Supporting Information

SI Methods

Compatibility for Unordered Multistate Characters. Compatibility is easy to calculate for binary characters: any pair with 3 or fewer combinations (state-pairs) fits any number of trees with only one derivation per state (Fig. S1A). However, once a 4th combination appears, then there must have been a parallelism or reversal in one or both characters (1, 2). It is slightly more difficult to calculate compatibility if one character has 3+ states. The characters clearly are incompatible if every possible combination is present. However, incompatibility is possible with fewer than the maximum number of state-pairs. Here, we calculate multistate character compatibility by breaking down the characters into all possible binary comparisons. There are two criteria for compatibility: 1) all of the binary comparisons must have fewer than 4 combinations; 2) at least one state-pair must not be the intermediate pair in any of those comparisons.

Consider two 3-state characters with the following state-pairs. Italics denote the state-pair that is intermediate between the other two. For all comparisons, there are fewer than four state-pairs. Moreover, two of those state-pairs (**12** & **21**) are not the intermediate state-pair in any of its combinations. We can create a character state tree that does not demand homoplasy (Fig. S1B), meaning that the characters are compatible.

Data	Binary Breakdowns							
00	***00***	**00**		**00**				
01	**10**		**01**	***01***	**01**			
10	**01**	***10***				**10**	**10**	
12		**12**	**12**				**12**	**12**
21				**21**	**21**	**21**		**21**

Now, consider a similar pair of characters that have one extra state-pair, 22. Again, italicized pairs are the “intermediate” state-pair in each comparison. In all cases, there are fewer than four state-pairs. However, every state-pair now is intermediate in one breakdown. This means that we cannot draw a tree with open branches; instead, there must be a parallelism or reversal somewhere and the characters are incompatible (Fig. S1C).

Data	Binary Breakdowns								
00	***00***	**00**		**00**	**00**				
01	**10**		**01**	***01***		**01**			
10	**01**	***10***					**10**	**10**	
12		**12**	**12**					***12***	**12**
21				**21**		***21***	**21**		**21**
22					**22**	**22**		**22**	***22***

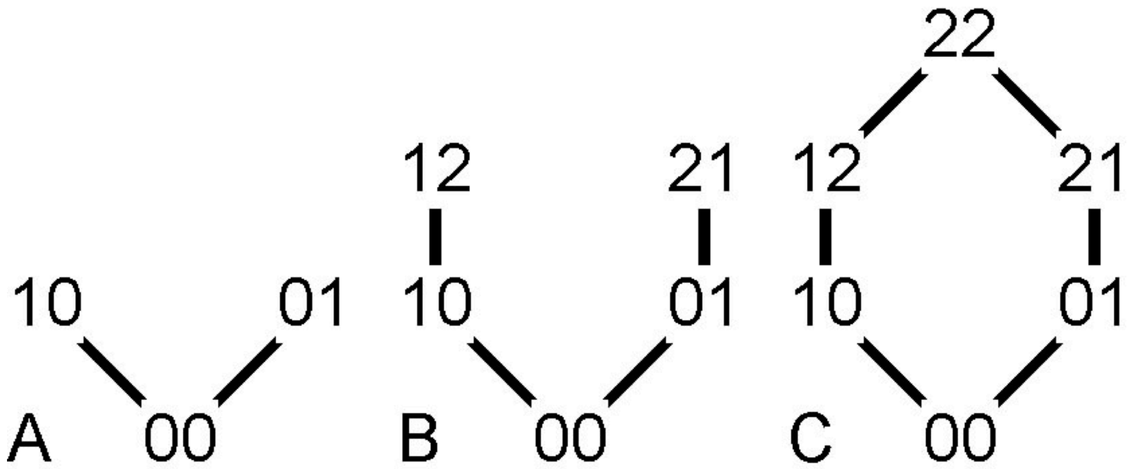


Fig. S1 – “Trees” for the two hypothetical examples. A) Compatible binary pair. B). Two compatible 3-state characters. C) Two incompatible 3-state characters. Although each pair is linked to only 2 other pairs, every state-pair is intermediate in one comparison, which demands homoplasy.

Finally, when dealing with more than 3 states per character, the same routine must be broken down to ensure that there are no “closed circuits” among any state trio (e.g., Fig. S1C).

Stratigraphic Compatibility for Unordered Multistate Characters. We examine stratigraphic compatibility for all binary breakdowns with three combinations. For a binary + 3-state character, we can have two comparisons. This can generate two hierarchical (HSC) pairs (Fig. S2A) if a derived pair (e.g., 10) is intermediate on two sequences. Alternatively, this can generate one HSC and one divergent (DSC) pair if the oldest combination (**00**) is intermediate on one sequence but not on the other (Fig. S2B). If both characters have 3-states, then we can see two HSC cases (Fig. S3A). However, we can see up to four DSC cases if we get all four possible binary breakdowns with the oldest combination intermediate each time (Fig. S3C). Note also that this example is compatible if we assume unordered character state evolution.

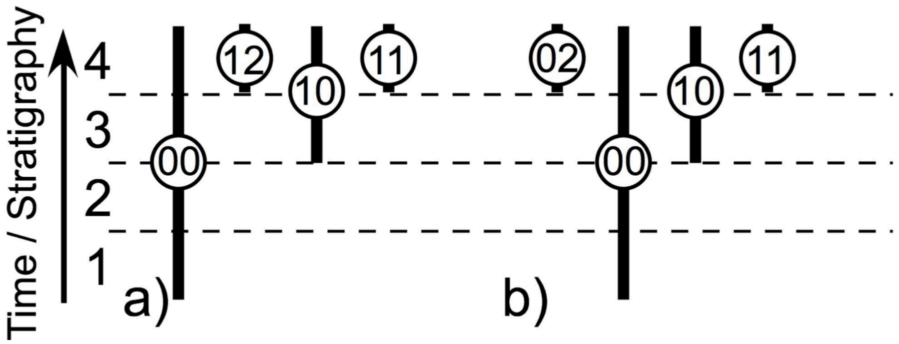


Fig. S2 – A 2-state and 3-state character pair. A. Two case of hierarchical stratigraphic compatibility (HSC; **00→10→11** and **00→10→12**). B. One case of HSC (**00→10→11**) and one case of divergent stratigraphic compatibility (DSC; $\mathbf{00}{}^{\to\,\mathbf{10}}_{\to\,\mathbf{02}}$).

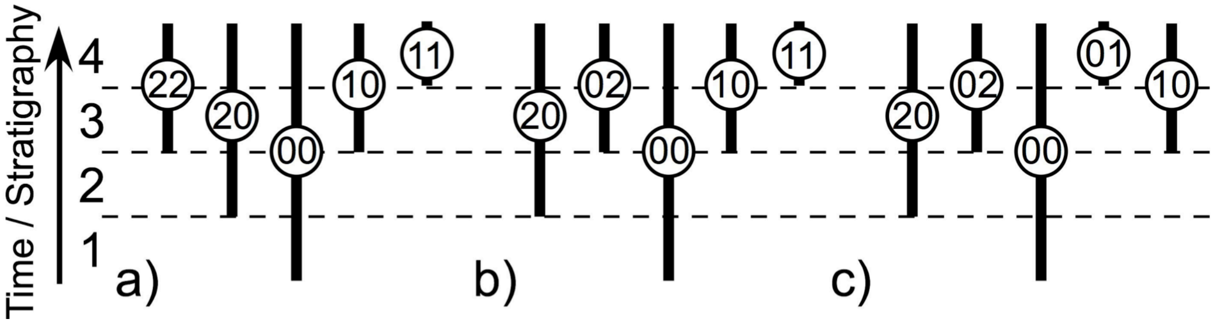


Fig. S3 – Two 3-state character pair. A. Two case of HSC (**00→10→11** and **00→20→22**). B. One case of HSC (**00→10→11**) and two cases of DSC ($\mathbf{00}{}^{\to\,\mathbf{10}}_{\to\,\mathbf{02}}$ and $\mathbf{00}{}^{\to\,\mathbf{20}}_{\to\,\mathbf{02}}$). C. Four cases of DSC ($\mathbf{00}{}^{\to\,\mathbf{10}}_{\to\,\mathbf{01}}$, $\mathbf{00}{}^{\to\,\mathbf{20}}_{\to\,\mathbf{01}}$, $\mathbf{00}{}^{\to\,\mathbf{10}}_{\to\,\mathbf{02}}$ and $\mathbf{00}{}^{\to\,\mathbf{20}}_{\to\,\mathbf{02}}$).

On the Relationship between Compatibility and Homoplasy. The first principles deduction that numbers of compatible character-pairs should decrease as amounts of homoplasy increase is easy to verify through simulations (4-6). We repeat these here (Fig. S4), in simulations using 32 taxa with 100 binary characters (and thus 100 derived states). As the number of changes per derived state increases (i.e., as the number of homoplasies increases), compatibility for the whole matrix decreases. This illustrates that simulations can generate a probabilistic distribution of expected compatibility given X changes among Y characters with Z derived states. For our purposes, when simulations of *S* taxa with Y characters and Z derived states matches compatibility observed in a real dataset of S taxa with Y characters and Z derived states, then the simulation has used a plausible number of total changes.

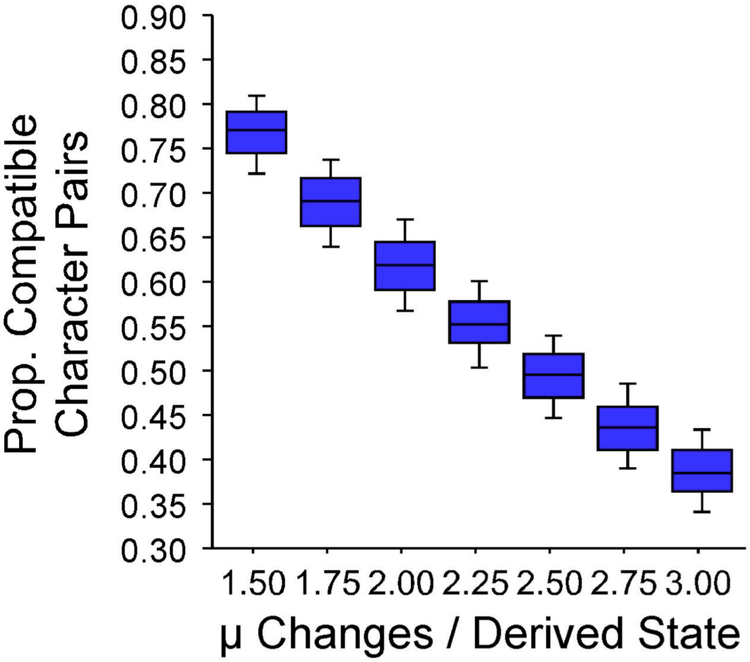


Fig. S4 – Effects of homoplasy on expected compatibility. Based on simulations of 16 taxa with 50 binary characters.

The Effects of Different Sampling and Evolutionary Parameters on Expected Hierarchical Stratigraphic Compatibility. We simulate the evolution of 32 taxa with 100 binary characters to explore the effects of a variety of sampling and evolutionary parameters on the expectations of both general stratigraphic compatibility (GSC) and hierarchical stratigraphic compatibility (HSC;

see main text). The varying parameters include: 1) basic speciation/cladogenetic model; 2) typical sampling intensity; 3) temporal variation in sampling intensity; 4) frequencies of homoplasy; and, 5) continuous exponential versus logistic diversification over different logistic parameters. We assess the effects of speciation models by using both budding and bifurcating cladogenesis. The budding model is used in many Monte Carlo analyses conducted by paleobiologists (7-11) and it is the expectation of speciation models such as punctuated equilibrium (12). For the genus-level, budding is an expectation among polytypic genera even if speciation is anagenetic: even if one species anagenetically evolves so much that later (morpho)species are placed in another genus, other species from the "ancestral" genus will persist. The bifurcating model is frequently assumed in neontological analyses (e.g., 14). If rates of anagenesis match those of cladogenesis, then bifurcating patterns will be common. Models such as vicariance also predict bifurcating patterns (15). The primary difference is that ancestral species persist after speciation in the budding model and thus a single species can have any number of descendants, whereas ancestral species become anagenetically extinct ("pseudoextinct"; 16) at cladogenesis and give rise to two descendants in the bifurcating model. Pseudo-extinction raises expected stratigraphic compatibility slightly by making it impossible for ancestors to first appear in younger strata than their descendants (Fig. 3A-D). However, budding generally raises expected HSC by making it easier for a single species to have multiple descendants without shifts in speciation rates (Fig. 3A-D).

We address two effects of sampling intensity: that of relatively good/poor sampling, and that of variation in sampling over time. This is critical because different higher taxonomic groups have different general sampling rates: e.g., molluscs typically show higher preservation rates than do fishes (17). We examine expectations given the same general rate of character change per sampled taxon (here, 1.5 changes per character state) and assuming exponential diversification with both budding and bifurcating models. The cladogenesis rates are 1.1× extinction rates. We give the sampling rates relative to extinction rates; when these are equal, then we expect to sample a species of median duration once; at 0.01 we expect to sample 1% of taxa with median durations. We expect GSC in 90-95% of compatible character pairs over all ranges of sampling (Fig. S5A); as noted above, we expect slightly higher GSC given bifurcating cladogenesis than given budding cladogenesis. Expectations for HSC also show little trend, with an expectation of approximately 40% over all sampling rates, with slightly higher expectations with budding cladogenesis rather than bifurcating cladogenesis.

In addition to varying among taxa, sampling intensity also can vary fairly substantially over time within higher taxonomic groups (e.g., 18, 19). This *decreases* rather than increases the expected stratigraphic gaps implied by phylogenies (20) and thus might affect stratigraphic compatibility. Therefore, we repeat the simulations with lognormal variation in the sampling rates. We scale the variation so that every standard deviation doubles the rate; thus, 15.8% of "stages" have more than twice the median sampling rate and 15.8% have less than one half the median sampling rate; 2.2% have more than four times the median sampling rate, and 2.2% have less than one quarter the median sampling rate, etc. This has little effect on the expected GSC (Fig S3B). Variable sampling decreases expected HSC among stratigraphically compatible pairs, albeit only very slightly. This suggests that our overall results are slightly conservative.

To assess the effect of homoplasy, we repeat the simulations over a wide range of rates of character-change. Sampling rates here is 0.31× extinction rates and diversification is exponential. We again use both budding and bifurcating cladogenetic models. As frequencies of homoplasy increase, expected GSC drops slightly whereas the expected HSC increases slightly

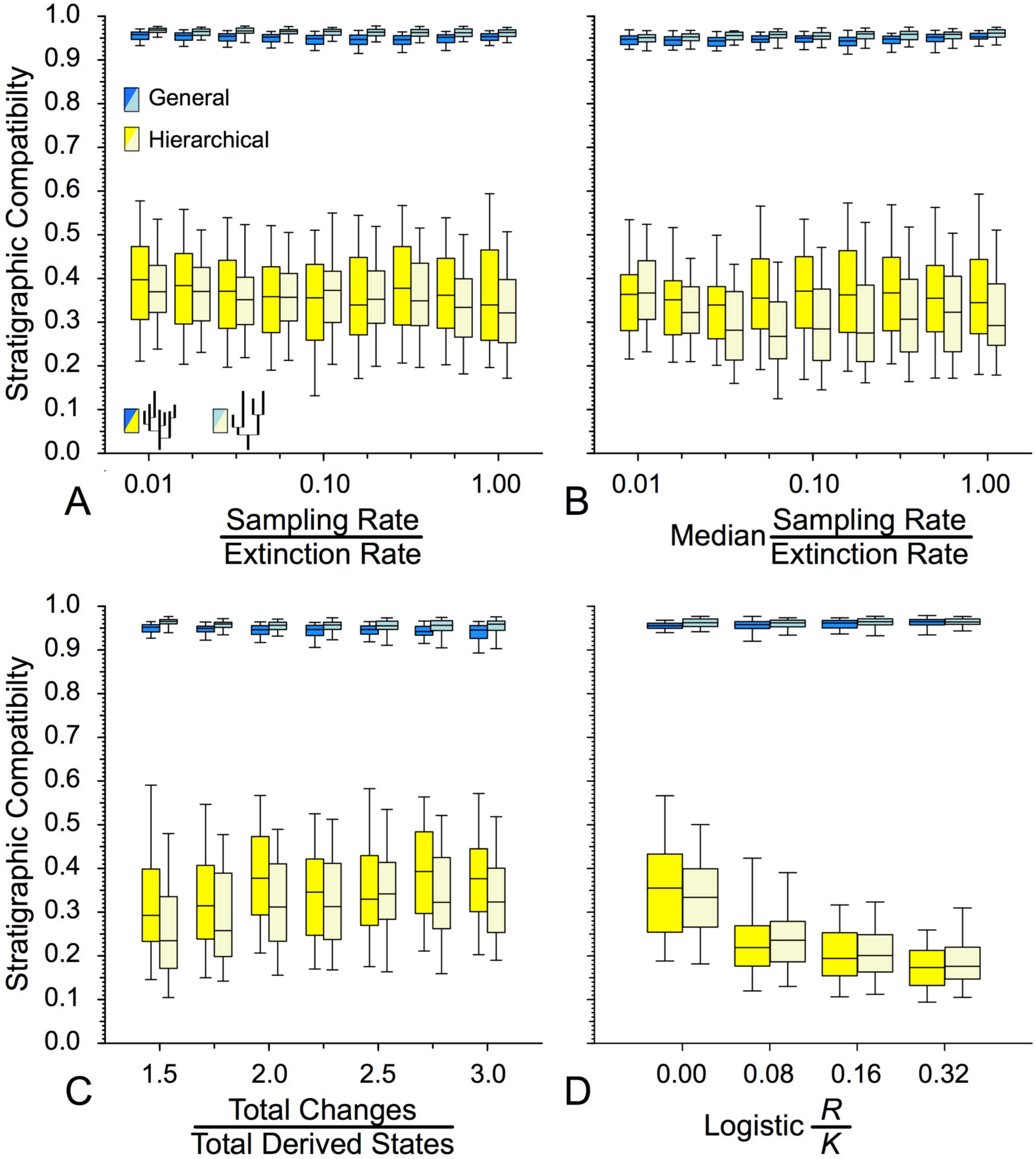


Fig. S5 – Simulated expectations for general (GSC) and hierarchical (HSC) stratigraphic compatibility using 32 taxa and 100 binary characters. Dark shades give expectations from budding cladogenesis and pale shades give expectations from bifurcating cladogenesis. (A) Sampling intensity relative to extinction intensity. (B) Sampling intensity varying over time. (C) Effects of homoplasy. (D) Effects of logistic diversification. *R* is the intrinsic rate of diversification. Equilibrium richness $K=\infty$ at $R/K = 0$, making diversification exponential; $K=25$ in all other cases. Diversification is exponential in (A), (B) and (C). Characters average 1.5 changes per derived state in (A), (B) and (D); Sampling intensity is uniform and 0.31× the extinction rate in (C) and (D).

(Fig. S5C). Again, expected GSC is slightly higher given bifurcation and expected HSC is slightly higher given budding.

Numerous paleontological studies (21-24) and some molecular studies (25) suggest that diversification is not exponential, but instead decreases as standing richness increases. We use logistic diversification (e.g., 26) to assess the possible effects of decreasing net origination over time. Under this model,

$$\Delta S = RS(1 - \frac{S}{K})$$

where *S* is the standing richness, ΔS is the change in richness, *R* is an intrinsic rate of increase, and *K* is the equilibrium richness (27). We assume constant extinction rates (μ), which means that cladogenesis rate λ shifts so that:

$$\lambda = \mu + \ln(S + \Delta S) - \ln(S) \text{ (see 28).}$$

Thus, as *R* increases relative to *K*, the difference between μ and initial λ increases and the time required to reach *K* decreases. (Thus, exponential diversification is essentially a special case of logistic diversification in which *K*=∞ and thus *R*/*K* is essentially 0). We expect slightly more GSC given logistic diversification than we do given exponential diversification; we also expect markedly less HSC given logistic diversification than we do given exponential diversification (*R*/*K* = 0; Fig. S5D). Within different logistic systems, expectations for both GSC and HSC become more pronounced as *R* (and thus early cladogenesis rates) increases relative to *K*. Both patterns simply reflect speciation rates being highest among taxa that have had the fewest chances to accumulate derivations. Thus, **00** taxa frequently have (over their history) higher speciation rates than **01** taxa, which in turn elevates expected divergent stratigraphic compatibility for the same reasons that elevated net speciation would elevate expected HSC. More complex richness-dependent diversification models such as hierarchical diversification (e.g., 29) typically predict more rapid early rises in diversity than do logistic models do. Thus, the differences between exponential and richness-dependent models should become more pronounced as the intrinsic rate of diversification increases relative to maximum richness.

Estimating Cumulative Disparity for the First Half of Clade Evolution. Disparity studies typically examine relative amounts of disparity (however measured) in different time units or different clades. However, the relevant hypotheses here make explicit predictions about the cumulative character space (= morphospace) occupied by a clade; that is, the size of the character

Table S1. Estimating Cumulative Disparity at *S*/2 among Devonian *Floweria* species (3).

Taxon	*F. be.*	*F. de.*	*F. pa.*	*F. pe.*	*F. an.*	*F. ar.*	*F. co.*	*F. cr.*	*F. li.*	*F. ch.*	*F. io.*	*F. ma.*	*F. pr.*	*F. tr.*
F. be.	•	0.520	0.643	0.536	0.536	0.464	0.375	0.375	0.583	0.464	0.444	0.583	0.500	0.542
F. de.	0.520	•	0.720	0.720	0.240	0.640	0.208	0.500	0.208	0.400	0.417	0.667	0.400	0.500
F. pa.	0.643	0.720	•	0.179	0.571	0.321	0.750	0.625	0.708	0.464	0.556	0.333	0.607	0.458
F. per.	0.536	0.720	0.179	•	0.536	0.393	0.708	0.667	0.667	0.429	0.556	0.375	0.643	0.500
F. an.	0.536	0.240	0.571	0.536	•	0.643	0.292	0.542	0.250	0.321	0.296	0.625	0.321	0.542
F. arc.	0.464	0.640	0.321	0.393	0.643	•	0.667	0.500	0.792	0.429	0.667	0.333	0.679	0.458
F. co.	0.375	0.208	0.750	0.708	0.292	0.667	•	0.333	0.208	0.458	0.208	0.708	0.208	0.500
F. cr.	0.375	0.500	0.625	0.667	0.542	0.500	0.333	•	0.458	0.458	0.375	0.625	0.458	0.583
F. li.	0.583	0.208	0.708	0.667	0.250	0.792	0.208	0.458	•	0.417	0.333	0.708	0.333	0.542
F. ch.	0.464	0.400	0.464	0.429	0.321	0.429	0.458	0.458	0.417	•	0.481	0.375	0.571	0.458
F. io.	0.444	0.417	0.556	0.556	0.296	0.667	0.208	0.375	0.333	0.481	•	0.667	0.074	0.458
F. ma.	0.583	0.667	0.333	0.375	0.625	0.333	0.708	0.625	0.708	0.375	0.667	•	0.667	0.208
F. pr.	0.500	0.400	0.607	0.643	0.321	0.679	0.208	0.458	0.333	0.571	0.074	0.667	•	0.458
F. tr.	0.542	0.500	0.458	0.500	0.542	0.458	0.500	0.583	0.542	0.458	0.458	0.208	0.458	•

F. be.=Floweria becraftensis; *F. de.=F. deformis*; *F. pa.=F. pandora*; *F. pe.=F. perversa*; *F. an.=F. anomala*; *F. ar.=F. arctostriata*; *F. co=F. cornucopia*; *F. cr.=F. crassa*; *F. li.=F. lirella*; *F. ch.=F. chemungensis*; *F. io.=F. iowensis*; *F. ma.=F. magnacicatrix*; *F. pr.=F. prava*; *F. tr.=F. transversalis*. Numbers give pairwise dissimilarity between species, i.e. the number differing characters divided by the number of characters for which both species are coded. This is done after polymorphic characters are fixed to the state maximizing stratigraphic compatibility. Cumulative disparity is estimated from the average pairwise dissimilarity among: 1) *F. becraftensis – F. perversa* (the four early Devonian species); 2) *F. becraftensis – F. lirella* (the nine early-middle Devonian species); and, 3) *F. becraftensis – F. transversalis* (the 14 total species). Note that *F. perversa* survives into the Middle Devonian. The final number gives the cumulative disparity for all 14 species. The disparity for the first 7.5 species (i.e., the first half of *Floweria* evolution) is interpolated from the first and second numbers assuming a linear change in disparity with a logarithmic change in richness (13; Fig. S6).

space occupied by all *S* species in a clade. Elevated evolvability predicts that available character space is greater at the end of clade evolution than it was at the onset, whereas the null hypothesis predicts that there are no major additions to character space. If elevated evolvability is correct, then the cumulative disparity among early members of the clade (say, the first *S*/2 species) should be less than expected if the entire character space is available to all species and that rates of change are reasonably consistent through time. The null hypothesis (no major addition of characters to any derived taxa) predicts that cumulative disparity at *S*/2 is simply a product of the size of total character space and the average overall rate of change (13).

We present an empirical example of how we estimate cumulative disparity at *S*/2 using 14 Devonian brachiopod species from the genus *Floweria* (3). Table S1 gives the average pairwise dissimilarity between each species, which is a common metric of disparity (e.g., 30). We separate these species into three general stratigraphic units: Early Devonian (*F. becraftensis* – *F. perversa*), Middle Devonian (*F. anomala* – *F. lirella*) and Late Devonian (*F. chemungensis* – *F. transversalis*). The key difference between our approach and typical approaches is that we estimate disparity not among just Middle Devonian or Late Devonian species, but among all species sampled in through the Middle Devonian or Late Devonian; thus, cumulative disparity for the first 9 species (i.e., through the middle Devonian) is the average of the pairwise dissimilarities among the first 9 species in Table S1, and the cumulative disparity for the entire clade is the average of all disparities in Table S1 (Fig. S6A).

As often is the case, the stratigraphic divisions do not neatly partition the 14 species into a first and second half; moreover, the true midpoint for 14 species is at 7.5 species because clades start with one species, not zero. Therefore, we interpolate cumulative disparity at *S*/2 assuming a log-linear relationship between richness and disparity (13, 31). For example, the average

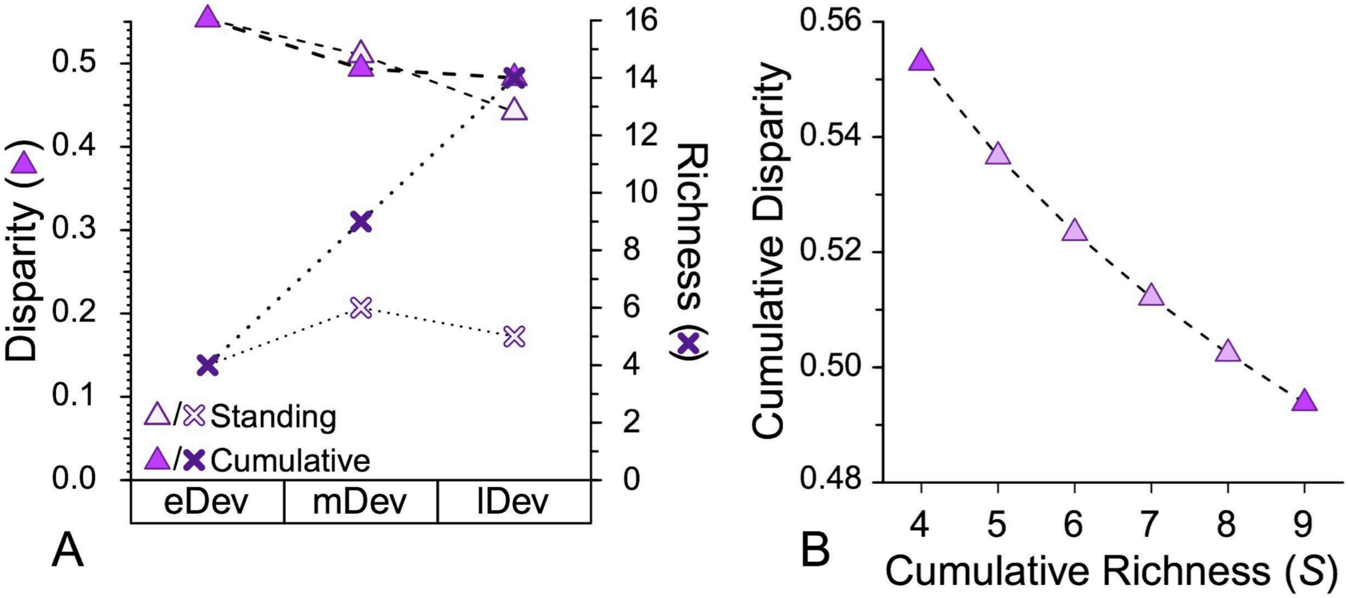


Fig. S6 – Cumulative vs. standing disparity and richness for *Floweria* species (A) and interpolated cumulative disparity halfway through clade evolution (B). Cumulative richness and disparity sum all species sampled through the Middle or Late Devonian, whereas standing richness and disparity reflect only species present at those times. (B) Interpolates the shift in disparity from the Early Devonian (i.e., the first 4 species) and the Middle Devonian (i.e, the first 9 species). The pale triangles give the estimated cumulative disparity assuming an linear increase change in disparity with an exponential change in richness. Finally, note that the actual midpoint here (and in all clades with even numbers of species) used is at *S*=7.5, as clade evolution starts at *S*=1.

pairwise dissimilarity among the first 4 species is 0.553 whereas the average pairwise dissimilarity is 0.494 among the first 9 species. Therefore, the slope is: $\frac{0.553-0.494}{\ln(9)-\ln(4)}$=-0.073, and the interpolated disparity among the first 5 species is 0.553-0.073x(ln[5]-ln[4]) =0.537 (Fig. S6B). Isolated experiments show that we obtain nearly identical values if we randomly order the 5 Middle Devonian species repeatedly and take average cumulative disparities; as this is computationally more time consuming, we used interpolation instead.

Finally, note that disparity actually decreases in this group, which is not uncommon (see Table S7). This simply reflects the rapid exhaustion of character space, which is common among fossil taxa (32), resulting in later evolution generating new combinations of existing character states and filling in character space, which in turn reduces disparity.

SI Results

Additional Summaries of Results Presented in Main Text. The *P*-values from multiple independent tests should follow a uniform distribution. Table 1 in the main text shows this is not the case. A histogram of the *P*-values further emphasizes this (Fig. S7).

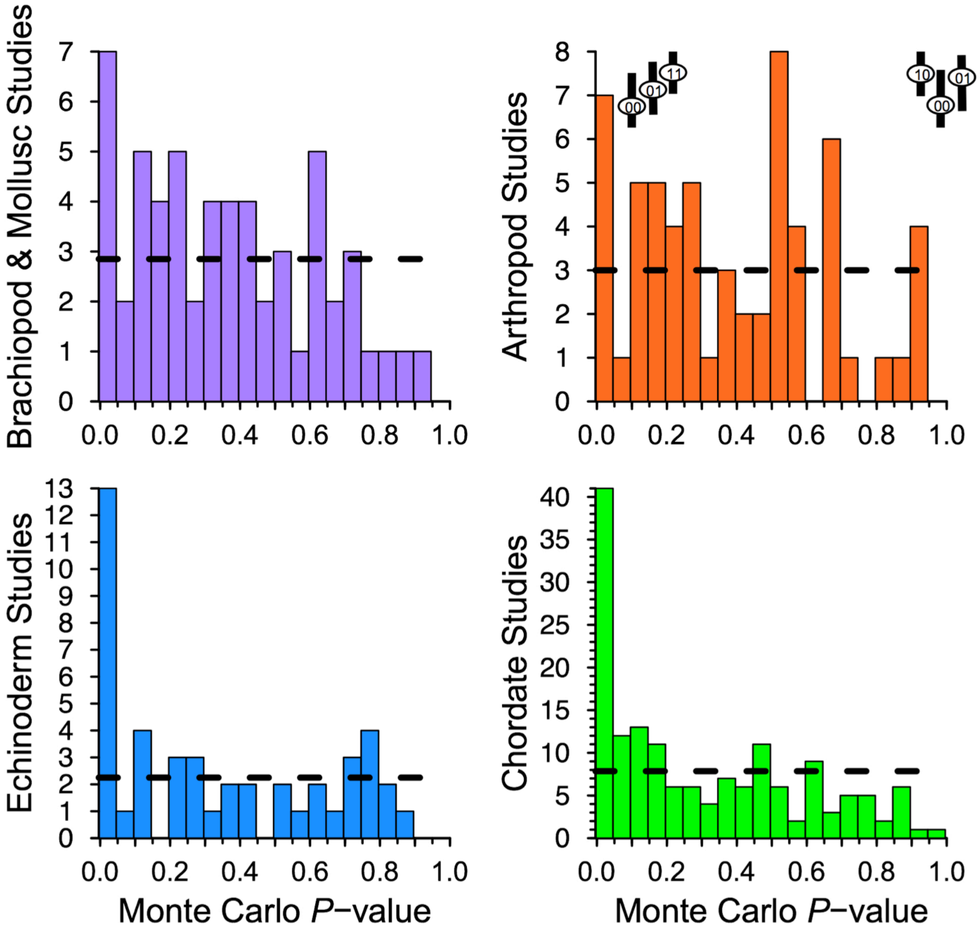


Fig. S7. Distributions of *P*-values from Monte Carlo tests assuming budding cladogenesis. Values <0.5 indicate excess HSC. Dashed lines give expected distributions.

Additional Correlations between Paraclade Durations and HSC. Excess HSC shows a strong correlation with paraclade center-of-gravity (CG) that is lower than expected given trait-independent diversification. Additional correlations exist showing that paraclades retaining primitive state-pairs go extinct earlier than expected given null models of diversification.

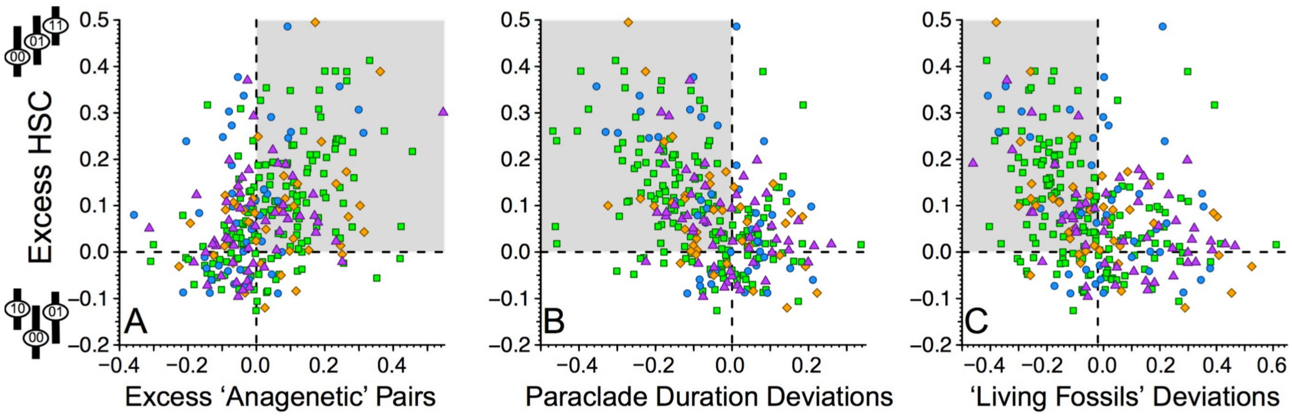


Fig. S8. Excess Hierarchical Stratigraphic Compatibility (HSC) and paraclade extinction patterns. Colors and shapes as in main text. Gray boxes reflect predicted associations given elevated net extinction. (A) Anagenetic pairs, where **00** (or **10**) disappears when **10** (or **11**) appears. (B) Paraclade durations. This is observed paraclade durations as a proportion of clade duration divided by expected paraclade durations divided by clade durations. (C) "Living fossils." This gives the proportion of paraclades diagnosed by **00** present at the end of clade history divided by the expected proportion.

"Anagenetic" HSC pairs are those where the last taxa scored **00** occur in the same or prior interval as the first taxa scored **10.** (We allow for **00**-taxa and **10**-taxa to occur in the same intervals because we use broad intervals such as stages in which both anagenetic ancestor and descendant are present.) "Anagenetic" patterns tend to increase as HSC increases (Kendall's $\tau=0.248$, $P=4.2\times10^{-11}$; Fig. S8A). We measure paraclade duration as the proportion of a clade's history that a paraclade retaining any **00** state-pair persists. Paraclade durations decrease as HSC increases (Kendall's $\tau=–0.298$, $P=2.2\times10^{-15}$; Fig. S8B). The frequency of "living fossils" (paraclades bearing **00** state-pairs extant late in clade history) is important for neontological studies. "Living fossil" paraclades decrease as HSC increases (Kendall's $\tau=-0.247$, $P=4.8\times10^{-11}$; Fig. S8C).

Results given Bifurcating Cladogenesis. Tests assuming bifurcating cladogenesis provide slightly more emphatic support for our conclusions (Table S3; Fig. S9). Thus, our conclusions do not depend on a particular model of speciation/cladogenesis prevailing.

Table S3. Cases of excess Hierarchical Stratigraphic Compatibility (HSC) at Monte Carlo significance of P≤0.05, ≤0.25 and <0.50 assuming Bifurcating Cladogenesis.

Group	N	*P*[HSC]≤0.05	*P*[HSC]≤0.25	*P*[HSC]<0.50
Brachiopods + Molluscs	57	7 (7.2×10^{-3})	26 (2.1×10^{-4})	36 (0.017)
Arthropods	60	9 (7.4×10^{-4})	25 (1.5×10^{-3})	43 (2.0×10^{-4})
Echinoderms	45	13 (2.3×10^{-8})	23 (4.4×10^{-5})	33 (4.1×10^{-4})
Chordates	153	54 (3.2×10^{-31})	88 (7.7×10^{-20})	121 (2.9×10^{-14})

Numbers of clades from each major group showing different levels of significance for excess HSC. Numbers in parentheses give binomial probabilities of these outcomes given an expectation of uniform distributions of binomial *P* values.

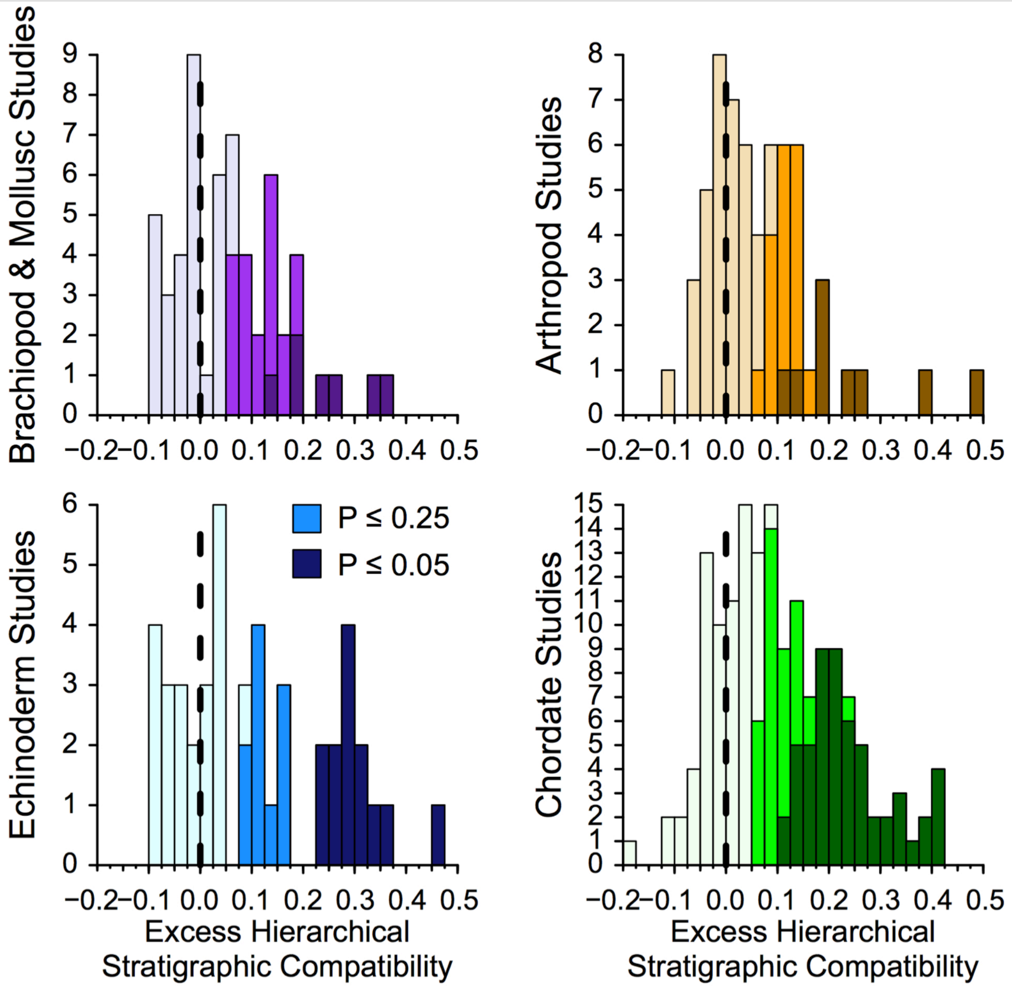


Fig. S9. Deviations from expectations given bifurcating cladogenesis. Observed hierarchical stratigraphic compatibility deviates even further from expectations than under the budding model. Shading denotes general significance of deviations.

Table S4. Period-by-Period contrasts of HSC Deviations assuming Budding Cladogenesis.

Period	Cm	O	S	D	C	P	Tr	J	K	Pg	Ng
Cambrian	•	0.042	0.040	$8\text{x}10^{-4}$	0.169	0.015	0.018	0.026	$5\text{x}10^{-4}$	$5\text{x}10^{-4}$	$4\text{x}10^{-3}$
Ordovician	**0.794**	•	0.485	0.230	0.737	0.355	0.591	0.396	0.090	0.048	0.206
Silurian	**0.837**	0.975	•	0.974	0.540	0.955	0.547	0.772	0.935	0.887	0.766
Devonian	**0.689**	0.943	1.000	•	0.281	0.944	0.681	0.876	0.964	0.491	0.761
Carboniferous	0.891	1.017	1.073	1.065	•	0.273	0.662	0.360	0.156	0.128	0.234
Permian	**0.816**	0.968	1.008	0.996	0.898	•	0.665	1.000	0.771	0.646	0.694
Triassic	**0.796**	0.977	1.071	1.028	0.950	1.061	•	0.627	0.589	0.321	0.411
Jurassic	**0.801**	0.960	1.031	1.015	0.898	1.005	0.962	•	0.639	0.636	0.604
Cretaceous	**0.645**	0.907	0.997	0.996	0.830	0.960	0.947	0.959	•	0.674	0.828
Paleogene	**0.644**	**0.890**	0.982	0.942	0.821	0.943	0.905	0.962	0.975	•	0.982
Neogene	**0.778**	0.952	0.970	0.987	0.888	0.960	0.939	0.963	0.991	1.000	•

Lower left gives summed ranks for the older interval divided by the expected summed ranks given the null hypothesis. Numbers less than one indicate that deviations for the older period are lower than expected given the null hypothesis. Bold values indicate "significant" differences. Upper right gives the probability of the distributions of ranked HSC deviations given the same null hypothesis as assessed by a Mann-Whitney test.

Period-by-Period Contrasts. The Cambrian is unique for not deviating strongly from the expectations of trait-independent diversification. Mann-Whitney tests (Table S4) show that the Cambrian deviations are significantly lower than those for all intervals other than the Cambrian. Among the remaining 45 contrasts, only Ordovician and Paleogene datasets differ significantly in excess HSC. This is well within the expectations of Type I error.

Cambrian vs. Post-Cambrian Arthropods. The Cambrian vs. Post-Cambrian pattern in HSC almost entirely reflects Cambrian trilobites. This distinction is very strong within arthropods alone (Fig. S10; Table S5. Cambrian arthropods fit the null expectations very well. In contrast,

Table S5. Numbers of cases of excess Hierarchical Stratigraphic Compatibility (HSC) at Monte Carlo significance of P≤0.05, ≤0.25 and <0.50 for Arthropods only.

Group	N	*P*[HSC]≤0.05	*P*[HSC]≤0.25	*P*[HSC]<0.50
Cambrian	19	0 (0.377)	4 (0.465)	6 (0.916)
Post-Cambrian				
All Arthropods	41	7 (8.5×10^{-4})	18 (2.4×10^{-3})	29 (2.2×10^{-3})
Trilobites Only	31	6 (7.1×10^{-4})	13 (0.012)	21 (0.015)

Numbers of clades from each major group showing different levels of significance for excess HSC. Numbers in parentheses give binomial probabilities of these outcomes given an expectation of uniform distributions of binomial *P* values.

Ordovician – Neogene arthropods deviate from null expectations as strongly as do echinoderms or vertebrates.

The bulk (30 of 40) of the post-Cambrian studies also represent trilobites. Thus, this pattern largely reflects Cambrian vs. Post-Cambrian trilobites (see also Fig. S11A below). Note, however, that Ordovician trilobites fail to show strong excess HSC patterns, too (Fig. S11A).

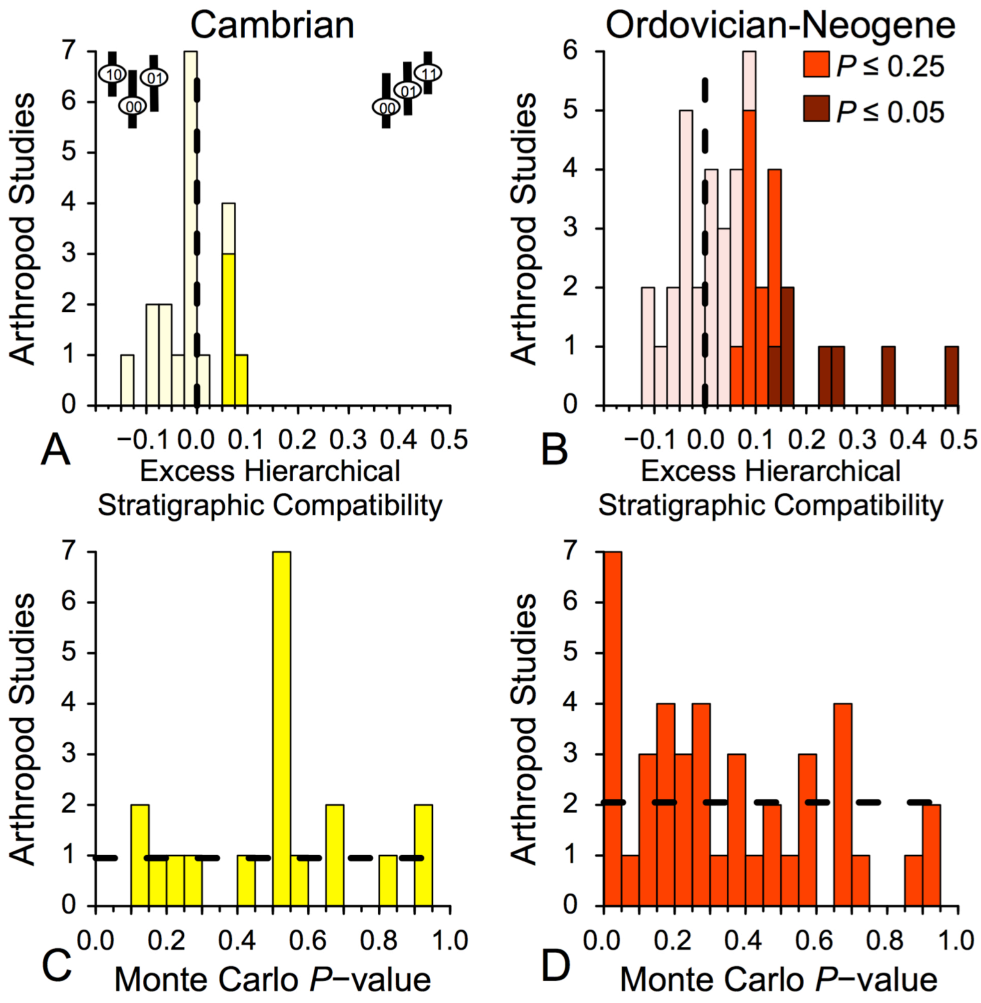


Fig. S10. Deviations between observed and expected Hierarchical Stratigraphic Compatibility (HSC) for Cambrian (A,C) and Ordovician – Neogene (B,D) arthropods. Shadings denote significance of excess HSC. Expectations reflect Monte Carlo simulations of trait-independent diversification using budding cladogenesis and origination, extinction, sampling and character change rates appropriate for each dataset.

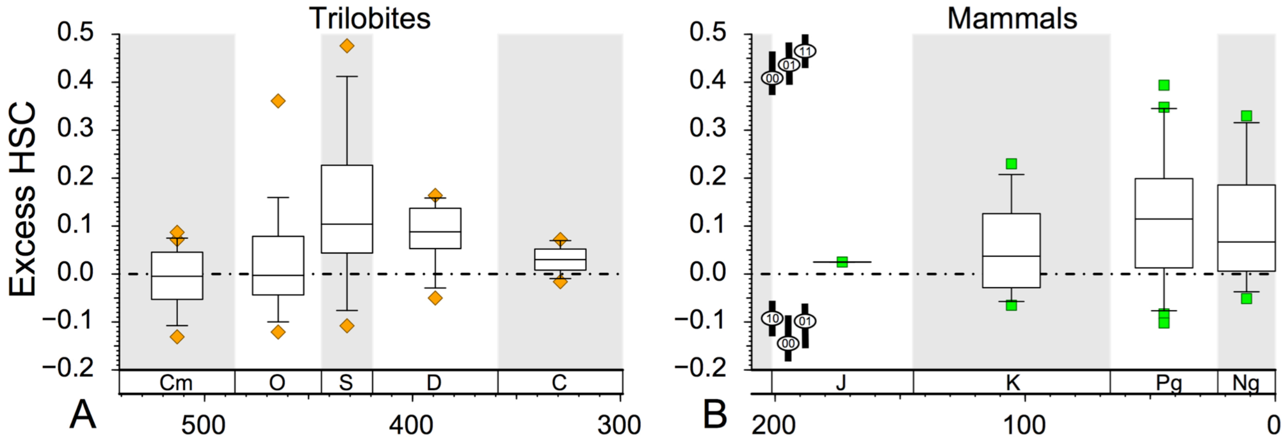


Fig. S11 – Distributions of excess Hierarchical Stratigraphic Compatibility (HSC) over time. (A) Trilobites. (B) Mammals. Mammals show no shifts in net diversification rates over the Cenozoic whereas trilobites show decreases in net diversification rates after the Cambrian and Ordovician.

Patterns of Hierarchical Stratigraphic Compatibility against General Patterns of Diversification. Elevated net speciation posits that subclades within a larger clade sometimes produce daughter lineages at a higher rate than the rest of the clade. If elevated net speciation is a primary driver of HSC, then we do not expect to see excess HSC when net speciation rates are stable or decreasing. We illustrate two examples showing that excess HSC often is unassociated with increased diversification rates. Mammals (Fig. S11B) show considerable excess HSC throughout their history. However, net speciation rates do not show increase over that time (23). Trilobites commonly show excess HSC after the Ordoivcian (Fig. S11A). However, not only do net speciation rates not increase, they instead decrease (33). Conversely, HSC patterns among trilobites do not deviate from the expectations of trait-independent change when their net speciation rates are highest in the Cambrian.

SI Discussion

A Hypothetical Example of Coupled Logistic Diversification. Sepkoski (27) proposed a fairly simple equation for diversification patterns of two “competing” groups:

$$\Delta S_i = R_i S_i (1 - \frac{S_i + c_{ij} S_j}{K})$$

where S is the richness of the group, R is the "intrinsic" net diversification, K is the equilibrium richness, c_{ij} is the effect of Group j on Group i, and ΔS_i is the expected change in richness over time for group i or j. Here we illustrate a simple hypothetical example, generated with $R_1=R_2=1.5$, and $K_1=K_2=20$ (Fig. S12A). Instead of two competing clades, Group 1 represents a paraclade of taxa diagnosed by primitive condition **00** whereas Group 2 represents a derived subclade of taxa diagnosed by a derived condition **01** (Fig. S12B). Declining origination rates rather than increasing extinction rates drive the decline of the paraclade here. Moreover, net diversification rates for the *entire* clade also do not change: the decline in origination rates for the paraclade is offset by elevated rates in the subclade. The negative net diversification of a paraphyletic portion of the clade also would encourage "anagenetic" HSC by increasing the chances of the last "red" lineages bearing some **00** conditions disappears shortly after some

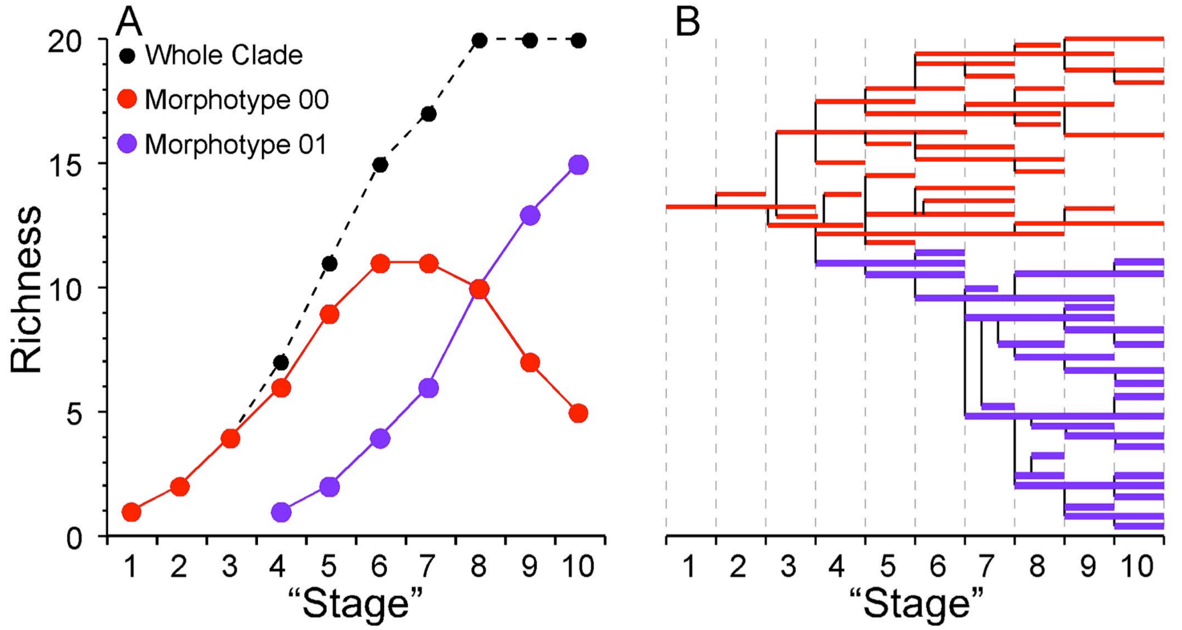


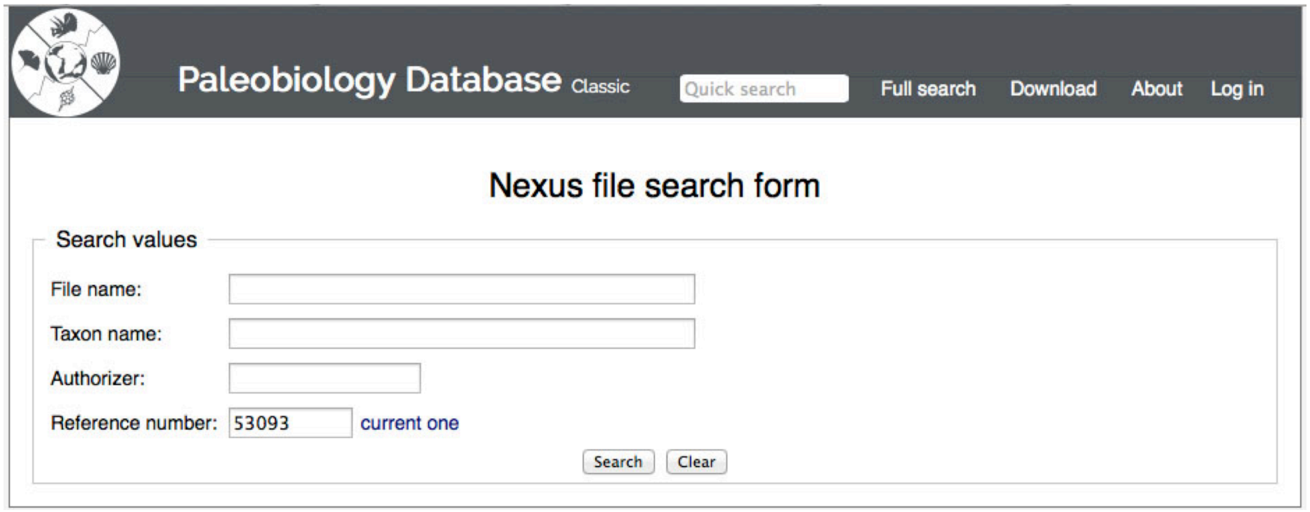
Fig. S12. Hypothetical example of coupled logistic diversification. (A) Richness over time for species with conditions 00 (red) and 01 (purple) for state-pairs involving some "key" character. (B) Underlying phylogeny showing the diversification of "red" and "purple" taxa over time. See text for parameters.

“purple” lineage bearing a new **01** condition evolves.

Finally, note that phylogenetic pattern in Fig. S12B would create the illusion of elevated net speciation if we analyzed only the taxa from the final “stage.” This reflects two things. One, because the five “living fossil” lineages from the **00** paraclade provide no evidence of greater past diversity, they will actively mislead estimates of net diversification at the base of the tree. This leads to the second problem. The boost in net diversification among the “purple” lineages now appears to be a shift in rates. However, 1) diversification rates actually are *lower* than the net diversification rates at the base of the tree, and 2) the only “new” parameters introduced are those reflecting the advantage of the purple lineages over the red lineages.

SI Data

Accessing NEXUS files. The character matrices used in this study can be accessed at: http://www.paleobiodb.org/cgi-bin/bridge.pl?a=nexusFileSearch. Enter “53093” under the reference number to return the relevant files (Fig. S13).



Nexus file search form

Search values

File name:

Taxon name:

Authorizer:

Reference number: 53093 current one

Fig. S13. Instructions for collecting data used here from http://www.paleobiodb.org/cgi-bin/bridge.pl?a=nexusFileSearch.

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Table S5. Observed vs. Expected Hierarchical Stratigraphic Compatibility (HSC)

Higher Taxon	Analyzed Taxon	Per.	OTU	SCP	Obs. HSC	E[HSC|Bud]	*P*	E[HSC|Bif]	*P*	Ref.
Brachiopod	Anopliidae	3	28	160	0.406	0.458	0.689	0.462	0.719	1
Brachiopod	Atrypidae	2	25	438	0.502	0.429	0.215	0.424	0.167	2
Brachiopod	Billingsellida	1	20	214	0.474	0.435	0.344	0.434	0.334	3
Brachiopod	Echinoconchidae	4	14	174	0.534	0.494	0.387	0.496	0.381	4
Brachiopod	*Floweria*	4	14	180	0.433	0.532	0.906	0.511	0.858	5
Brachiopod	*Kutchithyris*	8	12	180	0.547	0.472	0.248	0.472	0.242	6
Brachiopod	Leptenellidae	2	23	103	0.345	0.429	0.756	0.441	0.828	7
Brachiopod	Leptestiidae	2	10	193	0.661	0.502	0.046	0.513	0.040	8
Brachiopod	Linguloidea	1	23	866	0.383	0.407	0.604	0.413	0.629	9
Brachiopod	*Orbirhynchia*	9	16	162	0.809	0.514	0.009	0.461	0.004	10
Brachiopod	Parastrophinidae	2	26	518	0.486	0.418	0.234	0.420	0.234	11
Brachiopod	*Plaesiomys*	2	10	50	0.780	0.527	0.049	0.542	0.043	12
Brachiopod	*Schizophoria*	4	22	214	0.584	0.486	0.176	0.453	0.085	5
Brachiopod	Strophomenoidea	2	14	33	0.409	0.500	0.725	0.500	0.758	13
Brachiopod	Terebratuloidea	4	78	309	0.388	0.352	0.376	0.339	0.317	14
Brachiopod	Tritoechiidae	2	13	394	0.426	0.526	0.858	0.498	0.821	15
Brachiopod	Virgianidae	2	12	449	0.392	0.476	0.822	0.477	0.854	16
Rostroconch	Conocardioidea	4	43	962	0.448	0.347	0.134	0.346	0.122	17
Rostroconch	Eopteriidae	2	20	699	0.522	0.438	0.155	0.430	0.113	17
Rostroconch	Pseudobigaleaidae	3	24	1731	0.506	0.458	0.292	0.401	0.093	17
Rostroconch	Ribeiriidae	2	27	615	0.498	0.431	0.230	0.425	0.183	17
Rostroconch	Technophoridae	2	14	869	0.498	0.449	0.318	0.451	0.287	17
Bivalve	Caprinoidea	9	23	311	0.706	0.349	0.004	0.343	0.006	18
Bivalve	Cardiidae	10	33	356	0.367	0.336	0.410	0.383	0.563	19
Bivalve	*Chione*	10	19	112	0.567	0.440	0.130	0.437	0.135	20
Bivalve	*Chionopsis*	10	19	164	0.427	0.420	0.468	0.430	0.521	20
Bivalve	Corbulidae	9	12	2828	0.476	0.491	0.599	0.489	0.580	21
Bivalve	Eucardiidae	9	20	156	0.715	0.441	0.026	0.461	0.021	22
Bivalve	Hippuritoidea	9	36	427	0.489	0.280	0.045	0.305	0.039	23

"Per.." gives Period of peak richness (1=Cambrian, 2=Ordovician, 3=Silurian, 4=Devonian, 5=Carboniferous, 6=Permian, 7=Triassic, 8=Jurassic, 9=Cretaceous, 10=Paleogene, 11=Neogene). OTU=number of taxa examined. SCP = Stratigraphically Compatible Pairs. E[HSC] gives expected HSC under given either budding (Bud) or Bifurcating (Bif) cladogenesis.

Higher Taxon	Analyzed Taxon	Per.	OTU	SCP	Obs. HSC	E[HSC|Bud]	*P*	E[HSC|Bif]	*P*	Ref.
Bivalve	*Leptodesma*	4	22	128	0.492	0.500	0.518	0.437	0.255	24
Bivalve	Megadesmidae	6	15	213	0.498	0.478	0.445	0.414	0.220	25
Bivalve	Ostreaoidea	9	34	439	0.295	0.304	0.536	0.316	0.590	26
Bivalve	Pholadidae	9	25	197	0.492	0.385	0.177	0.325	0.083	27
Cephalopod	Acanthoceratidae	9	20	562	0.482	0.468	0.447	0.486	0.517	28
Cephalopod	Ceratitida	6	32	891	0.299	0.365	0.746	0.383	0.854	29
Cephalopod	Goniatitoidea	5	13	244	0.545	0.381	0.157	0.369	0.096	30
Cephalopod	Hamitidae	9	27	651	0.326	0.320	0.484	0.335	0.538	31
Cephalopod	Hammatoceratinae	8	11	60	0.467	0.524	0.652	0.517	0.653	32
Cephalopod	Hildoceratidae	8	17	85	0.535	0.476	0.306	0.475	0.310	33
Cephalopod	Scaphitacoidea	9	13	189	0.563	0.397	0.146	0.392	0.108	10
Cephalopod	*Semiformiceras*	8	11	110	0.532	0.566	0.628	0.535	0.523	34
Cephalopod	Turrilitoidea	9	26	316	0.503	0.320	0.078	0.322	0.076	35
Tergomyan	Cyrtonelloidea	2	21	920	0.486	0.426	0.226	0.411	0.175	36
Gastropod	Ancillinae	10	30	376	0.418	0.334	0.267	0.337	0.235	37
Gastropod	Bucaniidae	8	40	1034	0.346	0.376	0.631	0.366	0.580	36
Gastropod	Columbellidae	11	24	304	0.474	0.454	0.427	0.452	0.402	38
Gastropod	Eotomarioidea	2	40	2363	0.372	0.346	0.384	0.343	0.350	39
Gastropod	Harpidae	10	18	357	0.520	0.402	0.135	0.394	0.120	40
Gastropod	Hormotomidae	2	34	2778	0.308	0.355	0.713	0.355	0.746	39
Gastropod	Macluritidae	2	18	1434	0.611	0.436	0.021	0.431	0.010	39
Gastropod	Muricidae	10	18	566	0.549	0.399	0.097	0.404	0.078	41
Gastropod	Nassariidae	10	26	185	0.443	0.406	0.385	0.401	0.336	42
Gastropod	Rapaninae	10	27	206	0.379	0.411	0.630	0.428	0.692	43
Gastropod	Sinuitidae	2	16	465	0.492	0.437	0.319	0.437	0.272	36
Gastropod	Subulitoidea	5	27	132	0.386	0.413	0.613	0.413	0.626	44
Gastropod	Trochonematoidea	2	55	469	0.319	0.332	0.548	0.326	0.521	45, 46
Gastropod	Tropidodiscidae	2	22	596	0.537	0.413	0.116	0.405	0.078	36
Trilobite	Agnostoidea	1	82	1786	0.351	0.284	0.232	0.272	0.158	47
Trilobite	Agnostoidea	1	43	231	0.348	0.377	0.592	0.372	0.597	48
Trilobite	Alokistocaridae	1	19	1160	0.459	0.468	0.537	0.469	0.570	49
Trilobite	Basal Trilobita	1	17	241	0.647	0.557	0.125	0.531	0.073	50
Trilobite	Burlingiidae	1	16	71	0.570	0.500	0.285	0.479	0.229	51

Higher Taxon	Analyzed Taxon	Per.	OTU	SCP	Obs. HSC	E[HSC|Bud]	*P*	E[HSC|Bif]	*P*	Ref.
Trilobite	Emuellidae	1	15	348	0.330	0.458	0.911	0.446	0.923	52
Trilobite	Euptychaspidinae	1	12	273	0.443	0.455	0.536	0.440	0.492	53
Trilobite	Iwayaspidinae	1	14	137	0.423	0.478	0.696	0.481	0.721	54
Trilobite	Kochaspidae	1	66	1344	0.385	0.447	0.810	0.380	0.463	55
Trilobite	Missisquoiidae	1	22	331	0.418	0.516	0.919	0.484	0.842	56
Trilobite	Nevadoidea	1	22	686	0.493	0.495	0.511	0.488	0.467	57
Trilobite	Olenelloidea	1	26	921	0.584	0.509	0.145	0.480	0.050	58
Trilobite	Oryctocephalidae	1	22	493	0.526	0.458	0.191	0.451	0.151	59
Trilobite	Oryctocephalinae	1	24	189	0.497	0.503	0.518	0.464	0.341	60
Trilobite	Polymeroidea	1	19	438	0.372	0.373	0.504	0.383	0.556	61
Trilobite	Pterocephaliidae	1	36	625	0.397	0.381	0.434	0.387	0.461	62
Trilobite	Ptychoparioidea	1	48	2144	0.397	0.399	0.512	0.358	0.323	63
Trilobite	Wuaniidae	1	37	13	0.385	0.467	0.658	0.400	0.529	64
Trilobite	Acanthoparyphinae	2	24	644	0.469	0.474	0.510	0.400	0.274	65
Trilobite	*Ceratocara*	2	10	141	0.564	0.590	0.594	0.565	0.507	66
Trilobite	Deiphoninae	2	21	115	0.443	0.489	0.663	0.460	0.575	67
Trilobite	Dimeropygidae	2	18	306	0.497	0.517	0.556	0.457	0.358	68
Trilobite	Illaenidae	2	28	214	0.418	0.417	0.493	0.409	0.458	69
Trilobite	*Ovalocephalus*	2	10	215	0.853	0.489	0.001	0.456	0.001	70
Trilobite	*Pseudopetigurus*	2	17	210	0.581	0.486	0.162	0.456	0.085	71
Trilobite	*Pseudosphaerexochus*	2	10	216	0.412	0.486	0.730	0.450	0.635	72
Trilobite	Reedocalymeninae	2	32	146	0.479	0.400	0.255	0.403	0.256	73
Trilobite	Shumardiidae	2	33	584	0.423	0.506	0.910	0.463	0.756	74
Trilobite	Sphaerexochinae	2	31	402	0.552	0.474	0.212	0.402	0.068	75
Trilobite	*Stenoblepharum*	2	10	169	0.521	0.479	0.357	0.474	0.336	76
Trilobite	Tetralichinae	2	11	104	0.644	0.542	0.179	0.520	0.137	77
Trilobite	Toernquistiidae	2	38	756	0.319	0.437	0.909	0.386	0.757	78
Trilobite	*Acanthopgye*	3	25	40	0.725	0.469	0.050	0.475	0.033	79
Trilobite	*Edgecombeaspis*	3	9	88	0.966	0.487	<0.001	0.468	<0.001	80
Trilobite	Encrinurinae	3	32	596	0.345	0.450	0.864	0.370	0.605	81
Trilobite	Odontopleuridae	3	62	357	0.457	0.398	0.283	0.313	0.075	82
Trilobite	Phacopidae	3	50	311	0.441	0.401	0.325	0.385	0.265	83-85
Trilobite	Trochurinae	3	19	163	0.650	0.491	0.047	0.458	0.022	86

Higher Taxon	Analyzed Taxon	Per.	OTU	SCP	Obs. HSC	E[HSC|Bud]	*P*	E[HSC|Bif]	*P*	Ref.
Trilobite	Asteropyginae	4	38	855	0.367	0.414	0.669	0.411	0.689	87
Trilobite	*Basidechenella*	4	16	186	0.581	0.496	0.195	0.454	0.078	88
Trilobite	*Dechenella*	4	17	598	0.607	0.472	0.049	0.470	0.039	88
Trilobite	Koneprusiinae	4	39	116	0.647	0.500	0.084	0.455	0.046	89
Trilobite	*Malvinella*	4	14	817	0.537	0.520	0.413	0.520	0.424	90
Trilobite	*Metacryphaeus*	4	17	525	0.635	0.468	0.030	0.448	0.018	91
Trilobite	Proetidae	4	21	696	0.514	0.422	0.171	0.419	0.155	88
Trilobite	*Trimerocephalus*	4	14	294	0.558	0.488	0.295	0.409	0.085	92
Trilobite	*Kaskia*	5	19	146	0.449	0.462	0.548	0.451	0.507	93
Trilobite	Phillipsidae	5	21	108	0.532	0.457	0.287	0.460	0.273	94, 95
Trilobite	Lichoidea	2	36	804	0.521	0.413	0.118	0.412	0.090	96
Chelicerate	Adelophthalmoidea	3	12	155	0.629	0.496	0.121	0.465	0.067	97
Chelicerate	Cambrian Arachnomorpha	1	24	742	0.357	0.384	0.593	0.379	0.604	98
Chelicerate	Eurypetriidae	3	23	660	0.472	0.449	0.393	0.455	0.405	99
Chelicerate	*Eurypterus*	3	13	144	0.562	0.513	0.369	0.474	0.259	100
Chelicerate	Stylonurina	3	23	631	0.368	0.408	0.660	0.397	0.617	101
Crustacean	Astacidae	8	17	253	0.731	0.498	0.005	0.472	<0.001	102
Crustacean	Astacidae	8	23	375	0.488	0.357	0.134	0.380	0.155	103
Crustacean	Beyrichiocopa	2	34	464	0.417	0.339	0.201	0.333	0.174	104
Crustacean	Phyllocarida	4	41	1288	0.503	0.431	0.236	0.359	0.052	105
Crustacean	Thylacocephala	4	18	125	0.548	0.538	0.474	0.505	0.317	106
Crustacean	Xanthoidea	10	21	1255	0.399	0.450	0.697	0.373	0.386	107
Stylophoran	Anomalocystitidae	2	20	2267	0.374	0.478	0.892	0.439	0.807	108
Stylophoran	Chauvelicystinae	2	12	73	0.637	0.553	0.244	0.515	0.168	109
Stylophoran	Cincta	1	21	1702	0.427	0.459	0.622	0.396	0.364	110
Stylophoran	Cornuta	2	32	1662	0.364	0.415	0.707	0.353	0.443	111
Stylophoran	Cornuta	2	22	383	0.520	0.424	0.227	0.363	0.073	112
Stylophoran	Cornuta	2	28	226	0.416	0.433	0.555	0.377	0.343	113
Stylophoran	Dendrocystitidae	2	15	107	0.561	0.492	0.285	0.446	0.148	114, 115
Stylophoran	Mitrata	2	13	577	0.791	0.455	0.005	0.420	<0.001	116
Stylophoran	Mitrata	2	17	4167	0.433	0.486	0.728	0.435	0.508	117
Stylophoran	Stylophora	2	42	1966	0.446	0.337	0.107	0.318	0.069	114
Edrioasteroid	Agelacrinitinae	4	10	30	1.000	0.516	0.004	0.526	0.005	118

Higher Taxon	Analyzed Taxon	Per.	OTU	SCP	Obs. HSC	E[HSC|Bud]	*P*	E[HSC|Bif]	*P*	Ref.
Edrioasteroid	Edrioasteroidea	2	15	192	0.776	0.474	0.021	0.476	0.022	119
Edrioasteroid	Isorophida	2	11	42	0.631	0.454	0.099	0.459	0.071	120
Asterozoan	Asterozoa	2	36	7260	0.350	0.350	0.508	0.321	0.365	121
Asterozoan	Goniasteridae	8	21	1151	0.424	0.496	0.795	0.450	0.638	122
Blastozoan	Blastoidea	4	68	2863	0.390	0.341	0.272	0.340	0.254	123
Blastozoan	Glyptocystitidae	3	11	109	0.766	0.518	0.008	0.497	0.003	124
Blastozoan	Pleurocystitidae	2	12	147	0.782	0.524	0.033	0.507	0.033	125
Crinoid	Basal Crinoidea	2	33	143	0.409	0.437	0.603	0.441	0.634	126
Crinoid	Botryocrinidae	5	13	88	0.369	0.450	0.759	0.456	0.798	127
Crinoid	Calceocrinidae	3	22	99	0.692	0.454	0.045	0.455	0.025	128
Crinoid	Camerata	2	28	439	0.432	0.414	0.420	0.421	0.453	129
Crinoid	Cladida	2	27	308	0.305	0.372	0.764	0.391	0.850	129
Crinoid	Cupulocrinidae	2	13	237	0.741	0.527	0.024	0.461	0.001	130
Crinoid	*Cyathocrinites*	5	14	74	0.399	0.514	0.846	0.459	0.708	131
Crinoid	Disparida	2	45	648	0.299	0.349	0.720	0.355	0.770	129
Crinoid	*Mespilocrinus*	5	10	40	0.562	0.508	0.363	0.449	0.234	132
Crinoid	Pereichocrinidae	4	20	258	0.391	0.457	0.788	0.473	0.851	133
Echinoid	Arbacoidea	9	21	749	0.730	0.395	0.011	0.410	0.005	134
Echinoid	Arbacoidea	7	25	224	0.538	0.410	0.109	0.384	0.063	135
Echinoid	Cassiduloidea	9	69	620	0.318	0.281	0.362	0.274	0.309	136
Echinoid	Cassiduloidea	9	49	382	0.651	0.277	0.001	0.309	<0.001	137
Echinoid	Clypeasteroidea	9	43	695	0.355	0.298	0.304	0.319	0.346	138
Echinoid	Disasteroidea	9	26	189	0.696	0.391	0.007	0.411	0.016	139
Echinoid	Holasteroidea	9	43	478	0.341	0.319	0.430	0.338	0.489	140
Echinoid	Hypsaleniinae	9	10	44	0.568	0.489	0.297	0.471	0.259	134
Echinoid	Irregularia	8	27	401	0.613	0.376	0.011	0.386	0.013	141
Echinoid	Loveniidae	10	14	626	0.450	0.484	0.654	0.485	0.696	142
Echinoid	Mesozoic Echinoidea	7	46	1471	0.444	0.323	0.107	0.331	0.081	143
Echinoid	Ordovician Echinoidea	2	11	206	0.745	0.474	0.015	0.467	0.003	144
Echinoid	Somaliasteridae	9	19	190	0.479	0.386	0.232	0.394	0.244	145
Echinoid	Spatangoidea	10	50	1910	0.410	0.287	0.116	0.319	0.126	146
Echinoid	Spatangoidea	9	37	635	0.350	0.361	0.544	0.373	0.601	147
Echinoid	Temnopleuridae	10	16	400	0.360	0.453	0.819	0.441	0.844	148

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Echinoid	Toxasteridae	8	35	474	0.661	0.367	0.003	0.340	0.001	149
Conodont	*Hindeodus–Isarcicella*	6	21	113	0.465	0.389	0.275	0.402	0.307	150
Conodont	*Kockelella*	3	17	311	0.595	0.453	0.070	0.446	0.035	151
Conodont	*Palmatolepis*	4	15	233	0.442	0.424	0.467	0.383	0.308	152
Cephalaspid	Thyestiidae	3	18	274	0.478	0.508	0.628	0.513	0.639	153
Pteraspid	Pteraspidiformes	4	26	902	0.639	0.447	0.005	0.443	0.004	154
Placoderm	Actinolepidae	3	18	446	0.410	0.443	0.617	0.407	0.486	155
Placoderm	Arthrodira	4	31	731	0.486	0.428	0.304	0.429	0.268	156
Placoderm	Bothriolepidae	4	12	100	0.650	0.403	0.109	0.413	0.107	157
Placoderm	Eubrachythoraci	4	19	799	0.557	0.494	0.194	0.485	0.161	158
Placoderm	Phyllolepidae	4	38	940	0.457	0.385	0.235	0.380	0.197	159
Placoderm	Selenosteidae	4	10	62	0.476	0.509	0.613	0.491	0.564	160
Chondrichthian	Basal Chondricthyes	5	10	74	0.493	0.489	0.491	0.489	0.489	161
Actinopterygian	Amblypteridae	5	50	771	0.694	0.402	<0.001	0.340	<0.001	162
Actinopterygian	Amiidae	10	21	771	0.350	0.372	0.560	0.313	0.341	163
Actinopterygian	Basal Teleostei	8	26	7451	0.557	0.381	0.025	0.358	0.015	164, 165
Actinopterygian	Devonian Palaeonisciformes	4	15	821	0.523	0.521	0.492	0.453	0.207	166
Actinopterygian	Ginglymodi	10	27	1869	0.428	0.412	0.439	0.398	0.389	167, 168
Actinopterygian	Osteoglossomorphes	7	18	1392	0.449	0.466	0.608	0.473	0.639	169
Actinopterygian	Perleidiformes	7	14	240	0.433	0.498	0.756	0.463	0.633	167
Actinopterygian	Scanalepiformes	4	13	1014	0.470	0.473	0.507	0.430	0.353	170
Actinopterygian	Tetradontiformes	4	36	1688	0.547	0.440	0.122	0.384	0.025	171
Sarcopterygian	Basal Sarcopterygia	5	32	6829	0.443	0.385	0.285	0.392	0.281	172
Sarcopterygian	Basal Sarcopterygia	5	25	6580	0.472	0.408	0.240	0.413	0.243	173
Sarcopterygian	Coelocanthiformes	5	30	1535	0.533	0.457	0.193	0.416	0.074	174
Sarcopterygian	Coelocanthiformes	7	24	3201	0.739	0.430	<0.001	0.433	<0.001	175, 176
Sarcopterygian	Devonian Dipnoi	4	26	1164	0.573	0.419	0.065	0.413	0.040	177
Sarcopterygian	Mesozoic Dipnoi	4	16	100	0.890	0.495	<0.001	0.468	<0.001	178
Sarcopterygian	Rhipidistia	10	30	3196	0.603	0.401	0.014	0.401	0.010	179
Tetrapod	Early Tetrapoda	5	21	4646	0.714	0.504	0.001	0.457	<0.001	180
Temnospondyl	Basal Temnospondyli	5	10	1047	0.455	0.531	0.780	0.476	0.589	181
Temnospondyl	Brachyopoidea	6	21	634	0.421	0.465	0.720	0.431	0.555	182, 183
Temnospondyl	Branchiosauridae	6	19	484	0.606	0.419	0.044	0.415	0.025	184

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Temnospondyl	Capitosauria	7	22	648	0.596	0.449	0.077	0.384	0.010	185
Temnospondyl	Capitosauridae	6	11	333	0.683	0.524	0.029	0.517	0.015	186
Temnospondyl	Dvinosauridae	5	10	858	0.528	0.518	0.446	0.512	0.409	187
Temnospondyl	Edopoidea	5	15	304	0.704	0.535	0.016	0.519	0.006	188, 189
Temnospondyl	Mastodonsauroidea	6	21	292	0.560	0.471	0.214	0.464	0.186	190
Temnospondyl	Rhytidosteoidea	6	11	52	0.740	0.530	0.068	0.445	0.022	191
Temnospondyl	Stegoceephalia	5	16	818	0.416	0.501	0.909	0.480	0.851	192
Temnospondyl	Stereospondylia	6	15	1965	0.544	0.464	0.196	0.464	0.179	193
Synapsid	Basal Synapsida	6	17	619	0.448	0.524	0.827	0.481	0.668	194
Synapsid	Varanopidae	7	10	50	0.660	0.576	0.263	0.556	0.207	195
Synapsid	Anomodontia	6	30	2241	0.422	0.449	0.619	0.386	0.324	196, 197
Synapsid	Cynodontia	6	16	1155	0.494	0.458	0.351	0.435	0.252	198
Synapsid	Dicynodontia	7	29	1620	0.458	0.411	0.300	0.403	0.240	199
Synapsid	Eutheriodontia	7	23	2648	0.621	0.464	0.025	0.410	0.004	200
Synapsid	Eutherocephalia	7	21	1629	0.378	0.475	0.863	0.426	0.709	201; 202
Synapsid	Traversodontidae	7	16	511	0.634	0.455	0.023	0.455	0.024	203, 204
Synapsid	Amphilestidae	9	20	1381	0.339	0.402	0.760	0.397	0.761	205
Synapsid	Anomaluroidea	10	14	4889	0.610	0.503	0.112	0.462	0.026	206
Synapsid	Anthracotheriidae	10	9	95	0.421	0.464	0.601	0.454	0.588	207
Synapsid	Arctoidea	10	20	375	0.327	0.427	0.876	0.422	0.895	208
Synapsid	Basal Aplodontoidea	10	61	11758	0.507	0.394	0.040	0.378	0.020	209
Synapsid	Basal Cetacea	10	17	714	0.676	0.459	0.010	0.463	0.008	210
Synapsid	Basal Ctenodactyloidea	10	14	185	0.535	0.467	0.283	0.458	0.216	211
Synapsid	Basal Ruminantia	10	10	292	0.522	0.489	0.367	0.487	0.362	212
Synapsid	Borhyaenoidea	10	10	493	0.792	0.447	0.008	0.450	0.010	213
Synapsid	Borophaginae	10	66	3528	0.431	0.285	0.037	0.279	0.029	214
Synapsid	Brontotheriidae	10	47	3113	0.658	0.354	<0.001	0.343	<0.001	215
Synapsid	Carnivoramorpha	10	24	2210	0.542	0.412	0.086	0.416	0.060	216
Synapsid	Carpolestidae	10	13	392	0.801	0.451	0.001	0.453	0.003	217
Synapsid	Ceratomorpha	10	22	273	0.438	0.429	0.481	0.430	0.480	218
Synapsid	Chalicotheriidae	10	17	814	0.452	0.471	0.603	0.476	0.623	219
Synapsid	*Cormohipparion*	11	12	1356	0.749	0.519	0.008	0.480	0.001	220
Synapsid	Cretaceous Eutheria	9	23	2170	0.551	0.455	0.120	0.452	0.112	221

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Synapsid	Dichobunidae	10	23	186	0.672	0.473	0.018	0.433	0.009	222
Synapsid	Didolodontidae	10	13	74	0.541	0.464	0.325	0.402	0.175	223
Synapsid	Elephantiformes	11	31	1101	0.658	0.347	0.002	0.360	0.001	224
Synapsid	Eocene Equidae	10	18	1325	0.830	0.434	<0.001	0.420	<0.001	225
Synapsid	Eotheria	8	21	1341	0.433	0.408	0.423	0.413	0.396	226
Synapsid	Equidae	10	17	1151	0.712	0.479	0.002	0.442	<0.001	227
Synapsid	Equinae	11	19	506	0.539	0.492	0.303	0.457	0.176	228
Synapsid	Hathliacynidae	10	10	658	0.742	0.486	0.003	0.496	0.004	229
Synapsid	Hippopotamidae	10	16	366	0.548	0.444	0.160	0.442	0.136	230
Synapsid	Hippotragini	11	15	181	0.395	0.421	0.579	0.420	0.589	231
Synapsid	Hominidae	11	14	4309	0.581	0.526	0.197	0.499	0.070	232
Synapsid	Hominoidea	11	14	4783	0.722	0.526	<0.001	0.515	<0.001	233
Synapsid	Hyaenidae	11	18	77	0.494	0.452	0.375	0.446	0.354	234
Synapsid	Hyaenodontida	10	34	983	0.551	0.373	0.018	0.366	0.011	235, 236
Synapsid	Hypsodontidae	10	11	239	0.435	0.502	0.751	0.467	0.640	237
Synapsid	Louisinidae	10	22	2712	0.560	0.452	0.083	0.445	0.047	238
Synapsid	Machairodontinae	11	12	399	0.695	0.526	0.021	0.489	0.009	239
Synapsid	Megalochinidae	11	14	770	0.569	0.482	0.144	0.484	0.130	240
Synapsid	Megalonychidae	11	14	106	0.524	0.523	0.499	0.491	0.381	241
Synapsid	Mioclaenidae	10	31	831	0.412	0.399	0.450	0.391	0.411	242
Synapsid	Multituberculata	9	32	1424	0.702	0.470	<0.001	0.466	<0.001	243
Synapsid	Mustellidae	11	9	743	0.518	0.528	0.540	0.496	0.378	244
Synapsid	Mysticetiidae	11	32	9722	0.498	0.390	0.117	0.388	0.086	245
Synapsid	Nimravinae	10	11	428	0.463	0.494	0.612	0.498	0.644	246
Synapsid	Notohippidae	10	17	309	0.579	0.380	0.082	0.359	0.045	247
Synapsid	Odobenidae	11	15	1157	0.777	0.445	0.003	0.445	0.001	248
Synapsid	Omomyidae	10	29	35489	0.356	0.437	0.851	0.390	0.673	249
Synapsid	Paucituberculata	10	21	713	0.616	0.525	0.157	0.475	0.045	250
Synapsid	Perissodactyla	10	10	467	0.498	0.487	0.442	0.487	0.452	237
Synapsid	Protoselendonta	10	23	186	0.672	0.480	0.040	0.437	0.008	251
Synapsid	Selenodonta	10	22	1107	0.696	0.472	<0.001	0.469	<0.001	252
Synapsid	Splacotheriidae	9	11	132	0.564	0.579	0.541	0.549	0.446	253
Synapsid	Taeniodonta	10	10	723	0.632	0.509	0.059	0.503	0.055	254

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Synapsid	Toxodontidae	11	20	1275	0.421	0.470	0.729	0.467	0.737	255
Synapsid	Xenungulata	10	22	128	0.582	0.454	0.107	0.449	0.088	256
Synapsid	Zapodidae	10	25	223	0.619	0.442	0.039	0.423	0.024	257
Anapsid	Ankyramorpha	6	19	2329	0.565	0.487	0.164	0.442	0.053	258
Anapsid	Baenidae	9	14	802	0.587	0.491	0.152	0.491	0.107	259
Anapsid	Basal Testudinata	8	33	3076	0.755	0.380	<0.001	0.349	<0.001	260
Anapsid	Leptopleuroninae	7	10	455	0.542	0.499	0.357	0.491	0.289	261
Anapsid	Millerettidae	6	10	422	0.698	0.564	0.081	0.547	0.032	262
Anapsid	Nanhsiungchelyidae	9	10	154	0.484	0.542	0.652	0.469	0.459	263
Anapsid	Procolophonoidea	7	21	865	0.636	0.502	0.057	0.454	0.010	264
Ichthyosaur	Ichthyosauria	8	31	3904	0.676	0.425	0.001	0.411	<0.001	265, 266
Sauropterygian	Mosasauridae	9	33	2183	0.484	0.452	0.322	0.398	0.099	267-269
Sauropterygian	Cryptocleidoidea	9	11	1174	0.445	0.508	0.729	0.503	0.744	270
Sauropterygian	*Nothosaurus*	7	11	138	0.656	0.515	0.101	0.487	0.056	271
Sauropterygian	Placodontia	7	10	1436	0.537	0.511	0.363	0.509	0.338	272
Sauropterygian	Plesiosauridae	8	11	300	0.360	0.477	0.863	0.481	0.876	273
Sauropterygian	Plesiosauroidea	8	32	5881	0.527	0.436	0.108	0.428	0.097	274
Sauropterygian	Polycotylidae	9	10	433	0.582	0.501	0.244	0.515	0.260	275
Sauropterygian	Sphenodontia	7	22	771	0.506	0.501	0.482	0.478	0.319	276
Archosaur	Archosauromorpha	7	20	6293	0.442	0.437	0.478	0.425	0.432	277
Archosaur	Basal Crocodylia	7	11	95	0.363	0.477	0.805	0.481	0.849	278
Archosaur	Basal Crocodyliformes	9	33	5966	0.437	0.434	0.487	0.370	0.214	279
Archosaur	Basal Crurotarsia	7	20	4607	0.417	0.501	0.893	0.464	0.772	280
Archosaur	Chroniosuchia	6	12	121	0.876	0.509	0.008	0.489	0.008	281
Archosaur	Crocodylia	9	48	6662	0.500	0.388	0.080	0.358	0.048	282, 283
Archosaur	Diplocynodontinae	10	35	4718	0.563	0.421	0.088	0.362	0.008	284
Archosaur	Dyrosauridae	9	10	153	0.529	0.524	0.491	0.500	0.370	285
Archosaur	Metriorhynchidae	8	34	2335	0.407	0.379	0.391	0.368	0.322	286
Archosaur	Metriorhynchinae	8	18	1138	0.454	0.430	0.417	0.415	0.324	287
Archosaur	Phytosauridae	7	10	1045	0.688	0.532	0.029	0.497	0.010	288
Archosaur	Phytosauroidea	7	18	240	0.558	0.512	0.297	0.433	0.023	289, 290
Archosaur	Protosuchidae	8	14	5979	0.472	0.526	0.730	0.489	0.579	291
Archosaur	Sebecosuchia	10	16	295	0.235	0.419	0.981	0.399	0.978	292, 293

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Archosaur	Thalattosauriformes	7	12	87	0.454	0.528	0.778	0.496	0.691	294
Archosaur	Basal Pterosauria	8	18	1878	0.660	0.480	0.026	0.429	0.004	295
Archosaur	Pterosauria	8	56	6076	0.449	0.342	0.109	0.337	0.095	296
Archosaur	Allosauroidea	8	12	367	0.733	0.527	0.010	0.511	0.004	297
Archosaur	Ankylosauria	9	45	3872	0.544	0.462	0.111	0.459	0.088	298
Archosaur	Ankylosauroidea	9	16	741	0.549	0.513	0.245	0.520	0.279	299
Archosaur	Basal Iguanodontia	8	21	272	0.759	0.532	0.008	0.504	0.001	300
Archosaur	Carcharodontosauria	9	14	384	0.613	0.487	0.147	0.479	0.118	301
Archosaur	Ceratopsidae	9	13	109	0.569	0.575	0.514	0.487	0.273	302
Archosaur	Ceratosauria	9	18	1441	0.644	0.520	0.187	0.488	0.053	303
Archosaur	Chasmosaurinae	9	18	1491	0.547	0.451	0.168	0.443	0.100	304
Archosaur	Deinonychosauria	9	17	1391	0.471	0.499	0.625	0.489	0.586	305-307
Archosaur	Diplodocoidea	8	20	3632	0.421	0.433	0.548	0.432	0.535	308
Archosaur	Dromaeosauridae	9	17	2385	0.401	0.455	0.745	0.453	0.760	309
Archosaur	Euornithopoda	8	10	121	0.488	0.529	0.698	0.526	0.692	310
Archosaur	Hadrosaurinae	9	10	2031	0.482	0.492	0.530	0.493	0.541	311
Archosaur	Hadrosauroidea	9	29	5866	0.769	0.456	0.001	0.369	<0.001	312
Archosaur	Megalosauroidea	8	19	2757	0.474	0.521	0.677	0.480	0.531	301
Archosaur	Neoceratopsia	9	18	4413	0.537	0.446	0.201	0.456	0.175	313, 314
Archosaur	Ornithopoda	9	14	1203	0.379	0.462	0.859	0.469	0.904	315
Archosaur	Oviraptosauria	9	13	249	0.512	0.470	0.356	0.467	0.340	306, 316
Archosaur	Prosauropoda	7	15	2786	0.549	0.452	0.176	0.456	0.168	317
Archosaur	Saurolophidae	9	28	18063	0.472	0.468	0.482	0.411	0.183	318
Archosaur	Sauropoda	8	28	28844	0.471	0.467	0.483	0.425	0.276	319
Archosaur	Titanosauriformes	9	21	1258	0.579	0.458	0.124	0.445	0.101	320
Archosaur	Tyranosauroidea	9	19	25404	0.858	0.499	<0.001	0.443	<0.001	321

Table S6. Differences between Observations and Expectations for Parameters Hypothesized to Elevate Hierarchical Stratigraphic Compatibility.

	Cum. Disp. $\frac{S}{2}$		Clade CG		Paracl. CG		Pair Anag.		Paracl. Dur.		"Living Fossils"	
Analyzed Taxon	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.
Anopliidae	0.962	0.890	0.436	0.444	0.677	0.619	0.069	0.134	0.696	0.672	0.554	0.315
Atrypidae	0.993	0.854	0.437	0.447	0.324	0.292	0.223	0.351	0.318	0.275	0.160	0.129
Billingsellida	0.867	0.847	0.368	0.452	0.406	0.496	0.190	0.247	0.446	0.508	0.338	0.237
Echinoconchidae	0.887	0.858	0.394	0.461	0.590	0.605	0.320	0.220	0.695	0.652	0.375	0.291
Floweria	1.051	0.872	0.476	0.444	0.653	0.645	0.269	0.324	0.732	0.701	0.611	0.431
Kutchithyris	0.927	0.861	0.409	0.456	0.415	0.563	0.289	0.310	0.461	0.595	0.198	0.296
Leptenellidae	0.965	0.875	0.529	0.439	0.557	0.496	0.106	0.173	0.540	0.521	0.300	0.261
Leptestiidae	0.885	0.903	0.375	0.472	0.477	0.436	0.486	0.492	0.531	0.421	0.447	0.172
Linguloidea	0.949	0.832	0.552	0.435	0.538	0.471	0.216	0.225	0.524	0.495	0.177	0.246
Orbirhynchia	0.825	0.818	0.511	0.442	0.451	0.502	0.853	0.317	0.355	0.532	0.040	0.286
Parastrophinidae	1.051	0.846	0.534	0.474	0.395	0.388	0.124	0.265	0.361	0.384	0.117	0.167
Plaesiomys	1.023	0.929	0.469	0.464	0.999	0.786	<0.001	0.125	0.994	0.888	0.974	0.423
Schizophoria	1.000	0.867	0.460	0.442	0.772	0.696	0.052	0.146	0.826	0.756	0.591	0.443
Strophomenoidea	1.054	0.913	0.396	0.459	0.505	0.503	0.074	0.214	0.556	0.521	0.556	0.235
Terebratuloidea	0.955	0.829	0.435	0.432	0.695	0.513	0.056	0.083	0.699	0.560	0.533	0.239
Tritoechiidae	0.830	0.855	0.643	0.465	0.352	0.370	0.385	0.514	0.350	0.354	0.162	0.145
Virgianidae	0.974	0.859	0.554	0.458	0.443	0.389	0.205	0.445	0.442	0.373	0.286	0.164
Conocardioidea	0.861	0.812	0.488	0.459	0.437	0.510	0.191	0.148	0.425	0.527	0.263	0.238
Eopteriidae	0.943	0.842	0.576	0.478	0.475	0.551	0.304	0.293	0.445	0.529	0.137	0.219
Pseudobigaleaidae	0.881	0.818	0.427	0.439	0.445	0.461	0.513	0.355	0.429	0.469	0.283	0.240
Ribeiriidae	0.985	0.853	0.545	0.451	0.329	0.427	0.316	0.251	0.321	0.446	0.202	0.212
Technophoridae	1.021	0.818	0.536	0.466	0.410	0.475	0.258	0.414	0.430	0.453	0.197	0.195
Caprinoidea	0.617	0.771	0.347	0.462	0.428	0.530	0.178	0.282	0.526	0.558	0.069	0.250
Cardiidae	0.981	0.825	0.352	0.426	0.579	0.447	0.008	0.161	0.623	0.466	0.623	0.215
Chione	1.188	0.866	0.373	0.440	0.559	0.603	0.051	0.153	0.628	0.662	0.628	0.324

“Disp. $\frac{S}{2}$” = cumulative clade disparity after half of taxa have evolved. “Clade CG” gives center of gravity for the whole clade. “Paracl. CG” gives the CG for paraclades diagnosed with states **00** from HSC pairs. “Pair Anag.” Gives state-pairs in which the older state-pair disappears at the same time the derived pair appears from HSC pairs. “Paracl.” Duration gives duration of paraclades diagnosed by **00** from HSC character-pairs. Duration is as a proportion of the entire clade. “Living fossils” gives the proportion of paraclades diagnosed by **00** that are still extant at the end of a study.

	Cum. Disp. $\frac{S}{2}$		Clade CG		Paracl. CG		Pair Anag.		Paracl. Dur.		"Living Fossils"	
Analyzed Taxon	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.
Chionopsis	1.153	0.842	0.407	0.439	0.764	0.539	0.007	0.195	0.870	0.572	0.840	0.293
Corbulidae	0.896	0.867	0.344	0.451	0.547	0.434	0.179	0.419	0.588	0.434	0.587	0.196
Eucardiidae	0.909	0.879	0.406	0.448	0.237	0.364	0.204	0.317	0.248	0.368	0.162	0.160
Hippuritoidea	0.821	0.780	0.350	0.417	0.497	0.674	0.117	0.104	0.614	0.761	0.249	0.392
Leptodesma	0.899	0.857	0.712	0.439	0.803	0.705	0.044	0.165	1.000	0.776	1.000	0.500
Megadesmidae	0.972	0.802	0.384	0.444	0.607	0.568	<0.001	0.338	0.707	0.603	0.707	0.337
Ostreaoidea	0.821	0.779	0.434	0.417	0.792	0.605	0.077	0.134	0.758	0.661	0.711	0.350
Pholadidae	1.057	0.775	0.388	0.461	0.651	0.606	<0.001	0.219	0.726	0.645	0.656	0.274
Acanthoceratidae	1.029	0.907	0.394	0.435	0.239	0.252	0.147	0.362	0.259	0.228	0.222	0.109
Ceratitida	0.896	0.835	0.392	0.420	0.671	0.587	0.060	0.122	0.743	0.627	0.574	0.321
Goniatitoidea	0.654	0.761	0.410	0.450	0.671	0.666	0.274	0.287	0.787	0.729	0.075	0.336
Hamitidae	0.691	0.769	0.353	0.439	0.461	0.493	0.123	0.256	0.521	0.509	0.286	0.261
Hammatoceratinae	0.992	0.910	0.335	0.451	0.660	0.633	0.036	0.200	0.729	0.688	0.714	0.333
Hildoceratidae	0.828	0.887	0.497	0.451	0.492	0.577	0.275	0.160	0.532	0.613	0.286	0.300
Scaphitacoidea	0.869	0.786	0.376	0.455	0.417	0.547	0.228	0.333	0.525	0.578	0.525	0.270
Semiformiceras	0.791	0.865	0.532	0.452	0.254	0.398	0.726	0.522	0.214	0.393	0.023	0.167
Turrilitoidea	0.929	0.771	0.342	0.441	0.698	0.641	0.047	0.179	0.833	0.699	0.805	0.355
Cyrtonelloidea	1.081	0.819	0.397	0.471	0.397	0.461	0.406	0.386	0.356	0.415	0.197	0.186
Ancillinae	0.974	0.790	0.450	0.425	0.885	0.743	0.038	0.081	0.893	0.856	0.599	0.443
Bucaniidae	0.967	0.824	0.571	0.462	0.403	0.425	0.164	0.223	0.401	0.435	0.290	0.189
Columbellidae	0.946	0.841	0.384	0.466	0.693	0.512	0.458	0.277	0.742	0.528	0.740	0.217
Eotomarioidea	0.904	0.812	0.373	0.444	0.490	0.414	0.064	0.200	0.518	0.429	0.454	0.201
Harpidae	0.836	0.800	0.424	0.465	0.507	0.444	0.247	0.387	0.600	0.433	0.318	0.188
Hormotomidae	0.950	0.809	0.455	0.442	0.450	0.445	0.186	0.214	0.460	0.468	0.376	0.227
Macluritidae	0.939	0.837	0.462	0.460	0.358	0.460	0.310	0.301	0.356	0.467	0.165	0.219
Muricidae	0.749	0.820	0.350	0.439	0.445	0.530	0.129	0.236	0.519	0.562	0.458	0.287
Nassariidae	0.959	0.835	0.319	0.446	0.482	0.579	0.186	0.160	0.551	0.611	0.418	0.292
Rapaninae	0.992	0.868	0.336	0.430	0.740	0.624	<0.001	0.110	0.780	0.681	0.780	0.324
Sinuitidae	0.773	0.839	0.472	0.464	0.675	0.477	0.287	0.353	0.736	0.485	0.606	0.219
Subulitoidea	0.950	0.843	0.387	0.449	0.725	0.547	0.034	0.272	0.753	0.489	0.706	0.245
Trochonematoidea	0.927	0.804	0.357	0.458	0.743	0.536	0.109	0.070	0.782	0.588	0.782	0.240
Tropidodiscidae	1.019	0.821	0.391	0.469	0.342	0.422	0.440	0.347	0.369	0.409	0.179	0.180

	Cum. Disp. $\frac{S}{2}$		Clade CG		Paracl. CG		Pair Anag.		Paracl. Dur.		"Living Fossils"	
Analyzed Taxon	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.
Agnostoidea	0.980	0.771	0.661	0.478	0.688	0.551	0.034	0.067	0.667	0.625	0.606	0.227
Agnostoidea	0.986	0.831	0.426	0.460	0.567	0.516	0.102	0.104	0.563	0.551	0.373	0.232
Alokistocaridae	1.020	0.886	0.467	0.464	0.363	0.386	0.365	0.382	0.368	0.372	0.205	0.164
Basal Trilobita	0.894	0.868	0.402	0.446	0.796	0.565	0.293	0.376	0.797	0.598	0.741	0.325
Burlingiidae	0.658	0.868	0.436	0.442	0.515	0.735	0.389	0.227	0.564	0.797	0.029	0.412
Emuellidae	0.674	0.832	0.541	0.471	0.733	0.634	0.122	0.289	0.751	0.671	0.338	0.286
Euptychaspidinae	0.976	0.803	0.478	0.473	0.828	0.487	0.283	0.503	0.757	0.477	0.329	0.188
Iwayaspidinae	0.920	0.887	0.356	0.453	0.805	0.616	0.017	0.226	0.879	0.656	0.879	0.327
Kochaspidae	0.960	0.826	0.563	0.447	0.449	0.412	0.240	0.261	0.429	0.390	0.291	0.184
Missisquoiidae	0.880	0.896	0.462	0.437	0.647	0.579	0.262	0.252	0.632	0.570	0.304	0.302
Nevadoidea	0.981	0.887	0.642	0.487	0.615	0.548	0.211	0.282	0.577	0.558	0.332	0.225
Olenelloidea	0.982	0.893	0.404	0.436	0.514	0.505	0.206	0.212	0.550	0.520	0.251	0.276
Oryctocephalidae	1.043	0.863	0.506	0.482	0.225	0.370	0.287	0.365	0.240	0.350	0.079	0.146
Oryctocephalinae	1.056	0.843	0.420	0.441	0.413	0.398	0.356	0.398	0.428	0.403	0.357	0.207
Polymeroidea	0.719	0.793	0.458	0.439	0.766	0.472	0.112	0.286	0.840	0.479	0.814	0.245
Pterocephaliidae	0.861	0.825	0.435	0.435	0.599	0.518	0.113	0.132	0.604	0.554	0.560	0.259
Ptychoparioidea	0.912	0.785	0.417	0.466	0.534	0.467	0.299	0.247	0.621	0.475	0.545	0.189
Wuaniidae	0.931	0.879	0.392	0.441	0.490	0.495	<0.001	0.062	0.600	0.533	0.333	0.250
Acanthoparyphinae	0.692	0.781	0.515	0.438	0.448	0.572	0.330	0.241	0.496	0.596	0.255	0.309
Ceratocara	1.022	0.879	0.333	0.449	0.785	0.694	0.230	0.371	0.884	0.753	0.837	0.394
Deiphoninae	0.787	0.874	0.518	0.438	0.687	0.710	0.230	0.160	0.747	0.790	0.208	0.436
Dimeropygidae	0.836	0.797	0.583	0.448	0.478	0.500	0.592	0.364	0.451	0.517	0.191	0.235
Illaenidae	1.053	0.835	0.505	0.461	0.443	0.370	0.131	0.292	0.465	0.361	0.315	0.154
Ovalocephalus	0.950	0.788	0.442	0.443	0.257	0.429	0.857	0.545	0.251	0.432	<0.001	0.197
Pseudopetigurus	0.911	0.862	0.579	0.471	0.377	0.468	0.242	0.374	0.375	0.465	0.150	0.202
Pseudosphaerexochus	0.948	0.785	0.442	0.450	0.685	0.680	0.362	0.382	0.790	0.747	0.692	0.412
Reedocalymeninae	0.831	0.837	0.418	0.442	0.635	0.597	0.125	0.086	0.663	0.671	0.557	0.320
Shumardiidae	0.867	0.858	0.511	0.442	0.535	0.457	0.432	0.326	0.499	0.432	0.302	0.228
Sphaerexochinae	0.902	0.836	0.516	0.441	0.359	0.641	0.457	0.178	0.350	0.640	0.081	0.270
Stenoblepharum	0.936	0.843	0.449	0.469	0.381	0.489	0.386	0.456	0.454	0.485	0.234	0.206
Tetralichinae	0.878	0.852	0.500	0.448	0.540	0.575	0.470	0.491	0.496	0.598	0.164	0.308
Toernquistiidae	0.851	0.820	0.461	0.439	0.686	0.532	0.166	0.147	0.692	0.558	0.547	0.270

	Cum. Disp. $\frac{S}{2}$		Clade CG		Paracl. CG		Pair Anag.		Paracl. Dur.		"Living Fossils"	
Analyzed Taxon	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.
Acanthopgye	0.954	0.891	0.315	0.468	0.395	0.536	0.172	0.229	0.433	0.522	0.222	0.217
Edgecombeaspis	0.748	0.793	0.491	0.472	0.384	0.548	0.635	0.532	0.378	0.553	<0.001	0.213
Encrinurinae	0.997	0.783	0.381	0.438	0.713	0.515	0.196	0.240	0.776	0.545	0.738	0.263
Odontopleuridae	0.954	0.808	0.479	0.435	0.606	0.490	0.143	0.179	0.562	0.513	0.269	0.241
Phacopidae	0.826	0.854	0.544	0.467	0.271	0.303	0.520	0.251	0.236	0.288	0.064	0.123
Trochurinae	0.815	0.858	0.462	0.443	0.430	0.457	0.373	0.302	0.428	0.470	0.286	0.266
Asteropyginae	0.988	0.855	0.422	0.455	0.588	0.549	0.107	0.128	0.614	0.588	0.448	0.260
Basidechenella	1.144	0.802	0.550	0.448	0.515	0.613	0.338	0.386	0.585	0.599	0.279	0.303
Calmoniidae	0.993	0.878	0.397	0.463	0.570	0.586	0.343	0.330	0.598	0.608	0.276	0.246
Calmoniidae	0.937	0.832	0.278	0.480	0.554	0.575	0.489	0.297	0.665	0.582	0.519	0.237
Dechenella	1.043	0.871	0.325	0.466	0.524	0.530	0.149	0.291	0.622	0.540	0.275	0.243
Koneprusiinae	0.921	0.833	0.409	0.435	0.701	0.570	0.513	0.288	0.676	0.567	0.460	0.278
Proetidae	0.866	0.843	0.432	0.441	0.752	0.711	0.037	0.130	0.833	0.769	0.559	0.394
Trimerocephalus	1.347	0.759	0.324	0.444	0.420	0.488	0.416	0.525	0.472	0.503	0.310	0.238
Kaskia	0.877	0.878	0.459	0.463	0.792	0.655	0.252	0.144	0.686	0.710	0.492	0.322
Phillipsidae	1.036	0.853	0.561	0.457	0.647	0.645	0.170	0.097	0.566	0.715	0.200	0.303
Lichoidea	0.995	0.856	0.480	0.428	0.293	0.508	0.236	0.197	0.281	0.489	0.057	0.231
Adelophthalmoidea	0.816	0.785	0.534	0.470	0.540	0.612	0.626	0.583	0.554	0.523	0.032	0.177
Cambrian Arachnomorpha	0.879	0.785	0.433	0.461	0.513	0.502	0.121	0.336	0.603	0.500	0.448	0.215
Eurypetriidae	0.947	0.842	0.456	0.478	0.466	0.371	0.368	0.481	0.443	0.337	0.251	0.132
Eurypterus	1.021	0.808	0.420	0.463	0.607	0.392	0.438	0.707	0.588	0.366	0.324	0.079
Stylonurina	0.887	0.782	0.622	0.451	0.659	0.664	0.167	0.312	0.613	0.665	0.344	0.289
Astacidae	0.841	0.883	0.457	0.461	0.394	0.489	0.473	0.325	0.372	0.503	0.034	0.233
Astacidae	0.831	0.839	0.350	0.435	0.305	0.432	0.093	0.263	0.339	0.435	0.241	0.217
Beyrichiocopa	0.902	0.769	0.319	0.441	0.780	0.597	0.164	0.225	0.806	0.603	0.782	0.275
Phyllocarida	0.872	0.787	0.207	0.438	0.654	0.484	0.489	0.236	0.688	0.497	0.655	0.246
Thylacocephala	0.802	0.881	0.528	0.442	0.225	0.328	0.693	0.463	0.231	0.325	0.155	0.177
Xanthoidea	1.075	0.762	0.338	0.441	0.906	0.687	<0.001	0.249	0.967	0.758	0.967	0.411
Anomalocystitidae	0.993	0.826	0.444	0.441	0.617	0.724	0.229	0.184	0.709	0.803	0.387	0.449
Chauvelicystinae	1.151	0.858	0.429	0.452	0.571	0.463	0.274	0.466	0.576	0.483	0.205	0.242
Cincta	0.883	0.772	0.405	0.443	0.425	0.488	0.242	0.382	0.467	0.508	0.232	0.248
Cornuta	0.941	0.766	0.549	0.439	0.732	0.644	0.143	0.206	0.694	0.711	0.357	0.366

	Cum. Disp. $\frac{S}{2}$		Clade CG		Paracl. CG		Pair Anag.		Paracl. Dur.		"Living Fossils"	
Analyzed Taxon	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.
Cornuta	0.968	0.763	0.474	0.444	0.650	0.698	0.207	0.230	0.704	0.767	0.467	0.412
Cornuta	0.876	0.818	0.587	0.440	0.469	0.375	0.144	0.323	0.484	0.378	0.320	0.200
Dendrocystitidae	0.915	0.864	0.424	0.443	0.385	0.490	0.350	0.371	0.437	0.510	0.154	0.275
Mitrata	0.841	0.742	0.457	0.469	0.296	0.535	0.624	0.459	0.290	0.544	0.005	0.212
Mitrata	0.927	0.800	0.583	0.435	0.395	0.413	0.434	0.410	0.380	0.404	0.113	0.206
Stylophora	0.889	0.784	0.590	0.479	0.261	0.318	0.305	0.317	0.213	0.304	0.053	0.127
Agelacrinitinae	0.727	0.904	0.394	0.458	0.547	0.556	0.383	0.357	0.628	0.556	0.567	0.250
Edrioasteroidea	0.640	0.808	0.477	0.483	0.573	0.578	0.233	0.349	0.632	0.576	0.374	0.191
Isorophida	1.197	0.812	0.540	0.465	0.874	0.666	0.170	0.333	0.800	0.683	0.429	0.289
Asterozoa	1.017	0.751	0.494	0.462	0.751	0.607	0.136	0.232	0.785	0.631	0.577	0.264
Goniasteridae	0.851	0.831	0.490	0.443	0.693	0.661	0.189	0.272	0.696	0.729	0.403	0.391
Blastoidea	0.910	0.798	0.482	0.428	0.572	0.518	0.125	0.174	0.492	0.531	0.300	0.241
Glyptocystitidae	0.875	0.852	0.483	0.443	0.309	0.615	0.500	0.429	0.317	0.622	0.025	0.346
Pleurocystitidae	1.055	0.835	0.491	0.468	0.418	0.612	0.585	0.370	0.406	0.598	0.049	0.212
Basal Crinoidea	1.013	0.892	0.425	0.433	0.387	0.312	0.111	0.282	0.392	0.308	0.184	0.143
Botryocrinidae	0.838	0.849	0.514	0.450	0.497	0.524	0.215	0.328	0.499	0.530	0.188	0.245
Calceocrinidae	1.027	0.882	0.597	0.432	0.310	0.442	0.069	0.234	0.298	0.458	0.048	0.222
Camerata	1.028	0.876	0.302	0.429	0.396	0.357	0.231	0.285	0.449	0.360	0.338	0.181
Cladida	1.060	0.826	0.326	0.426	0.558	0.375	0.080	0.278	0.603	0.372	0.581	0.184
Cupulocrinidae	1.002	0.804	0.411	0.446	0.440	0.402	0.318	0.575	0.524	0.409	0.458	0.205
Cyathocrinites	0.787	0.818	0.548	0.439	0.714	0.610	0.136	0.378	0.727	0.657	0.727	0.393
Disparida	0.965	0.849	0.420	0.428	0.406	0.358	0.081	0.217	0.436	0.367	0.410	0.179
Mespilocrinus	0.959	0.781	0.452	0.444	0.745	0.582	0.122	0.514	0.761	0.616	0.364	0.286
Pereichocrinidae	1.035	0.877	0.503	0.439	0.633	0.635	0.129	0.205	0.616	0.662	0.425	0.321
Arbacoidea	0.706	0.799	0.553	0.441	0.466	0.602	0.056	0.160	0.465	0.658	0.033	0.289
Arbacoidea	1.052	0.838	0.398	0.483	0.548	0.454	0.203	0.272	0.579	0.464	0.381	0.180
Cassiduloidea	0.808	0.780	0.416	0.437	0.561	0.478	0.055	0.099	0.624	0.525	0.539	0.233
Cassiduloidea	0.947	0.818	0.376	0.404	0.410	0.558	0.008	0.090	0.529	0.610	0.444	0.315
Clypeasteroidea	0.976	0.810	0.386	0.411	0.651	0.559	0.006	0.099	0.728	0.625	0.676	0.322
Disasteroidea	0.941	0.824	0.518	0.428	0.374	0.546	0.049	0.182	0.347	0.556	0.085	0.267
Holasteroidea	0.816	0.801	0.410	0.419	0.621	0.536	0.040	0.104	0.665	0.591	0.432	0.296
Hypsaleniinae	0.680	0.827	0.417	0.462	0.797	0.592	0.280	0.409	0.919	0.623	0.792	0.313

	Cum. Disp. $\frac{S}{2}$		Clade CG		Paracl. CG		Pair Anag.		Paracl. Dur.		"Living Fossils"	
Analyzed Taxon	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.
Irregularia	0.968	0.835	0.385	0.424	0.421	0.608	0.189	0.132	0.478	0.664	0.438	0.333
Loveniidae	1.003	0.913	0.458	0.446	0.666	0.511	0.060	0.292	0.706	0.520	0.702	0.234
Mesozoic Echinoidea	0.806	0.776	0.279	0.424	0.486	0.532	0.172	0.183	0.552	0.566	0.505	0.281
Ordovician Echinoidea	1.097	0.845	0.536	0.478	0.657	0.508	0.340	0.509	0.577	0.483	0.361	0.182
Somaliasteridae	1.031	0.818	0.402	0.441	0.633	0.602	0.088	0.185	0.642	0.653	0.242	0.329
Spatangoidea	0.892	0.813	0.283	0.398	0.649	0.541	0.002	0.107	0.766	0.595	0.764	0.309
Spatangoidea	0.964	0.831	0.304	0.415	0.504	0.513	0.162	0.121	0.590	0.559	0.583	0.287
Temnopleuridae	1.074	0.833	0.568	0.471	0.806	0.564	0.057	0.263	0.760	0.586	0.417	0.257
Toxasteridae	0.963	0.812	0.345	0.468	0.346	0.441	0.431	0.177	0.397	0.454	0.193	0.202
Hindeodus–Isarcicella	0.763	0.820	0.490	0.439	0.799	0.741	0.124	0.117	0.950	0.870	0.583	0.423
Kockelella	0.580	0.841	0.416	0.483	0.755	0.678	0.327	0.355	0.713	0.662	0.514	0.258
Palmatolepis	0.755	0.750	0.388	0.443	0.714	0.658	0.248	0.339	0.768	0.709	0.175	0.365
Thyestiidae	0.919	0.891	0.661	0.462	0.703	0.584	0.073	0.314	0.640	0.586	0.192	0.242
Pteraspidiformes	1.002	0.842	0.507	0.468	0.483	0.466	0.248	0.230	0.492	0.477	0.216	0.202
Actinolepidae	0.878	0.788	0.461	0.462	0.629	0.687	0.235	0.270	0.683	0.708	0.134	0.315
Arthrodira	0.825	0.807	0.598	0.462	0.607	0.641	0.259	0.195	0.602	0.667	0.319	0.276
Bothriolepidae	0.435	0.721	0.534	0.494	0.288	0.529	0.623	0.506	0.313	0.526	0.015	0.107
Eubrachythoraci	0.963	0.861	0.361	0.481	0.622	0.527	0.403	0.394	0.671	0.521	0.265	0.201
Phyllolepidae	0.755	0.794	0.585	0.460	0.640	0.686	0.167	0.176	0.667	0.719	0.361	0.297
Selenosteidae	0.659	0.787	0.489	0.452	0.714	0.726	0.729	0.510	0.552	0.705	0.250	0.345
Basal Chondricthyes	0.994	0.833	0.410	0.500	0.955	0.482	0.082	0.474	1.000	0.479	1.000	0.147
Amblypteridae	0.903	0.819	0.593	0.439	0.359	0.522	0.298	0.115	0.305	0.543	0.096	0.285
Amiidae	1.019	0.725	0.535	0.458	0.712	0.611	0.342	0.326	0.691	0.624	0.532	0.276
Basal Teleostei	0.903	0.778	0.472	0.478	0.414	0.525	0.297	0.286	0.405	0.551	0.181	0.227
Devonian Palaeonisciformes	0.903	0.784	0.456	0.446	0.585	0.570	0.420	0.497	0.647	0.591	0.390	0.278
Ginglymodi	0.746	0.810	0.396	0.469	0.620	0.555	0.429	0.249	0.652	0.583	0.544	0.246
Osteoglossomorphes	0.848	0.838	0.483	0.451	0.609	0.539	0.251	0.396	0.635	0.500	0.494	0.214
Perleidiformes	0.966	0.842	0.454	0.445	0.663	0.628	0.200	0.341	0.704	0.663	0.444	0.363
Scanalepiformes	0.826	0.806	0.614	0.448	0.670	0.595	0.545	0.474	0.612	0.599	0.334	0.262
Tetradontiformes	1.080	0.781	0.528	0.440	0.328	0.482	0.530	0.358	0.339	0.471	0.124	0.205
Basal Sarcopterygia	0.973	0.770	0.548	0.448	0.703	0.611	0.122	0.289	0.676	0.608	0.380	0.256
Basal Sarcopterygia	0.946	0.783	0.402	0.451	0.663	0.690	0.184	0.281	0.677	0.631	0.448	0.294

	Cum. Disp. $\frac{S}{2}$		Clade CG		Paracl. CG		Pair Anag.		Paracl. Dur.		"Living Fossils"	
Analyzed Taxon	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.
Coelocanthiformes	0.872	0.834	0.620	0.435	0.335	0.594	0.383	0.298	0.309	0.585	0.110	0.279
Coelocanthiformes	0.742	0.805	0.570	0.468	0.371	0.613	0.395	0.290	0.365	0.653	0.031	0.261
Devonian Dipnoi	0.945	0.809	0.425	0.457	0.738	0.614	0.293	0.329	0.817	0.604	0.569	0.248
Mesozoic Dipnoi	1.110	0.837	0.540	0.479	0.275	0.441	0.697	0.531	0.205	0.390	0.080	0.140
Rhipidistia	1.125	0.774	0.463	0.453	0.529	0.592	0.184	0.307	0.577	0.599	0.193	0.252
Early Tetrapoda	0.714	0.819	0.591	0.433	0.286	0.535	0.609	0.397	0.297	0.569	0.069	0.262
Basal Temnospondyli	1.073	0.804	0.525	0.446	0.607	0.555	0.368	0.524	0.647	0.604	0.294	0.292
Brachyopoidea	1.023	0.785	0.700	0.439	0.613	0.618	0.214	0.384	0.588	0.598	0.321	0.299
Branchiosauridae	1.053	0.817	0.477	0.462	0.416	0.604	0.322	0.219	0.445	0.656	0.252	0.287
Capitosauria	0.879	0.779	0.518	0.442	0.564	0.628	0.187	0.254	0.584	0.670	0.168	0.348
Capitosauridae	1.111	0.897	0.430	0.455	0.569	0.619	0.607	0.355	0.566	0.660	0.243	0.346
Dvinosauridae	0.850	0.888	0.514	0.492	0.588	0.600	0.451	0.394	0.554	0.612	0.222	0.237
Edopoidea	0.932	0.916	0.516	0.461	0.570	0.617	0.364	0.264	0.563	0.657	0.150	0.302
Mastodonsauroidea	0.972	0.845	0.513	0.458	0.675	0.683	0.150	0.120	0.669	0.761	0.480	0.322
Rhytidosteoidea	1.434	0.767	0.456	0.446	0.645	0.629	0.506	0.545	0.628	0.676	0.192	0.310
Stegoceophalia	0.945	0.877	0.436	0.472	0.625	0.668	0.269	0.271	0.667	0.669	0.379	0.304
Stereospondylia	0.899	0.822	0.380	0.450	0.693	0.657	0.189	0.276	0.751	0.721	0.688	0.334
Basal Synapsida	1.100	0.803	0.397	0.443	0.582	0.546	0.318	0.448	0.619	0.567	0.300	0.261
Varanopidae	1.182	0.831	0.350	0.454	0.682	0.619	0.515	0.445	0.775	0.658	0.515	0.333
Anomodontia	0.999	0.811	0.508	0.440	0.412	0.514	0.334	0.317	0.421	0.519	0.196	0.239
Cynodontia	0.856	0.827	0.382	0.479	0.540	0.518	0.518	0.371	0.584	0.527	0.335	0.210
Dicynodontia	0.970	0.820	0.472	0.466	0.606	0.504	0.147	0.313	0.591	0.479	0.232	0.203
Eutheriodontia	0.676	0.816	0.481	0.437	0.364	0.542	0.466	0.286	0.367	0.557	0.159	0.295
Eutherocephalia	0.886	0.806	0.585	0.439	0.748	0.600	0.165	0.282	0.765	0.652	0.378	0.335
Traversodontidae	0.893	0.842	0.535	0.469	0.420	0.598	0.383	0.318	0.429	0.601	0.067	0.252
Amphilestidae	0.921	0.790	0.606	0.463	0.589	0.524	0.261	0.350	0.571	0.537	0.086	0.235
Anomaluroidea	1.116	0.823	0.543	0.447	0.303	0.488	0.506	0.422	0.322	0.496	0.098	0.240
Anthracotheriidae	1.098	0.797	0.516	0.462	0.854	0.624	0.237	0.435	0.956	0.652	0.824	0.254
Arctoidea	0.741	0.829	0.559	0.449	0.770	0.555	0.216	0.250	0.716	0.569	0.321	0.279
Basal Aplodontoidea	0.767	0.795	0.345	0.459	0.693	0.575	0.109	0.196	0.741	0.594	0.601	0.235
Basal Cetacea	0.855	0.823	0.459	0.483	0.240	0.430	0.703	0.536	0.217	0.360	0.056	0.134
Basal Ctenodactyloidea	0.783	0.857	0.506	0.471	0.657	0.533	0.444	0.365	0.683	0.522	0.385	0.224

	Cum. Disp. $\frac{s}{2}$		Clade CG		Paracl. CG		Pair Anag.		Paracl. Dur.		"Living Fossils"	
Analyzed Taxon	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.
Basal Ruminantia	1.002	0.864	0.544	0.469	0.606	0.545	0.261	0.407	0.676	0.551	0.323	0.240
Borhyaenoidea	0.837	0.760	0.527	0.466	0.332	0.477	0.486	0.567	0.299	0.469	0.039	0.157
Borophaginae	0.683	0.771	0.497	0.439	0.421	0.479	0.158	0.154	0.397	0.514	0.137	0.234
Brontotheriidae	0.890	0.783	0.453	0.457	0.454	0.486	0.135	0.233	0.468	0.483	0.151	0.207
Carnivoramorpha	0.817	0.833	0.410	0.440	0.478	0.560	0.162	0.231	0.507	0.578	0.335	0.277
Carpolestidae	0.763	0.800	0.536	0.471	0.336	0.355	0.595	0.608	0.299	0.319	0.102	0.111
Ceratomorpha	0.582	0.810	0.577	0.436	0.684	0.584	0.126	0.266	0.817	0.573	0.804	0.280
Chalicotheriidae	0.883	0.863	0.611	0.462	0.667	0.494	0.099	0.377	0.652	0.482	0.177	0.209
Cormohipparion	1.084	0.839	0.367	0.438	0.161	0.308	0.836	0.620	0.150	0.291	0.042	0.124
Cretaceous Eutheria	0.927	0.844	0.424	0.469	0.509	0.464	0.296	0.379	0.469	0.454	0.271	0.191
Dichobunidae	0.764	0.828	0.388	0.437	0.405	0.569	0.448	0.279	0.442	0.581	0.168	0.296
Didolodontidae	0.850	0.776	0.643	0.441	0.411	0.634	0.325	0.375	0.392	0.706	<0.001	0.378
Elephantiformes	0.975	0.799	0.328	0.422	0.718	0.604	0.040	0.244	0.827	0.600	0.772	0.291
Eocene Equidae	0.633	0.797	0.438	0.466	0.456	0.586	0.536	0.273	0.416	0.633	0.034	0.278
Eotheria	0.961	0.813	0.483	0.444	0.568	0.562	0.223	0.279	0.554	0.598	0.262	0.292
Equidae	0.838	0.829	0.494	0.464	0.299	0.468	0.545	0.375	0.298	0.469	0.082	0.208
Equinae	0.946	0.849	0.548	0.446	0.339	0.473	0.486	0.329	0.312	0.495	0.085	0.279
Hathliacynidae	1.072	0.826	0.357	0.462	0.204	0.609	0.482	0.440	0.250	0.621	0.090	0.280
Hippopotamidae	0.888	0.834	0.481	0.456	0.335	0.602	0.349	0.302	0.381	0.588	0.112	0.271
Hippotragini	1.005	0.778	0.452	0.448	0.580	0.537	0.224	0.402	0.630	0.570	0.385	0.268
Hominidae	0.872	0.872	0.397	0.440	0.390	0.522	0.500	0.581	0.322	0.448	0.108	0.220
Hominoidea	0.647	0.857	0.520	0.480	0.487	0.461	0.537	0.592	0.494	0.469	0.026	0.168
Hyaenidae	0.917	0.868	0.431	0.440	0.511	0.647	0.118	0.194	0.548	0.679	0.208	0.340
Hyaenodontida	0.876	0.814	0.487	0.440	0.529	0.668	0.139	0.120	0.489	0.675	0.202	0.330
Hypsodontidae	0.684	0.806	0.525	0.450	0.571	0.490	0.550	0.515	0.587	0.506	0.304	0.239
Louisinidae	1.007	0.843	0.566	0.482	0.368	0.366	0.451	0.426	0.346	0.350	0.223	0.139
Machairodontinae	1.059	0.843	0.425	0.444	0.386	0.502	0.461	0.467	0.419	0.529	0.191	0.269
Megalochinidae	0.986	0.876	0.299	0.464	0.514	0.487	0.301	0.412	0.579	0.463	0.500	0.202
Megalonychidae	0.781	0.883	0.467	0.443	0.636	0.509	0.252	0.341	0.629	0.534	0.549	0.308
Mioclaenidae	0.873	0.822	0.587	0.451	0.670	0.540	0.083	0.164	0.679	0.571	0.513	0.261
Multituberculata	0.840	0.844	0.405	0.461	0.359	0.547	0.498	0.344	0.281	0.496	0.138	0.218
Mustellidae	0.641	0.775	0.551	0.454	0.669	0.646	0.501	0.631	0.680	0.618	0.294	0.272

	Cum. Disp. $\frac{S}{2}$		Clade CG		Paracl. CG		Pair Anag.		Paracl. Dur.		"Living Fossils"	
Analyzed Taxon	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.
Mysticetiidae	1.036	0.801	0.488	0.464	0.724	0.487	0.254	0.275	0.695	0.494	0.602	0.209
Nimravinae	1.073	0.833	0.451	0.465	0.631	0.490	0.222	0.626	0.639	0.379	0.511	0.134
Notohippidae	0.846	0.777	0.353	0.481	0.470	0.539	0.510	0.396	0.501	0.515	0.092	0.193
Odobenidae	0.607	0.823	0.448	0.467	0.308	0.411	0.567	0.493	0.314	0.404	0.018	0.155
Omomyidae	0.851	0.785	0.595	0.440	0.571	0.530	0.119	0.326	0.621	0.551	0.369	0.307
Paucituberculata	0.775	0.818	0.422	0.441	0.464	0.496	0.607	0.362	0.458	0.510	0.197	0.254
Perissodactyla	0.789	0.868	0.401	0.458	0.456	0.466	0.347	0.457	0.487	0.460	0.370	0.212
Protoselendonta	0.764	0.819	0.396	0.440	0.448	0.551	0.448	0.309	0.450	0.564	0.168	0.293
Selenodonta	1.020	0.892	0.561	0.458	0.457	0.580	0.316	0.298	0.444	0.548	0.119	0.235
Splacotheriidae	0.880	0.817	0.555	0.445	0.604	0.706	0.862	0.452	0.500	0.710	0.070	0.333
Taeniodonta	0.986	0.865	0.519	0.475	0.319	0.410	0.673	0.621	0.218	0.359	0.055	0.128
Toxodontidae	1.027	0.861	0.490	0.454	0.643	0.553	0.198	0.331	0.591	0.521	0.324	0.222
Xenungulata	0.976	0.875	0.392	0.460	0.470	0.315	0.248	0.332	0.451	0.294	0.295	0.134
Zapodidae	0.867	0.822	0.455	0.468	0.611	0.568	0.167	0.225	0.596	0.610	0.231	0.250
Ankyramorpha	1.063	0.798	0.530	0.441	0.592	0.653	0.358	0.351	0.563	0.645	0.259	0.332
Baenidae	0.971	0.816	0.532	0.481	0.433	0.565	0.442	0.499	0.407	0.536	0.121	0.200
Basal Testudinata	0.993	0.780	0.428	0.469	0.198	0.513	0.489	0.370	0.237	0.515	0.084	0.194
Leptopleuroninae	0.982	0.825	0.486	0.479	0.310	0.571	0.829	0.505	0.274	0.574	0.005	0.213
Millerettidae	0.959	0.881	0.353	0.460	0.658	0.552	0.675	0.501	0.737	0.561	0.152	0.235
Nanhsiungchelyidae	0.922	0.784	0.444	0.446	0.546	0.587	0.466	0.648	0.577	0.577	0.300	0.224
Procolophonoidea	0.737	0.786	0.585	0.446	0.431	0.565	0.583	0.499	0.351	0.505	0.054	0.220
Cryptocleidoidea	0.801	0.836	0.479	0.472	0.324	0.442	0.536	0.626	0.306	0.431	0.078	0.138
Ichthyosauria	0.871	0.802	0.602	0.455	0.218	0.496	0.621	0.331	0.188	0.524	0.026	0.215
Mosasauridae	0.926	0.801	0.377	0.430	0.579	0.637	0.303	0.252	0.637	0.651	0.545	0.350
Nothosaurus	1.131	0.820	0.423	0.447	0.533	0.573	0.403	0.433	0.551	0.602	0.349	0.310
Placodontia	0.870	0.901	0.525	0.467	0.635	0.553	0.303	0.508	0.595	0.538	0.173	0.218
Plesiosauridae	0.756	0.799	0.521	0.490	0.699	0.562	0.370	0.453	0.693	0.588	0.296	0.202
Plesiosauroidea	0.785	0.816	0.546	0.465	0.599	0.563	0.262	0.284	0.565	0.570	0.288	0.231
Polycotylidae	0.719	0.780	0.442	0.474	0.517	0.558	0.334	0.631	0.549	0.507	0.381	0.183
Sphenodontia	1.011	0.848	0.542	0.448	0.537	0.571	0.442	0.394	0.457	0.527	0.206	0.225
Archosauromorpha	0.887	0.810	0.597	0.485	0.641	0.567	0.347	0.338	0.493	0.561	0.210	0.219
Basal Crocodilia	0.983	0.874	0.528	0.466	0.742	0.565	0.370	0.468	0.883	0.590	0.667	0.233

	Cum. Disp. $\frac{S}{2}$		Clade CG		Paracl. CG		Pair Anag.		Paracl. Dur.		"Living Fossils"	
Analyzed Taxon	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.
Basal Crocodyliformes	0.967	0.784	0.380	0.446	0.593	0.556	0.241	0.318	0.585	0.569	0.276	0.248
Basal Crurotarsia	0.931	0.824	0.567	0.442	0.635	0.661	0.359	0.434	0.690	0.621	0.467	0.273
Chroniosuchia	0.548	0.815	0.483	0.482	0.553	0.513	0.535	0.397	0.745	0.524	0.677	0.162
Crocodylia	0.938	0.782	0.345	0.480	0.531	0.579	0.352	0.274	0.588	0.543	0.342	0.210
Diplocynodontinae	1.070	0.773	0.512	0.425	0.375	0.598	0.388	0.295	0.381	0.588	0.093	0.263
Dyrosauridae	1.024	0.843	0.700	0.447	0.286	0.579	0.358	0.430	0.207	0.621	<0.001	0.306
Metriorhynchidae	0.876	0.774	0.527	0.464	0.568	0.419	0.322	0.404	0.509	0.404	0.220	0.165
Metriorhynchinae	0.612	0.806	0.650	0.480	0.436	0.375	0.557	0.531	0.431	0.335	0.187	0.123
Phytosauridae	0.766	0.824	0.417	0.450	0.382	0.510	0.741	0.556	0.401	0.536	0.109	0.278
Phytosauroidea	0.922	0.838	0.386	0.388	0.725	0.662	0.729	0.453	0.864	0.746	0.854	0.602
Protosuchidae	0.876	0.806	0.452	0.447	0.480	0.567	0.620	0.525	0.580	0.584	0.453	0.256
Sebecosuchia	1.045	0.749	0.444	0.472	0.662	0.503	0.402	0.544	0.590	0.452	0.380	0.162
Thalattosauriformes	0.903	0.851	0.563	0.444	0.616	0.663	0.791	0.451	0.679	0.667	0.441	0.371
Basal Pterosauria	0.916	0.793	0.473	0.450	0.390	0.564	0.466	0.423	0.447	0.585	0.173	0.262
Pterosauria	0.877	0.793	0.458	0.452	0.404	0.539	0.177	0.199	0.411	0.559	0.127	0.227
Allosauroidea	0.949	0.896	0.333	0.447	0.397	0.656	0.842	0.432	0.535	0.669	0.236	0.292
Ankylosauria	0.869	0.838	0.416	0.474	0.709	0.663	0.209	0.306	0.750	0.620	0.538	0.245
Ankylosauroidea	0.933	0.915	0.411	0.465	0.637	0.629	0.381	0.394	0.649	0.586	0.399	0.259
Basal Iguanodontia	0.856	0.837	0.400	0.446	0.458	0.520	0.653	0.556	0.488	0.523	0.138	0.218
Carcharodontosauria	1.052	0.797	0.612	0.474	0.430	0.591	0.540	0.657	0.414	0.440	0.114	0.140
Ceratopsidae	0.816	0.779	0.402	0.449	0.548	0.489	0.411	0.595	0.567	0.506	0.500	0.222
Ceratosauria	1.061	0.815	0.365	0.439	0.251	0.641	0.762	0.677	0.324	0.495	0.196	0.146
Chasmosaurinae	0.844	0.831	0.484	0.462	0.546	0.564	0.393	0.353	0.528	0.571	0.070	0.238
Deinonychosauria	1.038	0.796	0.494	0.461	0.595	0.528	0.443	0.614	0.650	0.450	0.159	0.156
Diplodocoidea	0.723	0.802	0.620	0.457	0.507	0.656	0.112	0.426	0.449	0.583	0.081	0.213
Dromaeosauridae	1.167	0.811	0.368	0.461	0.574	0.618	0.368	0.519	0.607	0.512	0.330	0.188
Euornithopoda	1.166	0.888	0.552	0.486	0.461	0.637	0.585	0.582	0.399	0.565	0.082	0.212
Hadrosaurinae	0.847	0.821	0.500	0.472	0.770	0.529	0.311	0.507	0.795	0.538	0.638	0.204
Hadrosauroidea	0.929	0.738	0.334	0.440	0.433	0.593	0.309	0.313	0.545	0.621	0.356	0.284
Megalosauroidea	0.549	0.869	0.699	0.438	0.692	0.549	0.478	0.579	0.577	0.534	0.143	0.190
Neoceratopsia	0.806	0.809	0.401	0.467	0.480	0.560	0.464	0.456	0.457	0.503	0.211	0.200
Ornithopoda	0.874	0.838	0.471	0.460	0.752	0.692	0.201	0.298	0.719	0.686	0.353	0.302

	Cum. Disp. $\frac{S}{2}$		Clade CG		Paracl. CG		Pair Anag.		Paracl. Dur.		"Living Fossils"	
Analyzed Taxon	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.
Oviraptosauria	1.236	0.795	0.382	0.466	0.632	0.556	0.563	0.595	0.669	0.477	0.343	0.152
Prosauropoda	1.018	0.821	0.563	0.462	0.526	0.665	0.250	0.396	0.549	0.620	0.332	0.256
Saurolophidae	0.969	0.781	0.433	0.443	0.710	0.547	0.279	0.373	0.635	0.515	0.436	0.241
Titanosauriformes	0.786	0.816	0.518	0.452	0.558	0.578	0.361	0.408	0.530	0.616	0.086	0.259
Sauropoda	0.846	0.817	0.500	0.442	0.583	0.608	0.352	0.396	0.449	0.541	0.130	0.228
Tyranosauroidea	0.658	0.736	0.357	0.440	0.439	0.584	0.706	0.459	0.409	0.579	0.103	0.255

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