Ecological uniformitarianism - key or lock?

Discussion Event

3 March 2022	
16.25	**Event Opens**
16.30	**Welcome Address from conveners**
Session 1	
16.40	Ecophysiological responses to changing environmental conditions in marine invertebrates: molecular keys to adaptation **Ana Riesgo (National Museum of Natural Sciences, Madrid)**
16.55	Discussion
17.05	Niche shift or not for some major European tree Species over the Holocene **Rachid Cheddadi (University of Montpellier, France)**
17.20	Discussion
17.30	Niche stability and conservation paleobiology: Clams, condors and cottonwoods **Karl W. Flessa, (University of Arizona)**
17.45	Discussion
17.55	**Break**
Session 2	
18.05	How warm were Pleistocene interglacials? Reconstructing past temperatures using terrestrial fossil assemblages. **Tom S. White (Natural History Museum, London)**
18.20	Discussion
18.30	Late Neogene – early Quaternary seasonality changes recorded in North Atlantic dinoflagellate cyst assemblages **Jan A.I. Hennissen (British Geological Survey)**
18.45	Discussion
18.55	Ecological uniformitarianism: A deep time perspective **Marci M. Robinson and Harry J. Dowsett (US Geological Survey)**
19.10	Discussion
19.20	Concluding Remarks from conveners and discussion
19.30	**Close**

Ecophysiological responses to changing environmental conditions in marine invertebrates: molecular keys to adaptation

Ana Riesgo (National Museum of Natural Sciences, Madrid)

The marine realm is currently suffering the effects of global warming with dramatic consequences for its fauna, including range shifts, disease and decimations, and extinctions. This is not the first time that the Earth has experienced periods of cooler and warmer temperatures, although the first time that the change is accelerated by the human hand. But like with any other environmental challenge, while some organisms are struggling to cope with the changes, some others are adapting to live in warmer waters and even thriving. We have compared the mechanisms of molecular response to temperature challenges in several marine invertebrates from both Antarctic and Mediterranean waters. Antarctic and Mediterranean sponges exposed to waters several degrees warmer exhibited adaptive responses based on activation of heat shock proteins and immune system pathways, but interestingly Mediterranean sponges were able to adapt to the highest temperatures rather quickly. In turn, the Mediterranean black sea urchin did not show any response to quick seawater temperature increases, and cold temperatures induced a stronger transcriptional response. Our results highlight the variety of strategies exhibited by marine invertebrates to current temperature challenges, remarking the necessity of studying a wide array of key threatened species in depth to understand how marine species are coping with temperature shifts due to global warming.

Niche shift or not for some major European tree Species over the Holocene

Rachid Cheddadi (University of Montpellier, France)

We quantified the extent to which the relationship between the geographic distribution of three major European tree species and a climate variable (January temperature) has remained stable over the past 10,000 years. If such a relationship has changed over time, then the species' niche is not stable over time.

As a first step, we reconstructed the spatial variation in temperature for each 1000-year time slice between 10,000 and 3000 years BP. We omitted the last 3000 years because of the relationship between climate and plants, which could be more or less modified by human activities. Then we evaluated the relationships between the occurrence of the three species in each time slice and the spatially interpolated climate variable and compared them with their modern values.

Our results show that two species experienced climate values during the Holocene that differ from those of the present, while one species occurred in a range comparable to its present. The substantial changes observed in realized thermal niches during the Holocene suggest that the niche of some European trees is not stable over time and that prediction of future species distributions should not be based solely on modern realized niches, but must also take into account past variations in climate variables that determine species distributions.

Niche stability and conservation paleobiology: Clams, condors and cottonwoods

Karl W. Flessa, (University of Arizona)

Niche lability is a good thing at decadal and centennial time scales. (1) A species of mactrid bivalve was once abundant in the brackish water of the Colorado River estuary. Surprisingly, a small population persists in the estuary's now hypersaline waters. (2) California condor fossils are known from caves in the Grand Canyon, far from where their entire population was captured for breeding in 1987. Rewilding offspring to where the species lived 11,000 years ago has been a success - despite the lack of their original megafaunal food supply. (3) As altered hydrologic regimes have reduced the extent of cottonwood-willow riparian habitat in the southwestern U.S., some endangered southwestern willow flycatchers have resorted to nesting in the invasive tamarisk. Low quality is better than no quality.

Nature needs help. Active management of species and habitats at decadal time scales is easier when fundamental niche space exceeds the realized space.

How warm were Pleistocene interglacials? Reconstructing past temperatures using terrestrial fossil assemblages.

Tom S. White (Natural History Museum, London)

Pleistocene palaeoclimatic and palaeoecological reconstructions are founded on information about the ecological preferences and environmental tolerances of extant plant and animal species found as fossils. In Britain, the Last Interglacial (Ipswichian, ~125, 000 ka) is often depicted as a balmy paradise, with higher summer temperatures than the present day indicated by the occurrence of species currently associated with much warmer parts of the world (most famously hippopotamus). But how reliable are these reconstructions, and was the Ipswichian climate really that different to the Holocene? More critical consideration of the ecological preferences of flora and fauna commonly used to reconstruct Ipswichian palaeotemperatures (and those of other Pleistocene interglacials) reveals a more complex story, and will hopefully generate a fascinating discussion on the accuracy, reliability and usefulness of such reconstructions more generally.

Late Neogene – early Quaternary seasonality changes recorded in North Atlantic dinoflagellate cyst assemblages

Jan A.I. Hennissen (British Geological Survey)

Dinoflagellate cysts (dinocysts) are widely used as tracers of sea surface conditions in late Quaternary marine records. However, palaeoenvironmental reconstructions across the Pliocene–Pleistocene climatic transition, and beyond, are limited because the hydrologic conditions influencing assemblage composition may not have a modern analogue, or the ecological optima of extinct species are not well known. To bypass these issues, I explore in this talk how dinocyst assemblage composition can be compared directly to palaeoecological parameters derived from foraminifers, recovered from the same samples. I utilise the results from studies on two cored sites in the central and eastern North Atlantic and show that near the Neogene–Quaternary boundary around 2.6 Ma, the intensification of Northern Hemisphere glaciation (iNHG) was marked by a southward shift of the North Atlantic Current and Arctic Front and a concurrent drop in sea surface temperature (SST) in the mid-latitudes of the North Atlantic. Around the same time, seasonality increased significantly, owing to a drop in early spring temperatures, and peaked during glacial episodes. Through canonical correspondence analysis we demonstrate the co-variation of seasonality and dinocyst paleoproductivity. Given the importance of dinoflagellates as primary producers, contributing significantly to the Earth's annual oxygen budget, this covariation may have important consequences now that it has been shown that the extant Atlantic Meridional Overturning is weakening.

Ecological uniformitarianism: A deep time perspective

Marci M. Robinson and Harry J. Dowsett (US Geological Survey)

Stationarity of ecological tolerances is a primary assumption of paleoenvironmental reconstructions based upon analog methods, one that the USGS PRISM project has relied upon for over thirty years of foraminiferal assemblage work aimed at a global understanding of the Pliocene ocean. To test this and other assumptions, we analyzed paired $U_{37}^{K'}$ sea surface temperature (SST) estimates and planktonic foraminiferal assemblage data from late Pliocene sequences. We determined Pliocene temperature preferences for four species: *Dentoglobigerina altispira, Globorotalia puncticulata, Neogloboquadrina atlantica,* and *Neogloboquadrina incompta*. *Neogloboquadrina incompta* (extant) shows similar temperature preferences in both late Pliocene and present-day assemblages. The data from the other three (extinct) taxa are mostly encouraging, supporting past PRISM conclusions, and otherwise valuable for testing previous taxonomic grouping decisions that were necessary to convert Pliocene foraminifer assemblages to SST.