Genetic activities on fish in the Faroe Islands

Genetic Workshop held in Øregrund, Sweden 25-27 September 2006

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Tøknifráreiðing/Technical Report
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Genetic investigation on fish species caught in Faroese territory has been carried out since 1965, when Sick (1965) also included cod from the Faroe Plateau in his pioneering genetic analysis on haemoglobin polymorphism in cod in the North Atlantic. Since then, a lot of genetic analyses have been conducted based on samples collected from fish in Faroese waters, but we have never had the necessary facilities (manpower or equipment) for conducting these analyses ourselves. However, during the last couple of years, the Food- Veterinary and Environmental agency has acquired facilities for DNA-analysis, but this has mainly been used for diagnostic purposes in the aquaculture and food industry.

Back in 1993, I finished my biology study at the University of Copenhagen with a master thesis on “Why is the cod growing faster on the Faroe Bank than on the Faroe Plateau? Growth experiments and genetics investigations of cod from the two areas” (Magnussen 1993), which later was published in two ICES papers (Magnussen 1996; Fjallstein & Magnussen 1996). During the last decade, most of my genetic activities on fish have been in collecting samples, which then, in cooperation with other scientists, have been analysed in laboratories in other countries.

Genetic analysis of fish caught in Faroese territory

Geographically isolated and located in the middle of the North Atlantic, fish species around the Faroe Islands have in many cases evolved a special character, which makes them different from species in other areas. Additionally, differences have also been found between fish living on the Faroe Plateau and Faroe Bank ecosystems. I will here give a review of the main genetic results on Faroese fish of different species.

Cod: Most of the genetic analyses on marine fishes have been performed on cod. Analysis of haemoglobin (Sick 1965) showed a significant difference in the HEM-1 allele frequency for cod on the western and eastern sides of the North Atlantic. On the Faroe Plateau the allele frequency was 0.06, in Iceland and Greenland between 0.01 and 0.02, whereas in the North Sea and west of Scotland it was between 0.5 and 0.7. The low HEM-1 allele frequency for the Faroe Plateau cod has later been confirmed, first by Jamieson & Birley (1989a), then by Magnussen (1996).

The Faroe Islands support two distinct cod stocks: the Faroe Bank stock and Faroe Plateau stock. The Faroe Bank stock is smaller and accounts for approximately 10% of the stock on the Faroe Plateau. The water temperature on the Bank is 1 to 2º C warmer than on the Plateau. Investigation by Jamieson & Jones (1967) on transferrin showed a significant difference between the Faroe Bank and the Faroe Plateau cod. This difference was also established by Joensen et al. (2000) using chemometry of fatty acid
composition in the heart-tissue of reared Faroe Bank and Faroe Plateau cod. However, these differences are in conflict with the genetic results found by Magnussen (1996) and Jamieson & Thompson (1972), which both show indistinguishable allele frequencies between Faroe Bank and Faroe Plateau cod in the haemoglobin, nine muscle enzymes and in the butyric serum esterase.

However, on the Faroe Bank the HEM-1 allele frequency was found to be a little higher than on the Faroe Plateau (0.08 versus 0.06) (Magnussen 1996). It is well known that the HEM-1 allele frequency increases with temperature. The higher HEM-1 allele frequency found for the cod on the Faroe Bank is thus consistent with the higher water temperature on the bank.

In spite of the correlation between HEM allele frequencies and the water temperature, the big difference between HEM allele frequencies on the eastern and western side of the Shetland Channel (0.6-0.7 versus 0.06) can not be explained by the water temperature alone.

A linear regression based on HEM allele frequencies and water temperature (T) given in Karpov & Novikov (1980) gave the following relationship:

\[
\text{HEM-1 allele frequency} = 0.06579 \times T - 0.12565, \quad r = 0.90
\]

Based on this equation, the allele frequency for cod around the Faroes should be on the order of 0.4, which is much higher than the observed values (0.06-0.08). When these low allele frequencies exist in all cod populations on the western side of the North Atlantic, there are probably also other selection mechanisms than temperature operating on haemoglobin.

During the last decade, analyses based on DNA-techniques have also been performed on Faroese fish. Dahle et al. (1995) showed substantial genetic differentiation between the Faroe Bank cod and three cod populations in northern Norway. In a forthcoming paper by Nielsen et al. on eight cod populations in the eastern part of the North Atlantic, it is concluded that “(i) The Faeroe populations are the relatively most divergent, probably reflecting their geographical isolation and (ii) there is clear evidence of divergent populations at the Faeroe Plateau and the Faeroe Bank”. No spatial genetic variation has so far been found within the Faroese cod populations. Analyses on mitochondrial cytochrom b on cod, collected from five localities on the Faroe Plateau, have shown no variation among areas (Sigurgislason & Arnason 2003).

**Other marine fish species**

Using microsatellites and mitochondrial DNA on plaice (*Pleuronectes platessa*), Hoarau et al. (2004) found a significant differentiation between the continental shelf populations and plaice from Iceland and the Faroe Plateau, which also were those with lowest genetic diversity. Analyses on single locus minisatellite and on allozymes suggest reproductively isolated population of poor cod (*Trisopterus minutus minutus*) for the Faroe Bank population (Mattiangeli et al. 2000; Mattiangeli et al. 2002).

Based on meristic and morphological methods, redfish populations (*Sebastes marinus* and *S. mentella*) in the North Atlantic have been separated (Reinert & Lastein 1992), but this separation could not be confirmed genetically (Nedreaas & Nævdal 1991).
However, in chemometry analyses of the fatty acid profile in heart-tissue of *Sebastes mentella* in the North Atlantic performed by Joensen & Grahl-Nielsen (2004) it was concluded that there is: (i) a clear distinction between *S. mentella* on the Faroe Plateau and *S. mentella* in the deeps south-west of the Faroe Bank and on the Wyville Thomson Ridge; (ii) a relationship between *S. mentella* inhabiting the Faroe Plateau and the Norwegian Sea; and (iii) two significantly distinct stocks of *S. mentella* dwelling on the Icelandic Plateau.

Although genetic differences have been identified for some of the fish species around the Faroe Islands, many of them appear to be genetically equal with fish in the surrounding areas. Lush (1970) found no difference in LDH frequencies in *saithe* (*Pollachius virens*) around the Faroes, Iceland, and the area west of Scotland. Fevolden & Haug (1988) analysed isoenzymes in *halibut* (*Hippoglossus hippoglossus*) caught around the Faroes, west Greenland and Norway, but found no differences between populations. In investigations by Jamieson & Birley (1989b), *haddock* (*Melanogrammus aeglefinus*) around the Faroes was not found to be an independent genetic population. Using enzyme electrophoresis no genetic differences could be found among *tusk* (*Brosme brosme*) from the Faroe Islands and tusk from three other localities in the North Atlantic (Johansen & Nævdal 1991). A similar genetic homogeneity was also found for the *sandeel* (*Ammodytes marinus*) among seven localities in the northeast Atlantic, including the Faroe Islands (Nævdal et al. 1996).

In addition, the Icelandic sandeel shows deviation from the other populations.

**Reference List**


