

***Cladocora caespitosa* and *Pinna nobilis*: useful climatic archives to reconstruct Last Interglacial paleotemperatures**

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The **anthropogenic pressure** and **climate change** are causing the **rising of ocean temperatures**

Climate Change



Past climatic dynamics of the Mediterranean Sea allow us to understand ongoing and **future climate changes**

Paleotemperatures



Last Interglacial period (LIG) as an **analogue** for future climate scenarios

LIG (~129 to 116 ka)

CLIMATIC ARCHIVES

Cladocora caespitosa

(fossil)

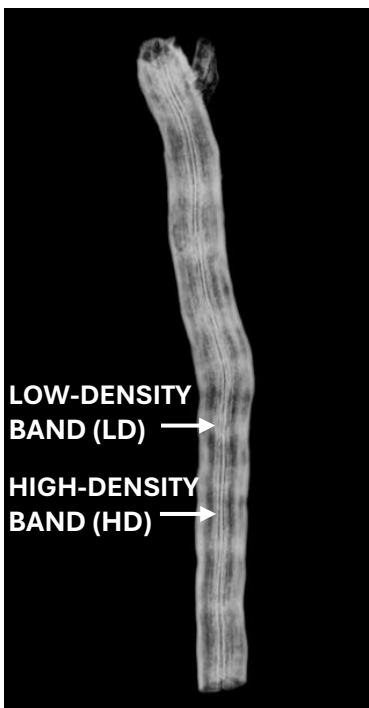
Sr/Ca

Li/Mg

 $\delta^{11}\text{B}$ 

Cladocora caespitosa is a temperate **scleractinian coral endemic** to the Mediterranean Sea. It deposits **two density bands per year**: a high-density (**HD**) band during winter and a low-density (**LD**) band during summer.

Accordingly, one year of growth corresponds to the distance between two successive HD peaks. The coral's aragonitic skeleton **incorporates trace elements** and **stable isotopes** that can be used **as proxies** for seawater parameters. In particular, **Li/Mg** and **Sr/Ca** ratios are used as **temperature proxies**, while the boron isotope ratio ($\delta^{11}\text{B}$) serves as a proxy for **seawater pH**. The aim of this study is to **reconstruct the climatic conditions** of the **Last Interglacial (LIG)**.

*Pinna nobilis*
(modern) $\delta^{18}\text{O}$ 

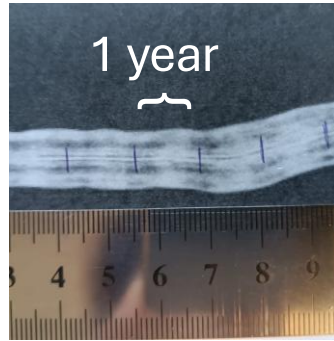
Pinna nobilis is an endemic bivalve species of the Mediterranean Sea. The **geochemical properties** of its **shell** can serve as proxies for seawater parameters, such as temperature. In this study, the stable oxygen isotope ratio ($\delta^{18}\text{O}$) is used as a **proxy** for modern **seawater temperature**, as its values are **inversely related** to temperature. The aim is to evaluate *P. nobilis* as a **potential climatic archive** and to assess whether its application can be extended to fossil specimens for paleotemperature reconstruction.



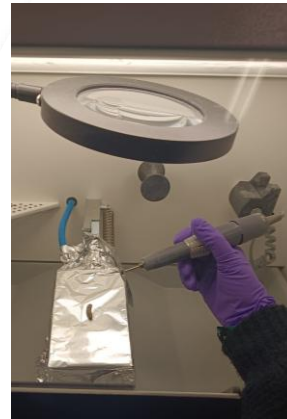
Cladocora caespitosa



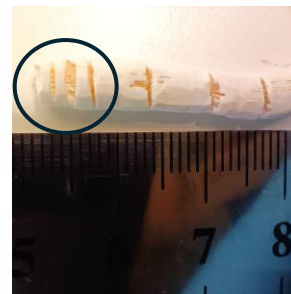
Sampling of *Cladocora caespitosa* corallites



Identification of **high-density band peaks**



Cut of corallites using a **drill** to reconstruct paleotemperatures



Seasonal resolution was achieved by performing **sampling** between successive HD peaks. The number of samples varied according to the annual growth rate



Removal of **impurities** from aragonite to reduce contamination for geochemical analysis



The **Li/Mg (mmol/mol)** and **Sr/Ca (mmol/mol)** results at seasonal resolution were used to obtain **paleotemperatures**.

Cladocora caespitosa **specific equation** were used:

- Linear regression based on data about fibrous aragonite in Montagna *et al.*, 2014 for the proxy Li/Mg
- Linear regression based on data in Montagna *et al.*, 2007 for the proxy Sr/Ca

Paleotemperatures were compared with **modern seasonal time series from 1987 to 2024** of the Mar Grande (Taranto, Italy) at 10 m depth. Modern water temperature has been obtained from the high-resolution CMCC Taranto Forecasting System. Paleotemperatures series were shifted to achieve the **best overlap** with modern series and then, they were **cross-correlated**. The aim was to compare:

- **Seasonality**
- **Mean temperatures in each season**

Next Step 

In the following months the objective is to ebalance $\delta^{11}\text{B}$ results and to **calculate LIG seawater pH**



- **Collecting** modern specimens



- **Collecting calcite** samples from modern specimens with a resolution ranging from 2 to 5 mm depending on the thickness of the calcite



- Measuring $\delta^{18}\text{O}$ stable isotopes using the IR-MS



Age depth model

Knowing the year of death of *Pinna nobilis* specimens from the Mar Piccolo and the Gulf of Oristano, we reconstructed the **seasonal summer and winter peaks** for each year. An **age–depth model** was developed using **linear interpolation** in Python. February and August were selected as **tie points**, corresponding to the maxima and minima of the isotopic signal. Assuming constant growth between these two tie points, **intermediate months** were resampled to convert spatial measurements into a monthly time series.

Composite record equation

To obtain a species-specific calibration, **five** specimens from Mar Piccolo were combined to produce a **monthly composite record**. A **linear regression** was then performed between the **monthly $\delta^{18}\text{O}$ values** of the shells and the corresponding **monthly temperatures** measured by CMCC. The resulting regression **equation** was **evaluated** by applying it to $\delta^{18}\text{O}$ values from specimens collected in the Gulf of Oristano. Finally, the reconstructed temperatures were compared with CMCC modelled temperatures for the same area.

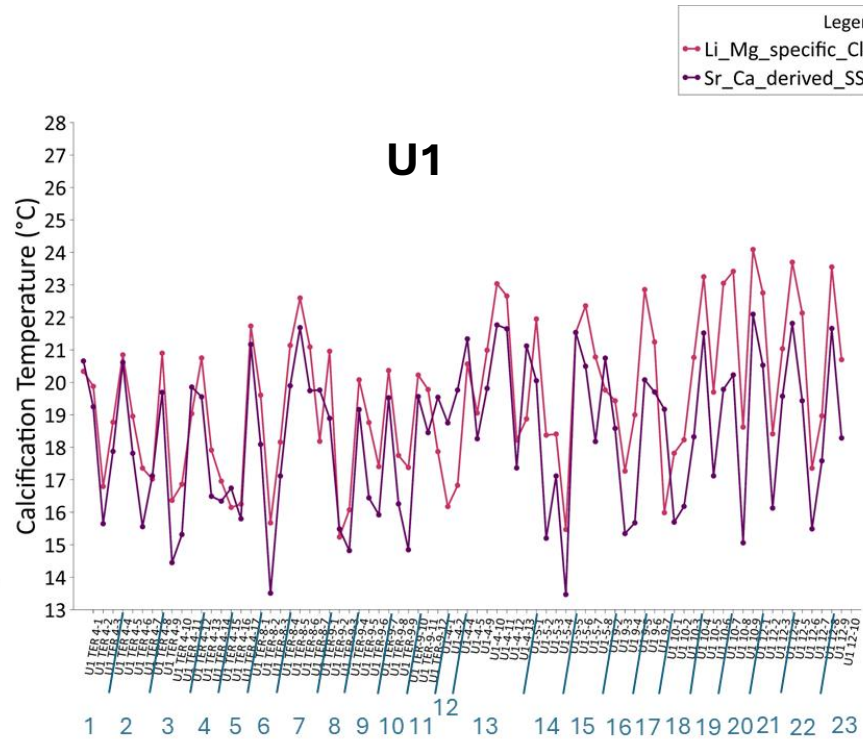
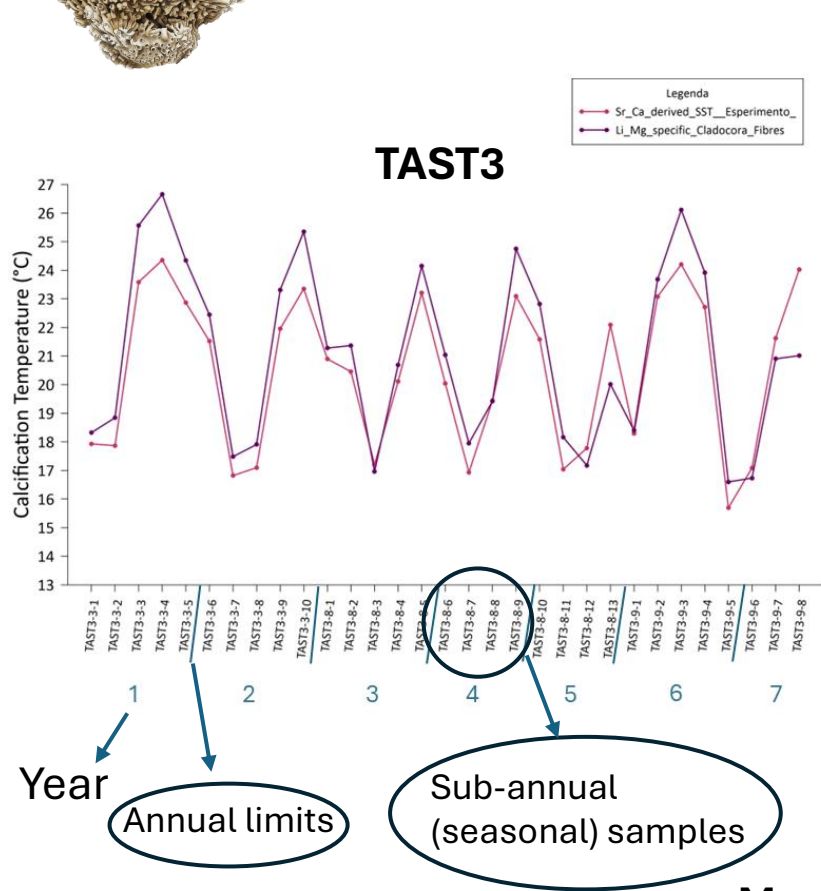
Modern time series

Monthly temperature time series for the Mar Piccolo (Taranto, Italy) were extracted from the **high-resolution CMCC Taranto Forecasting System** for the period between February 2010 and February 2017. Temperatures were obtained for the depth interval corresponding to the occurrence of *Pinna nobilis* (5–8 m). Monthly temperature and salinity data for the Gulf of Oristano were obtained from the **Copernicus Marine Service reanalysis** (Escudier *et al.*, 2020, 2021). Data were extracted at 3 m depth for the period 2008–2016. All datasets correspond to the specific sampling sites.



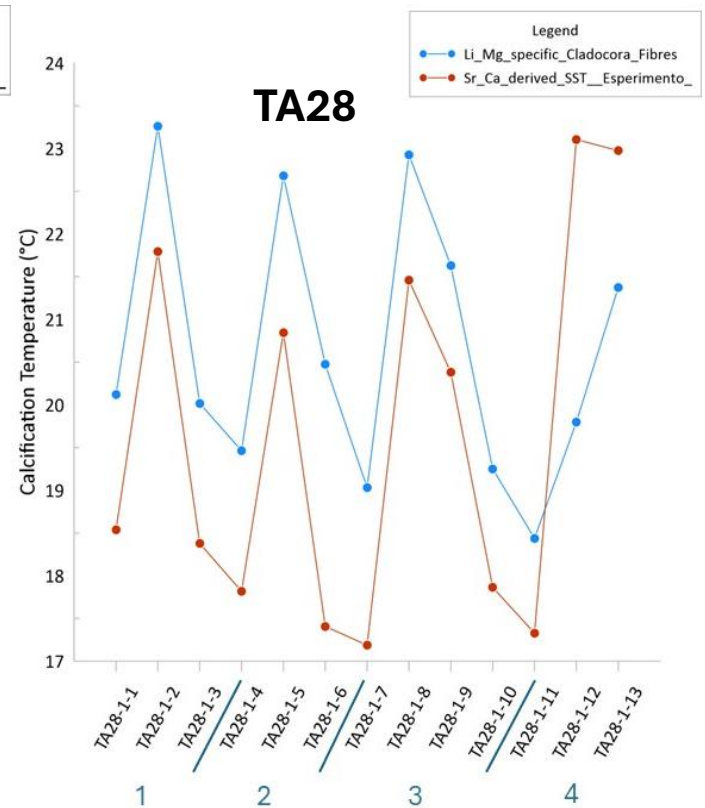
Cladocora caespitosa

Results and Discussions



Legend

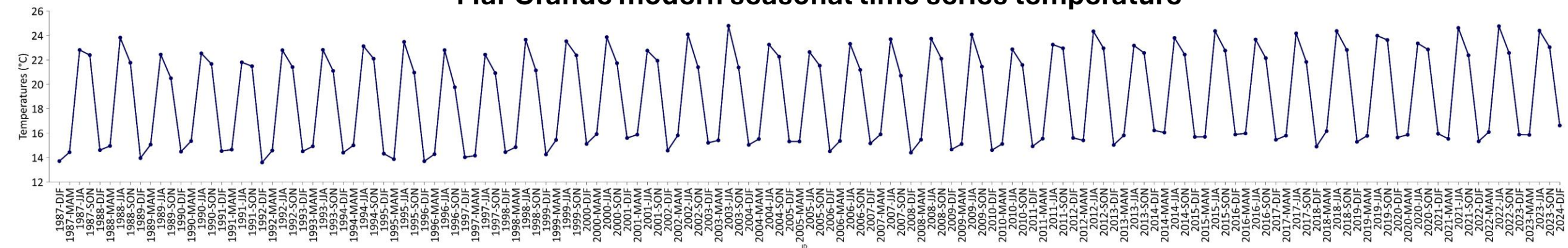
- Li_Mg_specific_Cladocora_Fibres
- Sr_Ca_derived_SST_Esperimento_



Legend

- Li_Mg_specific_Cladocora_Fibres
- Sr_Ca_derived_SST_Esperimento_

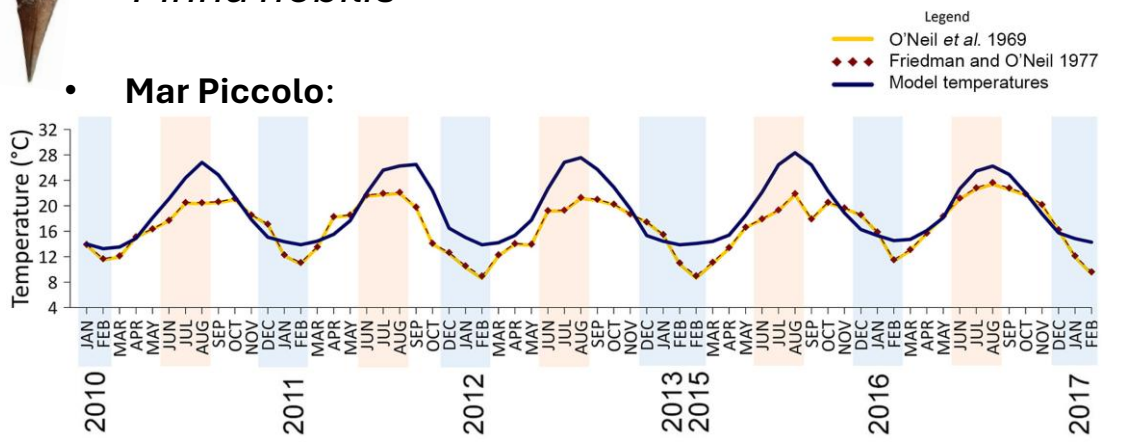
Mar Grande modern seasonal time series temperature





Pinna nobilis

Mar Piccolo:



O'Neil et al. (1969)
equation (T°C)

Friedman and
O'Neil (1977)
equation (T°C)

Model T°C

Total Average	16.73±4.08	16.88±4.06	19.23±4.77
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OFFSET

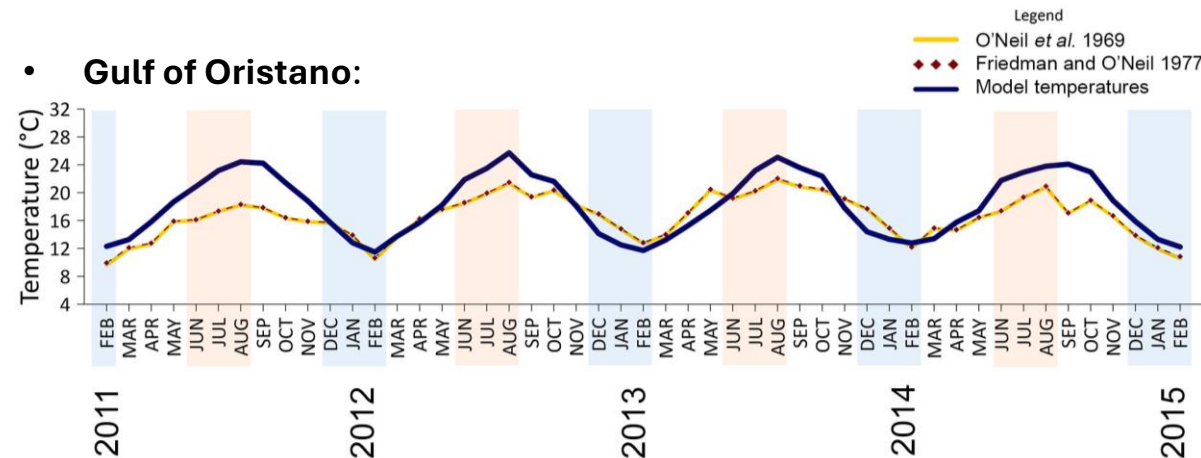
Total	-2.50	-2.35
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Summer	-4.37	-4.22
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Winter	-1.68	-1.50
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Results and Discussions

Gulf of Oristano:



O'Neil et al. (1969)
equation (T°C)

Friedman and
O'Neil (1977)
equation (T°C)

Model T°C

Total Average	16.52±3.10	16.63±3.08	18.23±4.45
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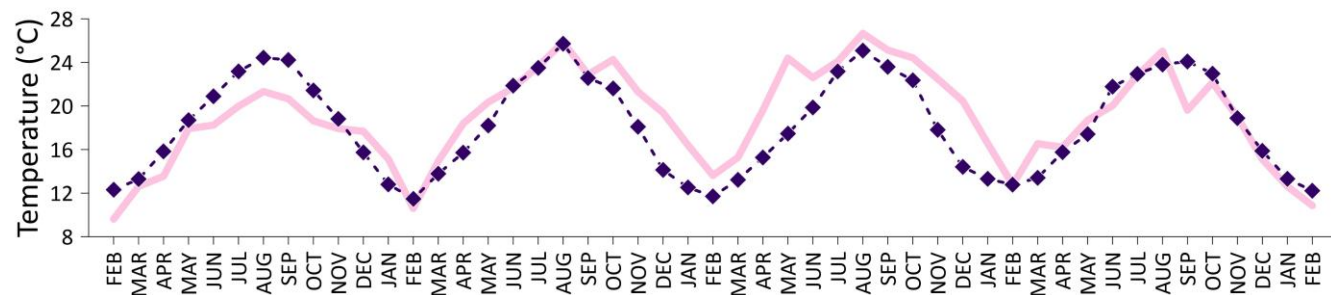
OFFSET

Total	-1.71	-1.60
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Summer	-3.88	-3.77
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Winter	+0.38	+0.52
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Legend
—◆— Composite record equation
- -◆- - Model Temperatures



	Composite record equation	Model T°C
Total Average	18.97±4.33	18.23±4.45
OFFSET		
Total	+0.74	
Summer	-0.36	
Winter	+1.74	

! These are preliminary results and may change once the $\delta^{18}\text{O}$ values of the water from Mar Piccolo and the Gulf of Oristano are measured.

GRAZIE PER
L'ATTENZIONE!

