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Nordic Nummulites: are Eocene hyperthermals driving range expansion of warm water taxa?

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As modern global warming continues, invasive species, expansion and migrations of warm water taxa are becoming increasingly common. Using the past to understand the dynamics driving changes in species' geographic range is therefore exceptionally important to understand the future.

Nummulites are giant single celled organisms (up to 10 cm), that were abundant throughout the tropical seas of the Eocene (56-33.9 million years ago). They lived in a very similar way to corals, containing photosynthetic algae, which is thought to have helped them reach such large sizes. Also like corals, they were generally restricted to shallow tropical and sub-tropical seas. However, recently in the Natural History Museum of Denmark collections a specimen of early Eocene *Nummulites* found in a glacial erratic from Jysk Rev was reidentified, indicating they occurred much further north than previously thought. During the early Eocene the climate was not only warmer than today, but punctuated by several short-lived rapid warming events known as hyperthermals. These sudden warming events may have allowed for tropical organisms, such as the *Nummulites*, to expand well beyond their normal range.

In this project, we will collect samples from Albæk Hoved in eastern Jutland, and the Harre-1 borehole, which span the lower Eocene interval containing the hyperthermal events. Using geochemistry and biostratigraphy we aim to define the magnitude and extent of the warming in Denmark during these events. This data will then be used with climate models and studies of *Nummulites* populations across NW Europe, to examine potential migration routes and whether the sudden warming events of the early Eocene allowed them to expand across higher latitudes.

Nordiske *Nummulites*: drev Eocæne hypertermiske klimaepisoder udvidelsen af varmvandsformers geografiske udbredelse?

Spredning og migration af varmvandsarter som Invasive arter bliver mere og mere almindeligt i takt med at den globale opvarmning fortsætter via spredning og migration af varmvandsarter mod højebreddegrader. Brugen af fortiden til at forstå drivkræfterne bag ændringer i arters geografiske udbredelse er derfor ekstremt vigtig for at forstå fremtiden.

Nummulitter er store encellede organismer (op til 10 cm), der var almindelige i de tropiske farvande igennem Eocæn (56–33,9 mio. år siden). Deres livsstil mindede om den for koraller, indebærende fotosyntetiserende alger, hvilket menes at have hjulpet dem med at opnå så store størrelser. Ligesom koraller var de generelt begrænset til lavmarine, tropiske og subtropiske have. Dog blev et eksemplar af en tidlig Eocæn nummulit genidentificeret i en glacial vandreblok fra Jyske Rev, som nu befinder sig i samlingerne ved Statens Naturhistoriske Museum. Dette antyder, at nummulitter levede længere nordpå end tidligere antaget. I tidlig Eocæn var klimaet ikke blot varmere end i dag, det oplevede også flere korte og hurtige opvarmninger kendt som hypertermaler. Disse pludselige stigninger i temperaturer tillod måske tropiske organismer, såsom nummulitter, at sprede sig langt ud over deres normale udbredelsesområder.

I dette projekt vil vi samle prøver fra Albæk Hoved i Østjylland og fra Harre-1 boringen, der dækker det nedre eocæne interval med de hypertermale hændelser. Ved brug af geokemi og biostratigrafi vil vi forsøge at bestemme størrelsen og omfanget af opvarmningen i Danmark i løbet af disse hændelser. Resultaterne vil blive brugt sammen med klimamodeller og studiet af nummulit-

populationer fra det nordvestlige Europa til at undersøge mulige migrationsruter, og om de pludselige varmhændelser i tidlig Eocæn tillod dem at sprede sig over højere breddegrader.