Microstructural and geochemical impacts of El Niño events on the shell growth of several mollusc species from the Chilean and Peruvian coasts and calibration of climatic and environmental proxies

Marc Gosselin, Ernesto Fernandez** & Luc Ortlieb**

* IRD, PALEOTROPIQUE, Centre IRD d'Ile de France, 32 avenue Henri Varagnat, F-93 143 Bondy Cedex (France) [e-mail: Marc.Gosselin@bondy.ird.fr], ** IMARPE, Instituto del Mar del Perú, Esq. Gamarra y Gral Valle S/N, Chucuito, Callao - Apartado postal 22, Lima (Peru).

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The El Niño phenomenon (EN) is the major cause of global climate variability, intensively manifested every few years in the South-East Pacific region. Along the Peruvian coasts, positive sea surface temperature anomalies reaching several degrees during a few months severely affect local ecosystems and trigger ecological and socio-economical disturbances.

To investigate at a small time scale the occurrence and intensity of recent and past EN events, scleroclimatological studies are developed on several species of coastal molluscs. During the process of growth increments formation, carbonate structure of the exoskeleta can record daily to seasonal information on environmental variations such as food supply, water temperature or chemical composition.

This work focuses on the microstructural and geochemical characterisation of specific growth shell patterns before, during and after recent El Niño (1982-83; 1997-1998) or La Niña (1998-2000) events. These growth anomalies recorded in bivalves shells from Peru and Chile will tentatively be linked to oceanographic data.

A first objective is to detect and describe shell growth anomalies caused by environmental conditions that can be specific to EN. Theses anomalies might be visible at macroscopic and microscopic scales. Macroscopic scale is consisted to the observation of external ridges or marks of growth direction changes in the shell surface. Microscopic scale corresponds to observation of internal growth increments, visualized by a succession of semi-parallel black/white layers. Rhythmicity of these biomineralised layers (thickness increment) will be compared with environmental disturbances induced by EN effects.

A second objective is to assess the geochemical signature of EN events. Trace metal and stable isotope have been previously used in other kinds of records (*e.g* corals) to obtain information on upwelling intensity, salinity or sea surface temperature. Geochemical analyses will be done in bivalve shell increments at a daily temporal resolution scale, using performing sampling and analytical techniques (Micromill® and mass spectrometer and laser ablation coupled to an ICP-MS).

Bivalves species envisaged for this kind of studies should be sensitive to ecological variations and well adapted to environmental changes occurring during EN events. Thus, and in accordance with target species studied in Censor project, the chosen bivalves are: *Trachycardium procerum, Argopecten purpuratus* and *Mesodesma donacium.*

To study growth features, thin sections of shells were realized. Thin sections were generally prepared with bivalve shells collected on beach deposits. Each valve was cut along the maximum growth axis using a linear precision saw. One half valve was glued on a glass slide with epoxy resin and cut again to obtain shell slices of 300-700 µm thick. Thin sections were polished with decreasing size grits, from 70 to 1 µm. Slides were observed under an optical microscope (magnification 40-100x) or a scanning electron microscope (SEM).

Different techniques were tested with the aim to better observe the succession of increments. They consist on testing different etching treatments after the sections were polished and changing the microscope light settings for the observation. Acetate peels were also prepared by pressing an etched shell section (previously bathed in acetone) over an acetate sheet. Thus, a "print" of growth increments may be observed. Microscope observation was carried out under varied conditions: reflected, transmitted or fluorescent lights.

A thin section of a shell marked with calcein at a concentration of 50 ppm during 3 hours was prepared and observed under blue light (460-490nm). This material allowed us to estimate a first growth rate for *T. procerum.*

Preliminary results concern microstructure analysis on *T. procerum* and *A. purpuratus.*

Growth increments of *A. purpuratus* are particularly conspicuous on the surface of the shell while they are unreadable internally, in a thin section. On the contrary, fine growth increments of *T. procerum* are clearer in thin sections than on the shell surface.

Efforts have been dedicated to the study of the growth patterns and shell microstructure in thin sections of *T. procerum*. For this species, observation of polished sections gives better results than acetate peels because the latter evidence the crystallographic more than the structural (increment) patterns. Variations of increments thickness in *T. procerum* suggest that the growth rhythm is sensitive to ecological variations and biological factors. A mean increment thickness of 37 ± 9 µm has been measured in the studied shells. However due to a lack of data in literature concerning growing rhythm of *T. procerum*, no temporal correlation could be made.

The calcein-marked shell grew 411.5 µm during 83 days. Forty pairs of black/white growth increments were counted. Thus, a daily growth rate of 5.14 ± 2.89 µm was estimated for a three-month period in austral fall-winter season.

Concerning growth rhythmicity, preliminary results on *Trachycardium procerum* open perspectives for the study of biomineralisation processes in other bivalve species. Geochemical characterisation of EN period in carbonate shells will further be considered. Growth measure techniques and geochemical analyses should be standardized prior to calibration study with respect to environmental parameters.

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