

ABSTRACTS OF TALKS TO BE PRESENTED AT THE MALACOLOGICAL SOCIETY MEETING 14 APRIL 2010

Arctica islandica, the “tree of the sea”: unlocking the archive

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Detailed understanding, at high spatial and temporal resolutions, of forcings and feedbacks within the climate system has hitherto been limited because the temperate marine environment has lacked an absolute timescale of the kind provided by tree-rings for the terrestrial environment and by corals for the tropical marine environment. This deficiency is now being rectified by the construction of cross-dated master chronologies (‘sclerochronologies’) based on annual increments in the shell of the ocean quahog, *Arctica islandica*. This presentation will review the *A. islandica* archive, the nature of the increment series in the hinge and along the shell margin, and stable isotopic and mark-recapture evidence for the annual nature of the growth increments. We will present cross-dating and radiocarbon evidence for the extreme longevity of *A. islandica*, including a live-collected specimen from the north Icelandic shelf that lived in excess of 500 years and which is considered the longest-lived non-colonial animal known to science. We will present the first annually resolved, multi-centennial, absolutely dated, shell-based marine master chronologies for the Irish and North Seas, and for the north Icelandic shelf. These chronologies have been constructed by detrending, cross-matching and averaging annual growth increment widths in the shells of multiple specimens. The techniques used in cross-matching shell increment series will be discussed with particular emphasis on different detrending techniques (negative exponential function, segment length dependent spline and regional curve standardization) employed to preserve low-frequency signals, and their characteristics will be compared. The strength of the common environmental signal expressed in the chronologies is fully comparable with equivalent statistics for tree-ring chronologies. These data justify the description of *A. islandica* as the “tree of the sea”. The strength and robustness of the chronologies generated from *A. islandica* demonstrate that molluscan sclerochronology will become a major branch of palaeoceanographic and palaeoenvironmental research over the coming years. Further applications of the longevity of *A. islandica* in research into ageing will be briefly discussed.

The shell of *Arctica islandica* as a unique natural archive of the marine environment during the past millennium

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Recent work on growth increment patterns and geochemistry in the aragonite shell of the long-lived bivalve *Arctica islandica* has shown that it constitutes a unique natural archive for the North Atlantic shelf seas. Circulation patterns and ocean-atmosphere fluxes in the North Atlantic Ocean play key roles in the global climate system, and palaeoclimate records derived from the *A. islandica* archive have significant potential as constraints in coupled climate models of the past millennium. Results presented here, based on multi-centennial *A. islandica* master chronologies from the Irish Sea and the North Icelandic shelf show:

- (a) shell growth generally responds positively to seawater temperatures;
- (b) there is coherent variability in the marine radiocarbon reservoir on the North Icelandic shelf which may indicate changes in the respective influences of Arctic and Atlantic water masses;
- (c) there is a trend to isotopically light shell carbon in Irish Sea waters during the past 200 years, indicating a flux from atmosphere to ocean of carbon derived from fossil fuel sources.

Sclerochronology of long-lived bivalve molluscs: a multi-species approach to palaeoenvironmental reconstruction

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Bivalve molluscs, such as the long-lived ocean quahog (*Arctica islandica*), contain records of their ontogeny in the form of internal growth lines. These growth-lines have formed the foundation of annually resolved multi-centennial sclerochronologies, which can be applied in powerful high resolution palaeoenvironmental reconstructions of parameters such as sea water temperature, nutrient availability and population dynamics. *Arctica islandica*, which has been perceived to be the most important molluscan sclerochronological archive, has been utilized in a large number of sclerochronological investigations due to its' great longevity (>400 years), proven annual periodicity of growth increments (Witbaard *et al.*, 1994) and proven synchronous growth amongst individuals within populations. The distribution of *A.*

islandica however is not homogenous in the marine environment, and is constrained by water depth and sediment type. It is therefore advantageous to broaden the spectrum of species utilized as sclerochronological archives to incorporate species constrained by complementary sediment types. Current research has highlighted that the heart cockle, *Glossus humanus* (~100 years maximum longevity) and in particular the dog cockle, *Glycymeris glycymeris* (>200 years maximum longevity), have potential in the construction of high resolution multi-centennial sclerochronologies. Utilizing these species will broaden the geographic spectrum over which sclerochronological archives can be applied and thus allow areas which contain no *A. islandica* to be reconstructed at annual to sub-annual resolution.

Intraspecific patterns in freshwater mussel shell morphologies and their potential use for reconstructing environments

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Most species of freshwater mussels (Unionoida) show a wide variation in various shell morphological characters, most notably shell shape and sculpture. Understanding the factors that determine such intraspecific morphological trends can assist in the reconstruction of (palaeo)environments, for example, by comparing fossil and modern morphotypes. However, despite a long history of mostly anecdotal observations, patterns and mechanisms of intraspecific variation in unionoid shell morphology are still poorly understood. Only recently has an ecophenotypic trend in shell form that is consistently exhibited by several freshwater mussel species been identified. This talk will review current knowledge on morphology-habitat associations and, focusing on current work on modern unionoid species, discuss how modern morphometric techniques can help detect intraspecific ecophenotypic trends that could be used in environmental reconstructions. The extent to which non-habitat factors, such as allometric growth, sexual dimorphism and trematode parasitism, influence unionoid shell morphology will also be examined.

Polar molluscs: a view from the fossil record

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How far back in time can we trace distinctive polar molluscan faunas? There is now some evidence to suggest that the Antarctic fauna is considerably older than the Arctic and has at least some elements that can be traced back to the Late Mesozoic. The Arctic fauna most likely has an Early Cenozoic origin in the Northern Pacific regions and it is clear that faunal interchange between the two developing cold temperate/polar faunas occurred repeatedly along the western coast of the Americas. We are now beginning to understand that the mass extinction event at the K-T boundary reset the evolutionary clock for marine molluscan faunas and it would

appear that, throughout the Cenozoic, the polar regions were net importers of taxa. Nevertheless, a number of cool/cold water clades have clearly flourished in both polar regions and understanding the nature and timing of these evolutionary radiations remains a high research priority.

Terrestrial mollusc faunas and quantified climatic reconstructions: assemblages or individuals?

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During the last twenty years three transfer functions have been developed and applied to fossil terrestrial mollusc faunas to quantify climatic parameters (e.g. temperatures, precipitation and so on). All are interpolation methods that allow quantified reconstructions only within the range of their calibration data set. The methods are named “best analogue”, “mutual climatic range” and “malacothermometry”, and are based on the principle of actualism (uniformitarianism). Their calibration requires the use of a varied and comprehensive data set so that they can be applied to fossil assemblages characterising different times and climatic periods. The link between the occurrence of molluscs and the climatic parameters controlling that occurrence is established at the level of the assemblage for the first method, and at the level of the taxa for both others. Different calibration biases thus impact quantitative reconstructions, and may require the application of corrections. During the development phase it is essential to check for the existence of a significant correlation between terrestrial molluscs and the climatic parameter to be reconstructed, and to determine physiological mechanisms justifying this correlation. All these points will be discussed for each of the three methods (when possible) to present the state-of-the-art of quantitative climatic reconstructions in terrestrial Quaternary malacology.

Molluscan biodiversity and biogeography: Pleistocene interglacial assemblages from NW Europe

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Recent malacological investigations on calcareous tufas and fluvial silts in Northern France have enabled the reconstruction of environmental conditions during different interglacial periods from the Middle Pleistocene up to the Holocene. Each temperate episode appears to be characterized by occurrences of specific land snails, including several species that are now extinct or which occurred far beyond their modern range. Not all interglacial periods are represented by a similar number of sites, but a preliminary comparison of molluscan data at a European scale has been attempted. The survey considers data from comparable contexts from the British Isles, Germany, Luxembourg and Northern France. The number of shade-demanding land snails decreases from the mid part of the Middle Pleistocene until now. Changes in the geographical distribution of species through time

allows the recognition of a so-called 'Oriental' and an 'Atlantic' province. When compared independently, the malacological data from each province produce similar results highlighting a dramatic difference between Holocene and Pleistocene interglacial sequences. This marked difference in forest malacological assemblages appears to be independent of human impact.

Recognition of human impact signals in Irish Holocene land snail successions

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Ireland has one of the most severely deforested landscapes in Europe. The nature and timing of this deforestation has usually been investigated by means of detailed pollen analysis, which generally reflects woodland disturbances in the landscape on a regional scale. Here we use changes in the composition of land snail assemblages, which reflect more local conditions, to identify short-lived disturbance events possibly resulting from human activity. Molluscan analyses were undertaken through two neighbouring tufa sequences of Holocene age in County Mayo, Ireland. Possible signs of human impact were recognized in both records. Four disturbance horizons were detected during the late Bronze Age and early-middle Iron Age at one site (Catronmacmannus), whereas the neighbouring site at Graffy provided evidence of a disturbance at about 2800 yr BP. The registration of these events differed significantly from the characteristic faunal signatures associated with comparable impacts in southern Britain. These differences result from the relative scarcity of certain critical taxa (e.g. *Vallonia costata*) in Ireland compared with their general abundance elsewhere.