

“MACOM”

Variations in growth among families of Atlantic cod

*The Atlantic cod (*Gadus morhua* L.) is one of the major target species for the European fishing fleet. All European cod stocks are under heavy fishing pressure, or are even overexploited. An effect of this overexploitation is a reduction in the average age and size of the fish with an increasing proportion of first-time spawners in the stock. Under current fishery management, the offspring of first-time spawners (also called recruit spawners) is regarded as contributing equally well to recruitment (i.e. the amount of fish added to the exploitable stock each year) as offspring from elder spawners (or repeat spawners). This is however not the case.*

Qualitative differences among offspring produced by a spawning stock have to a large extent been neglected in fisheries science, and are rarely incorporated in predictive models of fish recruitment. But new research results have pointed out that both age structure, proportion of recruit/repeat spawners and condition factors are important when considering the possible outcome of a given spawning stock biomass.

Recruit spawners normally produce fewer eggs per unit of body weight and spawn for a shorter time during the season. They are also known to produce smaller eggs and thereby smaller larvae. Thus, there are several reasons to believe that recruit spawners might be less reproductively successful, especially since larger larvae are believed to have a competitive advantage over smaller larvae under otherwise similar environmental conditions. Large larvae are better developed in their sensory and swimming ability, making them more efficient in capturing food and avoiding predators. In addition, fast growing larvae will pass more rapidly through stages in which predation risks are high, and will thereby suffer lower cumulative mortality.

To find out **if and how this theory also affected European cod stocks and their fishery**, the **MACOM** project set the following four objectives: (1) to examine the viability of offspring from recruit (first-time) female spawners compared to offspring from repeat (elder) female spawners of Atlantic cod; (2) to examine variations in viability between offspring of individual pairs of cod; (3) to analyse the demographic structure (age-, sex- and maturity structure) of selected European cod stocks by means of historical data sets; and (4) based on the results of objectives 1, 2 and 3, to evaluate the possible effects on cod recruitment and implications for fishery management.

Growth experiments compared nearly 30 family groups of cod reared in tanks of 2500m³ and 4400m³, before being transferred to on-growing tanks at ambient seawater temperature and fed on commercial cod feeds. The parental identity of offspring was ascertained using DNA microsatellite markers. In contrast to what was expected, the offspring of the recruit female spawners was largest. In addition, there was little difference in mortality in the rearing tanks between offspring of recruit and repeat spawners. It should however be noted that in these experiments the spawners used

Project acronym:

MACOM

Full title of Project:

Demonstration of maternal effects of Atlantic cod: combining the use of unique mesocosm and novel molecular techniques.

EU contract number:

QLK5-CT-1999-01617

Web-site:

<http://macom.imr.no>

Coordinator

Dr. Terje Svaasand
Institute of Marine Research
Nordnes, Postboks 1870
5817 Bergen
Norway

Phone : +47 55 23 68 91

Fax : +47 55 23 63 79

Email : terje.svaasand@imr.no

“MACOM RESULTS INDICATED THAT SPAWNING EXPERIENCE IS NOT PER SE A MAIN PARAMETER FOR DETERMINATION AND SURVIVAL OF THE OFFSPRING, GIVEN THAT THE SIZE AND THE CONDITION OF THE BROODSTOCK ARE SIMILAR“

(recruit and repeat) were of similar sizes, and the results cannot therefore be directly compared with a natural situation. In natural populations, repeat spawners are usually larger and produce larger eggs than recruit spawners.

These results indicate that spawning experience is not per se a main parameter for determination and survival of the offspring, given that the size and the condition of the broodstock are similar. However, results did suggest that egg size might positively influence survival rates, thus giving some backup to the “bigger is better” theory.

Significant differences were found in growth traits between families. Differences in egg size and egg energy content were gradually masked by differences in the growth potential of different families: some families could hatch as the smallest larvae and grow to become the largest juveniles and vice versa. There was thus no relationship between size at hatching and length after two years. In addition, tests indicated large differences in survival ability between families: for some of the families there was parallel mortality in the recruit and repeat spawners rearing tanks.

To achieve the fourth objective, historical time series of spawning stock size and composition by sex for Northeast Arctic and Eastern

Baltic cod were compiled, and the consequences for management strategies were discussed. The results of the analysis performed on Eastern Baltic cod showed that:

- biomass is not a reliable estimator of observed egg production and recruitment;
- FSSB (female stock spawning biomass) and PEP (potential egg production) are significantly related to egg production in the field;
- accounting for the proportions of recruit and repeat spawners does not significantly improve the explanatory power of FSSB and PEP; and
- the combination of environmental variables and advanced measures of reproductive potential proved to be the most reliable predictors of recruitment success.

The relationship between spawning stock and recruitment is probably the single most important factor in defining an optimal strategy for fishery management. This relationship decides the long-term yield that can be expected at different levels of exploitation, the range of sustainable levels of exploitation and, accordingly, what exploitation rates constitute a danger of stock collapse. By analysing the historical data sets of the two cod stocks, MACOM has contributed to and improved the basis for fisheries management.