Electronic supplementary material

The Palaeozoic colonization of the water column and the rise of global nekton

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Table of Contents

I. Supplemented Sepkoski's Compendium (SSCG) compared to Sepkoski's *Compendium* [S21]

We created the SSCG (Supplemented Sepkoski's Compendium of Genera) to update the diversity of Palaeozoic non-benthic aquatic genera in Sepkoski's *Compendium of Fossil Marine Animal Genera* [S21]. The SSCG incorporates stratigraphic ranges of additional genera for the following taxa: Radiodonta [S23], Eurypterida [S24], Ammonoidea [S25,S26], Heterostraci [S27,S28], Anaspida [S29], Thelodonti [S30], Galeaspida [S31], Osteostraci [S32], "Placodermi" [S33], "Acanthodii" [S34], Chondrichthyes [S35,S36], and Osteichthyes [S37,S38]. The *Methods* section of the main paper details the procedures we employed in constructing the SSCG. Here we present all differences between the SSCG and Sepkoski's *Compendium* [S21].

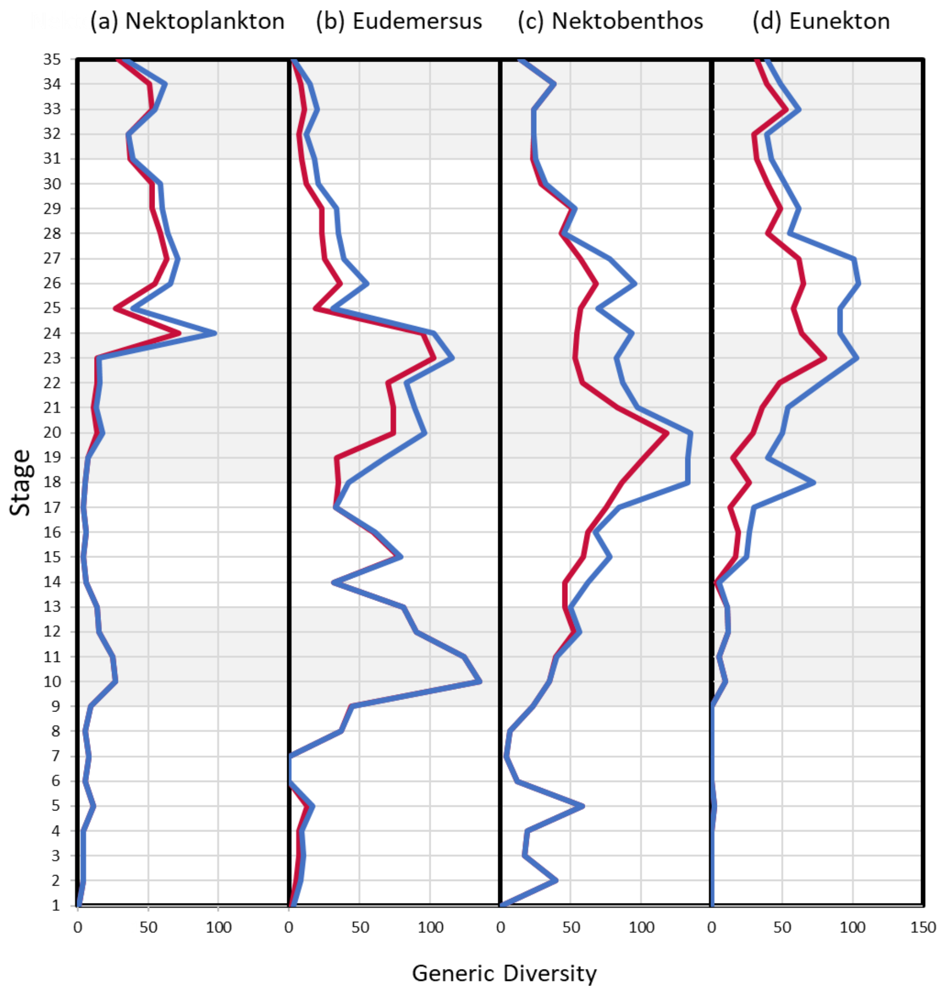


Figure S1. Ranged-through (RT) Palaeozoic generic diversity by life mode, (*a*) Nektoplankton, (*b*) Eudemersus, (*c*) Nektobenthos, (*d*) Eunekton. Maroon indicates Sepkoski's *Compendium* [S21], blue indicates Supplemented Sepkoski's Compendium of Genera (SSCG). The SSCG dataset did not increase euplanktic or planktonektic diversity compared to Sepkoski's *Compendium* [S21].

1= Tommotian, 2 = Atdabanian, 3 = Botomian, 4 = Tojonian, 5 = Stage 5, 6 = Dresbachian, 7 = Paibian, 8 = Trempealeauan, 9 = Tremadocian, 10 = Arenig, 11 = Darriwilian, 12 = Caradocian, 13 = Ashgillian, 14 = Llandovery, 15 = Wenlock, 16 = Ludlow, 17 = Pridoli, 18 = Lochkovian, 19 = Pragian, 20 = Emsian, 21 = Eifelian, 22 = Givetian, 23 = Frasnian, 24 = Famennian, 25 = Tournaisian, 26 = Visean, 27 = Serpukhovian, 28 = Bashkirian, 29 = Moscovian, 30 = Upper Pennsylvanian, 31 = Asselian, 32 = Sakmarian, 33 = Leonardian, 34 = Guadalupian, 35 = Lopingian.

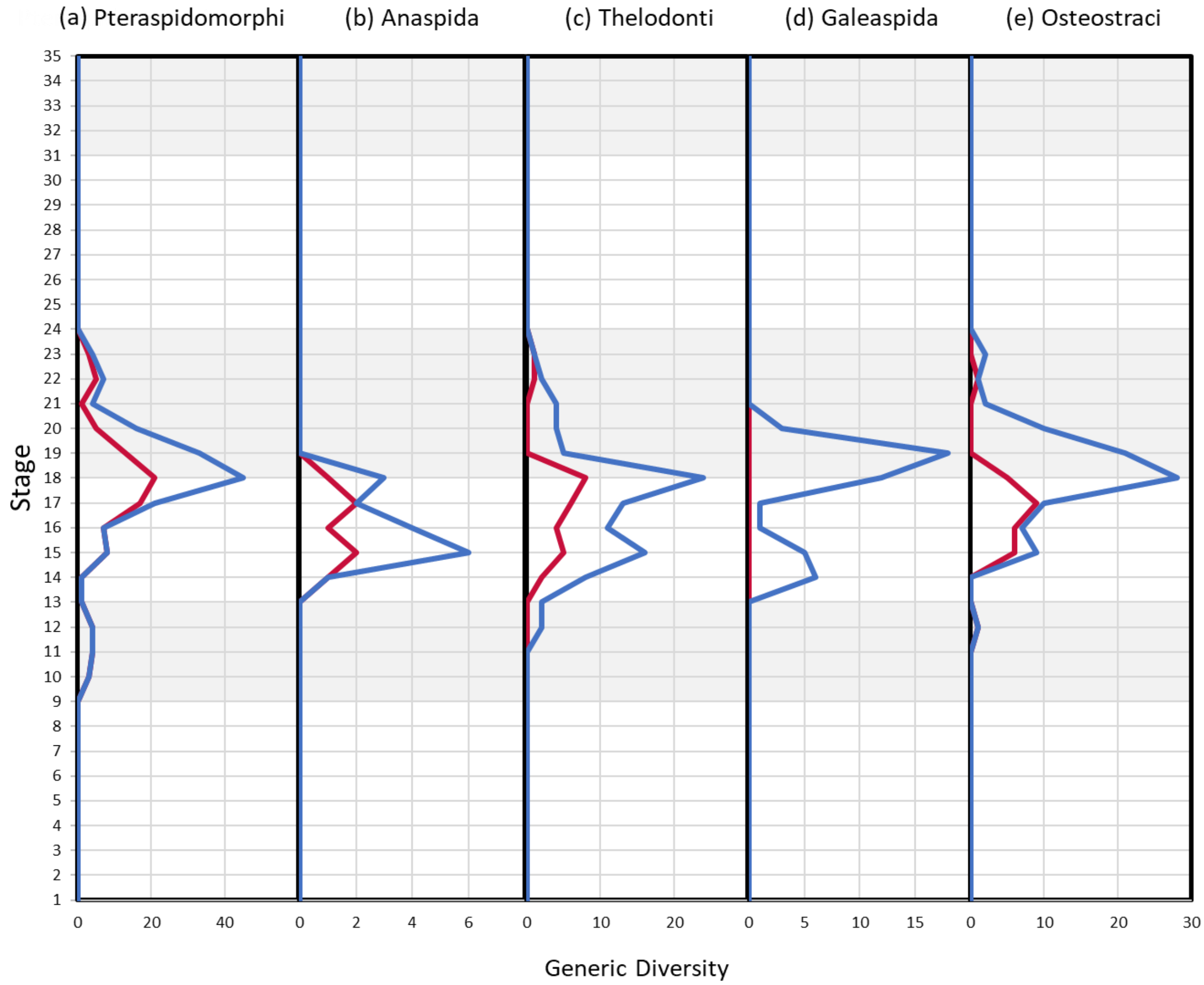


Figure S2. Ranged-through (RT) Palaeozoic vertebrate generic diversity by class, (*a*) Pteraspidomorphi, (*b*) Anaspida, (*c*) Thelodonti, (*d*) Galeaspida, (*e*) Osteostraci. Maroon indicates Sepkoski's *Compendium* [S21], blue indicates Supplemented Sepkoski's Compendium of Genera (SSCG). Stage numbers as in figure S1.

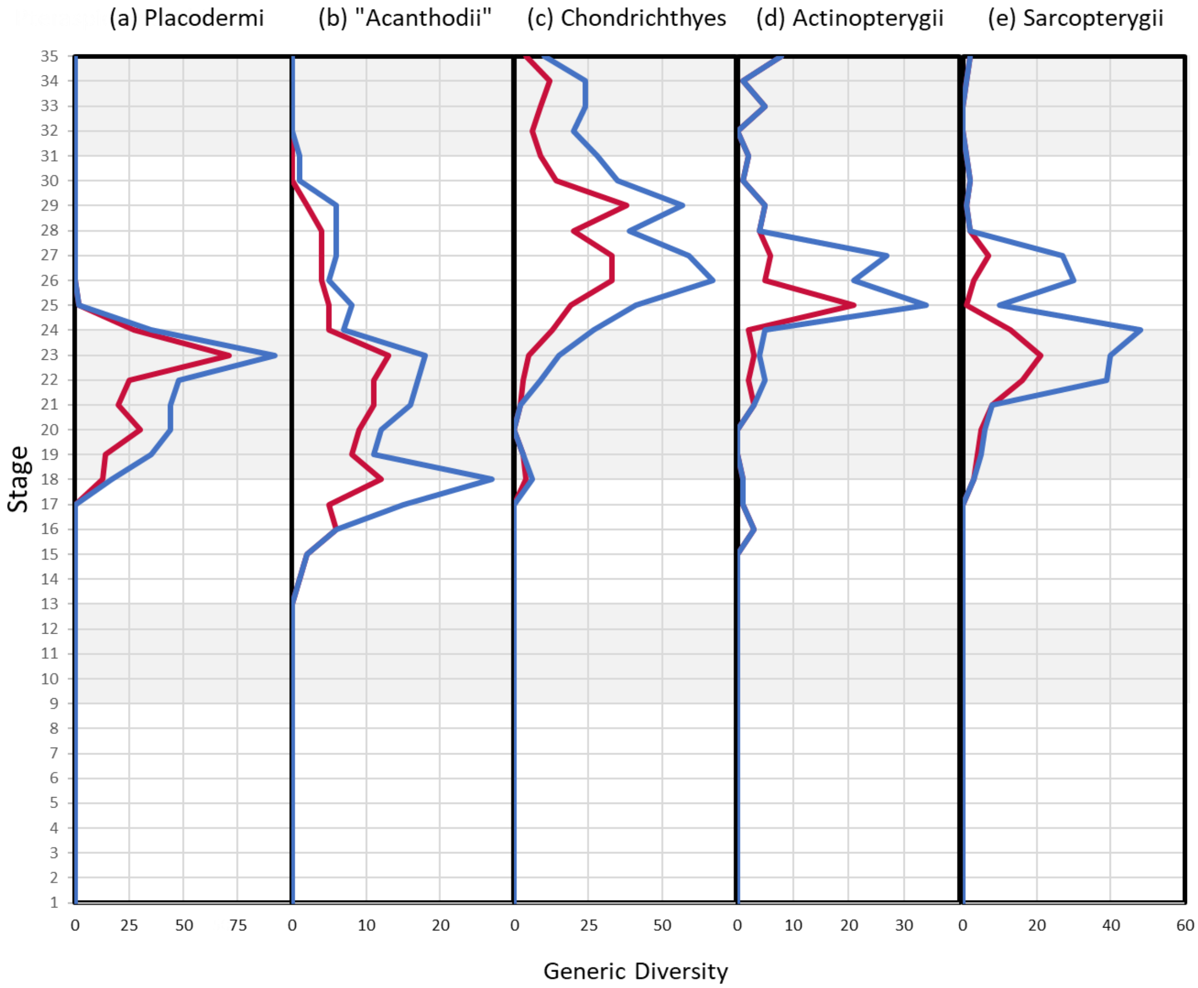


Figure S3. Ranged-through Palaeozoic vertebrate generic diversity by class, (*a*) 'Placodermi', (*b*) 'Acanthodii', (*c*) Chondrichthyes, (*d*) Actinopterygii, (*e*) Sarcopterygii. Maroon indicates Sepkoski's *Compendium* [S21], blue indicates Supplemented Sepkoski's Compendium of Genera (SSCG). Stage numbers as in figure S1.

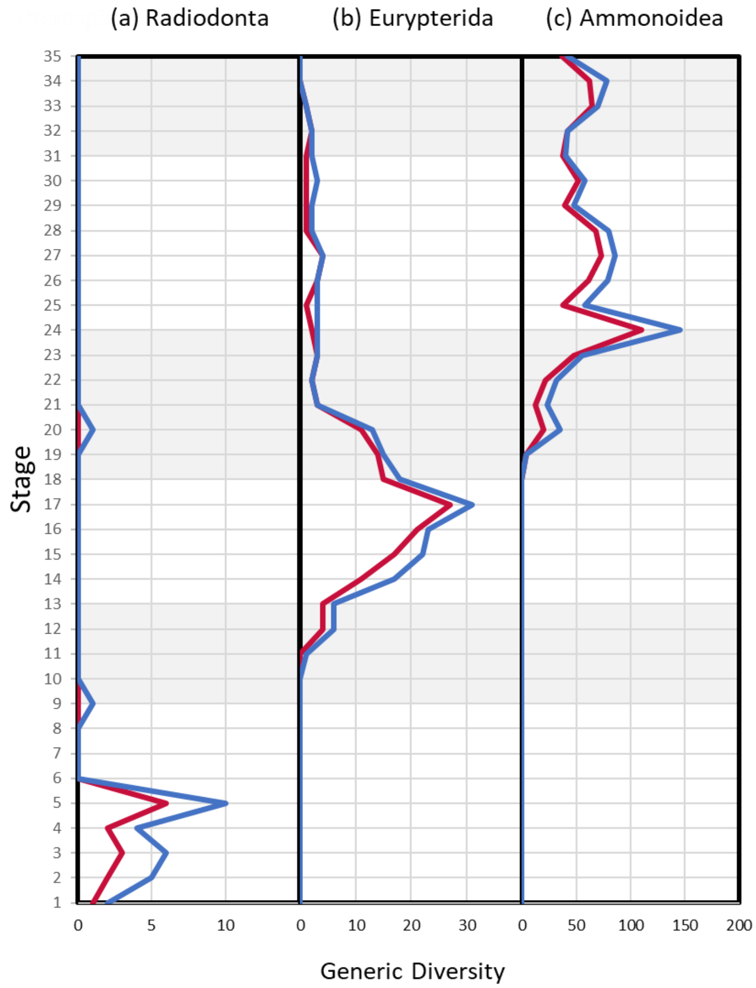


Figure S4. Ranged-through Palaeozoic generic diversity by taxon, (*a*) Radiodonta, (*b*) Eurypterida (*c*) Ammonoidea. Maroon indicates Sepkoski's *Compendium* [S21], blue indicates Supplemented Sepkoski's Compendium of Genera (SSCG). Stage numbers as in figure S1.

II. Paleobiology Database (PBDB) Data Preparation

We restricted our analysis to aquatic metazoans. Accordingly, all occurrences of the following taxa in the PBDB were not included in the study (only the highest-ranking taxa cataloged in the PBDB are listed here).

Plants

- Alethopteridae
- *Algites*
- Aneurophytophyta
- Angiospermae
- *Angulocellularia*
- *Annalepis*
- *Annularia*
- *Arberia*
- *Asterotheca*
- *Baltzerella*
- *Bija*
- *Bothrodendron*
- *Brittsia*
- Bryophyta
- *Buthotrephis*
- Calamitaceae
- *Cardiocarpon*
- *Carpolithes*
- *Chabakovia*
- Charophyta
- Chlorophyta
- *Chuaria*
- *Cirratriradites*
- *Cistella*
- Coniferae
- Cordaitales
- *Corynepteris*
- Cupressales
- Cycadeoideophyta
- Cycadophyta
- *Cymatiosphaera*
- *Cyperites*
- *Danaeites*
- *Danaeopsis*
- *Dictyopteridium*
- Dimorphosiphonaceae
- *Diplothmema*
- *Duisbergia*
- *Dutoitia*
- *Elkinsia*
- *Equisetina*
- *Equisetinostachys*
- Equisetophyta
- *Fetura*
- *Filicites*
- *Flabellofolium*
- *Flemingites*
- Florideophyceae
- Gigantopteridaceae
- Ginkgophyta
- *Hanskerpella*
- *Hemizgya*
- *Holcospermum*
- *Howisonia*
- Isoetophyta
- *Issinella*
- *Izhella*
- *Jansaella*
- *Kankakeea*
- *Knorria*
- Lagenospermopsida
- *Leiosphaeridia*
- Lepidodendraceae
- *Lepidophyllum*
- Lycophyta
- Lycopodiophyta
- Marchantiales
- *Margaretia*
- *Mitcheldeania*
- *Myeloxylon*
- *Myriotheca*
- Neuropteridae
- *Neuropteridium*
- *Nuia*
- *Obandotheca*
- *Oclloa*
- *Pachytesta*
- *Paleohyperamum*
- *Pecopteris*
- *Pelourdea*
- Peltaspermophyta
- *Phascolophyllaphycus*
- *Phyllotheca*
- *Pilasporites*
- *Pinakodendron*
- Pinophyta
- *Pitys*
- *Plumsteadia*
- *Ponsinella*
- Prasinophyta
- Progymnospermopsida
- *Protophyllocladoxylon*
- *Pseudoctenis*
- Psilophytophyta
- Pteridophyta
- Pteridospermophyta
- *Radicites*
- *Radiosphaera*
- *Raniganjia*
- *Reduviasporonites*
- *Rhacopteris*
- Rhizopodea
- Rhodophyceae
- Rhodophyta
- *Rubidgea*
- *Salpingostoma*
- *Sandrewia*
- *Selaginellites*
- Sigillariaceae
- *Sinocylindra*
- *Spermatites*

- Spermatophyta
- *Sphaerospongia*
- Sphenopteridae
- *Spiropteris*
- Spongiostroma
- *Stellatheca*
- *Sternbergia*
- *Stigmaria*
- *Striomonosaccites*
- *Taeniocrada*
- *Tasmanites*
- *Tharama*
- *Tomiodendron*
- Tracheophyta
- *Trigonocarpus*
- *Tubulites*
- Ulvophyta
- *Valmeyeraphycus*
- *Wardia*
- *Whittleseya*
- Zosterophyllophyta

Microfossils

- *Acanthodiacrodium*
- *Aetholicopalla*
- *Allonema*
- *Archaeooides*
- *Asterosphaera*
- *Bacinella*
- *Calcidiscus*
- *Calcisphaera*
- *Comasphaeridium*
- *Cristallinium*
- Cyanobacteria
- Dinophyceae
- *Disonella*
- *Epiphyton*
- *Estiastra*
- *Flabellia*
- Foraminferea
- Foraminifera
- *Goniosphaeridium*
- *Gorgonisphaeridium*
- *Granomarginata*
- *Heliosphaeridium*
- *Leiofusa*
- *Leiomarginata*
- *Lophosphaeridium*
- *Lusatia*
- *Megathrix*
- *Micrhystridium*
- *Navifusa*
- *Nummulostegina*
- *Osagia*
- Peridiniales
- *Planolites*
- *Polyedryxium*
- *Pustulatisporites*
- Radiolaria
- Rhizopodea
- *Siphonophycus*
- *Skiagia*
- *Solisphaeridium*
- *Spirellus*
- *Syringomorpha*
- Triticitidae
- *Veryhachium*

Palynoflora

- *Accintisporites*
- *Alisporites*
- *Apiculiretusispora*
- *Aratrisporites*
- *Brachysaccus*
- *Chomotriletes*
- *Chordasporites*
- *Conbaculatisporites*
- *Cyclogranisporites*
- *Diatomozonotriletes*
- *Falcisporites*
- *Geminospora*
- *Globochaete*
- *Grandispora*
- *Guttatisporites*
- *Hymenozonotriletes*
- *Klausipollenites*
- *Knoxisporites*
- *Licrophycus*
- *Limitisporites*
- *Lophotriletes*
- *Lundbladispora*
- *Monosaccites*
- *Perotriletes*
- *Phyllothecotriletes*
- *Playfordiaspora*
- *Plicatipollenites*
- *Punctatosporites*
- *Raistrickia*
- *Retusotriletes*
- *Rhabdosporites*
- *Stenozonotriletes*
- *Striatopodocarpites*
- *Sulcatisporites*
- *Todites*
- *Triangulatisporites*
- *Trileites*
- *Triplexisporites*
- *Trisaurus*
- *Vitreisporites*
- *Vittatina*

Ichnofossils

- *Arcuatichnus*
- *Arenicolites*
- *Arthraria*
- *Arthrophycus*
- Asteriacitidae
- *Astropolithon*

- *Attenosaurus*
- *Aulichnites*
- *Bascomella*
- *Bergaueria*
- *Bifungites*
- *Bipedes*
- *Calycraterion*
- *Catenichnus*
- *Caulostrepsis*
- *Chondrites*
- *Cincosaurus*
- *Circulichnis*
- *Clinolithes*
- *Clionolithes*
- *Cochlichnus*
- *Conchifora*
- *Condranema*
- *Crossopodia*
- *Cruziana*
- *Ctenerpeton*
- *Curvolithus*
- *Cylindrichnus*
- *Dactyloidites*
- *Dactylophycus*
- *Dendroidichnites*
- *Didymaulichnus*
- *Dimorphichnus*
- *Diplichnites*
- *Diplocraterion*
- *Diplopodichnus*
- *Dolopichnus*
- *Elingua*
- *Fuersichnus*
- *Furculosus*
- *Gastrochaenolites*
- *Glockerichnus*
- *Gordia*
- *Granularia*
- *Guanshanichnus*
- *Gyrolithes*
- *Gyrophyllites*
- *Helicosalpinx*
- *Helminthopsis*
- *Hydromeda*
- *Kouphichnium*
- *Lingulichnus*
- *Lockeia*
- *Margaritichnus*
- *Matthewichnus*
- *Merostomichnites*
- *Monocraterion*
- *Monomorphichnus*
- *Multilamella*
- *Nanopus*
- *Nereites*
- *Nododendrina*
- *Oichnus*
- *Oldhamia*
- *Palaeophycus*
- *Palaeosabella*
- *Paleodictyon*
- *Permichnium*
- *Petalichnus*
- *Phycodes*
- *Phycosiphon*
- *Plagiogmus*
- *Platicytes*
- *Protichnites*
- *Protohaploxypinus*
- *Protovirgularia*
- *Psammichnites*
- *Puertollanopus*
- *Quadropedia*
- *Rhizocorallium*
- *Rogerella*
- *Ropalonaria*
- *Rosselia*
- *Rusophycus*
- *Sagittichnus*
- *Saurichnites*
- *Scalarituba*
- *Scolicia*
- *Scoyenia*
- *Seminolithes*
- *Skolithos*
- *Spirophyton*
- *Streptichnus*
- *Talpina*
- *Taphrhelminthopsis*
- *Tasmanadia*
- *Teichichnus*
- *Terebellina*
- *Thalassinoides*
- *Tiernavia*
- *Tomaculum*
- *Torrowangea*
- *Treptichnus*
- *Trypanites*
- *Undichna*
- *Vermiforichnus*
- *Walpia*
- *Zoophycos*

Terrestrial (Non-Aquatic) Invertebrates

- Arachnida
- Chilopoda
- Diplura
- Insecta
- *Leverhulmia*
- Myriapoda
- *Permobrya*
- *Rhyniella*
- *Rhynimonstrum*

Terrestrial (Non-Aquatic) Vertebrates

- *Acleistorhinus*
- *Adelosaurus*
- *Aenigmastropheus*
- Aistopoda
- *Altenglanerpeton*
- Amphibamidae
- *Anthodon*
- *Anthracosauria*
- *Antlerpeton*

- Araeoscelidia
- *Archerpeton*
- *Archosaurus*
- *Arganaceras*
- *Australothyris*
- Bolosauridae
- Brachystelechidae
- *Bradysaurus*
- *Bullimorpha*
- *Bunostegos*
- Caerorhachidae
- Captorhinidae
- *Chelydosaurus*
- Chroniosuchia
- *Coelurosauravus*
- Cotylosauria
- Cricotidae
- Dendrerpetonidae
- Diademodontidae
- Dissorophidae
- Edopidae
- *Eldeceeon*
- Elginerpetontidae
- *Elginia*
- Embolomeri
- *Enosuchus*
- Eoherpetontidae
- *Erpetonyx*
- Eryopidae
- *Eucritta*
- *Eunotosaurus*
- *Galesphyrus*
- Gephyrostegidae
- *Goniocephalus*
- *Honania*
- Hyloplesiontidae
- *Jakubsonia*
- *Kirktonecta*
- Lanthanosuchidae
- *Livoniana*
- *Metaxygnathus*
- Millerettidae
- *Milnererpeton*
- *Miobatrachus*
- *Nanoparia*
- Nycteroleteridae
- Odonterpetontidae
- Owenettidae
- *Paleothyris*
- *Pantylus*
- *Parasaurus*
- Pareiasaurida
- Pareiasauridae
- *Pareiasaurus*
- *Pareiasuchus*
- Pelycosauria
- *Pleuronoura*
- *Polycynodon*
- Proterogyrinidae
- *Protorosaurus*
- *Pumiliopareia*
- Romeriidae
- Scincosauridae
- Seymouriamorpha
- Seymouriidae
- *Shansisaurus*
- *Shihtienfenia*
- *Silvanerpeton*
- *Sinostega*
- *Solenodonsaurus*
- Theriodontia
- *Thuringothyris*
- Trematopidae
- Tuditanomorpha
- *Utaherpeton*
- Waggoneriidae
- *Youngina*
- Zatracheidae

Pseudofossils
- *Kullingia*

Stromatolites
- *Charaulachia*
- *Vetella*

Fungi
- *Scutularia*

Rocks
- Encrinites

The following regional stratigraphic units crossed an International Commission on Stratigraphy (ICS) stage boundary or ICS Silurian series boundary. All taxa assigned to these series/stages in the PBDB were excluded if no associated biostratigraphic data could be utilized to correlate with discrete ICS stages (or Silurian series) using Gradstein *et al.* [S39].

- Acadian
- Adorf(ian)
- Agdzian
- Alexandrian
- Arenig(ian)
- Ashgill(ian)
- Atokan
- Autunian
- Batyrbaian
- Berounian
- Bolindian
- Botoman/Botomian
- Branchian
- Caerfai
- Caesaraugustian
- Canadian
- Canglangpuan
- Caradoc(ian)
- Cayugan
- Chadian
- Chatfieldian
- Chazy(an)
- Chesterian
- Dawan
- Delamaran
- Dobrotiva/Dobrotivian
- Dolgellian
- Dresbachian
- Dyeran
- Early Cambrian
- Elton
- Ensyan
- Fennian
- Franconian
- Furongian
- Gasconadian
- Harju
- Helderberg
- Hunneberg
- Ibexian
- Ketyan
- Klabava
- Lancefieldian
- Langevoja
- Lenian
- Leonard
- Maentwrogian
- Manykaian
- Marjuman/Marjumian
- Marmor
- Mayan
- Meishucunian
- Menevian
- Merioneth(ian)
- Middle Cambrian
- Millardan
- Mohawkian
- Murgabian
- Namurian
- Nemakit-Daldynian
- Niagaran
- Ningkuo
- Ontarian
- Ordian
- Osagean
- Placentian
- Rocklandian
- Rotliegend(es)
- Sakian
- Sanashtykgol
- Solvan
- St. David's
- Stephanian
- Steptoean
- Sunwaptan
- Taoyuanian
- Tatarian
- Tavgian
- Trempealeauan
- Trentonian
- Tulean
- Tyesaian
- Volkhov(ian)
- Warendian
- Westphalian
- Whiterock(ian)
- Wildernessian
- Wolfcampian

Additional Stratigraphic Correlation References

If possible, PBDB regional stratigraphic units were converted to ICS series/stages. For correlations, the following references supplemented those listed in the main paper [28-30] when necessary, with priority given to the more recent publication whenever conflicts arose (see *Methods* in the main paper).

S1. Babcock LE, Peng S. 2007 Cambrian chronostratigraphy: Current state and future plans. *Palaeogeogr. Palaeoclimatol. Palaeoecol.* **254**, 62–66. (doi:10.1016/j.palaeo.2007.03.011)

S2. Bergström SM, Chen X, Gutiérrez-Marco JC, Dronov A. 2009 The new chronostratigraphic classification of the Ordovician System and its relations to major regional series and stages and to δ13C chemostratigraphy. *Lethaia* **42**, 97–107. (doi:10.1111/j.1502-3931.2008.00136.x)

S3. Chen X, Zhang Y-D, Bergström SM, Xu H-G. 2006 Upper Darriwilian graptolite and conodont zonation in the global stratotype section of the Darriwilian stage (Ordovician) at Huangnitang, Changshan, Zhejiang, China. *Palaeoworld* **15**, 150–170. (doi:10.1016/j.palwor.2006.07.001)

S4. Cramer BD, *et al.* 2011 Revised correlation of Silurian provincial series of North America with global and regional chronostratigraphic units and δ13C$_{carb}$ chemostratigraphy. *Lethaia* **44**, 185–202. (doi:10.1111/j.1502-3931.2010.00234.x)

S5. Ernst A, Kraft P, Zágoršek K. 2013 Trepostome bryozoans from the Zahořany Formation (Upper Ordovician) of Loděnice, Prague Basin, Czech Republic. *Paläontologische Zeitschrift* **88**, 11–26. (doi:10.1007/s12542-013-0183-3)

S6. Fordham BG. 1992 Chronometric calibration of mid-Ordovician to Tournaisian conodont zones: a compilation from recent graphic-correlation and isotope studies. *Geol. Mag.* **129**, 709–721. (doi:10.1017/S001675680000844X)

S7. Fortey RA, Harper DAT, Ingham JK, Owen AW, Rushton AWA. 1995 A revision of Ordovician series and stages from the historical type area. *Geol. Mag.* **132**, 15–30. (doi:10.1017/S0016756800011390)

S8. Liñán E, Gámez Vintaned JA, Gozalo R. 2015 The middle lower Cambrian (Ovetian) *Lunagraulos* n. gen. from Spain and the oldest trilobite records. *Geol. Mag.* **6**, 1123–1136. (doi:10.1017/S0016756815000084)

S9. McKerrow WS, Lambert RSJ, Cocks LRM. 1985 The Ordovician, Silurian and Devonian periods. *Geol. Soc. London, Mem.* **10**, 73–80. (doi:10.1144/GSL.MEM.1985.010.01.08)

S10. Mitchell CE, *et al.* 2004 Discovery of the Ordovician Millbrig K-bentonite Bed in the Trenton Group of New York State: implications for regional correlation and sequence stratigraphy in eastern North America. *Palaeogeogr. Palaeoclimatol. Palaeoecol.* **210**, 331–346. (doi:10.1016/j.palaeo.2004.02.037)

S11. Mullins GL (2004) Microplankton biostratigraphy of the Bringewood Group, Ludlow Series, Silurian, of the type area. *J. Syst. Palaeontol.* **2**, 163–205. (doi:10.1017/S1477201904001129)

S12. Nõlvak J, Hints O, Männik P. 2006 Ordovician timescale in Estonia: recent developments. *Proc. Est. Acad. Sci. Geol.* **55**, 95–108.

S13. Rickard L V. 1973 Stratigraphy and structure of the subsurface Cambrian and Ordovician carbonates of New York. *New York State Museum Sci. Serv. Map Chart Ser.* **18**.

S14. Riley NJ. 1993 Dinantian (Lower Carboniferous) biostratigraphy and chronostratigraphy in the British Isles. *J. Geol. Soc. London.* **150**, 427–446. (doi:10.1144/gsjgs.150.3.0427)

S15. Rozanov AY. 1995 Precambrian-Cambrian boundary global stratotype ratified and a new perspective of Cambrian time: Comment and Reply. *Geology* **23**, 285–286. (doi:10.1130/0091-7613(1995)023<0285:PCBGSR>2.3.CO;2)

S16. Shanmugam G, Walker KR. 1980 Sedimentation, subsidence, and evolution of a foredeep basin in the Middle Ordovician, Southern Appalachians. *Am. J. Sci.* **280**, 479–496.

S17. Taylor ME. 1997 Early Paleozoic biochronology of the Great Basin, Western United States. *U.S. Geol. Surv. Prof. Pap.* **1579**.

S18. Twehhofel WH, *et al.* 1954 Correlation of the Ordovician formations of North America. *Bull. Geol. Soc. Am.* **86**, 247–298. (doi:10.1130/0016-7606(1954)65[299:COTOFO]2.0.CO;2)

S19. Zhang XL, Hua H. 2005 Soft-bodied fossils from the Shipai Formation, Lower Cambrian of the Three Gorge Area, South China. *Geol. Mag.* **142**, 699–709. (doi:10.1017/S0016756805000518)

S20. Zhu M-Y, Babcock LE, Peng S-C. 2006 Advances in Cambrian stratigraphy and paleontology: Integrating correlation techniques, paleobiology, taphonomy and paleoenvironmental reconstruction. *Palaeoworld* **15**, 217–222. (doi:10.1016/j.palwor.2006.10.016)

III. Palaeoecology
1. Ecomorphological Classification

The distinction between plankton and nekton was first noted by Haeckel [S40] - nekton are organisms that can swim against a strong current, or are "free to choose their path", while plankton are those organisms incapable of swimming against a strong current. While conceptually useful, this definition is somewhat vague, causing considerable ambiguity in ecological assignments. Thus, nekton have also been defined as those organisms that regularly experience turbulent flow, while plankton are those that regularly experience laminar flow [S41]. Flow regime can be expressed quantitatively with Reynold's number (Re): the ratio of inertial forces to frictional forces; $Re > 5.0 * 10^3$ delimit nekton, while $Re \leq 5.0 * 10^3$ delimit plankton [S41]. These divergent flow regimes imply specific profiles, thus the life mode of an organism can be deduced simply from its anatomy.

These definitions of plankton and nekton make no reference whatsoever to the position of the organism in the water column. Nekton are only defined by swimming ability and flow regime, thus all demersal taxa are strictly-speaking nektic, obviating the distinction underlying the DNR [S22]. However, the DNR does suggest an important pattern worth investigating, i.e., the confinement of most swimming taxa to the benthopelagic zone of the water column prior to the Devonian. This is essentially a distinction between pelagic nekton and benthopelagic nekton, which we call demersus (the noun equivalent of demersal). We maintain this more restricted sense of nekton for comparative purposes; however, without specifically defining these ecomorphological categories, the distinction quickly becomes overly subjective. Thus, we erected a tiered ecomorphological classification scheme predicated on Aleyev's [S41] work – modified to facilitate comparison to Klug *et al.'s* [S22] study.

Aleyev's [S41] Natatorial Ecomorphology

I. Type: Nekton
   a. Class: Eunekton (EN)
   b. Class: Planktonekton (PN)
   c. Class: Benthonekton (BN)
   d. Class: Xeronekton (XN)
II. Type: Plankton
   a. Class: Euplankton (EP)
   b. Class: Nektoplankton (NP)
III. Type: Benthos
   a. Class: Nektobenthos (NB)
IV. Type: Xeron
   a. Class: Nektoxeron (NX)

Aleyev's [S41] system involves four ecomorphological types (explicitly nekton and plankton, implicitly benthos and xeron) that encompass both the "typical representatives and various deviations" characteristic of the ascribed ecology. Each type is subdivided into ecomorphological classes to provide additional nuance, which captures the various specializations encompassed by the type. The prefix *eu-* denotes the idealized forms (i.e.

euplankton are idealized, non-swimming, *true* plankton); other combinations indicate morphologies most closely associated with the suffix, but possessing tendencies associated with the prefix (i.e. nektoplankton are swimming plankton, while planktonekton are poorly swimming nekton). These classes can be arranged in a continuum covering the full range of possible ecomorphologies. If desired, this system could be expanded with further subdivisions, elaborating down to ecomorph [S42], which could be viewed as the ecological equivalent of the taxonomic species. Thus, a full ecomorphological categorization can theoretically be constructed parallel to the phylogenetic Linnaean taxonomy.

We slightly modified Aleyev's [S41] ecomorphological classification system to better address the DNR as proposed by Klug *et al.* [S22].

Ecomorphological categories used in this analysis

I. Megaguild: Nekton
   a. Life Mode: Eunekton (EN)
   b. Life Mode: Planktonekton (PN)
   c. Life Mode: Xeronekton (XN)
   d. Life Mode: Nektoxeron (NX)

II. Megaguild: Plankton
   a. Life Mode: Euplankton (EP)
   b. Life Mode: Nektoplankton (NP)

III. Megaguild: Demersus
   a. Life Mode: Eudemersus (ED)*
   b. Life Mode: Nektobenthos (NB)

IV. Megaguild: Motile Benthos**

V. Megaguild: Sessile Benthos**

*Eudemersus = Benthonekton

**Life modes within these megaguilds are outside the scope of this paper

Ecomorphological Definitions

Along with definitions and Re values, typical characteristics and examples are provided for each term. These are included to give a sense of the meaning of the terms, not to restrict or modify the definitions. Examples are not ecological assignments of the relevant taxa. Many of these exemplar taxa include genera that do not conform to the ascribed life mode. See the electronic supplementary data for all of our exact ecological assignments.

I. Nekton – pelagic, swimming organisms that display laterally compressed and tapering morphologies. Typically Re > 5.0×10^3 [S41]

   a. Eunekton – true nekton; actively swimming pelagic organisms that experience turbulent flow, can locomote against a strong current, and do not possess morphologies indicating an obligatory connection to terrestrial or benthic environments. Typically, Re > 10^5 [S41]

i. Typical characteristics: compressiform, torpedo-shaped, large, deep-bodied, fusiform, well-stabilized, lightly armored, subcarangiform-carangiform and thunniform swimming
ii. Examples: Selachii, Teuthida, Cetacea, Palaeonisciformes

b. Planktonekton – "nekton tending towards plankton" [S41]; smaller, poorer-swimming, moderately-streamlined pelagic animals that possess nektic instead of planktic morphologies, which do not indicate an obligatory connection to terrestrial or benthic environments. Typically, $5.0 \times 10^3 < Re \leq 10^5$ [S41]
i. Typical characteristics: compressed, tubular, cigar-shaped, small, poorly stabilized
ii. Examples: Petromyzontiformes, Euconodonta

c. Xeronekton – primarily aquatic, actively swimming, semi-terrestrial organisms that maintain an obligatory connection to terrestrial environments
i. Typical characteristics: well-streamlined, compressed, poorly adapted for (but capable of) terrestrial locomotion, air-breathing
ii. Examples: Pinnipedia, Mesosauria

d. Nektoxeron – primarily terrestrial, actively swimming, semi-aquatic organisms that possess significant aquatic specializations and an obligatory connection to aquatic environments
i. Typical characteristics: poorly-streamlined, depressed, walking limbs, paddles, wings, well adapted for both terrestrial and aquatic locomotion, air-breathing
ii. Examples: Crocodilia, Laridae

II. **Plankton –** pelagic organisms that display unstreamlined or parachuting morphologies

a. **Euplankton –** truly passive drifters; pelagic organisms either incapable of movement or possessing only very limited lateral motility, which often display sinking-resistant morphologies and experience laminar flow. Typically, $Re \leq 5.0 \times 10^3$ [S41]
i. Typical characteristics: parachuting, branching, ornamented, small, gelatinous, colonial
ii. Examples: Graptoloidea, Ctenophora, Thaliacea

b. Nektoplankton – poorly streamlined pelagic organisms with some lateral swimming capability. Typically, $5.0 \times 10^3 < Re \leq 10^5$ [S41]
i. Typical characteristics: poorly streamlined, ornamented, small, unwieldy, bulky, armored, sail-like
ii. Examples: Clymeniida, Euphausiacea

III. Demersus – benthopelagic organisms capable of active swimming and often at least somewhat dorsoventrally depressed

a. Eudemersus – active swimming organisms restricted to near-benthic environments; display limited streamlining and are often somewhat dorsoventrally flattened

i. Typical characteristics: vaulted dorsum, flattened venter, somewhat depressed, somewhat streamlined, absence of walking limbs, heavily armored

ii. Examples: Nautilida, Holocephali, Arthrodira

b. Nektobenthos – Suprabenthic organisms capable of temporary swimming

i. Typical characteristics: highly depressiform, walking limbs, eel-like, ambushing; rajiform, amiiform, gymnotiform, and anguilliform swimming

ii. Examples: Batoidea, Anguilliformes, Amiiformes, Xiphosura, Stomatopoda

IV. Motile Benthos – Non-swimming locomotive benthic organisms

i. Examples: Gastropoda, Asteroidea

V. Sessile Benthos – Non-locomotive benthic organisms

i. Typical characteristics: holdfast, stalked, cemented, reef-building

ii. Examples: Porifera, Bryozoa

As the behavior of a fossil organisms can never be fully known, we categorize taxa based on ecomorphology rather than "true" ecology. Although these ecomorphological categories may not strictly correlate with behavioral ecologies, this abstraction is necessary for the results to have any consistent, repeatable validity. This morphology-centric approach allows the erection of clear, taxon-neutral guidelines for ecomorphological assignments (figure S5). Although this risks artificial delimitation, this explicit morphological framework is necessary to ensure repeatable, consistent, transparent, and meaningful results. That being said, these are guidelines, not rules – there are exceptions.

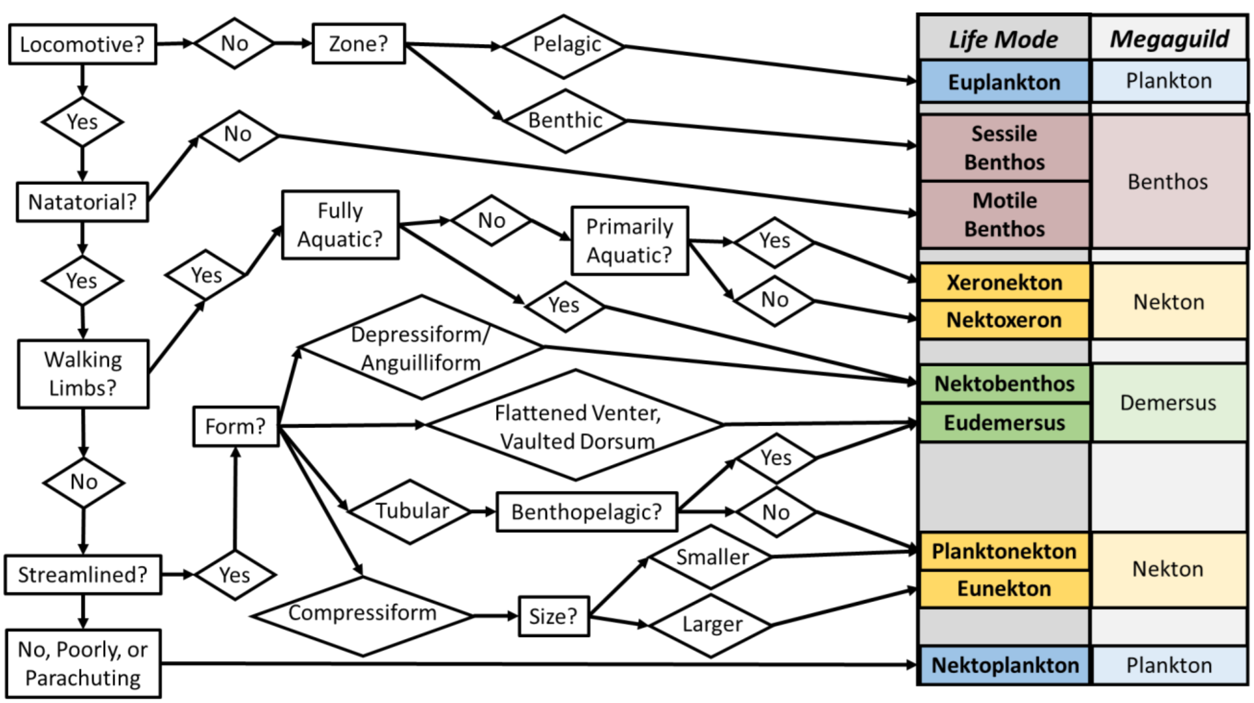


Figure S5. Life mode decision tree covering most taxa except for coiled cephalopods, which were handled in Westermann Morphospace.

2. Westermann Morphospace

Westermann [S43] arranged the various basic planispiral ammonoid shell shapes by morphology and inferred ecology (figure S6). At the three extremes of this ternary diagram are serpenticones, spherocones, and oxycones – suggestive of planktic drifters, planktic vertical migrants, and nekton, respectively. Demersal planorbicones, scaphitocones, and platycones are intermediate.

Ritterbush and Bottjer [S44] modified Raup's classic [S45] shell coiling parameters, transforming them into coordinates in Westermann Morphospace – the quantitative expression of Westermann's [S43] theoretical diagram. Serpenticones maximize U, spherocones Th, and oxycones w; where U, Th, and w indicate umbilical exposure, overall inflation, and whorl expansion, respectively (see p. 18 for metrics and equations). Westermann Morphospace provides a framework for quantitatively deriving the life mode of a coiled cephalopod using only five simple metrics. The method has been criticized as an oversimplification of total ammonoid disparity [S46], but we consider it sufficient for our purposes.

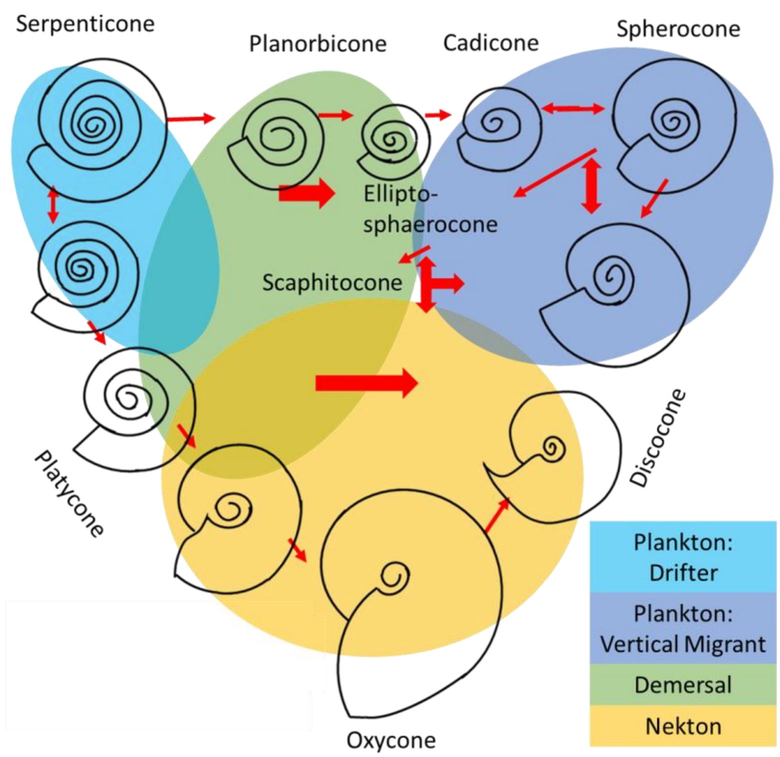


Figure S6. Basic planispiral shell shapes organized by morphology and hypothetical ecology; adapted from Westermann [S43, figure 1].

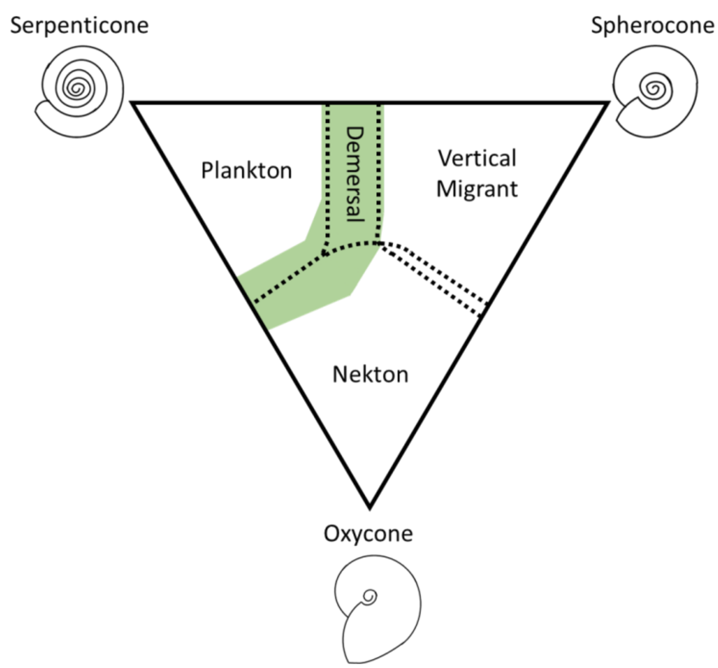


Figure S7. Westermann Morphospace; adapted from Ritterbush & Bottjer [S44, figure 1B].

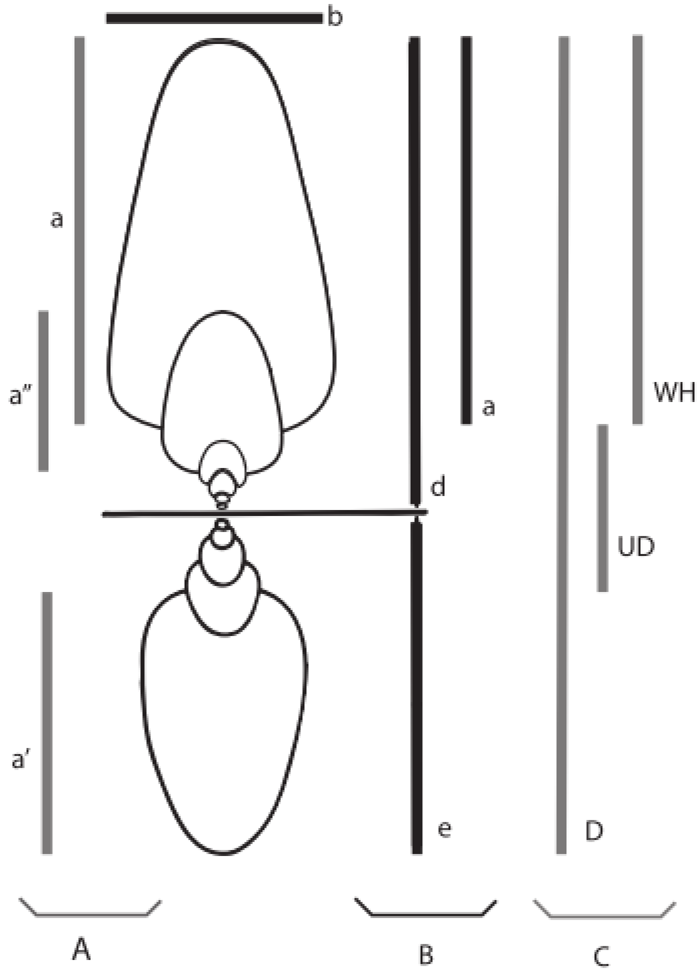


Figure S8. Hypothetical ammonoid cross-section showing measurements necessary to calculate umbilical exposure (U), overall inflation (Th), and whorl expansion (w) as well as other common ammonoid metrics, from Ritterbush & Bottjer [S44, figure 2]. A = whorl measurements, a = final whorl height, a' = 180° whorl height, a'' = height of whorl before final rotation. B = radial measurements, d = larger radius, e = smaller radius, a = final whorl height. C = diameter measurements, D = larger conch diameter, UD = umbilical diameter, WH = whorl height. b = whorl width.

Umbilical Exposure [S44]

$$U' = \frac{UD/D}{0.52}$$

$$U = \frac{U'}{U' + Th' + w'}$$

Overall Inflation [S44]

$$Th' = \frac{(b/D) - 0.14}{0.54}$$

$$Th = \frac{Th'}{U' + Th' + w'}$$

Whorl Expansion [S44]

$$w' = \frac{(a/a') - 1.0}{0.77}$$

$$w = \frac{w'}{U' + Th' + w'}$$

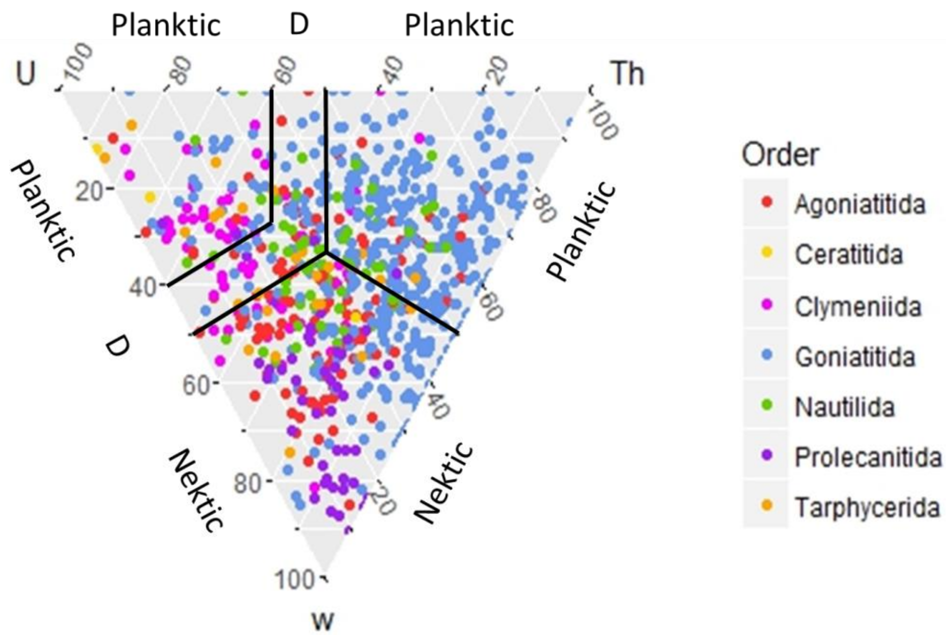


Figure S9. SSCG (Supplemented Sepkoski's Compendium of Genera) and PBDB (Paleobiology Database) coiled cephalopods in Westermann Morphospace. U = umbilical exposure (maximized in serpenticones), Th = overall inflation (maximized in spherocones), w = whorl expansion (maximized in oxycones). D indicates demersal. All plankton are nektoplankton, all demersus are eudemersus, all nekton are eunekton.

IV. Paleobiology Database (PBDB) Biases

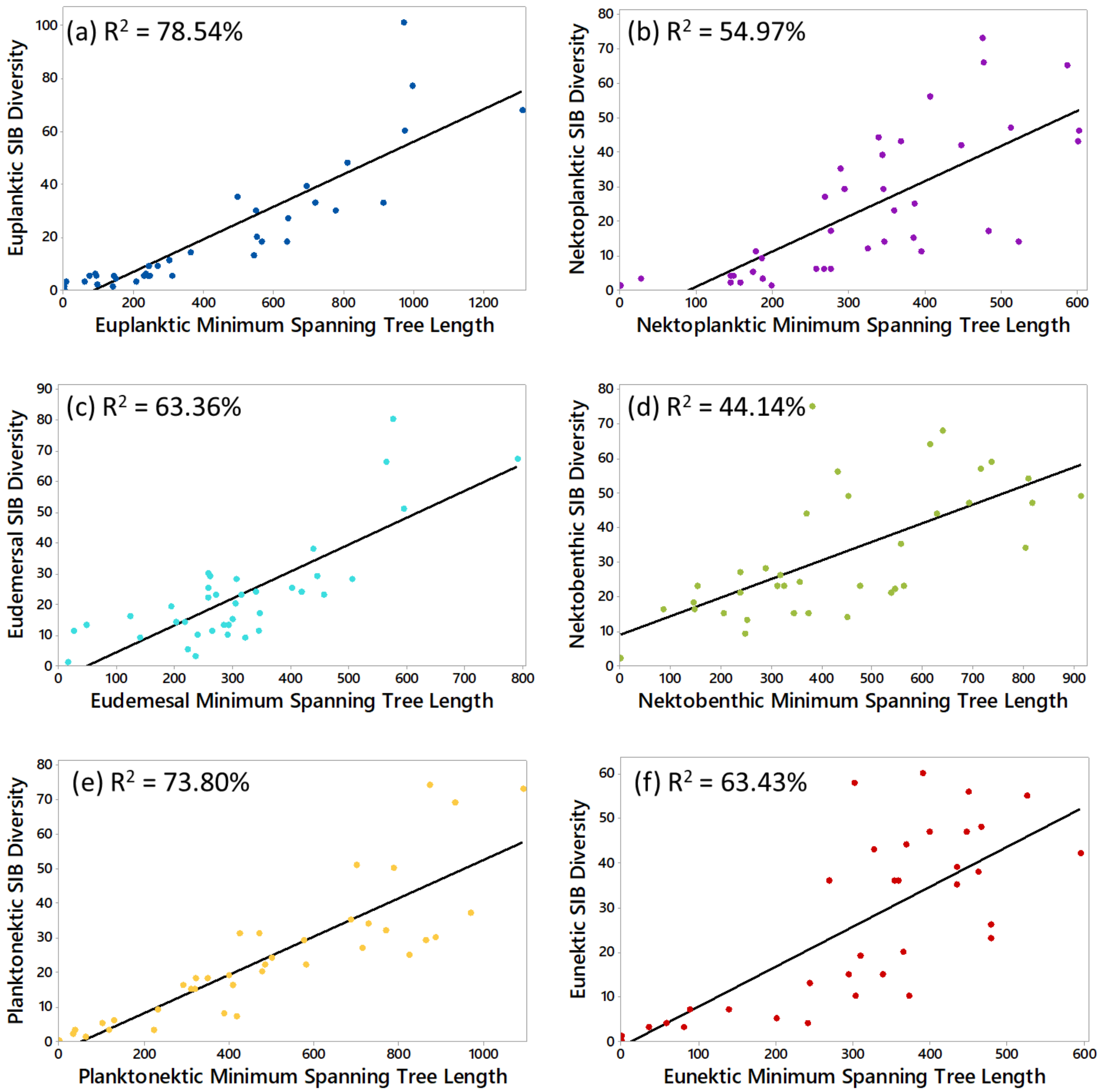


Figure S10. Paleobiology Database (PBDB) raw Palaeozoic SIB (sampled-in-bin) generic diversity by minimum spanning tree (MST) length for (*a*) euplankton, (*b*) nektoplankton, (*c*) eudemersus, (*d*) nektobenthos, (*e*) planktonekton, and (*f*) eunekton.

We tested whether or not the SQS standardized Paleobiology Database (PBDB) results were biased by the species-area effect. Following Alroy [S47] and Close *et al.* [S48], the palaeogeographic spread of all included PBDB collections was summarized using the length of the minimum spanning tree (MST) connecting the palaeocoordinates of each locality; unlike other metrics, the MST length captures spatial coverage, dispersion, and total extent. PBDB palaeocoordinates were binned to 1° x 1° grid cells in order to reduce the impact of densely clustered localities on the MST length [as in S47,S48]. MST lengths were calculated per stratigraphic bin and per ecomorphological life mode using the R package dispRity [S49]. We retained long branches as we consider all global aquatic (i.e. marine and freshwater) occurrences, rather than isolated continental faunas [as in S48]. We then compared raw SIB generic diversity (figure S10) and SQS standardized SIB generic diversity (figure S11) to MST length for each life mode.

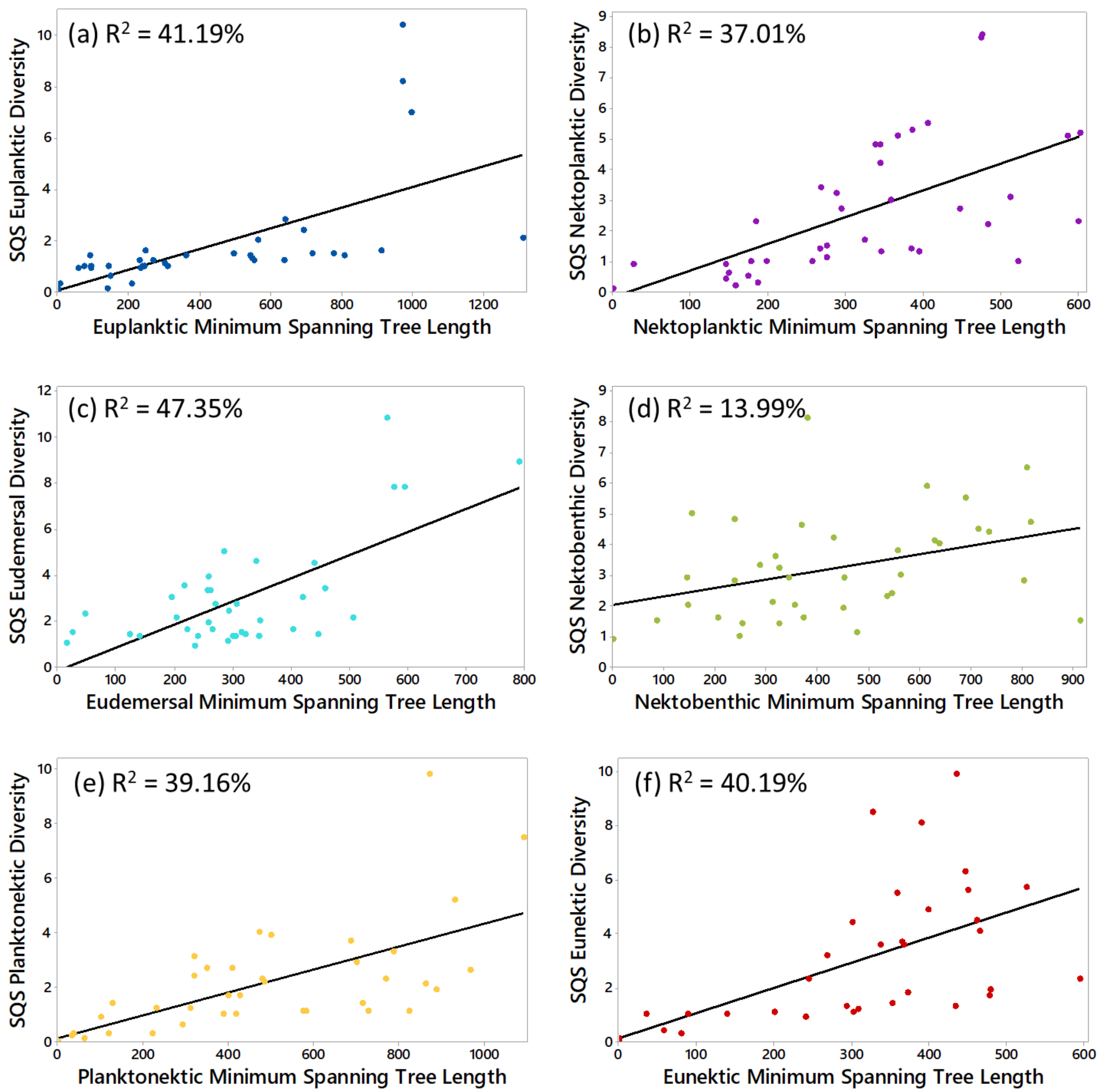


Figure S11. Paleobiology Database (PBDB) SQS (Shareholder Quorum Subsampling) standardized Palaeozoic sampled-in-bin (SIB) generic diversity by minimum spanning tree (MST) length for (*a*) euplankton, (*b*) nektoplankton, (*c*) eudemersus, (*d*) nektobenthos, (*e*) planktonekton, and (*f*) eunekton.

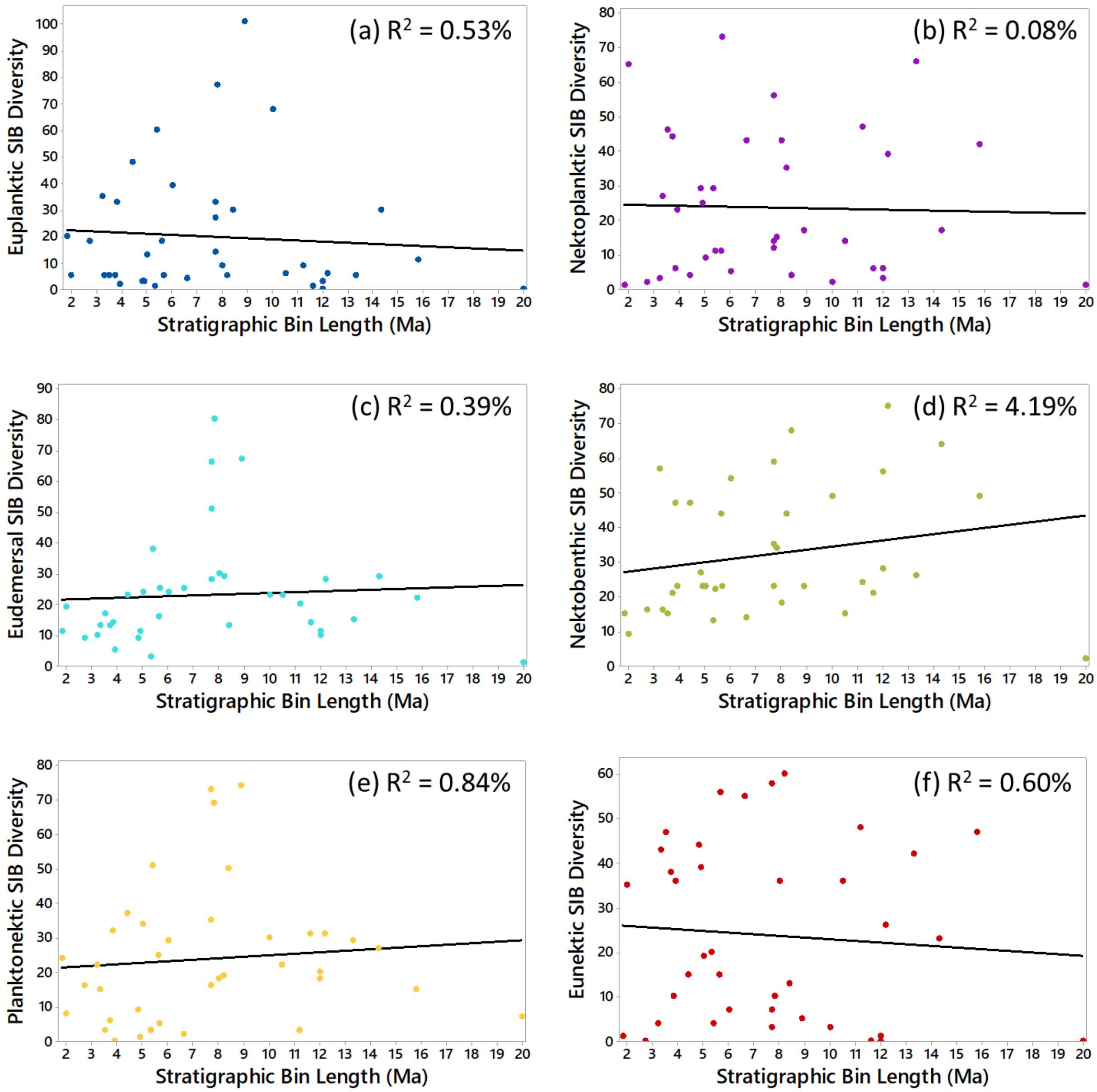


Figure S12. Paleobiology Database (PBDB) raw Palaeozoic SIB (sampled-in-bin) generic diversity by stratigraphic bin length for (*a*) euplankton, (*b*) nektoplankton, (*c*) eudemersus, (*d*) nektobenthos, (*e*) planktonekton, and (*f*) eunekton.

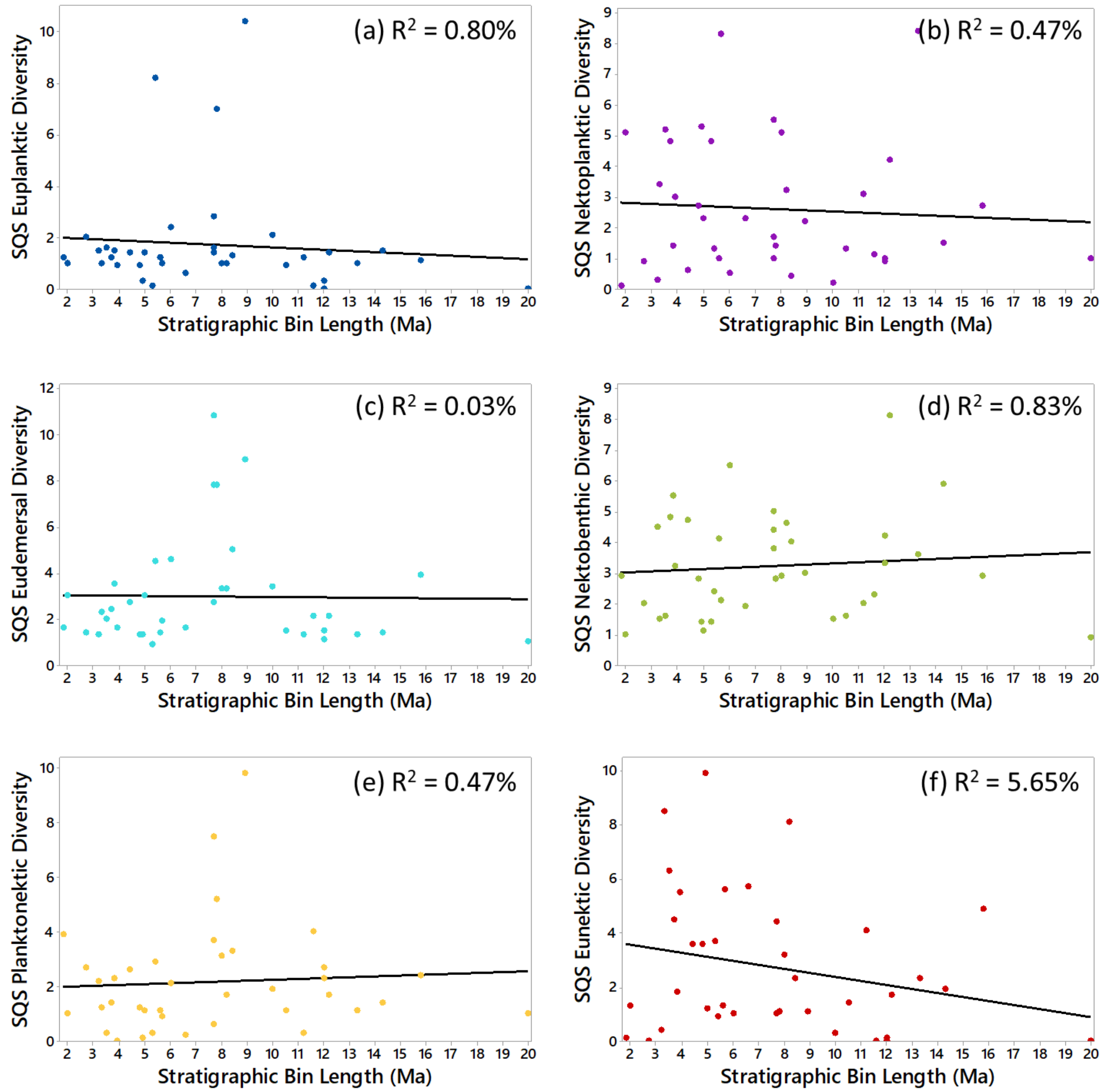


Figure S13. Paleobiology Database (PBDB) SQS (Shareholder Quorum Subsampling) standardized Palaeozoic sampled-in-bin (SIB) generic diversity by stratigraphic bin length for (*a*) euplankton, (*b*) nektoplankton, (*c*) eudemersus, (*d*) nektobenthos, (*e*) planktonekton, and (*f*) eunekton.

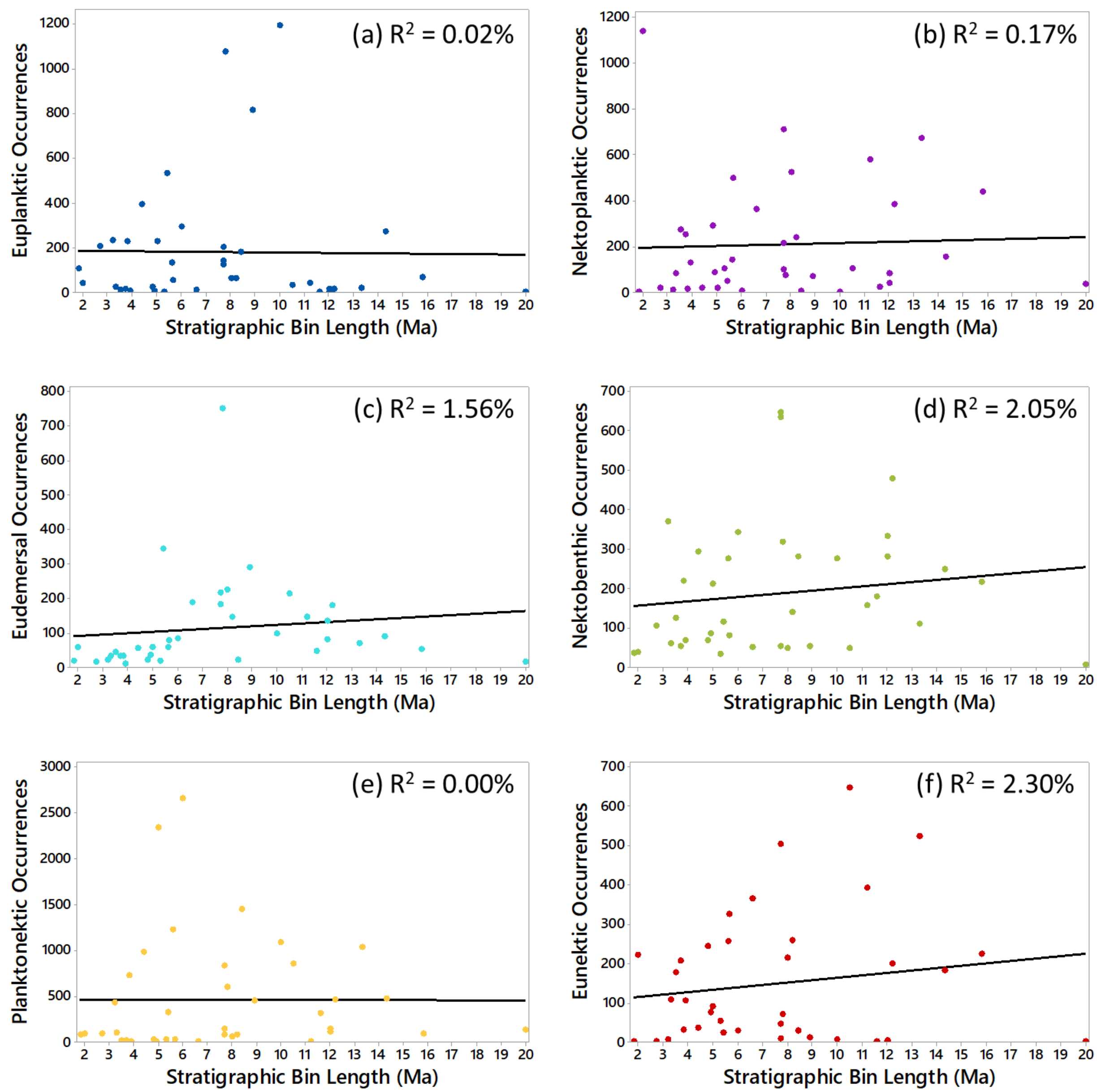


Figure S14. Paleobiology Database (PBDB) Palaeozoic generic occurrences by stratigraphic bin length for (*a*) euplankton, (*b*) nektoplankton, (*c*) eudemersus, (*d*) nektobenthos, (*e*) planktonekton, and (*f*) eunekton.

Raw SIB generic diversity appears to be impacted by palaeogeographic spread for all life modes except the nektobenthos and perhaps the nektoplankton (figure S10); however, SQS standardized generic diversity does not appear to be biased (figure S11). Considering these results and the small sample sizes for several stratigraphic-ecological bins, we did not standardize for space prior to SQS standardization. Neither PBDB generic occurrences, raw SIB diversity, nor SQS standardized SIB diversity appear to be biased by uneven chronostratigraphic bin length (figures S12-14).

IV. Results & Discussion
1. Data Tables of Palaeozoic Generic Diversity & Occurrences

Table S1. Supplemented Sepkoski's Compendium (SSCG) Ranged-Through Generic Diversity

		Plankton	Demersus	Nekton	EP	NP	ED	NB	PN	EN
Cambrian	Tomm	1	3	5	0	1	3	0	5	0
	Atda	6	47	11	2	4	8	39	11	0
	Boto	6	27	13	2	4	10	17	13	0
	Tojo	6	28	9	2	4	9	19	9	0
	Ag 5	14	75	25	3	11	17	58	23	2
	Dres	6	12	12	1	5	0	12	12	0
	Paib	9	4	13	1	8	0	4	13	0
	Trmp	7	44	23	2	5	37	7	23	0
Ordovician	Trma	23	68	60	14	9	45	23	60	0
	Aren	98	170	73	71	27	135	35	63	10
	Darr	128	164	78	103	25	124	40	73	5
	Cara	79	146	83	64	15	90	56	71	12
	Ashg	71	131	60	57	14	81	50	49	11
Silurian	Llan	76	94	31	70	6	32	62	26	5
	Wenl	63	157	55	59	4	79	78	30	25
	Ludl	86	128	53	80	6	61	67	26	27
	Prid	51	117	67	47	4	33	84	37	30
Devonian	Loch	43	175	113	38	5	42	133	41	72
	Prag	42	201	68	35	7	68	133	28	40
	Emsi	58	231	76	40	18	96	135	26	50
	Eife	57	186	77	44	13	89	97	23	54
	Give	47	170	108	31	16	84	86	30	78
	Fras	51	198	138	36	15	117	81	35	103
	Fame	133	196	135	36	97	103	93	44	91
Carboniferous	Tour	66	100	128	27	39	31	69	37	91
	Vise	99	150	138	33	66	55	95	34	104
	Serp	97	117	129	26	71	39	78	28	101
	Bash	79	80	74	15	64	35	45	19	55
	Mosc	74	87	85	14	60	34	53	23	62
	U Pn	73	53	67	14	59	21	32	15	52
Permian	Asse	51	43	51	12	39	18	25	9	42
	Sakm	41	36	48	5	36	12	24	9	39
	Leon	62	44	77	7	55	20	24	15	62
	Guad	69	53	61	7	62	15	38	12	49
	Lopi	37	17	46	4	33	3	14	7	39

Table S2. Paleobiology Database SQS Standardized Sampled-in-Bin Generic Diversity

		Plankton	Demersus	Nekton	EP	NP	ED	NB	XN	PN	EN
Cambrian	Terr	1	1	1	0	1	1	0.9	0	1	0
	Ep 2	1	13.4	6.1	0.3	1	1.1	4.2	0	2.3	0.1
	Ep 3	1.4	11.6	6.4	0	0.9	1.5	3.3	0	2.7	0
	Furo	2.9	8.7	9.7	0.1	1.1	2.1	2.3	0	4	0
Ordovician	Trma	6.7	27.6	19.3	1.6	1	10.8	4.4	0	7.5	1
	Floi	12.1	16.4	12.3	2.8	1.7	7.8	3.8	0	3.7	1
	Dapi	5.7	6.4	6.5	2	0.9	1.4	2	0	2.7	0
	Darr	31.8	31.7	26.7	10.4	2.2	8.9	3	0	9.8	1.1
	Sand	22.8	17.8	10.8	8.2	1.3	4.5	2.4	0	2.9	0.9
	Kati	22.5	28.1	20.4	7	1.4	7.8	2.8	0	5.2	1.1
	Hirn	3.5	18.8	10.2	1.2	0.1	1.6	2.9	0	3.9	0.1
Silurian	Llan	13.1	18.3	4.6	2.1	0.2	3.4	1.5	0	1.9	0.3
	Wenl	7.6	24.5	4.9	2.4	0.5	4.6	6.5	0	2.1	1
	Ludl	9	17.6	7.3	1.4	0.6	2.7	4.7	0	2.6	3.6
	Prid	7.3	20.5	6.8	1.5	1.4	3.5	5.5	0	2.3	1.8
Devonian	Loch	5.3	21.9	8.3	1.3	0.4	5	4	0	3.3	2.3
	Prag	7.4	14.8	5.5	1.5	0.3	1.3	4.5	0	2.2	0.4
	Emsi	9.6	29	8	1.5	1.5	1.4	5.9	0	1.4	1.9
	Eife	5.4	17.2	3.5	1.2	1	1.4	4.1	0	1.1	1.3
	Give	3.7	4.9	2	1.4	2.3	3	1.1	0	1.1	1.2
	Fras	4.5	7.4	5.9	0.9	1.3	1.5	1.6	0	1.1	1.4
	Fame	21.1	12.9	5.1	1	8.4	1.3	3.6	0	1.1	2.3
Carboniferous	Tour	11.4	27.3	8.5	1.4	4.2	2.1	8.1	0	1.7	1.7
	Vise	14.2	18.3	19.7	1.1	2.7	3.9	2.9	0	2.4	4.9
	Serp	18.6	12.3	14.3	1.4	5.5	2.7	5	0	0.6	4.4
	Bash	13.5	12.8	13.8	1	5.1	3.3	2.9	0	3.1	3.2
	Mosc	8.6	24.4	29.6	1	3.2	3.3	4.6	0.2	1.7	8.1
	Kasi	12	10.9	21	1	3.4	2.3	1.5	0	1.2	8.5
	Gzhe	8.4	19.3	12.4	0.9	2.7	1.3	2.8	0.1	1.2	3.6
Permian	Asse	8.2	12.5	15.9	0.9	3	1.6	3.2	0.4	0	5.5
	Sakm	13.6	8.9	31.2	0.3	5.3	1.3	1.4	0	0.1	9.9
	Arti	7.7	6.8	15	0.6	2.3	1.6	1.9	0	0.2	5.7
	Kung	10.5	9.1	11.6	1.2	3.1	1.3	2	0	0.3	4.1
	Road	14.2	9.8	19.8	1.6	5.2	2	1.6	0.2	0.3	6.3
	Word	12.9	19	14.2	1.2	4.8	2.4	4.8	0.3	1.4	4.5
	Capi	12	4.5	9.9	0.1	4.8	0.9	1.4	0	0.3	3.7
	Wuch	21.8	14	16.5	1	8.3	1.9	2.1	0.5	0.9	5.6
	Chan	14	9.8	6.2	1	5.1	3	1	0.1	1	1.3

Table S3. Paleobiology Database Generic Occurrences

		Plankton	Demersus	Nekton	EP	NP	ED	NB	NX	XN	PN	EN
Cambria	Terr	36	20	125	0	36	14	6	0	0	125	0
	Ep 2	92	409	109	11	81	78	331	0	0	107	2
	Ep 3	40	411	138	0	40	132	279	0	0	138	0
	Furo	24	222	303	2	22	44	178	0	0	303	0
Ordovician	Trma	413	847	835	200	213	214	633	0	0	828	7
	Floi	217	827	179	120	97	181	646	0	0	134	45
	Dapi	223	117	82	206	17	13	104	0	0	82	0
	Darr	878	340	454	812	66	288	52	0	0	443	11
	Sand	575	457	336	530	45	343	114	0	0	313	23
	Kati	1146	1066	658	1074	72	749	317	0	0	589	69
	Hirn	104	52	79	103	1	17	35	0	0	78	1
Silurian	Llan	1193	373	1083	1191	2	97	276	0	0	1079	4
	Wenl	299	425	2676	293	6	83	342	0	0	2650	26
	Ludl	407	347	1007	392	15	54	293	0	0	973	34
	Prid	240	249	747	227	13	31	218	0	0	717	30
Devonian	Loch	182	299	1465	177	5	20	279	0	0	1437	28
	Prag	238	389	429	230	8	21	368	0	0	425	4
	Emsi	425	334	642	272	153	87	247	0	0	462	180
	Eife	272	334	1479	131	141	58	276	0	0	1224	255
	Give	246	267	2419	228	18	57	210	0	0	2331	88
	Fras	133	259	1491	30	103	212	47	0	0	845	646
	Fame	687	177	1553	16	671	68	109	0	0	1030	523
Carboniferous	Tour	395	656	657	12	383	178	478	0	0	460	197
	Vise	501	267	309	65	436	51	216	1	0	84	224
	Serp	848	232	582	140	708	180	52	0	0	79	503
	Bash	585	269	270	61	524	223	46	1	0	55	214
	Mosc	298	281	336	59	239	143	138	5	2	72	257
	Kasi	101	92	199	21	80	32	60	0	0	93	106
	Gzhe	310	86	269	21	289	20	66	1	1	25	242
Permian	Asse	133	76	126	6	127	8	68	0	22	0	104
	Sakm	91	119	77	4	87	34	85	0	0	3	74
	Arti	369	237	365	8	361	187	50	0	0	2	363
	Kung	617	301	396	38	579	144	157	0	0	4	392
	Road	279	167	185	8	271	43	124	0	2	8	175
	Word	260	82	222	11	249	30	52	0	4	13	205
	Capi	102	50	68	1	101	18	32	0	0	17	51
	Wuch	548	155	350	51	497	75	80	0	5	20	325
	Chan	1177	96	309	38	1139	58	38	3	1	84	221

Table S4. Change in SSCG Ranged-Through Generic Diversity

		Plankton	Demersus	Nekton	EP	NP	ED	NB	PN	EN
Cambrian	Tomm	-	-	-	-	-	-	-	-	-
	Atda	5	44	6	2	3	5	39	6	0
	Boto	0	-20	2	0	0	2	-22	2	0
	Tojo	0	1	-4	0	0	-1	2	-4	0
	Ag 5	8	47	16	1	7	8	39	14	2
	Dres	-8	-63	-13	-2	-6	-17	-46	-11	-2
	Paib	3	-8	1	0	3	0	-8	1	0
	Trmp	-2	40	10	1	-3	37	3	10	0
Ordovician	Trma	16	24	37	12	4	8	16	37	0
	Aren	75	102	13	57	18	90	12	3	10
	Darr	30	-6	5	32	-2	-11	5	10	-5
	Cara	-49	-18	5	-39	-10	-34	16	-2	7
	Ashg	-8	-15	-23	-7	-1	-9	-6	-22	-1
Silurian	Llan	5	-37	-29	13	-8	-49	12	-23	-6
	Wenl	-13	63	24	-11	-2	47	16	4	20
	Ludl	23	-29	-2	21	2	-18	-11	-4	2
	Prid	-35	-11	14	-33	-2	-28	17	11	3
Devonian	Loch	-8	58	46	-9	1	9	49	4	42
	Prag	-1	26	-45	-3	2	26	0	-13	-32
	Emsi	16	30	8	5	11	28	2	-2	10
	Eife	-1	-45	1	4	-5	-7	-38	-3	4
	Give	-10	-16	31	-13	3	-6	-10	7	24
	Fras	4	28	30	5	-1	33	-5	5	25
	Fame	82	-2	-3	0	82	-13	11	9	-12
Carboniferous	Tour	-67	-96	-7	-9	-58	-72	-24	-7	0
	Vise	33	50	10	6	27	24	26	-3	13
	Serp	-2	-33	-9	-7	5	-16	-17	-6	-3
	Bash	-18	-37	-55	-11	-7	-4	-33	-9	-46
	Mosc	-5	7	11	-1	-4	-1	8	4	7
	U Pn	-1	-34	-18	0	-1	-13	-21	-8	-10
Permian	Asse	-22	-10	-16	-2	-20	-3	-7	-6	-10
	Sakm	-10	-7	-3	-7	-3	-6	-1	0	-3
	Leon	21	8	29	2	19	8	0	6	23
	Guad	7	9	-16	0	7	-5	14	-3	-13
	Lopi	-32	-36	-15	-3	-29	-12	-24	-5	-10

Table S5. Change in PBDB SQS Standardized Sampled-in-Bin Generic Diversity

		Plankton	Demersus	Nekton	EP	NP	ED	NB	XN	PN	EN
Cambrian	Terr	-	-	-	-	-	-	-	-	-	-
	Ep 2	0	12.4	5.1	0.3	0	0.1	3.3	0	1.3	0.1
	Ep 3	0.4	-1.8	0.3	-0.3	-0.1	0.4	-0.9	0	0.4	-0.1
	Furo	1.5	-2.9	3.3	0.1	0.2	0.6	-1	0	1.3	0
Ordovician	Trma	3.8	18.9	9.6	1.5	-0.1	8.7	2.1	0	3.5	1
	Floi	5.4	-11.2	-7	1.2	0.7	-3	-0.6	0	-3.8	0
	Dapi	-6.4	-10	-5.8	-0.8	-0.8	-6.4	-1.8	0	-1	-1
	Darr	26.1	25.3	20.2	8.4	1.3	7.5	1	0	7.1	1.1
	Sand	-9	-13.9	-15.9	-2.2	-0.9	-4.4	-0.6	0	-6.9	-0.2
	Kati	-0.3	10.3	9.6	-1.2	0.1	3.3	0.4	0	2.3	0.2
	Hirn	-19	-9.3	-10.2	-5.8	-1.3	-6.2	0.1	0	-1.3	-1
Silurian	Llan	9.6	-0.5	-5.6	0.9	0.1	1.8	-1.4	0	-2	0.2
	Wenl	-5.5	6.2	0.3	0.3	0.3	1.2	5	0	0.2	0.7
	Ludl	1.4	-6.9	2.4	-1	0.1	-1.9	-1.8	0	0.5	2.6
	Prid	-1.7	2.9	-0.5	0.1	0.8	0.8	0.8	0	-0.3	-1.8
Devonian	Loch	-2	1.4	1.5	-0.2	-1	1.5	-1.5	0	1	0.5
	Prag	2.1	-7.1	-2.8	0.2	-0.1	-3.7	0.5	0	-1.1	-1.9
	Emsi	2.2	14.2	2.5	0	1.2	0.1	1.4	0	-0.8	1.5
	Eife	-4.2	-11.8	-4.5	-0.3	-0.5	0	-1.8	0	-0.3	-0.6
	Give	-1.7	-12.3	-1.5	0.2	1.3	1.6	-3	0	0	-0.1
	Fras	0.8	2.5	3.9	-0.5	-1	-1.5	0.5	0	0	0.2
	Fame	16.6	5.5	-0.8	0.1	7.1	-0.2	2	0	0	0.9
Carboniferous	Tour	-9.7	14.4	3.4	0.4	-4.2	0.8	4.5	0	0.6	-0.6
	Vise	2.8	-9	11.2	-0.3	-1.5	1.8	-5.2	0	0.7	3.2
	Serp	4.4	-6	-5.4	0.3	2.8	-1.2	2.1	0	-1.8	-0.5
	Bash	-5.1	0.5	-0.5	-0.4	-0.4	0.6	-2.1	0	2.5	-1.2
	Mosc	-4.9	11.6	15.8	0	-1.9	0	1.7	0.2	-1.4	4.9
	Kasi	3.4	-13.5	-8.6	0	0.2	-1	-3.1	-0.2	-0.5	0.4
	Gzhe	-3.6	8.4	-8.6	-0.1	-0.7	-1	1.3	0.1	0	-4.9
Permian	Asse	-0.2	-6.8	3.5	0	0.3	0.3	0.4	0.3	-1.2	1.9
	Sakm	5.4	-3.6	15.3	-0.6	2.3	-0.3	-1.8	-0.4	0.1	4.4
	Arti	-5.9	-2.1	-16.2	0.3	-3	0.3	0.5	0	0.1	-4.2
	Kung	2.8	2.3	-3.4	0.6	0.8	-0.3	0.1	0	0.1	-1.6
	Road	3.7	0.7	8.2	0.4	2.1	0.7	-0.4	0.2	0	2.2
	Word	-1.3	9.2	-5.6	-0.4	-0.4	0.4	3.2	0.1	1.1	-1.8
	Capi	-0.9	-14.5	-4.3	-1.1	0	-1.5	-3.4	-0.3	-1.1	-0.8
	Wuch	9.8	9.5	6.6	0.9	3.5	1	0.7	0.5	0.6	1.9
	Chan	-7.8	-4.2	-10.3	0	-3.2	1.1	-1.1	-0.4	0.1	-4.3

Table S6. Change in Paleobiology Database Generic Occurrences

		Plankton	Demersus	Nekton	EP	NP	ED	NB	NX	XN	PN	EN
Cambrian	Terr	-	-	-	-	-	-	-	-	-	-	-
	Ep 2	56	389	-16	11	45	64	325	0	0	-18	2
	Ep 3	-52	2	29	-11	-41	54	-52	0	0	31	-2
	Furo	-16	-189	165	2	-18	-88	-101	0	0	165	0
Ordovician	Trma	389	625	532	198	191	170	455	0	0	525	7
	Floi	-196	-20	-656	-80	-116	-33	13	0	0	-694	38
	Dapi	6	-710	-97	86	-80	-168	-542	0	0	-52	-45
	Darr	655	223	372	606	49	275	-52	0	0	361	11
	Sand	-303	117	-118	-282	-21	55	62	0	0	-130	12
	Kati	571	609	322	544	27	406	203	0	0	276	46
	Hirn	-1042	-1014	-579	-971	-71	-732	-282	0	0	-511	-68
Silurian	Llan	1089	321	1004	1088	1	80	241	0	0	1001	3
	Wenl	-894	52	1593	-898	4	-14	66	0	0	1571	22
	Ludl	108	-78	-1669	99	9	-29	-49	0	0	-1677	8
	Prid	-167	-98	-260	-165	-2	-23	-75	0	0	-256	-4
Devonian	Loch	-58	50	718	-50	-8	-11	61	0	0	720	-2
	Prag	56	90	-1036	53	3	1	89	0	0	-1012	-24
	Emsi	187	-55	213	42	145	66	-121	0	0	37	176
	Eife	-153	0	837	-141	-12	-29	29	0	0	762	75
	Give	-26	-67	940	97	-123	-1	-66	0	0	1107	-167
	Fras	-113	-8	-928	-198	85	155	-163	0	0	-1486	558
	Fame	554	-82	62	-14	568	-144	62	0	0	185	-123
Carboniferous	Tour	-292	479	-896	-4	-288	110	369	0	0	-570	-326
	Vise	106	-389	-348	53	53	-127	-262	1	0	-376	27
	Serp	347	-35	273	75	272	129	-164	-1	0	-5	279
	Bash	-263	37	-312	-79	-184	43	-6	1	0	-24	-289
	Mosc	-287	12	66	-2	-285	-80	92	4	2	17	43
	Kasi	-197	-189	-137	-38	-159	-111	-78	-5	-2	21	-151
	Gzhe	209	-6	70	0	209	-12	6	1	1	-68	136
Permian	Asse	-177	-10	-143	-15	-162	-12	2	-1	21	-25	-138
	Sakm	-42	43	-49	-2	-40	26	17	0	-22	3	-30
	Arti	278	118	288	4	274	153	-35	0	0	-1	289
	Kung	248	64	31	30	218	-43	107	0	0	2	29
	Road	-338	-134	-211	-30	-308	-101	-33	0	2	4	-217
	Word	-19	-85	37	3	-22	-13	-72	0	2	5	30
	Capi	-158	-32	-154	-10	-148	-12	-20	0	-4	4	-154
	Wuch	446	105	282	50	396	57	48	0	5	3	274
	Chan	629	-59	-41	-13	642	-17	-42	3	-4	64	-104

2. Alternative Diversity/Occurrence Figures

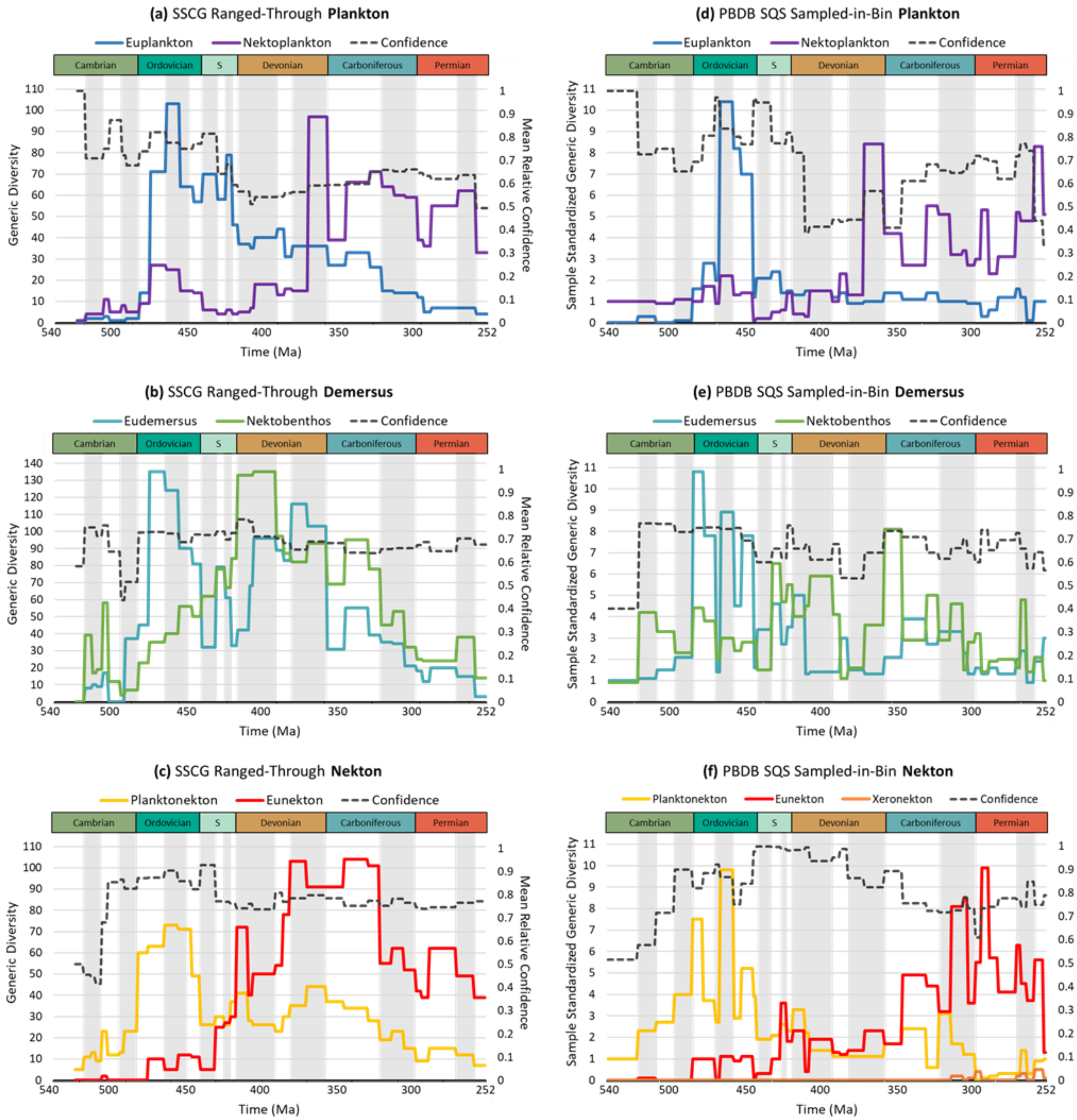


Figure S15. Palaeozoic generic diversity by life mode with mean relative confidence (dashed line). (*a,d*) Plankton: blue denotes euplankton, purple nektoplankton. (*b,e*) Demersus: cyan denotes eudemersus, green nektobenthos. (*c,f*) Nekton: yellow denotes planktonekton, red eunekton, orange xeronekton; too few nektoxeric taxa to sample standardize and plot. (*a-c*) SSCG (Supplemented Sepkoski's Compendium, Genera) ranged-through generic diversity. (*d-e*) PBDB (Paleobiology Database) SQS (Shareholder Quorum Subsampling) standardized sampled-in-bin generic diversity.

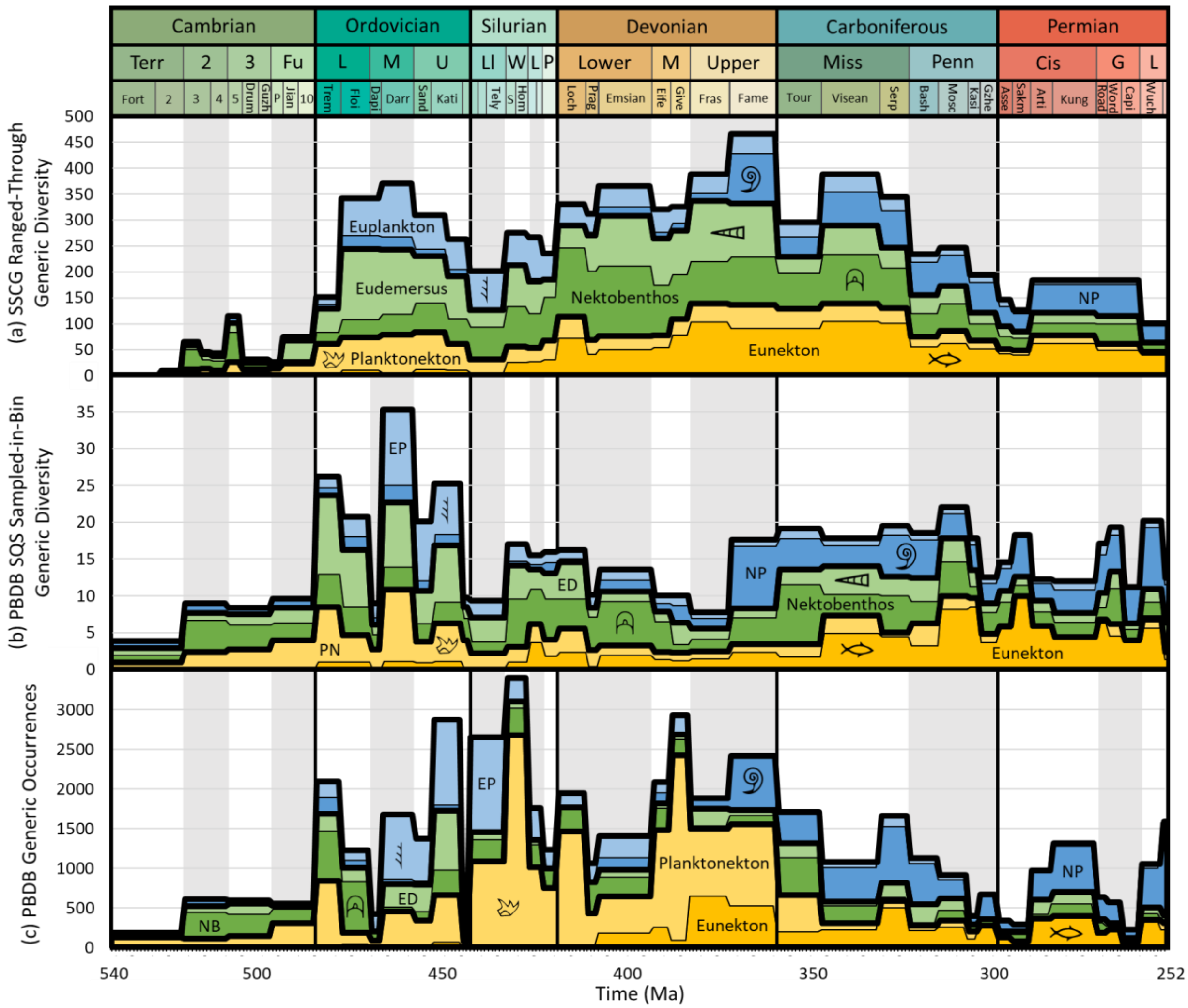


Figure S16. Stacked generic diversity by life mode. Blue denotes planktic, green demersal, yellow nektic. EP denotes Euplankton, NP Nektoplankton, ED Eudemersus, NB Nektobenthos, PN Planktonekton. Xeronekton and nektoxeron too insignificant to show. United States Geological Survey symbols here denote life mode not taxonomy; they do not necessarily indicate that all or most of the genera from the symbolized taxon exhibit the relevant life mode. (*a*) SSCG (Supplemented Sepkoski's Compendium of Genera) ranged-through diversity. (*b*) PBDB (Paleobiology Database) SQS (Shareholder Quorum Subsampling) standardized sampled-In-bin genus diversity. (*c*) PBDB (Paleobiology Database) genus occurrences.

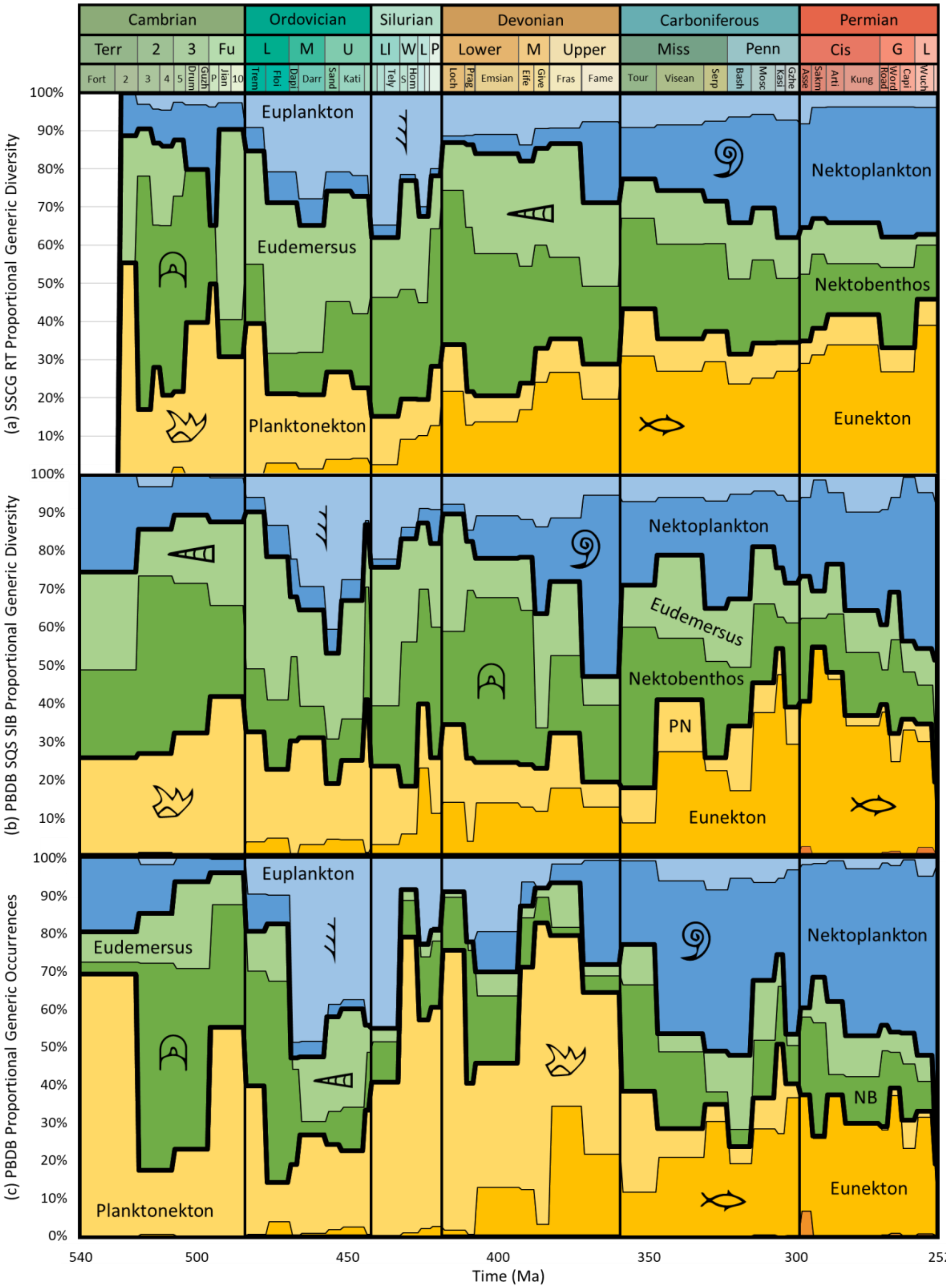


Figure S17. Alternative version of figure 1, without the Klug *et al.* [S22] megaguild overlays. NB denotes nektobenthos, PN planktonekton. Orange denotes xeronekton. Nektoxeron too insignificant to show. United States Geological Survey symbols here denote life mode not taxonomy; they do not necessarily indicate that all or most of the genera from the symbolized taxon exhibit the relevant life mode. (*a*) SSCG (supplemented Sepkoski's compendium of genera) RT (ranged-through) diversity. (*b*) PBDB (Paleobiology Database) SQS (Shareholder Quorum Subsampling) standardized SIB (sampled-in-bin) diversity. (*c*) PBDB (Paleobiology Database) generic occurrences.

3. Taxonomic Composition of Each Megaguild through the Palaeozoic

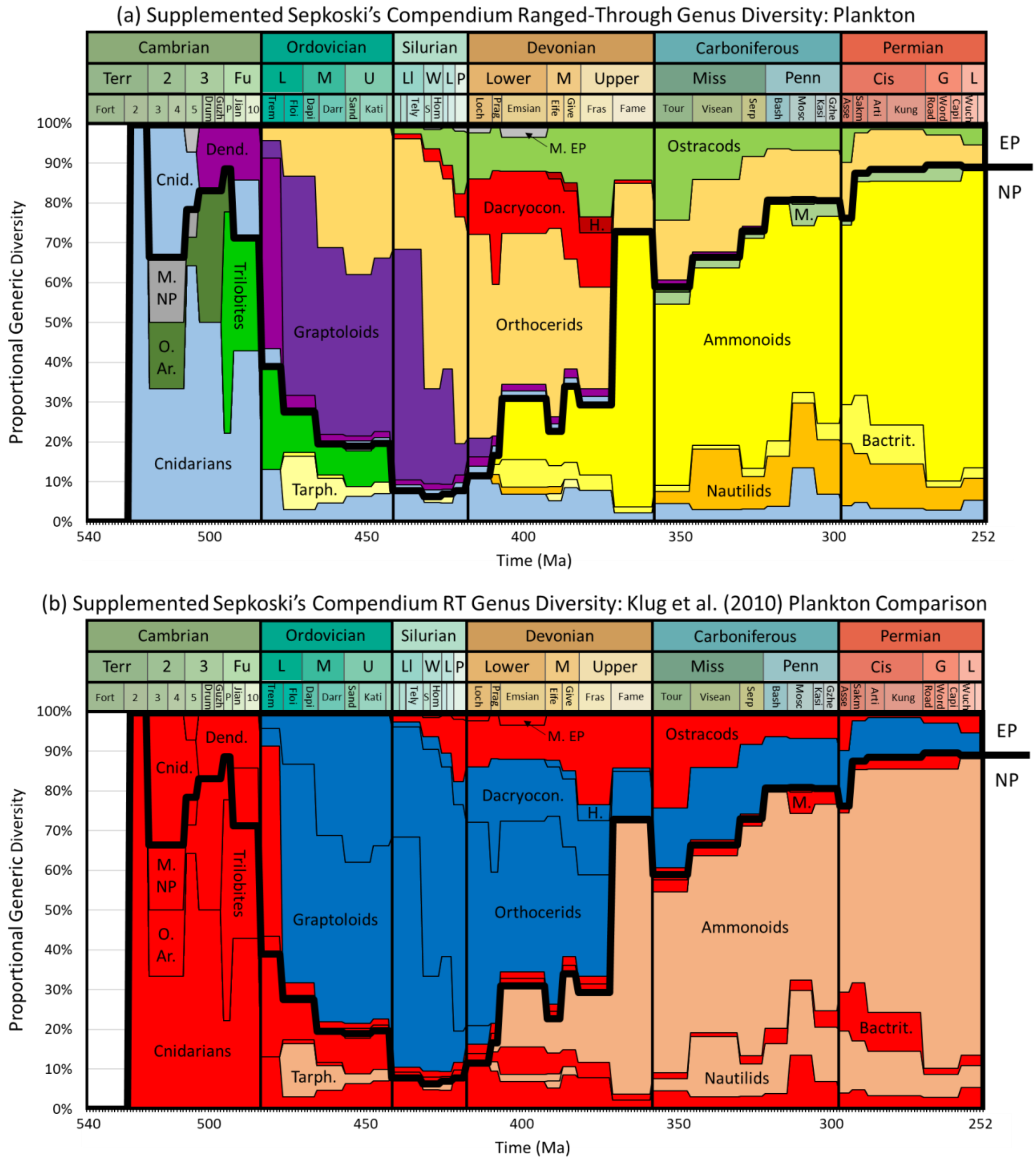


Figure S18. Supplemented Sepkoski's Compendium of Genera (SSCG) proportional ranged-through (RT) planktic diversity by taxon and life mode. Bold line separates nektoplankton (NP, bottom) from euplankton (EP, top). Tarph. = Tarphycerids, Bactrit. = Bactritoids, M. = Malacostracans, O. Ar. = Other Arthropods, M. NP = Minor Nektoplanktic Taxa, Cnid. = Cnidarians, Dend. = Dendroids, Dacryocon. = Dacryoconids, H. = Homoctenids, M. EP = Minor Euplanktic Taxa. (*a*) Taxonomic colors: yellows denote cephalopods, greens arthropods, pale blue cnidarians, purples graptolites, reds cricoconarids, greys others. (*b*) Colors highlight comparison to Klug *et al.* [S22]: blue denotes taxa included in Klug *et al.* [S22] and assigned to plankton, light red denotes taxa included in Klug *et al.* [S22] but not assigned to plankton, red denotes taxa not included in Klug *et al.* [S22].

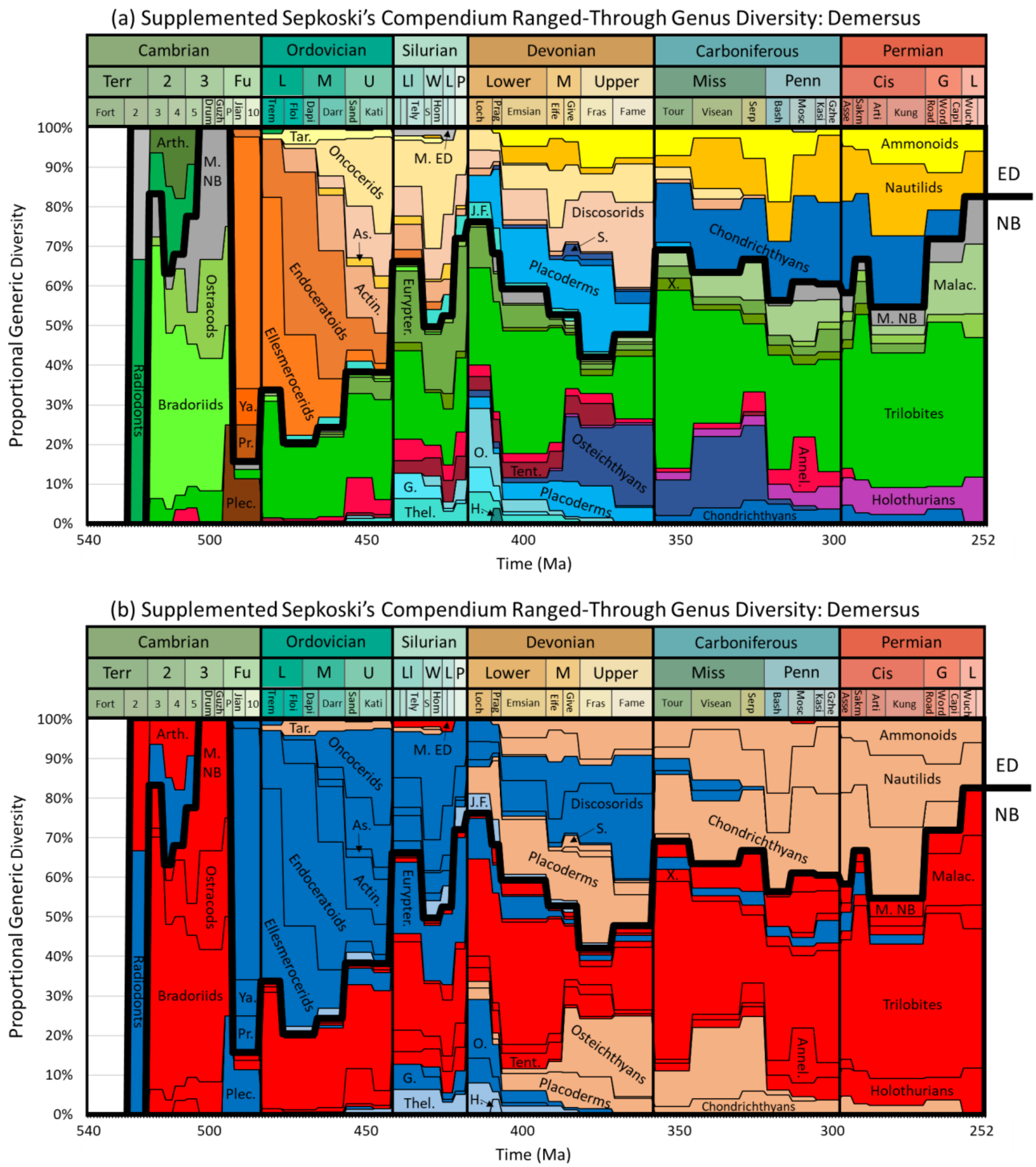
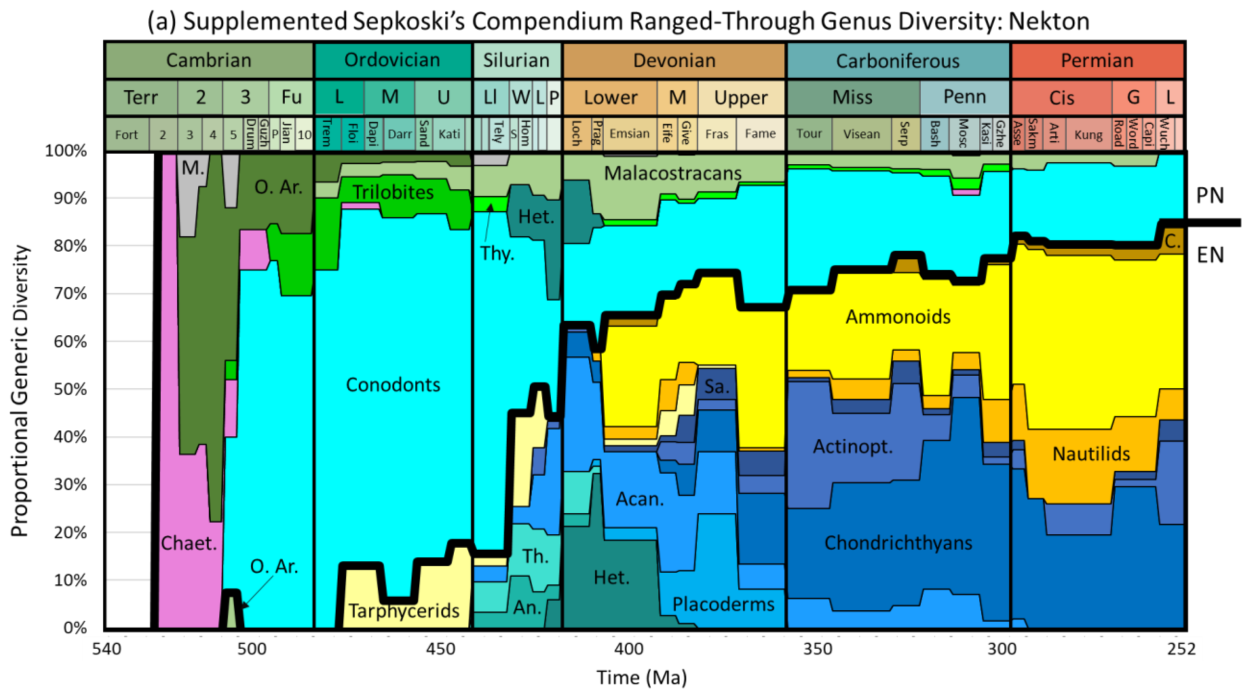


Figure S19. Supplemented Sepkoski's Compendium of Genera (SSCG) proportional ranged-through (RT) demersal diversity by taxon and life mode. Bold line separates nektobenthos (NB, bottom) from eudemersus (ED, top). H. = Heterostracans, Thel. = Thelodonts, G. = Galeaspids, O. = Osteostracans, Plec. = Plectronoceratids, Tent. = Tentaculitids, Annel. = Annelids, X. = Xiphosurans, Eurypter. = Eurypterids, Malac. = Malacostracans, M. NB = Minor Nektobenthic Taxa, J.F. = Jawless Fishes, S. = Sarcopterygians, Pr. = Protactinocerids, Ya. = Yanhecerids, Actin. = Actinoceratoids, As. = Ascocerids, Tar. = Tarphycerids, Arth. = Arthropods, M. ED = Minor Eudemersal Taxa. (*a*) Taxonomic colors: blues denote vertebrates, yellows/oranges cephalopods, light purple echinoderms, dark purple cricoconarids, magenta annelids, greens arthropods, greys others. (*b*) Colors highlight comparison to Klug *et al.* [S22]: blue denotes taxa included in Klug *et al.* [S22] and assigned to demersus, light blue denotes taxa included in Klug *et al.* [S22] and assigned to demersus but we only consider some members demersal, light red denotes taxa included in Klug *et al.* [S22] but not assigned to demersus, red denotes taxa not included in Klug *et al.* [S22].



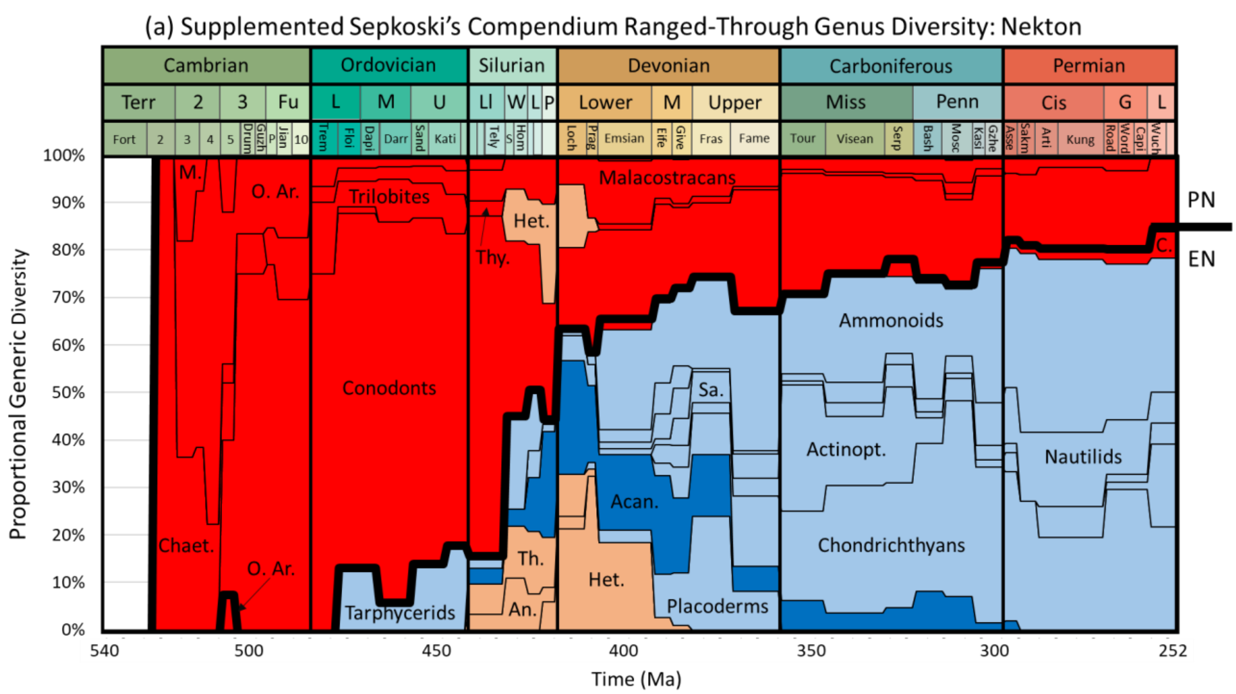


Figure S20. Supplemented Sepkoski's Compendium of Genera (SSCG) proportional ranged-through (RT) nektic generic diversity by taxon. Bold line separates eunekton (EN, bottom) from planktonekton (PN, top). Het. = Heterostracans, An. = Anaspids, Th. = Thelodonts, Acan. = Acanthodians, Actinopt. = Actinopterygians, Sa. = Sarcopterygians, C. = Other Cephalopods, O. Ar. = Other Arthropods, Chaet. = Chaetognaths, Thy. = Thylacocephalans, O. Ar. = Other Arthropods, M. = Minor Planktonektic Taxa. (*a*) Taxonomic colors: blues denote vertebrates, yellows cephalopods, greens arthropods, light purple chaetognaths, grey others. (*b*) Colors highlight comparison to Klug *et al.* [S22]: Blue denotes taxa included in Klug et al. [S22] and assigned to nekton, light blue denotes taxa included in Klug *et al.* [S22] and assigned to nekton but we only consider some members nektic, light red denotes taxa included in Klug *et al.* [S22] but not assigned to nekton, red denotes taxa not included in Klug *et al.* [S22].

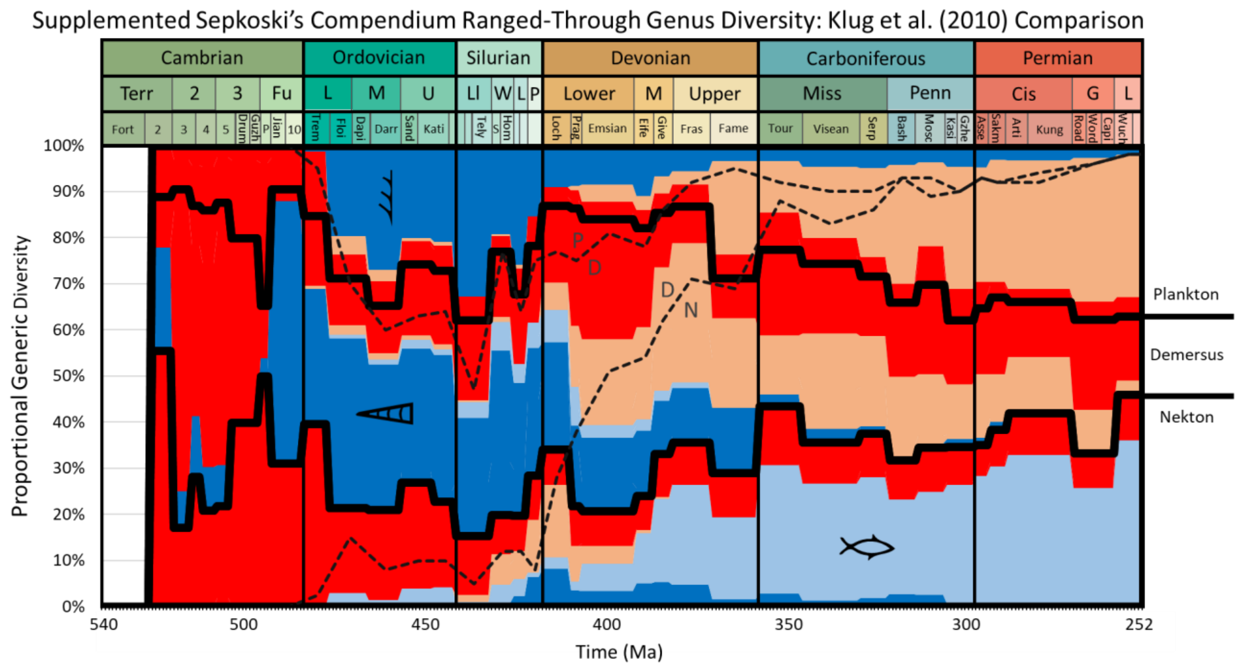


Figure S21. Supplemented Sepkoski's Compendium of Genera (SSCG) ranged-through (RT) proportional generic diversity by life mode highlighting comparison of our study to Klug *et al.* [S22]. Bold lines separate megaguilds (Plankton, Demersus, Nekton), dashed lines indicate Klug *et al.* [S22] proportional genus diversity results: P, Plankton; D, Demersus; N, Nekton. Blue denotes taxa included in Klug *et al.* [S22] and assigned to this megaguild, light blue denotes taxa included in Klug *et al.* [S22] and assigned to this megaguild but we reassign some members to other megaguilds, light red denotes taxa included in Klug *et al.* [S22] but not assigned to this megaguild, red denotes taxa not included in Klug *et al.* [S22]. United States Geological Survey symbols here denote megaguild not taxonomy; they do not necessarily indicate that all or most of the genera from the symbolized taxon exhibit the relevant megaguild.

4. Test Comparisons to Klug *et al.* [S22]

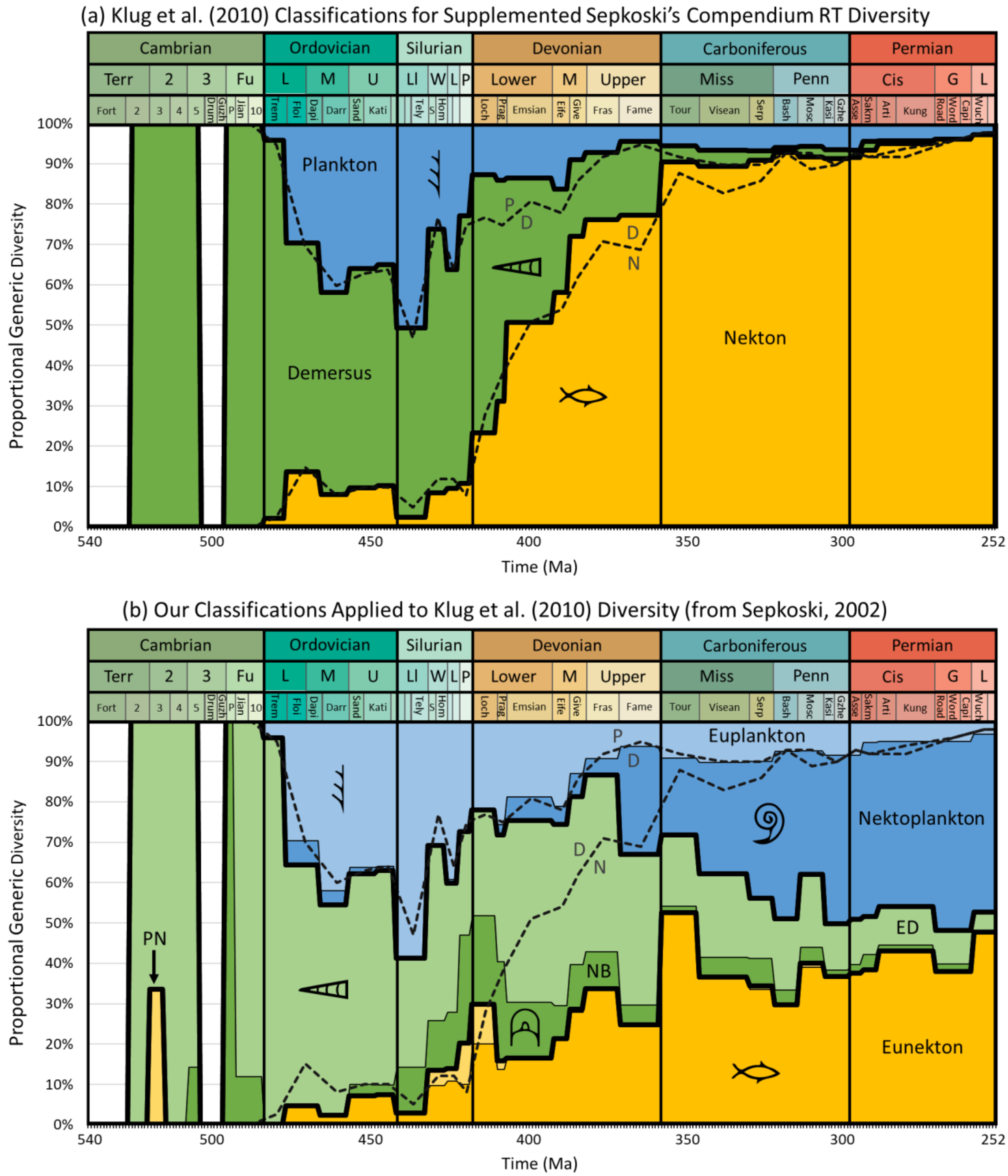
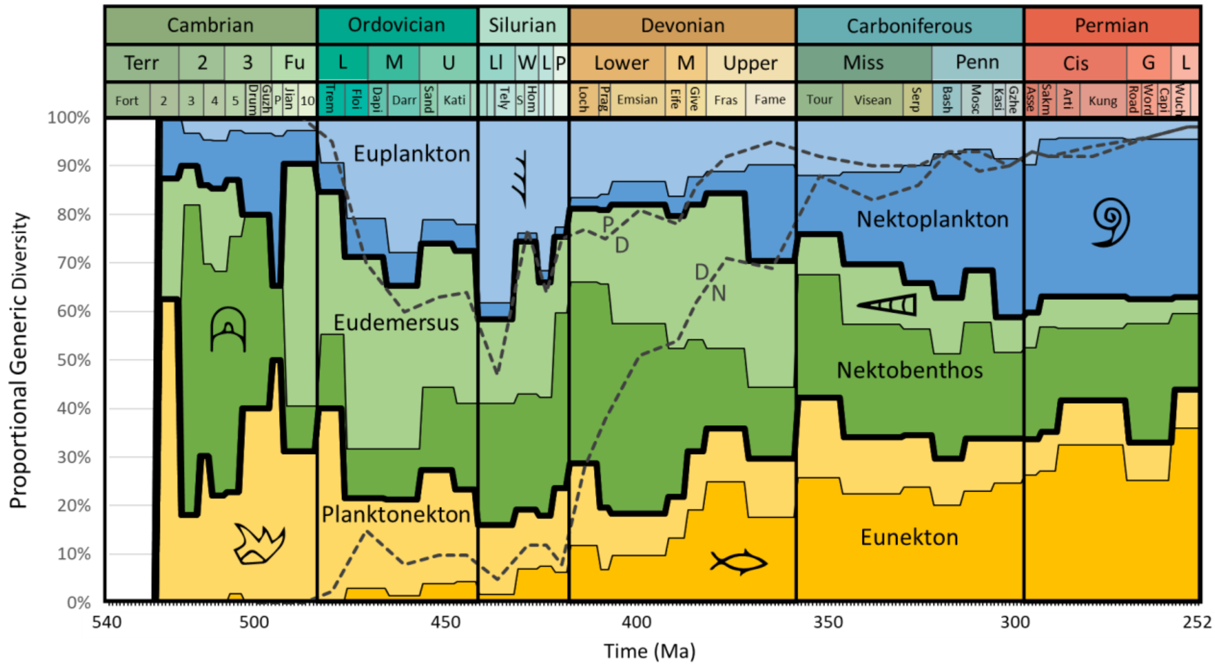


Figure S22. (*a*) Supplemented Sepkoski's Compendium of Genera (SSCG) ranged-through (RT) diversity with Klug *et al.* [S22] ecological classifications. (*b*) Our ecomorphological life mode classifications applied to the subset of Sepkoski's *Compendium of Fossil Marine Animal Genera* [S21] that was considered by Klug *et al.* [S22]. (*a,b*) Blue denotes plankton, green demersus, yellow nekton. United States Geological Survey symbols here denote life mode not taxonomy; they do not necessarily indicate that all or most of the genera from the symbolized taxon exhibit the relevant life mode. Dashed lines indicate Klug *et al.* [S22, figure 1] DNR results for comparison: P, plankton; D, demersus; N, nekton.

5. Sepkoski's *Compendium of Fossil Marine Animal Genera* [S21] Results

(a) Sepkoski's *Compendium of Fossil Marine Animal Genera* Ranged-Through Diversity by Life Mode



(b) Sepkoski's *Compendium of Fossil Marine Animal Genera* Ranged-Through Diversity by Life Mode

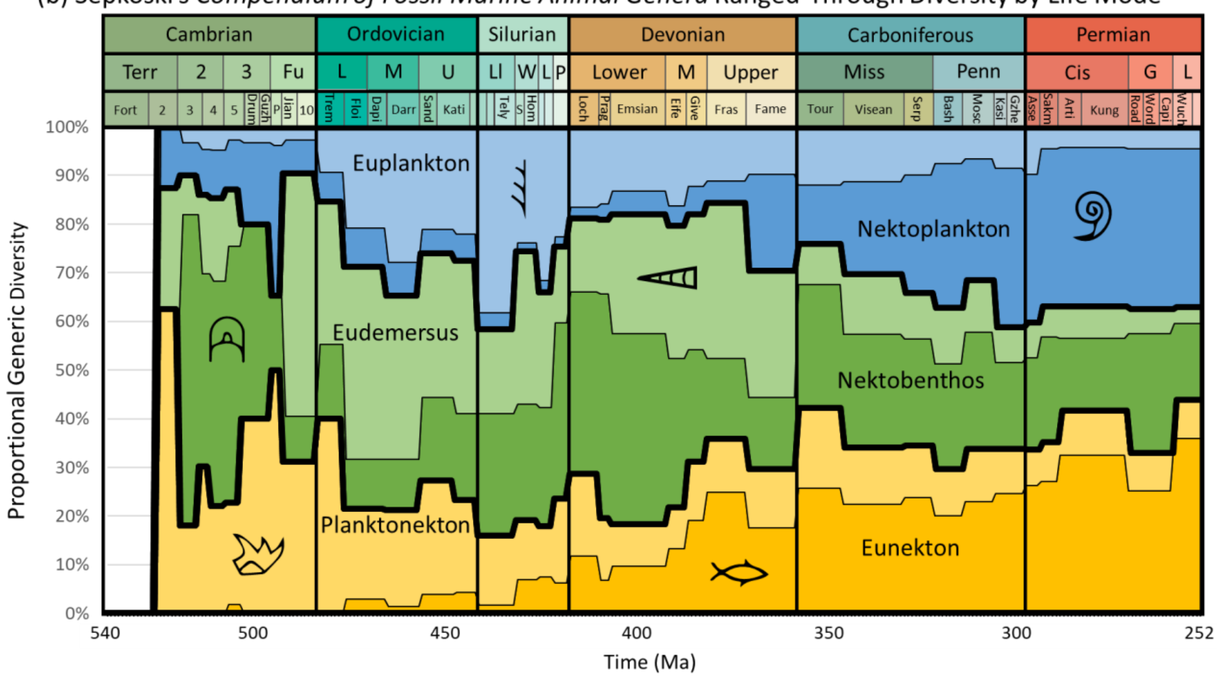


Figure S23. Sepkoski's *Compendium of Fossil Marine Animal Genera* [S21] ranged-through (RT) proportional generic diversity by ecomorphological life mode. Blue denotes plankton, green demersus, yellow nekton. (*a*) Dashed lines indicate Klug *et al.* [S22] DNR results for comparison: P, plankton; D, demersus; N, nekton. (*b*) without Klug *et al.* [S22] overlay. United States Geological Survey symbols here denote life mode not taxonomy; they do not necessarily indicate that all or most of the genera from the symbolized taxon exhibit the relevant life mode.

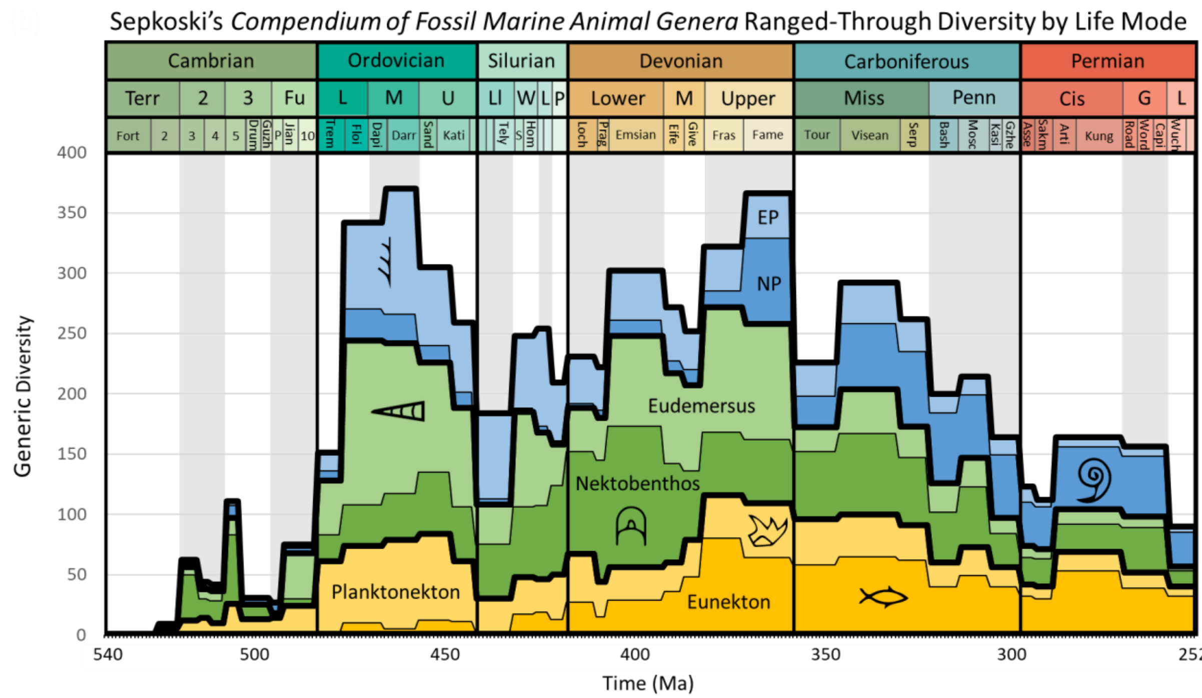
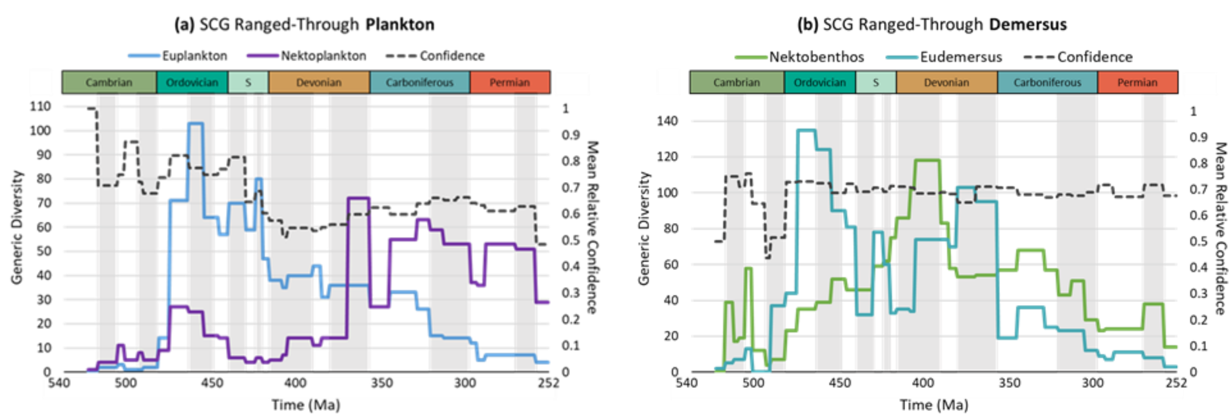


Figure S24. Sepkoski's *Compendium of Fossil Marine Animal Genera* [S21] stacked ranged-through (RT) diversity by life mode. Blue denotes plankton, green demersus, yellow nekton. EP denotes Euplankton, NP Nektoplankton. United States Geological Survey symbols here denote life mode not taxonomy; they do not necessarily indicate that all or most of the genera from the symbolized taxon exhibit the relevant life mode.



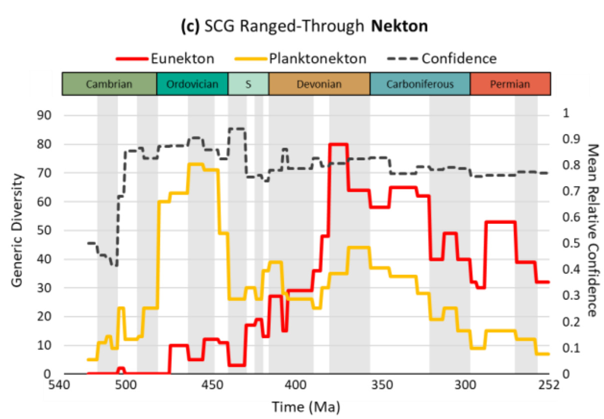


Figure S25. SCG (Sepkoski's *Compendium of Fossil Marine Animal Genera*) [S21] ranged-through (RT) diversity by life mode with mean relative confidence (dashed line). (*a*) Plankton: blue denotes euplankton, purple nektoplankton. (*b*) Demersus: cyan denotes eudemersus, green nektobenthos. (*c*) Nekton: yellow denotes planktonekton, red eunekton.

Table S7. Sepkoski's *Compendium* [S21] Ranged-Through Generic Diversity

		Plankton	Demersus	Nekton	EP	NP	ED	NB	PN	EN
Cambrian	Tomm	1	0	5	0	1	0	0	5	0
	Atda	6	44	11	2	4	5	39	11	0
	Boto	6	24	13	2	4	7	17	13	0
	Tojo	6	26	9	2	4	7	19	9	0
	Ag 5	14	71	25	3	11	13	58	23	2
	Dres	6	12	12	1	5	0	12	12	0
	Paib	9	4	13	1	8	0	4	13	0
	Trmp	7	44	23	2	5	37	7	23	0
Ordovician	Trma	23	67	60	14	9	44	23	60	0
	Aren	98	170	73	71	27	135	35	63	10
	Darr	128	163	78	103	25	124	39	73	5
	Cara	79	142	83	64	15	90	52	71	12
	Ashg	71	127	60	57	14	81	46	49	11
Silurian	Llan	76	78	29	70	6	32	46	26	3
	Wenl	63	137	47	59	4	78	59	30	17
	Ludl	86	122	45	80	6	60	62	26	19
	Prid	51	108	49	47	4	33	75	36	13
Devonian	Loch	43	121	66	38	5	35	86	39	27
	Prag	42	136	43	35	7	34	102	28	15
	Emsi	54	192	55	40	14	74	118	26	29
	Eife	55	157	59	44	11	74	83	23	36
	Give	45	128	78	31	14	70	58	30	48
	Fras	50	156	115	36	14	103	53	35	80
	Fame	108	149	108	36	72	95	54	44	64
Carboniferous	Tour	54	76	95	27	27	19	57	37	58
	Vise	88	104	99	33	55	36	68	34	65
	Serp	89	82	90	26	63	25	57	28	62
	Bash	74	66	59	15	59	23	43	19	40
	Mosc	67	74	72	14	53	23	51	23	49
	U Pn	67	41	55	14	53	12	29	15	40
Permian	Asse	49	32	41	12	37	9	23	9	32
	Sakm	41	31	39	5	36	7	24	9	30
	Leon	60	35	68	7	53	11	24	15	53
	Guad	58	46	51	7	51	8	38	12	39
	Lopi	33	17	39	4	29	3	14	7	32

6. Ranged-Through Paleobiology Database (PBDB) Results

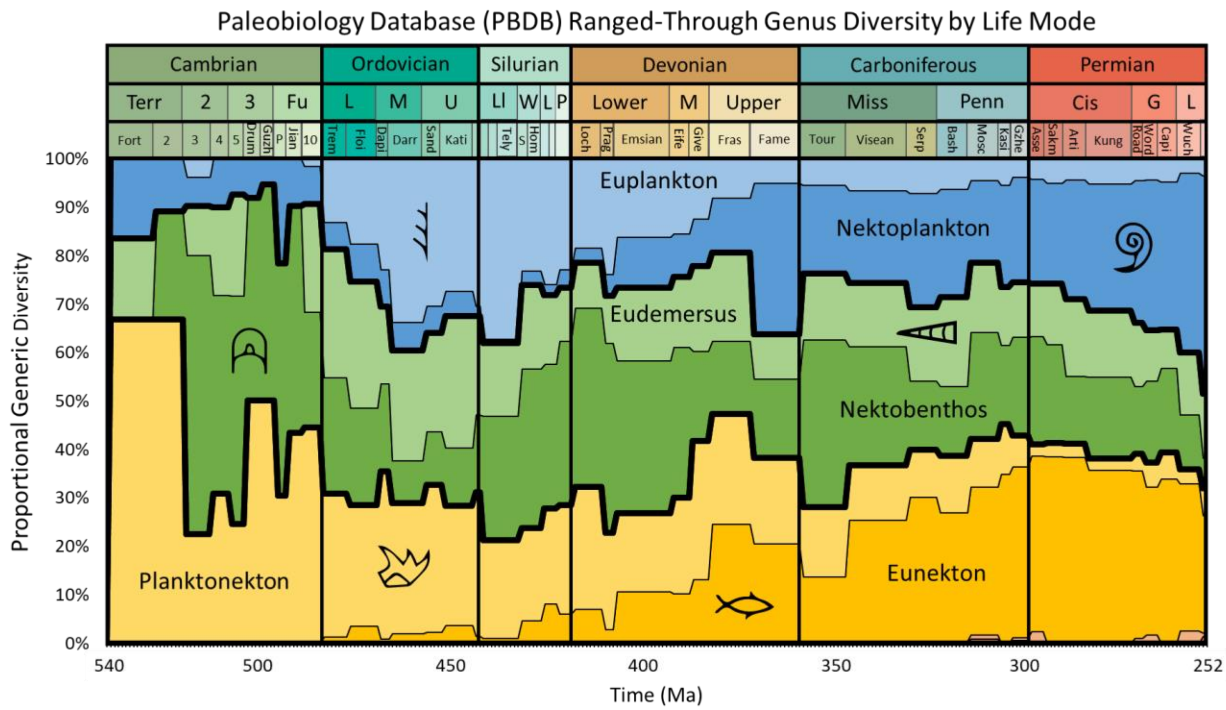


Figure S26. Paleobiology Database (PBDB) ranged-through (RT) proportional generic diversity by life mode. Blue denotes plankton, green demersus, yellow nekton. Xeronekton (orange) below eunekton. Nektoxeron (brown) below xeronekton. United States Geological Survey symbols here denote life mode not taxonomy; they do not necessarily indicate that all or most of the genera from the symbolized taxon exhibit the relevant life mode.

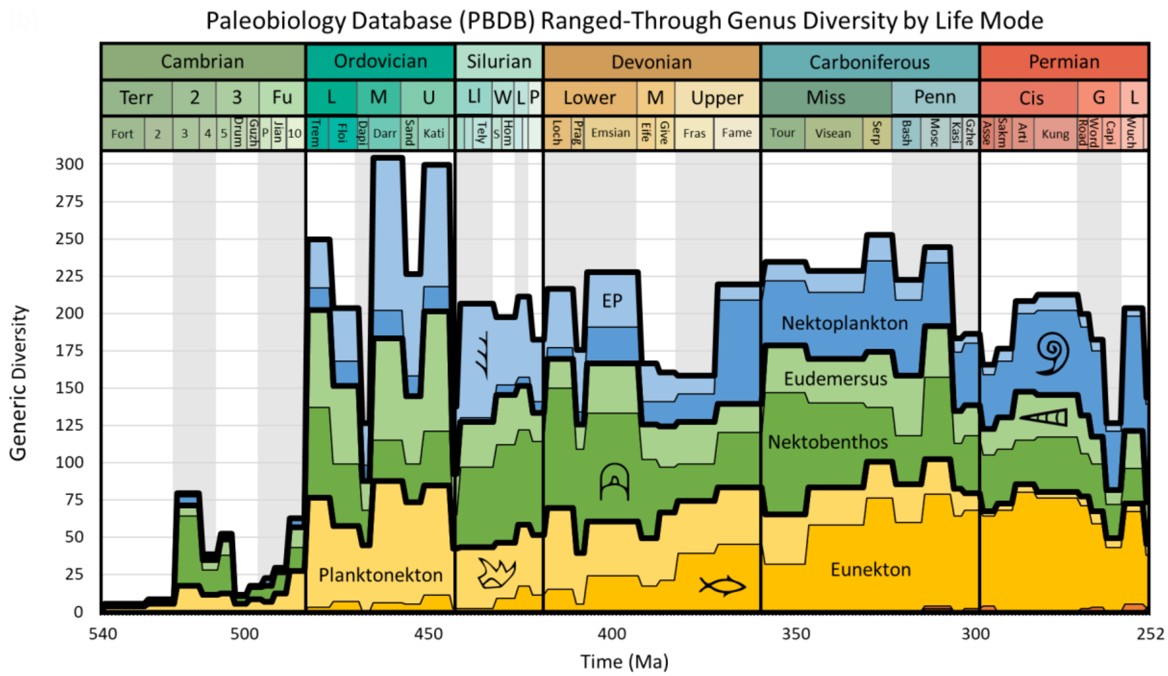
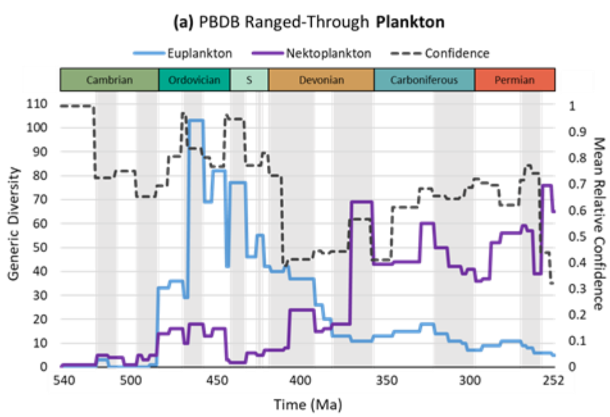
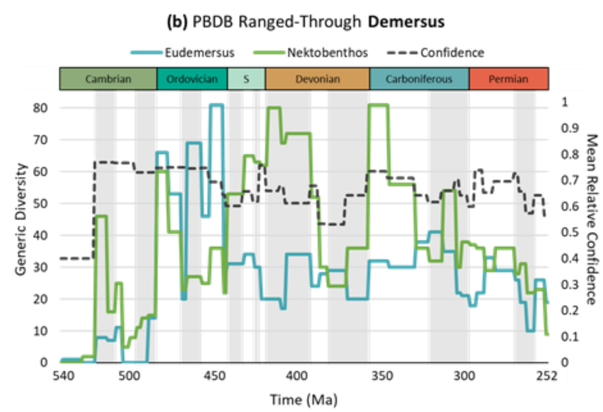


Figure S27. Paleobiology Database (PBDB) stacked ranged-through (RT) generic diversity by life mode. Blue = plankton, green = demersus, yellow = nekton. EP = Euplankton. Xeronekton (orange) below eunekton. Nektoxeron (brown) below xeronekton. United States Geological Survey symbols here denote life mode not taxonomy; they do not necessarily indicate that all or most of the genera from the symbolized taxon exhibit the relevant life mode.





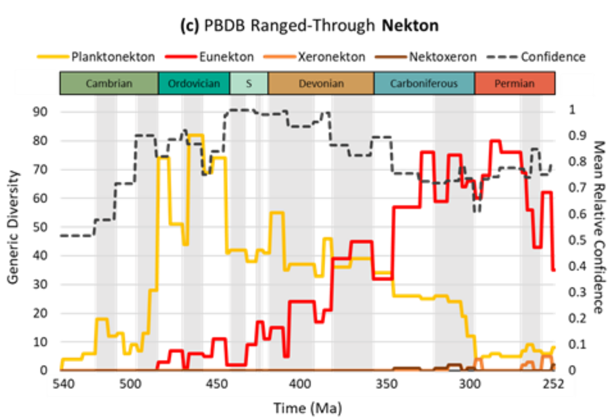


Figure S28. PBDB (Paleobiology Database) ranged-through (RT) generic diversity by life mode with mean relative confidence (dashed line). (*a*) Plankton: blue denotes euplankton, purple nektoplankton. (*b*) Demersus: cyan denotes eudemersus, green nektobenthos. (*c*) Nekton: yellow denotes planktonekton, red eunekton, orange xeronekton, brown nektoxeron.

Table S8. Paleobiology Database Ranged-Through Generic Diversity

		Plankton	Demersus	Nekton	EP	NP	ED	NB	NX	XN	PN	EN
Cambrian	Fort	1	1	4	0	1	1	0	0	0	4	0
	Ag 2	1	2	6	0	1	0	2	0	0	6	0
	Ag 3	8	54	18	3	5	8	46	0	0	18	0
	Ag 4	4	23	12	0	4	7	16	0	0	12	0
	Ag 5	4	36	13	0	4	11	25	0	0	13	0
	Drum	1	5	6	0	1	0	5	0	0	6	0
	Guzh	1	8	9	0	1	0	8	0	0	9	0
	Paib	5	11	7	0	5	0	11	0	0	7	0
	Jian	3	14	13	0	3	0	14	0	0	13	0
	Ag 10	6	29	28	1	5	14	15	0	0	28	0
Ordovician	Trma	47	126	77	33	14	66	60	0	0	74	3
	Floi	52	94	58	36	16	53	41	0	0	51	7
	Dapi	39	43	45	29	10	20	23	0	0	44	1
	Darr	121	96	88	103	18	69	27	0	0	82	6
	Sand	82	71	74	69	13	46	25	0	0	69	5
	Kati	98	117	85	82	16	81	36	0	0	74	11
	Hirn	45	50	43	42	3	28	22	0	0	41	2
Silurian	Llan	79	84	44	77	2	31	53	0	0	42	2
	Wenl	52	99	47	46	6	34	65	0	0	38	9
	Ludl	60	93	59	55	5	30	63	0	0	42	17
	Prid	49	82	52	42	7	20	62	0	0	41	11
Devonian	Loch	47	100	70	40	7	20	80	0	0	55	15
	Prag	50	86	40	42	8	17	69	0	0	35	5
	Emsi	61	106	61	37	24	34	72	0	0	37	24
	Eife	41	76	50	26	15	24	52	0	0	33	17
	Give	36	58	67	20	16	28	30	0	0	46	21
	Fras	31	53	75	13	18	29	24	0	0	36	39
	Fame	80	56	84	11	69	20	36	0	0	39	45
Carboniferous	Tour	56	113	66	13	43	32	81	0	0	34	32
	Vise	59	86	84	15	44	30	56	1	0	26	57
	Serp	78	74	101	18	60	38	36	0	0	25	76
	Bash	64	73	86	14	50	41	32	1	0	26	59
	Mosc	53	89	103	11	42	35	54	2	2	24	75
	Kasi	49	52	83	10	39	22	30	0	0	19	64
	Gzhe	48	59	80	7	41	21	38	1	1	12	66
Permian	Asse	43	55	68	7	36	18	37	0	4	4	60
	Sakm	46	58	73	9	37	22	36	0	0	5	68
	Arti	61	62	86	9	52	33	29	0	0	6	80
	Kung	67	65	81	11	56	29	36	0	0	5	76
	Road	68	54	78	9	59	26	28	0	2	7	69
	Word	65	50	68	8	57	19	31	0	3	9	56
	Capi	45	32	50	6	39	10	22	0	0	7	43
	Wuch	82	49	73	6	76	26	23	0	5	6	62
	Chan	70	28	46	5	65	19	9	2	1	8	35

7. Paleobiology Database (PBDB) Raw Sampled-in-Bin (SIB) Results

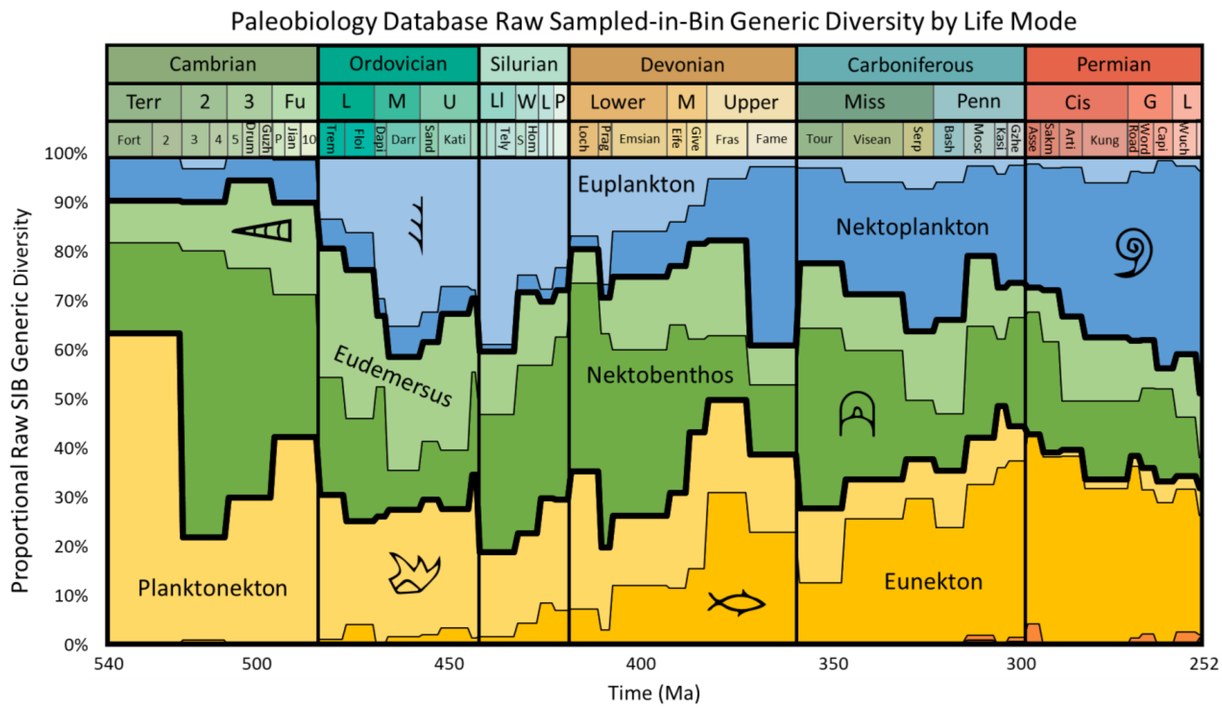


Figure S29. Paleobiology Database (PBDB) raw sampled-in-bin (SIB) proportional generic diversity by life mode. Blue = plankton, green = demersus, yellow = nekton. Xeronekton (orange) below eunekton. Nektoxeron (brown) below xeronekton. United States Geological Survey symbols here denote life mode not taxonomy; they do not necessarily indicate that all or most of the genera from the symbolized taxon exhibit the relevant life mode.

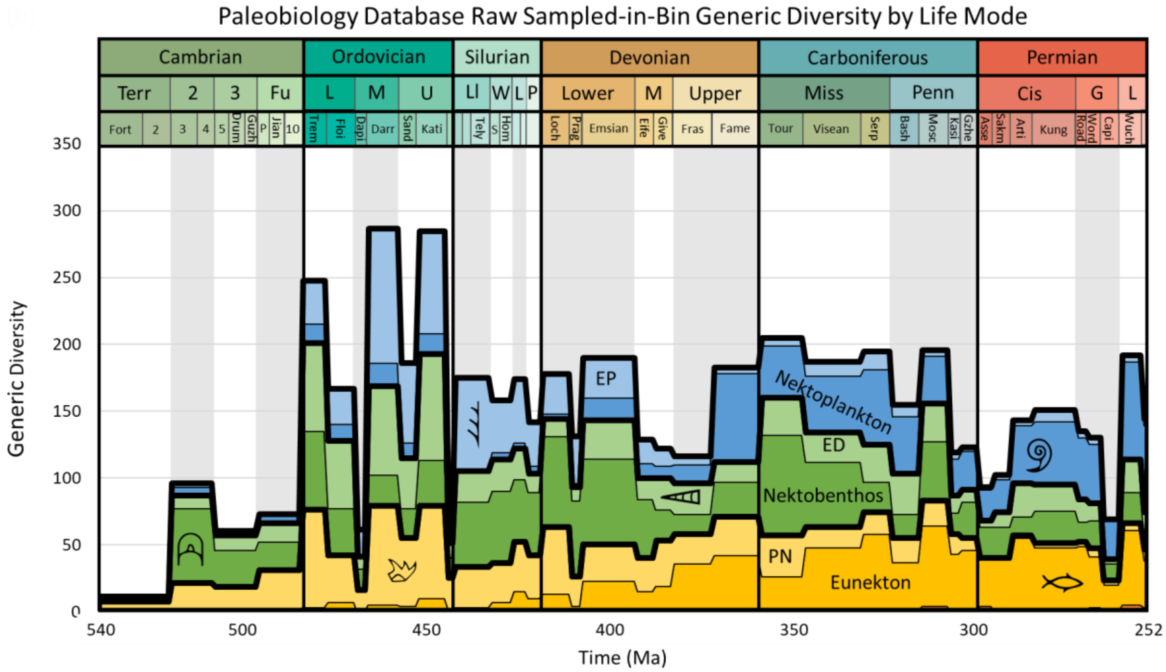


Figure S30. Paleobiology Database (PBDB) stacked raw sampled-in-bin (SIB) proportional generic diversity by life mode. Blue denotes plankton, green demersus, yellow nekton. EP denotes Euplankton, ED Eudemersus, PN Planktonekton. Xeronekton (orange) below eunekton. Nektoxeron (brown) below xeronekton. United States Geological Survey symbols here denote life mode not taxonomy; they do not necessarily indicate that all or most of the genera from the symbolized taxon exhibit the relevant life mode.

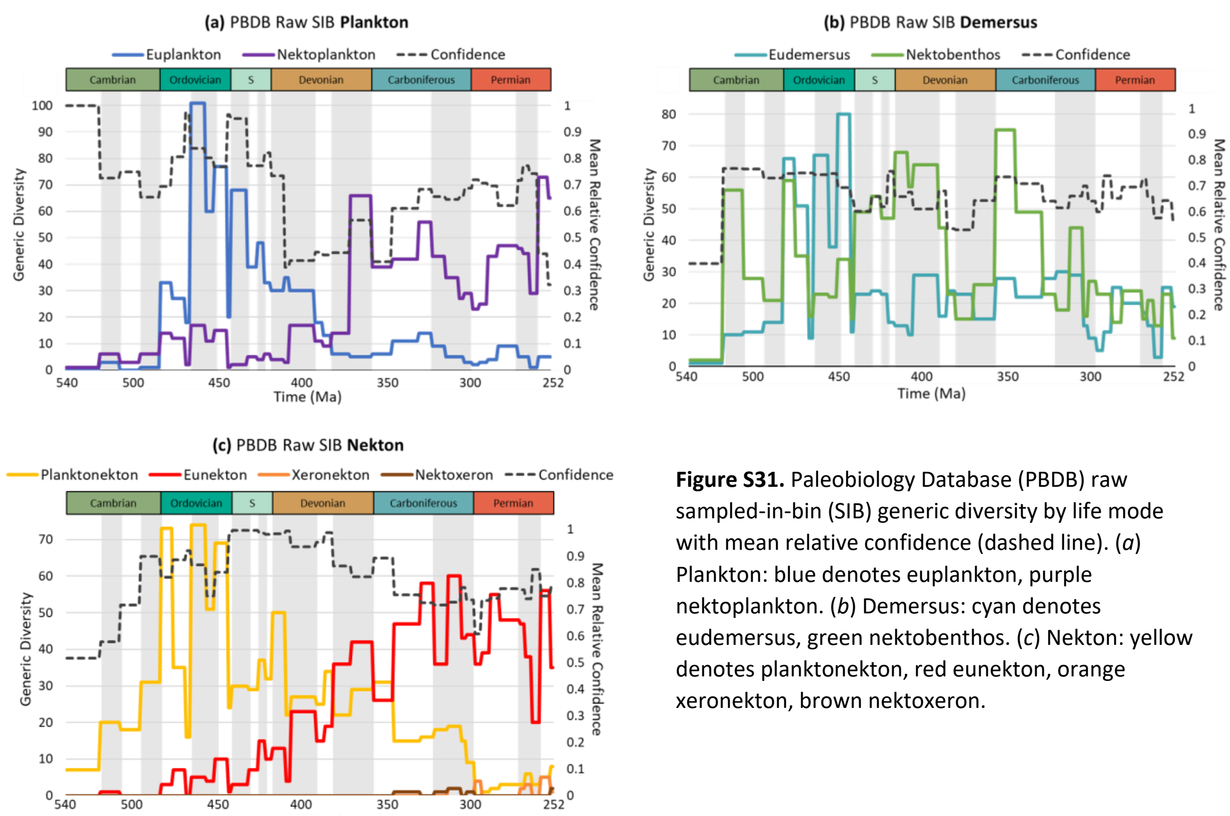


Figure S31. Paleobiology Database (PBDB) raw sampled-in-bin (SIB) generic diversity by life mode with mean relative confidence (dashed line). (*a*) Plankton: blue denotes euplankton, purple nektoplankton. (*b*) Demersus: cyan denotes eudemersus, green nektobenthos. (*c*) Nekton: yellow denotes planktonekton, red eunekton, orange xeronekton, brown nektoxeron.

Table S9. Paleobiology Database Raw Sampled-in-Bin (SIB) Generic Diversity

		Plankton	Demersus	Nekton	EP	NP	ED	NB	NX	XN	PN	EN
Cambrian	Terr	1	3	7	0	1	1	2	0	0	7	0
	Ep 2	9	66	21	3	6	10	56	0	0	20	1
	Ep 3	3	39	18	0	3	11	28	0	0	18	0
	Furo	7	35	31	1	6	14	21	0	0	31	0
Ordovician	Trma	47	125	76	33	14	66	59	0	0	73	3
	Floi	39	86	42	27	12	51	35	0	0	35	7
	Dapi	20	25	16	18	2	9	16	0	0	16	0
	Darr	118	90	79	101	17	67	23	0	0	74	5
	Sand	71	60	55	60	11	38	22	0	0	51	4
	Kati	92	114	79	77	15	80	34	0	0	69	10
	Hirn	21	26	25	20	1	11	15	0	0	24	1
Silurian	Llan	70	72	33	68	2	23	49	0	0	30	3
	Wenl	44	78	36	39	5	24	54	0	0	29	7
	Ludl	52	70	52	48	4	23	47	0	0	37	15
	Prid	39	61	42	33	6	14	47	0	0	32	10
Devonian	Loch	34	81	63	30	4	13	68	0	0	50	13
	Prag	38	67	26	35	3	10	57	0	0	22	4
	Emsi	47	93	50	30	17	29	64	0	0	27	23
	Eife	29	60	40	18	11	16	44	0	0	25	15
	Give	22	47	53	13	9	24	23	0	0	34	19
	Fras	20	38	58	6	14	23	15	0	0	22	36
	Fame	71	41	71	5	66	15	26	0	0	29	42
Carboniferous	Tour	45	103	57	6	39	28	75	0	0	31	26
	Vise	53	71	63	11	42	22	49	1	0	15	47
	Serp	70	51	74	14	56	28	23	0	0	16	58
	Bash	52	48	55	9	43	30	18	1	0	18	36
	Mosc	40	73	83	5	35	29	44	2	2	19	60
	Kasi	32	29	58	5	27	13	16	0	0	15	43
	Gzhe	32	36	55	3	29	9	27	1	1	9	44
Permian	Asse	25	28	40	2	23	5	23	0	4	0	36
	Sakm	28	34	40	3	25	11	23	0	0	1	39
	Arti	47	39	57	4	43	25	14	0	0	2	55
	Kung	56	44	51	9	47	20	24	0	0	3	48
	Road	51	32	52	5	46	17	15	0	2	3	47
	Word	49	34	47	5	44	13	21	0	3	6	38
	Capi	30	16	23	1	29	3	13	0	0	3	20
	Wuch	78	48	66	5	73	25	23	0	5	5	56
	Chan	70	28	46	5	65	19	9	2	1	8	35

VI. Causes of Eunektic Diversity

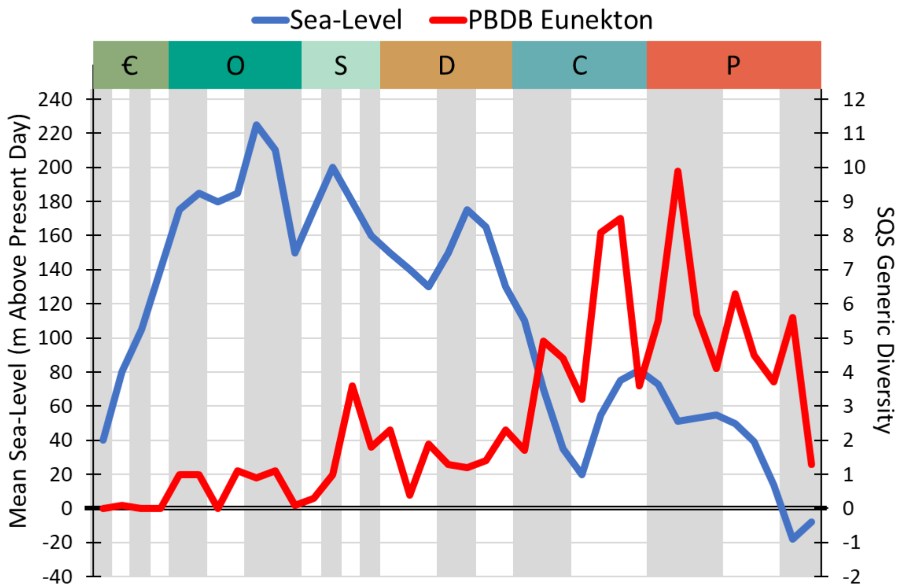


Figure S32. Left axis: blue denotes Palaeozoic mean sea level measured in meters above present day [S50]. Right axis: red denotes PBDB (Paleobiology Database) SQS (Shareholder Quorum Subsampling) standardized sampled-in-bin (SIB) eunektic diversity.

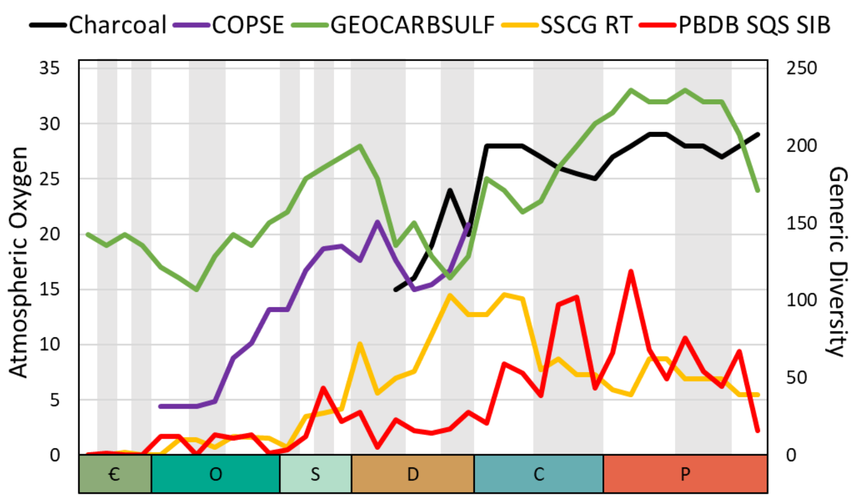


Figure S33. Left axis: Percentage of O_2 in atmosphere as suggested by sedimentary charcoal (black) [S51], COPSE (purple) [S52], and GEOCARBSULF (green), [S53]. Right axis: generic eunektic diversity from the SSCG (Supplemented Sepkoski's Compendium) RT (ranged-through) counts (yellow), and the PBDB (Paleobiology Database) SQS (Shareholder Quorum Subsampling) standardized SIB (sampled-in-bin) counts (red, 12x scaled).

VII. Stratigraphic Abbreviations

- Cambrian
    - Terr – Terreneuvian
        - Fort – Fortunian
        - 2 – Stage 2
    - (Ser) 2 – Series 2
        - 3 – Stage 3
        - 4 – Stage 4
    - (Ser) 3 – Series 3
        - 5 – Stage 5
        - Drum – Drumian
        - Guzh – Guzhangian
    - Fu/Furo – Furongian
        - P – Paibian
        - Jian – Jiangshanian
        - 10 – Stage 10
- Ordovician
    - L – Lower Ordovician
        - Trem – Tremadocian
        - Floi – Floian
    - M – Middle Ordovician
        - Dapi – Dapingian
        - Darr – Darriwilian
    - U – Upper Ordovician
        - Sand – Sandbian
        - Kati – Katian
        - Hirn – Hirnantian
- Silurian
    - Ll/Llan – Llandovery
        - R – Rhuddanian
        - – Aeronian
        - Tely – Telychian
    - W/Wenl – Wenlock
        - S – Sheinwoodian
        - Hom – Homerian
    - L/Ludl – Ludlow
        - – Gorstian
        - L – Ludfordian
    - Prid – Pridoli
- Devonian
    - Lower Devonian
        - Loch – Lochkovian
        - Prag – Pragian
        - Emsi –Emsian
    - M – Middle Devonian
        - Eife – Eifelian
        - Give – Givetian
    - Upper Devonian
        - Fras – Frasnian
        - Fame – Famennian
- Carboniferous
    - Miss – Mississippian
        - Tour – Tournaisian
        - Vise – Visean
        - Serp – Serpukhovian
    - Penn – Pennsylvanian
        - Bash – Bashkirian
        - Mosc – Moscovian
        - Kasi – Kasimovian
        - Gzhe – Gzhelian
- Permian
    - Cis – Cisuralian
        - Asse – Asselian
        - Sakm – Sakmarian
        - Arti – Artinskian
        - Kung – Kungurian
    - G/Guad – Guadalupian
        - Road – Roadian
        - Word – Wordian
        - Capi – Capitanian
    - L/Lopi – Lopingian
        - Wuch – Wuchiapingian
        - Chan – Changhsingian

Additional SCG/SSCG Stratigraphic Abbreviations

- Cambrian
  - Series 2
    - Atda – Atdabanian
    - Boto – Botomian
    - Tojo – Tojonian
  - Series 3
    - Dres – Dresbachian
  - Furongian
    - Tremp – Trempealeauan
- Ordovician
  - Middle Ordovician
    - Aren – Arenigian
    - Cara – Caradocian
  - Upper Ordovician
    - Ashg – Ashgillian
- Carboniferous
  - Pennsylvanian
    - U_Pen – Upper Pennsylvanian
- Permian
  - Cisuralian
    - Leon – Leonardian

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