Assessing *Chamelea gallina* biomineralization dynamics in the Holocene of the Northern Adriatic Sea (Italy)

Alessandro Cheli[1,2]*, Arianna Mancuso[1,2], Giuseppe Falini[2,3], Stefano Goffredo[1,2], Daniele Scarponi[1,2]
[1]*Departement of Biological, Geological and Environmental Sciences - BIGEA, University of Bologna, Italy*
[2]*Fano Marine Center for Research on Marine Biodiversity, Resources and Biotechnologies, Fano (PU), Italy*
[3]*Department of Chemistry "Giacomo Ciamician", University of Bologna, Bologna, Italy*
* *alessandro.cheli2@unibo.it*

ALMA MATER STUDIORUM UNIVERSITY OF BOLOGNA

FishMed-PhD

FANO MARINE CENTER

RESEARCH GOAL

Fig 1. *C. gallina* valves dated 7.6 ky BP

The bivalve ***Chamelea gallina*** is an economically valuable species in the Mediterranean Sea and is expected to be impacted by several anthropogenic stressors. Therefore, conservation and management strategies require a good understanding of species long-term adaptive response to changing climate and environment. The **recent fossil record** offers an archive of ecological responses to past climate-driven environmental transitions.

In this study, we investigate **skeletal** and **growth** parameters of ***Chamelea gallina,*** in relation to temperature along a temporal gradient of ~ 8000 years (Mid-Late Holocene).

Study area: Holocene sedimentary succession of the Po-Adriatic System.

Investigation of two different geomorphologic configurations of North Adriatic coastal systems (estuarine vs deltaic system).

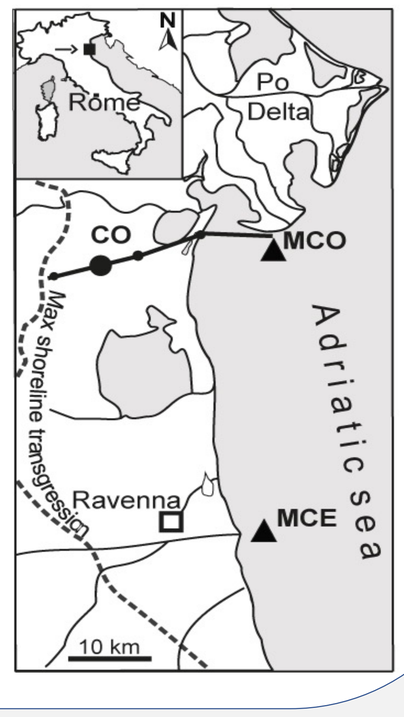


Fig 2. Study area map and stratigraphic framework of the latest Quaternary Po-Adriatic sedimentary succession. In the left panel, black dots mark the locations of fossil sampled cores (CO1, CO2); black triangles mark sampled thanatocoenosis from present-day shoreface environments (MCE, MCO), and the black solid line represents the along-dip cross section of the Po coastal plain

METHODS

2 <u>Fossil horizons</u> from the Holocene climatic optimum (7.6 and 5.9 ky BP),
compared with
2 <u>Modern thanatocoenoses</u> from the same area (Northern Adriatic)

Decreasing temperature trend to nowadays
ΔT= ~1.5 °C

Multi-scale analysis to determine:

- **shell skeletal parameters**
  - micro-density (mass per unit volume of the shell material, excluding the volume of pores)
  - bulk density (the density of the valve, including the volume of pores)
  - apparent porosity (percentage of the pore volume connected to the external surface)
- **growth parameters**
  - linear extension rates (length/age ratio)
  - net calcification rates (mass of $CaCO_3$ deposited per year per unit area g y^{-1} cm^2)

The growth function for each assemblage was determined from 3 independent ageing methods (shell surface growth rings, shell internal bands, and stable isotope composition).

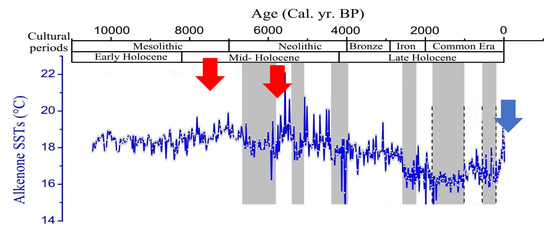


Fig 3. Temporal reconstruction of sea surface temperatures (SSTs) in the Mediterranean Sea over the past 10000 years (Jalali et al., 2016). Red arrows indicate fossil horizons while blue one indicates present-day.

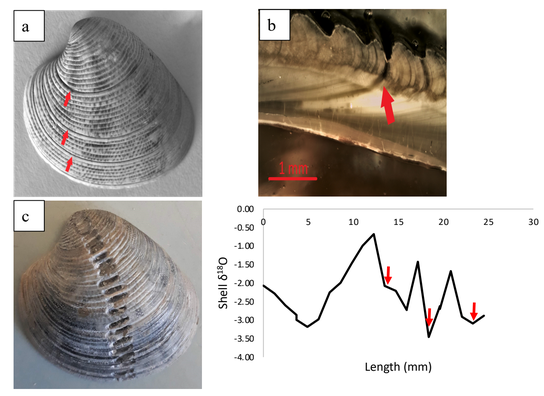


Fig 4. Shell ageing methods. (a) external growth rings; (b) Internal annual growth band in the shell section; (c) Samples for shell oxygen isotope analysis collected along the growth axis; age is indicated by the sequence of lower (summer) and higher (winter) $\delta^{18}O$ values recorded by the shells.

RESULTS

Von Bertalanffy growth function (VBGF) for each investigated fossil and modern assemblages

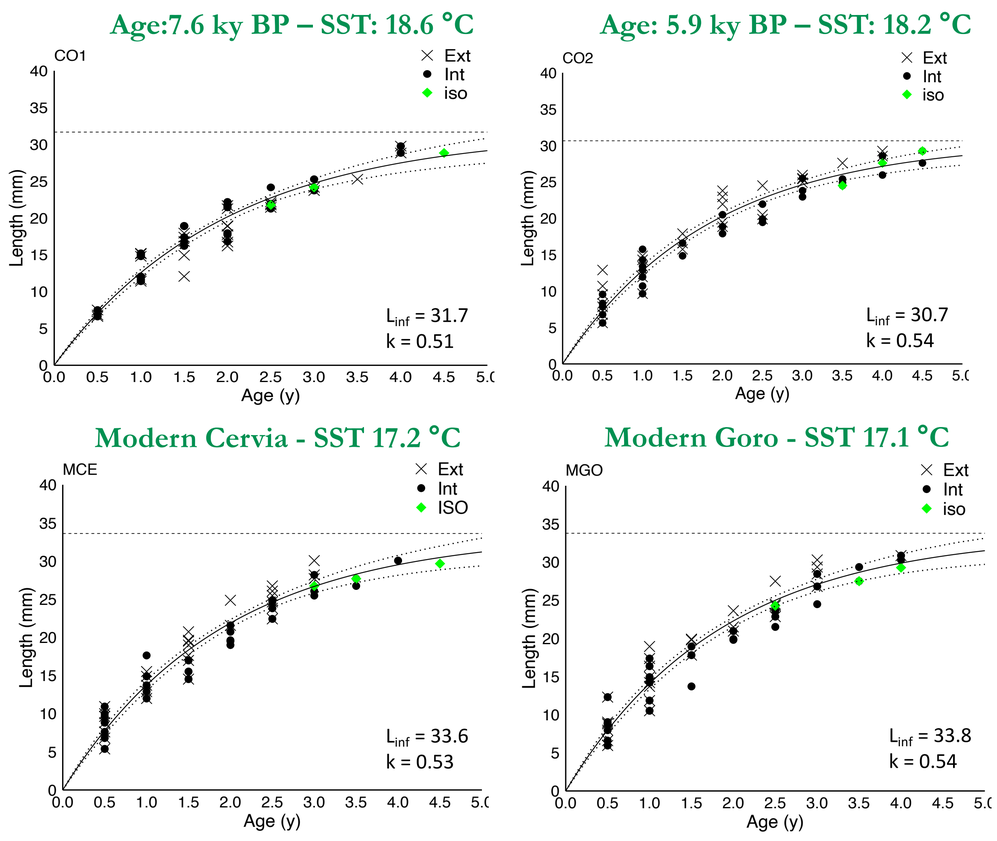
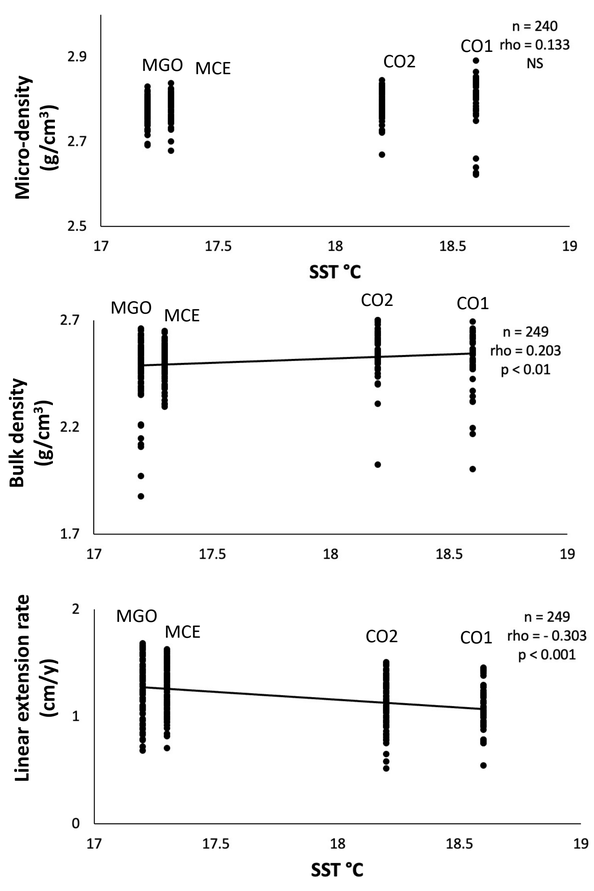


Fig 5. VBGF. The age-length von Bertalanffy growth curve in each horizon was obtained by data from the two ageing methods (counting of external rings represented with crosses and counting of internal rings represented with black dots). Green diamonds, obtained from the $\delta^{18}O$ profiles, are figured as validation to the ageing rings methods. Dashed lines indicate the maximum expected shell length (Linf), dotted lines indicate the confidence intervals constructed through the bootstrap method.

Variation of shell **skeletal and growth parameters** with sea surface temperature



Horizon	N	Bulk Density (g/cm^3)	CI	Linear extension rate (cm/y)	CI	Net calcification rate (g/cm^2 y)	CI
CO1	49	2.52	0.04	1.08	0.06	2.71	0.1
CO2	59	2.55	0.03	1.11	0.06	2.83	0.2
MCE	68	2.51	0.02	1.26	0.06	3.16	0.1
MGO	73	2.47	0.04	1.27	0.06	3.12	0.1

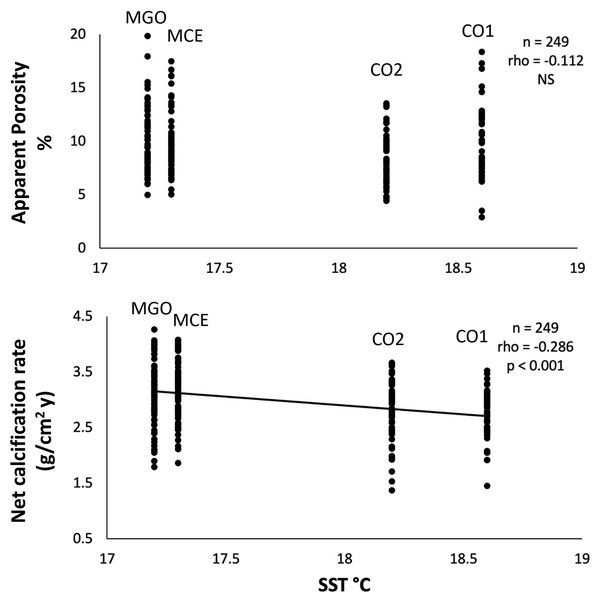


Fig 6. Skeletal and growth parameters.
SST = sea surface temperature; rho = Spearman's determination coefficient. In the table, mean values of parameters correlated to SST: n = number of individuals; CI = confidence interval

CONCLUSIONS

- *C. gallina* shows skeletal and growth variations in skeletal properties along the temporal gradient. No taphonomic recrystallization process occurred
- Shells of past fossil horizon living in warmer water present denser shells than modern specimens, likely due to a higher aragonite saturation state in warmer water. Temperature effects were boosted by geomorphological setting
- Net calcification rates are higher in modern specimens, as a result of a significant increase in linear extension rates: modern specimens promote a faster growth rate at the expense of less dense shells
- This approach should allow the reconstruction of *C. gallina* natural range of variability on time-scale well beyond the ecological monitoring or small-scale experiments and offer insights on the adaptive capacities of *C. gallina* facing near-future anthropogenic warming.