IBACS: Integrated Approach to the Biological Basis of Age Estimation in Commercially Important Fish Species

European Union Project (QQLRT-2001-01610) October 2002 – November 2005

http://ibacs.uib.es

RESEARCH TEAM

- B.MoralesNin[1,2], IMEDEA: Instituto Mediterráneo de Estudios Avanzados (CSIC/UIB), Esporles, Spain
- R.Millner[2], CEFAS: Fisheries Laboratory Lowestoft, UK
- A.Lombarte[2], CEMIMA: Centre Mediterrani d'Investigacions Marines i Ambientals Institut de Ciències del Mar (CSIC), Barcelona Spain
- H.Mosegaard [2] DIFRES: Danish Institute for Fisheries Research, Denmark
- P.Wright [2]MARLAB: Fisheries Research Services, Scottish Executive Rural Affairs Department, Aberssen,UK
- A.Geffen & A.Folkvord [2] UoB: University of Bergen, Norway
- J.Cabestany [2] UPC: Technical University of Catalunya, Barcelona,Spa

[1] Project Coordinator
[2] Team Leader

OBJECTIVE

This project is a co-operative venture to improve our understanding of the biological basis of age estimation for commercial fish species. Our objective is to integrate modelling, laboratory and field observations to provide an objective basis for interpreting the macrostructures of otoliths used for estimation of fish age.

TARGET SPECIES

Cod (*Gadus morhua*)

European hake (*Merluccius merluccius*)

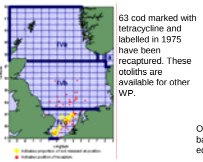
PROJECT IN PROGRESS AND RELATED TO SEVERAL CONTRIBUTIONS TO THIS SYMPOSIUM

TASK 1: Model development

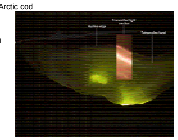
WP1: Evaluating existing otolith collections and environmental data

Institute	Specie	Area	Otolith Type		Whole	Section	Digitised	Aged	Validated	Conditions
		N.Atl.ICES	M	**R**						
CEFAS	cod	IVc	45			45	45	45	45	Tag, released and recaptured fish
	cod	IVc	2606			2606			2606	From a shallow high variable temperature zone
	cod	IVab	2767			2767			2767	Deeper water more stable environment
DIFRES	cod	Vb1, Vb2		**257**	257	257	257	257	257	Faroe Islands
UoB	cod	NCC-labA		**121**	121					
	cod	NCC-labA		**151**	151					
	cod	NCC-labB		**98**	98					
	cod	NCC&NAC-Lab juv		**2172**	2172					
	cod	NCC-pen reared		**108**	108		108			
CSIC	hake	Medwest	825		667	825	825	825		Stable Tº:13ºC

M-market; R-reared
NCC - Norwegian coastal cod; NAC - Northeast Arctic cod



63 cod marked with tetracycline and labelled in 1975 have been recaptured. These otoliths are available for other WP.



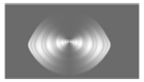
Otolith from the North Sea, showing the tetracycline band deposited before the final opaque and hyaline edge

WP2: Otolith growth model

Bioenergetic model on aragonite crystallization. A number of basic bio-energetic relationships are suggested to control the biomineralisation of otolith aragonite:

$$S_{new} = C - R_{standard} - R_{Swimming} - SDA - E$$
$$R_{standard} = D_{circ} - S_{circ}$$
$$A_{prot} = \beta \times S_{new} + \delta \times S_{circ}$$
$$A_{min} = \alpha \times R_{standard} + p \times A_{prot}$$
$$C = s_1 \times WW^{c} \times food \times (a_C + b_C \times T^{d_C})$$
$$R_{standard} = s_1 \times WW^{R} \times (a_R + b_R \times e^{d_R * T})$$
$$Opacity = (area \times A_{prot} + \lambda \times A_{min})/(A_{min})$$
$$A_{area} = f(A_{prot}; A_{min})$$

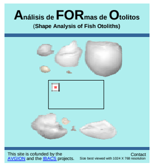
S=synthesis of protein, $_{new}$ from food and $_{circ}$ re-circulated after respiratory costs taken from D
D=degraded pool of protein
R=respiration; standard reflects costs of maintenance and swimming are related to costs of locomotion and reproduction
SDA (Standard Dynamic Action)=costs from transportation and processing of the absorbed energy.
E=excretion and defecation
A=otolith accretion, with $_{prot}$ being the production and secretion of organic parts necessary for biomineralisation of aragonite and $_{min}$ being the large mineral calcification part (with a possible dependence p of the organic part).
WW= cod mass
T= ambient temperature
Opacity of the accreted otolith layer is modelled with a specific area effect to mirror differences in growth and structure around the surface of the otolith.



First results on opacity based on the model for cod

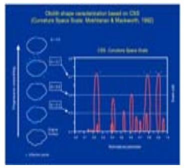
WP3: Otolith Database and Model development

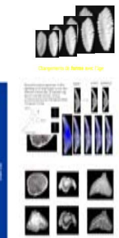
STEP 1: Otolith database



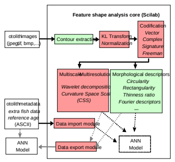
http://lea.cmima.csic.es/aforo

STEP 2: Morphological descriptors





STEP 3: Age attribution based on morphology



TASK 3: Generic model refinement

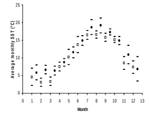
TASK 4: Development of ageing protocols and production of an accessible database and interactive web site for fisheries age estimation laboratories and fishermen's organisations

To be carried out the last year project

TASK 2: New observations from Laboratory Experiments and Field Investigations

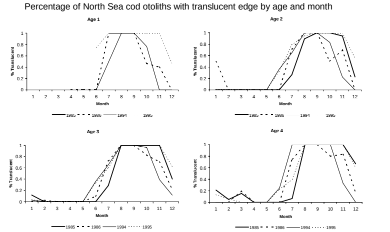
WP4: Marginal otolith Analysis

Cod otolith showing general direction and position of measurements to assess otolith increment width

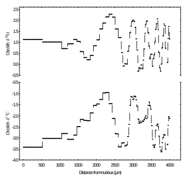


Average monthly temperature in ICES area IVc +/- one standard deviation, in years 1985 and 1995

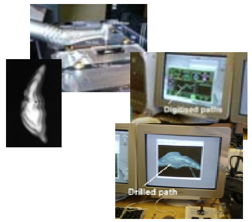
Percentage of North Sea cod otoliths with translucent edge by age and month



WP5: Oxygen isotope analysis

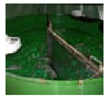


Otolith δ18O and δ13C values from a six years old cod. Samples were collected from otoliths nucleus to the edge. 15



WP6: Laboratory experiments: Long time rearing for monitoring of near natural conditions

IN PROGRESS WITH COD



SHORT TERM: different feeding regimes

LONG TERM: seasonal impact

WP7: Short term experimentation

To test model development

Figure 2 – Section of otolith from cod 4FF from experiment 1. Each experimental period is defined by counting 14 increments from the temperature marking x 400 magnification.

Validation that increments are formed on a daily basis was achieved by counting the number of primary increments (white dots) between thermal marking and deth (age of the otolith).

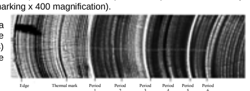


Table 3 – Mean daily increment widths (microsns) for two fish (4FF & 679) with contrasting experimental histories. Numbers in red refers to the periods of starvation.

temp	6.2 (period 6)	7.7 (period 4)	9.5 (period 5)	10.7 (period 2)	12.6 (period 3)	15.2 (period 1)
4FF	2.2	2.4	2.8	2.8	3.4	3.5
679	1.7	2.8	2.9	2.5	3.82	4.1

It is too early to draw conclusions, but it appears that with increasing temperature, there is an increase in increment width and a decrease in opacity (Fig. 2; Table 3). It is less clear if feeding is having a significant effect on increment width or opacity.

Complete team (from left to right and back to front): A.Tidd, A.Geffen, G.Pilling, P.Wright, H.Mosegaard,R.Millner, J.Tomás, L.W.Clausen, B.Morales-Nin, J.Cabestany, J.Piera, F.Neat, M.Palmer, T.Lombarte, H.Høie, V.Parisi and O.Chic