

The Food of the Norway Lobster *Nephrops norvegicus* L

by

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Introduction

The biology of the Norway lobster is incompletely known. The food of the Norway lobster is referred to by Höglund (1942)\* who states that the stomach contents are for the most part so finely ground that nothing is identifiable except fragments of mussel-shell and chitinous parts of small crustacea. The diet is probably very varied.

The following investigation of the food of the Norway lobster was carried out during 1960-61, at the Marine Laboratory, Aberdeen.

Material and Methods

The following samples of Norway lobsters were examined:-

females, carapace length 17-51 mm,

1960	July-August	Firth of Forth (No. examined 90)
		Moray Firth (60)
		Minch (40)
		Firth of Clyde (110)
	October	South-east Scotland (57);

females, carapace length 15-46 mm,

1961	March	Minch (14)
		Firth of Clyde (50);

males, carapace length 48-63 mm,

1961	July	Moray Firth (10)
		Minch (33)

random sample for sex and size,

1961	September	Firth of Forth (91 males, 38 females);
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females, carapace length 22-40 mm,

1961	November	Minch (77)
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both sexes, carapace length 20-46 mm,

1961	November	Firth of Clyde (7 males, 29 females).
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Examination of the food organisms was confined to those occurring in the foregut (stomach). In addition to unidentifiable particulate material much of the food can be classified according to the phylum and about half according to the family and often to the genus.

Records of stomach contents are related to the frequency of occurrence expressed as the percentage of those foreguts, excluding empties, which were found to contain the particular food organism or class of food. Extremely few were empty.

Stomach Contents

The relative occurrence of the different animal groups, excluding Foraminifera (see p. 3), found in the foreguts of female Norway lobsters of random size taken during July and August 1960 in the Firth of Clyde, the Minch, the Moray Firth and the Firth of Forth, together with the relative number of empty foreguts, are shown

\* Höglund, H. 1942. *Nephrops norvegicus* (Linné) (Havskräftan eller Kejsarhummeren, *Nephrops norvegicus*). *Industriell Fiske och Fiske i Norden*. I. 293-296

in Figure 1. Polychaeta, Crustacea and Mollusca form the bulk of the food, the relative proportions of these groups being not greatly different within the four areas. The occurrence of Echinodermata on the contrary varies to a much greater extent. Foreguts often contain a considerable variety of food. Of 677 foreguts containing food from the five main food types (Polychaeta, Crustacea, Mollusca, Echinodermata and miscellaneous types) 82 contained all five in combination whilst only 64 were restricted to a single type of food (Table 1). The majority contained three food types and of these the commonest combination, which occurred in 87 foreguts, was of polychaetes, crustaceans and molluscs. Forty-nine foreguts contained crustaceans, molluscs and echinoderms, the next commonest combination. In general there appears to be little selection of food, which probably comprises organisms, occurring either on or just within the sea floor of the area foraged, which the Norway lobster is capable of catching, handling and masticating with its appendages.

The relative occurrences of the different animal types in the food of male Norway lobsters of 48-62 mm carapace length taken in the Minch and the Moray Firth in July 1961 agree closely with the corresponding data for females from the same areas at the same season in 1960 (Fig. 2). There would, therefore, appear to be no marked difference of feeding between the sexes or the different size-groups of Norway lobsters, whilst year to year variations probably depend only on the variation in the relative abundance of the available food organisms.

The above interpretation is substantiated by the data relating to both male and female Norway lobsters of random size distribution taken in the Firth of Forth at the end of September 1961 (Fig. 3a). The presence of the animal groups in the foregut contents of males and females correspond closely in the two sexes. However, the percentage containing echinoderms was very much higher in September 1961 than in August 1960 whilst the 'other' category in 1961 reached 24% as compared with 4% in 1960. This difference mainly relates to hydroids and polyzoans. Polychaetes were markedly more abundant in August 1960 than in September 1961. It is reasonable to suppose that the scarcity of available Polychaeta is responsible for the increased percentage in 1961 of Echinodermata and especially of Coelenterata and Polyzoa.

The relative occurrence of the various animal groups in the food of female Norway lobsters taken off Berwickshire, south-east Scotland, in October 1960 is given in Figure 3b. In this sample Crustacea in the form of portunids and crangonids occurred in 93% of the stomachs. The proportion of echinoderms was also high (64%).

The relative occurrence of the different animal groups in the foreguts of female Norway lobsters, 15-46 mm carapace length, taken in the Firth of Clyde and the Minch in March and November 1961 are shown in Fig. 4. The percentages for November in each area are broadly similar to the corresponding percentages for July-August (Fig. 1). The small sample (14 foreguts of which three were void) from the Minch in March suggests a lower level of feeding intensity which may in part be due to the fact that this sample included 10 berried females. The general foregut content is, however, not markedly different from that at other seasons. In the Clyde on the other hand a marked increase in the occurrence of polychaetes and fish in March 1961, as compared with June and November, was accompanied by a decrease in the occurrence of Crustacea and Echinodermata. Post-larval Ammotrypane aulogaster were responsible for the increase in the Polychaeta. These results suggest that seasonal differences occur in the feeding of Norway lobsters, owing to the temporary abundance of certain food organisms following settlement.

Combining all the data from the 706 foreguts examined, 2% were empty and in the remainder Polychaeta occurred in 66%, Crustacea in 67%, Mollusca in 64%, Echinodermata in 50% and Foraminifera in 41%. Fish occurred in 13% of the foreguts and polyzoans and hydroids each in 3%.

The frequencies of organisms occurring in the foreguts are given in Table 2.

#### Polychaeta

Of the foreguts containing solid matter, polychaetes were present in 66%. Sedentary polychaetes constituted the majority of the forms, being present in 30% of the foreguts, the commonest being Pectinaria species. In the Firth of Forth, August 1960, 37% of the foreguts contained Pectinaria sp. This was the principal polychaete food species identified in all areas except the Moray Firth. The Oweniidae (5%

Myriochele sp. was common in the foreguts from the Firth of Clyde but was not found elsewhere. Similarly, although not recorded from any other sample, Ammotrypane aulogaster was found in 67% of the foreguts from the Firth of Clyde in March 1961 (Table 2). The specimens consisted wholly of juveniles originating from a recent dense settlement of larvae. Amongst errant polychaetes the Glyceridae (9% of foreguts) were eaten in most areas, their occurrence being more marked in 1961 than in 1960 whilst Nereidae were represented in 5% of the foreguts.

Whilst certain foreguts contained whole or large parts of polychaetes, the majority of this group found in the stomachs were represented by fragments identifiable only by jaws, setae, tubes, etc.

#### Crustacea

Crustacea were the most frequently occurring type of identifiable foregut contents in all areas and at all seasons. Crustacean remains were found in 67% of the stomachs. Reptant decapods (21% of foreguts) were found in all areas at all seasons, the commonest form being Portunus sp. These were of immediate post-larval stages. Whole specimens were relatively frequent and more than one occurred in certain stomachs. Natant decapods (6% of foreguts), mainly Crangon sp., were represented by early settlement forms, small forms or broken pieces of larger specimens. Ostracods (15% of foreguts) were also of widespread and frequent occurrence. Also widespread were amphipods (7% of foreguts), mainly Ampeliscidae, either as small whole animals or broken up larger specimens. Cumacea (6% of foreguts), complete animals up to 8 mm in length, were widespread, whilst Copepoda (5%), mainly harpacticoids, were commonly eaten in the Firth of Clyde.

#### Mollusca

Molluscs were present in all areas at all seasons and overall occurred in 64% of the foreguts. All the main families were represented including Cephalopoda. The most frequently occurring group was the Lamellibranchia (59% of foreguts) amongst which Nucula sp. (20%) and Abra sp. (18%), consisting of small but whole specimens, up to 3 mm in diameter, or broken up larger forms, were of most frequent occurrence. Abra sp. were found in all areas at all seasons but Nucula sp. was absent from the Nephrops examined from the Firth of Forth. Frequently several specimens of the one species were found in individual foreguts. Veneridae (8%) were also eaten over a wide area. Small gastropods (8%) were found in most areas, being represented in the main by small post-larval specimens.

#### Echinodermata

Although of less frequent occurrence than polychaetes, crustaceans and molluscs, echinoderms were found in 50% of the Norway lobsters from all areas and at all seasons. The most common class was the echinoids (28%), represented by broken tests. Those identifiable were irregular urchins. Also of widespread and frequent occurrence were ophiuroids (16%), identifiable by fragments of the arms or discs. The size of the discs ranged up to a maximum of 3 mm.

#### Pisces

Fish (13% of foreguts) were of fairly widespread occurrence. The group was represented by early settlement forms or by bones and scales from small metamorphosed animals.

#### Foraminifera

Foraminifera were present in 41% of the foreguts in most areas. The feeding habits of the Norway lobster suggest that microscopic Foraminifera may occur in the foreguts of Norway lobsters as secondary food organisms, having been derived from the alimentary tracts of larger animals, such as echinoderms, eaten by the Norway lobster. However, it is possible that large Foraminifera, of about 1 mm diameter, are preyed upon directly by the Norway lobster.

#### Miscellaneous

Coccolenterates were present in only 3% of the stomachs from all areas but in 1961 they occurred in 17% of foreguts from the Firth of Forth. They consisted exclusively of hydroids. Polyzoa also appeared frequently in this same sampling (19% of foreguts) although not occurring generally elsewhere. Phoronidea and Echiuroidea were also found to have been eaten in this sampling which was undertaken in late September. The occurrence of these forms, mainly in the autumn sampling, possibly

The majority of foreguts (68%) contained in addition to identifiable food material, fine material referred to as particulate matter. This consisted of the indigestible residue from various food organisms, mud and sand, all probably from the alimentary tracts of animals preyed upon, together with some partly digested organic matter which was too macerated to permit identification with any particular animal group. The possibility that algae were also included in this residue cannot be excluded.

#### Summary

At various seasons, during each of the years 1960-1961, Norway lobsters were collected from the five principal fishing areas for this species around Scotland, males and females respectively, in a variety of length categories. The foregut contents of these were examined and as far as possible the contents identified down to species. The frequency of occurrence of food organisms is expressed as the percentage of those foreguts, excluding empties, found to contain the particular food organisms or class of food. The Norway lobster is in general a varied feeder regardless of sex or size and takes indiscriminately the available food organisms occurring either on or just within the sea bottom. A high proportion of the foreguts contain three or more food types. Since the Norway lobster is invariably caught on a bottom of sticky mud, the available food organisms are closely similar in all areas. This uniformity is reflected in the types and species of organism occurring in the foregut which are closely similar for all five areas investigated at all seasons of the year.

Polychaetes, crustaceans and molluscs are eaten in roughly equal numbers. Echinoderms, although less common, are also of general occurrence amongst the foregut contents.

Table 1. The number of foreguts, per sample and overall, containing food identifiable as Polychaeta (P), Crustacea (C), Mollusca (M), Echinodermata (E) and other types, and the number of foreguts containing combinations of the main food types.

Year	Area		Total no. of stomachs	No. of stomachs with identifiable organisms	No. of stomachs containing combinations of different food types					No. of stomachs containing 3 or 4 of the main food types in combination				
					1 type	2 types	3 types	4 types	All 5 types	PCM	PCE	PME	CME	PCME
1960	Firth of Clyde July-August		110	108	13	34	33	25	3	17	2	3	11	5
	Minch "		40	39	-	2	9	14	14	7	1	4	3	16
	Moray Firth "		60	59	2	6	25	14	12	12	4	3	3	13
	Firth of Forth "		90	84	12	28	26	15	3	21	3	2	-	9
	South-east Scotland )	October	57	55	9	21	20	4	1	4	6	-	11	4
1961	Firth of Clyde )	March	50	49	6	15	19	6	3	4	-	3	-	3
		November	36	32	2	12	8	8	2	1	1	-	5	3
	Minch )	March	14	11	2	3	1	5	-	-	-	2	-	-
		July	33	33	-	3	9	20	1	2	7	1	2	18
		November	77	77	1	1	15	34	26	11	1	17	4	29
	Moray Firth	July	10	8	2	4	1	1	-	-	-	1	-	1
	Firth of Forth September		129	122	15	26	38	26	17	8	8	6	10	28
Overall				677	64	155	204	172	82	87	33	41	49	129

Table 2. The number of foreguts examined, the number containing food and the frequency of occurrence of the different food types per 100 foreguts containing food in each of 12 samples and overall.

	1960					1961							Overall
	July	July	July-Aug.	Aug.	Oct.	March	March	July	July	Sept.	Nov.	Nov.	
	110	40	60	90	57	50	14	33	10	129	36	77	
No. examined	1	0	0	2	2	1	3	0	2	4	2	0	706
No. empty													17
Area	F. of Clyde	Minch	Moray Firth	F. of Forth	S.E.	F. of Clyde	Minch	Minch	Mcraiv Firth	F. of Forth	F. of Clyde	Minch	
POLYCHAETA (Total)	44	83	65	82	38	88	36	91	63	66	26	88	66
Errantia (unidentified)	6	13	15	8	5	2	9	12	-	3	-	3	6
Aphroditidae	1	5	-	-	4	-	-	3	-	1	-	-	1
<u>Aphrodite aculeata</u>	-	-	-	-	2	-	-	3	-	-	-	-	+
Polymoinae	-	-	-	-	2	-	-	-	-	-	-	-	+
Sigalioninae	-	-	-	-	-	-	-	-	-	1	-	-	+
Nereidae	-	-	-	1	2	27	-	-	-	10	-	-	4
Nephtydidae	1	8	-	1	2	2	-	-	13	3	8	-	2
Glyceridae	3	-	10	12	4	10	18	27	50	14	6	3	9
<u>Goniada sp.</u>	-	-	2	-	2	-	-	-	-	2	-	-	1
<u>G. norvegica</u>	-	-	-	-	-	-	-	6	-	-	-	-	+
<u>G. maculata</u>	-	-	-	-	-	-	9	-	-	-	-	-	+
Eunicidae	2	-	-	-	-	4	-	3	-	-	-	3	1
<u>Lumbriconereis sp.</u>	2	-	-	-	-	2	-	3	-	-	-	1	1
Sedontaria (unidentified)	15	68	38	36	11	24	27	45	13	11	12	74	30
Spionidae	1	-	2	3	-	-	-	-	-	-	-	-	1
Chlorhaemidae	-	-	-	1	-	-	-	-	-	2	-	1	1
<u>Ammotrypane aulogaster</u>	-	-	-	-	-	67	-	-	-	-	-	-	5
Capitellidae	-	3	-	-	-	2	-	-	-	1	-	-	+
Oweniidae	16	3	2	1	-	-	-	9	-	2	-	10	5
<u>Owenia fusiformis</u>	1	3	2	1	-	-	-	9	-	2	-	10	3
<u>Myriochele sp.</u>	15	-	-	-	-	-	-	-	-	-	-	-	2
Pectinaria sp.	8	10	8	37	2	-	-	24	-	24	-	5	14
<u>Hydroides norvegica</u>	-	-	-	-	-	-	-	-	-	1	-	-	+
Unidentified, polychaetes	17	5	20	12	11	2	-	27	-	14	3	9	12

continued on page 7 .....

	1960					1961							Overall
	July	July	July-Aug.	Aug.	Oct.	March	March	July	July	Sept.	Nov.	Nov.	
	110	40	60	90	57	50	14	33	10	129	36	77	
No. examined													
No. empty	1	0	0	2	2	1	3	0	2	4	2	0	17
Area	F. of Clyde	Minch	Moray Firth	F. of Forth	S.E.	F. of Clyde	Minch	Minch	Moray Firth	F. of Forth	F. of Clyde	Minch	
CRUSTACEA (Total)	61	80	74	68	93	35	54	94	63	70	44	62	67
Ostracoda	28	13	33	1	-	20	9	3	-	9	24	22	15
<u>Philomene sp.</u>	-	-	-	-	-	-	-	-	-	-	-	1	+
Copepoda	22	-	3	1	-	6	-	-	-	1	15	-	5
Harpacticoida	22	-	-	-	-	6	-	-	-	1	15	-	5
<u>Nebalia bipes</u>	-	-	-	2	-	-	-	-	-	-	-	-	+
Cumacea	-	10	15	6	-	-	-	21	-	2	-	16	6
Leucoridae	-	-	-	-	-	-	-	-	-	-	-	9	1
<u>Campylapsis costata</u>	-	-	-	-	-	-	-	-	-	-	-	1	+
Tanaidae	-	-	-	-	-	-	-	-	-	1	-	6	1
Isopoda	-	5	-	-	-	-	-	3	-	-	-	3	1
<u>Cirolana borealis</u>	-	-	-	-	-	-	-	3	-	-	-	-	+
Amphipoda	4	-	5	11	5	-	-	15	-	10	-	18	7
Ampeliscidae	-	-	-	7	2	-	-	9	-	6	-	6	4
Phoxocephalidae	-	-	-	-	-	-	-	-	-	-	-	1	+
Amphiloichidae	-	-	-	-	-	-	-	-	-	-	-	1	+
Oedicerotidae	-	-	-	-	-	-	-	-	-	-	-	1	+
<u>Lembos longipes</u>	1	-	-	-	-	-	-	-	-	-	-	-	+
Caprellidae	-	-	-	-	-	-	-	-	-	2	-	-	+
Mysidae	-	-	-	-	4	-	-	-	-	-	-	-	+
Natant decapoda	1	-	2	2	36	-	18	15	-	5	-	1	5
<u>Processa sp.</u>	-	-	-	-	-	-	-	-	-	1	-	-	+
<u>Cranon sp.</u>	-	-	2	1	30	-	-	-	-	2	-	-	3
Reptant decapoda	15	8	35	35	54	-	9	51	50	10	6	9	21
<u>Nephrops norvegicus</u>	-	-	-	-	-	-	-	3	-	-	-	-	+
Galatheididae	1	3	-	1	-	-	-	-	-	-	-	1	1
<u>Porcellana sp.</u>	1	-	-	1	-	-	-	-	-	-	-	-	+
Thalassinidea	-	-	-	-	-	-	-	3	-	-	-	-	+
Paguridae	1	-	5	2	-	-	-	6	-	2	-	-	2
<u>Anapagurus laevis</u>	-	-	-	-	-	-	-	3	-	-	-	-	+
<u>Portunus sp.</u>	3	-	17	18	30	-	-	-	-	2	-	-	4
<u>Corystes cassivelaunus</u>	-	-	-	2	-	-	-	-	-	-	-	-	+
Unidentified crustacea	28	75	45	28	60	12	18	23	13	53	15	14	35

continue on page 8

continued from page 7

	1960					1961							Overall
	July	July	July-Aug.	Aug.	Oct.	March	March	July	July	Sept.	Nov.	Nov.	
	No. examined	No. empty											
No. examined	110	40	60	90	57	50	14	33	10	129	36	77	706
No. empty	1	0	0	2	2	1	3	0	2	4	2	0	17
Area	F. of Clyde	Minch	Moray Firth	F. of Forth	S.E.	F. of Clyde	Minch	Minch	Moray Firth	F. of Forth	F. of Clyde	Minch	
MOLLUSCA (Total)	64	83	80	65	42	51	45	70	50	51	59	91	64
Solenogastres	-	-	-	-	-	-	-	3	-	4	-	6	1
Gastropoda	-	28	10	3	9	2	-	6	-	18	-	4	8
Bullomorpha	-	3	-	2	-	2	-	-	-	6	-	1	2
<u>Turbonilla sp.</u>	-	-	-	1	-	-	-	-	-	-	-	-	+
Scaphandridae	-	-	-	-	-	-	-	-	-	1	-	-	+
Philinidae	-	-	-	1	-	-	-	-	-	6	-	-	1
Scaphopoda	-	35	2	-	-	-	9	-	-	1	-	45	8
Lamellibranchia	62	73	80	64	34	43	45	67	50	40	59	87	59
<u>Nucula sp.</u>	30	53	25	-	-	6	27	12	-	-	18	69	20
Pectenidae	-	-	-	1	-	-	-	-	-	-	-	1	+
<u>Cyprina islandica</u>	-	-	2	-	-	-	-	-	-	-	-	-	+
<u>Mysella sp.</u>	1	-	-	-	-	-	-	-	-	-	-	-	+
<u>Cardium sp.</u>	1	-	-	-	7	-	-	6	-	2	3	16	3
Vereridae	2	3	13	8	2	2	9	6	-	10	-	1	8
<u>Abra sp.</u>	18	38	37	28	2	2	9	9	37	6	8	25	18
Tellinidae	-	-	-	-	-	-	9	-	-	-	6	-	+
Solenidae	-	-	2	-	-	-	-	-	-	1	3	-	+
<u>Carbula gibba</u>	-	-	-	-	-	-	-	-	-	-	-	1	+
<u>Hiatella sp.</u>	2	-	-	-	-	-	-	-	-	-	-	-	+
<u>Mya sp.</u>	-	-	-	1	-	-	-	-	-	-	-	-	+
Cephalopoda	2	-	-	1	5	6	-	-	-	1	-	-	2
Unidentified Molluscs	-	-	-	-	-	-	-	-	-	2	-	-	+

1  
8  
1

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No. examined No. empty	1960					1961							Overall
	July	July	July- Aug.	Aug.	Oct.	March	March	July	July	Sept.	Nov.	Nov.	
	110 1	40 0	60 0	90 2	57 2	50 1	14 3	33 0	10 2	129 4	36 2	77 0	
A r e a	F. of Clyde	Minch	Moray Firth	F. of Forth	S.E.	F. of Clyde	Minch	Minch	Moray Firth	F. of Forth	F. of Clyde	Minch	
ECHINODERMATA (Total)	46	65	42	23	64	18	36	88	38	54	65	71	50
Ophiuroidea	-	37	13	6	21	2	18	51	-	18	-	32	16
<u>Amphiura sp.</u>	-	-	-	-	-	-	-	9	-	2	-	-	1
<u>A. chiajei</u>	-	-	-	-	-	-	-	3	-	1	-	-	+
<u>A. filiformis</u>	-	-	-	-	-	-	-	9	-	-	-	-	1
<u>Ophiura sp.</u>	-	8	8	1	-	-	-	-	-	-	-	-	1
Echinoidea	30	13	28	-	-	12	27	33	13	37	59	65	28
Irregular urchins	30	-	-	-	-	-	9	15	13	22	32	3	12
Holothurioida	-	-	-	-	-	-	-	-	-	1	-	-	+
Echinoderm (unidentified)	15	28	12	18	52	6	9	33	25	14	6	3	17
PISCES	2	3	2	5	7	67	9	-	-	16	24	25	13
FORAMINIFERA	52	78	73	16	-	38	55	12	-	14	67	90	41
COELENTERATA (Hydroid)	-	-	-	-	-	-	-	-	-	17	15	4	3
NEMERTINA	-	3	-	-	-	-	-	-	-	-	-	-	+
ECHIUROIDEA	-	-	-	-	-	-	-	-	-	2	-	-	+
INSECTA	-	-	-	1	-	-	-	-	-	-	-	-	+
PHORONIDEA	-	-	-	-	-	-	-	-	-	2	-	-	1
POLYZOA	-	3	-	-	-	-	-	-	-	19	-	-	3
PARTICULATE MATTER	89	93	93	74	80	92	55	3	-	11	87	92	68

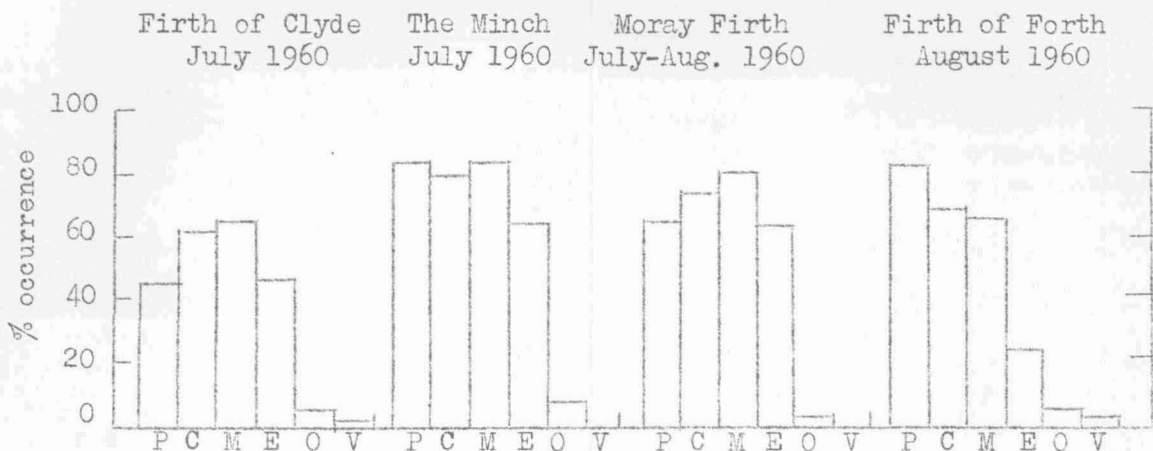


Fig. 1 Percentages of foreguts examined containing polychaetes (P), crustaceans (C), molluscs (M), echinoderms (E) and others (O). Voids are indicated by V. Samples of female Norway lobsters taken during July-August 1960 from the Firth of Clyde, the Minch, the Moray Firth and the Firth of Forth respectively.

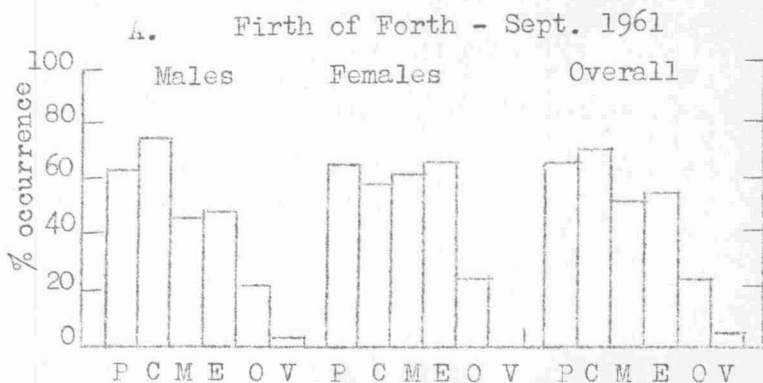


Fig. 3 Percentages of foreguts containing the various food types; polychaetes (P), crustaceans (C), molluscs (M), echinoderms (E), others (O); V indicates voids; (A) male and female Norway lobsters, respectively and collectively, taken during September 1961 from the Firth of Forth

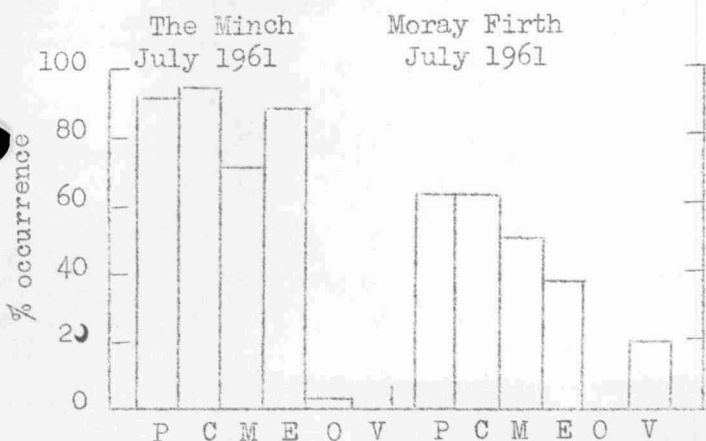
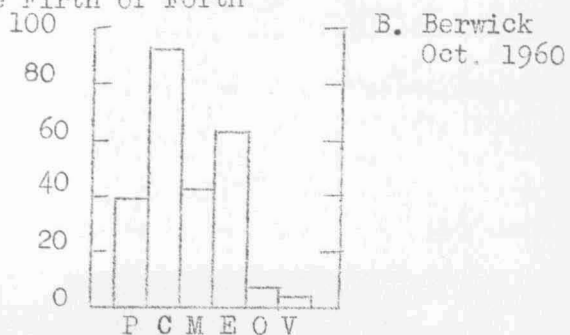


Fig. 2 Percentages of foreguts containing the various food types; male Norway lobsters of carapace lengths 48-63 mm, taken during July 1961 in the Minch and in the Moray Firth. (Key as in Fig. 1).



(B) female Norway lobsters taken during October 1960 off Berwickshire

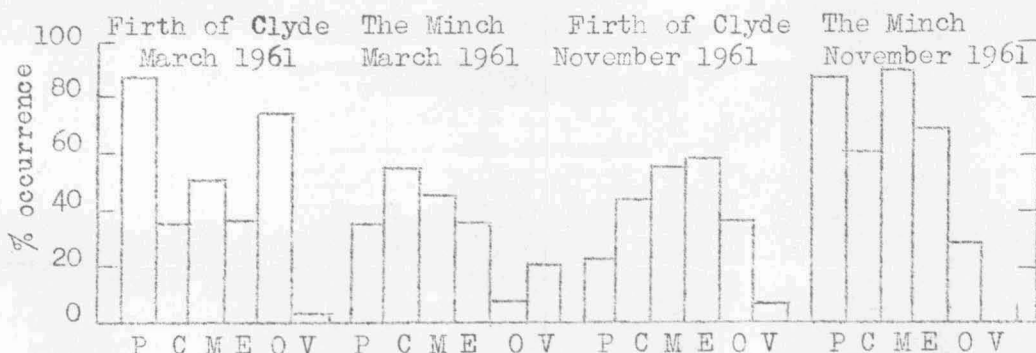


Fig. 4. Percentages of foreguts containing the various food types; polychaetes (P), crustaceans (C), molluscs (M), echinoderms (E), others (O) and voids (V); female Norway lobsters of carapace length 15-46 mm taken during March and November 1961 in the Firth of Clyde and in the Minch.