

¹Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, ²Carl von Ossietzky University of Oldenburg, ³Helmholtz Institute for Functional Marine Biodiversity, ⁴Scottish Association for Marine Science

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Circadian Clock Involvement in Zooplankton Diel Vertical Migration

Key Messages

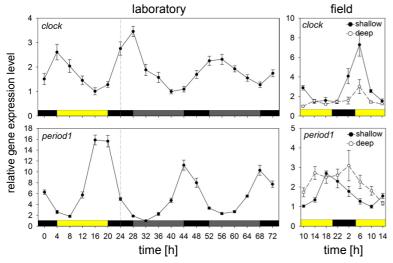
- The northern Atlantic key copepod Calanus finmarchicus possesses an endogenous circadian clock that is functioning under field conditions and affects diel phenotypic rhythms including diel vertical migration (DVM).
- To understand marine rhythms of life and how they will be affected by climate change, a mechanistic understanding of marine clock systems will be crucial, especially for key species like C. finmarchicus that drive ecosystem functioning.

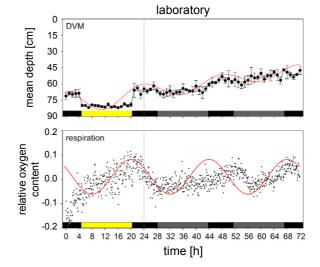
Reasoning

- Endogenous clock are crucial for the control of biological rhythms like diel behavioural cycles or seasonal life cycles, but they have hardly been addressed in marine organisms^[1,2].
- The DVM of zooplankton is central in shaping marine pelagic ecosystems and carbon flux in particular, but the factors controlling this 24h rhythm are still poorly understood^[3,4].
- C. finmarchicus is a northern Atlantic ecological key species with a highly rhythmic diel and seasonal lifestyle that includes DVM.

Approach

To determine if C. finmarchicus possesses a functioning circadian clock and how it affects DVM, diel rhythms in clock gene expression, metabolic activity and DVM behaviour were monitored in the laboratory. Diel clock gene patterns were also investigated in a DVM-performing C. finmarchicus field population in Loch Etive, Scotland.





Expression of the genes clock and period1 in C. finmarchicus. In the laboratory, copepods were kept under a natural light/dark cycle for one day, followed by two days of constant darkness. In the field, expression was measured in shallow (5-50 m) and deep waters (50-140 m). mean ± SE is shown. 6 out of the 8 investigated clock genes showed persistent diel rhythmicity.

Circadian rhythms in C. finmarchicus DVM and respiration. Copepods were kept under a natural light/dark cycle for one day, followed by two days of constant darkness. Phenotypic rhythms persisted under constant darkness (red curves added for illustration).

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DolarTime universität



^[5]Häfker NS, Meyer B, Last KS, Pond D, Hüppe L, Teschke M (2017) Circadian Clock Involvement in Zooplankton Diel Vertical Migration. Current Biology 27(14), 2194-2201, doi 10.1016/j.cub.2017.06.025

References

<sup>Thereined H (1993) Circadian rhythms. Current Opinion in Neurobiology 3, 1005-1010, doi 10.1016/0959-4388(93)90174-W

Takeniga H (1993) Circadian rhythms. Current Opinion in Neurobiology and ecology. Phylosophical Transactions of the Royal Society B: Biological Science 372, 20160253, doi 10.1098/rstb.2016.0253
Breferdey AS (2014) Del Vertical Migration. Current Biology 24(22), R1074-1076, doi 10.1016/j.ub.2014.08.054
Cohen JH, Forward Jr. RB (2005) Del vertical migration of the marine copepod Calanopia americana. II. Proximate role of exogenous light cues and endogenous rhythms. Marine Biology 147(2), 399-410, doi 10.1007/s00227-005-1570-4</sup>