Pleistocene and Holocene temperature reconstructions using earthworm-produced calcite

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Although not widely appreciated, many earthworm species are true biomineralisers, producing calcium carbonate (predominantly calcite) granules in specialised glands [1,2]. Granule production in European soils is dominated by two earthworm species, *Lumbricus terrestris* and *L. rubellus*. By means of laboratory experiments, using a wide range of temperatures (3–20 °C) and water compositions, we have established an oxygen-isotope ($\delta^{18}O$) palaeothermometer for *L. terrestris*. Granules produced by this species are consistently enriched in ^{18}O by 1.5‰ in comparison to equilibrium [3]. Well-preserved earthworm granules are commonly found in archaeological finds and buried soils up to at least ~2 Ma old. In combination with direct U-Th series dating they offer the potential for accurate temperature reconstructions for specific Quaternary time windows.

A selection of earthworm granule samples have been analysed for $\delta^{18}O$ values and U-Th composition. The samples originate from several interglacials and interstadials (e.g. Weichselian, Hoxnian, Gelasian), as well as Holocene time intervals and well-known archaeological sites (e.g. Silbury Hill, Boxgrove). Temperature reconstructions yield credible values. They show considerable intra-sample variation, which is probably a reflection of seasonal temperature variations. In addition, clear differences can be distinguished between different time intervals. Results will be discussed in context with existing climate reconstructions. We argue that $\delta^{18}O$ values of earthworm-produced calcite granules provide a useful and reliable terrestrial proxy for palaeotemperature reconstructions.

[1] Canti & Piearce (2003) *Pedobiologia* **47**, 511-521, 10.1078/0031-4056-00221; [2] Lambkin *et al.* (2011) *Pedobiologia* **54**, S119-S129, 10.1016/j.pedobi.2011.09.003; 3] Versteegh *et al.* (in press), GCA, 10.1016/j.gca.2013.06.020

2000 yrs of central Mediterranean change – what do proxies tell us?

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The Mediterranean is extremely vulnerable to climate warming through decrease of the critical precipitation - evaporation (P-E) balance. Despite its rele-vance for society and environment, the natural dynamics of this balance and the human influence thereupon are poorly understood, especially on decadal to millennial time scales.

To increase this understanding we analysed the coastal sediments of the eastern Gulf of Taranto and the Adriatic Mud Belt. The high sedimentation rates, low bioturbation and excellent tephra, ^{14}C, ^{137}Cs and ^{210}Pb and XRF-core scanning-based regional age model allow reconstruction of terrestrial and marine dynamics with a subdecadal resolution.

We present lipid, dinoflagellate and foraminifera-based environmental reconstructions focusing on temperature, the hydrological cycle and human impact during the last two centuries, the Little Ice Age and the Roman Optimum.

The process of regional proxy calibration appeared challenging, not in the least due to having multiple proxies for the "same" environmental variable such as SST (Fig. 1), terrestrial input or productivity. This forced us to reconsider established proxy-environment relations – their accuracy and what they stand for – strongly improving them as sources of knowledge on past environmental change.

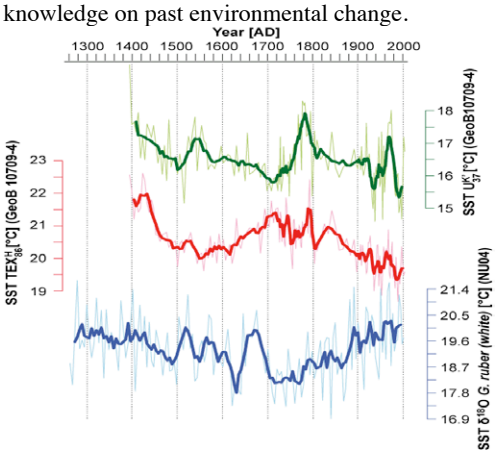

Figure 1: SST: one region, different proxies.

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