Evidence of Cod (*Gadus morhua* L.) Migrations from the Norway Coast to the Faroese Islands

By

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During routine examination of otoliths from cod caught by the F.R.S. "Explorer" off the Faroe Islands two pairs of otoliths were found that had a structural pattern differing considerably from that typical of Faroese cod but strongly resembling that of Arcto-Norwegian cod. In particular the nuclei of the atypical otoliths were fairly uniform in structure without pronounced splits. The second and third opaque zones showed some splits. These were fewer and less pronounced than those of Faroese cod otoliths in which these splits make it difficult to distinguish the winter hyaline zones with certainty (Plate I).

The fish from which these otoliths were taken were considerably larger than any other specimens sampled for age determination, being 121 cm and 118 cm total length compared with a maximum of 109 cm among fish with typical Faroe otoliths. Growth curves calculated from the two pairs of otoliths and from typical Faroese and Arcto-Norwegian otoliths show that the two atypical fish have a growth-rate similar to that of Arcto-Norwegian cod (Fig. 1). A linear relationship between fish length and otolith growth has been assumed.

It is therefore considered that these two atypical cod were derived from the Arcto-Norwegian stock. There is no record of a tagged cod from the Arcto-Norwegian stock being caught at the Faroe Islands, despite the large number of fish tagged and the intensive fishing off the Faroes, which suggests that there is no substantial movement between the two areas.

Long distance movements of cod between different sea areas are well known, fish tagged at Iceland having been recaptured off the Norwegian coast (JÓNSSON, 1953) and off the Faroes (TÅNING, 1937), and cod tagged off Bear Island from the R.V. "Ernest Holt" being caught off Greenland and off Iceland (unpublished data).

There are two possible ways in which these movements could occur. Either there is an orientated movement directly between the two areas, for the most part against the prevailing currents, or there is an unorientated drift in the anti-clockwise current gyral in the Greenland Sea.

A direct movement from the Norwegian coast to the Faroes would entail the fish swimming across water deeper than 1000 fathoms, and in order to orientate themselves it would be necessary for the fish to swim in contact with or in sight of the bottom unless there is orientation to the sun. Cod have been

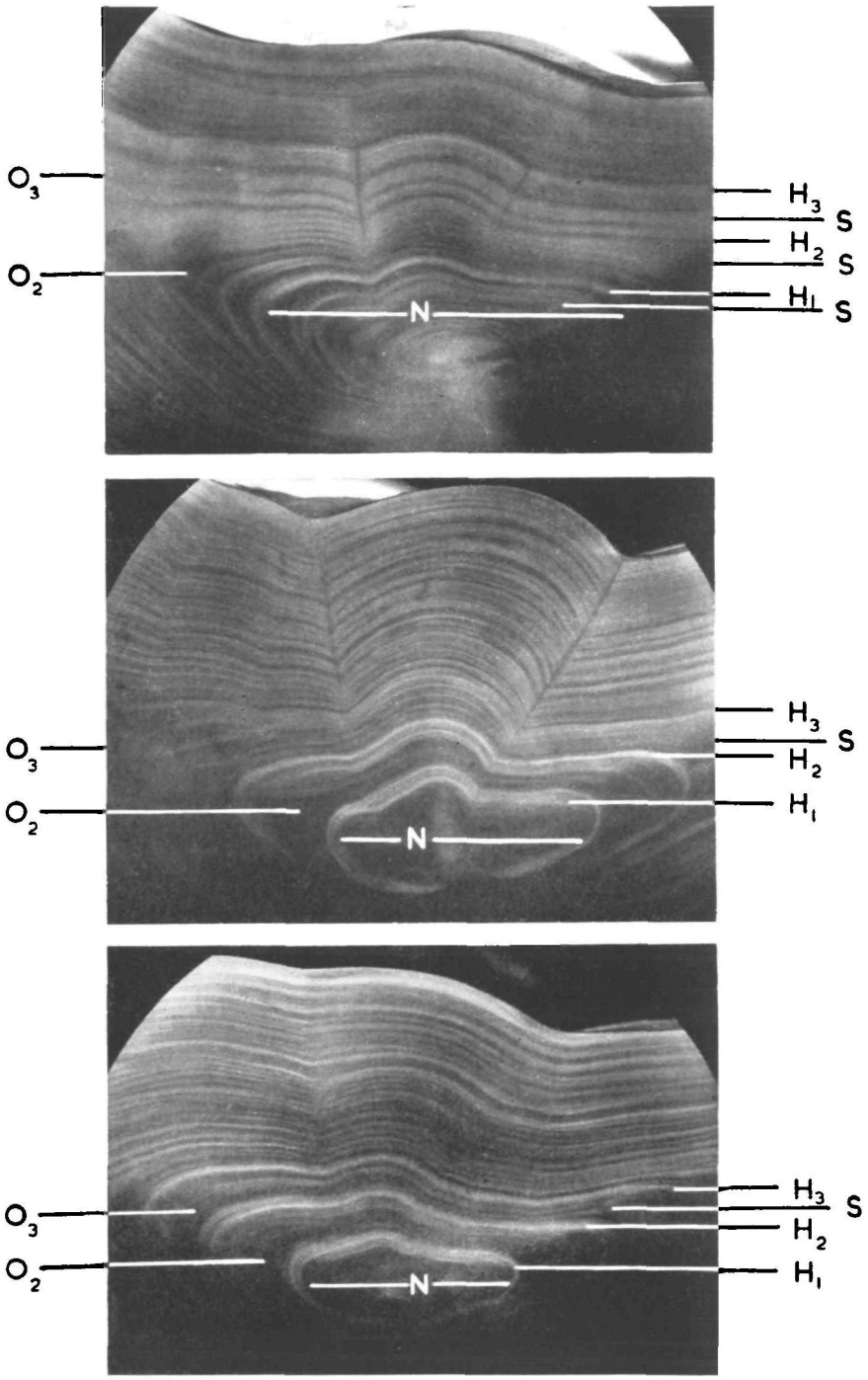

Plate 1. Typical Faroese (top) and Arcto-Norwegian (bottom) cod otoliths with atypical cod otolith (centre). (N = nucleus, O = opaque zone, H = hyaline zone, S = splits: suffixes denote years.)

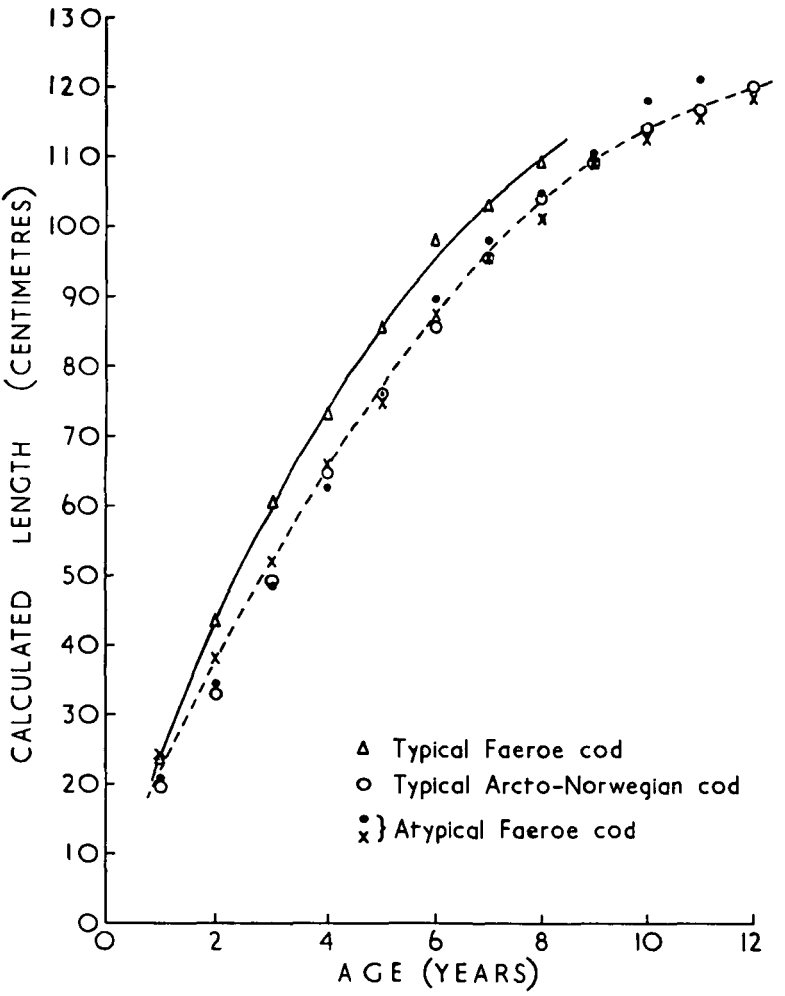

Figure 1. Growth-rates calculated from otoliths (linear relationship assumed). Rates for typical Faroese and Arcto-Norwegian cod taken from the otoliths illustrated in Plate 1.

caught in this area, but only on long-lines and not in a trawl (JENSEN, 1905), indicating that they are swimming not demersally but pelagically, in which state they would be unable to orientate themselves to the current and would drift with it. There is considerable evidence that such movements are a passive drift in the currents. TÅNING (1937) quotes four cases in which the time taken for cod to move between two areas closely approximated to that taken by drift bottles.

The main current in the Greenland Sea is the Atlantic Current, which flows from the Faroe-Shetland Channel along the Norwegian coast. This gives rise to the West Spitsbergen Current, an offshoot of which turns west from Spitsbergen to eventually flow under the East Greenland Current, some of which

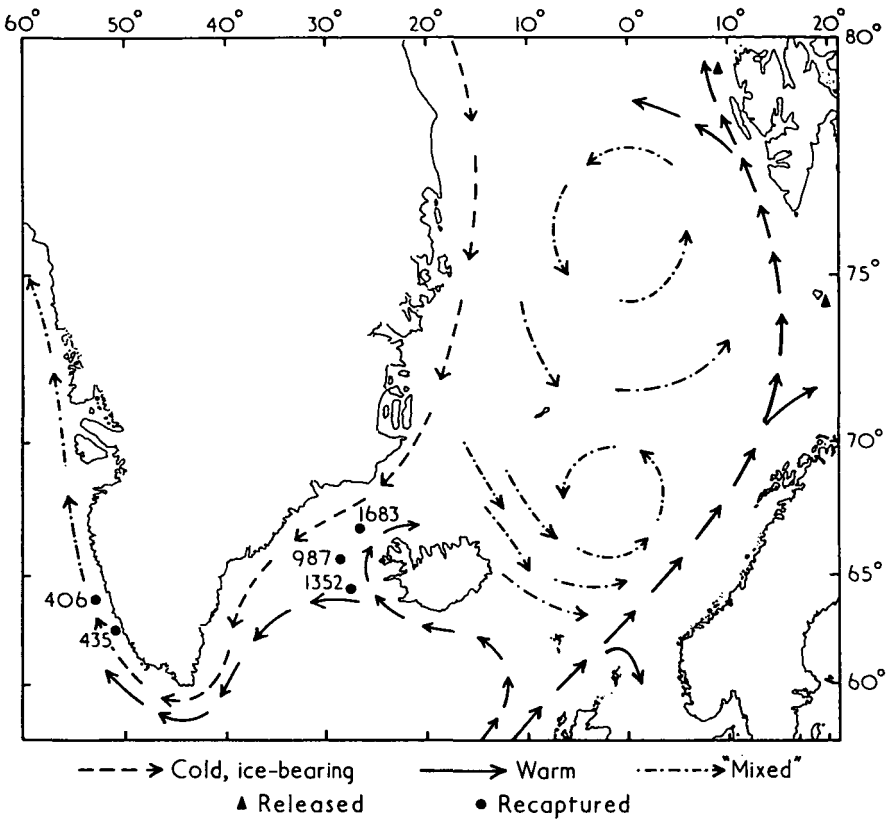

Figure 2. Greenland Sea, showing main currents and positions of recapture of tagged cod, together with number of days at liberty.

turns south-east to join the East Icelandic Current, the remainder flowing round Cape Farewell to form part of the West Greenland Current. Between the West Spitsbergen, East Greenland, and East Icelandic Currents are a series of eddies of "mixed" water (Fig. 2.).

Returns from tagging carried out from the R.V. "Ernest Holt" show that there is some movement of cod from Bear Island and West Spitsbergen to Greenland and Iceland. The number of days at liberty, 406 and 435 days for two recaptures off West Greenland and 987, 1,352, and 1,683 for three recaptures between East Greenland and north-west Iceland indicates that this movement is first to West Greenland, in the East Greenland Current, and then to Iceland, against the Irminger Current. The lack of returns outside this area suggests that these cod remain with the Icelandic-Greenland stock and do not migrate further to reach the Faroes.

Therefore fish that reach the Faroes must either leave the East Greenland Current or remain in the eddies of "mixed" water, in either case eventually joining the East Icelandic Current. The lack of recaptures of cod tagged from the Arcto-Norwegian stock at the Faroes and their presence at Greenland suggests that fish joining the East Greenland Current are always carried by it

to Greenland and that fish reaching the Faroes do so in the eddies between the main current systems, the final migratory path only being in the East Icelandic Current. Cod tagged at Jan Mayen have been recaptured off Iceland (IVERSEN, 1934), and JENSEN (1905) fishing in the Greenland Sea trawled up several gadoid otoliths, including one cod otolith. These were found most frequently at the stations between Jan Mayen, north-east Iceland, and the Faroes, and were assumed to have come from pelagically swimming cod that had died and which would have been swimming in the East Icelandic Current. DEVOLD (1952) suggests that part, at least, of the Atlanto-Scandian herring stock follows this route.

Summary

1. Two pairs of otoliths from cod caught at the Faroes were found to have a structure similar to that of Arcto-Norwegian cod otoliths and dissimilar to that of Faroese cod otoliths. It is concluded that the fish originated from the Arcto-Norwegian stock.

2. The path of movement between the two regions is discussed. It is shown that it most probably lies in the anti-clockwise current gyral in the Greenland Sea and that there is a drift with the currents from Spitsbergen via Jan Mayen and north-east Iceland to the Faroes.

References

DEVOLD, F., 1952. "A contribution to the study of the migrations of the Atlanto-Scandian herring". Rapp. Cons. Explor. Mer, **131**: 103–07.

IVERSEN, T., 1934. "Some observations on cod in northern waters. Preliminary report." Fiskeridir. Skr. Havundersøk., **4** (8).

JENSEN, A. S., 1905. "On fish-otoliths in the bottom-deposits of the sea. I. Otoliths of the Gadus-species deposited in the Polar Deep." Medd. Komm. Havunders. Fisk., Kbh., **1** (7).

JÓNSSON, J., 1953. "Migrations of cod from Iceland to Norwegian waters." Ann. biol., Copenhague, **9**: 41–43.

TÅNING, A. V., 1937. "Some features in the migration of cod." J. Cons. int. Explor. Mer, **12**: 3–35.