

LIFE HISTORY AND ECOLOGY OF THE MYCTOPHID FISH *NOTOSCOPELUS ELONGATUS KROEYERI* FROM THE NORTHEAST ATLANTIC

By

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ABSTRACT

GJØSÆTER, J. 1981. Life history of the myctophid fish *Notoscopelus elongatus kroeyeri* from the northeast Atlantic. *FiskDir. Skr. Ser. HavUnders.*, 17: 133-152.

Samples of *Notoscopelus elongatus kroeyeri* were collected by large commercial pelagic trawls north and west of the British Isles and off the coast of Norway. Otoliths were used for age determination. Primary rings in the otoliths, assumed to be laid down daily, were counted to determine the time of formation of the first hyaline zone.

The growth of the fish followed the equation

$$l_t = 11.91 \text{ cm} (1 - e^{-0.89(t + 0.17)})$$

Back calculation of growth revealed a pronounced Lee's phenomenon. The instantaneous mortality rate of the age groups 3 to 6 was 0.8. For fish recruited to the area at age 2, the production was about 3 grams per recruit per year.

None of the fish studied had ripening gonads which, in addition to the total lack of young fish and larvae in the area, suggests that the observed population was expatriated.

The main food of *N. e. kroeyeri* was euphausiids, but during the spring copepods were also found in some stomachs. Feeding took place at all times, but most intensively at night-time.

INTRODUCTION

Notoscopelus elongatus kroeyeri (MALM 1861) is a widely distributed lantern fish in the temperate North Atlantic. In the western part of the ocean its northern limit is approximately 60°N and in the eastern part 65°N. Occasionally, it is also found further north. Its southern limit of distribution is approximately 37°N (BOLIN 1959, KARRER 1973, KASHKIN 1974, NAFFAKTITIS *et al.* 1978). *N. e. kroeyeri* is also found in the Mediterranean Sea (KREFFT and BEKKER 1973, NAFFAKTITIS 1975).

The taxonomy of the genus *Notoscopelus* was in a state of confusion until the work by BOLIN (1959) created a clearer scheme. This was further developed by NAFFAKTITIS (1975) who gave *N. kroeyeri* subspecific status. According to this, the population treated in the present paper should be named *N. elongatus kroeyeri*.

Few data have been published about ecology and life history of *N. e. kroeyeri*. As lantern fishes are supposed to play important parts in the marine ecosystem, and also seem to be a potential resource for the future fisheries, data on their abundance, production and life history are needed.

The subject for this work is aspects of the life history and some of the parameters needed to assess the population dynamics of an apparently expatriated population of *N. e. kroeyeri* found west of the British Isles and in the waters adjacent to Norway. Estimates of the abundance of this species and other mesopelagic fishes in the same area are treated in a separate paper (GJØSÆTER 1978).

The material used was collected from cruises conducted for other purposes and was therefore not optimal to the study of *N. e. kroeyeri*. However, in spite of its many limitations, the study was considered useful as a first step towards a better understanding of the biology of this species.

MATERIALS AND METHODS

The specimens and data used in this work were collected by the vessels of the Institute of Marine Research, Bergen, mainly during blue whiting surveys. Most samples were taken by a commercial 1600-meshes pelagic trawl. The sampling localities are shown in Fig. 1. On the whole, trawling was not carried out to catch mesopelagic fish, and these were taken only as a bycatch. The depth of the trawl was monitored by a net sonde.

Most samples from both day and night were taken at a depth between 200 and 500 m. Therefore it is not known whether fish taken at night-time are from the surface waters or from the maximum trawl depth. The samples of *N. e. kroeyeri* were frozen onboard and carried to the laboratory for examination. Standard length was measured on all specimens. Weight was recorded in some samples using an electronic balance. Before weighing, the fish were thawed and water on their surface removed with filter paper.

In most of the samples otoliths were removed, cleaned and stored in 80% ethanol. For age reading they were transferred to creosote and viewed by binocular microscope using reflected light and black background. The diameter parallel to the longest axis of the otoliths and the corresponding diameters of the hyaline zones were measured using an ocular micrometer. All otoliths were read by two persons. In cases where disagreement arose (less than 10 percent of the cases) the otoliths were reread and discussed. If agreement was still not reached, the otoliths were disregarded.

Some otoliths were studied to find the primary growth increments supposed to be laid down daily. The otoliths were broken through the nucleus normal to the longest axis (the XZ-plane in Fig. 6) for studying under the scanning electron microscope (SEM). They were mounted to the specimen stubs and the broken surfaces were ground and etched with 1% HCl for approximately 5 minutes. The otoliths were then coated with gold in a vacuum evaporator

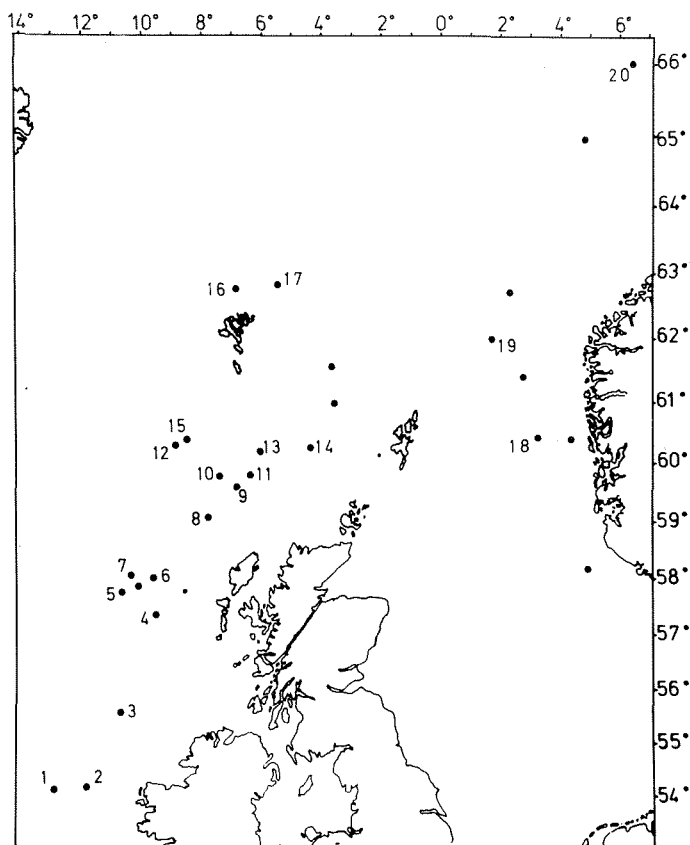


Fig. 1. Sampling localities for *Notoscopelus e. kroeyeri* 1971–1976. The numbers refer to Table I.

(BROTHERS, MATHEWS and LASKER 1976). Those used for light microscopy were ground from the medial and the lateral sides until a thin section through the nucleus (in the XY-plane in Fig. 6) was left. Before examination, they were cleared with creosote and mounted between glass slides.

In most of the specimens collected, the gonads were examined in order to determine their stage of sexual development. Some of them were sectioned and stained with haematoxylin and eosin for histological examination.

Stomach contents were examined in most samples. The degree of filling was assigned according to an arbitrary scale 0 to 4. The stage of digestion was also noted, but as the time between catch and conservation varied, it was not considered to be a useful parameter for the state at capture. The stomach contents were sorted into groups and in some cases into species. Dimensions of the stomach in a filled condition were measured in a few fish, and the volume was calculated.

Regression analysis has been used to calculate fish length from otolith diameters, to estimate the weight/length relation and the mortality from a catch curve. For these purposes RICKER (1973) recommended the use of a

functional regression instead of the predictive type commonly applied. Although the mathematical implications are doubtful (see JOLICOEUR 1975, RICKER 1975), the geometric mean regression is used in the present work. The confidence limits of the regression coefficient b were calculated as

$$b (\sqrt{B + 1} - B) \text{ and } b (\sqrt{B + 1} + B)$$

where $B = F (1 - r^2)/(N - 2)$, r is the correlation coefficient, N the number of pairs of variates and F the variance ratio at the 95% confidence level for $n_1 = 1$ and $n_2 = N - 2$ degrees of freedom (see RICKER 1975).

RESULTS

OTOLITHS AND AGE DETERMINATION

Viewed by reflected light against a dark background, a typical otolith (sagitta) of *N. e. kroeyeri* has a large, opaque central area (Fig. 2A). Infrequently there is a small hyaline zone near the nucleus (Fig. 2B). This was regarded as a larval zone and not counted (see ZURBRIGG and SCOTT 1972). Outside this central area hyaline and opaque zones alternate. In many otoliths the opaque zones contain narrow hyaline lines.

The edge of the otoliths was usually opaque during January and November, while hyaline edges dominated in samples taken in February, March, April, May and July. Samples from other months are lacking (Fig. 3). Usually the

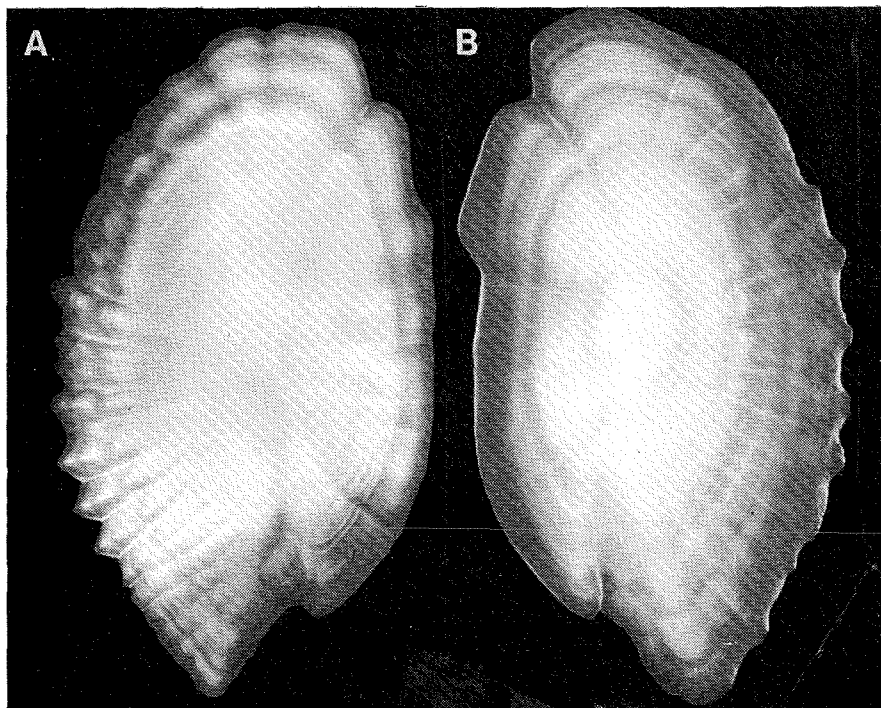


Fig. 2. Otoliths of *Notoscopelus e. kroeyeri*. A: Three years old, broad hyaline edge. B: Five years old, broad hyaline edge. The central zone is probably formed at the larval stage.

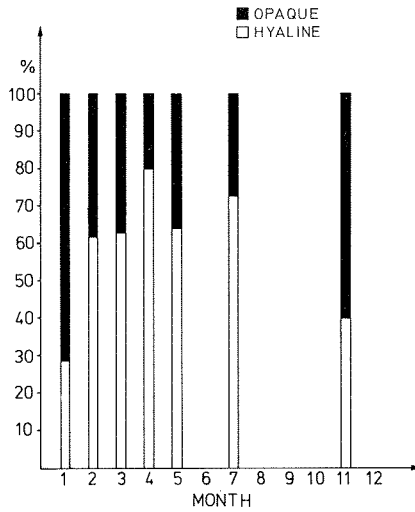


Fig. 3. Distribution of otolith edge characters during the year.

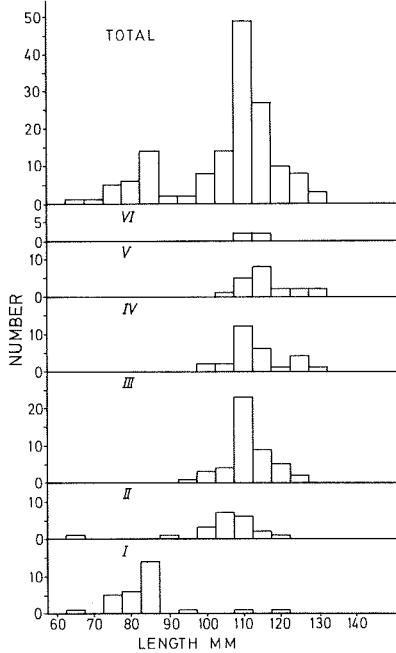


Fig. 4. Length distribution of *Notoscopelus e. kroeyeri* designed as age group I through VI based on otolith reading.

opaque edges found in the spring were broad, while opaque edges found in July were narrow. The hyaline edges found in wintertime were always narrow and may correspond to the hyaline lines often observed in the opaque zones. Exclusively hyaline or opaque zones were not found in samples from one particular month. The reason for this may be that the zones were not laid down simultaneously in the whole population, but it may also indicate formation of false zones or failure of zone formation.

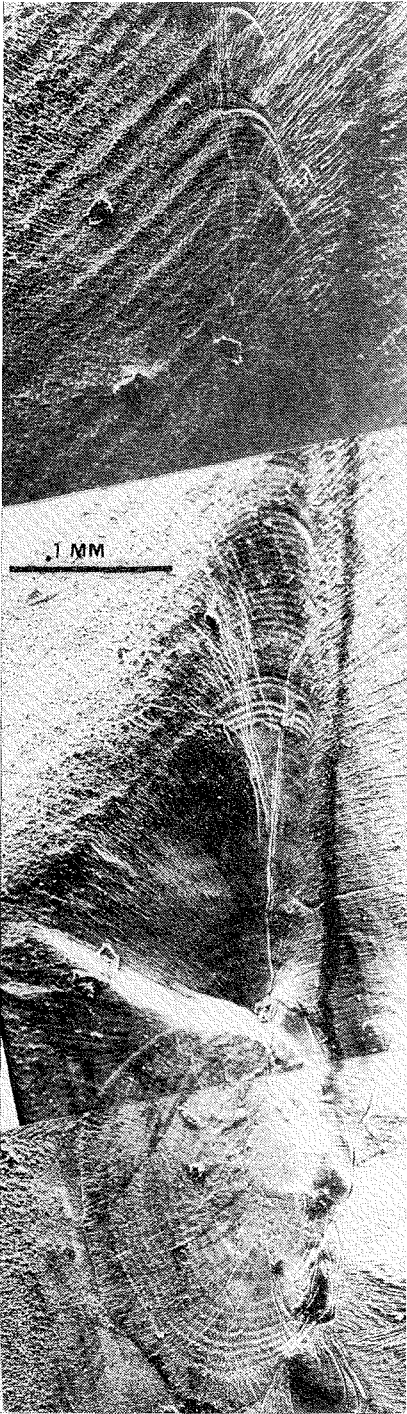


Fig. 5. Scanning electron microscope picture of central area of *Notodcopelus e. kroeyeri* otolith.

Although the evidence from study of edge formation is not conclusive, zones are tentatively considered to be formed annually and used for ageing. To acquire further evidence for the validity of the ageing procedure, the Petersen method (see TESCH 1968) was tried on all aged samples from the months February and March (Fig. 4). The first age group corresponds well with the maximum in the length frequency distribution, but the older ages fall into one group. A Cassie curve (TANAKA 1962, MATHEWS 1974) was also tried. This made it possible to identify the second age group, but the older groups could still not be separated.

Three otoliths were studied by SEM. Two of these had a nucleus surrounded by 12 rings of the type described by PANNELLA (1971, 1974). Radia of the outermost of these 12 rings; measured along the X-axis (Fig. 5 and 6), were 0.12 and 0.15 mm respectively. A narrow area (0.15 mm) without visible rings followed before the rings continued (Fig. 5). In the third otolith there was no interruption in the rings. The mean number of rings per millimeter along the X-axis, indicated in Fig. 6, are given in Table 1.

Rings of three otoliths viewed by light microscope (Nos 4–6 in Table 1) were also counted. It was not possible to count rings near the nucleus in these otoliths. The number of rings per millimeter was much higher in the area adjacent to the hyaline zone than in the central and inner part of the opaque zone. It was not possible to count rings in the hyaline zones, although some irregularly spaced rings were observed.

There is no evidence from this study that the observed rings represent daily

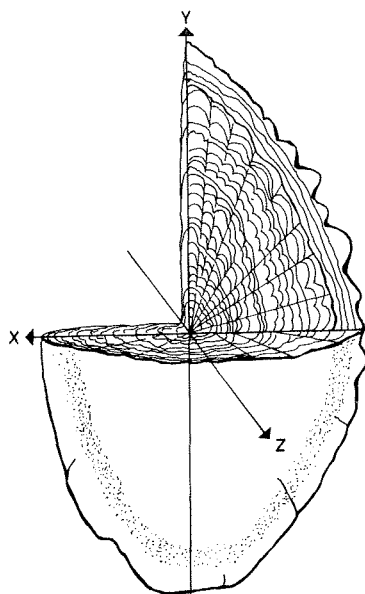


Fig. 6. Section of *Notoscopelus e. kroeyeri* otolith showing axis referred to in the text.

Table 1. Growth rings in otoliths of *N. e. kroeyeri*. Number of rings per mm indicating growth rate, and total number, indicating age in days when the first hyaline zone was formed.

Otolith no	Number of rings per millimeter along x-axis			Number of rings within first hyaline zone	Size of fish when first hyaline zone was formed (back calculated), mm.	Method
	near nucleus	central area	near hyaline zone			
1	120	230		ca 250	74	SEM
2	80	160		ca 260	79	SEM
3	98	210				SEM
4		225	415	ca 300	75	LM
5		225		ca 260	73	LM
6		160				

SEM: scanning electron microscope

LM: light microscope

growth layers. There are, however, many indications that rings like those observed are laid down daily in other fishes (PANNELLA 1971, 1974, BROTHERS, MATHEWS and LASKER 1976, TAUBERT and COBLE 1977). If the rings are formed daily, the rings observed inside the first hyaline zone indicate that the fish studied were spawned in autumn, approximately 200 to 300 days before they start forming the first hyaline zone (Table 1).

AGE AND MORTALITY

The age composition of fish caught during winter and spring is shown in Fig. 7. Usually the three-year-old fish were most abundant, while in 1972 and 1974, when the stock size in the area was very large (GJØSÆTER 1978), younger

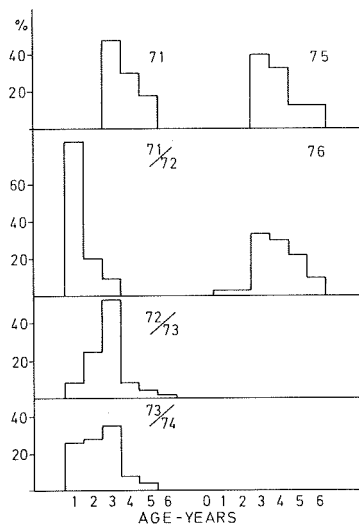


Fig. 7. Age composition of *Notoscopelus e. kroeyeri* caught during November–March. Those taken during November–December are given the age they would reach 1st January. The numbers refer to year of capture.

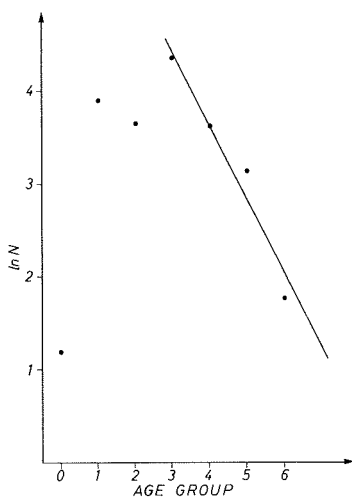


Fig. 8. Catch curve used to estimate the mortality of *Notoscopelus e. kroeyeri*. Only age groups 3 to 6 are used for estimating the regression line.

fish predominated. It appears that recruitment takes place between age one and three. As other mesopelagic species (*Benthoosema glaciale*, *Maurollicus muelleri*) were taken at a much smaller size, the age composition evidently reflects the availability more than gear selection.

A catch curve (Fig. 8) was constructed using the data presented in Fig. 7. The mortality $Z = 0.8$ was found using a geometric mean (standard major axis) regression (see RICKER 1973) for the age groups 3 to 6 which seemed to be fully recruited. By taking the mean of the years concerned, the differences in recruitment and in effort between the years are levelled out and an average mortality is found. Constructing catch curves for the years separately gave mortalities ranging from 0.4 (1975 and 1976) to 1.1 (1974) with a mean $Z = 0.7$. These values are, however, sensitive to differences in the year class strength. The mortality, as here computed, represents both mortality *sensu stricto*, the difference between immigration (recruitment) and emigration, and it may also include gear selectivity. It is not possible to assess the relative importance of these components.

LENGTH - WEIGHT RELATIONSHIP

Weight was recorded for 60 fishes caught in the months January to April. The length-weights of the samples were plotted separately, but no difference between years or sampling areas was evident. All the samples were therefore combined without further tests.

Following RICKER (1973), the regression line $l_g = W = a + b \lg l$ was fitted to the data using a geometric mean regression (standard major axis). The results were:

$$b = 2.95$$

with 95% confidence limits 2.77 and 3.14

$$a = -1.926$$

$$r^2 = 0.94$$

Therefore

$$W = 0.01186 l^{2.95}$$

where W is weight in gram and l standard length in cm.

GROWTH

For each month mean length of the age groups was calculated (Fig. 9, Table I) and a Bertalanffy growth curve

$$l_t = L_\infty (1 - e^{-K(t - t_0)})$$

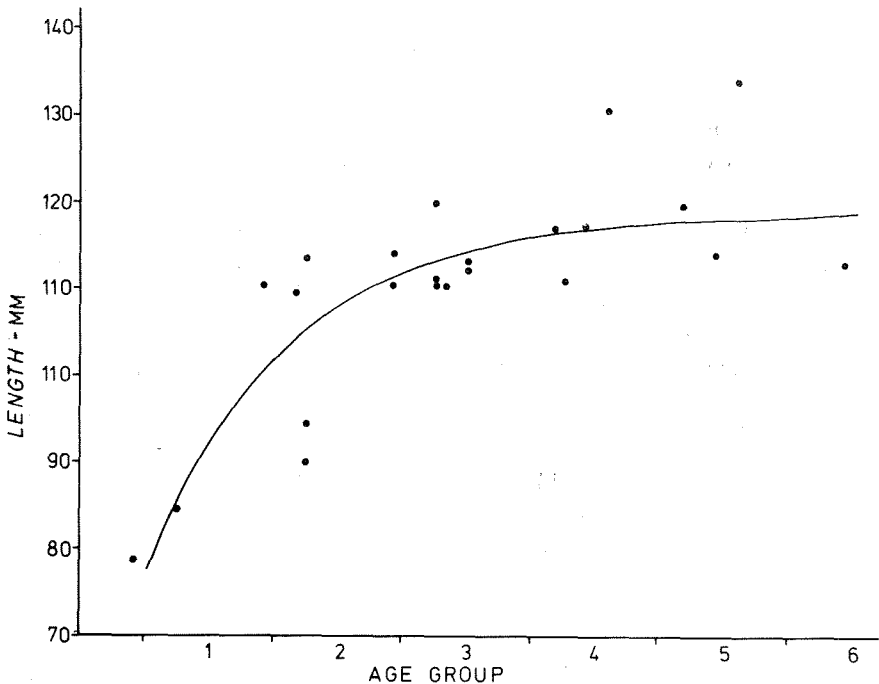


Fig. 9. Growth of *Notoscopelus e. kroeyeri*. The von Bertalanffy growth curve $l_t = 11.9 (1 - \exp [-0.89 (t + 0.17)])$ is indicated. Each point represents a sample mean.

was fitted to the data using a method described by ALLEN (1966). This method gives the best least-square estimates of the parameters L_∞ , K and t_0 and estimates of the variances of these parameters.

Based on 200 specimens, the following equation was obtained:

$$l_t = 11.91 \text{ cm } (1 - e^{-0.89 (t + 0.17)})$$

$$\hat{V} (L_\infty) = 3.92$$

$$\hat{V} (K) = 0.03$$

$$\hat{V} (t_0) = 0.05$$

using the length/weight relation $W_\infty = 17.70 \text{ g}$.

Fish taken in Norwegian waters were generally older than those taken north or west of the British Isles, but the material at hand was not suited to demonstrate any differences in growth rate between the areas.

In order to carry out back calculation of growth, the diameters of the otoliths and of the hyaline zones were measured along their longest axis in Fig. 6) in 176 fishes. A trial plot of fish length against otolith length suggested that the variance increased with increasing fish length. All data were transformed to

Table 2. Diameters of zones in the otoliths of *N. e. kroeyeri*.

Zone no.	Age of fish, years	Number measured	Mean diameter, mm	95% conf. lim. ±
1	2	49	4.019	0.163
	3	78	3.778	0.066
	4	34	3.640	0.119
	5	21	3.607	0.146
2	3	78	4.739	0.071
	4	34	4.461	0.133
	5	21	4.310	0.223
3	4	34	5.000	0.126
	5	21	4.790	0.226
4	5	21	5.187	0.213

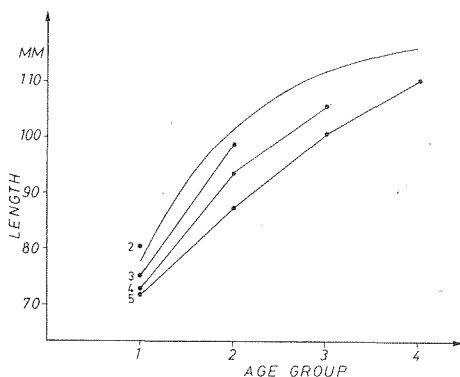


Fig. 10. Back calculated lengths of *Notoscopelus e. kroeyeri*: 2-5 indicates age of fish from which otoliths were taken. The curved line shows the von Bertalanffy's equation, $l_t = 11.9 (1 - \exp [-0.89 (t + 0.17)])$.

logarithmes to minimize the effect of this. Geometric mean estimate of the regression line for the data gave:

$$\lg l = 1.183 \lg d + 1.196$$

were l length of fish in cm and d diameter of otoliths in mm. The 95% confidence limits for the regression coefficient was 1.139 to 1.227 and the coefficient of determination $r^2 = 0.94$.

Means with confidence limits for diameters of the hyaline otolith zones are shown in Table 2. All fish where the zones were not clearly defined were omitted from this study. Lengths corresponding to the diameters were computed according to the equation above and are presented in Fig. 10. A Lee's phenomenon was very pronounced. Several explanation are possible (see

RICKER 1969), but the data were considered unsuitable for further analysis of this.

PRODUCTION

When the growth of a fish can be described by the von Bertalanffy's growth curve and the mortality is exponential, BEVERTON and HOLT (1957, equation 9.20) have shown that the annual production P of the recruited part of the stock is:

$$P = RW_{\infty} \sum_{n=0}^3 -n K \Omega_n e^{-nK} (t_p - t_0) \left(\frac{1 - e^{-(M+nK)\rho}}{M+nK} + \frac{e^{-(M+nK)\rho} (1 - e^{-(Z+nK)\lambda})}{Z+nK} \right)$$

when R is number of recruits, t_p is age at recruitment, W_{∞} , K and t_0 are the constants from the Bertalanffy's growth equation, M and Z are natural and total mortality respectively, ρ is time between recruitment and start of exploitation, λ is fishable life-span and Ω_n is the summation constant ($\Omega_0 = 1$, $\Omega_1 = -3$, $\Omega_2 = 3$, $\Omega_3 = -1$). When there is no exploitation, the equation is reduced to:

$$P = RKW_{\infty} \sum_{n=0}^3 \frac{-n\Omega_n}{M+nK} e^{-nK} (t_p - t_0) \left(1 - e^{-(M+nK)\lambda} \right)$$

In this case λ represents the whole life-span considered.

In the population studied, recruitment to the area west of the British Isles and northwards seemed to take place between age 1 and 3, and λ can be set like 5. Using parameters $W_{\infty} = 17.70$, $K = 0.89$, $t_0 = -0.17$ and $M = 0.8$, fish recruited at age 1, 2 and 3 will produce 5.9, 5.3 and 1.5 g per recruit per year respectively.

REPRODUCTION

Gonads were studied in 185 specimens and 179 fish from 16 samples could be sexed. In 11 of the samples there were more females than males. In 4 samples there were most males, whereas in the remaining samples the sexes were equally abundant. Totally there were 75% females and 25% males. The difference in size between males and females was studied in 5 samples and in 4 of these the females were larger than the males (Table 3). Mann-Whitney tests (e.g. ZAR 1974) showed, however, that the difference was only significant ($p < 0.05$) in sample No. 6.

The samples were taken from January, February, March, April, May and December, but no gonads showed any sign of ripening. Histological sections of ovaries showed that they contained oogonia and resting oocytes containing no yolk (Fig. 11). The size of the largest oocytes was about 80–100 μm , and their nuclei measured about 40–50 μm . There was no sign of previous spawning (residual eggs, thick ovary wall etc.) in any of the gonads studied. This

Table 3. Mean length for males and females in 5 samples of *N. e. kroeyeri*, and results of Mann-Whitney U test. The sample numbers refer to Fig. 1.

Sample No.	N	Males		N	Females		U	Significance
		<i>l</i>	SD		<i>l</i>	SD		
6	9	115.0	7.5	8	127.3	11.6	12	$p < 0.05$
7	6	84.7	8.7	5	95.6	20.5	8	ns
8	3	107.0	3.0	3	115.0	2.7	0	$p = 0.05$
12	3	118.7	4.0	5	118.2	11.0	7	ns
18	4	112.5	8.9	36	115.7	6.0	44.5	ns

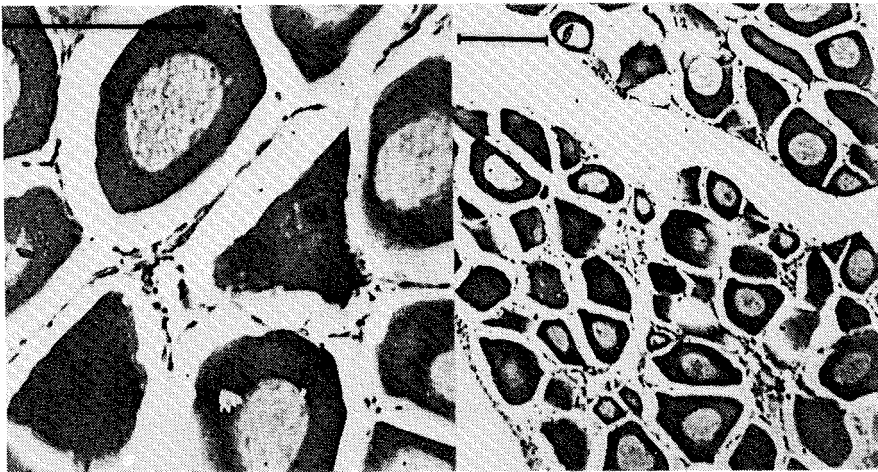


Fig. 11. Ovarian sections from *Notoscopelus e. kroeyeri* caught west of the British Isles. The scales (black lines) are 100 μm .

situation is similar to that described for expatriated myctophids by O'DAY and NAFPAKTITIS (1967) and ZURBRIGG and SCOTT (1972). The supracaudal luminescent organs of the males were poorly developed. The smallest specimen found in any sample was 68 mm, and no juveniles or larva were caught. It seems therefore that the population studied is not reproducing, but is maintained by fish drifting from another spawning population.

FOOD AND FEEDING

The composition of the stomach contents was studied in 128 specimens. Of these, 102 specimens had contents which could be identified to groups (Table 4). Euphausiids was the only food organism identified in fish taken during the winter season (December–February). During spring (March–May) the diversity was slightly higher, but euphausiids was still the most important food item found in 69% of the stomachs. The degree of filling was graded according to the

Table 4. Stomach contents of *Notoscopelus e. kroeyeri*.

	Winter		Spring	
	n	%	n	%
Copepoda only			1	1
Krill only	50	88	36	51
Copepoda and krill			13	18
Other			2	3
Unidentifiable	7	12	19	27
N.....	57		71	

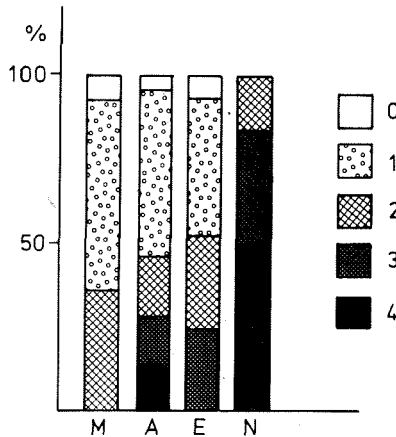


Fig. 12. Diurnal variation in degree of filling of stomachs of *Notoscopelus e. kroeyeri* caught during M, morning; A, afternoon; E, evening and N, night. The numbers indicate the degree of filling.

scale 0: empty, 1: little contents, 2: half filled, 3: full, and 4: extended stomach. The following distribution was found in 185 specimens studied:

Degree of filling	0	1	2	3	4
Percentage	5	42	22	23	8

There was no difference between fishes caught during winter and spring; material from other seasons is lacking.

The diurnal variation in degree of filling is shown in Fig. 12. In samples taken during night-time (0300–0500 hrs.) nearly 85% of the fish had full or extended stomachs, during the afternoon (1200–1600 hrs.) and in the evening (2000–2200 hrs.) about 25%, and in the morning (0900 hrs.) none of the fish examined had full or extended stomachs.

The semiaxes of the stomachs were measured in 17 of the specimens with degree of filling classified as full or extended. The volume was calculated according to the formula $\frac{4}{3} ab^2$, where a and b are the major and minor semiaxes. The mean volume was 593 mm³ (SD = 145) and the range

303–865 mm³. The lengths of the fish studied were 105–142 mm. The volume of the fish was not recorded, but assuming that the volume of the fish equals weight \times 1.05, stomachs represented 2–5% (mean 3.2%) of the volume of the fishes.

DISCUSSION

There is some evidence that the investigated population of *N. e. kroeyeri* is expatriated. The fish failed to show any sign of ripening or of previous spawning, and the supracaudal luminous glands of the males, which are secondary sexual characters, were weakly developed. The age distribution shown in Fig. 7 may also suggest a population drifting through the sampling area, as in a stable population it should be possible to follow strong year classes from one year to the next. The lack of juveniles in the area is probably not an effect of the gears used. FRASER (1961) lists larvae from several species of Myctophidae from extensive sampling in the northeast Atlantic by Scottish research vessels, but he did not observe any *N. e. kroeyeri*. Sampling depth can, however, not be ruled out as an explanation for the lack of juveniles.

According to KASHKIN (1974), *N. e. kroeyeri* reproduce east of the Azores, where juveniles from a length of about 10 mm were found in June. Sampling in the Gulf Stream and adjacent waters west of 50°W indicated that *N. e. kroeyeri* were rare or absent (JAHN and BACKUS 1976). Sampling has also been carried out in the area influenced by the North Atlantic Drift east of 50°E (e.g. BOLIN 1959, BEKKER 1967, GEISTDOERFER, HUREAU and RANNOU 1971), but only few *N. e. kroeyeri* were caught. Larvae spawned east of the Azores will, if they follow the current in the upper 100 m, drift southwards (e.g. FRASER 1958), but extensive investigations in the Canary Islands area have not revealed any larval or adult *N. e. kroeyeri* (BADCOCK 1970, BADCOCK and MERRETT 1976). The hydrographical conditions east of the Azores, where KASHKIN (1974) found a reproductive population of *N. e. kroeyeri*, is similar to those slightly further northeast, where larvae would be expected to drift towards British waters (see e.g. FUGLISTER 1960, FRASER 1958). If the young stages live in deeper water masses, they can follow Lusitanian waters from Gibraltar and northwards (FRASER 1958, TULLOCH and TAIT 1959, HILL 1976). It is therefore an open question from which area the *N. e. kroeyeri* population here studied is recruited. Also, the time of spawning is unknown.

Age determination by means of otoliths is well established for boreal myctophids (ODATE 1966, HALLIDAY 1970, SMOKER and PEARCY 1970, GJØSÆTER 1973a). In an expatriated population of *Myctophum punctatum*, zones supposed to be laid down annually were also found, but as the formation time of the first zone was not known, they were not used for age determination (ZURBRIGG and SCOTT 1972).

Growth has been estimated in several myctophid species and parameters K and L_{∞} from the Bertalanffy's growth equation are shown in Table 5. *N. e.*

Table 5. Growth parameters of the von Bertalanffy's equation for various myctophid species.

Species	K	L_{∞} mm	Author
<i>Myctophum affine</i>	0.45	83	ODATE (1966)
<i>Stenobrachius leucopsarus</i>	0.34	85	SMOKER & PEARCY (1970)
<i>Benthoosema glaciale</i>	0.36	68	HALLIDAY (1970)
<i>Benthoosema glaciale</i>	0.45	75	GJØSÆTER (1973 a)
<i>Lampanyctodes hectoris</i>	0.31	100	ANON. (1974)
<i>Notoscopelus e. kroeyeri</i>	0.89	114	this study

kroeyeri has a much higher growth rate and maximum length (L_{∞}) than the other species studied.

Measurements of stomach volumes indicated that a *N. e. kroeyeri* can eat about 5% of its body weight in one meal. HOLTON (1969) weighed *Lampanyctus mexicanus* and discovered that their stomach contents could weigh up to 14% of the total fish weight. The mean values from different samples range from about 4 to 7%. LEGAND and RIVATON (1969), who studied several myctophids from the tropical Indian Ocean, and SAMYSHEV and SCHETINKIN (1971) working with myctophids from northwest Africa, found mean values from about 0.3 to about 2% in various samples. BAIRD, HOPKINS and WILSON (1975), who studied *Diaphus taaningi*, used dry weights of both stomach contents and fish body and got 0.8% as a maximum value.

Krill was the most important food item of the fish studied and among the krill *Meganyctiphanes norvegica* was most commonly found. Both this species and the *Thysanoessa* species, which range next in abundance in the area, are omnivores (MAUCHLINE and FISHER 1969). *N. e. kroeyeri* are therefore partly on the third and fourth trophic level.

N. e. kroeyeri probably feed at any time of the day and at any depth, but most intensively at night-time. This feeding pattern of myctophids was suggested by MARSHALL (1960) and for several species confirmed by e.g. PAXTON (1967), HOLTON (1969), GJØSÆTER (1973b) and MERRETT and ROE (1974). Other species seem to feed during the night only (BAIRD *et al.* 1975) or equally well both day and night (SAMYSHEV and SCHETINKIN 1971).

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Table I. Length distribution of *N. kroeyeri*. The sample nos refer to Fig. 1.

Sample no.	Month	Year	Age group	N	\bar{l} mm	Konf. lim.
1	11	72	0	3	78,3	74,50
2, 3	3	72	1	29	84,7	2,74
4	3	74	1	5	85,0	6,69
5	11	71	1	5	111,0	7,56
6	2	73	2	5	109,4	5,99
2	3	72	2	3	90,0	39,72
7	3	73	2	4	113,0	10,70
4, 8, 9,	3	74	2	7	94,6	12,71
5	11	71	2	4	111,5	16,95
1	11	72	2	5	114,4	14,91
10	1	73	3	12	112,6	2,86
11	1	73	3	6	109,5	4,90
12, 13	2	71	3	21	112,8	1,70
7	3	73	3	3	120,3	6,23
4, 8, 9,						
14, 15	3	74	3	11	112,6	6,68
16	3	76	3	13	112,7	4,41
17	4	74	3	5	111,6	8,08
18	7	72	3	5	131,6	11,95
12, 13	2	71	4	13	117,3	5,17
16	3	76	4	12	112,3	2,54
19	5	75	4	5	117,4	12,47
18	7	72	4	3	135,7	5,71
12, 13	2	71	5	8	119,6	4,96
19	5	75	5	9	114,7	2,72
19	5	75	6	4	113,5	6,42