

On the life history of the spotted catfish (*Anarhichas minor* Olafsen)

BY

OLE JOHAN ØSTVEDT

Fiskeridirektoratets Havforskningsinstitut

INTRODUCTION

The spotted catfish or wolffish, *Anarhichas minor* Olafsen, is an arctic boreal species common near Spitsbergen, Bear Island, in the Barents Sea and along the coast of Finnmark in Northern Norway. It has been found as far south as Bergen. It is also common in Iceland and Greenland waters (Saemundsson 1949) and along the American coast where it occurs southwards to Gulf of Maine (Bigelow and Schroeder 1953).

According to Barsukov (1957) *A. minor* occurs in the Barents Sea and adjacent areas mainly in waters with temperatures from $-0,96^{\circ}$ to $7,4^{\circ}\text{C}$ and depths of 25 to 450 m. The maximum numbers are found at 100 to 150 m depths at temperatures from 4° to 6°C .

Investigations on the age and growth of the Anarhichidae have been limited. Maslov (1944) gives the mean length for each age group according to age determination from scales of *A. minor* and *A. lupus*, taken by trawl during 1933–39 in the Barents Sea. Lümann (1954) states that age determination of *A. minor* from vertebrae is difficult due to false rings, probably caused by the difference in time between spawning period, tooth exchange and the winter period with limited food supply. In *A. lupus*, however, tooth exchange and spawning occur during the same period of mid-winter when the growth has probably stagnated, and false rings are rarely observed in the vertebrae.

Length-frequency curves and the relation between length and weight of *A. minor* taken by long-line in Greenland waters have been published by Hansen (1958). The morphology, distribution and feeding of the young of Anarhichidae in the Barents Sea has been studied by Baranenkova et al. (1960).

A. minor and *A. lupus* are usually marketed as «ocean catfish» to distinguish it from the freshwater catfish *Ictalurus* sp. In the fishery statistics the landings of *A. minor* and *A. lupus* are combined.

The latter species is, however, more restricted to coastal waters and no regular fishery is carried out for it. About 80 per cent of the landings in Norway are taken on the banks of Finnmark and in the Barents Sea, where *A. minor* completely dominates.

Before the last world war the total annual catch of catfish in the Norwegian Sea, Barents Sea and near Spitsbergen and Bear Island was about 2,000 tons. After the war the catch increased and in 1960 more than 16,000 tons were taken in these waters. Until 1950 the Norwegian catch made up more than 80 per cent of the total, but it has since dropped to less than 20 per cent. The main part of the catch in recent years has been taken by trawlers from USSR (72 %), and England (10 %). The Norwegian catch is mainly taken by long-line on the banks of Finnmark from April to August.

In view of the growing demand of frozen catfish-fillets an investigation on the life history of *A. minor* was initiated in 1953 by the Institute of Marine Research in Bergen.

A preliminary report of the result of the first years' tagging experiments has been published (Østvedt 1956). In the present work all returns received until January 1963 are included.

MATERIALS AND METHODS

The present investigation is based on examination of catfish captured by long-liners fishing off the coast of Finnmark in June 1953 and 1954. In June–July 1954 the exploratory fishing vessel «Thor Iversen» was used near Bear Island for two weeks fishing with long-line. On various cruises in 1953 and 1954 with R/V «G. O. Sars» to the Barents Sea a small number of *A. minor* were caught by trawl. Most of them were used for tagging experiments, but 75 of the smallest catfish taken in the spring of 1953 are included in the present growth study.

The total length was measured to the nearest cm. The mean length for each age group has also been calculated to the nearest cm, but in the figures and the tables the length-frequency is given to the 5 cm group below, with no correction, however, for the ½ cm offset scale used on the measuring board.

The maturity was classified in four different stages; stage I-immature, stage II-maturing, stage III-mature or spawning and stage IV-spent.

As the catfish usually are landed headless, otoliths for age determination could not be collected from commercial catches on land. In addition, the otoliths are minute and rather difficult to dissect

from the skull. The scales (cycloid) have previously been used for age determination of Anarhichidae (Maslov 1944), but they are very small, having a diameter of about 2 mm on a fish of 100 cm in total length. The vertebrae appeared to show sharp rings and since they were more convenient to use than the scales, all age determinations in the present investigation refer to those from vertebrae.

After the head was removed immediately after capture, four or five anterior vertebrae were collected and placed in envelopes or boxes for drying. The rings in the vertebrae could easily be counted with a microscope without any special treatment. In reflected light the narrow opaque rings have been counted as winter zones and the broader, hyaline rings as summer zones. The interpretation of the first winter ring in the center was not always quite clear.

For the tagging experiments Lea Hydrostatic tags (same size as those used for cod) were attached in front of the dorsal fin by nylon thread.

AGE AND GROWTH

In Figure 1 and in Table 1 and 2 are shown the length (to the 5 cm group below) and age distributions for males and females of *A. minor* taken by long-line at Nordbank in 1953, at Hjelmsøybank and Bear Island in 1954. The samples from Nordbank and Hjelmsøybank show only small variations in age and length distribution. The range in length of males and females combined was 60–140 cm with a mean of 99,9 cm at Nordbank and 103,5 cm at Hjelmsøybank. In both years there was an excess of males in the length group above 95 cm as well as a corresponding dominance of males in the older age groups. The sample from Bear Island showed a similar range in length compared with the two other samples, but the dominating length groups were 80–90 cm and the mean length 90,4 cm. The age determination also revealed that at Bear Island more young fish were present, 8 and 9 year old fish being most abundant, as against 12–14 year old fish at Nordbank and Hjelmsøybank.

Also shown in Table 1 is the length distribution of catfish taken by trawl on different fishing grounds in the Barents Sea in the spring of 1953. It can be seen that fish smaller than 60 cm were caught by the trawl, but in small numbers. Most of these fish bigger than 60 cm were used for tagging experiments (total 77).

The length distribution of all fish in the different age groups based on the combination of all the data in both years is shown in Table 3. This table also lists the mean length of each group of males

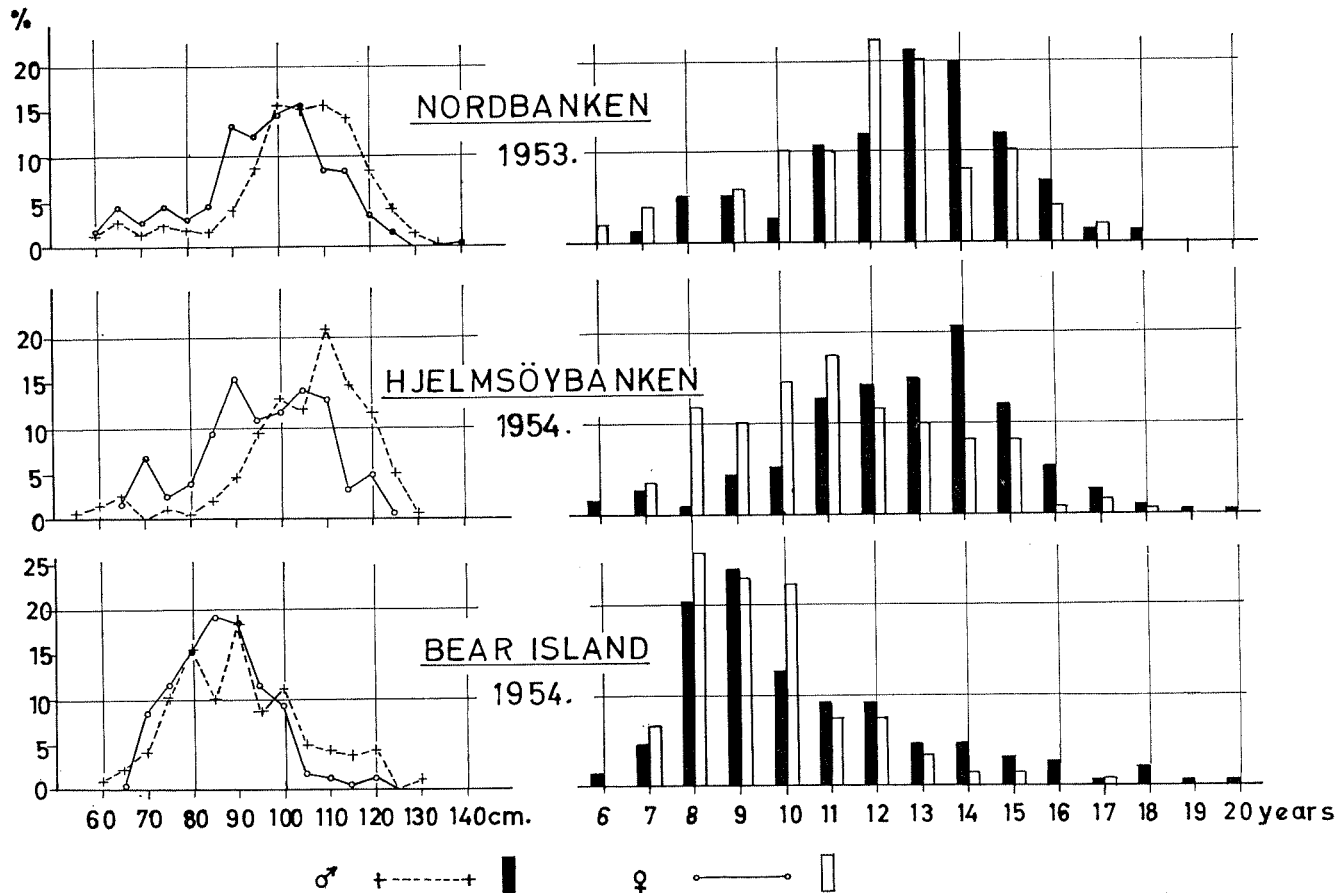


Figure 1. Length and age distribution of spotted catfish.

Table 1. Length composition of spotted catfish taken by long-line and trawl in 1953 and 1954 (%).

<i>Barents Sea 1953</i>		<i>Nordbanken 1953</i>			<i>Hjelmsøyb. 1954</i>			<i>Bear Island 1954</i>		
Length cm	Trawl Total	Long-line			Long-line			Long-line		
		♂	q	Tot.	♂	q	Tot.	♂	q	Tot.
20	1.3									
25	1.3									
30	2.6									
35	2.0									
40	2.6									
45	3.3									
50	5.3									
55	10.5	—	—	—	0.5	—	0.3	—	—	—
60	13.8	1.4	1.8	1.5	1.5	—	0.9	1.0	—	0.6
65	15.1	2.7	4.5	3.4	2.5	1.7	2.2	2.4	0.6	1.7
70	9.9	1.4	2.7	1.9	—	6.8	2.5	4.3	8.3	6.1
75	9.2	2.2	4.5	3.1	1.0	2.5	1.6	10.1	11.5	10.7
80	4.6	1.9	3.2	2.4	0.5	4.2	1.9	15.5	15.4	15.4
85	5.3	1.6	4.5	2.8	2.0	9.3	4.7	10.1	19.3	14.0
90	2.0	4.1	13.3	7.5	4.5	15.3	8.6	18.4	18.6	18.4
95	2.6	8.8	12.3	10.1	9.5	11.0	10.2	8.7	11.5	9.9
100	2.6	15.7	15.0	15.5	13.1	11.9	12.6	11.2	9.7	10.5
105	0.7	15.1	15.5	15.2	12.1	14.4	12.9	4.8	1.9	3.6
110	1.3	15.7	8.6	13.0	21.1	13.6	18.3	4.3	1.3	3.0
115	2.6	14.4	8.2	12.0	14.6	3.4	10.4	3.9	0.6	2.5
120	0.7	8.5	3.6	6.7	11.6	5.1	9.1	4.3	1.3	3.0
125	0.7	4.4	1.8	3.4	5.0	0.8	3.5	—	—	—
130	—	1.6	—	1.0	0.5	—	0.3	1.0	—	0.6
135	—	0.5	—	0.3	—	—	—	—	—	—
140	—	—	0.5	0.2	—	—	—	—	—	—
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total numb.	152	364	220	584	199	118	317	207	156	363

and females separately and combined. No significant differences in growth rate of males and females were found. The annual length increment determined by comparing the mean length of each age group at capture seems to be about 10 cm during the first 6–7 years. The overlap in the length distribution of the different age groups increases considerably beyond these age groups. In the older age groups, therefore, length is of little significance for the age determination.

The present data on mean length for age of the catfish may be used for calculation of the asymptotic length L_{∞} . By using Walfords

Table 2. Age distribution of spotted catfish taken by long line in 1953 and 1954 (%).

Age Years	Nordbanken 1953			Hjelmsøyb. 1954			Bear Island 1954		
	♂	q	Tot.	♂	q	Tot.	♂	q	Tot.
6	—	2.0	0.8	1.6	—	1.0	1.5	—	0.9
7	1.3	4.1	2.4	2.7	3.6	3.0	4.6	6.8	5.5
8	5.3	—	3.2	1.0	11.9	5.1	20.4	25.8	22.7
9	5.3	6.1	5.6	4.4	10.1	6.4	24.0	23.1	23.6
10	2.7	10.2	5.6	5.3	14.7	8.8	12.7	22.4	11.8
11	10.7	10.2	10.5	12.8	17.6	14.4	9.2	7.5	8.5
12	12.0	22.5	16.2	14.4	11.9	13.5	9.2	7.5	8.5
13	21.4	20.4	21.0	14.9	10.1	13.1	4.6	3.4	4.1
14	20.0	8.2	15.4	20.8	8.4	16.2	4.6	1.4	3.2
15	12.0	10.2	11.3	12.1	8.4	10.8	3.1	1.4	2.3
16	6.7	4.1	5.6	5.3	0.8	3.7	2.6	—	1.5
17	1.3	2.0	1.6	2.7	1.7	2.4	0.5	0.7	0.6
18	1.3	—	0.8	1.0	0.8	1.0	2.0	—	1.2
19	—	—	—	0.5	—	0.3	0.5	—	0.3
20	—	—	—	0.5	—	0.3	0.5	—	0.3
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total number	75	49	124	188	109	297	196	147	343

graphical method (Walford 1946), plotting L_t against L_{t+1} and fitting the best line by the method of least squares, a value of L_∞ of 155 cm is obtained.

MATURITY

The maturity stage distribution according to length is given in Table 4. The males show only little variation in maturity, and only fish in stage I and II have been encountered. The males in maturity stage I had thread-like testes with greyish colour and were obviously immature. The fish in stage II had wrinkled testes with dark colour, but were all of a small size and showed no sign of an approaching spawning season. On various cruises in the Barents Sea during spring and autumn catfish caught by trawl have been examined, but males with ripe gonads have so far not been observed.

As seen in Table 4, 85,5 % of the females taken at Nordbank and Hjelmsøybank were in maturity stage II. The size of the eggs of the females in this stage varied greatly and more detailed classification might have been possible. It seems likely that females in

Table 3. Length — frequency distribution and mean length of the age groups of spotted catfish.

Length/ Age cm	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Sum
20	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
25	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
30	—	2	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4
35	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
40	—	—	3	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4
45	—	—	1	1	2	1	—	—	—	—	—	—	—	—	—	—	—	—	—	5
50	—	—	—	5	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8
55	—	—	—	2	9	2	—	—	—	—	—	—	—	—	—	—	—	—	—	13
60	—	—	—	—	6	6	—	—	—	—	—	—	—	—	—	—	—	—	—	12
65	—	—	—	—	1	15	10	3	—	—	—	—	—	—	—	—	—	—	—	29
70	—	—	—	—	1	6	26	6	—	—	—	—	—	—	—	—	—	—	—	39
75	—	—	—	—	—	5	24	9	4	1	—	—	—	—	—	—	—	—	—	43
80	—	—	—	—	—	6	28	24	9	2	—	—	—	—	—	—	—	—	—	69
85	—	—	—	—	—	1	14	30	20	3	—	—	—	—	—	—	—	—	—	68
90	—	—	—	—	—	—	4	36	34	19	10	3	—	—	—	—	—	—	—	106
95	—	—	—	—	—	—	—	9	16	24	24	9	2	—	—	—	—	—	—	84
100	—	—	—	—	—	—	—	—	1	10	26	30	15	11	5	—	—	—	—	98
105	—	—	—	—	—	—	—	—	—	1	9	16	19	16	8	1	—	—	—	70
110	—	—	—	—	—	—	—	—	—	—	2	9	21	24	14	4	—	—	—	74
115	—	—	—	—	—	—	—	—	—	—	1	9	17	14	6	4	2	—	1	54
120	—	—	—	—	—	—	—	—	—	—	—	2	9	9	10	4	5	1	—	40
125	—	—	—	—	—	—	—	—	—	—	—	—	1	1	2	2	3	1	1	12
130	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	3
	2	4	9	9	22	42	106	118	94	86	90	79	80	55	23	11	8	2	2	842
Mean length																				
♂	—	27.5	39.6	52.3	60.4	69.8	77.3	86.4	90.9	98.6	101.8	108.7	112.1	114.6	119.5	121.7	120.7	125.5	121.5	
♀	23.0	30.5	38.5	50.0	56.2	70.0	78.4	86.3	91.5	97.3	100.7	104.8	108.6	114.1	114.0	121.5	122.0	—	—	
Total	23.0	29.0	38.2	50.8	58.5	69.9	77.8	84.4	91.3	97.9	101.3	107.4	111.5	114.5	118.7	121.6	120.9	125.5	121.5	

Table 4. Maturity Stage distribution according to length of spotted catfish.

Maturity stage Length cm	Nordbank 6/6—15/6 1953						Hjelmøybank 31/5—10/6 1954						Bear Island 14/6—4/7 1954						
	♂		♀				♂		♀				♂		♀				
	I	II	I	II	III	IV	I	II	I	II	III	IV	I	II	I	II	III	IV	
55	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
60	5	—	4	—	—	—	3	—	1	—	—	—	2	—	—	—	—	—	—
65	10	—	9	1	—	—	3	2	2	—	—	—	5	—	1	—	—	—	—
70	4	1	5	1	—	—	—	—	7	1	—	—	9	—	5	8	—	—	—
75	4	4	5	5	—	—	—	2	3	—	—	—	18	3	8	10	—	—	—
80	2	5	3	4	—	—	—	1	2	3	—	—	25	7	6	17	1	—	—
85	2	4	2	8	—	—	—	4	2	9	—	—	12	9	1	25	4	—	—
90	—	15	—	29	—	—	—	9	—	18	—	—	3	35	—	22	5	2	—
95	—	32	—	27	—	—	—	19	—	13	—	—	—	18	—	7	11	—	—
100	—	57	—	33	—	—	—	26	—	14	—	—	—	23	—	6	8	1	—
105	—	55	—	32	2	—	—	24	—	16	1	—	—	10	—	2	1	—	—
110	—	57	—	19	—	—	—	42	—	15	—	1	—	9	—	—	—	2	—
115	—	52	—	18	—	—	—	29	—	4	—	—	—	8	—	—	—	1	—
120	—	31	—	8	—	—	—	23	—	6	—	—	—	9	—	—	—	2	—
125	—	16	—	3	—	1	—	10	—	1	—	—	—	—	—	—	—	—	—
130	—	6	—	—	—	—	—	1	—	—	—	—	—	2	—	—	—	—	—
135	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
140	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
Sum	27	337	28	188	2	2	7	192	17	100	1	1	74	133	21	97	30	8	—
%	7.42	92.58	12.73	85.45	0.91	0.91	3.52	96.48	14.29	84.03	0.84	0.84	35.75	64.25	13.46	62.18	19.23	5.13	—

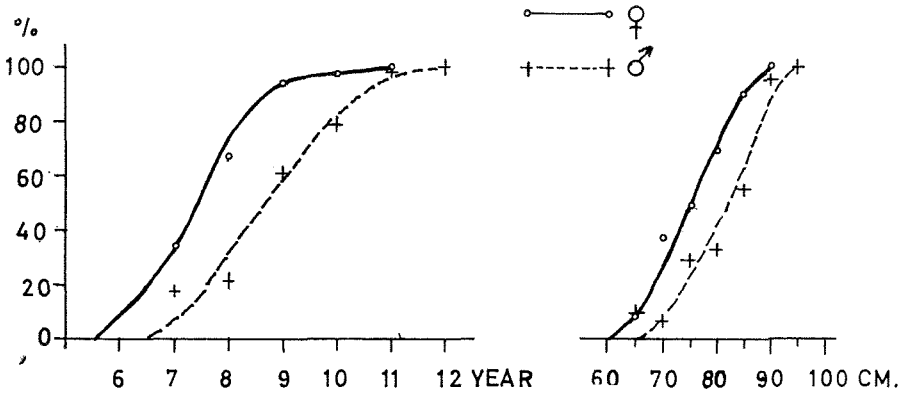


Figure 2. Percentage of mature spotted catfish in each age and length group.

stage II with the smallest eggs not would spawn within the same year, but they were nevertheless more developed than the females in stage I. Fish in stage III were, both at Nordbank and Hjelmsøy-bank, caught in insignificant numbers. The sample from Bear Island taken at the end of June and beginning of July, about 3–4 weeks later than the two other samples contained, however, 19,2 % females in stage III and 5,1 % in stage IV. This observation indicated that around Bear Island spawning occurred in July. As a large proportion of the females were still in stage II, it seems likely that the spawning season also extended into August.

The percentage of mature fish in each length and age group of males and females is given in Figure 2. The figure reveals that the majority of the females mature at an age of 7–8 years with a corresponding length of 75 cm. Age and length at earliest maturity is probably 6 years and 60–65 cm. The males mature approximately one year later than the females and at a critical length (50 % mature) of 80–85 cm and at an age of 8–9 years.

TAGGING EXPERIMENTS

During 1953, 1954 and 1955 a total of 432 catfish were tagged with Lea Hydrostatic tag attached in front of the dorsal fin with nylon thread. As listed in Table 5 the fish were liberated on various localities in the Barents Sea and off the coasts of Finnmark and Bear Island.

Until January 1963, 72 tagged catfish were returned. The return of the tagged trawl-caught fish was 60 or 21,8 % whereas only 12 or 7,6 % were returned from the fish caught by long-line. During the

Table 5. Release and recovery data for tagged spotted catfish.

Year of tagg.	Date	Tagging locality	Fishing gear	Number of tagged fish	Year of recapture										Total						
					1953	1954	1955	1956	1957	1958	1959	1960	1961	1962							
1953	23/2-10/4	South. Barents Sea ..	Trawl	8	3	—	—	—	—	1	—	—	—	—	—	4					
1953	8/6-16/6	Nordbank	Longline	33	1	1	—	—	—	—	—	—	—	—	—	2					
1953	17/8-14/10	Bear Island, Centralbank, South. Barents Sea.....	Trawl	77	1	4	1	2	2	1	—	—	—	—	—	11					
1954	17/3-2/4	Finmarkbank, Centralbank, S. Barents Sea	Trawl	50	—	9	1	1	2	2	—	—	—	—	1	16					
1954	3/6-10/6	Hjelmsøybank	Longline	50	—	2	—	1	2	1	—	—	—	—	—	6					
1954	26/6-1/7	Bear Island	Longline	74	—	1	3	—	—	—	—	—	—	—	—	4					
1954	7/10-25/10	Finmarkbank, Centralbank, South Barents Sea	Trawl	73	—	5	3	—	3	1	—	—	1	—	—	13					
1955	2/3-21/5	Bear Island, Centralbank, Southern Barents Sea	Trawl	67	—	—	3	2	3	4	1	1	1	1	1	16					
Total				432	5	22	11	6	13	9	1	2	1	2	2	72					
Sum trawl				275	4	18	8	5	11	8	1	2	1	2	2	60					
Sum longl.				157	1	4	3	1	2	1	—	—	—	—	—	12					
Years in liberty					0-½	½-1	1-1½	1½-2	2-2½	2½-3	3-3½	3½-4	4-4½	4½-5	5-5½	5½-6	6-6½	6½-7	7-7½	7½-8	8-8½
Number of recaptures ..					26	11	1	2	4	9	5	4	4	0	3	0	0	0	1	0	1

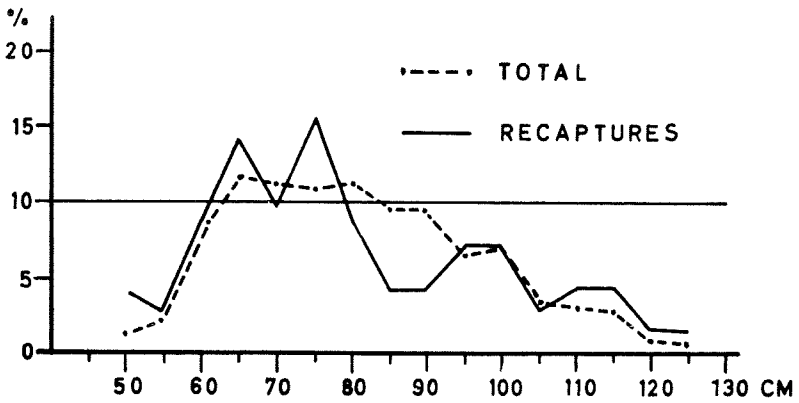


Figure 3. Length distribution of tagged and recaptured spotted catfish.

tagging experiments it was observed that fish from the long-line catches were often in very poor condition and not suitable for tagging.

The length distribution of the tagged and recaptured fish, depicted in Figure 3, follow the same trend. The range in total length is from 50–125 cm with a maximum between 60 and 80 cm. The majority of the tagged fish has most probably been immature or in the first stage of maturation.

The majority (52 %) of the recaptured fish was taken by Soviet trawlers. The others were taken by English (14 %), German (7 %) and Norwegian trawlers (4 %) and Norwegian long-liners (19 %). For 3 (4 %) returns from Norwegians fishing boats gear were not stated.

Tagging localities and position at recapture for 63 returns with complete information are shown in Figure 4. Of these, 28 were taken within 50 n. miles or less from the tagging locality, even after periods of more than 3 years (two returns). Long-distance migration was demonstrated by fish released at Finger Bank near Bear Island and recaptured at Skolpen Bank, a distance of more than 300 n. miles.

Figure 4 demonstrates that there is a great deal of intermingling between catfish from the different areas. One fish released and recaptured off Hornsund at Spitsbergen is not included on Figure 4. Only five fish have been tagged in Spitsbergen waters and so far none has been recaptured outside this area.

The catfish is supposed to be a slow moving and inactive fish. The present tagging experiments show, however, a maximum average migration distance of 5 n. miles per day (one fish recaptured 44 days after liberation about 250 n. miles from tagging locality).

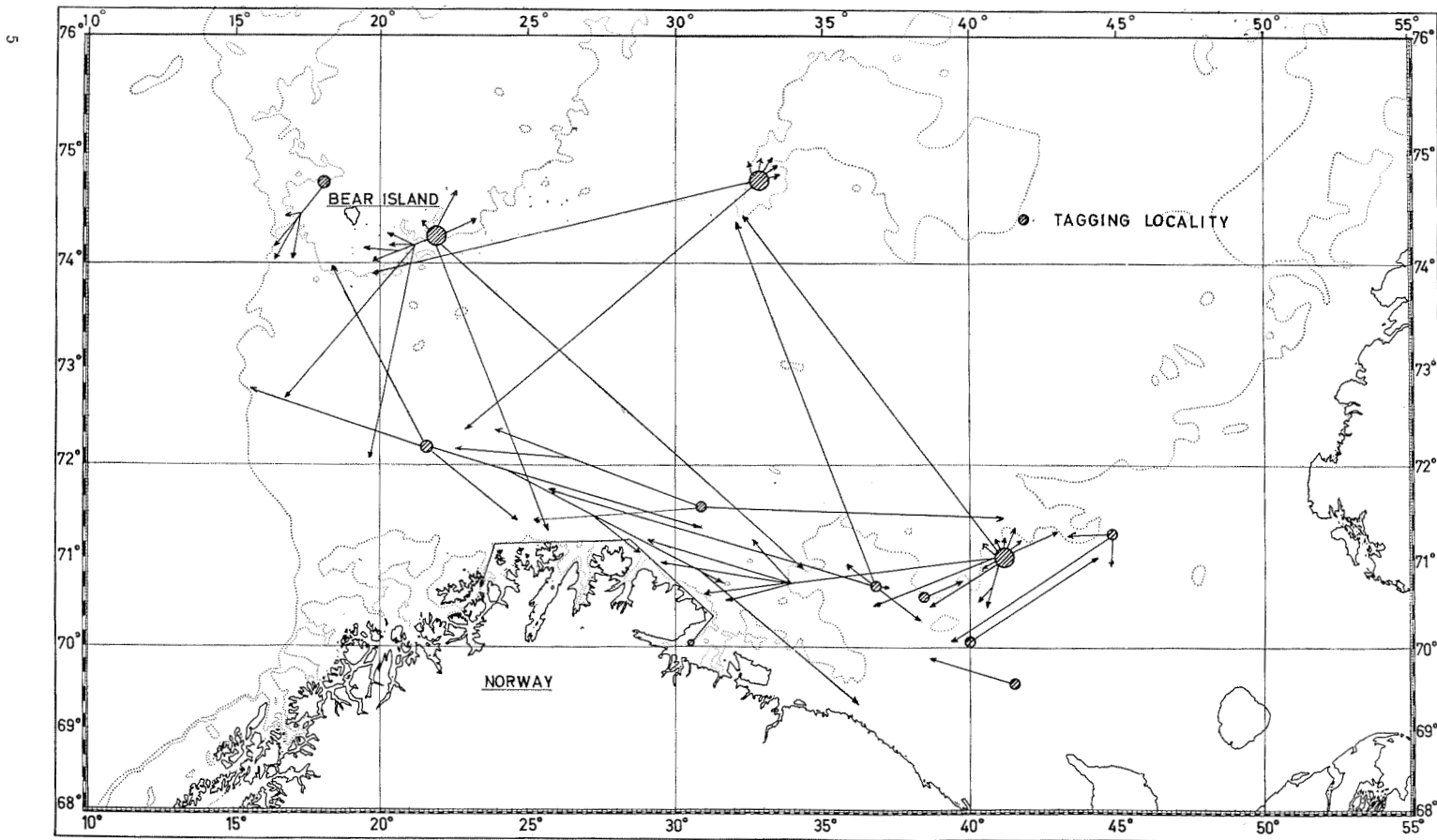


Figure 4. Tagging locality and place at recapture for spotted catfish tagged in 1953, 1954 and 1955.

Table 6. Number of recaptures in each month according to area.

Month/Area	South of lat. 73°N			North of lat. 73°N	
	East of long. 35°E	Between long. 30–35°E	West of long. 30°E	Centralbank	Bear Island
January	2	—	—	—	1
February	1	—	—	—	—
March	7	1	—	—	—
April	2	1	3	—	2
May	1	2	4	—	1
June	2	2	4	—	1
July	1	—	2	1	4
August	2	—	—	3	1
September	—	—	—	1	—
October	2	—	1	1	—
November	1	1	—	1	2
December	2	—	2	—	1
Total .	23	7	16	7	13

The number of returns within half a year after tagging is rather high, totalling 26, and of these 19 were caught during the first three months after tagging. Most of the tagged fish and especially those caught by trawl were released on fishing grounds where fishing was in operation. One fish was even recaptured the same day as it was released. This explains the high number of recoveries soon after tagging. As appears from the table only three fish have been recaptured 1–2 years after liberation, while more tagged fish were returned from the same experiments during the following years. The years with few returns are mainly 1955 and 1956.

Table 6 shows the number of recaptures each month in the different areas irrespective of the time in liberty. East of longitude 35°E the maximum number of recoveries was taken in January–March, while further west, off the coast of Finnmark, most of the recoveries were taken in April–June. In more northern waters, at Bear Island and the Centralbank, tagged fish were mostly recaptured in the autumn.

The growth of the tagged fish is demonstrated in Figure 5 which shows the difference between length at recapture and length at release for 32 returns. The other returns were not accompanied by information of length or the fish were measured headless. The reported

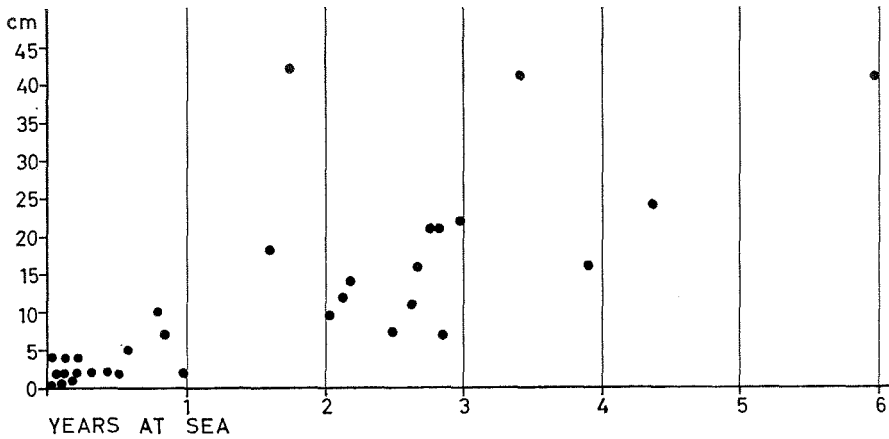


Figure 5. Length increment of recaptured spotted catfish according to time at liberty.

length of some of the recaptured fish is obviously too great. One fish measuring 78 cm at release was reported to be 120 cm after only 1 year and 9 months, while another fish 93 cm at release showed a growth of 42 cm after nearly 6 years at sea.

DISCUSSION

The growth rate of *A. minor* as determined from this study is in agreement with the data given by Maslov (1944). His values tend, however, to be slightly lower. This discrepancy may probably be ascribed to the time of the year the samples have been secured. Maslov's material was obtained from trawlers throughout the year, while the present samples, except 75 young fish (Table 1), were taken from long-liners in June–July.

The reported lengths of the recaptured fish from the tagging experiments (Figure 5) may be used to test the estimated growth rate. In Figure 6 the length of the recaptured fish is plotted according to length at release and time at sea. For most of the recaptures the deviation from the empirical growth curve is less than 5 cm. It seems therefore fair to conclude that the estimated growth rate based on age readings from the vertebrae is not very far from the true value.

The size composition of the catfish taken by long-line (Figure 1) shows that fish smaller than 60–70 cm and larger than 130 cm were only caught in small numbers. The maturity stage distribution according to length shows that *A. minor* reaches sexual maturity at a length of 70–90 cm with a critical length at 75 cm for females and 80–85 cm for males. This result indicates that *A. minor* is not caught

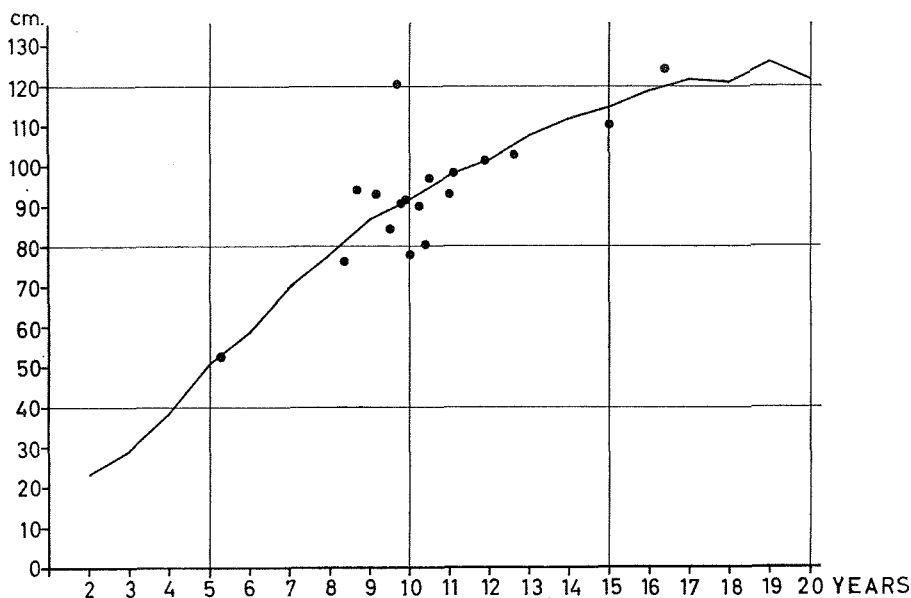


Figure 6. Age — length relationship of spotted catfish and the length at recapture of tagged fish plotted according to time in liberty.

to any great extent by long-line before reaching maturity. In Greenland waters fish smaller than 80 cm were also scarce in the long-line catches and the size composition was similar to that found off Finnmark (Hansen 1958). Information on maturity is not given by Hansen, but his data on length and weight show that, in the length group between 70–90 cm, length decreases in relation to weight which is typical when a fish reaches sexual maturity. Barsukov's (1957) data shows that immature catfish are caught in greater numbers by the trawlers and the same result is indicated by the present material. The size composition in the catches is apparently dependent on the depth of fishing. According to Barsukov nearly 40 % of the catfish with total length of 20–59 cm, were taken by the trawlers at depths greater than 200 m, whereas less than 30 % of the bigger fish 60–130 cm were caught at this depth. The long-line fishing in April–July off Finnmark usually occurs at depth from 100–150 m. The depth distribution of *A. minor* also varies with the time of the year and Barsukov found the maximum concentration of fish in all length groups between 100–150 m in August–October and in deeper water throughout the rest of the year.

According to Smitt (1892) and later authors the maximum size of *A. minor* is 180 cm or more. The present growth data show,

however, that the asymptotic length is about 155 cm and no records of bigger fish have been found in the literature. The biggest fish from the present material measured 144 cm and was about 25 years old.

A. minor has been regarded as a late winter spawner (Maslov 1944). The present investigation shows, however, that *A. minor* spawn in the vicinity of Bear Island in July. The samples taken off Finnmark in June also indicate spawning in late summer. It is most likely, therefore, that the main spawning season for *A. minor* in the Barents Sea and adjacent waters is in July and probably also August. This is in agreement with the time of spawning stated by Barsukov (1957) who, however, does not give any further information or references. In Icelandic waters Lühmann (1954) observed females with ripe eggs in July–August and he concluded that spawning occurred later in the year around Iceland than in the Barents Sea where *A. minor* according to previous authors was reported to spawn at the end of the winter.

From the maturity stage distribution it is seen that males in stages III and IV have not been observed and information on maturity stages in males from other areas has also not been given. Since histological investigation has not been undertaken, it cannot be ascertained that all the males grouped in maturity stage II were in this stage, but the size and the form of the testes were similar. On the assumption that the present observation is correct, the duration of maturity stages III and IV in males may be very short or the maturity cycle different from the females with regard to the time of the year. In the latter case mating and internal fertilization probably must occur. Further investigations are needed before the sexual development and spawning of *A. minor* can be fully explained.

The eggs of *A. minor* and the other species of Anarhichidae are deposited on the bottom in large loose lumps. According to McIntosh and Prince (1890) the eggs of *A. lupus* hatch after 2–3 months and it takes another 3½ months after hatching before the yolk sac is absorbed. Seydlitz (1957), referring to eggs of *A. lupus* found off the west coast of Spitsbergen in August, says that *A. lupus* larvae are able to hatch in a very early stage of development by shock, but normally do not hatch until the yolk is absorbed and fin rays are formed. According to Andrijashev (1954), *A. lupus* spawn in December–January. The observation of Seydlitz suggests, therefore, that the larvae do not hatch until the following summer, 6–8 months after spawning. If the larvae of *A. minor* need approximately the same time before hatching and assuming the spawning season to be July–August the larvae would normally not hatch until late winter

or early spring. This would explain the previous assumption of *A. minor* being a late winter spawner.

The result of the tagging experiments show that catfish from the eastern part of the Barents Sea, off the Norwegian coast and around Bear Island intermingle to a great extent. So far none of the tagged fish have been recaptured outside this area. *A. minor* also occurs along the west coast of Spitsbergen, but none of the tagged fish released near Bear Island or further south has been recaptured in Spitsbergen waters. It does not seem reasonable, however, that the stock of *A. minor* off Spitsbergen should be isolated from the stock further south and that intermingling not takes place. Most probably the stock of *A. minor* in the Barents Sea, along the coast of Northern Norway, at Bear Island and Spitsbergen belong to one single unit.

The age and length distribution of the samples taken near Bear Island and off Finnmark show that more young fish were present near Bear Island. This different distribution of the age groups may, however, be seasonal. The recaptures during the first years indicated a westward migration from the eastern part of the Barents Sea to the banks off Finnmark in the spring and westward migration in the autumn (Østvedt 1956). By including recaptures from all years, this seasonal migration is more confused. The number of recaptures in each area for the different months show, however, that east of longitude 35°E the maximum number of recoveries were taken in January—March, as against April—June further west. In the northernmost areas, Central Bank and Bear Island, tagged fish were mainly recaptured in July—August. The Norwegian long-line fishery for catfish usually starts in April—May on the Skolpenbank. By the end of June the best catches are taken at Hjelmsøybank or even further west. Since a great part of the catch consists of maturing fish it is reasonable to link this change in fishing areas during the spring and summer with a westward migration to spawning grounds off Finnmark.

It has been shown that a higher percentage of returns was obtained from trawl-caught fish than fish tagged and liberated from the long-liners. It should be noted that fish from trawl catches were liberated on several localities as against only three localities for fish caught by long-line. Besides, the trawl-caught fish were mainly liberated on the usual trawling grounds where fishing often was in operation and the tagged fish may have been exposed to a higher fishing effort than the fish liberated from the long-liners.

These tagging experiments are too limited and have been conducted on so many localities that it seems unwarranted to correlate the number of returns in the different years with the total landings

of catfish. A striking feature is the low number of returns $1\frac{1}{2}$ –2 years after liberation, referring to the years 1955 and 1956, while the total landings show an increase nearly every year since these experiments were undertaken.

SUMMARY

Spotted catfish, *Anarhichas minor* Olafsen, were sampled from long line and trawl catches taken along the coast of Finnmark, near Bear Island and in the Barents Sea in 1953 and 1954. Age was determined from vertebrae. Fish younger than 6 years were not found in the long line samples. The age groups 12–14 were most abundant in the long line samples taken off Finnmark as against 8–9 years old fish dominating the samples taken near Bear Island.

The females were found to attain sexual maturity at an age of 6–7 years and a length of about 75 cm and the males approximately one year later at a length of 80–85 cm.

The present study indicates that the spotted catfish spawn in July–August.

In 1953, 1954 and 1955 a total of 432 catfish were tagged with Lea Hydrostatic tag. Until January 1963 71 were recaptured. The seasonal distribution and migration of the catfish are discussed.

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