Seafood Through Time Revisited:

Coupled body size evolution, metabolic activity, and ecological diversification in Phanerozoic bilaterian marine animals

Noel A. Heim, Matthew L. Knope, Jonathan L. Payne

Department of Geological & Environmental Sciences

Stanford University

Acknowledgments

Funding

- Stanford School of Earth Sciences Dean, Pamela Matson
- NSF CAREER Grant to J. L. Payne

Body Size

- History of Life and other high school interns
- Galen Griggs & Undergraduate researchers

Ecology

- Laura Zalles, Nicole Childs, Megan Faerber & Maria Cunniffe

Seafood through time: changes in biomass, energetics, and productivity in the marine ecosystem

Richard K. Bambach

(1) Diversity, ecosystem complexity, and the utilization of ecospace have increased during the Phanerozoic.

(2) The total biomass of marine consumers has increased.

(3) More energetic modes of life have become common among dominant macroscopic organisms.

(4) Within any particular Bauplan the effectiveness of nutrient acquisition does not increase with time, although increased resource partitioning (specialization) may occur if resources become more abundant.

(5) spread of organisms with more energetic modes of life from settings with established high rates of food supply in the early to mid-Paleozoic into habitats with lower relative rates of food supply in the Mesozoic and Cenozoic is indirect evidence of an increase in food availability in the marine ecosystem.

(6) An increase in the biomass at the base of the food chain (i.e., an increase in primary productivity) was necessary to support the increases in biomass, metabolic rates, tiering (both above and below the sediment/water interface), and predation that have occurred during the Phanerozoic.

(7) Evidence of increased global productivity during the Phanerozoic comes directly from both the rise of life on land and the increase in diversity of marine phytoplankton.

Seafood through time: changes in biomass, energetics, and productivity in the marine ecosystem

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On the global scale considered here an effort at quantification would be too speculative at this time.

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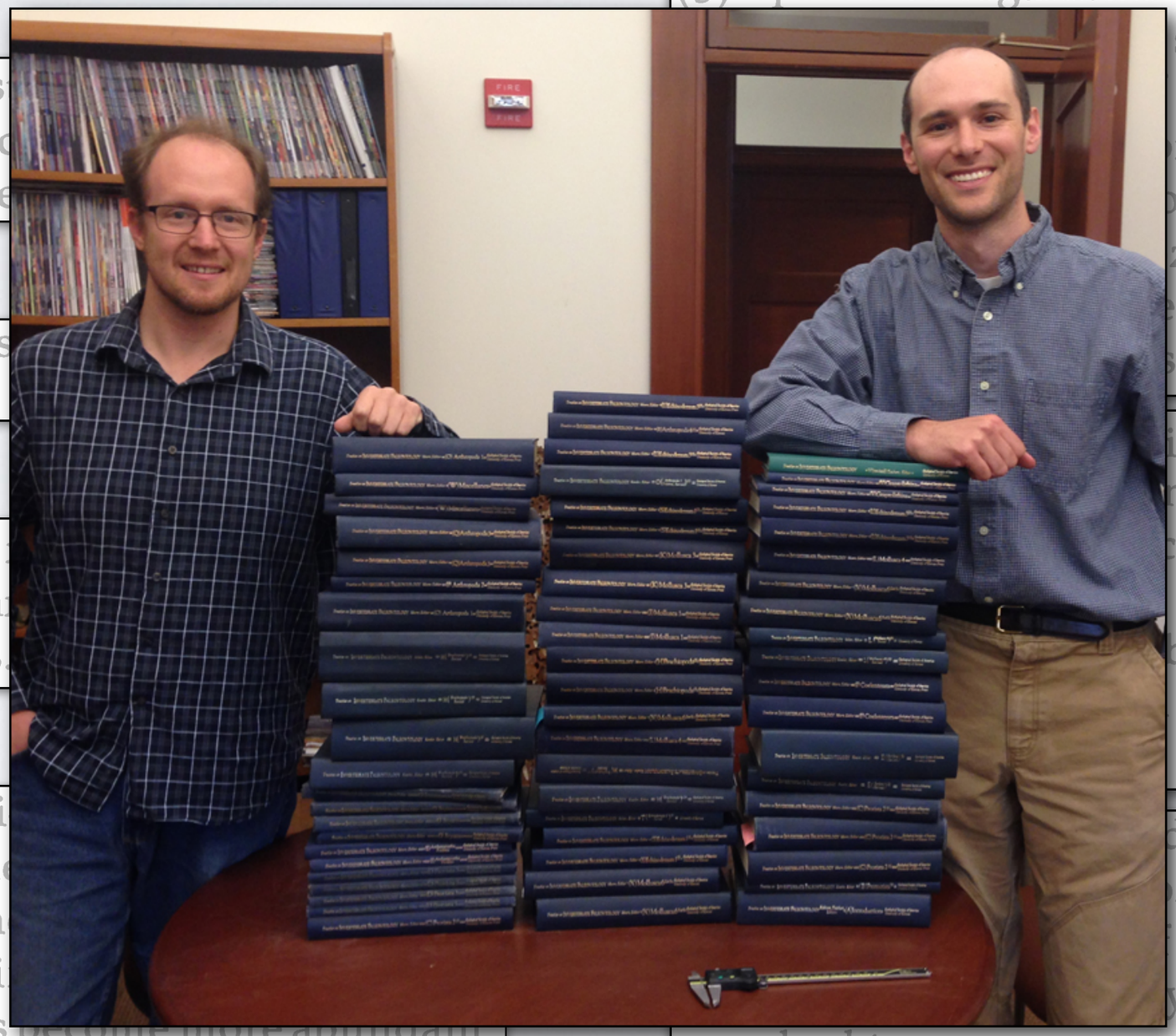

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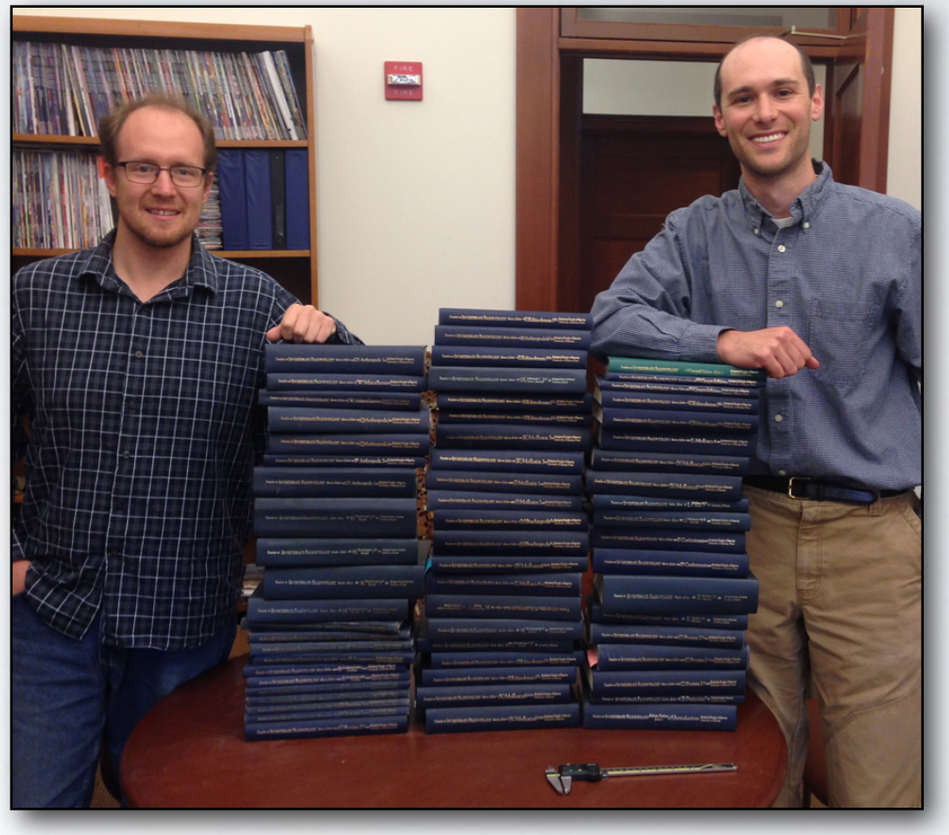
Quantifying Marine Animal Biovolume

Treatise on Invertebrate Paleontology



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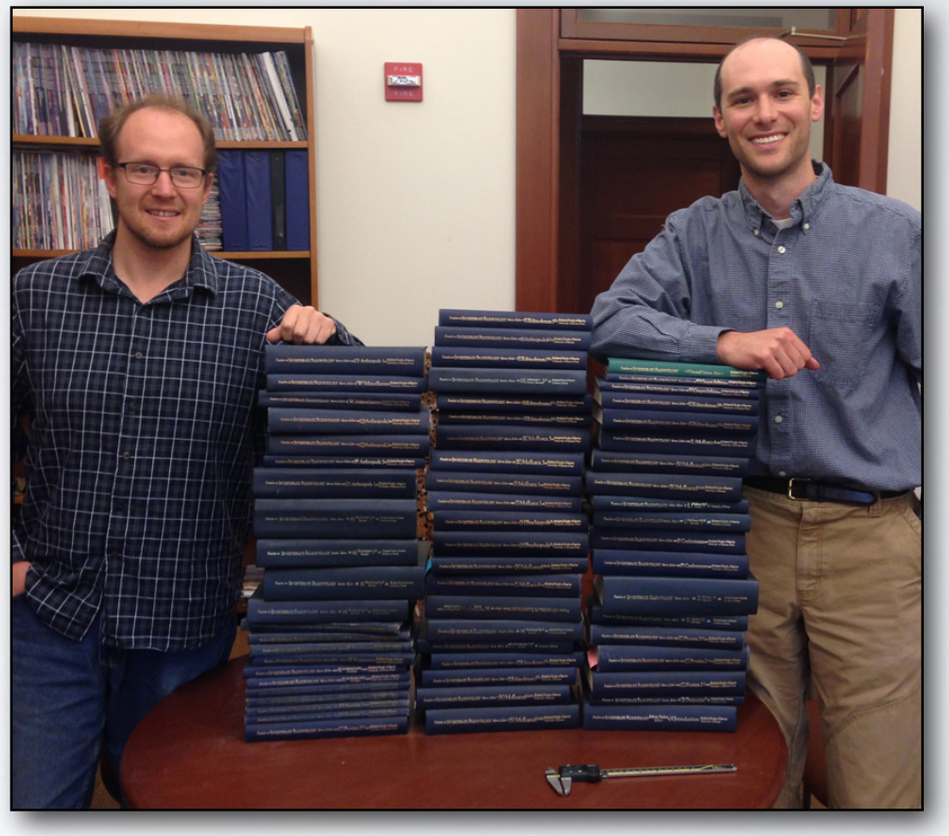

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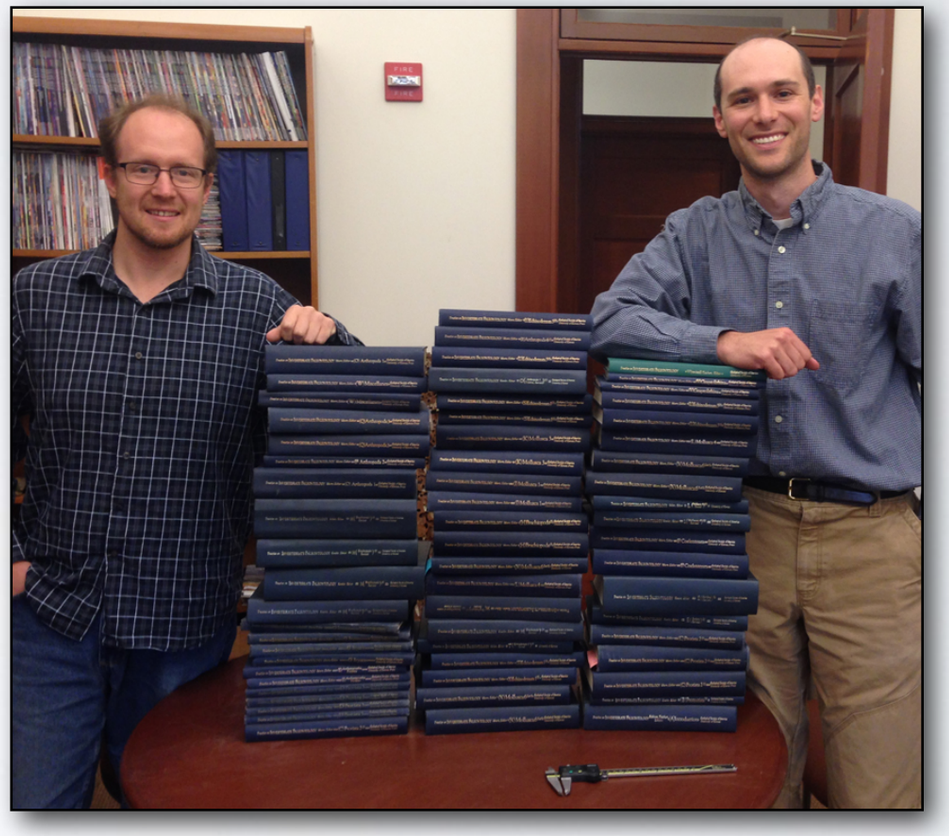

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Solitary Bilaterian Animals

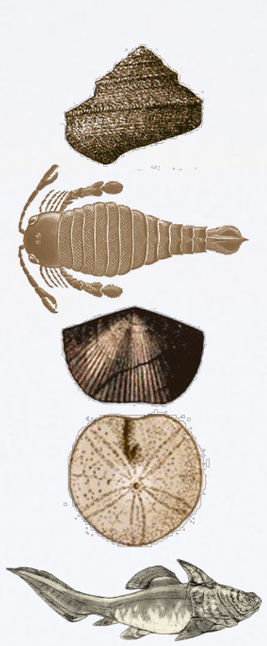
Molluscs

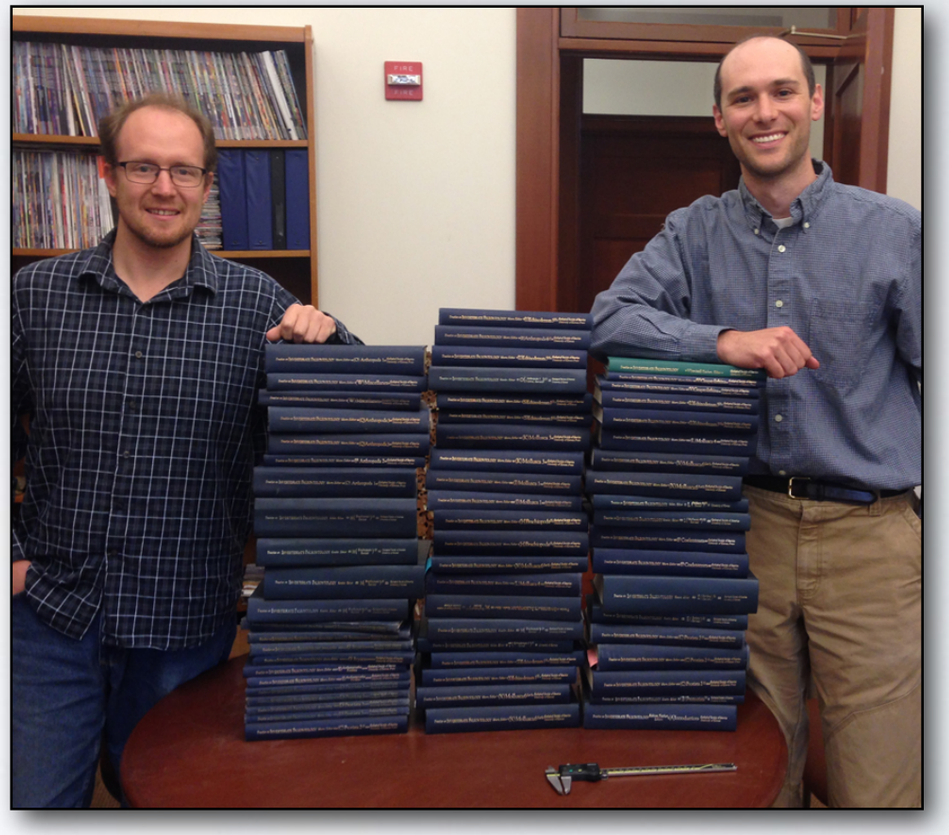
Arthropods

Brachiopods

Echinoderms

Chordates





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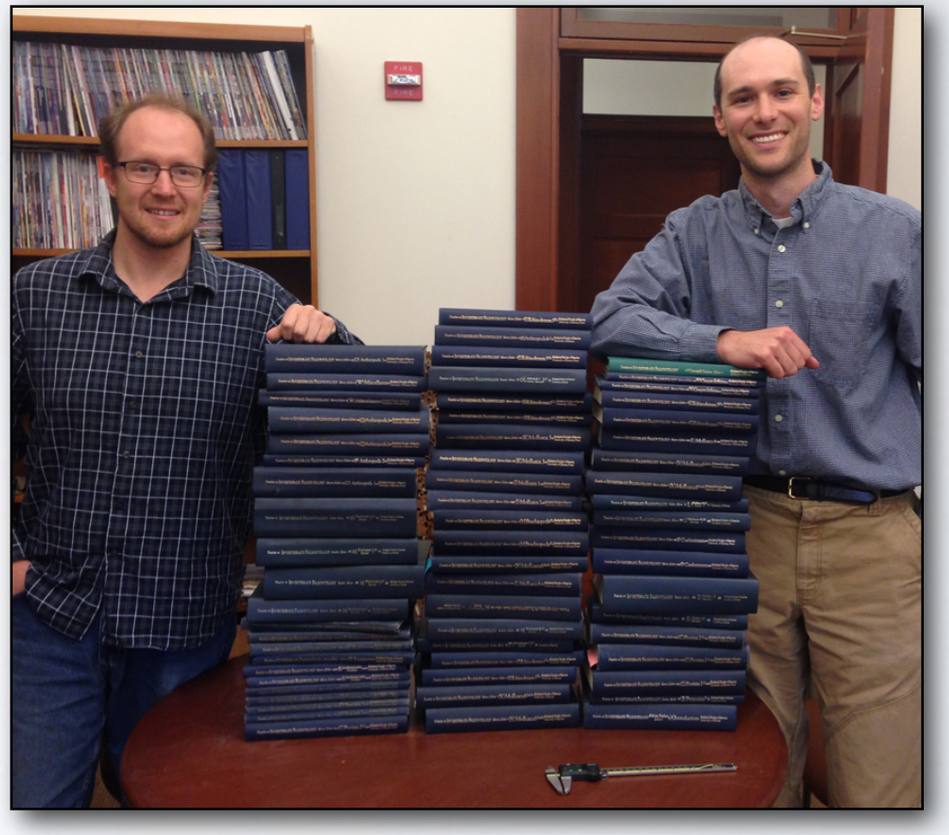

Molluscs
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Brachiopods
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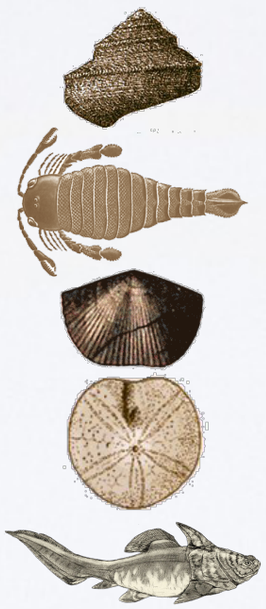
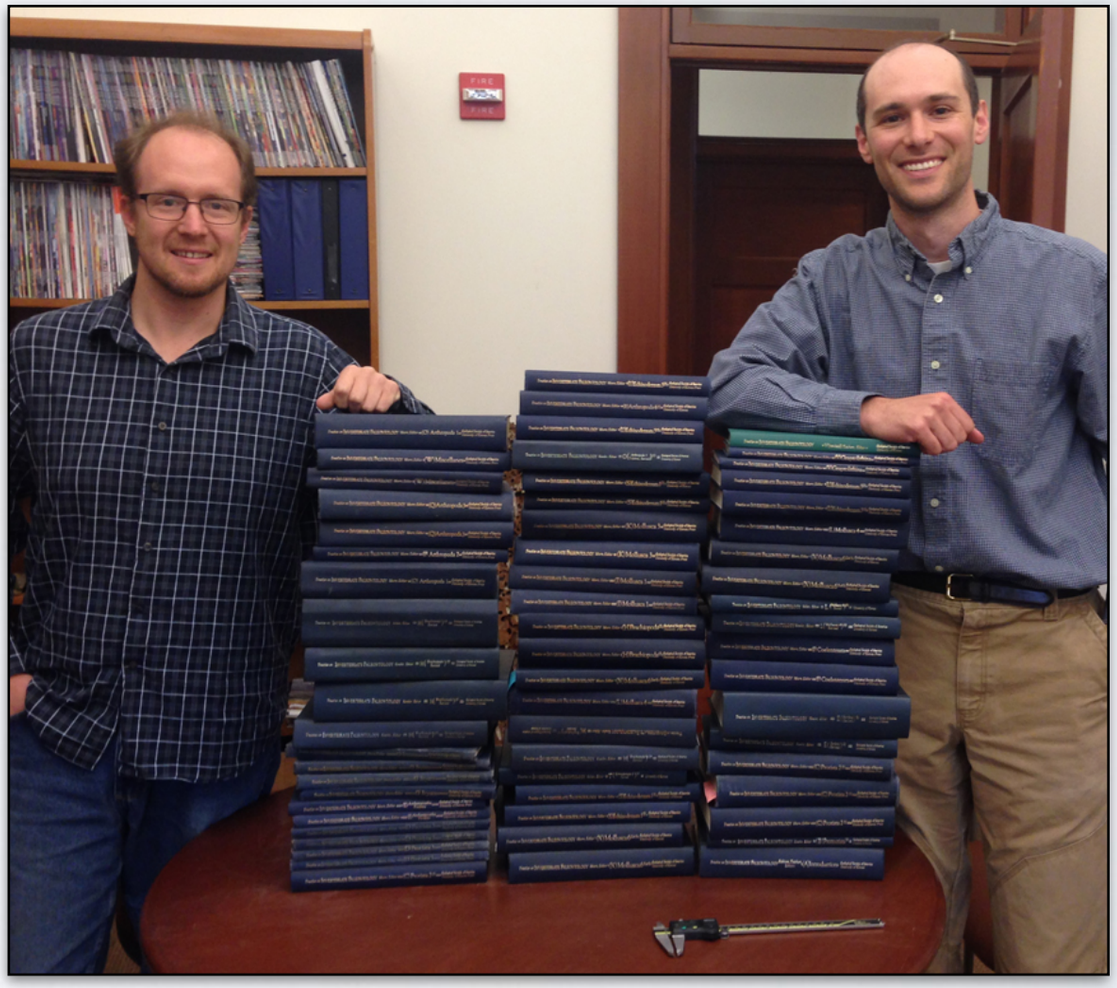


26,655 genera with stage-resolved strat. ranges
16,831 genera with ranges & sizes

Quantifying Marine Animal Biovolume



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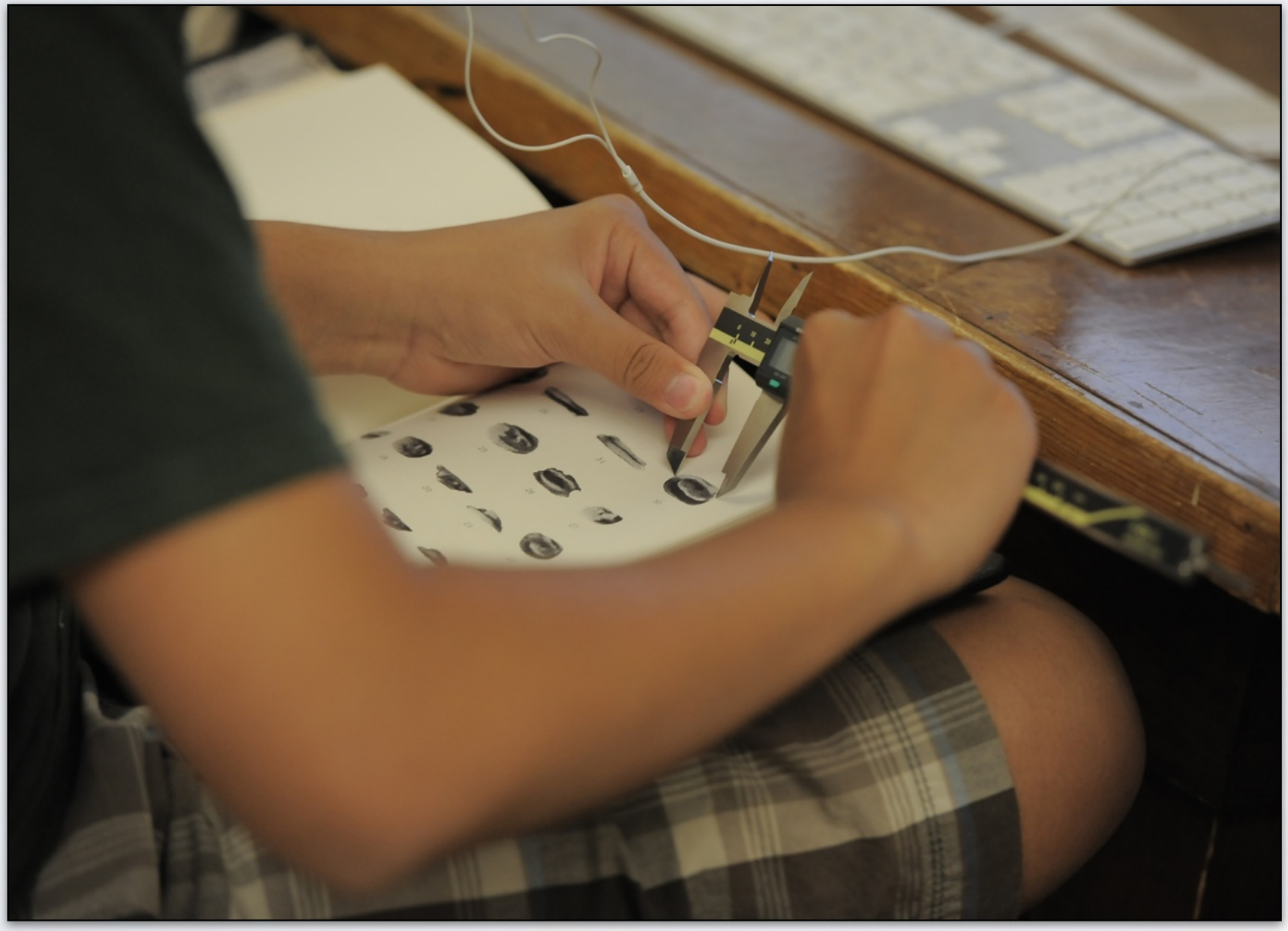
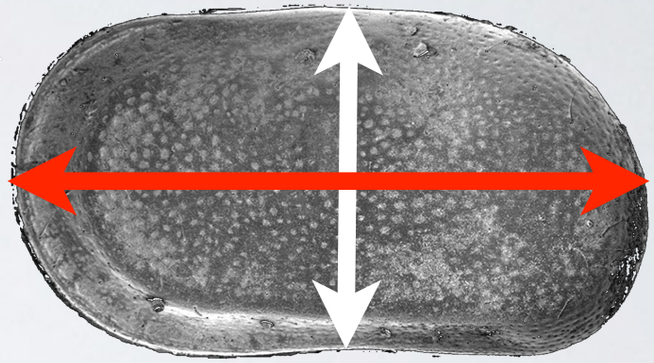
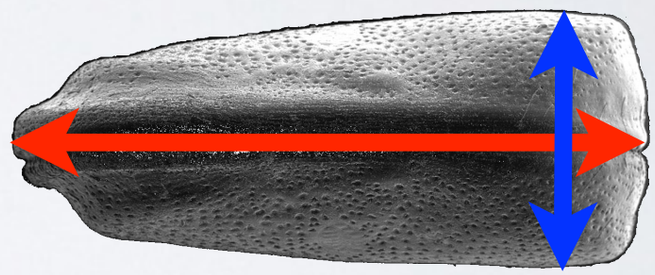
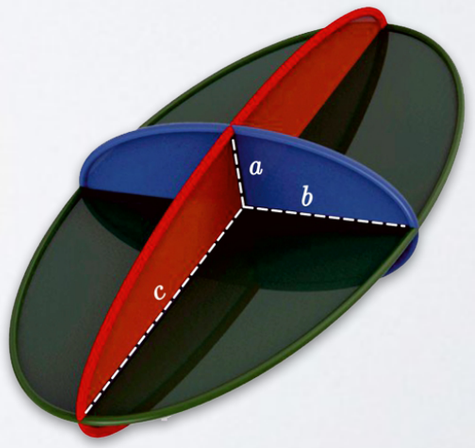
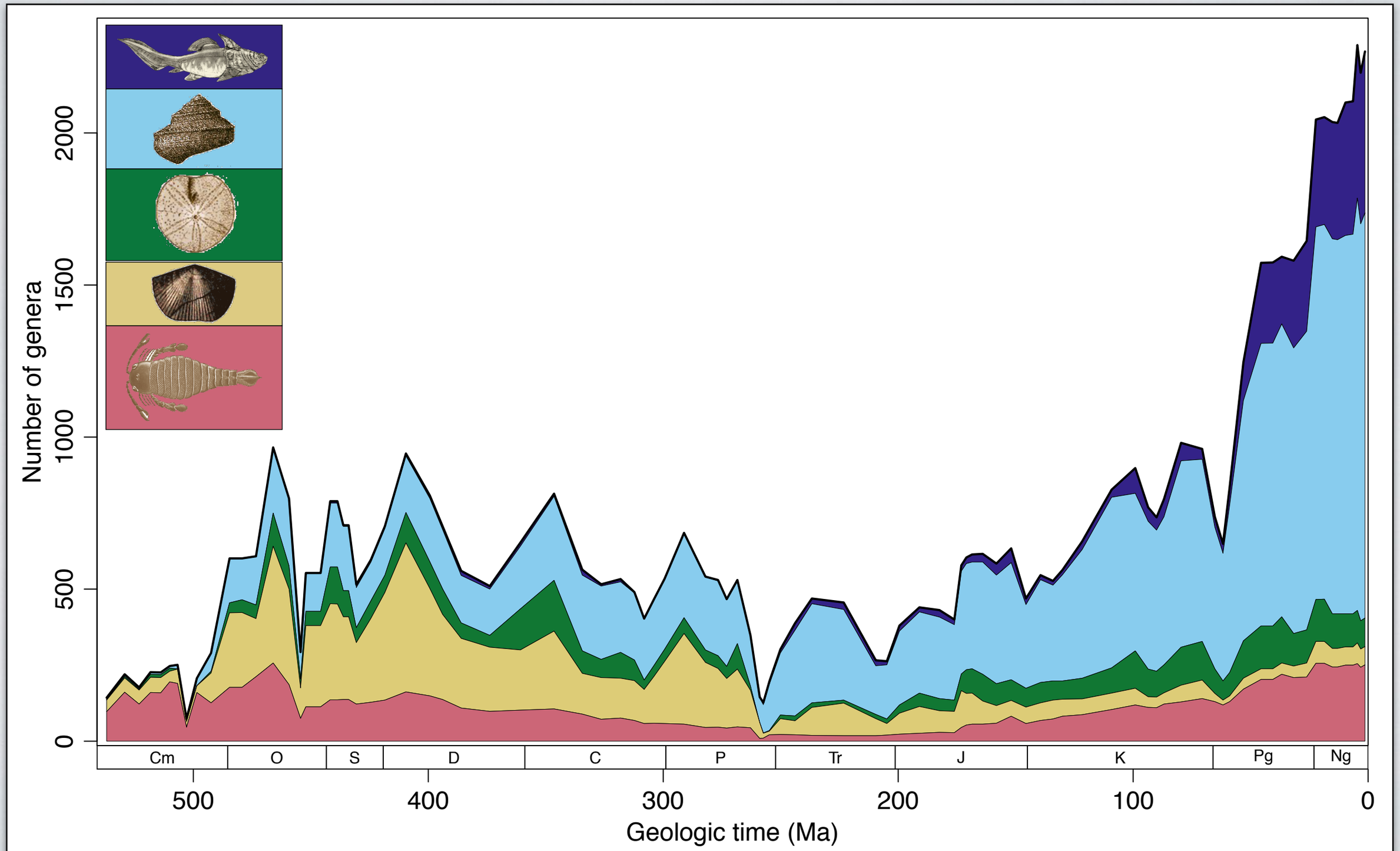








Marine Animal Genus Diversity

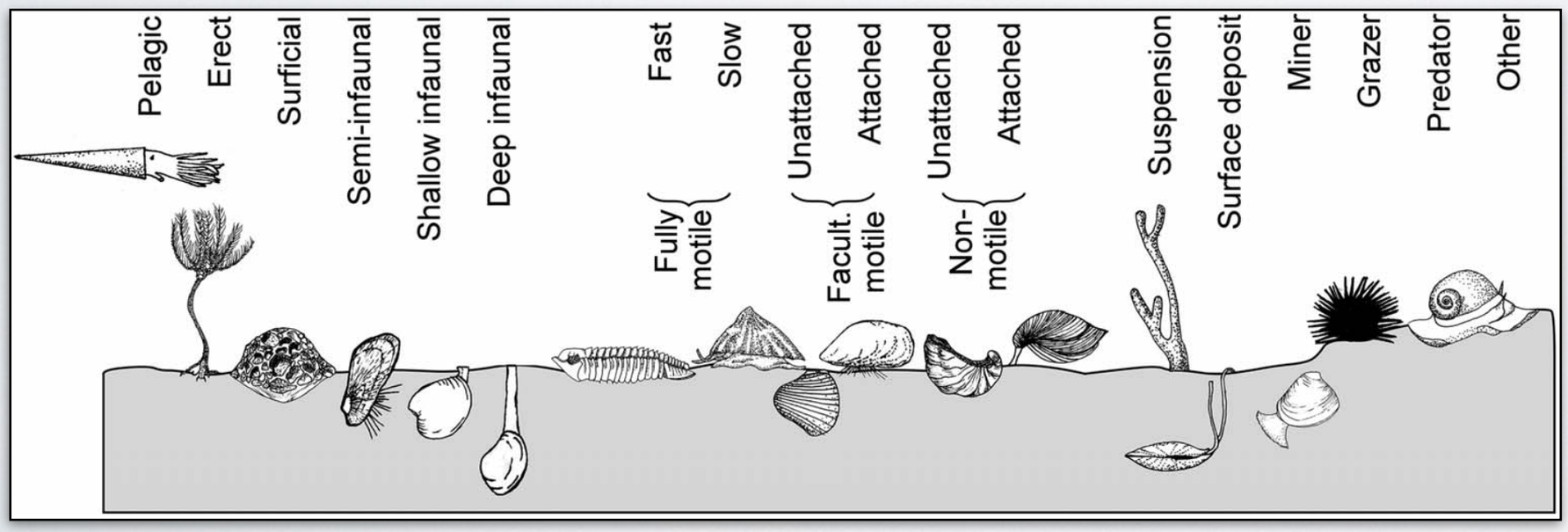


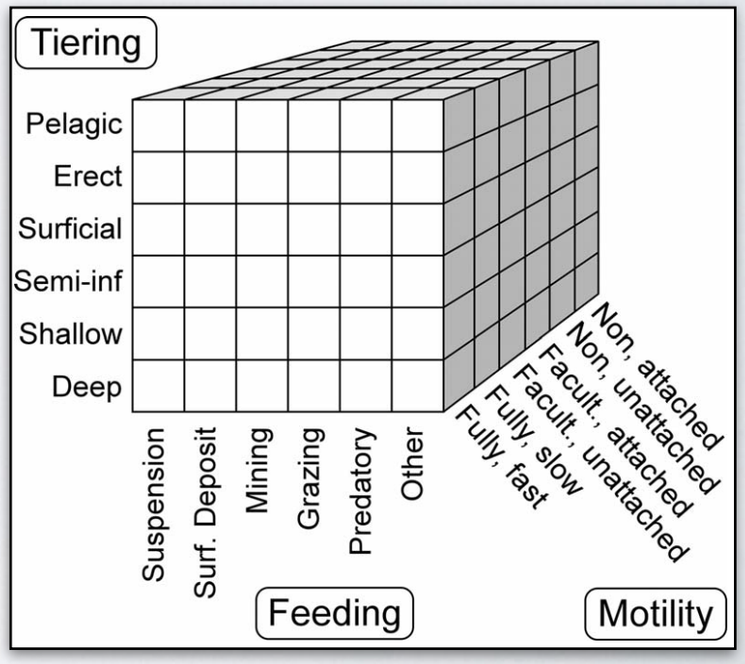
Quantifying Marine Animal Ecology

Changes in theoretical ecospace utilization in marine fossil assemblages between the mid-Paleozoic and late Cenozoic

Andrew M. Bush, Richard K. Bambach, and Gwen M. Daley

Paleobiology, 33(1), 2007, pp. 76–97





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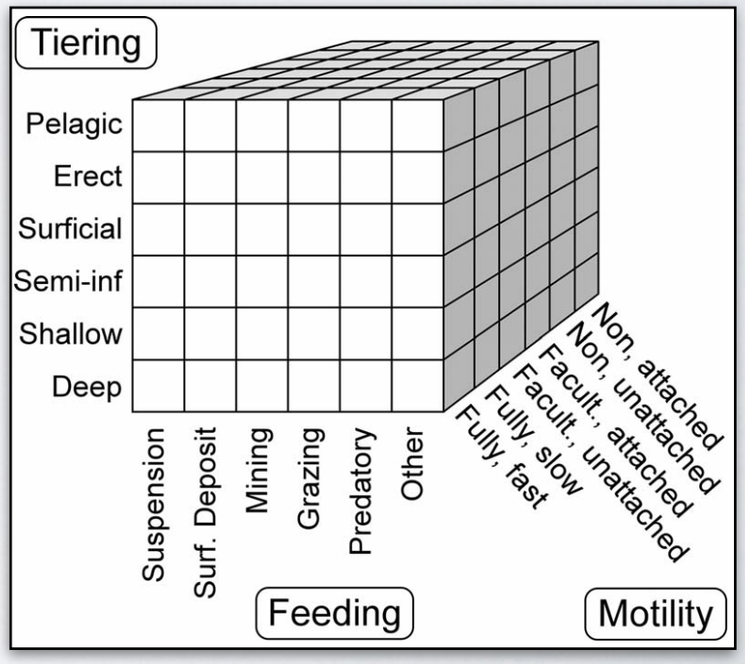
with ranges & ecologies

65 of 216 ecopaces filled



Quantifying Marine Animal Ecology

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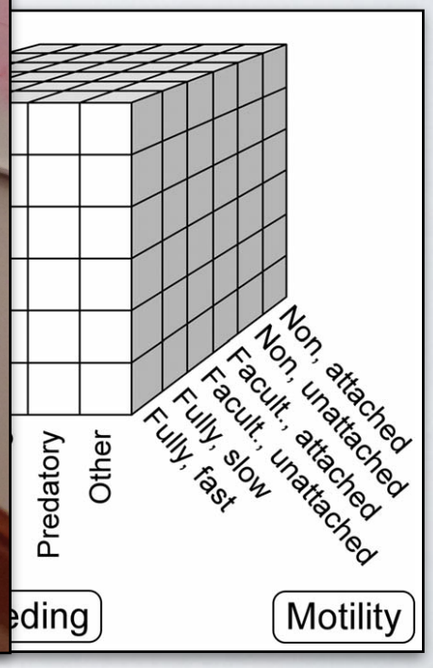

Quantifying Marine Animal Metabolism

Effects of Size and Temperature on Metabolic Rate

James F. Gillooly,[1]* James H. Brown,[1,2] Geoffrey B. West,[2,3] Van M. Savage,[2,3] Eric L. Charnov[1]

21 SEPTEMBER 2001 VOL 293 SCIENCE

$$B = b_o e^{-E/kT} M^{3/4}$$

B = Metabolic rate (Watts)

b_o = scaling constant

E = activation energy (~ 0.65 eV)

k = Boltzman's constant

T = temperature (K)

M = mass (kg)

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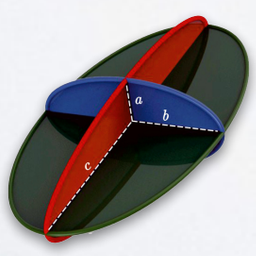


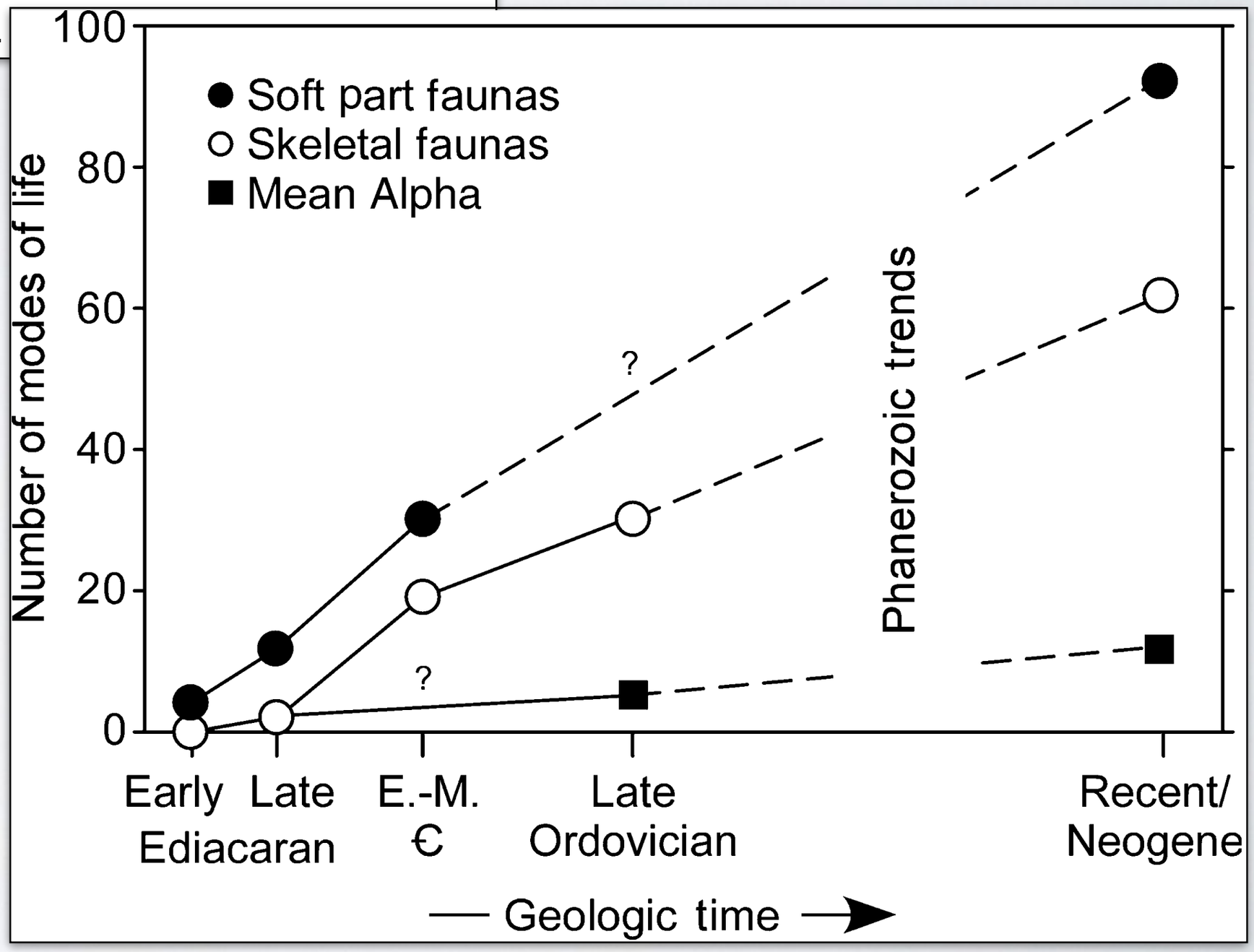
Ash Free Dry Mass

Marine Animal Ecology

AUTECOLOGY AND THE FILLING OF ECOSPACE: KEY METAZOAN RADIATIONS

by RICHARD K. BAMBACH*, ANDREW M. BUSH† *and* DOUGLAS H. ERWIN*

Palaeontology, Vol. 50, Part 1, 2007, pp.



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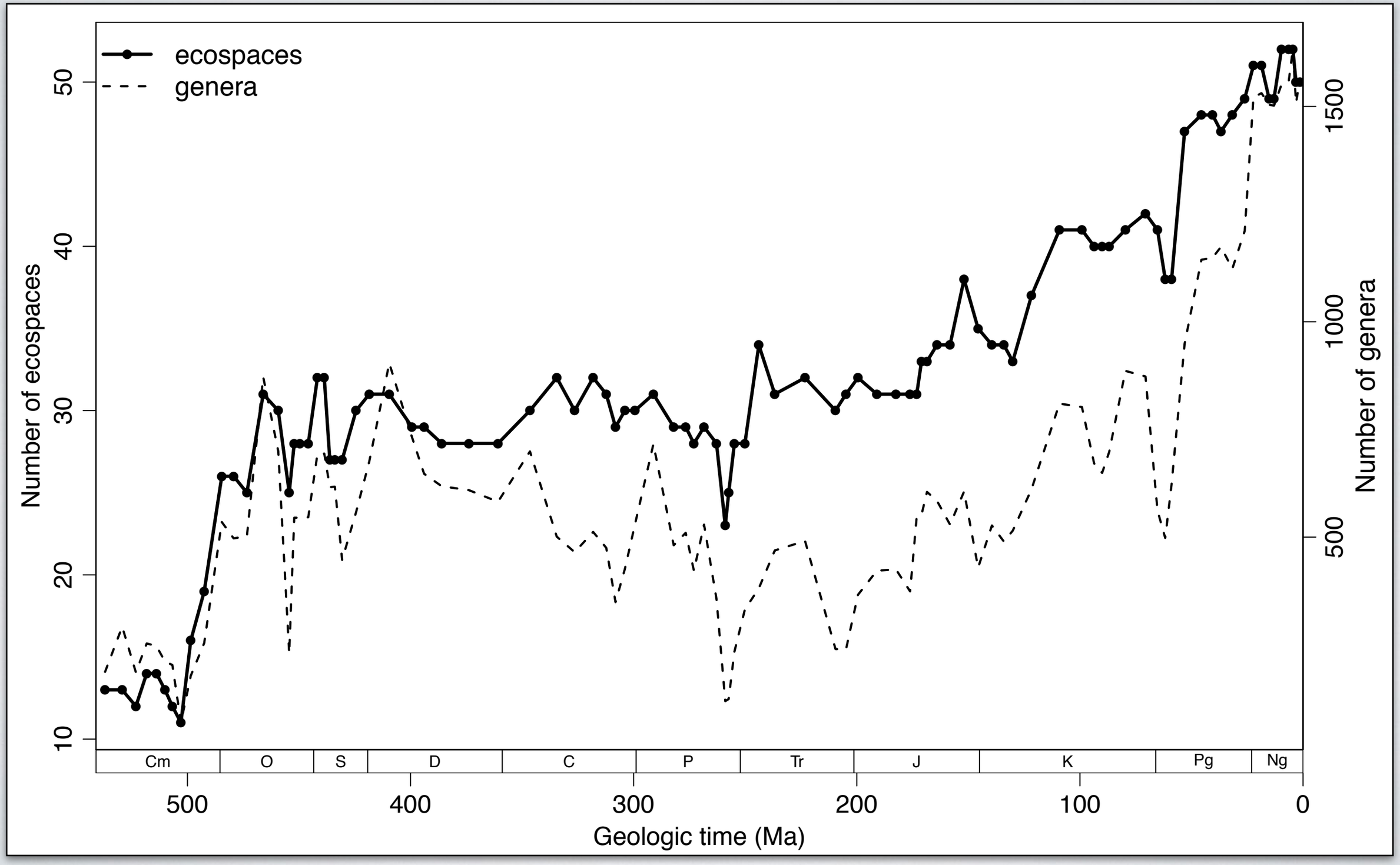

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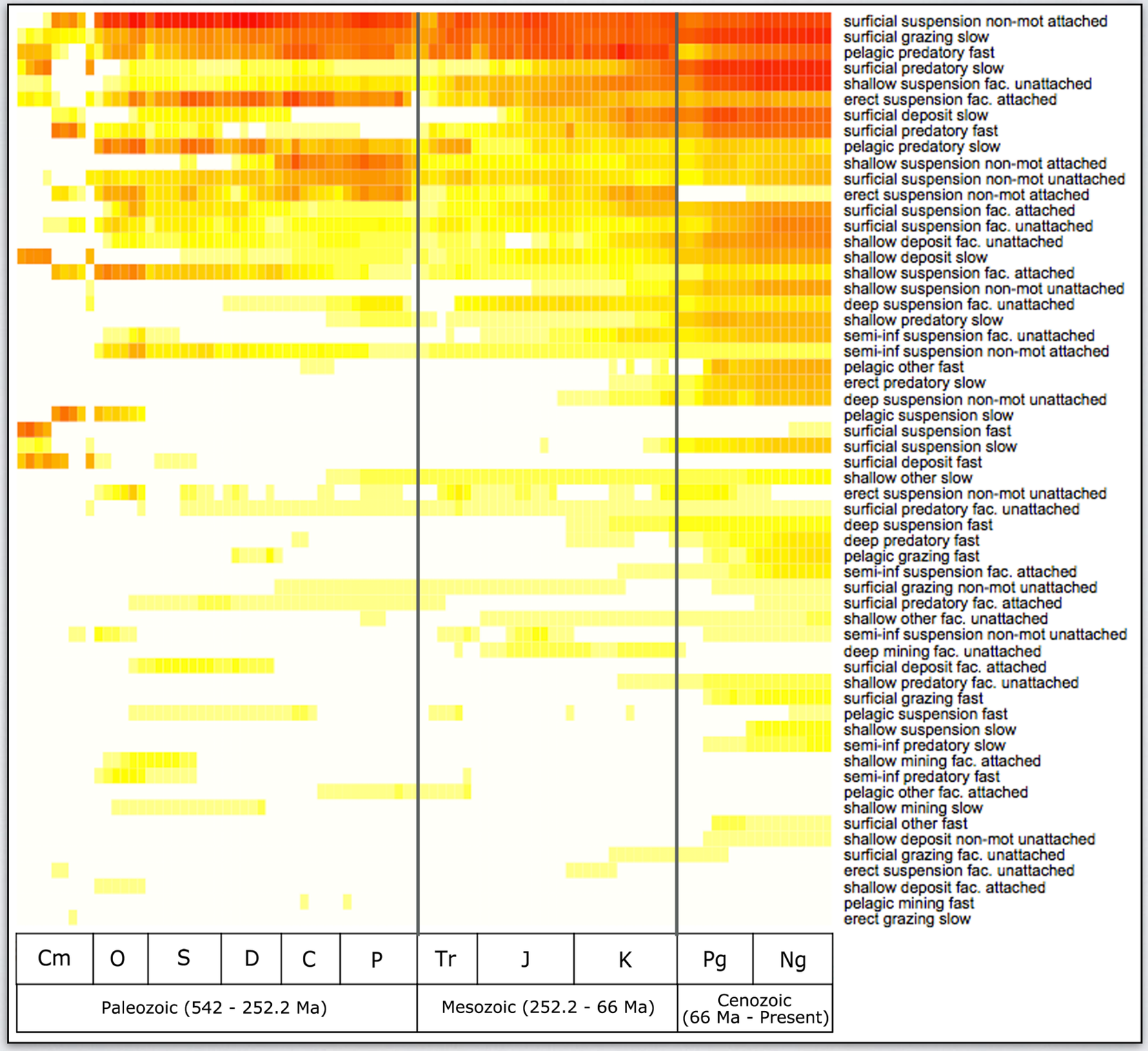

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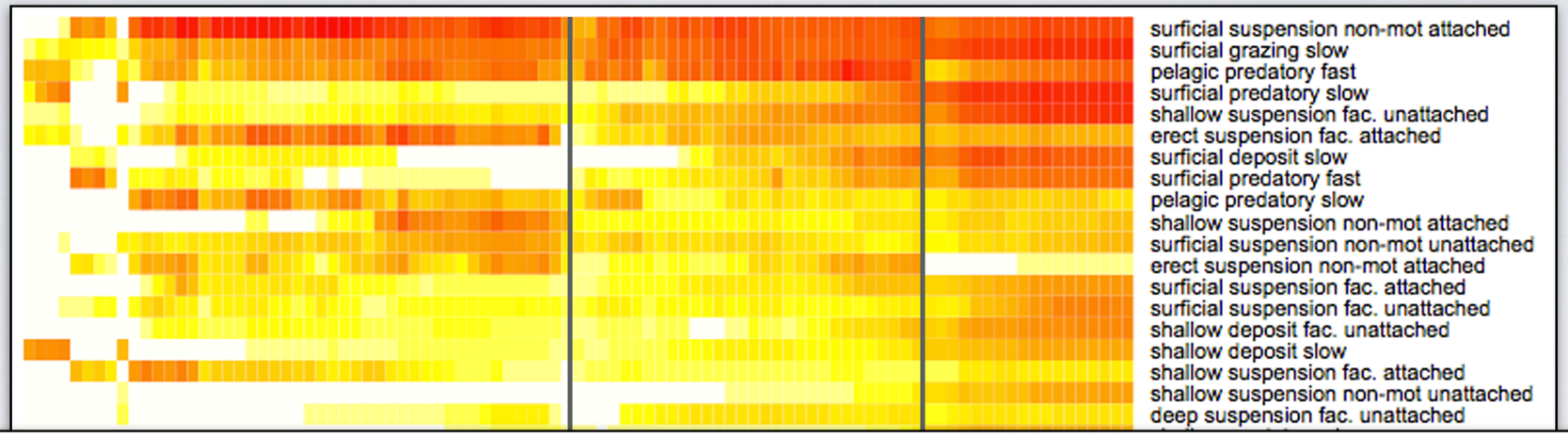

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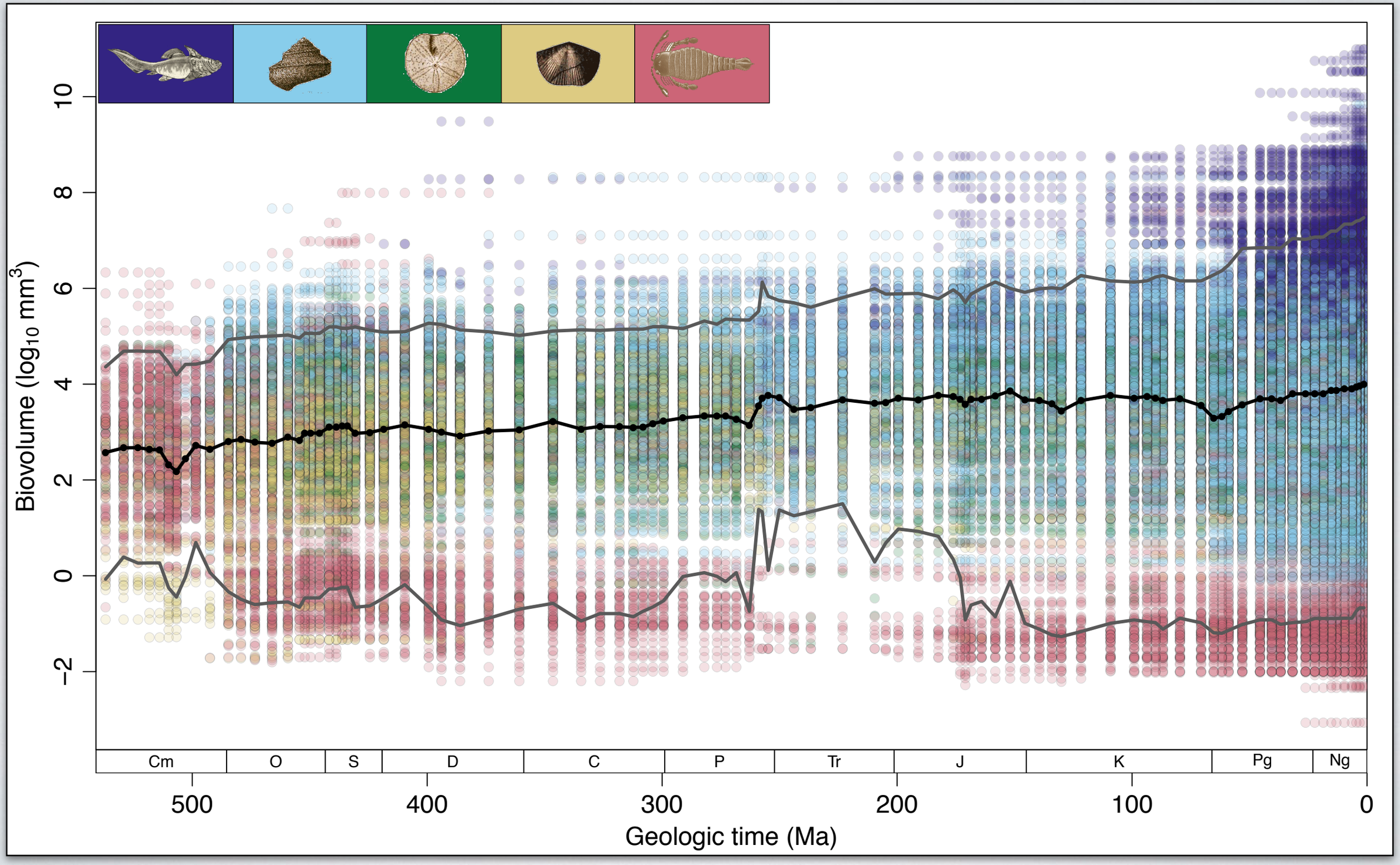
Marine Animal Biovolume



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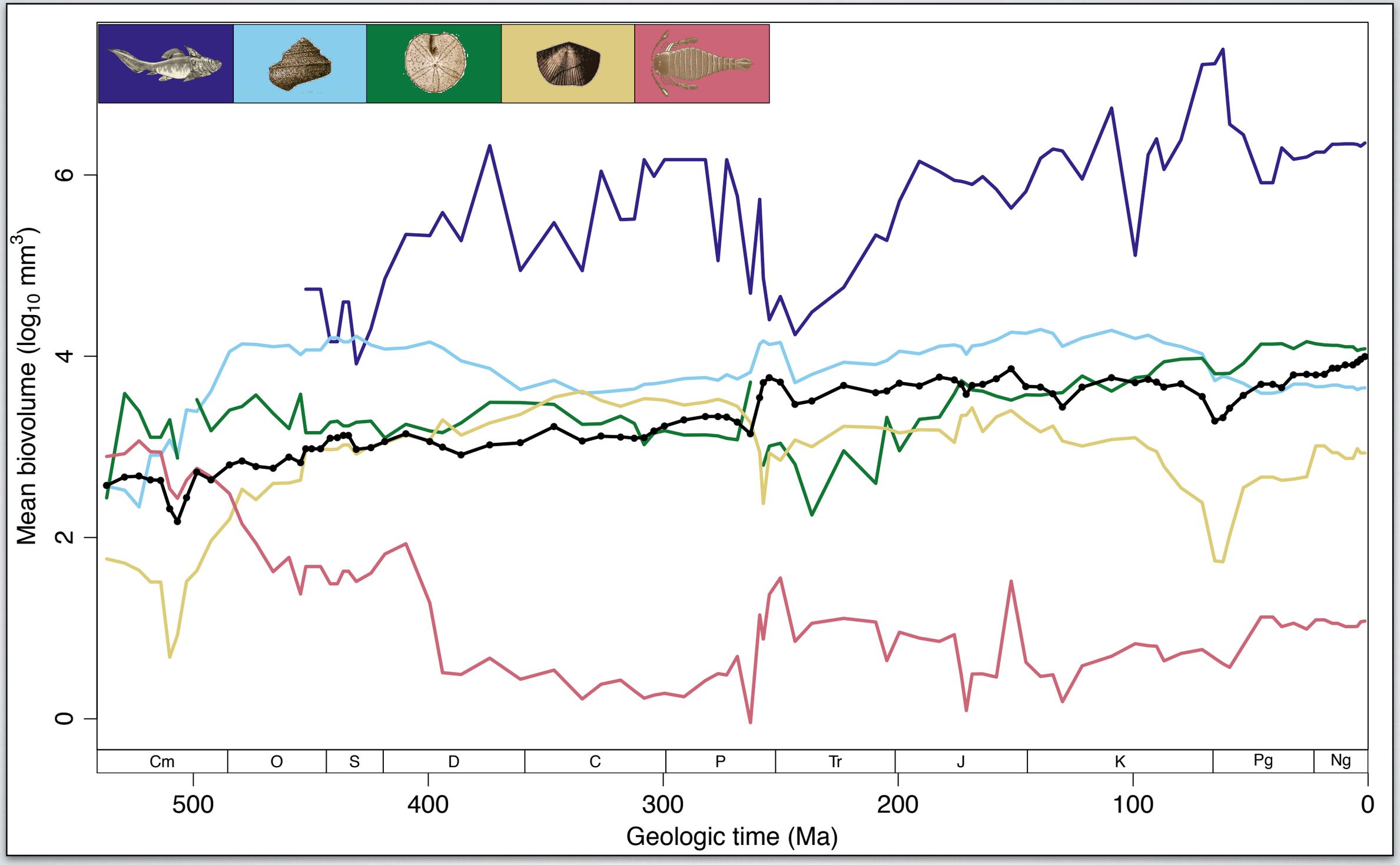

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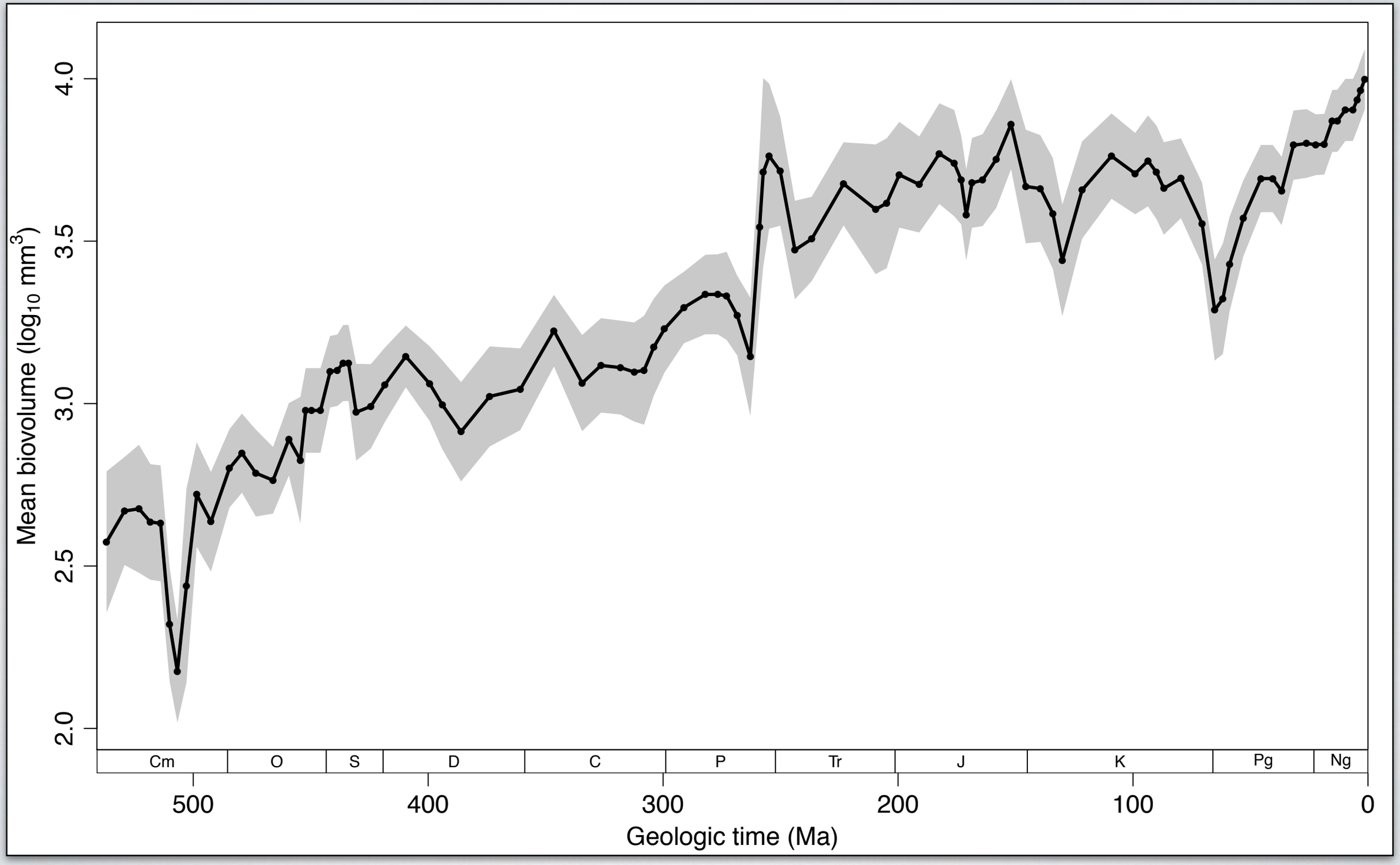

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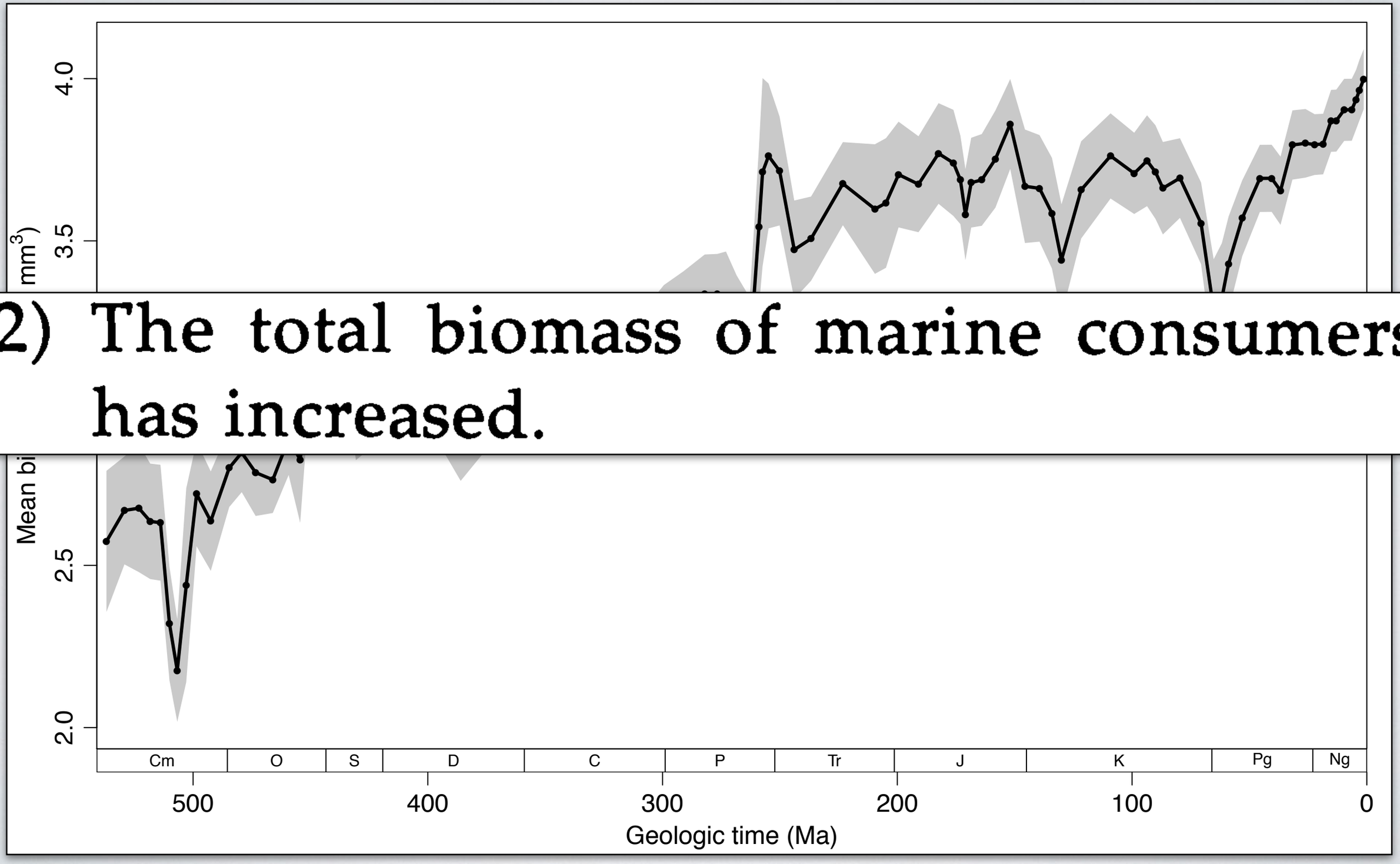

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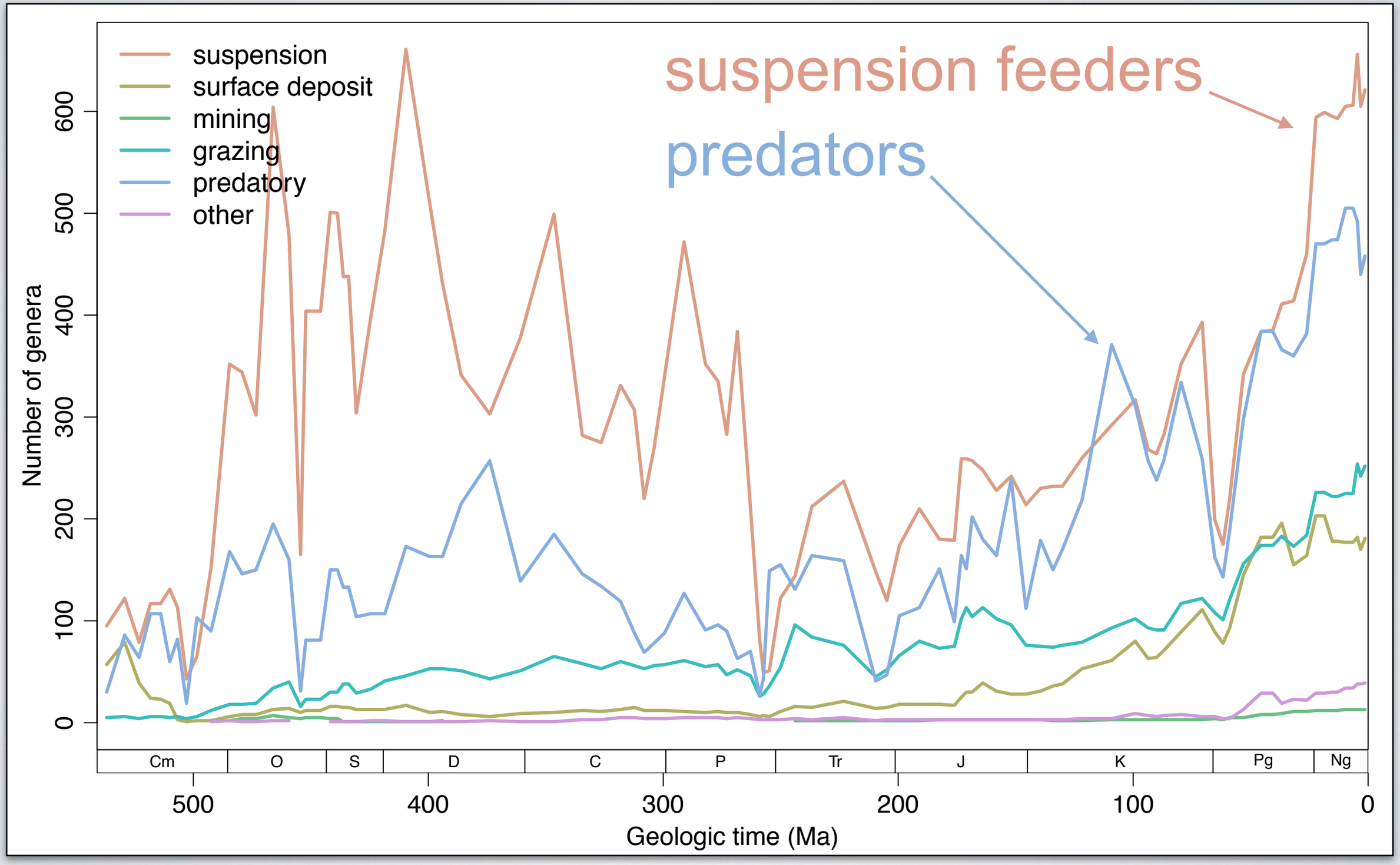
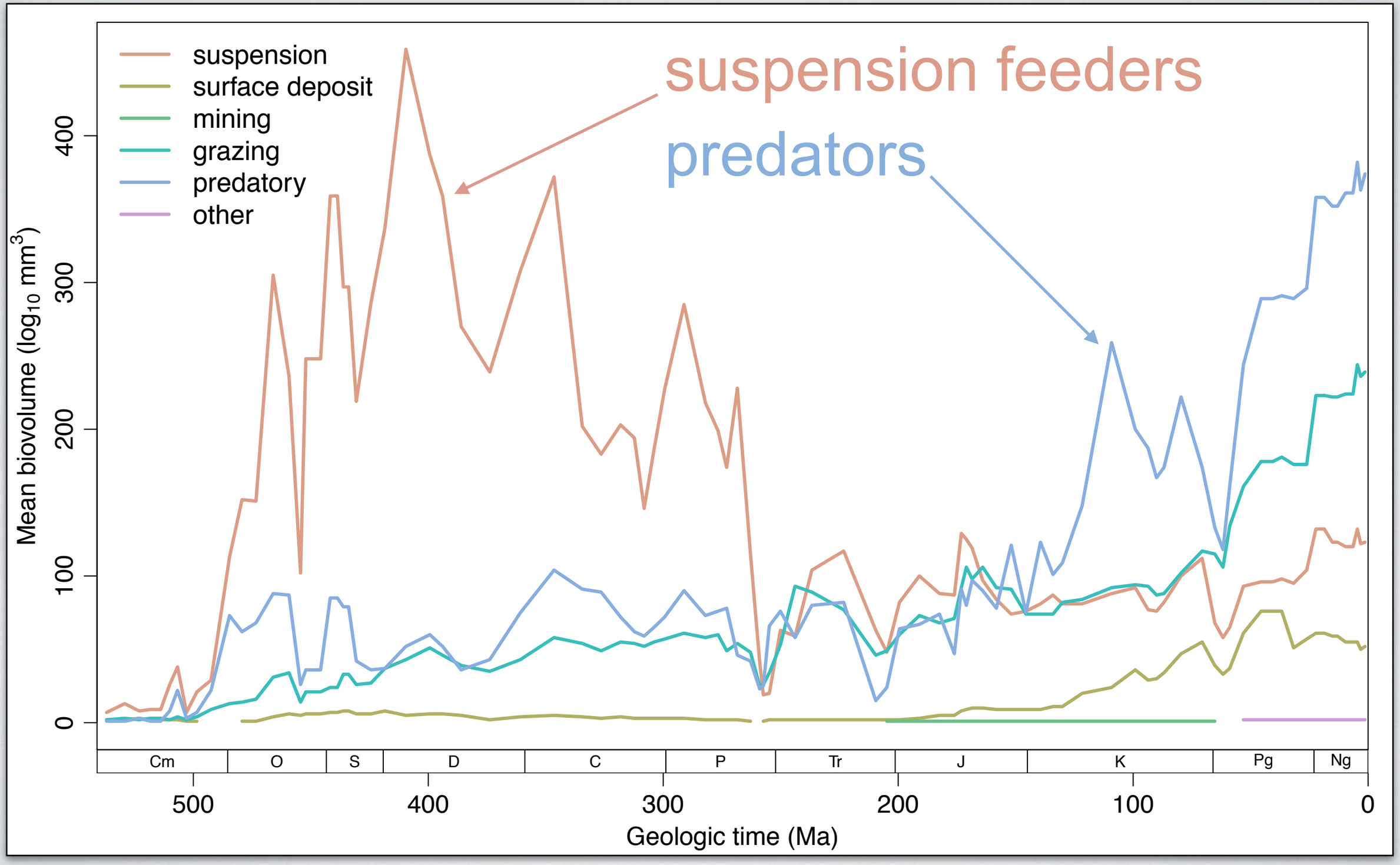
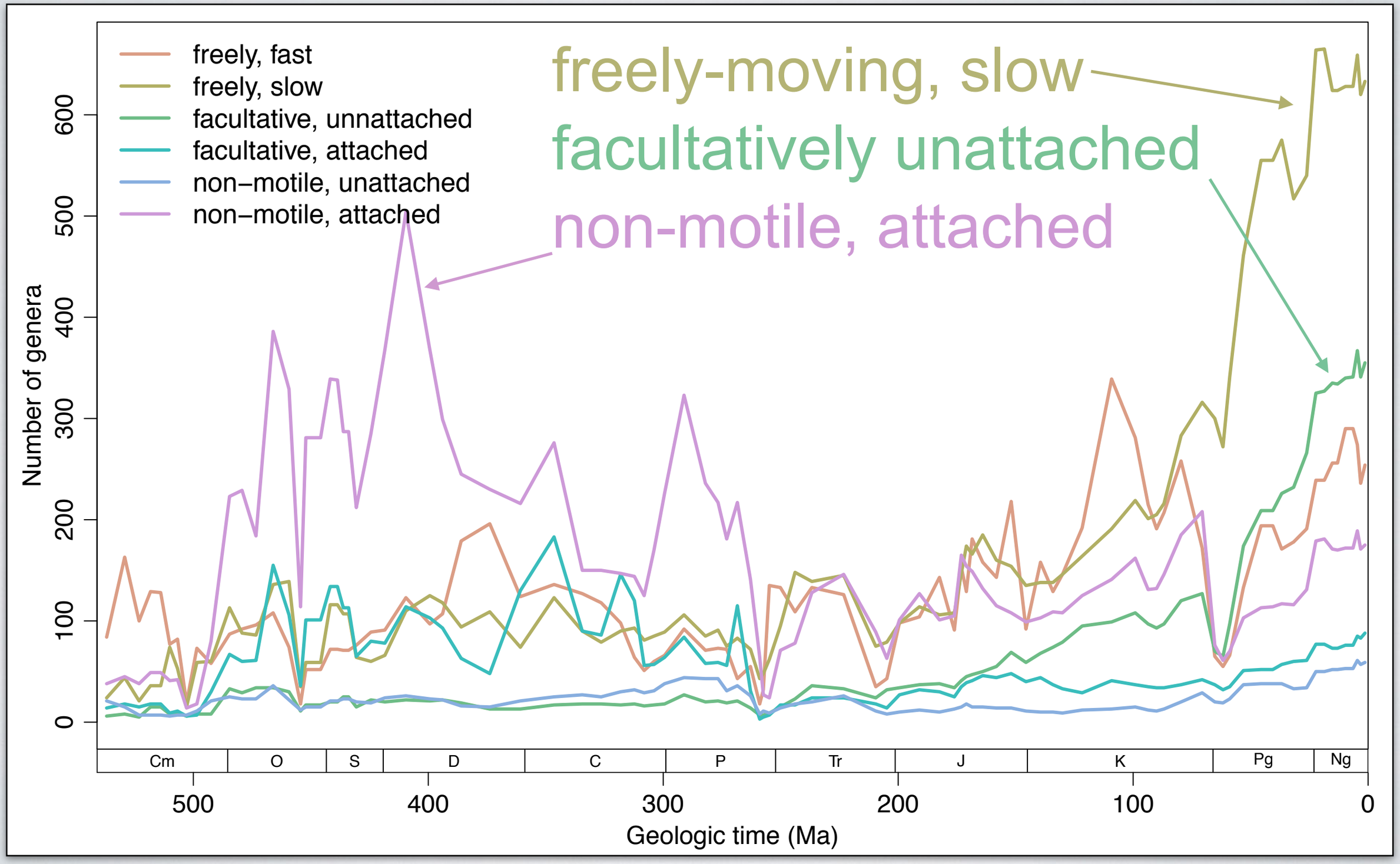
Feeding: Genus Diversity



Feeding: Mean Biovolume



Motility: Genus Diversity



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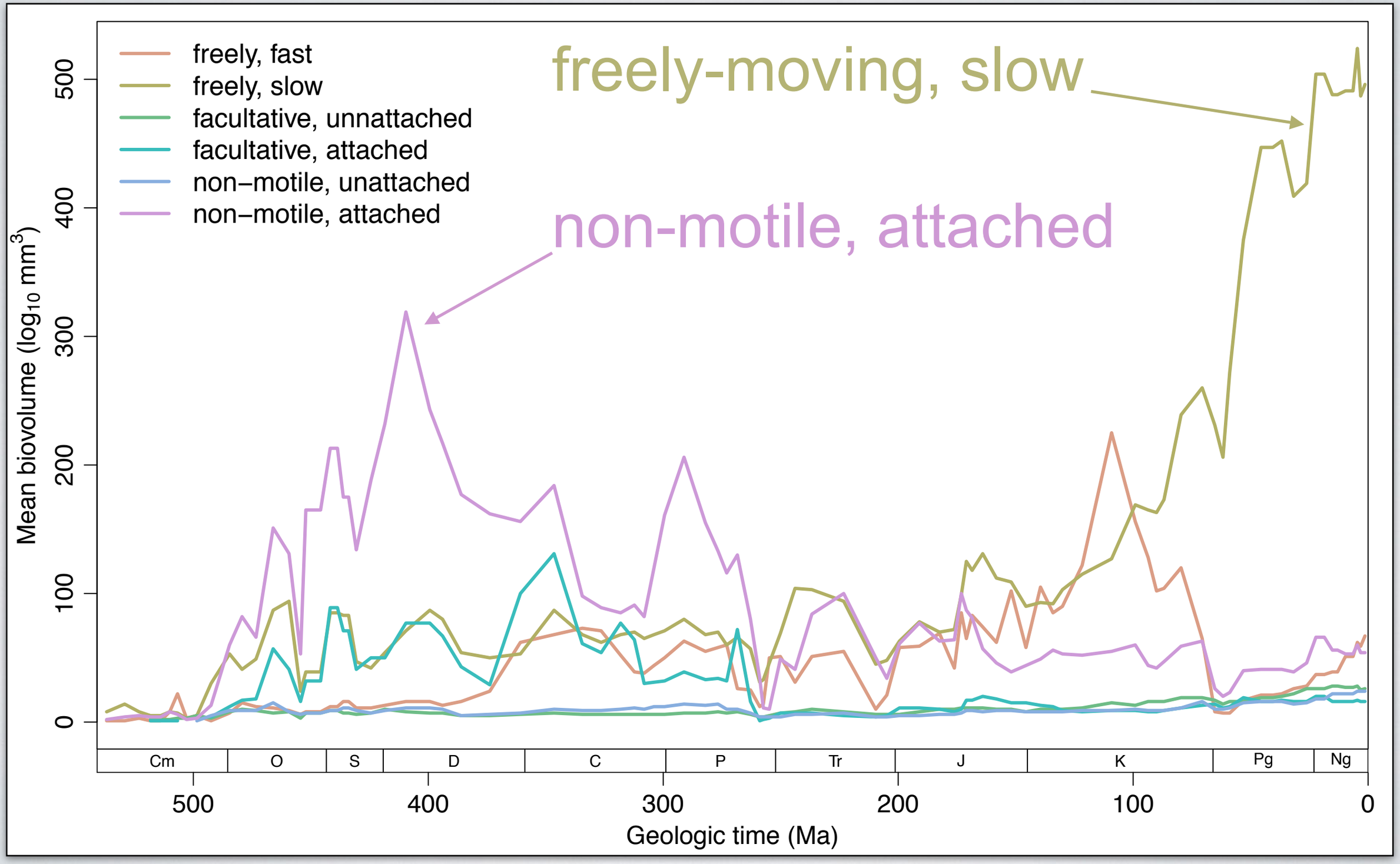
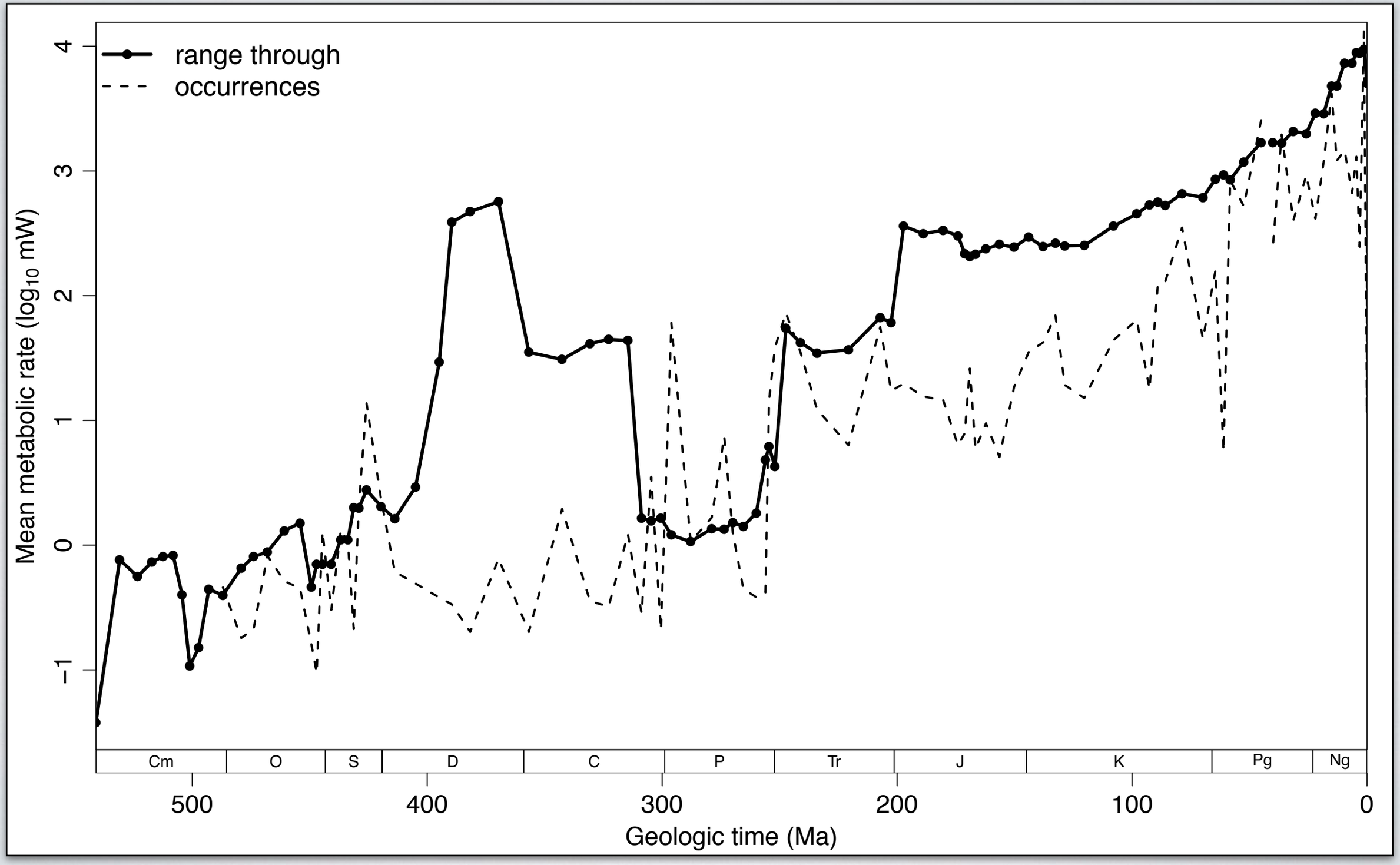


Marine Animal Metabolism

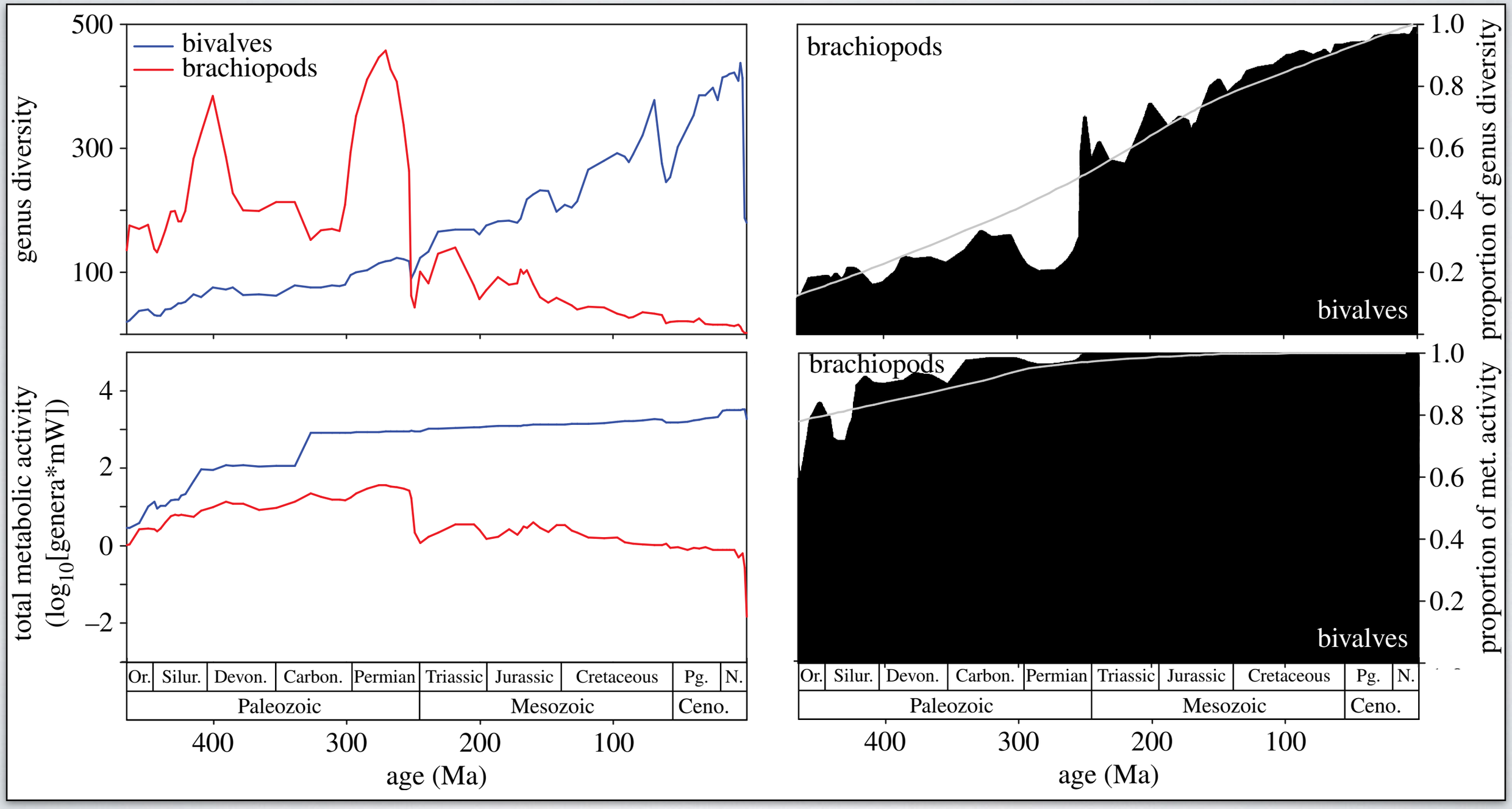


Metabolic dominance of bivalves predates brachiopod diversity decline by more than 150 million years

Jonathan L. Payne[1], Noel A. Heim[1], Matthew L. Knope[1] and Craig R. McClain[2]

Proc. R. Soc. B **281**: 20133122

Genera



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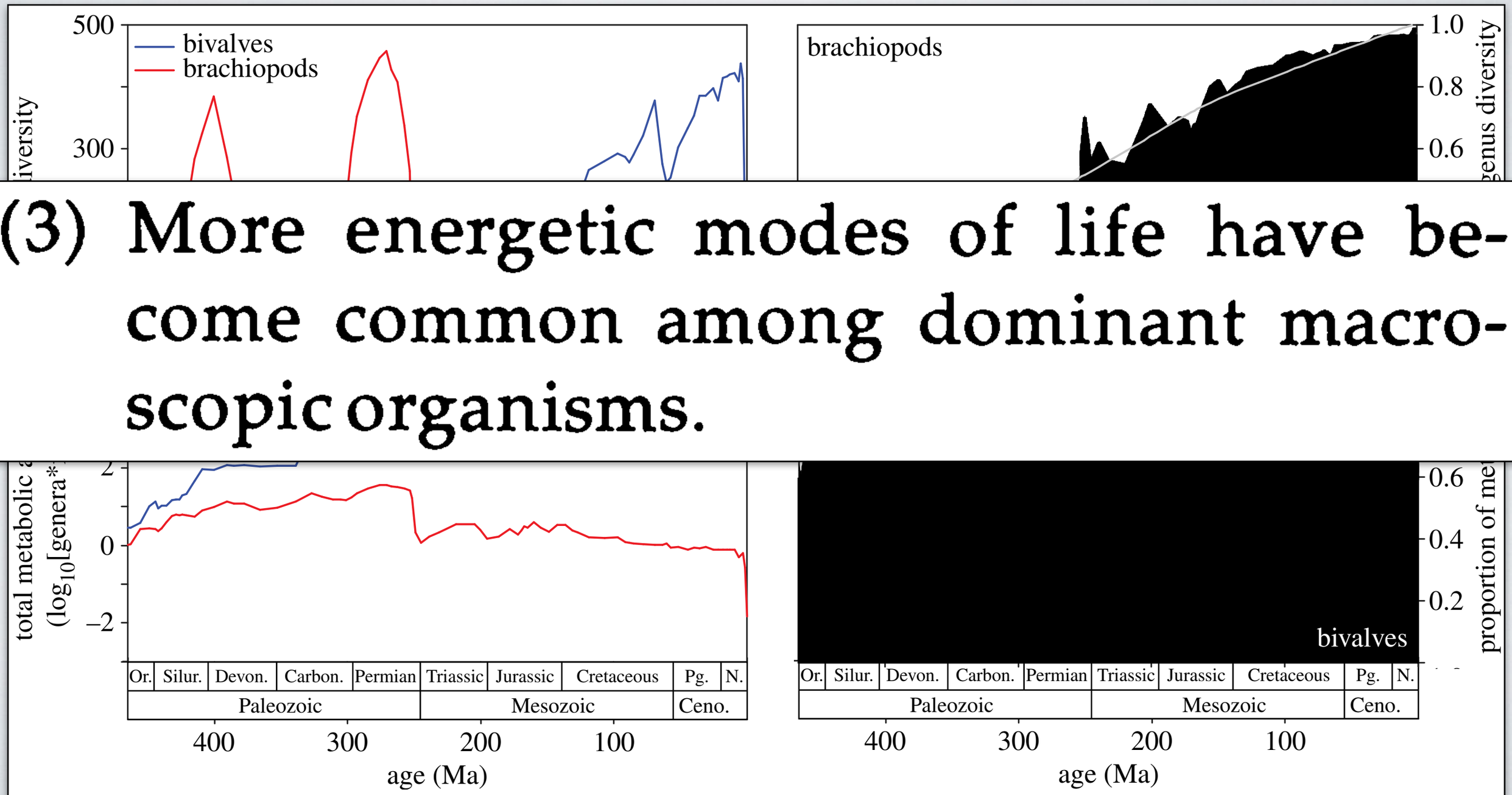

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Conclusions

Richard was right!

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