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Feeding and Food Consumption of Long-finned Squid (*Loligo pealei*) and Short-finned Squid (*Illex illecebrosus*) in Subareas 5 and 6, Northwest Atlantic*

by

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SPECIAL SESSION ON SQUIDS

ABSTRACT

Preliminary estimates were made of quarterly and annual quarterly and annual consumption by Illex and Loligo in Subareas 5 and 6, for 1979 and 1980. Euphausiids made up a considerable proportion of the diet of both species in the spring offshore. Overall, predation on fish was greater by Loligo and cannibalism was greater by Illex. Consumption estimates varied with feeding intensity and biomass.

Introduction

Two species of squid, the short-finned Illex illecebrosus, and the long-finned, Loligo pealei, are of commercial importance in the Northwest Atlantic. In 1981-82 the total catch was about 15,000 mt for each species. Minimum abundance estimates have ranged from 18-124 million individuals for Illex and 1.2 to 4.3 billion individuals for Loligo.

Illex migrate seasonally onto the continental shelf from the mid-Atlantic to the Gulf of Maine. This species feed through the summer and migrate offshore in late autumn.

Loligo also migrate seasonally to shallow inshore waters from Cape Cod Bay to the Chesapeake Bay in spring and summer to spawn. Spawning usually peaks in the spring and autumn. As a

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result, there are two distinct cohorts produced (Summers, 1971; Mesnil, 1977). These juvenile squid grow rapidly and feed intensively until late autumn when they move offshore (Lange, 1981).

This report focuses on the role of squid (Illex and Loligo) as predators. The importance of predation on fish and cannibalism is compared between species and between years.

Materials and Methods

During 1979 and 1980, Illex and Loligo were collected for food habits analysis on spring, summer and fall (inshore and offshore) groundfish surveys from Cape Hatteras to the Gulf of Maine, NAFO Subareas 5 and 6 (Figures 1 and 2). Generally, inshore cruises sampled coastal strata less than 40 m deep and offshore cruises sampled strata of depths greater than 40 m. At each station squid were randomly sampled by size and placed in a formaldehyde solution. In the laboratory, squid were measured and stomach contents identified to the lowest possible taxa and weighed to the nearest 0.001 g. Stomach contents which could not be identified were categorized as animal remains. For the purpose of this anlaysis the weight of animal remains has been proportioned among the identified prey. Also, prey categories which accounted for less than 0.01% stomach content weight were omitted.

Food consumption was calculated using an exponential model (Elliot and Persson, 1978; Eggers, 1979).

$$\frac{dS}{dt} = R - \alpha S$$

where S is the level of food in the stomach, R is the rate of food intake and α is the instantaneous rate of gastric evacuation. This is a volume dependent model which has been used extensively to estimate consumption of food by fish (Tyler, 1970; Elliot and Persson, 1978; Durbin and Durbin, 1980; Cohen and Grosslein, 1981). Given α and an estimate of $\bar{S}$ (average stomach contents), daily ration can be calculated (Eggers, 1979 and Pennington, 1981).

Unfortunately, very little information exists on the evacuation rates of squid. However, Fange and Grove (1979) found time of evacuation was related to temperature when fish were grouped by feeding types. Known stomach evacuation times were plotted on Fange and Grove's Figure 4 (Figure 3). Values reported for Illex at 10°C (Boucher-Rodini, 1975 and Wallace et al., 1981) and Loligo at 18°C (Karpov and Caillet, 1978) fall within the area of microphagous feeding types. A line connecting the most commonly cited evacuation time at 10°C (12 hours), and the time found by Karpov and Cailliet for Loligo at 18°C (6.6 hours) is similar in slope to that found by Jones (1974) for fish.

Assuming the Fange and Grove relationship relating temperature and feeding type is valid for squid, and defining "empty" as 1% of the initial weight of stomach contents remaining, the gastric evacuation time (t) can be described by:

$$t = 25.3353e^{-.0747(T^0)}$$

or, following Durbin and Durbin (1980):

$$\begin{aligned}\alpha &= ae^{b(T^0)} \\ &= 0.1818e^{.0747(T^0)}\end{aligned}$$

where α is the instantaneous gastric evacuation rate and T° is temperature (°C). Using this relationship, α was estimated for mean temperature at which squid were caught on the survey cruises (Table 1).

Average stomach contents, $\bar{S}$ were calculated assuming that samples were random within strata and with respect to time. Mean stomach content weight was estimated within 5 cm, size intervals for each cruise. If an interval was undersampled for stomach contents, it was omitted from the consumption estimate. Sampling adequacy was related to biomass observed; therefore, this procedure probably had a minimal effect on final estimates.

Average daily ration ($\bar{D}$) was estimated using the modified Bajkov equation (Eggers, 1979; Pennington, 1981):

$$\bar{D} = \alpha \; \bar{S} \; 24$$

Daily ration estimates were expressed as percent body weight. Estimates of minimum biomass and distribution of biomass within the 5 cm size intervals were calculated for each species on a cruise by cruise basis, using the groundfish survey analysis program SURVAN (Lange, pers. comm.). Length-weight relationships derived for _Illex_ and _Loligo_ by Lange and Johnson (1981) were used to convert predator length to body weight.

Consumption estimates were derived by multiplying daily ration (% body weight), within a size interval by the appropriate biomass (mt) and expanding to quarterly consumption (x 90 days). Inshore and offshore consumption were summed for _Loligo_ within summer and fall quarters. _Illex_ consumption estimates were based on offshore surveys only.

Results

Major differences were observed in overall food habits of _Illex_ and _Loligo_ (Table 2). Squid ranked first as prey (% weight) for _Illex_ in both years, followed by fish in 1979 and crustaceans in 1980. The incidence of empty stomachs was higher for _Illex_ in 1980 (25%) and the mean stomach content was smaller. _Loligo_ fed primarily on fish in both years (50%), followed by crustaceans in 1979 and squid in 1980. The incidence of empty stomachs was higher (27%) for _Loligo_ in 1980 and the mean stomach content (% body weight) was higher in 1980.

The composition of prey varied with predator size (Tables 3 and 4). In both years, 6-10 cm _Illex_ was feeding predominantly on squid (Table 3). Squid decreased in importance in the 11-15 cm group, which fed mostly on fish in 1979 and crustaceans in 1980. Crustaceans were the primary prey for 16-20 cm _Illex_ in both years, and decreased in importance with predator size. Squid increased in importance with predator size in greater than 20 cm _Illex_, strongly dominating largest size groups. Stomach content weight (g) increased with predator size in both years with the exception of the poorly sampled 31-35 cm size group in 1979. Mean stomach content weight ranged from 0.042 to 1.333 (% body weight) in 1979 Illex and from 0.181 to 0.919 (% body weight) in 1980 Illex. For Loligo in 1979, fish accounted for greater than 50% of the stomach content weight with crustaceans more than 32% of the diet of the 1-15 cm predators (Table 4). Fish became less than 50% of the diet of the 16-20 and 21-25 cm predator groups, but increased significantly with predator size greater than 26 cm. During 1980, fish dominated (67%) all size groups except 6-10 and 16-20 cm. Crustaceans peaked in importance (31%) in the 6-10 cm group, and decreased in importance with predator size. Cannibalism was greatest (47%) in the 16-20 cm size class. Stomach content weight (g) increased with predator size (with the exception of one 1979 size group). Mean stomach content weight (% body weight) ranged from 0.342 to 1.441 in 1979 and 0.588 to 1.698 in 1980.

A consistent seasonal feeding pattern was observed during both years for Illex (Tables 5 and 6). In 1979, offshore diet shifted from almost exclusively crustaceans (over 90%, mostly euphausiids) in the spring to a cannibalistic diet in the summer (76%) and fall (67%). A similar pattern occurred for Illex offshore in 1980; however, crustaceans made up a greater proportion of the summer diet before it shifted to fall cannibalism (67%). Inshore feeding in both years was dominated by fish (80%). In 1979, the highest percentage of empty stomachs (34%) occurred in summer (28%) and fall (25%). The mean stomach content (% body weight) during 1979 was high in the spring offshore and summer inshore, and lower in the summer offshore and fall. During 1980, the mean stomach content weight (% body weight) was lowest in spring offshore. Consistent seasonal and inshore-offshore feeding patterns were observed for Loligo (Tables 7 and 8). During both years, spring populations of Loligo were feeding on euphausiids and fish offshore. During summer, both inshore and offshore diets were primarily fish (about 45 and 65%). Fish remained an important component of the diet through the fall inshore. In the fall offshore in 1979, Loligo fed heavily on fish (72%), while in 1980, fall offshore

Loligo became more cannibalistic (62%). During 1979, the highest percentage of empty stomachs occurred during the fall (29% inshore and 25% offshore). The highest percentage of empty stomachs in 1980 occurred in the summer (32% inshore and 38% offshore) and fall offshore (33%). In 1979, the mean stomach content weight (% body weight) was highest in the spring, intermediate for summer (inshore and offshore) and low in the fall (inshore and offshore). In 1980, the mean stomach content weight (% body weight) was highest in the spring offshore, low inshore in the summer and fall and higher in the fall offshore.

Estimates of consumption by both species reflect major patterns in diet composition and daily ration. Quarterly consumption by *Illex* was lowest in spring in both years, consisting mostly of crustaceans (Table 9). Spring consumption contributed less than two percent of the annual consumption by *Illex* in either year. Consumption was highest in summer, making up over 80% of the annual estimate in both years. In the summer of 1979, cannibalism was 69% of the quarterly estimate, while in summer 1980, cannibalism was reduced to 37% of the quarterly estimate. Predation on fish was highest in summer of both years, and about 12-15% of the summer consumption estimate. Consumption was reduced in the fall to about 17% of the annual estimate in both years. Cannibalism accounted for 45 and 54% of the fall consumption estimate in 1979 and 1980. A difference of only 4% separated the annual estimates of consumption by *Illex* in 1979 and 1980. In 1979, cannibalism accounted for 63.6% and predation on fish accounted for 13% of the annual estimate. In 1980, cannibalism accounted for 40.3% and fish predation 17.7% of the annual estimate.

Quarterly consumption estimates for *Loligo* in 1979 were strongly dominated by crustaceans and fish (Table 10). Highest consumption was during the summer, lowest in the fall. Cannibalism was highest during the summer quarter and lowest in the fall. The annual consumption estimated for *Loligo* in 1979 consisted of 52% crustaceans, 40% fish and only 7.6% squid. In 1980, quarterly consumption was lowest in summer and highest in fall. Fall consumption was 84% of the annual estimate and consisted of 5% crustaceans, 42% fish and 53% cannibalism. The annual consumption estimate for 1980 consisted of 8.2% crustaceans, 46.9% fish and 44.8% cannibalism.

Discussion

Consumption estimates for Georges Bank by Cohen and Grosslein (in press) rank squid (Illex and Loligo) as major consumers of fish and squid, second only to silver hake in the fish community. Consumption by squid was estimated to be 17.4 Kcal $m^{-2}yr^{-1}$ of which approximately 50% was assumed to be fish and squid (Cohen and Grosslein, in press). Although our analysis is not separated by area, we have found the percentage of fish and squid to be consistently higher, from 62 to 83% for Illex and 64 to 89% for Loligo. Results indicate that Loligo is a major fish predator with fish making up over 50% of its diet in both years.

The consumption of pre-recruit fish by Loligo can be crudely assessed. Using the consumption estimates for Loligo and assuming the upper limit of prey size is roughly equal to the mantle length (O'Dor et al., 1980), we estimate that approximately 80% of the total fish consumption in fall 1979 was by squid 10 cm in length or less. In fall of 1980, 75% of the total fish consumption was by the ≤10 cm Loligo. The estimated consumption of ≤10 cm pre-recruit fish would be 17,600 mt in 1979 and 188,000 mt in 1980. Species with pre-recruits in this size range in the fall include cod, haddock, yellowtail flounder, silver hake, butterfish, scup, mackerel, herring, menhaden and sand lance.

Cannibalism by Illex does not appear to be a function of population biomass. In summer 1979, when biomass was 30,000 mt, cannibalism was highest for any quarter. In the following summer of 1980, biomass was double, 63,000 mt; and cannibalism was reduced to only 1/2 of the 1979 level. This suggests that the availability of alternate prey may be the primary mechanism controlling cannibalism for Illex.

Squid (Illex and Loligo) captured for food habits studies in the spring were distributed in a narrow band on the outer edge of the survey area. This edge is associated with the 10°C isotherm and the 100 m isobath. Results of our analysis indicate that both species are feeding heavily on euphausiids associated with this area in the mid-Atlantic and Southern New England regions. Loligo and Illex fed almost exclusively on euphausiids in both regions (92-98% by weight) in 1979. Studies on the Nova Scotian Shelf found that the feeding activity of Illex closely coincides with the seasonal availability of euphausiids (Amaratunga, 1983). This could be an important consideration if euphausiid availability were low: squid may become more cannibalistic or increase predation on co-occurring fish species. Fish predation by Illex in the spring is negligible. However, our estimates indicate Loligo consumes significant quantities of fish during the spring period. Species co-occurring with Loligo offshore in the spring include butterfish, mackerel and silver hake (Lange, 1978).

The 1980 summer biomass peak (63,641 mt) for Illex was unexpected. Past records show this species is traditionally more abundant on the shelf in the fall. This movement does not appear to be linked with prey availability since C:B ratio for this quarter is 3.4, about half of the 1979 value for the same quarter. This apparent early migration onto the shelf may be associated with temperature. All other biomass estimates fall within traditional limits (Lange, 1982).

Several sources of error should be noted. The catchability of squid was assumed to be 100%. Since squid are a pelagic schooling species, the groundfish survey trawl is not an adequate sampling tool. No catchability coefficients are available for squid. The catchability of haddock is considered to be 45% (Clark and Brown, 1977). Applying this to squid would raise the minimum biomass by a factor of 2.2. This is quite conservative, considering the differences between haddock and squid. The timing of the groundfish surveys may not sample the Loligo population each year at the same point in the spawning season. Position of the slope/shelf front could influence squid abundance in the survey area in the spring. The digestion rate for both species needs to be experimentally determined for different sized predators, types of prey, mean sizes and temperature. Small squid (<5 cm) were frequently undersampled for food habits analysis and are not retained completely by the groundfish trawl.

Experiments are being conducted on stomach contents to determine if electrophoresis can be used as a tool to identify fish prey to the species level. If successful, this method would provide data necessary to assess the effects of squid predation on individual fish stocks, especially predation by juvenile Loligo on larval and post-larval fish.

Our estimates of consumption by Illex and Loligo must be considered preliminary until the various sources of bias and the degree of variability in the annual and quarterly biomass estimates and the stomach content data have been further analyzed. Nevertheless, these preliminary values suggest that predation on fish and squid by squid may be a significant source of pre-recruit mortalty.

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Table 1. Temperature (°C) and instantaneous digestion rates (α) used for daily ration calculations.

	Loligo		Illex	
	T°	α	T°	α
1979				
SPRING				
OFFSHORE	9.6	0.3724	9.9	0.3809
SUMMER				
INSHORE	16.0	0.6007		
OFFSHORE	11.0	0.4135	9.0	0.3561
FALL				
INSHORE	16.5	0.6236		
OFFSHORE	11.9	0.4422	10.6	0.4013
1980				
SPRING				
OFFSHORE	9.75	0.3766	10.0	0.3837
SUMMER				
INSHORE	15.0	0.5575		
OFFSHORE	9.5	0.3697	8.5	0.3430
FALL				
INSHORE	16.0	0.6007		
OFFSHORE	12.8	0.4730	10.1	0.3886

Table 2. A summary of Illex and Loligo food habits expressed as percent stomach content weight for 1979-1980 from subareas 5 and 6.

	Illex		Loligo	
Prey	1979	1980	1979	1980
Polychaetes	--	0.1	--	0.5
Gammarid Amphipods	--	--	1.3	--
Shrimp	--	0.7	--	--
Euphauiids	9.0	1.0	20.8	4.8
Candacia	--	--	1.3	--
Total Crustaceans	15.6	31.7	35.5	10.0
Squid	45.8	49.3	13.3	28.2
Fish	38.1	18.8	51.2	61.2
Number examined	692	745	969	673
Number empty	120	190	156	185
Mean stomach content weight (g)	1.92	0.74	0.46	0.71
Mean predator length (cm)	21	18	12	12
Mean stomach content (% body wt)	1.01	0.57	0.85	1.31

Table 3. Composition of prey (% weight) within 5 cm predator size groups for Illex in subareas 5 and 6, 1979-1980.

Prey	Predator Length (cm)						
	1-5	6-10	11-15	16-20	21-25	26-30	31-35
Illex 1979							
Total Crustaceans	-	-	4.7	71.3	14.7	5.6	-
Chaetognaths	-	-	0.4	-	-	-	-
Squid	-	57.7	2.6	14.7	32.8	81.0	100
Fish	-	42.3	92.1	14.0	52.5	13.4	
Number of stomachs examined	0	35	56	132	377	90	2
Number empty	0	18	13	14	50	26	0
Mean stomach content (g)	-	0.008	0.552	0.978	2.165	3.911	0.586
Mean predator length (cm	-	9	12	19	22	26	32
Mean stomach content (% body weight)	-	.042	1.333	0.676	1.005	1.152	0.098
Illex 1980							
Polychaetes	-	-	9.5	-	-	-	-
Euphausiids	-	-	-	7.6	-	-	-
Total Crustaceans	-	29.9	48.9	50.7	28.6	22.2	-
Squid	-	67.1	27.3	20.1	44.9	74.3	-
Fish	-	2.9	14.2	20.5	25.2	3.4	-
Number stomachs examined	0	46	161	222	263	44	-
Number empty	0	20	46	63	56	5	-
Mean stomach content (g)	-	0.031	0.093	0.315	1.167	3.456	-
Mean predator length (cm)	-	8	13	18	22	27	-
Mean stomach content (% body weight)	-	0.225	0.181	0.252	0.543	0.919	-

Table 4. Composition of prey (% weight) within 5 cm predator size groups for Loligo in subareas 5 and 6, 1979-1980.

Prey	1-5	6-10	11-15	16-20	21-25	26-30	31-35
	Predator Length (cm)						
Loligo 1979							
Gammarid Amphipods	4.6	2.8	2.9	-	-	-	-
Crangon	-	-	1.0	-	-	-	-
Hermit Crab	-	0.9	-	-	-	-	-
Euphausiids	-	2.3	20.7	17.6	33.6	-	-
Candacia	-	11.1	-	-	-	-	-
Total Crustaceans	41.8	32.0	36.4	17.6	46.6	-	-
Chaetognaths	-	2.3	0.5	-	-	-	-
Squid	-	14.9	5.2	24.3	9.6	19.2	-
Fish	58.1	50.3	57.1	43.6	43.7	80.7	100.0
Number of stomachs examined	86	390	250	131	90	20	2
Number empty	23	62	40	13	14	4	0
Mean stomach content (g)	0.022	0.123	0.345	1.166	1.446	1.054	5.984
Mean predator length (cm	4	8	12	17	22	27	31
Mean stomach content (% body weight)	0.431	0.547	0.640	1.023	0.728	0.342	1.441
Loligo 1980							
Polychaetes	-	7.8	-	-	-	-	-
Euphausiids	-	5.4	10.3	3.4	-	-	-
Total Crustaceans	17.9	31.6	13.9	6.1	6.8	-	-
Squid	-	26.8	18.8	47.1	10.1	-	-
Fish	82.1	44.5	67.2	46.7	83.0	100.0	-
Number stomachs examined	54	227	241	98	45	8	0
Number empty	35	47	64	28	8	3	0
Mean stomach content (g)	0.030	0.382	0.531	1.474	2.068	3.200	-
Mean predator length (cm)	4	8	13	17	22	27	-
Mean stomach content (% body weight)	0.588	1.698	0.830	1.293	1.041	1.037	-

Table 5. Quarterly food habits data expressed as percent stomach content weight for Illex in subareas 5 and 6, 1979.

Prey	Spring	Summer		Fall	
	Offshore	Inshore	Offshore	Inshore	Offshore
Euphausiids	95.0	0.5	0.3	--	10.1
Total Crustaceans	96.1	4.2	11.7	2.8	17.7
Squid	--	3.0	76.1	12.0	67.0
Fish	3.9	92.7	12.0	85.2	15.3
Number of stomach examined	44	78	236	43	291
Number empty	0	3	11	6	100
Mean stomach content (g)	1.83	4.35	1.87	1.21	1.43
Mean stomach content (% body wt)	2.410	2.290	0.981	0.498	0.753
Mean predator size (cm)	15	21	21	23	21

Table 6. Quarterly food habits data expressed as percent stomach content weight for Illex in subareas 5 and 6, 1980.

Prey	Spring	Summer		Fall	
	Offshore	Inshore	Offshore	Inshore	Offshore
Polychaetes	--	2.4	--	--	--
Euphausiids	--	--	1.7		
Total Crustaceans	90.0	10.0	43.5	--	20.6
Squid	5.0	1.3	40.5	--	67.5
Fish	5.0	86.3	15.9	--	11.8
Number of stomach examined	58	52	354	--	281
Number empty	7	11	100		72
Mean stomach content (g)	0.036	0.603	0.754	--	0.889
Mean stomach content (% body wt)	0.07	0.66	0.52	--	0.71
Mean predator size (cm)	13	16	19	--	18

Table 7. Quarterly food habits data expressed as percent stomach content weight for Loligo in subareas 5 and 6, 1979.

Prey	Spring	Summer		Fall	
	Offshore	Inshore	Offshore	Inshore	Offshore
Gammarid Amphipods	--	6.3	--	--	--
Crangon septemspinosa	--	1.8	--	--	--
Hermit crab	--	--	--	--	0.3
Euphausiids	50.8	--	--	--	--
Candacia	--	--	14.4	--	--
Total Crustacea	63.5	13.0	43.3	--	15.3
Chaetognaths	--	0.4	--	1.0	--
Squid	4.6	38.3	--	1.6	11.7
Fish	29.9	47.7	55.5	93.7	72.5
Number of stomach examined	154	233	113	95	359
Number empty	5	27	2	28	91
Mean stomach content (g)	1.46	0.40	0.42	0.03	0.21
Mean stomach content (% body wt)	1.70	0.90	1.20	0.20	0.40
Mean predator size (cm)	15	11	10	7	12

Table 8. Quarterly food habits data expressed as percent stomach content weight for *Loligo* in subareas 5 and 6, 1980.

Prey	Spring	Summer		Fall	
	Offshore	Inshore	Offshore	Inshore	Offshore
Polychaetes	--	7.2	--	--	--
Euphausiids	15.1	--	--	--	--
Total Crustaceans	20.6	19.6	13.3	1.1	2.3
Chaetognaths	--	--	--	--	--
Squid	--	7.3	25.5	--	61.9
Fish	79.4	65.9	61.1	98.8	35.8
Number of stomach examined	148	106	131	27	214
Number empty	2	34	50	2	71
Mean stomach content (g)	1.771	0.122	0.286	0.068	0.635
Mean stomach content (% body wt)	2.767	0.191	0.640	0.293	1.41
Mean predator size (cm)	13	13	11	10	11

Table 9. Quarterly and annual consumption estimates in metric tons of prey for *Illex* from subareas 5 and 6.

	Quarterly Consumption (M.T.)			Annual Consumption (M.T.)
	Spring	Summer	Fall	
1979				
Crustaceans	4,659	37,695	17,636	59,990 (23.4)[1]
Squid	16	141,103	21,501	162,620 (63.6)
Fish	574	25,350	7,288	33,212 (13.0)
Consumption (M.T.)	5,249	204,148	46,425	255,812
Biomass (M.T.)	271	30,980	42,878	
C/B Ratio	19.36	6.58	1.08	
1980				
Crustaceans	63	95,559	7,718	103,340 (42.0)
Squid	3	75,021	23,895	98,919 (40.3)
Fish	3	32,395	11,054	43,452 (17.7)
Consumption (M.T.)	69	202,975	42,667	245,711
Biomass (M.T.)	121	63,641	14,026	
C/B Ratio	1.75	3.40	3.04	

[1] Percent annual consumption in parentheses.

Table 10. Quarterly and annual consumption estimates in metric tons of prey for Loligo from subareas 5 and 6.

	Quarterly Consumption (M.T.)			Annual Consumption (M.T.)
	Spring	Summer	Fall	
1979				
Crustaceans	35,650	53,574	5,788	95,012 (52.1)[1]
Squid	1,196	12,210	554	13,960 (7.6)
Fish	18,838	32,397	22,081	73,316 (40.1)
Consumption (M.T.)	55,684	98,181	28,423	182,288
Biomass (M.T.)	7,371	10,891	22,369	
C/B Ratio	7.55	9.01	1.27	
1980				
Crustaceans	21,570	3,586	32,868	58,024 (8.2)
Squid	--	1,693	313,599	315,292 (44.8)
Fish	63,090	15,776	251,035	329,901 (46.9)
Consumption (M.T.)	84,660	21,055	597,502	703,217
Biomass (M.T.)	4,438	6,364	35,148	
C/B Ratio	19.07	3.30	16.99	

[1] Percent annual consumption in parentheses.

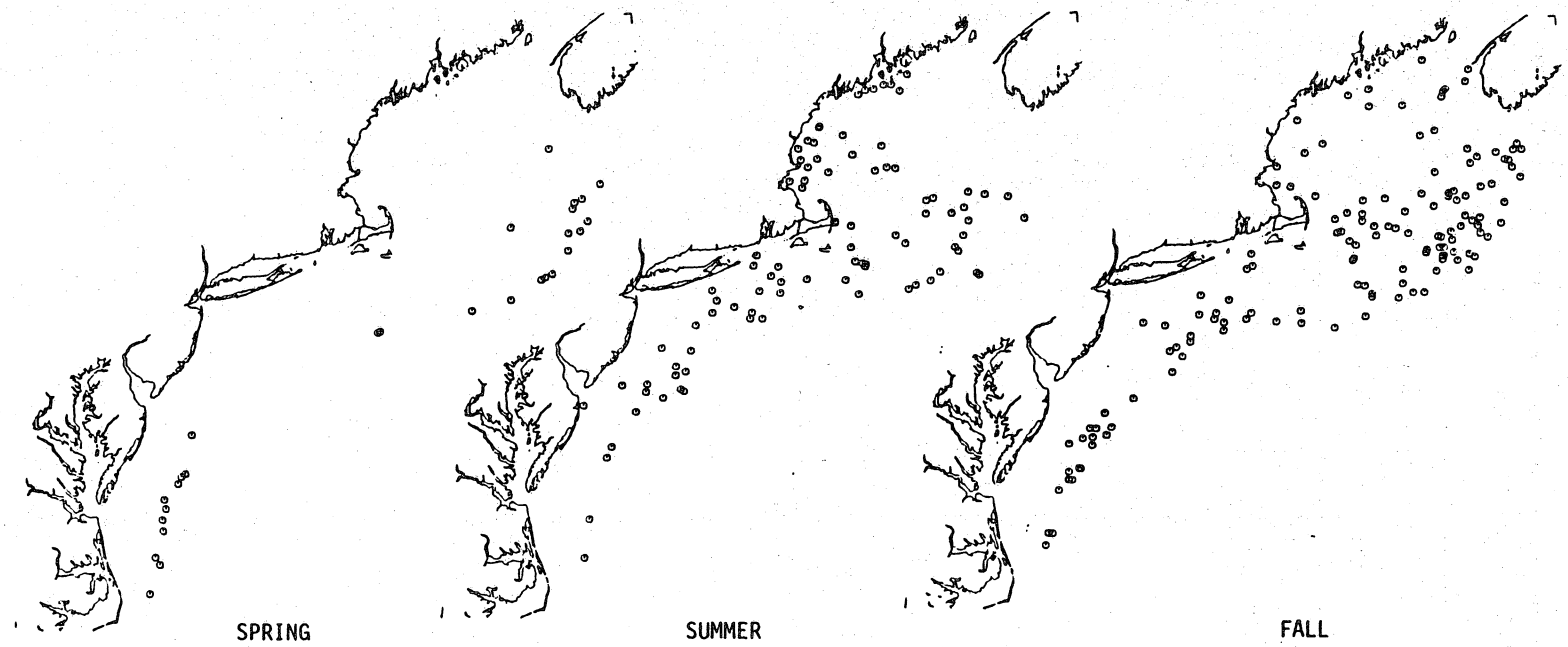

Figure 1. Stations where *Illex* were sampled for food habits analysis, 1979-1980.

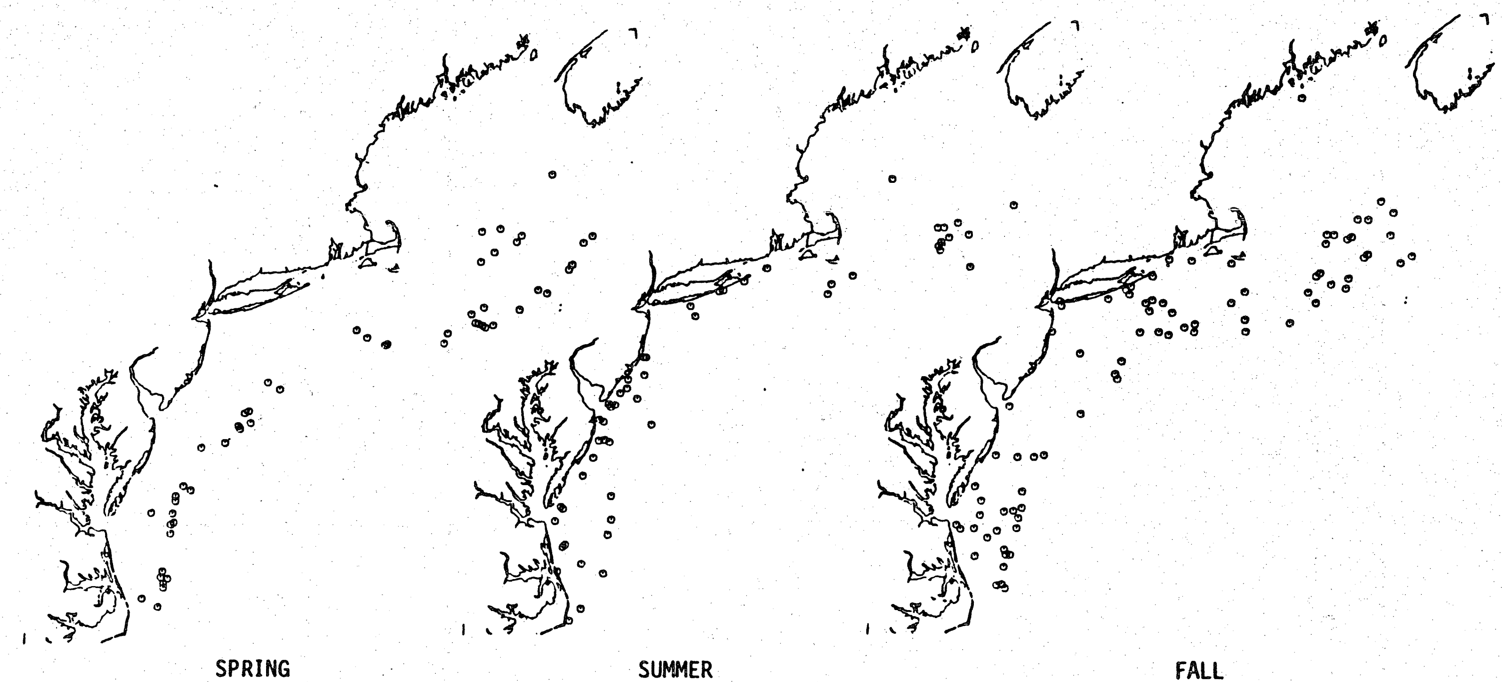

Figure 2. Stations where Loligo were sampled for food habits analysis, 1979-1980.

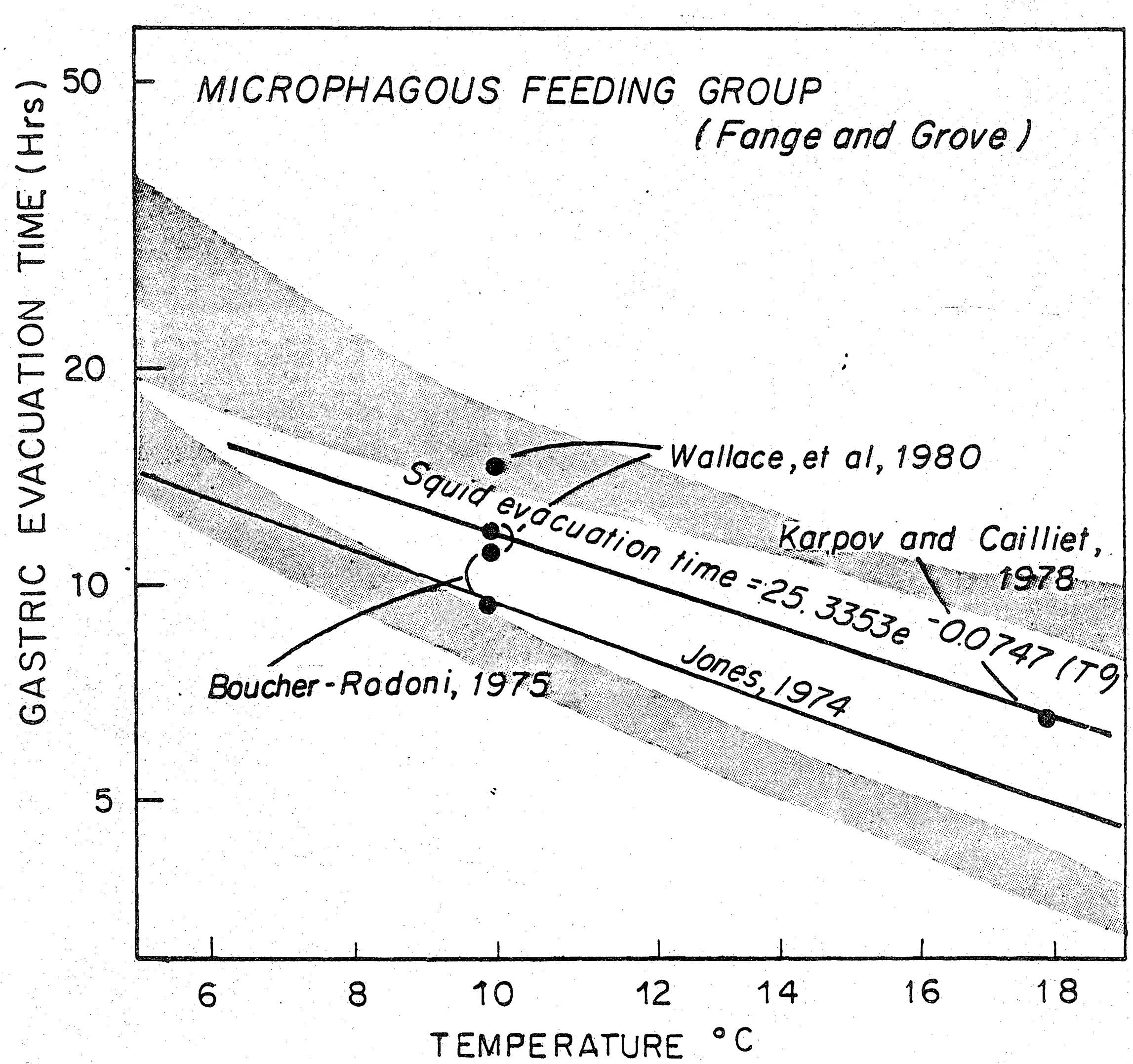

Figure 3. Gastric evacuation time as a function of temperature (after Fange and Grove, 1979) for microphagous fish. Known evacuation times for squid from the literature have been added. Proposed line for squid evacuation is shown.