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ERRATUM

In Figures 5 and 7 the colors of the curves have been exchanged by mistake.

These are the correct figures:

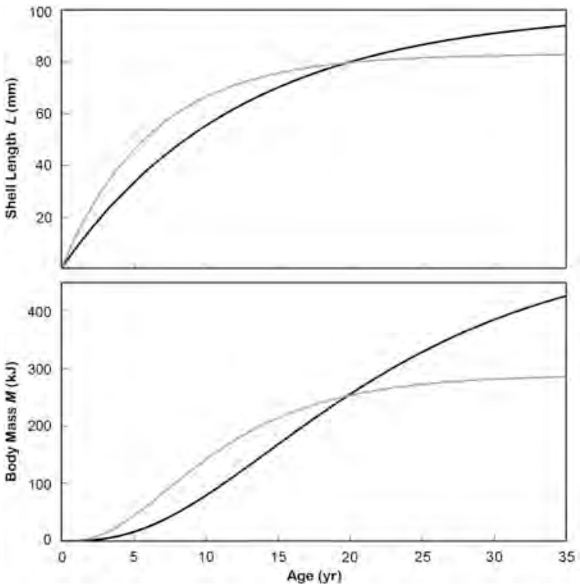

Fig. 5. Growth in shell length and in somatic body mass according to von Bertalanffy growth model $L_t = L_\infty * (1 - e^{-K*(t-t_0)})$ for the 1960s (black curve, $K = 0.08$ yr^{-1}; $L_\infty = 100$ mm, means for period 1961/62–69/70) and for the 2000s (gray curve, $K = 0.16$ yr^{-1}; $L_\infty = 83$ mm, means for period 1991/92–2009/10). t_0 is set to zero. Shell length L_∞ was derived from umbo size S_∞ by the relationship given in Table 1. Body mass was derived from shell length by means of the log–log regression given in Table 1.

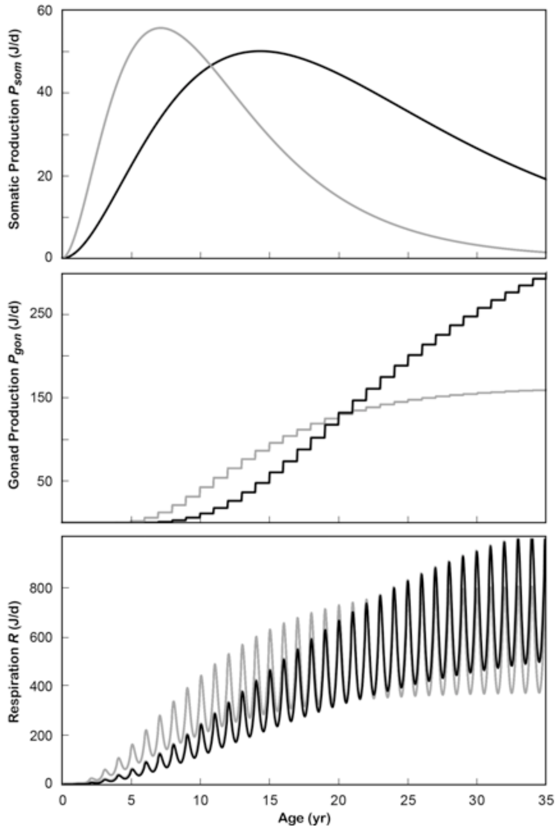

Fig. 7. Major parameters of *L. elliptica* lifetime energy budget in the 1960s (black curves) and in the 2000s (gray curves). Models are driven by shell growth (Fig. 5) and temperature (Fig. 6), and model equations are shown in Table 1. Somatic production P_{som} equals the increase in body mass with time. Note that daily production data are calculated values only, because seasonal variability in somatic growth and gonad development is not considered whereas the respiration model is driven by the seasonal temperature cycle (Fig. 6).

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The bivalve *Laternula elliptica* at King George Island — A biological recorder of climate forcing in the West Antarctic Peninsula region

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ABSTRACT

The West Antarctic Peninsula (WAP) has experienced marked recent climate change. Air temperature increased by ≤3 °C since the 1950s, glaciers are in retreat, and adjacent ocean sea ice cover has decreased. WAP also exhibits considerable inter-annual ocean–atmosphere variability, governed by the Southern Hemisphere Annular Mode (SAM) and by the Antarctic Dipole (ADI), which is itself modulated by ENSO. Both climate trends and oscillations affect WAP ecosystems, but sound evidence for mechanistic coupling of distinct processes to climate change is scarce. We analyzed decadal variability in shell growth over the past 49 years for the bivalve *Laternula elliptica* at Maxwell Bay, King George Island. Distinct changes in shell growth pattern include a near doubling of specific growth rate, a 25% decrease in maximum size, and a shift in individual energy expenditure from production to respiration. ENSO forces shell growth through local air temperature that constitutes the major link between regional climate forcing and the direct marine drivers of *L. elliptica* growth. The close coupling of shell growth to local and regional climate variability renders *L. elliptica* a promising tool for tracking climate forcing of Antarctic coastal systems in general, as well as for the reconstruction of coastal ecosystem variability from fossil shells.

1. Introduction

Long term trends and inter-annual variability are evident in many aspects of ecosystems – for example in ecosystem functioning as measured by total energy throughput, in primary production (the spatio-temporal distribution of carbon fixation and entry into the system), and in rates of individual growth and population recruitment – and these changes are suspected to be coupled to climate variability in many ways through local meteorological and oceanographic conditions (Smayda et al., 2004; Stenseth et al., 2002). However, many mechanisms can act as transmitters between climate signal and ecological response. At Antarctic latitudes, examples of such local forcing factors include mechanical ice impact on Southern Ocean benthic communities (Teixido et al., 2004), and the impact of sea ice extent on krill recruitment (Atkinson et al., 2004), and consequentially upon emperor penguin energetic investments in traveling (Croxall et al., 2002).

The West Antarctic Peninsula region (WAP) is the center stage of Antarctic climate change research. WAP is a "hotspot" of current climate trends (e.g., Vaughan et al., 2003; Meredith and King, 2005), and the marine ecosystem already is responding at various trophic levels, from a decrease in phytoplankton biomass to a shift from Adélie to Chinstrap and Gentoo penguins (Ducklow et al., 2007; Schofield et al., 2010). At the same time, inter-annual ocean–atmosphere variability is much more pronounced at WAP compared to other regions of the Southern Ocean (e.g., Yuan, 2004).

The dominant modes of inter-annual climate variability in the WAP region are the Southern Hemisphere Annular Mode (SAM) and the Antarctic Dipole (ADI). SAM (also known as the Antarctic Oscillation) is a circum-Antarctic annular atmospheric structure with synchronous pressure anomalies of opposite sign in mid-latitudes versus Antarctica, and which describes ±35% of total Southern Hemisphere climate variability (e.g., Marshall, 2007). Over recent decades, SAM has shown a positive trend strengthening the circumpolar westerly winds (e.g., Thompson et al., 2000). Additionally, the WAP region is at the center of the ADI (a system of coupled anomalies in pressure, air and sea water temperature, sea ice extent and other parameters) that is strongly connected to ENSO (El Niño Southern Oscillation). Changes in ENSO state from the warm (El Niño) to the cold (La Niña) extreme force a climatic shift in the South Pacific from a "cold" state (low pressure, low temperature, more sea ice) to a

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