 50-100 fm (91-183m) depth zone off North Carolina.

9. The commercially important species butterfish (*Peprilus triacanthus*) and Atlantic deep sea scallops (*Plactopecten magellanicus*) were the only species captured in significant commercial quantities incidental to squid.

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PROGRESS REPORT

Project Title: Exploratory Fishing and Research for Development of the Lobster Resource Off North Carolina: Relationship to Squid and Blue Crabs

Period: October 1 - December 31, 1974
(Second Quarter)

Investigators: N. B. Webb
F. B. Thomas
T. M. Miller
W. S. Otwell

I. Handling of Live Crabs

This phase of the project was completed with the submission of a joint report by the Industrial Extension Service, School of Engineering and the Department of Food Science, N. C. State University to the Department of Administration, State of North Carolina in December 1974. A copy of this report entitled, "Development of Improved Handling, Holding and Transporting Techniques for N. C. Blue Crabs" by N. B. Angel, G. L. Crow, N. B. Webb and W. S. Otwell is enclosed (Enclosure 1). Additional copies are available upon request.

II. Handling and Procesing of Squid

Sampling trips conducted by R/V Dan Moore August 19-30 and September 16-27 were described in the Quarterly Progress Report for July 1 to September 30, 1974. The first trip resulted in harvest compostion consisting of 98% Loligo peali Lesueur, and 2% Illex illecebrosus, while the second trip harvest was 100% of the former species.

Processing investigations, conducted at the N. C. State University Seafood Saboratory, Morehead City were aimed at gaining awareness of body structure of the species and knowledge of its proximate composition. The work involved separating a representative sampling of the catch into weight categories, dividing each category into component parts, and analyzing each portion in its relationship to the whole. The yield of cleaned and skinned mantle was considered relevant to future utilization experiments while cooking losses, based on

boiling water, seemed likely to provide guidance in designing future processing steps.

The relationships referred to in the previous paragraph may depend on how the squid have been handled at sea, and upon measures employed in seeking optimum preservation. The experimental design specified for handling the catch aboard the R/V Dan Moore involved dividing representative samplings of the catch into three lots to be chilled as rapidly as possible viz (1) by direct contact with ice, (2) by immersion in refrigerated sea water, followed by icing, or (3) by initiating freezing as rapidly as possible. Upon returning to port lots, (1) and (2) were classified, sub-samples separated into body components, packaged and frozen for later examination. Lot (3) was thawed, subjected to similar handling, then refrozen for later examination.

Preliminary compilation of the data has been accomplished. The data presented in this report are Catch Compostion (Enclosure 2), Proximate Analysis of the Whole Squid (Enclosure 3), Component Parts of the Whole Squid (Enclosure 4) and Component Parts of the Raw and Cooked Mantle for Various Weight Ranges (Enclosure 5). These data will be analyzed statistically for preparation of the final project report.

Mr. Y. Takegami[1] describes Loligo peali as rather thin in flesh, only sold in limited quantities in Japan @ U. S. $500/Metric

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[1]Letter to Mr. Alvah Ward from Mr. Y. Takegami, Hoko Fishing Co., Ltd., Tokyo, Japan, May 17, 1974.

Ton (22.7¢/lb.) CIF Tokyo. Those caught by Japanese trawlers, because of better quality which they attribute to rapid freezing at sea and packing standardization are sold at U. S. $900/Metric Ton (40.9¢/lb.) CIF Italy. "Packing Standardization", to which he refers, is based on the following categories, packed in 580mm x 325mm x 80mm (22.8" x 12.8" x 3.1") blocks:

WHOLE SQUID PACKED IN 13 KG. BLOCKS

Size Description	No./Block	Wt./Unit (Grams)
Very Large	1 to 25	500+
Large	26 to 52	250 to 500
Middle	53 to 130	100 to 250
Small	131 to 260	50 to 100
Very Small	261+	50-

Fisheries Development report[2] estimates the total European market for squid to be 113 million pounds based on Spain, Italy and France as the major consumers. It is stated that the most suitable product form in all markets is whole, cleaned (eyes removed) skin on fish. Because of its simplicity it is recommended that the whole fish product form be marketed in Europe, at least initially.

[2]Fisheries Development Limited, London, (National Marine Fisheries Service, New England Fisheries Development), January 1975.

SIZE GRADING

Length of Body		Weight
Less than 19 cms.	(4")	50 - 100 g (2 - 3 1/2 oz)
10 - 15 cms	(4" - 6")	100 - 150 g (3 1/2 - 5 oz)
15 - 20 cms	(6" - 8")	150 - 200 g (5 - 7 oz)
20 - 25 cms	(8" - 10")	200 - 300 g (7 - 9 oz)
25 - 30 cms	(10" - 12")	300 - 400 g (9 - 11 oz)
Over 30 cms	(Over 12")	Over 400 g (11 oz)

Other suggestions which have been made for marketing squid are:

1) Squid should be block frozen with a distinct preference for a blast frozen product, 2) Individual blocks should be wrapped in flexible film (e.g. polythene/polypropylene) envelopes.

In this and other assessments of market potential in foreign countries it is clearly indicated that there is competition. Breaking into this market must be done with regard to meeting or exceeding present quality standards at market prices not expected to improve in the face of present business outlook. These observations assume technological importent business outlook. These observations assume technological importance in attempting to judge what requirements must be met by N. C. fishermen in attempting to harvest this resource. There are two approaches to the utilization of squid in the U. S. market viz. 1) Modification of existing foreign products for the U. S. and 2) Developmentof totally new products. Kalikstein[3] explored the subject of marketability of squid. Attempts to introduce portions of squid with eye appeal (cleaned mantles) into dishes

[3]Kalikstein, P. H., "The Marketability of Squid," Massachusetts Institute of Technology, Report No. MITSG 74-24, May 20, 1974.

likely to have domestic consumer acceptance, evaluating results through taste panels and market research techniques, has provided useful information.

The seafood laboratory at Morehead City via The Nutrition Leaders Advisory Committee, has been working onthe modification of existing product types to utilize squid tissue. Squid sukiyaki has met with good acceptability by taste panels. The use of squid to extend and augment protein quality of other seafoods appears promising, e.g. clam chowder, in combination with mechanically deboned fish meats, etc.

III. Research Plans for 1975

The development of new products and the expansion of markets for food products which have not been widely accepted in the U. S., such as squid, requires extensive scientific research on functional properties in order to accomplish the visual goods on a sound basis. Therefore, research will be conducted on the functional properties of squid muscle proteins during 1975. These investigations will be extensive; reviewing the various types of functional property evaluation techniques for many types of food proteins with their subsequent application to squid proteins. Due to the need for the development, these techniques, it has been requested that the project completion date be extended from June 30, 1975 to December 31, 1975.

In addition, further work will be done on the modification of existing products to utilize squid tissue e.g. the use of squid in a seafood pizza.

Enclosures:

1. "Development of Improved Handling, Holding and Transporting Techniques for N. C. Blue Crabs."
2. "Catch Composition"
3. "Proximate Analysis - Whole Squid"
4. "Component Parts"
5. "Component Parts - Removing and Processing Mantle"

CATCH COMPOSITION*

TRIP #1 8/19/74 - 8/23/74

Loligo peali

Weight Range, Grams	0-50	51-100	101-250	250-500
Percent of Total Sample Weight	40.0	43.7	15.0	1.2
No. of Individuals/Size Range	974	566	80	4
Average Weight, Grams	37.2	63.9	129.1	275.0
Maximum Weight, Grams	47.3	90.3	220.0	298.0
Minimum Weight, Grams	25.3	48.3	94.0	252.0
Average Mantle Length, Cm.	10.6	13.1	18.1	28.1
Maximum Mantle Length, Cm.	12.0	15.9	23.2	29.3
Minimum Mantle Length, Cm.	8.2	11.4	14.9	27.3

* 98% Loligo peali and 2% Illex illecebrosus

PROXIMATE ANALYSIS - WHOLE SQUID

TRIP #1 8/19/74 - 8/23/74

Loligo peali

Weight Range	Treatment	Moisture	Fat	Protein	Ash
0-50	Iced	78.50%	0.60%	15.78%	2.66%
	Prechilled	81.01%	0.50%	14.62%	1.28%
	Frozen	79.08%	1.41%	15.43%	1.26%
Average		79.53%	0.84%	15.28%	1.73%
51-100	Iced	78.43%	0.61%	16.22%	1.59%
	Prechilled	80.28%	0.44%	15.06%	1.38%
	Frozen	79.06%	0.68%	16.35%	1.24%
Average		79.26%	0.58%	15.88%	1.40%
101-250	Iced	78.01%	0.54%	16.69%	1.49%
	Prechilled	80.25%	0.46%	16.15%	1.41%
	Frozen	77.29%	1.15%	17.09%	1.48%
Average		78.52%	0.72%	16.64%	1.46%
250-500	Prechilled	77.94%	0.47%	17.58%	1.27%

COMPONENT PARTS*

TRIP #1 8/19/74 - 8/23/74

Loligo pealei

Weight Range, Grams	0-50	51-100	101-250	250-500
Average Weight, Grams	35.1 (60 indiv.)	63.3 (60 indiv.)	127.7 (60 indiv.)	277.5 (4 indiv.)
MANTLE (% of Body Weight)	56.9 %	51.7 %	53.2 %	61.8 %
Moisture	79.94%	79.72%	78.40%	77.87%
Fat	0.87%	0.43%	0.84%	0.45%
Protein	15.57%	15.84%	16.77%	17.78%
Ash	1.72%	1.45%	1.53%	1.32%
TENTACLE (% of Body Weight)	15.2 %	18.9 %	20.2 %	18.1 %
Moisture	81.10%	79.69%	79.70%	79.48%
Fat	0.58%	0.62%	0.46%	0.60%
Protein	14.49%	15.67%	15.78%	16.33%
Ash	1.42%	1.20%	1.27%	1.13%
HEAD & VISCERA (% of Body Weight)	30.7 %	28.8 %	26.0 %	19.1 %
Moisture	78.67%	78.75%	77.82%	78.07%
Fat	0.92%	0.82%	0.68%	0.41%
Protein	14.76%	15.75%	16.30%	16.99%
Ash	1.93%	1.47%	1.49%	1.24%
QUILL (% of Body Weight)	0.5 %	0.6 %	0.8 %	1.0 %
Moisture	51.93%	54.12%	51.94%	51.65%
Fat	0.36%	0.26%	0.48%	0.05%
Protein	35.54%	35.60%	36.23%	37.71%
Ash	1.32%	0.82%	0.88%	0.54%

* 98% Loligo peali and 2% Illex illecebrosus

COMPONENT PARTS - REMOVING & PROCESSING MANTLE*

TRIP #1 8/19/74 - 8/23/74

Loligo peali

Weight Range, Raw Squid, Grams	0-50	51-100	101-250	250-500
Dressed Raw Mantle (% of Whole Raw Squid)	44.1 %	41.0 %	44.3 %	54.5 %
Moisture	80.54%	80.91%	79.61%	80.23%
Fat	0.38%	0.36%	0.39%	0.39%
Protein	15.87%	15.60%	15.76%	16.39%
Ash	1.11%	1.05%	1.17%	1.11%
Cooked Mantle (% of Whole Raw Squid)	22.8 %	24.6 %	28.9 %	41.1 %
Moisture	75.79%	73.99%	74.45%	75.05%
Fat	1.63%	1.53%	1.52%	1.68%
Protein	19.31%	21.41%	20.39%	20.19%
Ash	1.66%	1.16%	1.19%	1.16%

* 98% *Loligo peali* and 2% *Illex illecebrosus*