Contribution to the Biology of Catfish *(Anarhichas lupus)* at Iceland

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ABSTRACT

Three species of the family ANARHICHADIDAE are found at Iceland: the catfish *(Anarhichas lupus)*, the spotted catfish *(A. minor)* and the jelly-cat *(A. latifrons)*. Continuous investigations of *A. lupus* — by far the most common of the three — started in 1966. This paper describes the restults obtained up to 1976, as well as catch data up to 1980.

Distribution and habitat. The catfish has a wide distribution in the North Atlantic, ranging from the Barents Sea to the Bay of Biscay and from Greenland to Cape Cod. At Iceland the catfish is found all around the island, favouring depths of 40–180 m.

Catches. Icelandic waters have for a long time been the main catfish grounds in the North Atlantic, accounting for 31–79% of the total catch in the period 1945–1979.

Tagging and migrations. During the years 1966–1975 a total of 12,740 catfish have been tagged all around Iceland, the major tagging areas being Vestfirðir grounds and Látragrunn. Catfish were also tagged at East-Greenland in 1971–1975.

Spawning. Mature catfish migrate from shallower grounds to the deeper spawning grounds in autumn. Most fish migrate to outer Látragrunn — the major spawning ground at Iceland — where they remain during the months of September to December or even January, after which time they return to shallower grounds for feeding. The catfish spawn at 140–200 m depth in the area from Látragrunn to Hali in late September and in October.

Tooth exchange. Contrary to most fish species, the catfish exchanges its whole set of teeth once a year, i. e. loses the old teeth and renovates them with a new set. The tooth exchange occurs around or shortly after the spawning season in September-October with females preceding the males in the process.

Food. The food of catfish is dependent on the time of year, area and the size and age of the individual. The main diet of the catfish consists of echinoderms, molluscs and crustaceans.

Growth and age. Age determinations have been made by means of the otoliths. A total of 11,261 catfish have been age-determined during the years 1970–1976, out of which 5345 (52.6%) were males and 4811 (47.4%) females.

Age and length. The largest catfish recorded at Iceland was 116 cm. Males grow to a larger size than females, the latter rarely exceeding 90 cm with only on record over 100 cm at Iceland.

Age and weight. The weight and age of gutted and ungutted catfish caught during the fasting period in October 1975 and the feeding season in March–April 1976 are compared.

Catfish x spotted catfish. The possibility of hybrids between the two species *A. lupus* and *A. minor* is discussed.

Parasites. Some parasites known to affect the catfish are mentioned.

INTRODUCTION

There are three species of the family ANARHICHADIDAE in the northern North Atlantic, i. e. the catfish *(Anarhichas lupus* Linnaeus, 1758), the spotted catfish *(A. minor* Ólafsson, 1772) and the jelly-cat *(A. denticulatus* Krøyer, 1845 syn. *A. latifrons* Steenstrup & Hallgrímsson, 1842). All three are found at Iceland, the catfish being by far the most common and the jelly-cat the rarest. The last-mentioned species is more pelagic than the other two and inhabits deeper colder waters.

Out of just over 20 commercial fish species caught at Iceland during the last 10 years, the catfish has ranked the 8th to 10th in the catches — behind capelin, cod, saithe, herring, haddock, redfish, Greenland halibut and Norway pout — constituting 0.6–1.5% of the total. Although included in the fishery statistics, the spotted catfish is considered to be less than 5% of the total catfish catch.

Since 1966 continuous research has been carried out on catfish at Iceland, especially concerning its migrations, spawning, size, age, growth, food and condition of teeth. The present paper gives an account of the results obtained up to 1976 and catch data up to 1980.

Apart from data on catfish, information has been collected on the spotted catfish and the jelly-cat, when caught as by-catch. However, owing to the limited material concerning these two less important species, only the catfish *(A. lupus)* will be dealt with in this paper.

DISTRIBUTION AND HABITAT

The catfish inhabits both sides of the northern North Atlantic (Fig. 1). It is found off the west coast of Spitzbergen and in the Barents Sea from Novaya Zemlya to the White Sea. It also occurs along the coast of Norway, in the seas of Skagerak and Kattegat, in the Danish Straits and in the Baltic, even straying as far as the Gulf of Finland. In the North Sea it is commonly found north of 53° N and individual fish occur in the English Channel and in the Bay of Biscay. A stray specimen is reported from Genoa Bay in Italy. It is distributed around the British Isles — although rare in Irish waters — but common around the Shetlands, the Faroes and Iceland. It is found at East and West Greenland from Angmassalik Bay to Disco Bay, off the east coast of Canada south of Northern Labrador, off Newfoundland and northeast coast of the United States south to Cape Cod or even New Jersey, with individual fish having been caught as far south as Cape Hatteras.

The depth zone occupied by the catfish at Iceland extends from 8 to 450 m, the shallowest record being from a diver who identified a number of catfish when diving off Kolbeinsey, North Iceland, in the summer of 1971 (V. Thorsteinsson, pers. comm.). The deepest record was reported at pos. 64°40′N and 27°12′W off the west coast (Kotthaus and Krefft, 1957). However, at Iceland the catfish is most commonly found at 40–180 m depth.

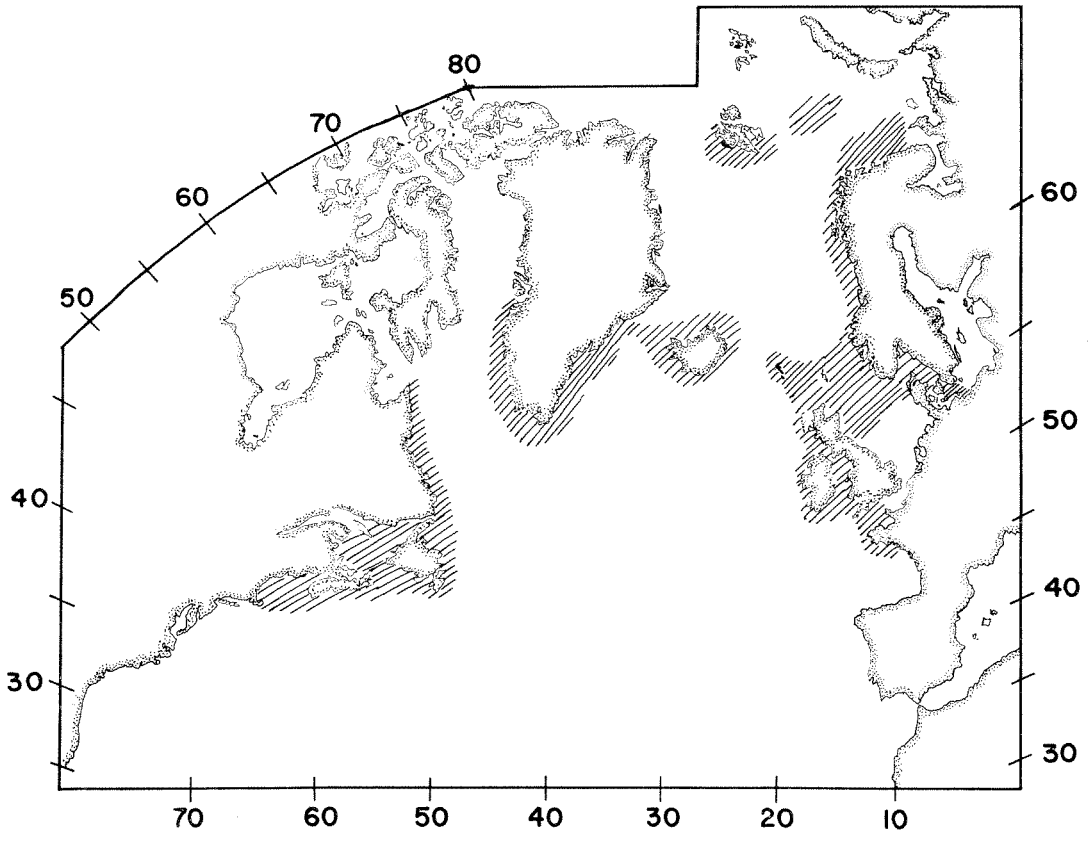

Fig. 1. Distribution of A. lupus in the northern North Atlantic.

At West Greenland catfish have been recorded at depths ranging from 14 m to 450 m on 'Little Halibut bank' (pos. 65° 01′N 55°04′W) and at East Greenland down to about 550 m depth (pos. 65° 24′N 30°45′W) in a Marine Research Institute survey during the summer of 1976. In the Barents Sea catfish have been caught at 18 to 380 m depth and off North America at 2 to 435 m (Barsukov, 1959/1972).

The catfish is a demersal species, inhabiting mainly stony but also sandy or muddy grounds. Barsukov (loc. cit.) considers the main habitat to be stony bottom, the young fish being particularly dependant on this bottom substrate. At Iceland the catfish is common on good trawling grounds and 15–35 cm fish, 3–6 years of age, are regularly caught in considerable numbers on relatively good trawling grounds deep off Vestfirðir and on Látragrunn in early winter.

Beese and Kändler (1969) regard the temperature tolerance of catfish to be from −1.3° to 10.2°C, based on their research off Iceland, Norway and the North Sea. However, the species is most common at sea temperatures of 1° to 4°

C, becoming rarer at temperatures above 6°C and not found at all above 11°C. Kotthaus and Krefft (1957) found catfish off Iceland at 1.8° to 7.1°C and in Greenland waters at 1.3° to 5.5°C. Off North America (Gulf og Maine) catfish have been found at temperatures ranging from 1° to 11°C (Bigelow and Schroeder, 1953) and in the Barents Sea at 1.0° to 7.4°C (Barsukov 1959/1972).

CATFISH CATCHES IN ICELANDIC AND OTHER NORTH ATLANTIC WATERS

The world's most productive catfish grounds are and have been in Icelandic waters (Fig. 2). Only in the last few years has the Barents Sea catch surpassed that of Icelandic grounds, the major proportion of the catch, however, being reported as spotted catfish (Lundbeck 1937, Barsukov 1959/1972). Fig. 3 shows the annual catfish catch from the Northeast Atlantic, the proportion taken on the Icelandic grounds as well as that taken by Icelanders in the period 1906–1979.

In the years 1906–1913, i. e. prior to World War I, the total Northeast Atlantic catfish catch increased from about 4000 to 11.000 metric tons a year with an average of 3,732 tons. During this period an average of 2,762 tons annually, or

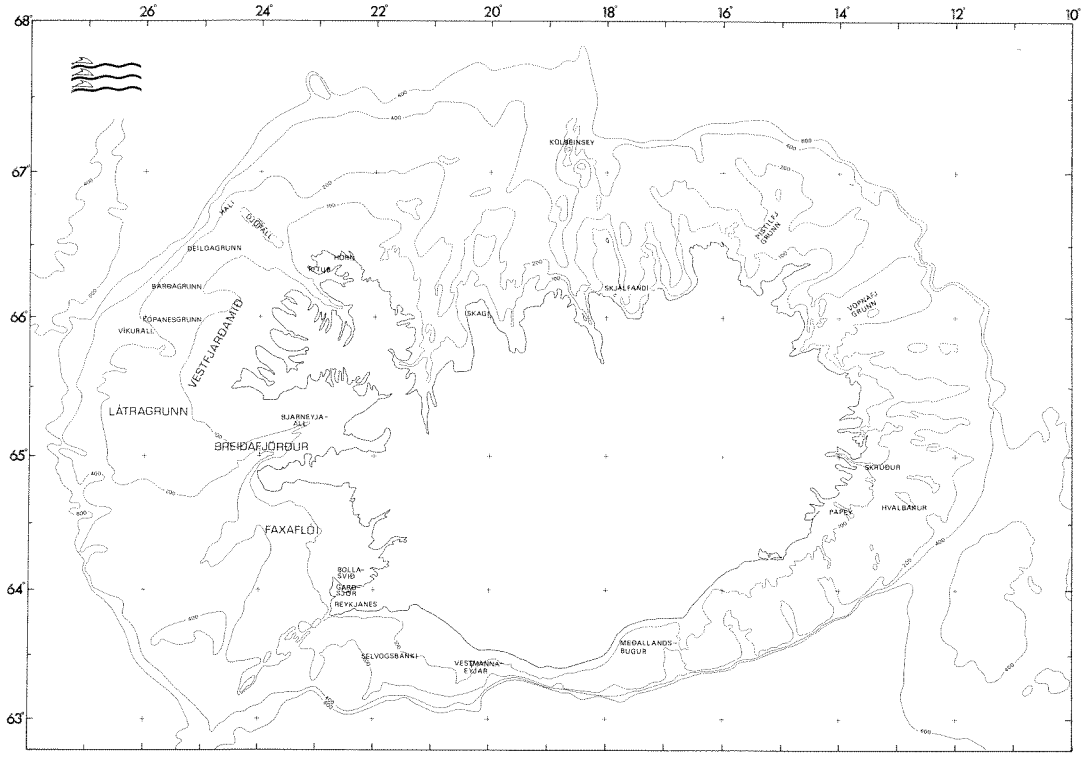

Fig. 2. Names of localities and fishing grounds referred to in the text.

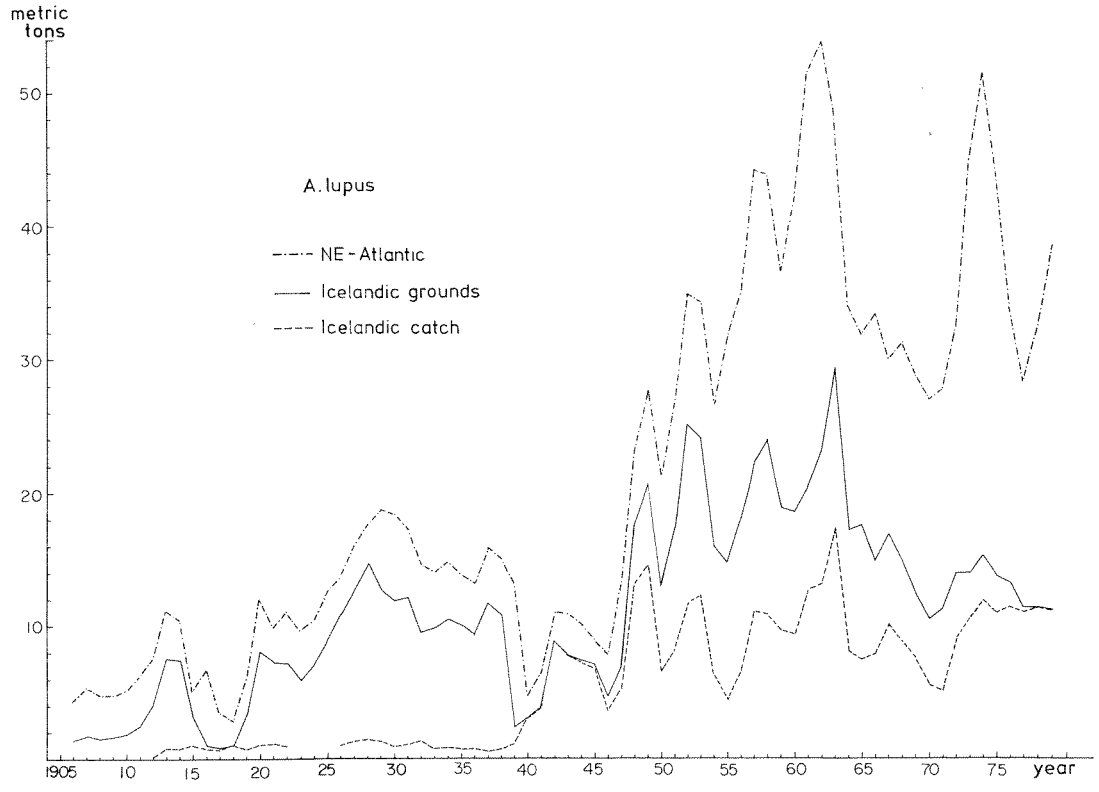

Fig. 3. Catches of catfish during 1906–1980 (in metric tons) from the North-East Atlantic Ocean, from the Icelandic grounds and catches taken by the Icelanders.

74% of the total were taken on the Icelandic grounds.

In 1914–1918, the years of World War I, the total Northeast Atlantic catch dropped to 1,679 tons in 1917. Of the average total Northeast Atlantic catch of 3,317 tons in 1914–1918, 2,373 tons were caught at Iceland. However, the catch taken by Icelanders during this period averaged only 852 tons.

In the years between World War I and II (1919–1938), NE Atlantic catfish catches increased from 4,075 tons in 1919 to a peak of 17,911 tons in 1928. This was mainly due to increased catch in Icelandic waters from 3,374 tons (71.7% of total) in 1919 to a peak of 14,224 tons (79.4% of total) in 1928. Unfortunately, Icelandic catch data are not available for a part of this period, i. e. 1923–1925.

During the 10 year period 1929–1938 catch rates remained at a relatively steady level and averaged 14,927 tons per year. An average of 72.7% of the total were taken on the Icelandic grounds during this period. The catch taken by Iceland remained small throughout the interwar period fluctuating between 565 and 1468 tons. As mentioned above the Icelandic catch

figures are, however, not available for the years 1923–1925.

During World War II, the catfish catches in the Northeast Atlantic dropped as a result of decreasing effort: 13,109 tons taken in 1939, but only 4,853 in 1940. The average for the seven year period 1939–1945 was 9,384 tons. At Iceland the catch was at its lowest in 1939 or only 2,349 tons, reaching 8,437 tons in 1942, most of which was caught by Icelandic vessels.

After World War II, catfish catches in the Northeast Atlantic rose from 7,852 tons in 1946 to an all time record of 53,726 tons in 1962. The Icelandic grounds accounted for 39% to 75% of the total catch annually, with 4,680 tons being taken in 1946 and 29,454 tons in 1963 — a record for these waters. Similarly the catch taken by Iceland increased from 3,689 tons in 1946 to 17,331 tons in 1963, averaging 9,222 tons for the period.

During the years 1966–1979, the average catfish catch in the Northeast Atlantic amounted to 35,112 tons, the Icelandic grounds accounting for 13,816 tons, of which 8,843 tons were taken by Icelandic vessels.

The catches of catfish in the Northwest Atlantic (ICNAF area), i. e. off West Greenland, Canada, Newfoundland and the United States, have never been large. Since 1954, the first year of available catch data, there has been an increase in catfish catches from 3,334 tons to 12,404 tons in 1973. The average catch during this period (omitting 1963 and 1966 due to lack of data) was 8,350 tons. The main fishing grounds have been off West Greenland.

TAGGING EXPERIMENTS AND MIGRATIONS

The catfish, with its body tapering back to a slender caudal peduncle and a small weak tail fin, has not the appearance of a good swimmer. Sæmundson (1926) reports: "The catfish is generally a slow moving species and most likely does not undertake any long journeys. However, it is not always stationary. Towards the autumn it leaves shallow grounds and moves towards deeper waters...". Barsukov (1959/1972) states: "Almost nothing is known about migration. Nevertheless, certain data enable us to suggest that their migrations are not of a long duration, as is the case with other Atlantic species. A number of authors who made observations on them near the coasts of Scandinavia, Iceland and North America (Nillsson, 1855:211; Smitt, 1893:235; Bigelow and Welsch, 1925:373; Sæmundsson, 1949:32; Bigelow and Schroeder, 1953:504) are of the view that the migrations of striped wolffishes are of short duration."

It is probably a matter of opinion whether migrations should be referred to as long or short. If migrations between continents (i. e. Europe and America) are in the "long" category, the journeys of the catfish are indeed short. However, tagging experiments at Iceland show without a doubt, that the catfish do undertake more than "a day's journey" in search of food and spawning

grounds. With the exception of the spotted catfish which have been tagged off Norway and in the Barents Sea (Östvedt, 1963) there have not been many, if any, catfish tagging experiments except at Iceland during the last few decades. The pioneer of catfish tagging at Iceland was the Danish fisheries biologist Dr. A. V. Tåning, under whose auspices 141 catfish were tagged in Faxaflói and Skjálfandi during the years 1933–1936. By 1938 24 (17%) had been recaptured, mostly in the proximity of the tagging areas. A few, however, had travelled from Faxaflói to Breiðafjörður and one each from Skjálfandi to the grounds off Skagi, Horn and Vestfirðir respectively (Tåning, 1938).

Apart from 10 fish that were tagged in Faxaflói in 1956 no catfish tagging experiments were carried out from 1936 to 1961. In 1961 100 catfish were tagged in Faxaflói (G. Jónsson, 1971) and since 1966 tagging experiments have annually been on the Icelandic catfish research programme. In the period 1966 to 1975 a total of 12,740 catfish have been tagged at Iceland, and the results up to 1970 have already been published (G. Jónsson, 1971). In addition to these experiments at Iceland some 476 catfish were tagged off East Greenland in 1971–1975, i. e. on Dohrn Bank, Fylkir Bank, Mösting Ground and Heimland Ridge.

At Iceland the largest number of catfish have been tagged off Vestfirðir or 61.6% of the total followed by Látragrunn with 22%. As a rule tagging has been carried out in March–April on the shallow grounds off Vestfirðir and in

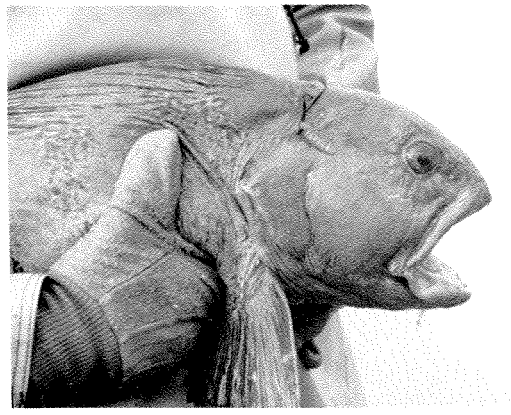

Fig. 4. A tagged catfish. (Photo: Vignir Guðmundsson).

September–October in deeper waters off Vestfirðir and on Látragrunn.

Table 1 summarizes catfish taggings and recoveries by years during the period 1956–1975. Most of the fish were tagged with a red or yellow plastic tag, engraved with one or two letters and a number. In 1971 89 fish were tagged with Lea hydrostatic tag. Generally the tag itself, threaded to the back of the head (Fig. 4), seem not to cause any additional scarring to the fish. All the fish used in the tagging experiments were caught in a bottom trawl. The standard duration of the hauls was about 60 minutes with occasional hauls as short as 30 and as long as 90 minutes. The fish appeared to be in a good condition when tagged.

During the first years relatively few catfish were tagged annually or only 45 individuals in Faxaflói (Bollasvið and Garðsjór) in 1966 and 101 in 1967. Only two of these catfish have been recovered — one from each tagging — both in the proximity of the tagging area. In 1968 tagging was initated all around the

country, although as a rule only a few were tagged in each area. In 1969 78 catfish were tagged during an experiment in Skjálfandi. The rate of returns reached 9.2% by the end of the year, the highest per annum up to now. In 1970 tagging began on a large scale off Vestfirðir and in 1971 on Látragrunn. Since then these two have been the main tagging areas at Iceland.

Recoveries vary a great deal from year to year or from 1.0% in 1967 to 9.2% in 1969. Up to 1976 the average recovery rate was 5.5% with 4.4% reported caught within one year from tagging. Undoubtedly a considerable proportion of recaptured tags are not returned, but their number is unknown.

TABLE 1

Returns of tagged catfish by fishing gear and countries during 1966–1975.

Gear	*%*	*Country*	*%*
Longline	53.5	Iceland	85.9
Bottom trawl ...	34.4	Britain	9.4
Danish seine ...	1.6	W-Germany	1.2
Hand line	0.3	Others	0.1
Unspecified	10.3	Unspecified	3.3

During the period 1966–1975 Icelandic vessels caught on the average 64.0% of the total catfish catch at Iceland and British and W-German vessels 24.3% and 10.0% respectively.

Spawning and feeding mitrations seem to form the main migratory pattern of catfish as in most other species of fish, but shorter migrations within each spawning or feeding area have also been observed.

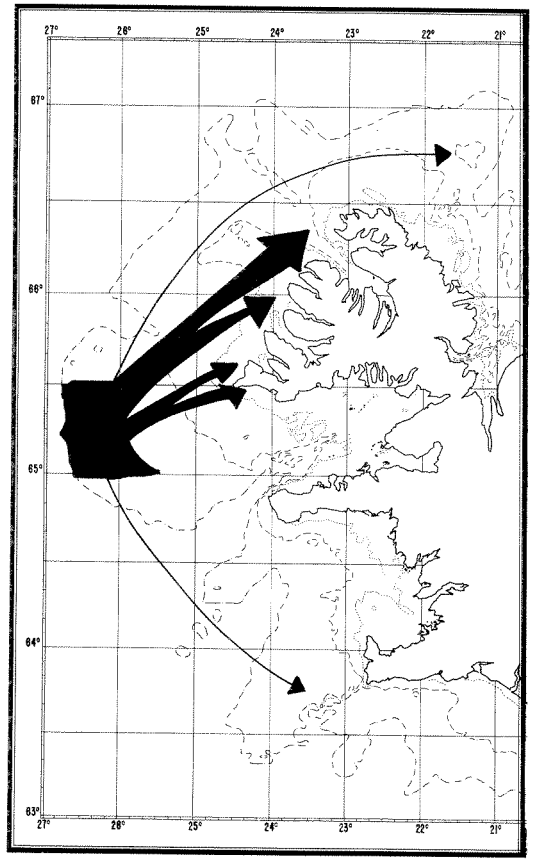

Fig. 5. The migration of A. lupus from the spawning grounds.

Fig. 5 shows the general pattern of catfish migrations from the main spawning grounds on outer Látragrunn to the feeding areas off Vestfirðir. These migrations occur mainly in January–March, prior the the most important catfish fishery in Iceland off Vestfirðir in March–May. Most of the catfish remain in this area until late summer (August) when they return to the spawning grounds of Látragrunn, Víkuráll and northwards along the continental slope to Hali. Many catfish migrate still far-

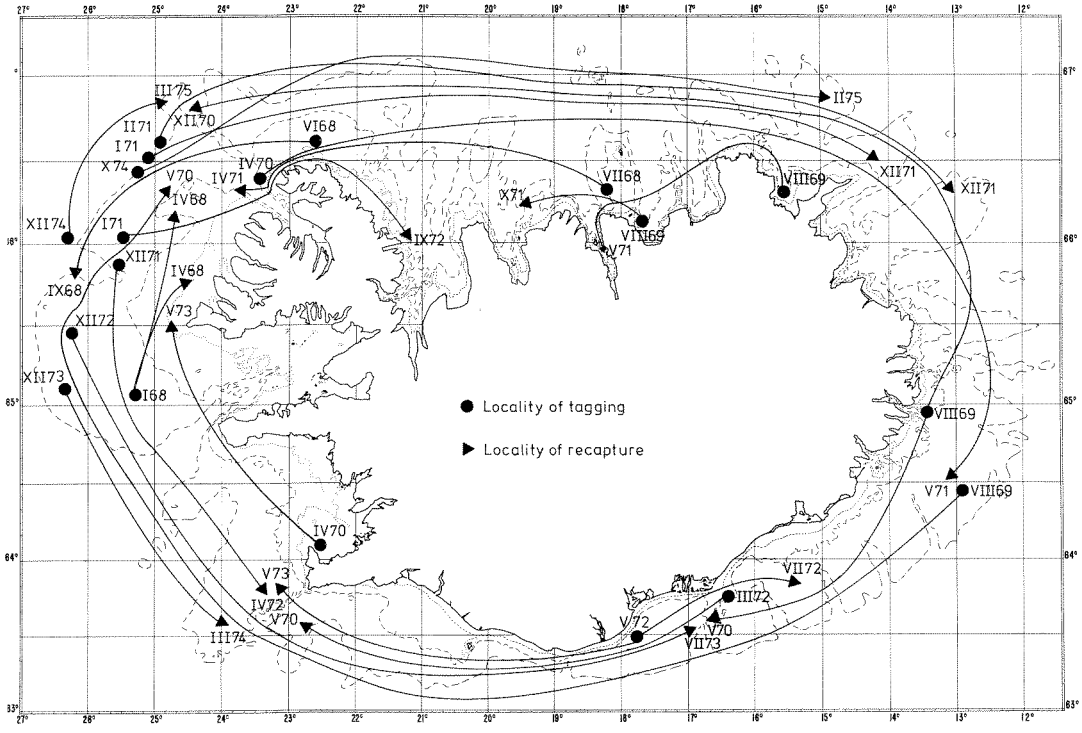

Fig. 6. The migration of A. lupus around Iceland.

ther to the north or south and then eastwards as far as the grounds off East Iceland (Fig. 6). Presumably these individuals migrate back for spawning off West Iceland in autumn.

A few of the more interesting catfish migrations shown in Fig. 6 are worth mentioning. A catfish tagged on outer Látragrunn in December 1972 was recaptured, presumably after having spawned, in July 1973 or 7 months later in Meðallandsbugur, some 300 nautical miles from the tagging position. Another catfish tagged in the same area in December 1973 was recaptured in March 1974 or 3 months later southwest of Reykjanes, having travelled a distance of 110 naut. miles. One catfish tagged off Vestfirðir (Ritur) in April 1970 was recaptured in May 1971 off southeast Iceland or about 360 miles from the tagging locality. From taggings carried out on Barðagrunn in January, February and October 1971, one fish was recaptured off Langanes in December 1971, another on Vopnafjarðargrunn, also in December 1971, and the third on Þistilfjarðargrunn in February 1975 or more than 3 years later. These fish had therefore travelled distances amounting to 280–320 miles each. Unfortunately the gonad maturity stages of the two catfish caught in December off the northeast coast are unknown, but such information would have given an indication of spawning in that area.

The migrations of two catfish tagged off East Iceland in August 1969 are also noteworthy. The first, tagged at Hvalbakur, was recaptured in May 1970 on Barðagrunn or about 400–500 nautical miles from the tagging station, depending on whether a northerly or southerly route was taken. The other, tagged at Skrúður, was recaptured on the Hali ground in December 1970, some 360 or 480 miles away depending on the route chosen.

Finally one should mention a catfish tagged in Garðsjór in April 1970 and recaptured off Látrabjarg in May 1973.

There is no evidence whatsoever of the Icelandic catfish migrating to other countries. Not a single fish tagged at Iceland has as yet been recaptured outside Icelandic waters.

None of the 476 catfish tagged off East Greenland have been recovered at Iceland. The Greenland catfish, although considerably smaller than those at Iceland, may however be of Icelandic ancestry, having drifted as larvae or fry, e. g. from the Víkuráll area to East Greenland.

Most data indicate greater activity of the species during the night than in the daytime and catch rates by trawl are higher at night. Whether the catfish remains completely stationary during the day (in hiding etc.) is unknown, although is is considered not unlikely. Barsukov (1959/1972) quotes: "Near the shores they are active only during night; during daytime they remain in shelters at bottom." When diving during daytime at Kolbeinsey in July 1971, a fellow colleague observed a great number of catfish hiding in crevices and seaweeds at 8 to 15 m depth (V. Thorsteinsson, pers. comm.).

SPAWNING

In autumn the mature catfish disappear from shallow waters around Iceland to spawn, the majority heading for Látragrunn and the deep waters off Vestfirðir. After remaining in the spawning area from September to December or even January, they proceed to move back to shallower waters off Vestfirðir for feeding. By March and April catfish in search of food have become abundant in these waters.

The eggs of the catfish are demersal and laid down in large clutches on stony substrate.

Until recently the Icelandic catfish were believed to spawn either in January–February (Sæmundsson, 1949) or in November–February with a peak in December–January (Lühmann, 1954b). Beese and Kändler (1969) considered that spawning was initiated in the last month of the year and finished by February–March. Barsukov (1959/1972) mentioned spawning in August–September.

According to recent studies at the Marine Research Institute the catfish at Iceland spawn mainly in September–October with a peak in October. Only a few late spawners have been observed in November or December, these being exceptions to the rule. The principal spawning area is on the outer Látra-

grunn, i. e. north of 65°10′N and west of 26°10′ W stretching northwards to Víkuráll. Lühmann (1954b) referring to a German trawler skipper quotes the area from 65°10′N to 65°35′N and 26° 35′W and 170 m depth on outer Látragrunn, as being the main spawning ground of catfish. Less important spawning grounds have been observed in Víkuráll, outer Kópanesgrunn, Barðagrunn, Deildargrunn north towards Hali and Djúpáll. Female catfish near spawning or newly spawned have been caught at 140–200 m depth in the area ranging from Látragrunn north to Hali and Djúpáll at the end of September and in October. By November and December the vast majority of the females in the area have already spawned. This is substantiated by catfish eggs found in stomach contents of spotted catfish in this area in December. Furthermore, demersal egg masses from catfish were caught in December 1975 and 1976 at three localities on Látragrunn (Fig. 7).

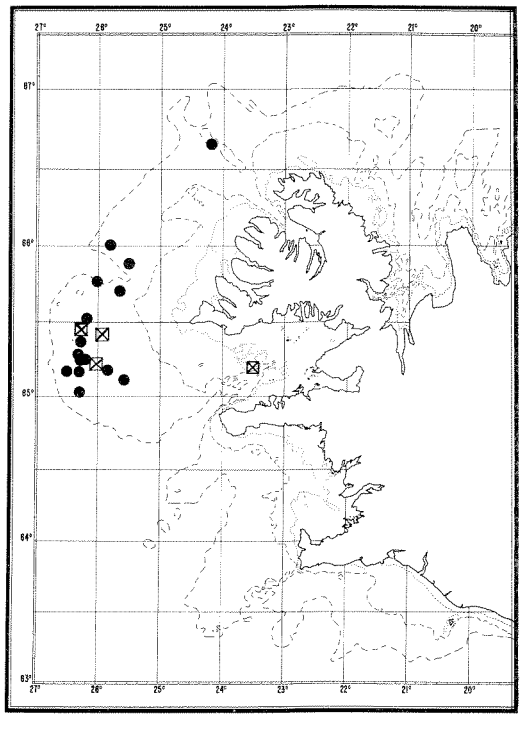

Fig. 7. Locations of A. lupus eggmasses ⊠ and eggs found in the stomach of A. minor ●.

Apart from the area mentioned above, egg masses have been found at other localities on two occasions. In Bjarneyjaáll in Breiðafjörður a mass of hatching eggs was caught at 95–118 m depth in February 1975 and another, also with hatching eggs, was found in February 1976 on Skrúðsgrunn off East Iceland. Thus the catfish appear to spawn outside the Látragrunn-Vestfirðir grounds, although probably to a much lesser extent.

The size of the egg mass varies according to the size of females, the ones mentioned above measuring 10–14 cm in diameter (Fig. 8). The number of eggs in each ranged from a few hundreds to a few thousands, with egg diameter varying from 5.9–6.3 mm (6.1 mm on the average). Such egg masses with larvae near hatching were reported off Scotland as far back as January 1888. Another agglomeration was caught in April 1931 in the Barents Sea at 78–84 m depth, wrongly identified at the time as belonging to spotted catfish. A third egg mass was found in February 1937 off Nova Scotia and a fourth in the Barents Sea in February 1950 (Barsukov 1959/ 1972). A female catfish that spawned in the Vestmannaeyjar (Westman Islands) aquarium in December 1974 was obser-

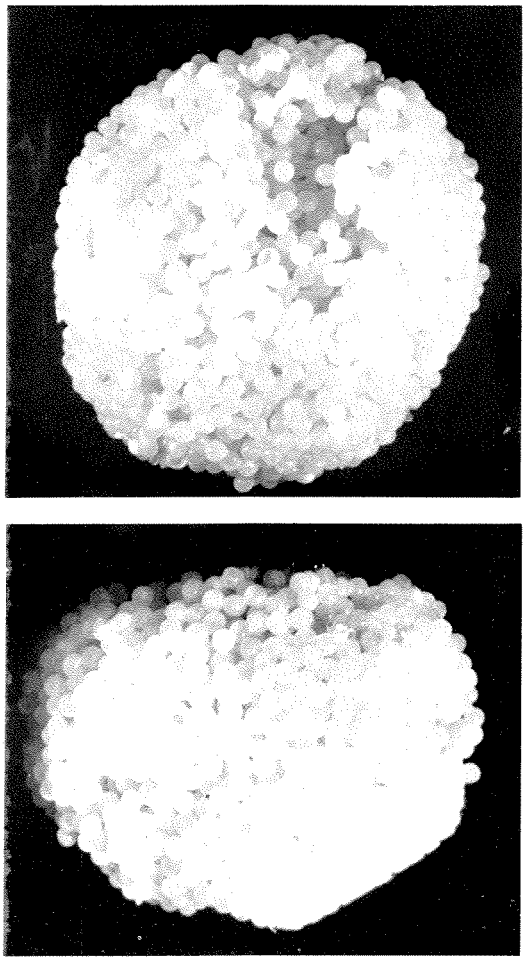

Fig. 8. Eggclutch of A. lupus. (Photo: Halldór Dagsson).

ved protecting the egg mass (Fig. 9) and trying to fend off other attacking catfish. However, when the intruders managed to nip into the egg mass the mother seemed to lose interest and actively took part in devouring her own eggs with the other fish. It is noteworthy, that the female fish guarded the eggs, not the male. Whether this is so in their natural habitat is not known, however, and Barsukov (1959/1972) reports uncertainty on this matter. Still the egg masses de-

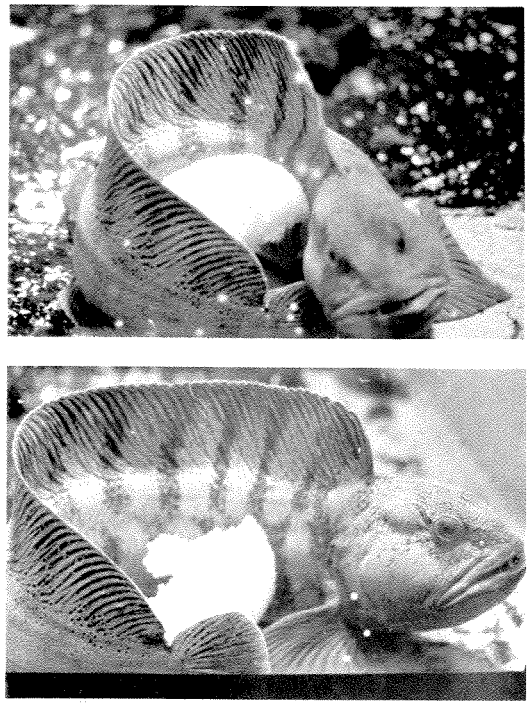

Fig. 9. A. lupus. female guarding her eggs in the Vestmannaeyjar Aquarium. (Photo: Sigurgeir Jónasson).

finitely need protection from enemies such as the spotted catfish which often is found with stomachs containing catfish eggs. Moreover catfish eggs have also been observed in catfish stomachs, although little food is taken during and immediately after the spawning season due to the tooth exchange. However, strong teeth are hardly essential in devouring a few catfish eggs.

The smallest mature female catfish recorded at Iceland was 25 cm and it contained 338 eggs about to be spawned. It was caught on outer Látragrunn (pos. 65°24′N and 26°20′W) at 150–165 m depth in the beginning of December 1975. The fish was aged 7 years (8 years on January 1, 1976). Another female

caught a short distance away (65°31'N and 26°15'W), at 150–160 m depth, measured 59 cm and contained 4900–5000 eggs near spawning. It was 9 years of age. The eggs of both of these females measured 5.0–5.5 mm in diameter. In December 1976, a 26 cm female 6 years of age was caught on Látragrunn containing 490 well developed eggs. All of these females therefore belong to the group of late spawners.

According to Barsukov (1959/1972) the fecundity of catfish ranges from 2,500 eggs in females of 43 cm length up to 23,580 in females of 81 cm (the Barents Sea), reaching 40,000 eggs in larger females in the North Sea (McIntosh and Masterman, 1897:200). The diameter of mature eggs is usually 5.5–6.0 mm (the North Sea, and Nova Scotia banks), occasionally reaching 6.5 mm or even 7.0 mm in the Barents Sea (Wollebæk, 1924:210; Knipowitsch, 1926:94).

TOOTH EXCHANGE

Most fish species renew their teeth gradually as they are worn down by use. This, however, does not apply to the catfish or related species (spotted catfish and jelly-cat), since they change their teeth regularly once a year — lose the old teeth and renovate them with a new set. The catfish is therefore toothless for a certain period of time and non-feeding. Lühmann (1954) describes the phenomenon of tooth exchange in detail, considering it to occur shortly before spawning i. e. in December to February at Iceland.

The present studies show, however, that the exchange of teeth predominates at or just after spawning in September–October, the females preceding the males in the process.

In a special study of the tooth exchange in catfish off Vestfirðir and on Látragrunn since September 1972, the condition of teeth has been roughly divided into 5 categories or stages as follows:

I)	old firm teeth	(o. f.)
II)	– loose —	(o. l.)
III)	toothless	(t. l.)
IV)	new loose teeth	(n. l.)
V)	— firm —	(n. f.)

In September–October, most males have old teeth or 58–99% (o. f. 39.87% and o. l. 13–25%), while the percentage of females with old teeth is 36–61% (o. f. 18–53% and o. l. 8–18%). At the same time, however, there is a considerable number of toothless females or 10–54%, while toothless males only amount to 0–5.5%. By December 67–87% of the males have acquired new teeth — mostly new loose teeth (n. l.) or 52–65% — whilst 90–97% of the females have new teeth but mainly firm (n. f.) or 49–78% (Table 2).

Thus apparently the tooth exchange occurs from September until December or even early January. In short, old teeth, worn by the 'hard-shelled' diet of molluscs, crustaceans and echinoderms, start to loosen in early September and are replaced by a new set of teeth, after the catfish has passed through an intermediate toothless period. Initially the

TABLE 2

A lupus. Tooth exchange off Vestfirðir and Látragrunn Sept. – Dec. 1972–1975

Month	1972						1973			
	Vestfj. IX–X		Vestfj. XI		Vestfj. XII		Vestfj. IX–X		Vestfj.–Látragr. XII	
N	183	36	101	113	145	159	109	39	618	626
o. f.	86.9	52.8	64.4	57.5	6.9	4.4	65.1	17.9	12.5	5.0
o. l.	12.6	8.3	15.8	7.1	3.4	0.6	24.8	17.9	1.5	0.2
t. l.	0.0	30.6	3.0	5.3	24.8	5.0	5.5	53.8	13.4	2.1
n. l.	0.5	8.3	14.9	27.4	50.3	15.7	3.0	7.7	60.0	44.1
n. f.	0.0	0.0	2.0	2.7	14.5	74.2	1.6	2.6	12.6	48.7
	100.0	100.0	100.1	100.0	99.9	99.9	100.0	99.9	100.0	100.1

Month	1974				1975			
	Vestfj. IX–X		Vestfj.–Látragr. XII		Látragr. X		Látragr.–Víkuráll XII	
N	386	148	334	404	200	83	255	368
o. f.	38.9	32.6	5.1	1.2	67.3	8.4	20.0	3.0
o. l.	19.2	8.3	0.0	0.2	18.4	2.4	2.0	0.0
t. l.	5.7	9.7	8.1	1.2	12.0	12.0	6.7	0.0
n. l.	0.0	2.8	57.5	19.3	2.0	73.5	65.5	30.2
n. f.	36.3	46.5	29.3	78.0	0.4	3.6	5.9	66.8
	100.1	99.9	100.0	99.9	100.1	99.9	100.1	100.0

new teeth are loose and of little use, surrounded by a soft and delicate gum. At this stage this hardy species is truly in a poorly state. This condition does not last very long, since already in December many individuals, especially females, have got new firm teeth, although there may be some variations according to areas or even years.

The tooth exchange occurs equally amongst young and old catfish and impedes greatly their feeding ability. Thus the catfish undergo a period of fasting from the time the old teeth start loosening until the new set has become firmly embedded.

FOOD

Along with studies on the teeth condition of catfish at Iceland, stomach and intestine contents have been examined. These investigations have been mostly qualitative as to the species or groups of animals taken as food, but to a lesser extent quantitative although the amount of food eaten has been noted.

Not unexpectedly, the study has revealed that the food taken depends on various aspects such as time of the year, area and size and age of the fish. During the spawning season and the tooth exchange period no food is taken as previously mentioned. Already by September most individuals, males and females alike, have an empty stomach and intestines, this condition lasting till December or even January. In October and November 60–95% of the catfish studied had completely empty stomachs and intestines, reaching 94–95% in December.

Before the catfish begins fasting it is normally fat, but by the end of the non-eating period it has become thin and is in a poor condition.

In January and February the teeth have become firm and the catfish turns into a voracious feeder. By this time it has left the spawning grounds and initiated its migration to shallower grounds, e. g. at Vestfirðir.

The main diet of the catfish consists of echinoderms *(Echinodermata)*, molluscs *(Mollusca)* and crustaceans *(Crustacea)*. Sæmundsson (1926) mentions the following as food of catfish: hermit crabs, spider crabs, whelks, sea-urchins and particularly various lamellibranchs ranging from small tellins to large ocean quahogs. Furthermore, the same author (1949) adds sandeels to the list of catfish food. In a table by Barsukov (1959/1972), comparing the food of the jelly-cat, the spotted catfish, the catfish and the White Sea catfish *(A. lupus maris albi)* it is shown that out of the 85 *A. lupus* investigated 72% of the stomachs contained molluscs, 62% crustaceans, 37% echinoderms, 8% fish species, 13% other organisms and 2% trawl refuse. Largely, however, the diet depends on the food available and the size of the fish. Various parts of the Látragrunn and southern Vestfirðir grounds are densely populated by sea-urchins. Hence catfish stomachs from these areas contain a high proportion of these animals. Horse mussels *(Modiolus modiolus)* are very common off northern Vestfirðir and consequently catfish caught in that area from March to early summer are filled with mussels and nothing else. Off Ísafjarðardjúp catfish stomachs predominately contain brittle stars, and in southern Faxaflói as well as in Skjálfandi the ocean quahog *(Arctica islandica)* dominates the menu of at least the larger fish. Morover, the catfish prey upon various species of fish when available (e. g. capelin, Norway pout and redfish fry).

Small catfish of 40 cm and less appear to subsist mostly on brittle stars, small bivalves and small gastropods. Fish of 41–60 cm length appear to concentrate more on polychaetes, sea-urchins and larger bivalves such as horse mussels and ocean quahogs, whereas catfish larger than 61 cm forage mostly on sea-urchins, horse mussels, ocean quahogs and fish species.

Thus from the middle of January to late August or even mid-September, the stomachs of catfish are generally filled with food, whereas from the middle of September to late December or early January they are mostly empty.

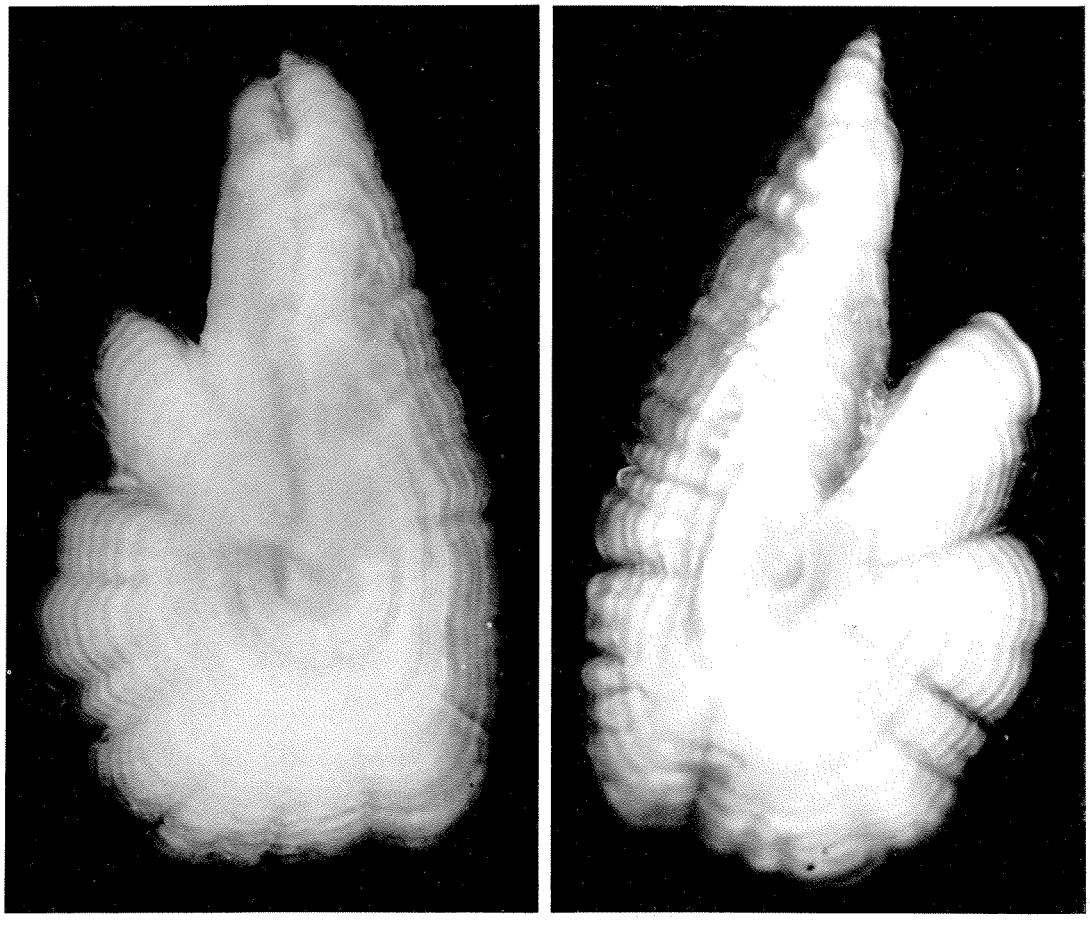

Fig. 10. Otoliths of A. lupus showing the summer and winter zones. (Photo: Halldór Dagsson).

GROWTH AND AGE DETERMINATIONS

Catfish at Iceland have been age determined solely by means of the otoliths. Other methods have not been favoured. Thus scale reading is not feasible owing to the smallness of the scales and much additional work is required for vertebral annuli counts.

The otoliths are firstly bathed in xylol or glycerine, thus rendering the growth zones more discernible. Afterwards the otolith is read under a descending light with a 9× or 12× binocular microscope. In this manner the annuli become clearly visible with summer zones showing up as opaque white and winter zones as translucent blue (Fig. 10).

When age determination of catfish is being made, the innermost rings (the first 2 years) sometimes prove difficult to read due to the thickness of the otoliths. This can be remedied, however, by thinning them down rendering these rings more discernible. Pseudo-rings or "false checks" often may pose some dif-

ficulty, especially in older fish, but an experienced worker can in most cases distinguish quite easily between "false checks" and winter and summer annuli. As the rings become closer together with age, it is often difficult, however, to distinguish one ring from the next in individuals of 20 years and older.

Catfish otoliths are very small. Beese and Kändler (1969) mention the following relation between size of otoliths and length of fish.

Length of fish	1 cm	—	otolith 1.3 mm
— - -	103 -	—	— 5.2 —

According to the present studies, the size of the otoliths varies with fish length as follows:

Length of fish	15 cm	—	age	2 years	—	otolith	2.0 mm
— - —	70 -		-	10 —		—	4.0 -
— - —	94 -		-	14 —		—	6.0 -
— - —	104 -		-	22 —		—	6.2 —

In fact catfish otoliths grow relatively thicker than longer with age, making them increasingly difficult to read. Crystallized otoliths also appear to be very common in catfish and are nearly impossible to read with any accuracy.

Otoliths were sampled from 11,261 catfish during the years 1970–1976 of which males numbered 6,054 (53.8%) and females 5,207 (46.2%). The fish were mostly caught in March–April and September–December off Vestfirðir and on outer Látragrunn. The sampling gear was bottom trawl apart from a few samples which were obtained from commercial catch by long-liners off Vestfirðir.

The material consists of fish ranging

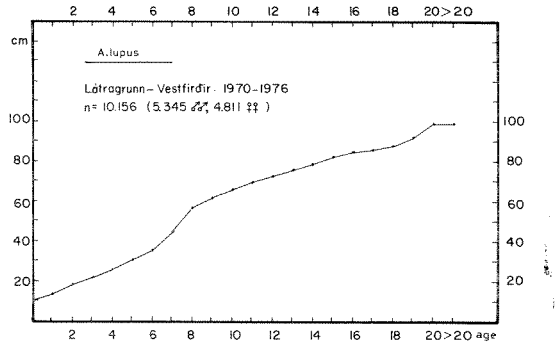

Fig. 11. The relation between age and length of A. lupus.

from 0–22 years of age. The oldest catfish known to have been caught at Iceland was, however, 24 years of age.

January 1 is taken as the catfishes' birthday.

During the first year growth is about 10–11 cm after which the growth rate slows down. From the age of 6 to 8 there is a small increase in the growth rate which then decreases again (Fig. 11). Average annual growth up the age of 18 years is 4.4 cm

1) Age and length

The largest catfish recorded from Icelandic waters measured 116 cm. It was caught by a research vessel on Bollasvið (64°08'N 22°22'W) in late May 1963. The age and sex of that particular catfish were not recorded. However, it was most certainly a male as they grow to a bigger size and females of this length are unheard of. Females have already be-

TABLE 3

A. lupus. *Age and length (cm) in the Northern Atlantic. (In brackets: Numbers examined)*

Age years	*Icel. grounds 1970–1975*		*Barents Sea (Barsukov '59)*		*North Sea Norway, Iceland (Beese & Kändler '69)*		*Greenland+ Barents Sea (Beese & Kändler '69)*	
0	10.5	(6)	10.1	(5)				
1	13.6	(94)	13.6	(13)				
2	18.0	(330)	17.4	(20)				
3	21.9	(471)	23.5	(14)				
4	25.8	(534)	28.7	(12)	24.0	(12)	21.8	(8)
5	30.8	(344)	42.8	(14)	26.4	(14)	24.2	(13)
6	35.6	(274)	48.6	(17)	34.7	(22)	28.6	(17)
7	44.9	(338)	59.4	(21)	38.4	(32)	36.7	(79)
8	56.8	(789)	66.4	(23)	45.7	(36)	42.4	(21)
9	61.7	(1417)	66.3	(7)	49.6	(32)	45.5	(22)
10	65.9	(1606)	71.8	(8)	54.4	(32)	48.6	(14)
11	69.6	(1321)			60.6	(29)	55.7	(6)
12	72.1	(969)			65.4	(24)	56.9	(14)
13	75.2	(634)			68.1	(22)	62.9	(7)
14	78.6	(385)			74.1	(10)	67.1	(8)
15	82.0	(229)			78.2	(17)	70.0	(4)
16	84.4	(170)			84.3	(4)	71.5	(4)
17	85.5	(105)			85.2	(3)	77.0	(2)
18	87.8	(64)			93.1	(7)	80.0	(1)
19	91.5	(32)			93.0	(3)		
20	98.4	(23)			96.7	(3)		
20	98.5	(21)						
		(10,156)		(154)		(304)		(160)

come rare amongst catfish over 90 cm in length and only one female over 100 cm long has been recorded so far. In December 1975 a 114 cm long catfish was caught at Iceland, being the second largest individual recorded.

Sæmundsson (1926) mentions that the catfish catch is normally comprised of fish ranging from 60–110 cm in length (weighing 2.5–15 kg) although they can reach 120 cm or more. Barsukov (1959/1972) states: "The length is up to 120–125 cm." Ehrenbaum (1936) mentions that a 120 cm catfish weighs 22.5 kg (50 lbs). Bigelow and Schroeder (1953) state: "A length of 5 feet seems about the maximum in Gulf of Maine waters; one more than 4 feet long is seldom seen, and the larger fish caught and brought in seem less than 3 feet." The largest catfish caught off Sweden was 116 cm (Malm, 1877) and in the Barents Sea 115 cm (Barsukov 1959/1972).

Males grow more rapidly than females. The difference in growth rate becomes discernible already amongst 2

year old fish although not obvious until 12 years of age. Males also live longer than females the latter rarely exceeding 18 years of age.

Table 3 compares the age of catfish at Iceland (Vestfirðir banks and Látragrunn during 1970–75), in the Barents Sea (Sahkno from Barsukov 1959/1972), the North Sea, Norway coast and Iceland (Beese and Kändler 1969) and from Greenland and the Barents Sea (Beese and Kändler loc. cit). The samples vary greatly in size, the largest by far consisting of 10,156 fish being from Iceland as against the others of 154, 304 and 160 individuals respectively. A marked difference is seen between areas. Growth appears to be most rapid in the Barents Sea and slowest in combined samples from Greenland and the Barents Sea. Thus a 10 year old catfish from Icelandic waters is of similar size as an 8 year old from the Barents Sea. On the other hand the Icelandic catfish are considerably larger than those of the combined material from the North Sea, Norway coast and Iceland (Beese and Kändler 1969).

In comparing the age and length composition of catfish from Látragrunn and East Greenland waters in September 1976 (Fig. 12), the Icelandic catfish are seen to grow much faster than those from Greenland. It is noteworthy that in both areas 9–12 year old fish predominate (Fig. 13).

No year-class appears to be especially strong or dominating when comparing the age distribution during the period 1970–1976 (Fig. 14). The majority of

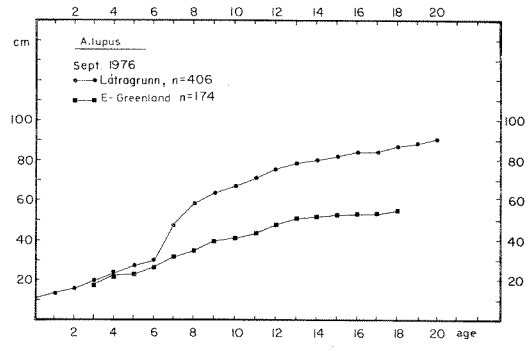

Fig. 12. The relation between age and length of A. lupus at Látragrunn (W-Iceland) and at E-Greenland.

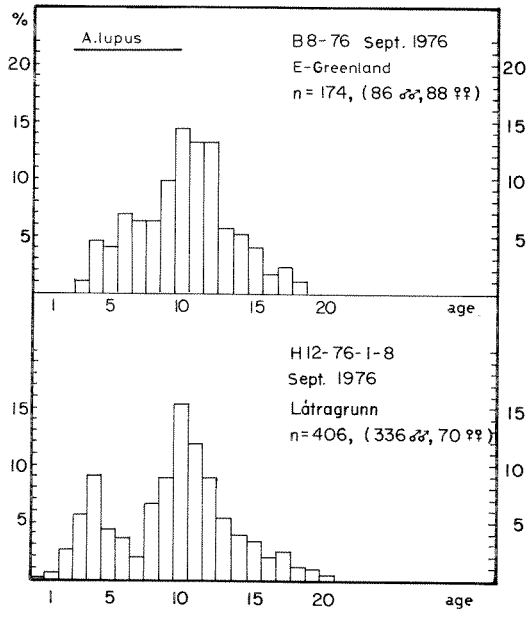

Fig. 13. A comparison of the age distribution of A. lupus at Iceland and Greenland.

the fish sampled every year are 9–13 years of age.

At present the maximum length of catfish is considered to be about 120 cm, although it is possible that larger catfish were caught many years ago (Sæmundsson, 1926). Regular length measure-

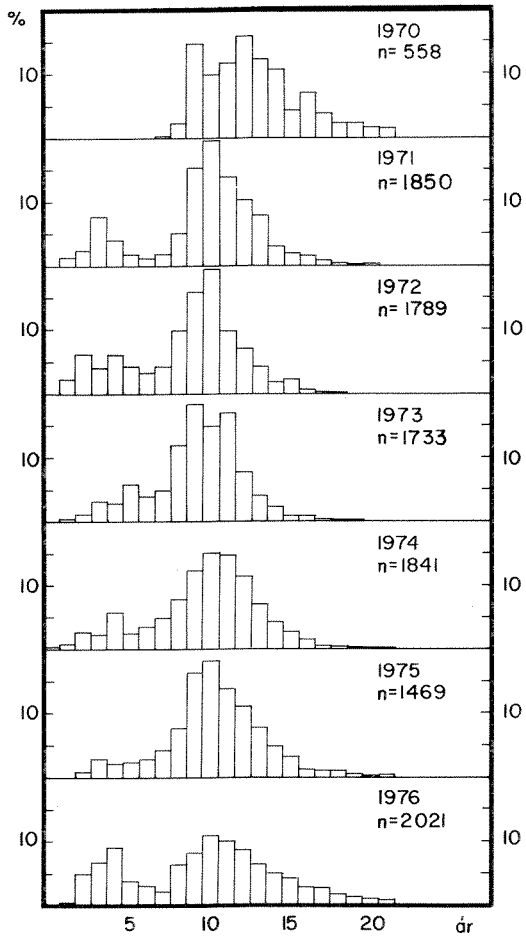

Fig. 14. A. lupus. Comparison of the age distribution during 1970–1976 on Látragrunn and Vestfirðir grounds.

ments of catfish at Iceland date back to 1954. The length data (including otolith and tagging samples) are comprised of 26,363 individual fish of which 7.3% are 91–100 cm in length and 1.4% are 101 cm and longer, totalling 8.7% which are 91 cm and longer. The number of large catfish has greatly decreased in recent years. Table 4 shows as an example the proportion of large catfish in the catch during 1954–1965 as compared to 1966–1976.

TABLE 4

The proportion of large catfish in the catch during 1954–1965 as compared to 1966–1975.

	91–100 cm	*>101 cm*	*>90 cm*
1954–1965	21.4%	4.1%	25.5%
1966–1975	2.6%	0.5%	3.1%
1954–1975	7.3%	1.4%	8.7%

Although the percentages are not altogether comparable, due to the research ships using a covered cod end occasionally since 1971, thus increasing the proportion of smaller fish in the catch, there is still no denying the decreasing percentage of larger fish both in research and commercial catches. At present large old catfish are rare. They are, however, sometimes caught in Faxaflói in the spring, especially in the shallow waters of Garðsjór where they appear to be feeding on sea-urchins and ocean quahogs which are the favorite food of large and old catfish.

2) Age and weight

In order to obtain some information on the length/weight relationship of catfish, 274 and 376 individuals from Vestfirðir grounds were measured and weighed in October 1975 and March–April 1976 respectively. At the same time otoliths were sampled and maturity stages, stomach and intestine contents and condition of teeth investigated. The fish were weighed both ungutted and gutted. The length/weight and age/

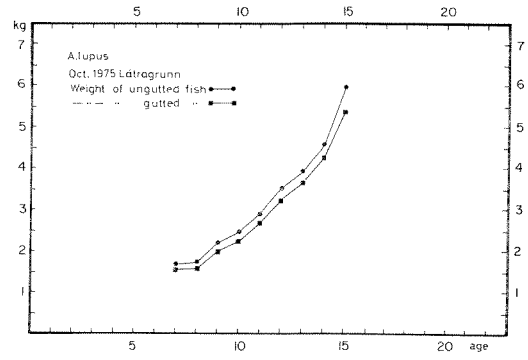

Fig. 15. Weight as a function of age of gutted and ungutted A. lupus from October 1975.

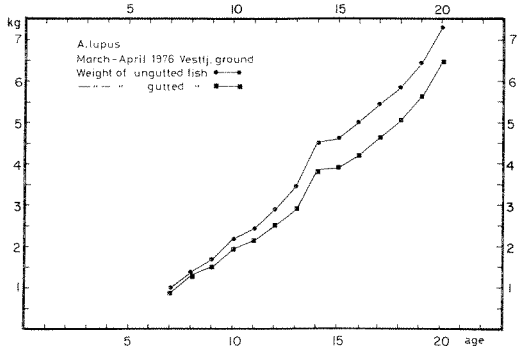

Fig. 16. Weight as a function of age of gutted and ungutted A. lupus from March/April 1976.

weight relationships are shown in Figs. 15 and 16.

The samples were composed of 7–17 years old fish in October 1975 and 7–20 years old or more in March–April 1976. However, due to the small number of fish, the data are limited with regard to age groups 7–8 and 14 and more in the October sample and age groups 7–8 in the March–April sample.

As the fasting period has begun in October due to the spawning and teeth rejuvenation, there is little difference in the weight of ungutted and gutted fish at that time. However, in March–April the catfish have started feeding again and a much greater difference is observed in the two weights.

By comparing the average weight of each year class in October to that of March–April the following year the increase in weight during the period can be observed.

The weight increase of gutted catfish is very small during this period or 30 g for 9–10 year old fish and 17 g for fish of 10–11 years. Most likely growth is largely checked during the months from September to January or February, as little or no food is eaten during the spawning season and the teeth renewal period.

CATFISH X SPOTTED CATFISH

Lühmann (1954) noticed that in the catfish catch landed in Kiel, W-Germany, there were individuals that resembled a blend of catfish and spotted catfish in colour, shape of head and teeth, apart from the tooth exchange apparently being deranged. These fish had been caught off the West and Northwest coast of Iceland whereas no such individuals appeared in catches from the grounds off Northeast Iceland. Lühmann considered these to be hybrids of catfish and spotted catfish, most likely between catfish males and spotted catfish females rather than the other way around. This is not an annual phenomenon, but only takes place when conditions are favourable and where the spawning grounds of the two species overlap. Possibly the spotted catfish

males are too few and far apart to fertilize the spotted catfish eggs. These hybrids are said to have a closer resemblance to the spotted catfish, both in colour and especially in teeth, although intermediate between the two species in appearance, shape and strength of jaws.

Barsukov (1959/1972) mentioned the possibility of such hybridization and gave an example of an individual of 111.5 cm in length, caught in the Barents Sea (pos. 70°28'N and 32°05'E) in May 1951. However, he considered that the effect of a disease is a more likely reason than hybridization.

In samples from Icelandic grounds that have been investigated during the course of this study only three individuals have been observed resembling a hybrid of catfish and spotted catfish. Despite their atypical teeth and the arrangement of spots in the manner of the transverse stripes of catfish, a closer investigation revealed without a doubt that these belonged to the species *A. minor*. The otoliths were identical to those of spotted catfish and the maturity stage of the ovaries — all three were females — was the same as that of other spotted catfish in the area and quite different from the maturity stage of catfish caught at the same time. Furthermore, the three fish in question appeared to be thin and were therefore possibly diseased. The occurrence of hybrids between catfish and spotted catfish is therefore considered unlikely.

PARASITES

The catfish like other fish species, is infected by various parasites. Barsukov (1959/1972), quoting Polyanskii (1955), mentions 19 species of endo- and ecto-parasites in catfish in the Barents Sea, apart from microbes on teeth. Most species belong to the class of trematodes (flukes).

Although no special effort has been directed at catfish parasites it was unavoidable to notice some parasites that infect catfish to a different degree during the course of this study.

The most noticeable ecto-parasite is a leech that attacks the area behind the pectoral fin but also other areas. The size of these leeches was about 5–20 mm, and they probably belong to the species *Platybdella anarhichae* Diesing, which can reach a size of 3 cm. It has been recorded on catfish from Látragrunn and Vestfirðir grounds as well as on catfish in the Vestmannaeyjar aquarium. A large egg mass was found in the skin of the caudal peduncle of a catfish in the aquarium, the eggs being 0.3–0.6 mm in diameter. The eggs are thought to have been those of *Platybdella*.

Endoparasites such as nematodes are not so common in catfish as in many other fish species such as the cod. Nematodes are especially found in the alimentary system of catfish but rarely in the muscles. According to Kreis (1958), the nematode *Contracaecum aduncum* (Rudolphi, 1802) Baylin 1920, has been found both in the stomach and the small intestines of catfish.

In December 1975, a tapeworm larva (Pleurocercoid larva of the Tryphanorhynchus type) of the specis *Hepatoxylon trichiuri,* was found in the small intestine of a female catfish caught on Látragrunn, but this species reaches maturity in the digestive tract of various elasmobranchs.[1]

Finally a protozoan parasite of the class *Sporozoa* should be mentioned as it may adversely affect the catfish as a market product. This parasite infects the muscles of the catfish appearing like discontinuous veins and infected fish go by the name 'hairy catfish'. Schäperklaus (1954) referring to A. Meyer, denotes that in the year 1952 sometimes as much as 10% of the landed catfish catch from west Icelandic grounds were inedible due to disagreeable appearance resulting from this sporozoan infection.

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[1] The larva was identified by the biologist Jónbjörn Pálsson.

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