Retrotapes exalbidus from southern South America: Are fossil shells reliable proxy archives for Holocene climate changes?

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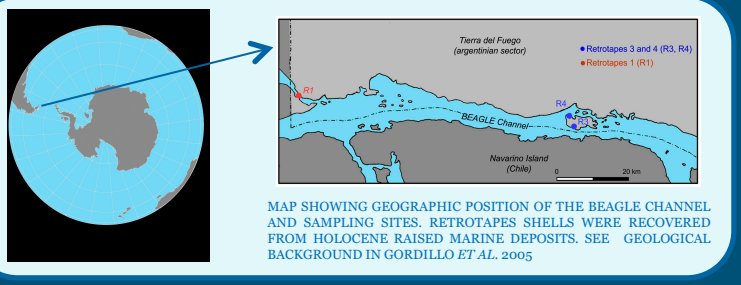
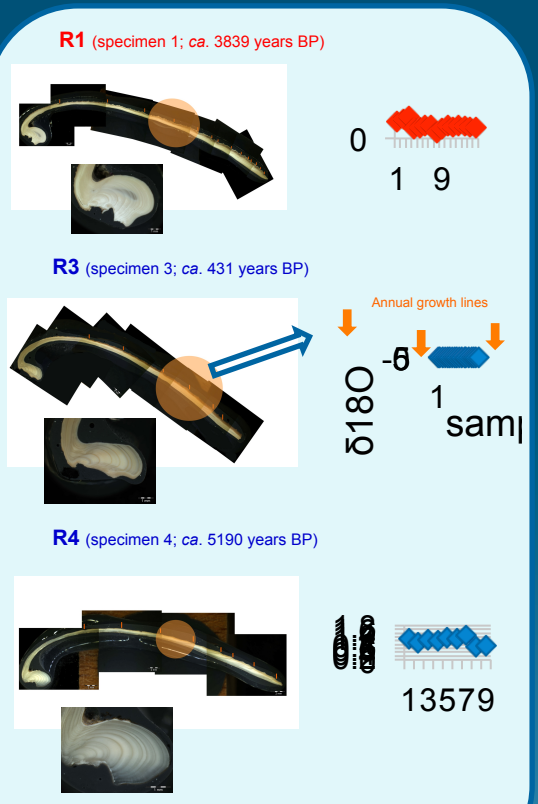
Introduction

In southern South America little is known about the biotic response of marine individual species to large scale climate variability along the Holocene. Fossil shells of the aragonitic bivalve *Retrotapes exalbidus* (previously called *Eurhomalea*) offer the possibility to investigate climate variability in the Beagle Channel and past seasonal dynamics of sea water temperature during the mid-to-late-Holocene. This selection is based on two reasons: extant *R. exalbidus* preserves annual increments in the outer shell layer (Lomovasky *et al*., 2002); and, although not very common as other venerids, this species is well preserved in different Holocene marine outcrops along the channel.



MAP SHOWING GEOGRAPHIC POSITION OF THE BEAGLE CHANNEL AND SAMPLING SITES. RETROTAPES SHELLS WERE RECOVERED FROM HOLOCENE RAISED MARINE DEPOSITS. SEE GEOLOGICAL BACKGROUND IN GORDILLO *ET AL.* 2005



SECTIONED SHELLS OF FOSSIL *RETROTAPES EXALBIDUS*. THE CIRCLES SHOW THE SAMPLED AREA IN EACH SPECIMEN. SHELL OXYGEN ISOTOPES SHOWED SEASONAL OSCILLATIONS.

Material and methods

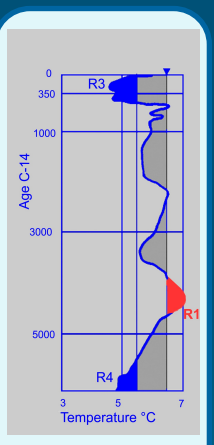
Holocene fossil shells of *R. exalbidus* were sectioned, polished, photographed and measured, and after examination three of them were selected for chemical sampling. In each case, one-half of the shell was used to resolve the annual growth bands and the other half was used for stable isotopes sampling. In addition, a fragment of each shell was used to C-14 dating performed in the Poznań Radiocarbon Laboratory with the accelerator mass spectrometry (AMS) technique. Ontogenetic ages were measured by counting the annual growth increments under a stereo microscope. For the reconstruction of paleotemperatures from shell oxygen isotopes we used an equation for aragonitic shells taking into account sea surface temperature (SST) and salinity (SSS) at the Beagle Channel (Colonese *et al*., 2012; Yan *et al*., 2012).

Results

Our results show differences between the three specimens. In the ontogenetic oldest individual (14 years), which gave a calibrated mean value age of 3839 BP, the δ18O values ranged from 1.53‰ to –1.16‰. The two other specimens (8 years), with calibrated mean ages of 5190 BP and 431 BP, gave δ18O values from 1.55‰ to 0.44‰ in the oldest specimen, and from 1.29‰ to 0.72‰, in the youngest one. Besides, we found variations in annual growth increment widths at different radiocarbon ages, probably correlated with environmental changes over the mid-to-late Holocene. We correlated the most positive δ18O values with winter and the most negative δ18O with summer. In addition, the summer values around 3800 yr BP are more negative than around 5000 years or 500 years BP.

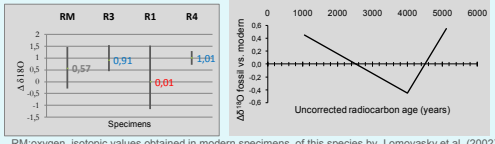
AGE, RESERVOIR EFFECT AND OXYGEN ISOTOPES

Samples	*Retrotapes 1*	*Retrotapes 3*	*Retrotapes 4*
Radiocarbon date	4100 +/- 35 (Poz45293)	1050 +/- 35 (Poz45121)	5120 +/- 35 (Poz45122)
Mean value (corrected age)	3839	431	5190
Delta R (reservoir effect)	221.0 +/- 40.0		
N	18	15	9
Max	1,53	1,55	1,29
Min	-1,16	0,44	0,72
Mean	0,01	0,91	1,01
Intrashell variability	2,69	1,11	0,57

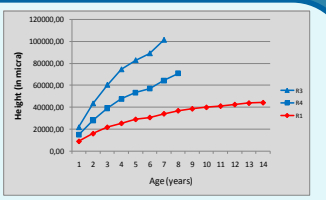


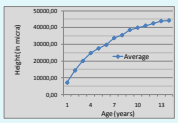
A WATER TEMPERATURE RECONSTRUCTION FOR THE BEAGLE CHANNEL COVERING THE LAST 6000 YEARS (OBELIC *ET AL.*, 1998); BLUE AREAS OF THE CURVE REPRESENT TEMPERATURES MORE THAN 1 °C COLDER THAN THE PRESENT MEAN VALUE. THE RED AREA CORRESPOND TO A WARMER PERIOD, THE HYPSITHERMAL, WITH TEMPERATURES UP TO 3 °C HIGHER THAN THE PRESENT MEAN VALUE (GRAPH MODIFIED FROM STRELIN *ET AL.* 2008).

COMPARISON BETWEEN LIVING AND FOSSIL SHELLS

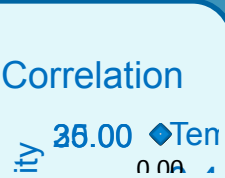


RM:oxygen isotopic values obtained in modern specimens of this species by Lomovasky et al, (2002)





SHELL INCREMENTS IN THREE SPECIMENS OF DIFFERENT RADIOCARBON AGE.



SEA SURFACE TEMPERATURE AND SALINITY FROM THE BEAGLE CHANNEL (PERIOD 1963-2011).

Conclusions

This sclerochronological study of the growth patterns and the oxygen isotope ratios in fossil *R. exalbidus* shells demonstrated that this species clearly exhibited annual cycles showing seasonality patterns through the mid-to-late Holocene, providing an opportunity to analyze intra-seasonal time scales in the fossil record.

These findings correlated well with an episode of cooling at ca. 5000 years BP, followed by a period of amelioration (the Hypsithermal at ca. 4000 years BP), and a new cooling event, at ca. 500 years BP, towards the end of the Holocene.

In the light of these preliminary results, future research focused on specifying to what extent these shells are formed in isotopic equilibrium with the ambient water, benefit investigations at a large spatiotemporal scale.

References

Colonese *et al*. 2012. J. Archaeological Science 39, 1738-1748. Gordillo *et al*. 2005. Scientia Marina 69 (Supl. 2), 337-348. Lomovasky *et al*. 2002. J. Sea Research 48, 209-216. Obelic *et al*. 1998. Quaternary of S. America and Ant. Pa 11, 47-71. Strelin *et al*. 2008. Pal. Pal. Pal. 260, 299-314. Stuiver, M., Reimer, P. 1993. Radiocarbon 35, 215-230 in conjunction with Radiocarbon Calibration Program Calib. Rev. 6.0. Yan *et al*. 2012. Pal. Pal. Pal. 350-352, 91-100.

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