Mollusc shells from the eastern and western tropical Pacific as recorders of environmental conditions

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**Introduction**

**Why work on mollusc shells?**

- Live, in abundance, in a wide range of environments → Great variety of environmental records
- High growth rate → High temporal resolution, < months
- Growth increment thicknesses and $\delta^{18}$O
- Found as fossil/archaeological remnants → Potential archives of paleo-environmental conditions

**Seasonal variations**

Related to sea surface temperature (SST)
Methodology

- Successive markings, calcein baths for 2-3h

  Preparation of the calcein bath

  Mark of the calcein mark in the shell (C. concholepas)

- Shell preparation

  Embedded cut shell

- Sclerochronology: shell growth increment thicknesses are measured under the microscope, using the Visilog software

  e.g. 576 increments measured

  Time
**Methodology**

**Shell analysis: geochemistry**

- Microdrill, computer assisted
- Stable isotopes (LOCEAN, Paris VI)
- Trace elements (liquid ICP-MS, Bondy)

80 µm in thickness
Days/weeks of growth

Shell section after micromill sampling

1 mm
South-East Pacific region

El Niño

Modern

Archaeological/Fossils


Records of paleo-El Niño conditions?
Sites, species

1. *P. thaca*

2. *C. concholepas*

- 25° S, Antofagasta
- 17° S, Pocoma
1/ *P. thaca* - sclerochronology

**Major growth anomalies**

- Groove at the shell surface
- Thick limits

**Specific summers**
- SST > 18°C
- For several weeks

"Summer checks"

1/ P. thaca - sclerochronology

"El Niño" shells

Shells sampled in 2000

At the surface and...

El Niño 97-98

Inside the shell

Shell section viewed under the optical microscope
Long lasting stress related to El Niño leads, in the *P. thaca* shells, to:

- Thicker Summer Check of the population

AND

- Highest variability in individual answer

*P. thaca* shells = potential archive of major events like El Niño.
25°S, Antofagasta

C. concholepas

- Big carnivorous gastropod, large seafood resource
C. concholepas – $\delta^{18}$O & SST

$\delta^{18}$O and SST are well related

This equation can be used to obtain paleo-SST from fossil C. concholepas shells.

SST = 19.82 -2.67 ($\delta^{18}$O_{shell} - $\delta^{18}$O_{water})

I. Valderrama, 2008
Giant clams: introduction

- Large bivalves living on coral reefs in similar environments than corals (*Porites sp.*)
- Dense aragonitic shell → Fossils well preserved, better than corals
- Used for human consumption → Abundantly found in archaeological sites, as whole shells or tools

Might assess or complement environmental records obtained from coral skeletons
Hippopus hippopus: calibration

- Collected in the Baie of St-Vincent, May 2003
- Lived in aquarium until February 2004
- SST, SSS and luminosity recorded during the growth in aquarium.

Noumea lagoon, New Caledonia

Hippopus hippopus shell

5 cm

Slab cut for analyses

Growth increment measurements

Inner layer, prismatic

Micromill sampling of the inner layer

A. Aubert et al., Coral Reefs, 2009
Hippopus hippopus: calibration

$\delta^{18}O$ vs. SST

This study ($r^2 = 0.61$)

$SST = 21.4 - 2.87 (\delta^{18}O_{\text{shell}} - \delta^{18}O_{\text{water}})$

Watanabe & Oba (99)

$SST = 22.4 - 3.91 (\delta^{18}O_{\text{shell}} - \delta^{18}O_{\text{water}})$

Relationship between $\delta^{18}O$ and SST

- almost identical to previous study on the same species

Hippopus are good recorders of SST changes

A. Aubert et al., Coral Reefs, 2009
Vanuatu archaeological shell

Santo Island in Vanuatu

The Aore excavation

A. Aubert, 2007; coll. J.-C. Galipaud, UR092, IRD

The H. Hippopus archaeological shell

3625 +/- 30 BP

Shell section and area analysed

Shell piece for SEM study

Sclerochronology

Geochemistry

A. Aubert, 2007; coll. J.-C. Galipaud, UR092, IRD
Vanuatu archaeological shell

- δ¹⁸O variations not so "seasonal", but analyses waiting…
- δ¹⁸O and growth variations similar through time
- Calculated paleo-SST higher and with larger seasonal amplitude the modern Vanuatu SSTs.

Shallower thermocline and larger fluctuations of the warm pool position

Monthly SST data Vanuatu 00-03: IGOSS, Reynolds & Smith, 94, *J. Climate*, 7
Conclusion

East Pacific

New potential proxies of environmental conditions along the East Pacific coasts, specifically for past ENSO reconstructions

West Pacific

Together with corals, fossil giant clams from two key-periods of the Holocene will be studied:

- 6000 BP: what kind of "ENSO-mode" did exist at this period?
- 3000 BP: Were the settlements of the first humans on the Central and West-Pacific Islands linked with better than before climatic conditions?

Work in progress...
Crossed-lamellar microstructure, outer layer, *H. hippopus*, SEM picture