Evolution of Molecular Ecosystems in a Hydrothermal Environment

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The sea floor near hot vents in the Hadean or Archaean ocean could have provided a prebiotic ecosystem being capable of its own evolution. In order to examine such a possibility of having prebiotic ecosystems in hydrothermal environments, we constructed a flow reactor simulating hydrothermal circulation of seawater through hot vents and studied the time development of the reaction solution itself comprising amino acid molecules of four different kinds; glycine, alanine, valine and aspartic acid. Each run of our experiment was subjected to the same initial and boundary conditions to the extent that the experimental controllability could permit us to do so. We repeated the similar experiments, each one of which lasted over three hours, more than fifty times, and classified the developmental patterns of the reaction products with the use of HPLC elution profiles. The developmental patterns of the elution profile demonstrated their clustering, which also varied in time within the total interval of three hours. What was unique to the clustering was its robustness. The soup of the four different kinds of amino acid was found to exhibit a phylogenetic tree even over such a short time interval of three hours. The tree demonstrated both divergence and convergence, whereas the divergence finally overcame the convergence. These observations, when combined together, suggest to us that the experimental hydrothermal environment can be competent not only in synthesizing oligomers but also in supporting an evolving molecular ecosystem altogether.

Testing concordance of oxygen isotope palaeotemperatures obtained from associated rodent tooth phosphate and freshwater carbonate: an Eocene example from the Hampshire Basin

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The oxygen isotopic composition of fossil rodent tooth enamel holds considerable potential for defining changes in the $\delta^{18}O$ of local meteoric water. Associated freshwater biogenic carbonates then provide a means of obtaining palaeotemperatures using conventional isotope thermometers. The objective of this study is to test temperature concordance of multiple palaeo-proxies at a single level. We report oxygen isotope data for rodent tooth enamel ($\delta^{18}O_{phosphate}$ = +17.7 ± 2.0 ‰ n = 74 (VSMOW)); along with fish scale ganoine ($\delta^{18}O_{phosphate}$ = +19.7 ± 0.7‰ n = 20 (VSMOW)); gastropod shell ($\delta^{18}O_{aragonite}$ = -1.7 ± 1.3 ‰ n = 50 (PDB)); charophyte gyrogonite ($\delta^{18}O_{calcite}$ = -2.4 ± 0.5 ‰ n = 20 (PDB)) and fish otolith ($\delta^{18}O_{aragonite}$ = $\delta^{18}O$ = -3.6 ± 0.6‰ n = 20 (PDB)) from the Late Eocene (Priabonian) Osborne Member (Headon Hill Formation, Solent Group, Hampshire Basin, UK). Data for rodent tooth enamel show a skewed distribution most likely as a result of the ingestion of evaporating water. The modal value was used to obtain a $\delta^{18}O_{local\ water}$ value of –1.3 ± 1.7‰ (Lindars et al, GCA, 65, 2535 (2001)). By combining the calculated $\delta^{18}O_{local\ water}$ value with the other four palaeoproxies, four mean palaeotemperatures were calculated. Those calculated using the fish scale and gastropod (*Lymnaea*) shell thermometry equations (both 21 ± 2˚C) most likely represent the mean temperature of the entire length of the growing season. The mean palaeotemperature calculated using the charophyte gyrogonite thermometry equation (21 ± 2˚C), on the other hand, most likely represents the mean temperature of a single month towards the end of the growing season. The fish otolith mean palaeotemperature most likely represents the mean temperature of the warmest months of the growing season. A mean growing season palaeotemperature of 21 ± 2˚C, with a warmest month temperature of 28 ± 2˚C, and high associated standard deviations suggest a subtropical seasonal climate.