High-resolution analysis of fish otoliths as indicators of marine environment and fishing practises in North Mauritania at 6730 BP

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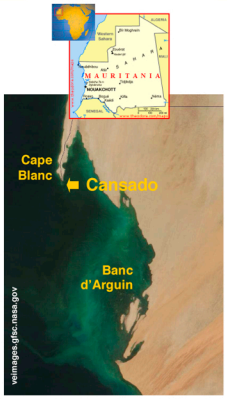
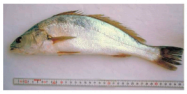
Cansado and the otolith material

The Epipaleolithic site of Cansado, radiocarbon dated at 6730 BP.



Meagre otoliths (ear stones)

Modern fish collected in Nouadhibou (19°N)



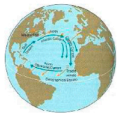
Meagre is a migrating benthopelagic fish, inhabiting coastal temperate waters from Western Europe to North West Africa, moving along the shore or offshore-onshore in response to temperature changes.

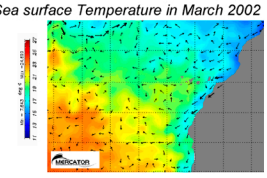
Meagre (*Argyrosomus regius*, Asso, 1801) is the dominant species, represented by thousands of otoliths. Otoliths are accretionary structures made of aragonite. $\delta^{18}O_{oto}$ values provide a record of temperature and $\delta^{18}O$ values of the ambient water ($\delta^{18}Ow$). They offer a unique opportunity to gain more insights into paleoenvironmental conditions as well as into fishing activities.

Modern context

The modern coast of Mauritania is characterized by continental arid conditions and productive marine waters.

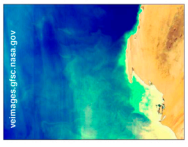
Sea surface Temperature in March 2002





The Canary current is the easternmost branch of the North Atlantic Subtropical Gyre flowing southward along the coast of West Africa. It brings cool and saline water toward the equator. Temperature at the surface varies from 16 to 23 °C and salinity varies between 35.5 and 37 psu.

Phytoplankton blooms in March 2002



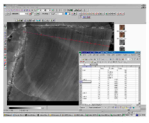
As northeasterly trade winds move the surface water, nutrient-rich deep waters reach the ocean's surface. This upwelling - permanent in the Cape Blanc region - creates a highly productive region.

Sampling and analytical methods

Otolith preparation and growth observation

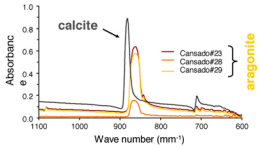
Transversal thin sections

Noemis Visilog® software



Otoliths are embedded into an epoxy resin, cut by a precision saw, mounted and polished to obtain thin sections. Growth structures are observed in reflected and transmitted light. Digital pictures are acquired and relative light intensity is measured by an image analysis software.

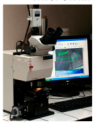
FTIR analyses



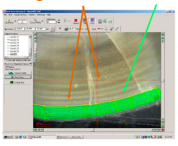
Local Infra-Red microscopy analyses of archaeological otolith sections indicate that original aragonite was preserved.

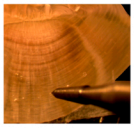
Micromilling and mass spectrometry

Micromill



growth bands *sampling paths*

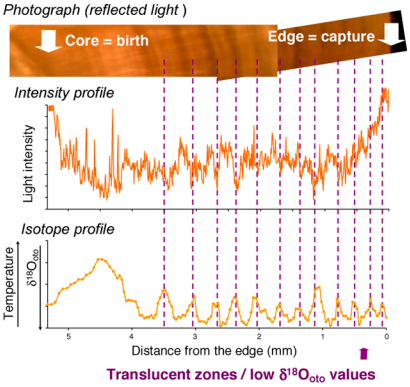




A sequential micromilling technique allows to recover aragonite micro-samples along otolith growth bands. Microsamples are analyzed by a Finnigan MAT 253 coupled to a KIEL device to obtain high-resolution profiles in $\delta^{18}O$ (‰ VPDB).

Schlerochronology

Photograph (reflected light)

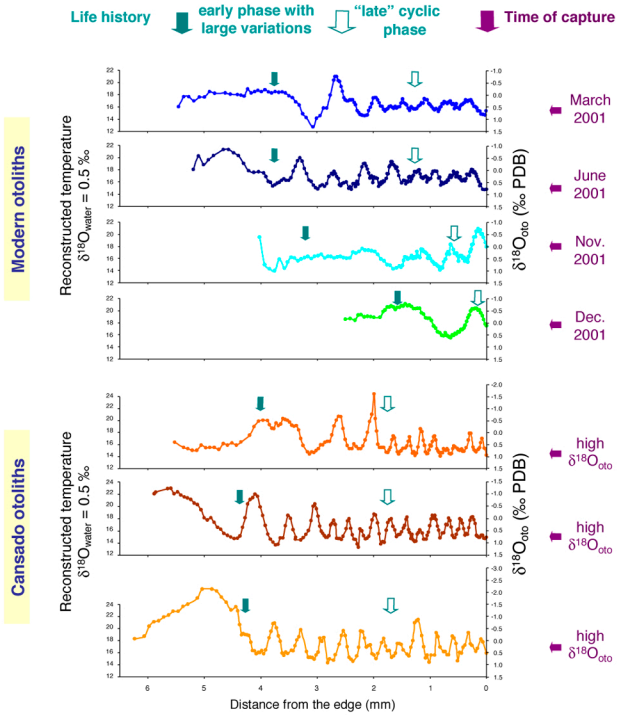


Growth structures are defined as an adjacent large opaque zone and fine translucent zone.

Under reflected light, areas with relative high measured light intensities are the opaque zones and areas with relative low measured light intensities are the translucent zones.

Cyclic variations in $\delta^{18}O_{oto}$ values are related to growth structures. One translucent zone is deposited at $\delta^{18}O_{oto}$ minima = ambient temperature maxima, one opaque zone is deposited at $\delta^{18}O_{oto}$ minima = seasonal maxima.

Fish life history, environment and fishing



Meagre life history and environmental history

Life history of modern and archaeological meagre is characterized by an early life phase with large variations in $\delta^{18}O$ that reflect a change of habitat, and a "late" phase presenting regular cyclic variations that reflects seasonal variations in ambient temperature.
Modern and archaeological specimens record intra-annual variations of ~2-5°C and cool ambient temperatures varying from 16°C to 24°C.

Fishing season in Cansado

At time of capture, $\delta^{18}O_{oto}$ values of modern otolith are those expected for the season of capture. Cansado otoliths present relatively high $\delta^{18}O_{oto}$ values compared to the rest of the seasonal cycle. When compared with profiles obtained on modern specimens this corresponds to the Spring. Spring (March – June) is the reproduction period of meagre in the region, a time when ambient temperature is low.

Conclusions

- **Timing and periodicity of growth structures: zone appearance in meagre otolith is related to cyclic variations in $\delta^{18}O$oto values and then to the seasonal temperature cycle.**
- **Intra-otolith isotope profiles are generated at monthly scale and offer a unique opportunity to gain more insights in fish life history, ambient environmental history at high temporal resolution, as well as in fishing activities.**
- **Modern and archaeological meagre specimens present similar life histories.**
- **Reconstructed thermal histories suggest fresh water conditions and the presence of coastal upwelling at 6730 BP along Mauritanian coasts.**
- **Meagre fishing in Cansado occurred seasonally during the fresh season, suggesting that human groups exploiting marine resources had a good knowledge of fish population behaviour.**