11.9° to 20.9° C for exposure times of 5, 30, and 60 min. The lowest ΔT at which 100% mortality was observed was 15.8° C. This occurred in larvae exposed 30 and 60 min. In the case of the 5 min exposure, some larvae survived up to a 19.4° C ΔT before experiencing 100% mortality. There was a high background mortality in these experiments which was probably due to stress resulting from the immediate transfer of larvae to seawater 1 d prior to treatment. This was not an unnatural stress, however, since in nature the larvae are immediately washed from the brook into the estuary, <50 m away, once they hatch from the adhesive eggs.

Discussion

The larvae of all three species appear to be able to survive ΔT's of short duration which are near the upper limits of cooling systems in most normally operating nuclear power plants (18.6° C, Schubel et al. 1978). Our results show that the Atlantic herring larvae are much more tolerant to brief (<60 min) increased temperature exposures than to the longer term exposure (24 h) reported by Blaxter (1960). It should be noted that Atlantic herring larvae are usually older and developed beyond the yolk-sac stage when they arrive at the inshore nursery areas from the spawning grounds and the results of these experiments should be considered in light of that fact. Smooth flounders, on the other hand, spawn in the estuaries and inshore areas of the Gulf of Maine and the larvae are susceptible to entrainment by power plants at an early age.[1] These larvae have a greater thermal tolerance than Atlantic herring and appear to be able to survive ΔT's in excess of those normally encountered during entrainment. Rainbow smelt larvae differ from both the Atlantic herring and smooth flounder. Rainbow smelt normally spawn in freshwater brooks during April and May in coastal Maine and almost immediately upon hatching the larvae are swept downstream into saltwater where they experience a sudden increase in salinity. The rainbow smelt larvae which we tested in brook water showed thermal tolerances very similar to smooth flounder larvae but those tested in seawater showed the lowest temperature tolerance of all the experiments. It appears, then, that if rainbow smelt larvae are entrained at this time the effects of increased salinity might act synergistically with the temperature increase to produce a lethal stress.

Acknowledgments

This work was supported by a grant from the Maine Yankee Atomic Power Company.

Literature Cited

BARKER, S. L., AND J. R. STEWART.
1978. Mortalities of the larvae of two species of bivalves after acute exposure to elevated temperature. *In* L. D. Jensen (editor), Proceedings of the Fourth National Workshop on Entrainment and Impingement, p. 203-210. E. A. Communications, Melville, N.Y.

BLAXTER, J. H. S.
1960. The effect of extremes of temperature on herring larvae. J. Mar. Biol. Assoc. U.K. 39:605-608.

SCHUBEL, J. R., C. C. COUTANT, AND P. M. J. WOODHEAD.
1978. Thermal effects of entrainment. *In* J. R. Schubel and B. C. Marcy, Jr. (editors), Power plant entrainment, a biological assessment, p. 19-93. Acad. Press, N.Y.

SHELBOURNE, J. E.
1964. The artificial propagation of marine fish. Adv. Mar. Biol. 2:1-83.

SETH L. BARKER
DAVID W. TOWNSEND
JOHN S. HACUNDA

Department of Oceanography
Ira C. Darling Center
University of Maine at Orono
Walpole, ME 04573

FOOD OF 10 SPECIES OF NORTHWEST ATLANTIC JUVENILE GROUNDFISH

The food of fishes in the northwest Atlantic has been studied over many years. Verrill (1871) was one of the first investigators to document the food of marine fish. Recent investigations have identified the food of commercially important fish or fish currently composing a large portion of the fish biomass in the northwest Atlantic (Edwards and Bowman 1979; Langton and Bowman 1980), but still little is known about the diet of juvenile groundfish.

Most groundfish larvae are wholly planktonic until they either become demersal or grow large

[1]Lindsay, P., S. L. Barker, and J. R. Stewart. 1978. Section 4. Monitoring of the effects of the condenser cooling water system on plankton and larval organisms. *In* Final report, environmental surveillance and studies at the Maine Yankee Nuclear Generating Station, 1969-1977, p. 4.1-4.1.135. Maine Yankee Atomic Power Company, Augusta, Maine.

enough and active enough to live independently of the currents (Graham 1956). This change in life style usually occurs during their first year of life and is reflected in their diet because they change from feeding mainly on plankton to benthic organisms (Nikolsky 1963). This paper identifies the types of food eaten by several species of juvenile groundfish, and further examines their change in diet with fish length.

Methods

Stomachs were collected from juvenile fish caught during annual spring and fall groundfish surveys conducted by the National Marine Fisheries Service (NMFS). A scheme of stratified random sampling was conducted within the five geographic areas of the northwest Atlantic (Figure 1). All bottom trawl tows were 30 min in duration and fishing continued over 24 h/d. (Further details of the bottom trawl survey techniques may be obtained from the Resource Surveys Investigation, Northeast Fisheries Center Woods Hole Laboratory, NMFS, NOAA, Woods Hole, MA 02543.) The feeding data for all species except haddock are based on collections made from 1969 through 1972; juvenile haddock were collected from 1953 to 1976, inclusive. The species collected were: Atlantic cod, *Gadus morhua*; haddock, *Melanogrammus aeglefinus*; silver hake, *Merluccius bilinearis*; pollock, *Pollachius virens*; red hake, *Urophycis chuss*; white hake, *U. tenuis*; spotted hake, *U. regius*; fourbeard rockling, *Enchelyopus cimbrius*; American plaice, *Hippoglossoides platessoides*; and yellowtail flounder, *Limanda ferruginea*. All of these species reach maturity when 2 or 3 yr old. This paper deals only with fish approximately 1 yr old or younger. The length, fork length (FL) when applicable, otherwise total length (TL), attained by each species when approximately 1 yr old is given at the bottom of Table 1 as the maximum length in each length range. Fish were either saved whole or their stomachs were excised aboard ship, labeled, and individually wrapped in gauze. All samples were preserved in 3.7% formaldehyde. The stomach contents of 3,065 fish, from 10 species, were analyzed. In the laboratory the individual stomachs were opened and their contents emptied onto a screen sieve with mesh openings of 0.18 mm. The contents were washed and then transferred into a dish from which the various prey items were manually sorted and counted. Prey were identified to the lowest taxonomic grouping possible, damp dried on absorbent paper, and immediately weighed to the nearest 0.001 g. Well-digested prey which were only identified within major prey categories (i.e., Crustacea and Pisces) or species within a major prey category which amounted to <0.1% of the diet of all predators are listed as "Other" in Table 1. Organisms of little apparent dietary significance and not belonging to any of the major prey categories listed make up the values calculated for the "Miscellaneous" category.

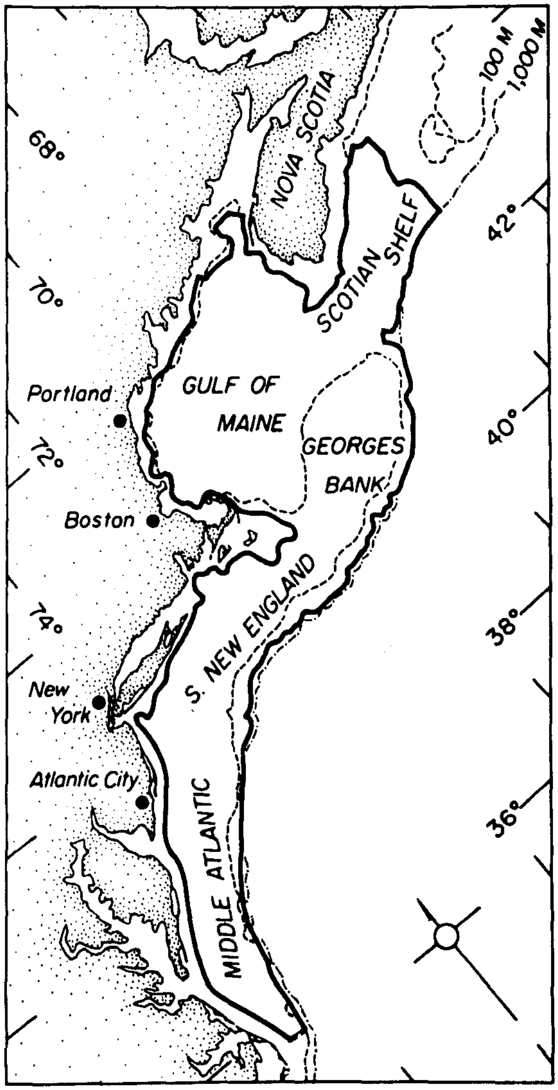

FIGURE 1.—Geographic areas of the northwest Atlantic, where the feeding habits of juvenile fish were studied. Fish were caught during bottom trawl surveys conducted from 1953 through 1976.

TABLE 1.—Summary of the stomach contents of juvenile groundfish from the northwestern Atlantic, expressed as a percentage of total food weight, for fish collected between the years of 1953 through 1976. Subtotals are italicized and a "+" indicates present in the diet but <0.1%. Dietary differences related to predator length are given in the text

Stomach contents	Atlantic cod	Haddock	Silver hake	Pollock	Red hake	White hake	Spotted hake	Fourbeard rockling	American plaice	Yellowtail flounder
Polychaeta	*0.4*	*13.6*	*0.3*	*0.7*	*2.4*	*2.9*	—	—	*72.1*	*3.0*
Crustacea	*81.6*	*62.3*	*89.0*	*68.2*	*90.1*	*94.9*	*85.9*	*33.3*	*21.1*	*94.4*
Amphipoda	22.5	27.6	6.6	1.5	19.4	15.4	77.1	33.3	17.3	38.8
Decapoda	11.2	11.5	30.4	0.3	41.6	58.2	+	—	+	3.7
Isopoda	—	0.7	+	1.2	0.1	—	—	—	—	1.0
Cumacea	0.2	0.7	0.1	—	0.5	—	—	—	+	10.2
Euphausiacea	18.0	13.0	44.4	55.8	6.4	—	—	—	—	—
Mysidacea	12.9	1.5	2.6	—	3.6	—	—	—	3.8	33.4
Copepoda	4.8	0.6	0.1	0.2	1.3	—	7.0	—	+	+
Other Crustacea	12.0	6.7	4.8	9.2	17.2	21.3	1.8	+	+	7.3
Mollusca	*0.1*	*0.1*	+	—	*0.2*	—	—	—	+	—
Chaetognatha	+	*0.2*	*0.8*	—	*0.3*	—	+	—	—	—
Echinodermata	—	*1.2*	—	—	+	—	—	—	—	—
Echinoidea	—	0.1	—	—	—	—	—	—	—	—
Ophiuroidea	—	1.1	—	—	+	—	—	—	—	—
Pisces	*16.0*	*5.0*	*8.5*	+	*1.9*	—	—	—	—	—
Ammodytes americanus	—	—	3.0	—	—	—	—	—	—	—
Merluccius bilinearis	—	2.2	—	—	—	—	—	—	—	—
Gadidae	—	—	2.1	—	—	—	—	—	—	—
Cottidae	—	—	2.3	—	—	—	—	—	—	—
Other Pisces	16.0	2.8	1.1	+	1.9	—	—	—	—	—
Miscellaneous	*0.1*	*0.6*	*0.7*	*5.8*	*0.2*	*0.1*	+	—	+	*0.2*
Unidentified	*1.6*	*15.5*	*0.7*	*24.9*	*4.9*	*1.3*	*14.1*	*66.7*	*3.9*	*2.0*
Sand	*0.2*	*1.5*	+	*0.4*	+	*0.8*	—	—	*2.9*	*0.4*
Number examined	107	2,159	440	22	229	23	16	3	10	56
Number empty	21	144	74	1	6	1	6	2	5	3
Mean weight per stomach (g)	0.064	0.107	0.086	0.271	0.061	0.085	0.038	0.020	0.010	0.043
Mean fish length (cm)	7 FL	13 FL	9 FL	17 FL	7 TL	9 TL	6 TL	8 TL	5 TL	7 TL
Length range (cm)	3-19 FL	2-20 FL	3-20 FL	4-20 FL	2-20 TL	5-20 TL	4-10 TL	6-9 TL	4-7 TL	4-9 TL

The stomach content data are summarized on a weight basis as the percentage weight each prey category made up of the total stomach contents weight for each of the 10 predators. Empty stomachs were included in the calculation of the mean weight per stomach for each species. In the text, the percentage weight is included in parentheses after the first mention of a particular prey to quantify the importance of that prey in the diet. Also included in the text, for each species of fish, is a two-part evaluation of the food based on fish length (given only for predators for which sufficient food data were available). This evaluation was made to determine the smallest fish collected of each species, which exhibited signs of feeding on the bottom, and also to discern, based on the available data, at what fish length the food was made up predominantly of prey usually associated with the bottom.

The nomenclatural distinctions categorizing prey species as either planktonic or benthic were taken from Gosner (1971). Planktonic organisms include the euphausiids and calanoid copepods. Benthic forms are typically noted as including most of the polychaetes, amphipods, and decapods. The distinction of these two generalized prey groupings, and what percentage they make up of the diet with fish length, indicates the fish's degree of association with the bottom when feeding. For the purpose of this paper it is assumed that when a fish's diet changes from primarily planktonic organisms to 50% or more benthic organisms (occurring when the fish has grown to within some specified length range), the fish can appropriately be referred to as "demersal." Before this change in diet occurs the fish are only loosely associated with the bottom and are therefore more likely to move off bottom in search of food.

Results

Table 1 summarizes the stomach contents of 10 species of juvenile groundfish collected during the years from 1953 through 1976. Only small numbers of such species as fourbeard rockling and spotted hake were available for stomach content analyses. Since little is known about their diets the data were included.

Atlantic Cod

Crustacea represented the largest portion of the diet of juvenile Atlantic cod (81.6%). Amphipods were the largest contributor to the crustacean prey (22.5%) and those identified were Gammaridae (6.5%) and Caprellidae (12.9%). Euphausiacea (mostly *Meganyctiphanes norvegica*) made up 18.0% of the stomach contents. The Mysidacea (12.9%) were primarily *Neomysis americana* (3.7%), and the Decapoda (11.2%) consisted mainly of *Crangon septemspinosa* (2.8%). Copepoda (4.8%) and Cumacea (0.2%) made up the rest of the crustacean portion of the Atlantic cod diet. None of the species of fish were identified (16.0%). The remaining prey were the Polychaeta (0.4%), Mollusca (0.1%), and Chaetognatha (+).

The predominant food of Atlantic cod 9 cm FL and longer was benthic organisms such as Gammaridae, Caprellidae, and Cumacea, which made up more than 50% of the diet. Plankton (i.e., copepods and euphausiids), the main food found in the stomachs of cod <9 cm FL, made up a progressively smaller percentage of the diet as the size of the fish increased. Small quantities of sand and gammarid amphipods were found in the stomachs of the smallest fish collected (3 cm FL).

Haddock

Small crustaceans accounted for 62.3% of the haddock diet. Amphipod crustaceans were the single most important food (27.6%). Corophiidae (primarily *Unciola* sp.) were by far the most common amphipod identified in the stomach contents (5.0%). Other amphipod groups frequently found as prey were, in order of dietary importance, Caprellidae (mainly *Aeginina longicornis*), Ampeliscidae, Aoridae, Hyperiidae, Gammaridae, and Pontogeneiidae. The Euphausiacea (chiefly *Meganyctiphanes norvegica*) accounted for 13.0% of the juvenile haddock diet. *Crangon septemspinosa* (2.6%) made up the largest part of the decapod prey. Crustaceans of lesser dietary importance to haddock were the Mysidacea (1.5%), Isopoda (0.7%), Cumacea (0.7%), and Copepoda (0.6%).

The largest contributor to the identified polychaete prey (13.6%) was nereidiform worms (almost 5%), with *Eunice* sp. being the most common nereidiform found in the stomach contents (1.0%). Other polychaete groups identified in the stomach contents included the suborders Spioniformia, Scoleciformia, Capitelliformia, Terebelliformia, and Sabelliformia.

Fish made up 5.0% of the diet, with silver hake composing almost half (2.2%) of this prey group. Small quantities (+) of Atlantic herring, *Clupea h. harengus*, and Bothidae were the only other fish identified. Echinodermata (1.2%), Chaetognatha (0.2%), and Mollusca (0.1%) were of little importance in the diet of juvenile haddock.

Haddock approximately 8 cm FL and longer fed heavily on the benthos (i.e., amphipods, decapods, and polychaetes). Pelagic organisms such as copepods and euphausiids were the predominant food of fish <8 cm FL. Benthic amphipods and cumaceans were found in the diet of haddock 2 cm FL.

Silver Hake

Silver hake preyed heavily on Crustacea (89.0%). Euphausiids were the single most important food (44.4%). *Meganyctiphanes norvegica* (22.8%) and *Thysanoessa* sp. (2.0%) were the common euphausiids identified in the stomach contents. Decapods (30.4%) included *Crangon septemspinosa* (21.5%) and pandalid shrimp (7.9%). Most of the pandalid shrimp were identified as *Dichelopandalus leptocerus* (3.8%). Amphipod prey (6.6%) came mostly from the families Ampeliscidae (1.9%) such as *Ampelisca* sp. (0.4%), or Tironidae (0.6%) which were identified as *Syrrhoe crenulata* (0.6%). Mysids (2.6%) taken by silver hake were all identified as *Neomysis americana* (2.0%). Cumaceans (0.1%), copepods (0.1%), and isopods (+) contributed little to the silver hake diet.

Small fish and fish larvae composed 8.5% of the silver hake food. The American sand lance, *Ammodytes americanus* (3.0%); sculpins (2.3%); and hakes (2.1%) were the only fish identified in the diet. Chaetognatha (0.8%), Polychaeta (0.3%), and Mollusca (+) were not important contributors to the food of juvenile silver hake.

Crangon septemspinosa and bottom living amphipods were found in the stomachs of the smallest (3 cm FL) silver hake collected. However, the benthos did not increase in importance in the diet of the larger silver hake. The primary prey of all silver hake collected (3-20 cm FL) was the euphausiid, *Meganyctiphanes norvegica*.

Pollock

Crustaceans (68.2%) were the most important food of pollock. Euphausiacea, primarily *Meganyctiphanes norvegica* (40.9%) and small quantities of *Thysanoessa inermis* (2.3%), made up 55.8% of the crustaceans found in the stomachs. *Byblis serrata* (1.3%), along with small amounts of Caprellidae and Haustoriidae, accounted for the majority of the amphipod prey (1.5%). Decapod larvae (0.3%), isopods (1.2%), and calanoid copepods (0.2%) made up the remainder of the crustacean prey. Items of little dietary importance to pollock were polychaetes (0.7%) and fish (+).

Only one small pollock (4 cm FL) was collected for stomach content analysis. The remainder of the fish ranged from 15 to 20 cm FL. Since only unidentified crustaceans were found in the stomach of the 4 cm fish, no data are available to discern at what length they first feed on the benthos.

Red Hake

Crustaceans (90.1%) accounted for most of the diet of red hake. The single most important crustacean prey was the decapod shrimp *Crangon septemspinosa* (40.6%). *Pagurus* sp. (0.4%) and *Hyas* sp. (0.1%) were the only other decapods identified in the stomach contents. Amphipod prey (19.4%) included Oedicerotidae (5.9%), Corophiidae (2.3%) [mainly *Unciola* sp. (1.9%)], and a large percentage of unidentified Gammaridea (7.1%). Euphausiids (6.4%), primarily *Meganyctiphanes norvegica* (1.6%), and mysids (3.6%) were the only other crustacean prey of importance to red hake. Only small quantities of copepods (1.3%), cumaceans (0.5%), and isopods (0.1%) were found in the stomach contents. Polychaeta (2.4%), Pisces (1.9%), Chaetognatha (0.3%), Mollusca (0.2%), and Echinodermata (+) contributed little to the food of red hake.

Red hake 6 cm TL fed predominantly on benthic foods such as Gammaridae, *C. septemspinosa*, and Cumacea. The food of fish <6 cm TL was mostly copepods and chaetognaths. *Crangon septemspinosa*, amphipods, and sand were found in the stomachs of red hake 3 cm TL.

White Hake

White hake preyed almost exclusively on crustaceans (94.9%). *Crangon septemspinosa* (57.9%) was of major dietary importance. Hermit crabs (0.3%) were the only other decapod eaten. Amphipods (15.4%) included Corphiidae (*Leptocheirus pinguis*) (4.6%), Aoridae (2.0%), Hyperiidae (0.5%), Pontogeneiidae (0.4%), Ampeliscidae (0.3%), and Caprellidae (0.2%). Polychaete worms made up 2.9% of the diet.

The stomachs of the smallest white hake collected (5 cm TL) contained sand and bottom living animals such as gammarid amphipods. Planktonic organisms were not found in any of the stomachs.

Spotted Hake

The most important prey of spotted hake were Crustacea (85.9%). Amphipods (all identified as Gammaridea) composed 77.1% of this juvenile fish's diet. Other crustacean groups were calanoid copepods (7.0%), small amounts of *Crangon septemspinosa* (+), and hermit crabs (+). The only other prey identified as part of the spotted hake diet was the Chaetognatha (+).

Although only 16 spotted hake were collected, the stomach content data showed that small quantities of hermit crabs (+) were eaten by a fish of only 4 cm TL (1 of 3 fish). Calanoid copepods made up the rest of the stomach contents of the 4 cm fish and were found in all three stomachs. At 5 cm TL (seven fish) spotted hake were eating bottom living organisms such as gammarid amphipods and *Crangon septemspinosa* (approximately 50% of their diet).

Fourbeard Rockling

Only one fourbeard rockling stomach contained food (two of the three stomachs collected were empty). Gammarid amphipods (33.3%) and small quantities of hermit crabs (+) were the only dietary items identified. The fish whose stomach contained food was 9 cm TL.

American Plaice

Polychaeta (72.1%) was the primary prey of the five specimens of American plaice which contained food (10 fish were collected in total). Only two families of polychaetes were identified, Capitellidae (10.6%) and Sabellidae (2.9%).

Crustacea (21.1%) and Mollusca (+) made up the remainder of the prey identified in American plaice stomachs. The crustacean dietary components were gammarid amphipods (17.3%), mysids (3.8%), small amounts of copepods [identified as *Centropages* sp. (+)], cumaceans (+), and hermit crabs (+). The molluscan (+) portion of the diet was identified as Dentalidae.

Worms (Sabellidae) and other benthic organisms, such as cumaceans and dentalids, made up most of the diet of the smallest American plaice collected (4 cm TL).

Yellowtail Flounder

Crustacea was the predominant prey of juvenile yellowtail flounder (94.4%). Amphipods (38.8%) were represented by the families Gammaridae (5.2%), Caprellidae (0.5%), Aoridae (+), Ampeliscidae (+), and Oedicerotidae (+). The Mysidacea (33.4%) were mostly *Erythrops* sp. (9.9%). Cumaceans (10.2%), decapods (composed of *Crangon septemspinosa*, 3.4%, and hermit crabs, 0.3%), isopods (1.0%), and copepods (+) made up the rest of the crustacean prey. Polychaeta (3.0%) was the only other dietary item noted in yellowtail flounder stomachs. They consisted mainly of Nerediformia (2.1%); most of which were identified as *Phyllodoce* sp. (0.9%).

The smallest yellowtail flounder collected (3 cm TL) ate organisms such as gammarid amphipods, cumaceans, and hermit crabs.

Discussion

A number of investigators have described the foods of juvenile groundfish. Although many of their studies were not conducted on the same species of fish or in the same geographic area as the present research, they provide evidence that the food of many juvenile fish species is similar. Arntz (1974), for example, studied the feeding of juvenile cod >11 cm FL in the western Baltic. His work showed that juvenile cod feed mostly on small bottom living crustaceans. Daan's (1973) results from studies on cod >8 cm FL in the North Sea also indicate that juvenile cod feed predominantly on small benthic organisms. Homans and Needler (1944) and Wigley (1956) included data on the food of juvenile haddock in their investigations. They found that small haddock generally eat crustaceans associated with the bottom, and polychaete worms. The diet of several juvenile flatfish species found in the North Sea consists mainly of small benthic crustaceans and polychaete worms (Braber and DeGroot 1973). The food of 33 juvenile demersal fish species collected in Long Island Sound, N.Y., was identified by Richards (1963); her data showed that when most inshore fishes are 1 yr old, they feed predominantly on the benthos.

Studies conducted on larval fish indicate that most groundfish species undergo several pelagic stages, and during these stages they feed predominantly on planktonic organisms (Rae 1953; Marak 1960, 1974; Laurence 1974, 1977; Last 1978). During their first year of life the majority of groundfish take up a bottom living habit and feed primarily on the benthos (Graham 1956). Assuming that the type of food found in a fish's stomach is indicative of its life stage, then the diet can give some approximation of a fish's age (length) when it makes the transition from pelagic to demersal living. Fish such as cod, for example, have been described as "seeking the bottom" when just over 2 cm FL (Hardy 1959) and stomachs from Atlantic cod 3 cm FL examined during this study contained small amounts of sand and benthic gammarid amphipods. Most of their food, however, was identified as copepods and euphausiids, indicating that the transition from feeding on principally plankton to other foods is a gradual change rather than an abrupt one.

The transition from pelagic to demersal habits of other gadoid fishes is apparently similar to that of cod. Haddock >8 cm FL tend to eat fewer pelagic organisms and prey more heavily on the benthos, but the stomachs of the smallest haddock collected (2 cm FL) contained some benthic animals, suggesting a slow change from a pelagic to demersal life. The same trend was noted for red hake, white hake, and spotted hake. The smallest fish collected had eaten small quantities of benthic organisms, but their primary food was copepods, euphausiids, and chaetognaths. The larger fish (>5 cm TL) fed mostly on bottom living organisms. Silver hake and pollock were rather unusual in that all the fish collected had consumed large quantities of euphausiids. They are less dependent on the benthos as a food even as adults than most other gadoids (Langton and Bowman 1980). Because of this it is difficult to distinguish, based on their diet, when they become demersal.

Only the two flatfish, American plaice and yellowtail flounder, where dependent on the benthos as a food source at the smallest fish lengths collected (3-4 cm TL). Since plaice and other flatfish metamorphose early in life (most have completed metamorphosis by 11 wk of age when they are between 1 and 2 cm TL) they take up life on the bottom at very small sizes (Hardy 1959). Winter flounder, *Pseudopleuronectes americanus*, was studied by Pearcy (1962), and it serves as a typical example of how the feeding habits of the flatfish change with age. He noted that the predominant food of metamorphosing larvae and juvenile winter flounder up to 1 cm TL is copepods; when the juveniles range in length from 1 to 2.5 cm TL, amphipods and polychaetes are their most important food. Polychaetes become increasingly important in the diet of older winter flounder, thus indicating a strong association with the bottom.

Overall, the analysis of the stomach contents reported on here indicates that relatively few prey species make up a large portion of the food of juvenile fish. Before groundfish begin to depend on the benthos as a food source, calanoid copepods and euphausiids (mostly *Meganyctiphanes norvegica*) are extremely important foods. The diet of most species of larger juvenile fish, which depend primarily on benthic animals as food, includes gammarid amphipods such as *Unciola* sp. and *Byblis serrata*, along with the caprellid amphipod *Aeginina longicornis*. Decapods found in the diet were represented by *Crangon septemspinosa* more than any other species. The only other prey which stands out as important in the diet of the juvenile fish reported on here was the mysid *Neomysis americana*.

Acknowledgments

I thank Roland Wigley and Richard Langton for their guidance in the preparation of the manuscript. I am also indebted to the many members of the staff at the Northeast Fisheries Center who helped to collect the fish and especially to J. Towns, D. Couture, and J. Murray who assisted in the stomach content analyses.

Literature Cited

ARNTZ, W. E.
1974. A contribution to the feeding ecology of juvenile cod (*Gadus morhua* L.) in the western Baltic. Rapp. P.-V. Réun. Cons. Int. Explor. Mer 166:13-19.

BRABER, L., AND S. J. DEGROOT.
1973. The food of five flatfish species (Pleuronectiformes) in the southern North Sea. Neth. J. Sea Res. 6:163-172.

DAAN, N.
1973. A quantitative analysis of the food intake of North Sea cod, *Gadus morhua*. Neth. J. Sea Res. 6:479-517.

EDWARDS, R. L., AND R. E. BOWMAN.
1979. Food consumed by continental shelf fishes. *In* H. Clepper (editor), Predator-prey systems in fisheries management, p. 387-406. Sport Fish. Inst., Wash., D.C.

GOSNER, K. L.
1971. Guide to identification of marine and estuarine invertebrates, Cape Hatteras to the Bay of Fundy. Wiley-Interscience, N.Y., 693 p.

GRAHAM, M. (editor).
1956. Sea fisheries, their investigation in the United Kingdom. Edward Arnold, Lond., 487 p.

HARDY, A. C.
1959. The open sea: its natural history. Part II. Fish & fisheries. Collins, Lond., 322 p.

HOMANS, R. E. S., AND A. W. H. NEEDLER.
1944. Food of the haddock (*Melanogrammus aeglifinus* Linnaeus). Proc. N.S. Inst. Sci. 21:15-49.

LANGTON, R. W., AND R. E. BOWMAN.
1980. Food of fifteen northwest Atlantic gadiform fishes. U.S. Dep. Commer., NOAA Tech. Rep. NMFS SSFR-740, 23 p.

LAST, J. M.
1978. The food of three species of gadoid larvae in the eastern English Channel and southern North Sea. Mar. Biol. (Berl.) 48:377-386.

LAURENCE, G. C.
1974. Growth and survival of haddock (*Melanogrammus aeglefinus*) larvae in relation to planktonic prey concentration. J. Fish. Res. Board Can. 31:1415-1419.
1977. A bioenergetic model for the analysis of feeding and survival potential of winter flounder, *Pseudopleuronectes americanus*, larvae during the period from hatching to metamorphosis. Fish. Bull., U.S. 75:529-546.

MARAK, R. R.
1960. Food habits of larval cod, haddock, and coalfish in the Gulf of Maine and Georges Bank area. J. Cons. 25:147-157.
1974. Food and feeding of larval redfish in the Gulf of Maine. *In* J. H. S. Blaxter (editor), The early life history of fish, p. 267-275. Springer-Verlag, N.Y.

NIKOLSKY, G. V.
1963. The ecology of fishes. Acad. Press, N.Y., 352 p.

PEARCY, W. G.
1962. Ecology of an estuarine population of winter flounder, *Pseudopleuronectes americanus* (Walbaum). IV. Food habits of larvae and juveniles. Bull. Bingham Oceanogr. Collect., Yale Univ. 18(1):65-78.

RAE, B. B.
1953. The occurrence of lemon sole larvae in the Scottish plankton collections of 1929, 1930 and 1931. Scotl. Home Dep. Mar. Res. 1953(1), 36 p.

RICHARDS, S. W.
1963. The demersal fish population of Long Island Sound. Bull. Bingham Oceanogr. Collect., Yale Univ. 18(2), 101 p.

VERRILL, A. E.
1871. On the food habits of some of our marine fishes. Am. Nat. 5:397-400.

WIGLEY, R. L.
1956. Food habits of Georges Bank haddock. U.S. Fish Wildl. Serv., Spec. Sci. Rep. Fish. 165, 26 p.

RAY E. BOWMAN

Northeast Fisheries Center Woods Hole Laboratory
National Marine Fisheries Service, NOAA
Woods Hole, MA 02543