Body-size increase in crinoids across the end-Devonian mass extinction

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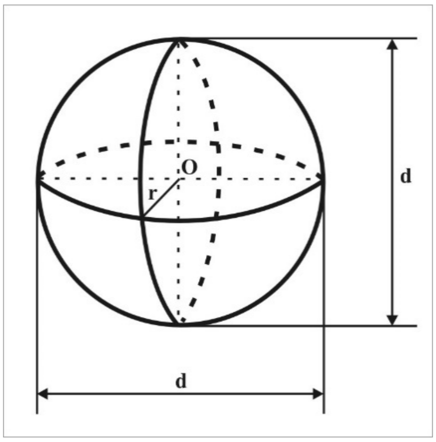
Supplementary Information

Materials and methods

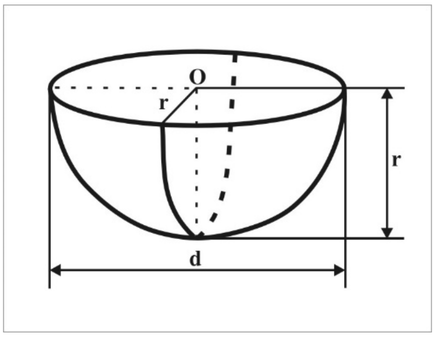
Calyx volume estimation

Measurements of calyces of holotypes of type species were taken in order to estimate their volumes. The measurements were made by using a caliper with a measuring error of 0.01 mm. The general volume of the calyx was approximated with standard volume calculations for different geometric solid following published methodology[1]. The calyx shape was classified into the following geometric figures: sphere (Supplementary Fig 1), hemisphere (Supplementary Fig 2), elongated spheroid (prolate) (Supplementary Fig 3), half of elongated spheroid (Supplementary Fig 4), flattened spheroid (oblate) (Supplementary Fig 5), half of flattened spheroid (Supplementary Fig 6), cone (Supplementary Fig 7), truncated cone (Supplementary Fig 8), cylinder (Supplementary Fig 9) and combine spherical solid figures (Supplementary Fig 10, 11). In addition, the calyxes of some type species display a slightly more complex shapes, such as a combination of the abovementioned solid figures, e.g., a truncated cone with a hemisphere or two truncated cones connected by a larger base. The following mathematical formulas were used to estimate the volume of calyxes displaying different shapes:

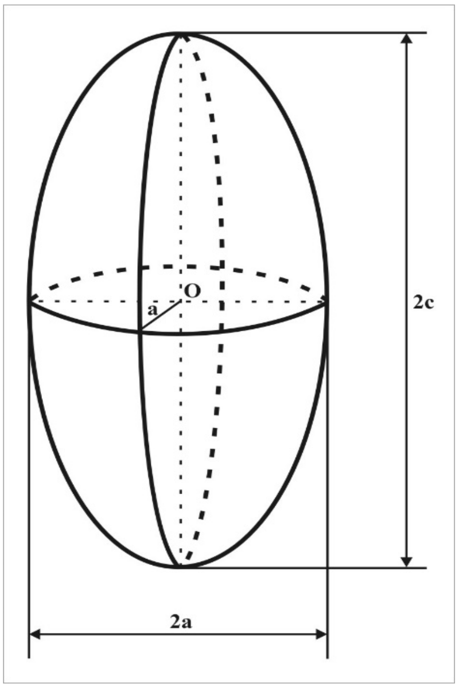
- sphere – $V = \frac{4}{3}\pi r^3$;
- hemisphere – $V = \frac{2}{3}\pi r^3$;
- elongated spheroid (prolate) – $V = \frac{4}{3}\pi a^2 c$;
- half of elongated spheroid – $V = \frac{2}{3}\pi a^2 c$;
- flattened spheroid (oblate) – $V = \frac{4}{3}\pi a^2 c$;
- half of flattened spheroid – $V = \frac{2}{3}\pi a^2 c$;
- cone – $V = \frac{1}{3}\pi r^2 h$;
- truncated cone – $V = \frac{1}{3}\pi h(R^2 + Rr + r^2)$;
- cylinder – $V = \pi r^2 h$.



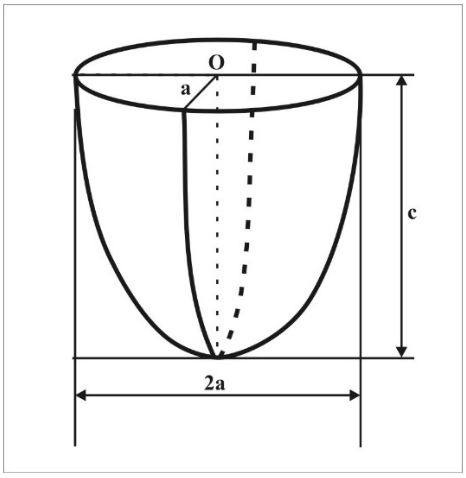
Supplementary Fig 1. Schematic drawing of sphere with marked sections, which are necessary to estimate the volume (r – radius, d – diameter).



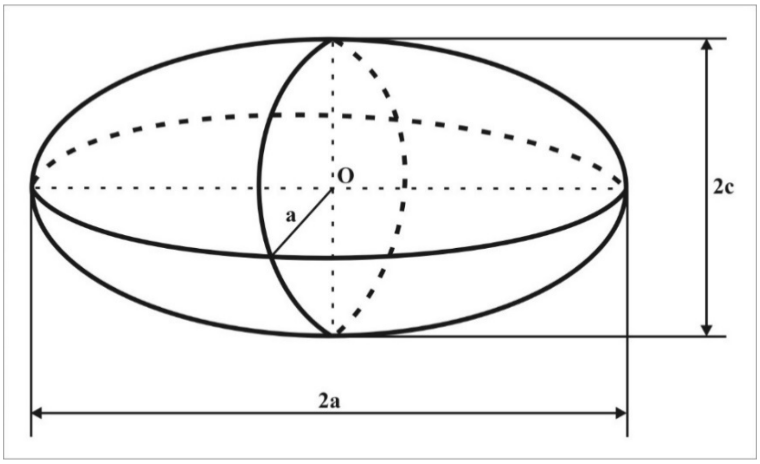
Supplementary Fig 2. Schematic drawing of hemisphere with marked sections, which are necessary to estimate the volume (r – radius, d – diameter).



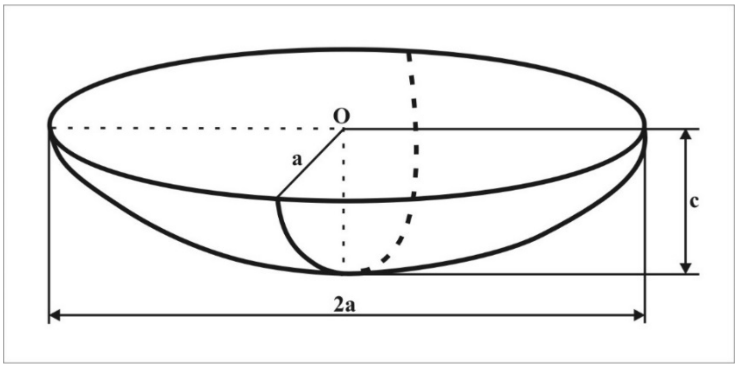
Supplementary Fig 3. Schematic drawing of elongated spheroid (prolate) with marked sections, which are necessary to estimate the volume (a – equatorial radius of the spheroid, c – distance from centre to pole along the symmetry axis).



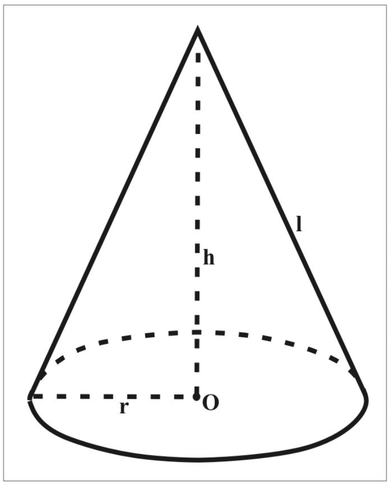
Supplementary Fig 4. Schematic drawing of half of elongated spheroid with marked sections, which are necessary to estimate the volume (a – equatorial radius of the spheroid, c – distance from centre to pole along the symmetry axis).



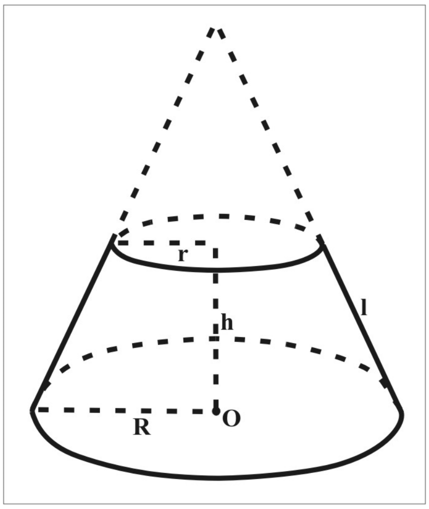
Supplementary Fig 5. Schematic drawing of flattened spheroid (oblate) with marked sections, which are necessary to estimate the volume (a – equatorial radius of the spheroid, c – distance from centre to pole along the symmetry axis).



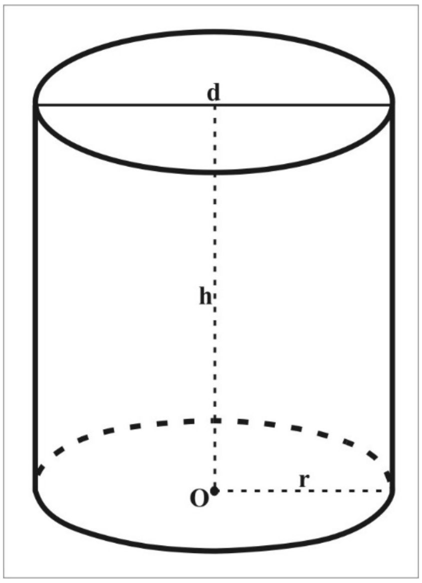
Supplementary Fig 6. Schematic drawing of half of flattened spheroid with marked sections, which are necessary to estimate the volume (a – equatorial radius of the spheroid, c – distance from centre to pole along the symmetry axis).



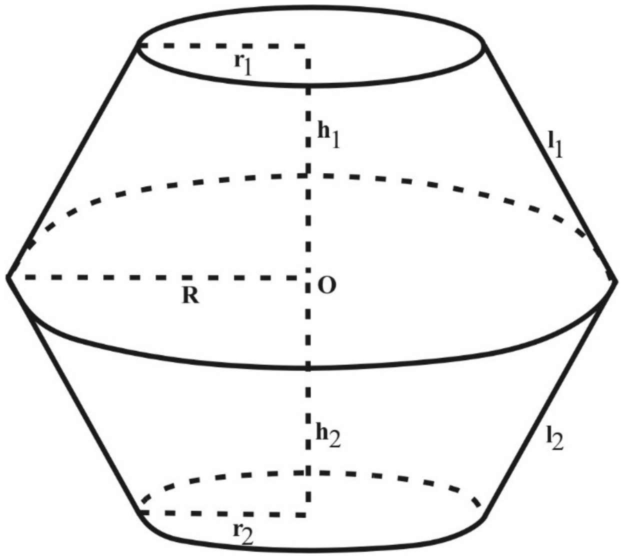
Supplementary Fig 7. Schematic drawing of cone with marked sections, which are necessary to estimate the volume (r – radius, h – height, l – slant height).



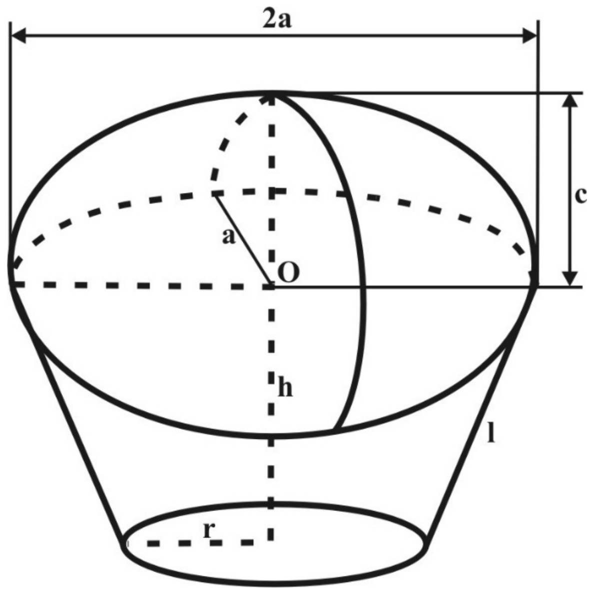
Supplementary Fig 8. Schematic drawing of truncated cone with marked sections, which are necessary to estimate the volume (r – smaller radius, R – bigger radius, h – height, l – slant height).



Supplementary Fig 9. Schematic drawing of cylinder with marked sections, which are necessary to estimate the volume (r – radius, d – diameter, h – height).



Supplementary Fig 10. Schematic drawing of combine spherical solid figures (two truncated cones connected by a larger base) with marked sections, which are necessary to estimate the volume (r_1, r_2 – smaller radii, R – bigger radius, h_1, h_2 – heights, l – slant heights).



Supplementary Fig 11. Schematic drawing of combine spherical solid figures truncated cone with a half of flattened spheroid) with marked sections, which are necessary to estimate the volume (r – smaller radius, R – bigger radius, h – height, l – slant height, a – equatorial radius of the spheroid, c – distance from centre to pole along the symmetry axis).

The measurements of calyces were mostly made from the Treatise on Invertebrate Paleontology[2]. However, when illustrations from the Treatise were insufficient to estimate the volume of calyx, we also used primary literature[3-23]. Measurements of recently described taxa were also taken from published source papers. Our dataset contains body sizes for 262

Frasnian-Visean crinoid genera (Supplementary Table 34). This dataset is estimated to contain 93,24% of all described crinoid genera from this interval (cf., the newest crinoid database[24]). Remaining named genera lack sufficient descriptions and/or figures.

Two different approaches were applied to analyze crinoid body trends. In the first approach, we used only one volume estimate for the entire stratigraphic range of a given genus[25]. This approach assumes that the size of the holotype of the type species is representative for the genus throughout its duration. Such an approach has been commonly used in paleontological literature and seems also valid at the scale of this study given that size variation among genera is greater than size variation within genera[25-27]. However, given that some crinoid genera may potentially display temporal size changes[28,29], we also applied a per-occurrence and per-genus approach in that we compared body sizes of the holotypes of the type species recorded from the Frasnian-Visean interval only (237 specimens), and treated all body size estimations as independent data points (i.e., without artificial extension of the calyx volume estimation of the type species throughout the entire stratigraphic range of the genus).

As noted above, crinoid body sizes were estimated from published figures of the holotypes of type species, which is considered an unbiased estimate of the median body size of species within a genus[30]. Although size measurements of figured specimens in monographs can be biased by a number of factors, the bias is very small and consistent across time and taxa, thus the inclusion of image-derived data in macroevolutionary studies is considered biologically meaningful[31]. Indeed our image-derived calyx volumes are essentially identical to those estimated from the real specimens of type species deposited in the Natural History Museum in Berlin (Germany) and the Natural History Museum in London (UK). However, the volumes obtained from the measurements of real specimens were not taken into account for statistical analysis because application of such a "mixed" approach in the same analysis may introduce bias[30].

Statistical analysis

All estimated calyx volumes were subjected to various statistical tests in the PAST software (PAleontological STatistics 3.18 version)[32]. The data were first transformed by Log_{10} to reduce the effects of allometry.

The first dataset comprising 262 volumes (with artificial extension of calyx volume for the entire stratigraphic range of a given genus) was subjected to normality tests (Shapiro-Wilk; significance level $\alpha = 0.05$) in order to determine whether a parametric or nonparametric test is appropriate. All four groups of volumes binned by stage did not exhibit normal distribution, therefore non-parametric tests were used for further analyses (Supplementary Table 1). Results of Mann-Whitney U-tests for pairwise stages with Bonferroni correction (significance level $\alpha = 0.05$) are presented in Supplementary Table 2.

Supplementary Table 1. Results of Shapiro-Wilk tests for calyx volumes of holotypes of type species binned to 4 stages in which given genera occurred (using a "range through approach"); N – number of data, *p*-value – probability value, * – indicates statistically significant result (*p*-value<0.05).

	N	***p*-value**
Frasnian	59	4.633E-14*
Famennian	67	3.91E-15*
Tournaisian	142	4.689E-21*
Visean	162	4.491E-17*

Supplementary Table 2. *p*-values obtained from U Mann-Whitney test for calyx volumes of holotypes of type species binned to 4 stages in which given genera occurred (using a "range through approach"); * – indicates statistically significant result (*p*-value<0.05).

	Frasnian	**Famennian**	**Tournaisian**	**Visean**
Frasnian	–	1	0.2335	0.04053*
Famennian		–	0.07611	0.01007*
Tournaisian			–	1
Visean				–

The same tests were applied to the second dataset comprising the estimated calyx volumes of holotypes of type species described from the Frasnian-Visean interval only, without artificial extension of the crinoid volume estimation of a given genus throughout its entire stratigraphic range ("per-occurrence approach"). The results of statistical analyses are presented in Supplementary Table 3 and 4.

Supplementary Table 3. Results of Shapiro-Wilk test for calyx volumes of holotypes of type species binned to 4 stages in which given type species was described (using a "per-occurrence approach"); N – number of data, *p*-value – probability value, * – indicates statistically significant result (*p*-value<0.05).

	N	***p*-value**
Frasnian	21	6.732E-05*
Famennian	13	8.001E-06*
Tournaisian	111	3.465E-19*
Visean	92	4.12E-12*

Supplementary Table 4. *p*-values obtained from U Mann-Whitney test for calyx volumes of holotypes of type species binned to 4 stages in which given type species was described (using a "per-occurrence approach"); * – indicates statistically significant result (*p*-value<0.05).

	Frasnian	**Famennian**	**Tournaisian**	**Visean**
Frasnian	–	1	0.03715*	0.0251*
Famennian		–	0.017*	0.0111*
Tournaisian			–	1
Visean				–

The same statistical procedures were repeated also at the lower taxonomic levels (i.e. between camerates (subclass Camerata = orders Diplobathrida and Monobathrida; Supplementary Table 5, 6) and pentacrinoids (subclass Pentacrinoidea = parvclass Disparida and parvclass Cladida; Supplementary Table 7, 8); between disparids (parvclass Disparida; Supplementary Table 9, 10) and cladides (parvclass Cladida = primitive and advanced cladids, Taxocrinida and Sagenocrinida; Supplementary Table 11, 12); and between eucladids (magnorder Eucladida = primitive and advanced cladids; Supplementary Table 13, 14) and flexibiles (superorder Flexibilia = order Taxocrinida and Sagenocrinida; Supplementary Table 15, 16)). In these analyses we only used a database comprising volumes of the holotypes of type species extended throughout the entire stratigraphic range of a given genus because it contains sufficient number of datapoints allowing statistical comparisons at a lower taxonomic level. Supplementary Table 17 summarizes all results obtained from U Mann-Whitney tests.

Supplementary Table 5. Shapiro-Wilk test results for calyx volumes of holotypes of type species of Camerata binned to 4 stages in which given genera occurred (using a "range through approach"); N – number of data, *p*-value – probability value, * – indicates statistically significant result (*p*-value<0.05).

	N	***p*-value**
Frasnian	19	1.622E-06*
Famennian	18	3.601E-06*
Tournaisian	57	2.818E-12*
Visean	44	0.0001645*

Supplementary Table 6. *p*-values obtained from U Mann-Whitney test adopted for calyx volumes of holotypes of type species of Camerata binned to 4 stages in which given genera occurred (using a "range through approach"); * – indicates statistically significant result (*p*-value<0.05).

	Frasnian	**Famennian**	**Tournaisian**	**Visean**
Frasnian	–	1	0.353	0.606
Famennian		–	1	1
Tournaisian			–	1
Visean				–

Supplementary Table 7. Shapiro-Wilk test results for calyx volumes of holotypes of type species of Pentacrinoidea binned to 4 stages in which given genera occurred (using a "range through approach"); N – number of data, *p*-value – probability value, * – indicates statistically significant result (*p*-value<0.05).

	N	***p*-value**
Frasnian	40	1.119E-12*
Famennian	49	3.504E-14*
Tournaisian	85	1.495E-16*
Visean	118	7.321E-17*

Supplementary Table 8. *p*-values obtained from U Mann-Whitney test adopted for calyx volumes of holotypes of type species of Pentacrinoidea binned to 4 stages in which given genera occurred (using a "range through approach"); * – indicates statistically significant result (*p*-value<0.05).

	Frasnian	**Famennian**	**Tournaisian**	**Visean**
Frasnian	–	1	1	0,02378*
Famennian		–	1	0.001889 *
Tournaisian			–	0,05014*
Visean				–

Supplementary Table 9. Shapiro-Wilk test results for calyx volumes of holotypes of type species of Disparida binned to 4 stages in which given genera occurred (using a "range through approach"); N – number of data, *p*-value – probability value, * – indicates statistically significant result (*p*-value<0.05).

	N	***p*-value**
Frasnian	6	2.945E-01*
Famennian	9	3.409E-02*
Tournaisian	8	1.149E-04*
Visean	10	1.384E-04*

Supplementary Table 10. *p*-values obtained from U Mann-Whitney test adopted for calyx volumes of holotypes of type species of Disparida binned to 4 stages in which given genera occurred (using a "range through approach"); * – indicates statistically significant result (*p*-value<0.05).

	Frasnian	**Famennian**	**Tournaisian**	**Visean**
Frasnian	–	1	1	1
Famennian		–	1	1
Tournaisian			–	1
Visean				–

Supplementary Table 11. Shapiro-Wilk test results for calyx volumes of holotypes of type species of Cladida binned to 4 stages in which given genera occurred (using a "range through approach"); N – number of data, *p*-value – probability value, * – indicates statistically significant result (*p*-value<0.05).

	N	***p*-value**
Frasnian	34	1.770E-11
Famennian	40	1.454E-12
Tournaisian	77	1.571E-15
Visean	107	9.605E-16

Supplementary Table 12. *p*-values obtained from U Mann-Whitney test adopted for calyx volumes of holotypes of type species of Cladida binned to 4 stages in which given genera occurred (using a "range through approach"); * – indicates statistically significant result (*p*-value<0.05).

	Frasnian	**Famennian**	**Tournaisian**	**Visean**
Frasnian	–	1	1	0.01909*
Famennian		–	1	0.00329*
Tournaisian			–	0.02932*
Visean				–

Supplementary Table 13. Shapiro-Wilk test results for calyx volumes of holotypes of type species of Eucladida binned to 4 stages in which given genera occurred (using a "range through approach"); N – number of data, *p*-value – probability value, * – indicates statistically significant result (*p*-value<0.05).

	N	***p*-value**
Frasnian	24	1,580E-06*
Famennian	32	3,321E-08*
Tournaisian	62	1,316E-12*
Visean	91	1,476E-12*

Supplementary Table 14. *p*-values obtained from U Mann-Whitney test adopted for calyx volumes of holotypes of type species of Eucladida binned to 4 stages in which given genera occurred (using a “range through approach”); * – indicates statistically significant result (*p*-value<0.05).

	Frasnian	**Famennian**	**Tournaisian**	**Visean**
Frasnian	–	1	1	0,006015*
Famennian		–	0,7768	0,0008316*
Tournaisian			–	0,02925*
Visean				–

Supplementary Table 15. Shapiro-Wilk test results for calyx volumes of holotypes of type species of Flexibilia binned to 4 stages in which given genera occurred (using a “range through approach”); N – number of data, *p*-value – probability value, * – indicates statistically significant result (*p*-value<0.05).

	N	***p*-value**
Frasnian	10	2.744E-06*
Famennian	8	3.076E-05*
Tournaisian	15	1.719E-05*
Visean	17	0.000237*

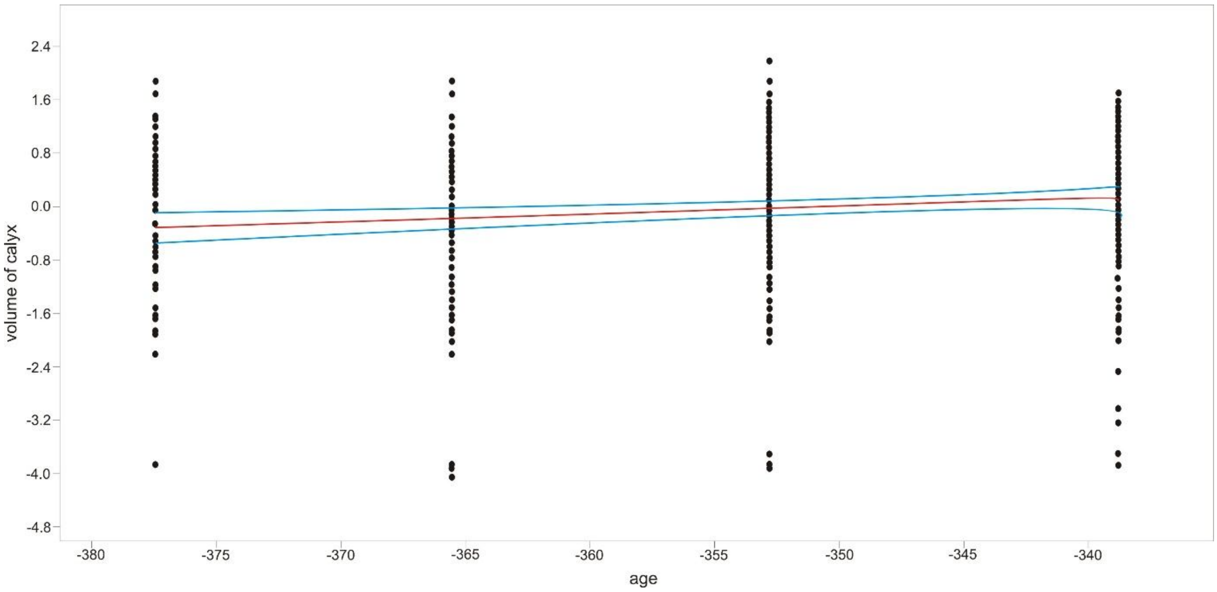
Supplementary Table 16. *p*-values obtained from U Mann-Whitney test adopted for calyx volumes of holotypes of type species of Flexibilia binned to 4 stages in which given genera occurred (using a “range through approach”); * – indicates statistically significant result (*p*-value<0.05).

	Frasnian	**Famennian**	**Tournaisian**	**Visean**
Frasnian	–	1	1	0.7526
Famennian		–	1	1
Tournaisian			–	1
Visean				–

Supplementary Table 17. Summary table showing *p*-values obtained from U Mann-Whitney tests; * – indicates statistically significant result (*p*-value<0.05).

	Frasnian-Famennian	Frasnian-Tournaisian	Frasnian-Visean	Famennian-Tournaisian	Famennian-Visean	Tournaisian-Visean
all crinoids (“range through approach”)	1	0.2335	0.04053*	0.07611	0.01007*	1
all crinoids (“per-occurrence approach”)	1	0.03715*	0.0251*	0.017*	0.0111*	1
Subclass Camerata (“range through approach”)	1	0.353	0.606	1	1	1
Subclass Pentacrinoidea (“range through approach”)	1	1	0.02378*	1	0.001889*	0.05014
Parvclass Disparida (“range through approach”)	1	1	1	1	1	1
Parvclass Cladida (“range through approach”)	1	1	0.01909*	1	0.00329*	0.02932*
Magnorder Eucladida (“range through approach”)	1	1	0.006015*	0.7768	0.0008316*	0.02925*
Superorder Flexibilla (“range through approach”)	1	1	1	0.7526	1	1

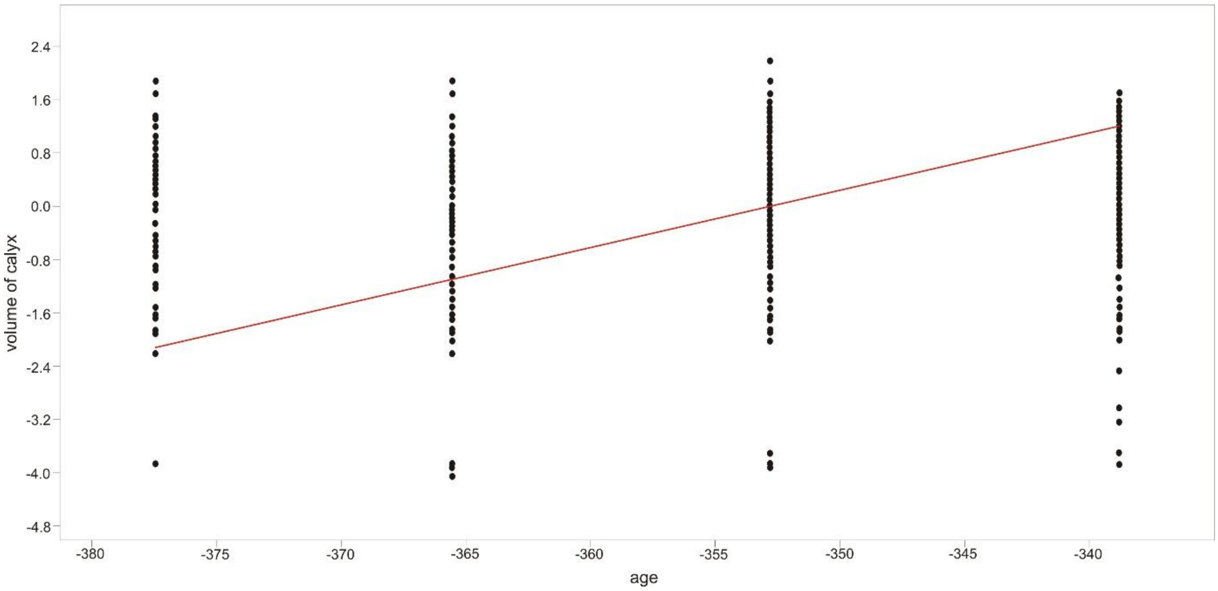
Linear regressions (Ordinary Least Squares (OLS) and Reduced Major Axis (RMA) were used to determine the significance and effect size of correlations between log-transformed volume of crinoid calyx and age (the midpoints of our time bins) (Supplementary Fig 12-27; Supplementary Tables 18-33). This was done for the overall dataset (using two approaches) and subsets (using the first approach).



Supplementary Fig 12. OLS regression: Late Devonian-Early Carboniferous Log volume/age. [holotypes of type species of all crinoids binned to 4 stages in which given genera occurred (using a "range through approach")].

Supplementary Table 18. OLS regression statistics: Late Devonian-Early Carboniferous sizes and age. [holotypes of type species of all crinoids binned to 4 stages in which given genera occurred (using a "range through approach")]. Confidence intervals from 1999 bootstrapped replicates. Body volume transformed by Log_{10}.

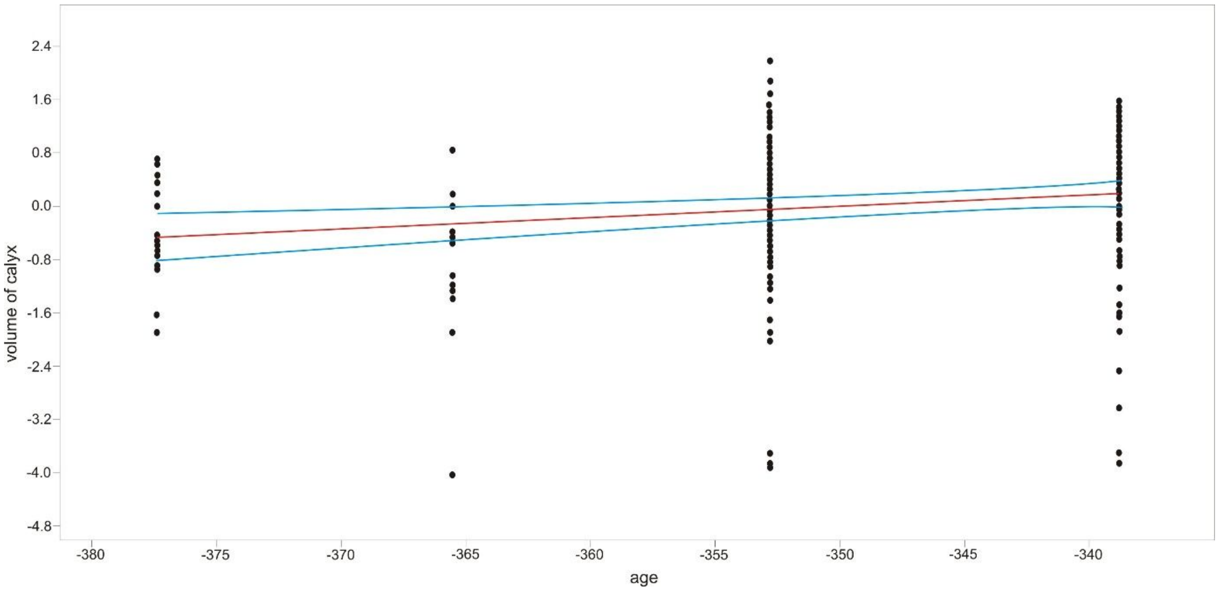
Slope *a*	0.011691	Std. error *a*	0.0040206
Intercept *b*	4.0878	Std. error *b*	1.4199
95% bootstrapped confidence intervals (N=1999)			
Slope *a*		(0.0038873, 0.019287)	
Intercept *b*		(1.3485, 6.7723)	
Correlation			
r		0.13918	
r^2		0.019371	
t		2.9077	
***p* (uncorr.)**		0.0038307	
permutation *p*		0.0048	



Supplementary Fig 13. RMA regression: Late Devonian-Early Carboniferous Log volume/age [holotypes of type species of all crinoids binned to 4 stages in which given genera occurred (using a "range through approach")].

Supplementary Table 19. RMA regression statistics: Late Devonian-Early Carboniferous sizes and age. [holotypes of type species of all crinoids binned to 4 stages in which given genera occurred (using a "range through approach")]. Confidence intervals from 1999 bootstrapped replicates. Body volume transformed by Log_{10}.

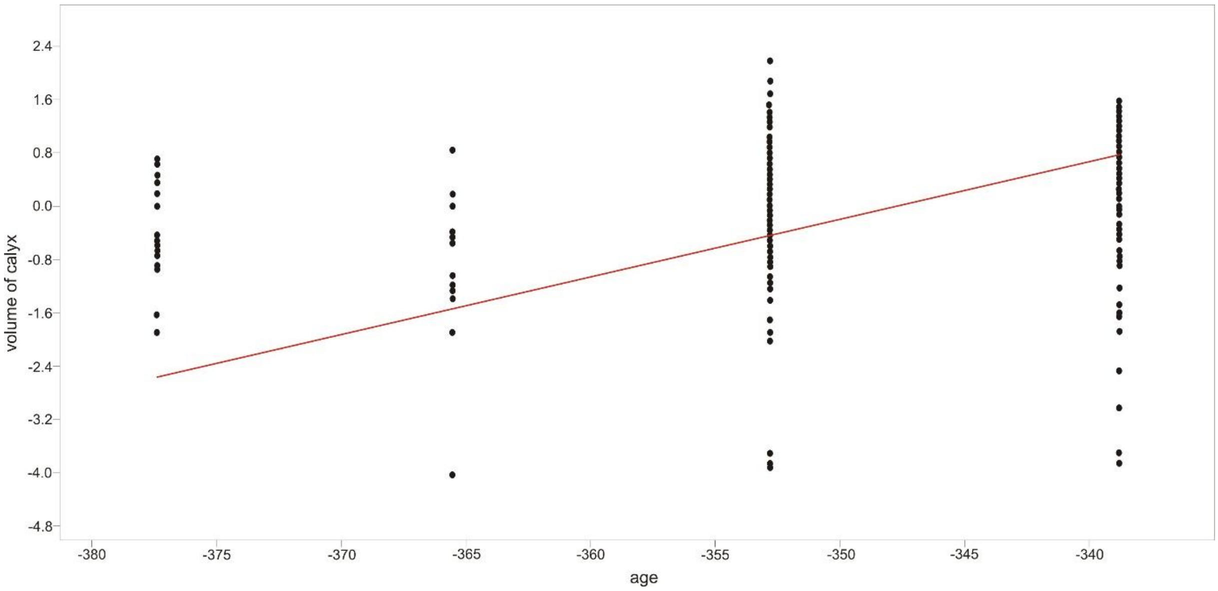
Slope *a*	0.083996	Std. error *a*	0.0040206
Intercept *b*	29.604	Std. error *b*	2.0183
95% bootstrapped confidence intervals (N=1999)			
Slope *a*		(0.075421, 0.092924)	
Intercept *b*		(26.645, 32.681)	
Correlation			
r		0.13918	
***r*²**		0.019371	
t		2.9077	
***p* (uncorr.)**		0.0038307	
permutation *p*		0.0039	



Supplementary Fig 14. OLS regression: Late Devonian-Early Carboniferous Log volume/age. [holotypes of type species of all crinoids binned to 4 stages in which given genera occurred (using a "per-occurrence approach")].

Supplementary Table 20. OLS regression statistics: Late Devonian-Early Carboniferous sizes and age. [holotypes of type species of all crinoids binned to 4 stages in which given genera occurred (using a "per-occurrence approach")]. Confidence intervals from 1999 bootstrapped replicates. Body volume transformed by Log_{10}.

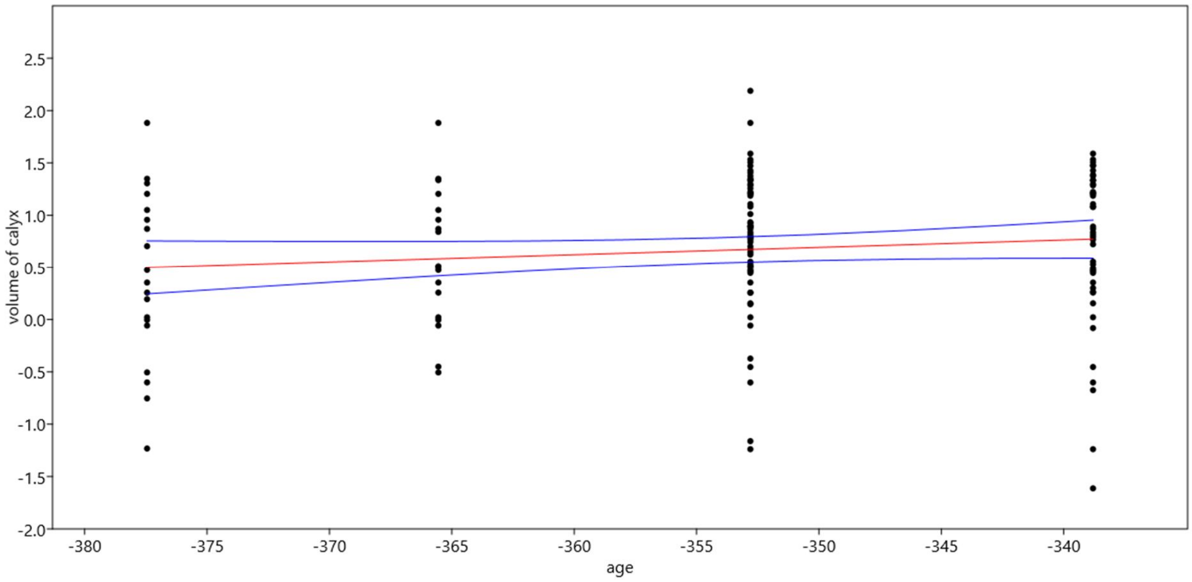
Slope *a*	0.017155	Std. error *a*	0.0061147
Intercept *b*	5.9986	Std. error *b*	2.1425
95% bootstrapped confidence intervals (N=1999)			
Slope *a*		(0.0063861, 0.027277)	
Intercept *b*		(2.238, 9.5898)	
Correlation			
r		0.18002	
***r*²**		0.032407	
t		2.8055	
***p* (uncorr.)**		0.0054447	
permutation *p*		0.0061	



Supplementary Fig 15. RMA regression: Late Devonian-Early Carboniferous Log volume/age. [holotypes of type species of all crinoids binned to 4 stages in which given genera occurred (using a "per-occurrence approach")].

Supplementary Table 21 – RMA regression statistics: Late Devonian-Early Carboniferous sizes and age. [holotypes of type species of all crinoids binned to 4 stages in which given genera occurred (using a "per-occurrence approach")]. Confidence intervals from 1999 bootstrapped replicates. Body volume transformed by Log_{10}.

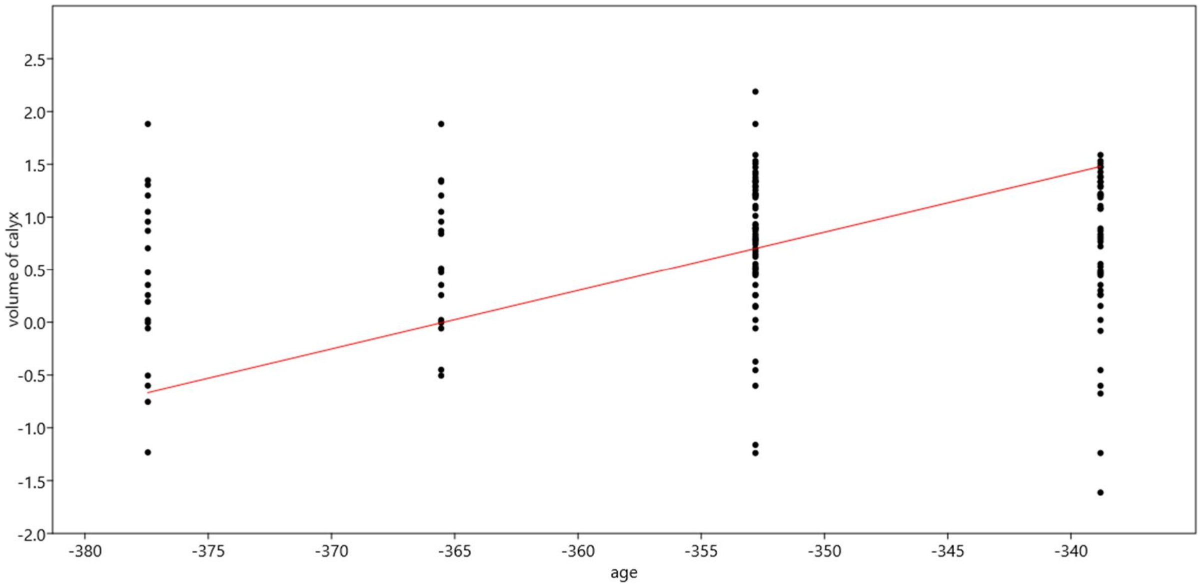
Slope *a*	0.095294	Std. error *a*	0.0061147
Intercept *b*	33.362	Std. error *b*	4.5936
95% bootstrapped confidence intervals (N=1999)			
Slope *a*		(0.078699, 0.10995)	
Intercept *b*		(27.683, 38.415)	
Correlation			
r		0.18002	
r^2		0.032407	
t		2.8055	
***p* (uncorr.)**		0.0054447	
permutation *p*		0.0058	



Supplementary Fig 16. OLS regression: Late Devonian-Early Carboniferous Log volume/age. [holotypes of type species of camerates binned to 4 stages in which given genera occurred using a "range through approach")].

Supplementary Table 22. OLS regression statistics: Late Devonian-Early Carboniferous sizes and age. [holotypes of type species of camerates binned to 4 stages in which given genera occurred using a "range through approach")]. Confidence intervals from 1999 bootstrapped replicates. Body volume transformed by Log_{10}.

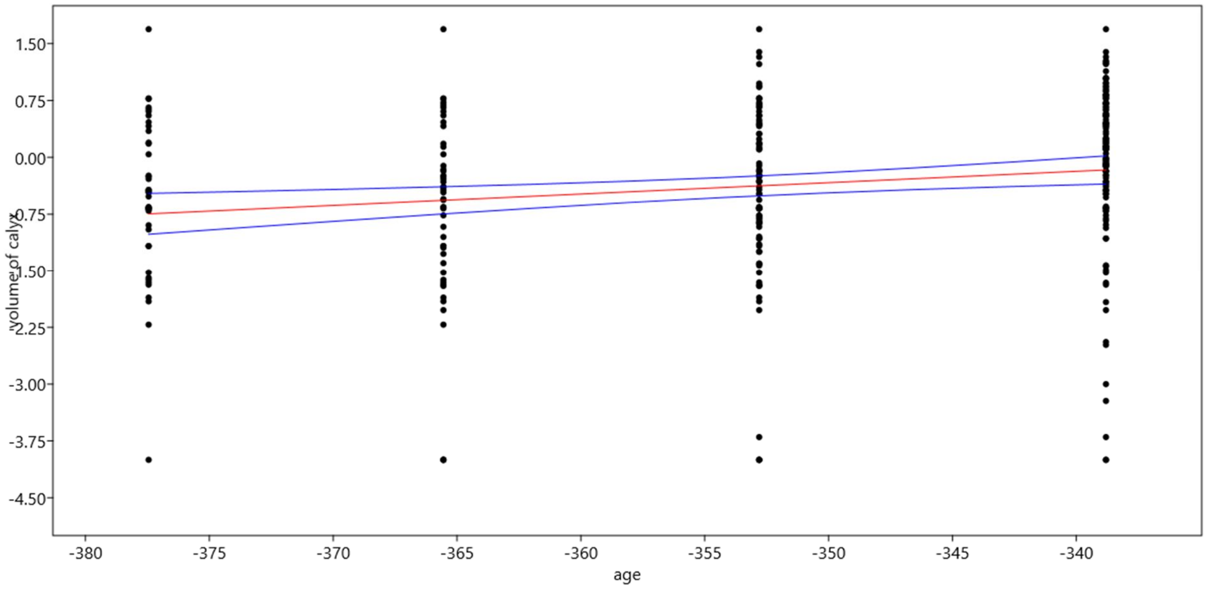
Slope *a*	0.0070326	Std. error *a*	0.0047207
Intercept *b*	3.1546	Std. error *b*	1.6694
95% bootstrapped confidence intervals (N=1999)			
Slope *a*		(-0.0030099, 0.016932)	
Intercept *b*		(-0.37364, 6.6729)	
Correlation			
r		0.12671	
***r*²**		0.016056	
t		1.4897	
***p* (uncorr.)**		0.13861	
permutation *p*		0.1375	



Supplementary Fig 17. RMA regression: Late Devonian-Early Carboniferous Log volume/age. [holotypes of type species of camerates binned to 4 stages in which given genera occurred using a "range through approach")].

Supplementary Table 23. RMA regression statistics: Late Devonian-Early Carboniferous sizes and age. [holotypes of type species of camerates binned to 4 stages in which given genera occurred using a "range through approach")]. Confidence intervals from 1999 bootstrapped replicates. Body volume transformed by Log_{10}.

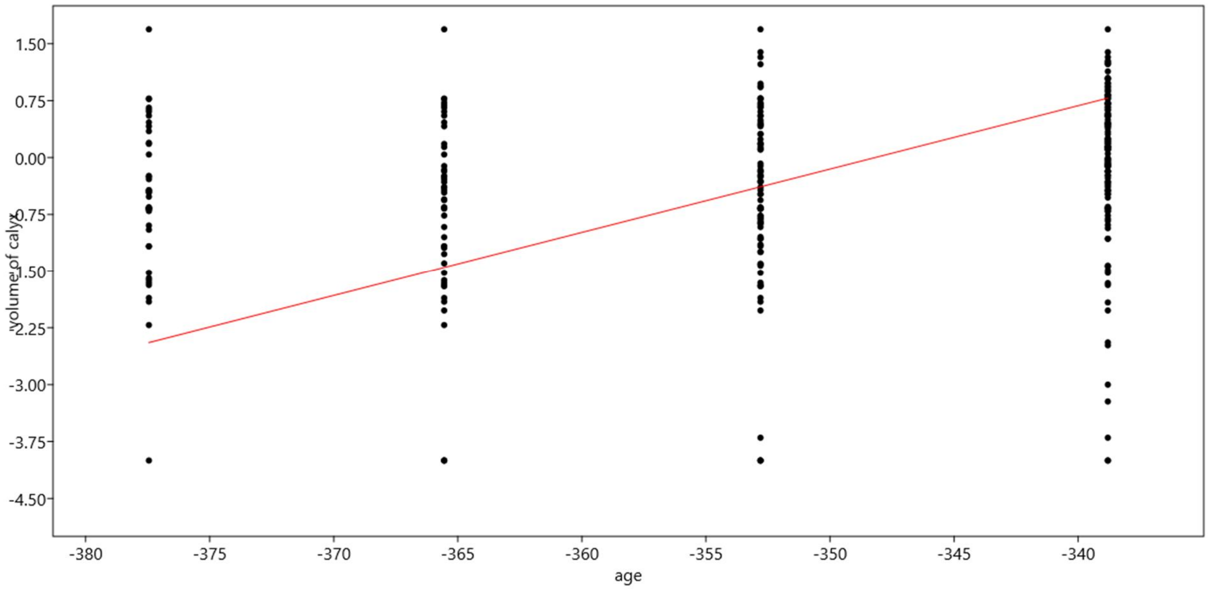
Slope *a*	0.0555	Std. error *a*	0.0047207
Intercept *b*	20.283	Std. error *b*	2.7897
95% bootstrapped confidence intervals (N=1999)			
Slope *a*		(0.046865, 0.17152)	
Intercept *b*		(17.278, 61.199)	
Correlation			
r		0.12671	
***r*²**		0.016056	
t		1.4897	
***p* (uncorr.)**		0.13861	
permutation *p*		0.1394	



Supplementary Fig 18. OLS regression: Late Devonian-Early Carboniferous Log volume/age. [holotypes of type species of Pentacrinoidea binned to 4 stages in which given genera occurred using a "range through approach")].

Supplementary Table 24. OLS regression statistics: Late Devonian-Early Carboniferous sizes and age. [holotypes of type species of Pentacrinoidea binned to 4 stages in which given genera occurred using a "range through approach")]. Confidence intervals from 1999 bootstrapped replicates. Body volume transformed by Log_{10}.

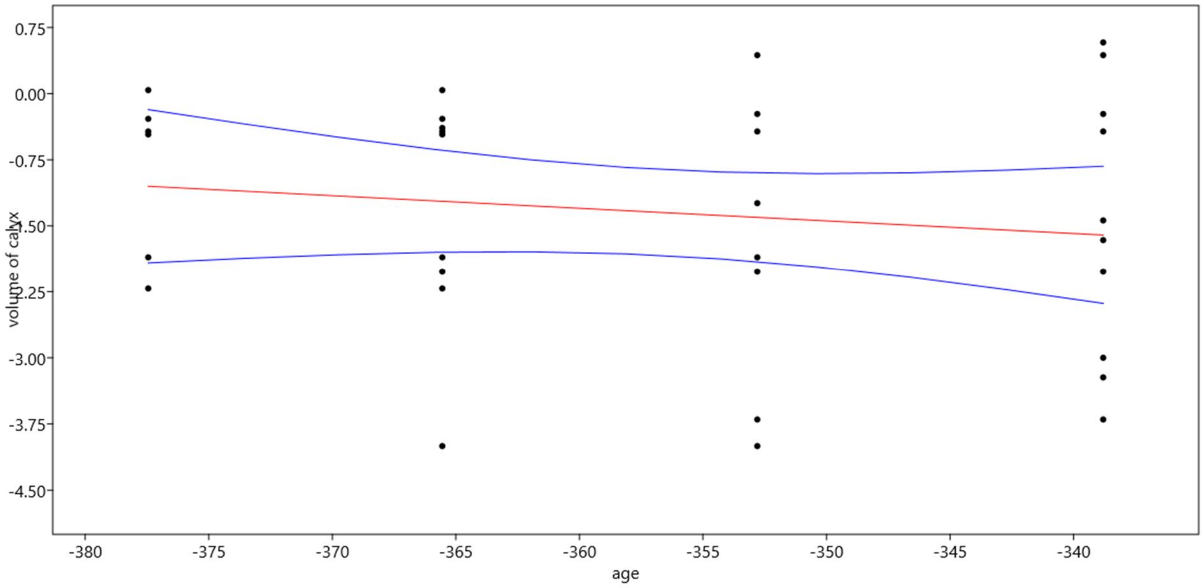
Slope *a*	0.01498	Std. error *a*	0.0048262
Intercept *b*	4.9088	Std. error *b*	1.7033
95% bootstrapped confidence intervals (N=1999)			
Slope *a*		(0.0056851, 0.024094)	
Intercept *b*		(1.5918, 8.1007)	
Correlation			
r		0.17933	
***r*²**		0.03216	
t		3.1041	
***p* (uncorr.)**		0.0021	
permutation *p*		0.002	



Supplementary Fig 19. RMA regression: Late Devonian-Early Carboniferous Log volume/age. [holotypes of type species of Pentacrinoidea binned to 4 stages in which given genera occurred using a "range through approach")].

Supplementary Table 25. RMA regression statistics: Late Devonian-Early Carboniferous sizes and age. [holotypes of type species of Pentacrinoidea binned to 4 stages in which given genera occurred using a "range through approach")]. Confidence intervals from 1999 bootstrapped replicates. Body volume transformed by Log_{10}.

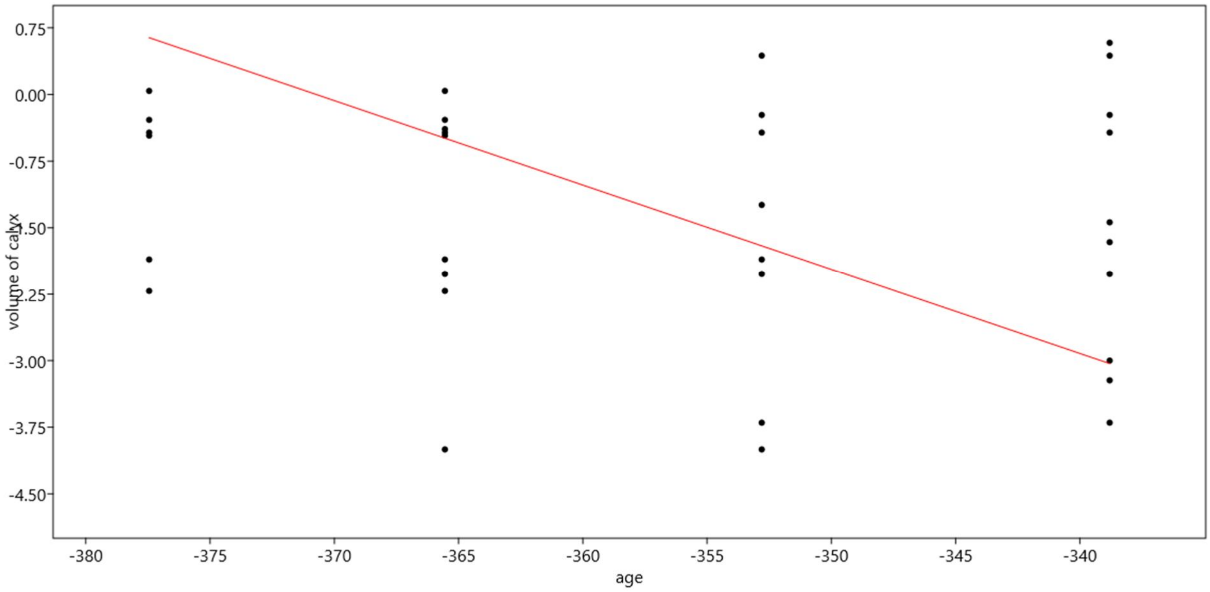
Slope *a*	0.08354	Std. error *a*	0.0048262
Intercept *b*	29.087	Std. error *b*	2.9043
95% bootstrapped confidence intervals (N=1999)			
Slope *a*		(0.072493, 0.093534)	
Intercept *b*		(25.293, 32.504)	
Correlation			
r		0.17933	
***r*²**		0.03216	
t		3.1041	
***p* (uncorr.)**		0.0021	
permutation *p*		0.0021	



Supplementary Fig 20. OLS regression: Late Devonian-Early Carboniferous Log volume/age. [holotypes of type species of disparids binned to 4 stages in which given genera occurred using a "range through approach")].

Supplementary Table 26. OLS regression statistics: Late Devonian-Early Carboniferous sizes and age. [holotypes of type species of disparids binned to 4 stages in which given genera occurred using a "range through approach")]. Confidence intervals from 1999 bootstrapped replicates. Body volume transformed by Log_{10}.

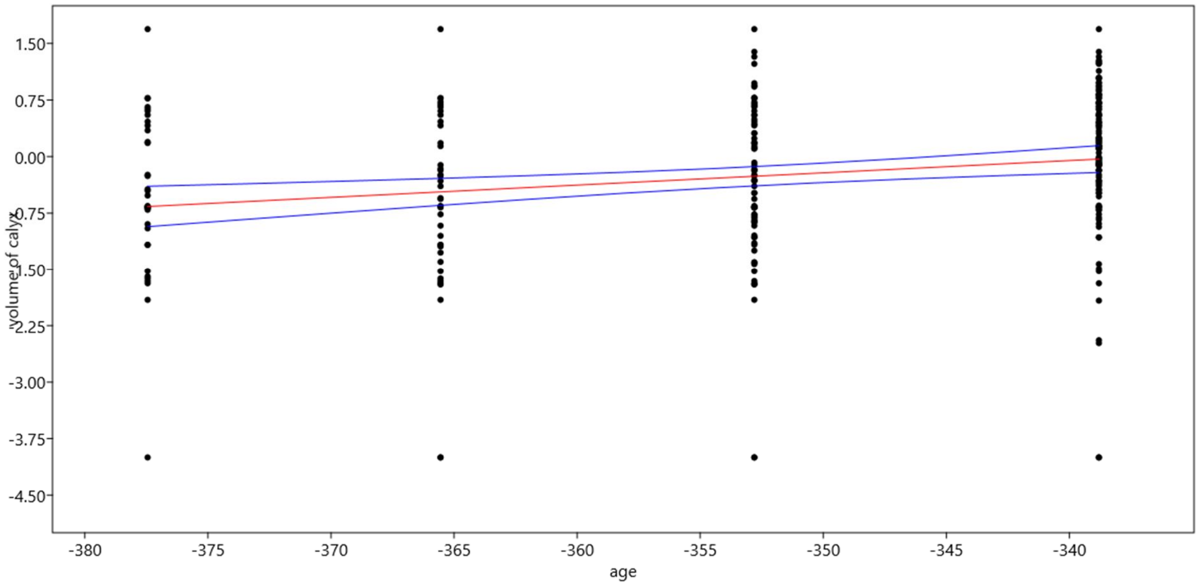
Slope *a*	-0.014312	Std. error *a*	0.01687
Intercept *b*	-6.4524	Std. error *b*	6.0191
95% bootstrapped confidence intervals (N=1999)			
Slope *a*		(-0.045549, 0.017944)	
Intercept *b*		(-17.586, 5.0763)	
Correlation			
r		-0.15063	
***r*²**		0.02269	
t		-0.84836	
***p* (uncorr.)**		0.40274	
permutation *p*		0.4088	



Supplementary Fig 21. RMA regression: Late Devonian-Early Carboniferous Log volume/age. [holotypes of type species of disparids binned to 4 stages in which given genera occurred using a "range through approach")].

Supplementary Table 27. RMA regression statistics: Late Devonian-Early Carboniferous sizes and age. [holotypes of type species of disparids binned to 4 stages in which given genera occurred using a "range through approach")]. Confidence intervals from 1999 bootstrapped replicates. Body volume transformed by Log_{10}.

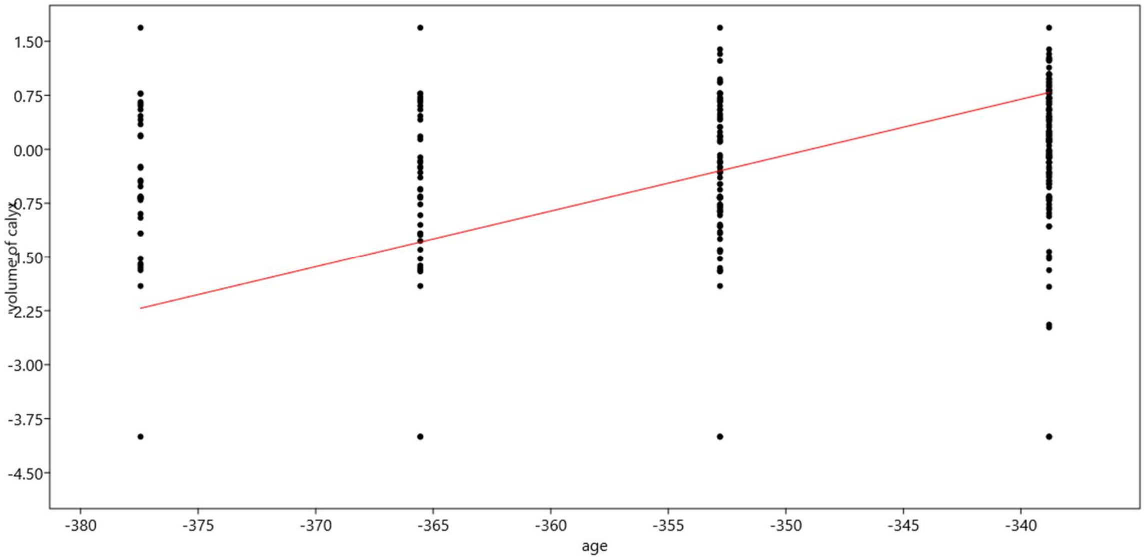
Slope *a*	-0.095011	Std. error *a*	0.01687
Intercept *b*	-35.223	Std. error *b*	36.269
95% bootstrapped confidence intervals (N=1999)			
Slope *a*		(-0.29857, -0.071233)	
Intercept *b*		(-107.61, -26.423)	
Correlation			
r		-0.15063	
***r*²**		0.02269	
t		-0.84836	
***p* (uncorr.)**		0.40274	
permutation *p*		0.407	



Supplementary Fig 22. OLS regression: Late Devonian-Early Carboniferous Log volume/age. [holotypes of type species of cladids binned to 4 stages in which given genera occurred using a "range through approach")].

Supplementary Table 28. OLS regression statistics: Late Devonian-Early Carboniferous sizes and age. [holotypes of type species of cladids binned to 4 stages in which given genera occurred using a "range through approach")]. Confidence intervals from 1999 bootstrapped replicates. Body volume transformed by Log_{10}.

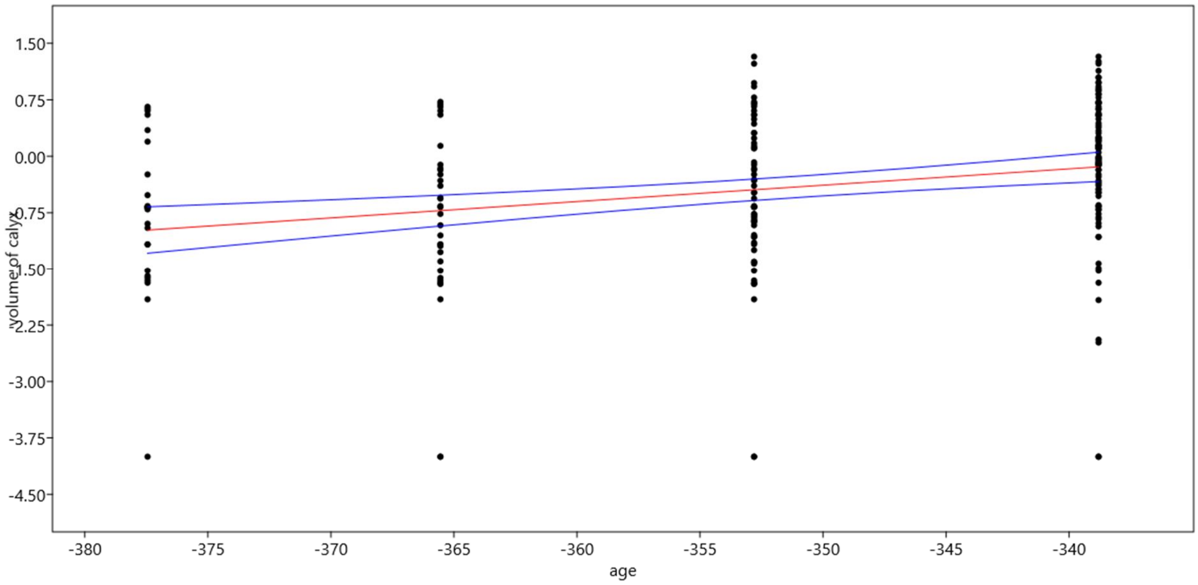
Slope *a*	0.016266	Std. error *a*	0.0047422
Intercept *b*	5.4783	Std. error *b*	1.6713
95% bootstrapped confidence intervals (N=1999)			
Slope *a*		(0.0069746, 0.025095)	
Intercept *b*		(2.1542, 8.5927)	
Correlation			
r		0.20923	
r^2		0.043776	
t		3.4301	
***p* (uncorr.)**		0.00070282	
permutation *p*		0.0008	



Supplementary Fig 23. RMA regression: Late Devonian-Early Carboniferous Log volume/age. [holotypes of type species of cladids binned to 4 stages in which given genera occurred using a "range through approach")].

Supplementary Table 29. RMA regression statistics: Late Devonian-Early Carboniferous sizes and age. [holotypes of type species of cladids binned to 4 stages in which given genera occurred using a "range through approach")]. Confidence intervals from 1999 bootstrapped replicates. Body volume transformed by Log_{10}.

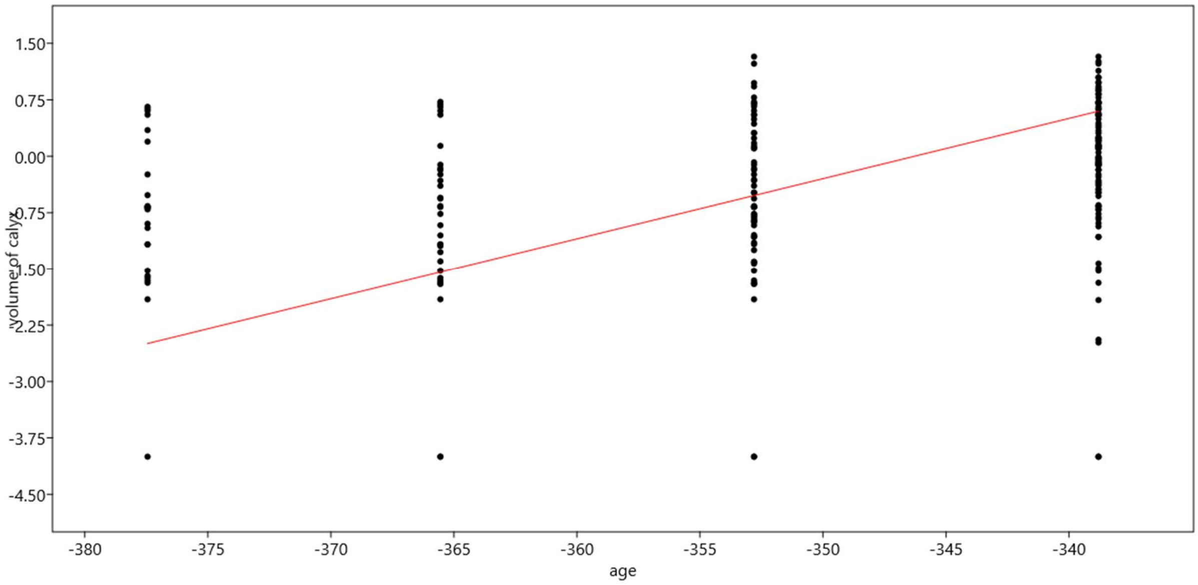
Slope *a*	0.077744	Std. error *a*	0.0047422
Intercept *b*	27.129	Std. error *b*	2.796
95% bootstrapped confidence intervals (N=1999)			
Slope *a*		(0.066109, 0.088737)	
Intercept *b*		(23.101, 30.917)	
Correlation			
r		0.20923	
***r*²**		0.043776	
t		3.4301	
***p* (uncorr.)**		0.00070282	
permutation *p*		0.0009	



Supplementary Fig 24. OLS regression: Late Devonian-Early Carboniferous Log volume/age. [holotypes of type species of eucladids binned to 4 stages in which given genera occurred using a "range through approach")].

Supplementary Table 30. OLS regression statistics: Late Devonian-Early Carboniferous sizes and age. [holotypes of type species of eucladids binned to 4 stages in which given genera occurred using a "range through approach")]. Confidence intervals from 1999 bootstrapped replicates. Body volume transformed by Log_{10}.

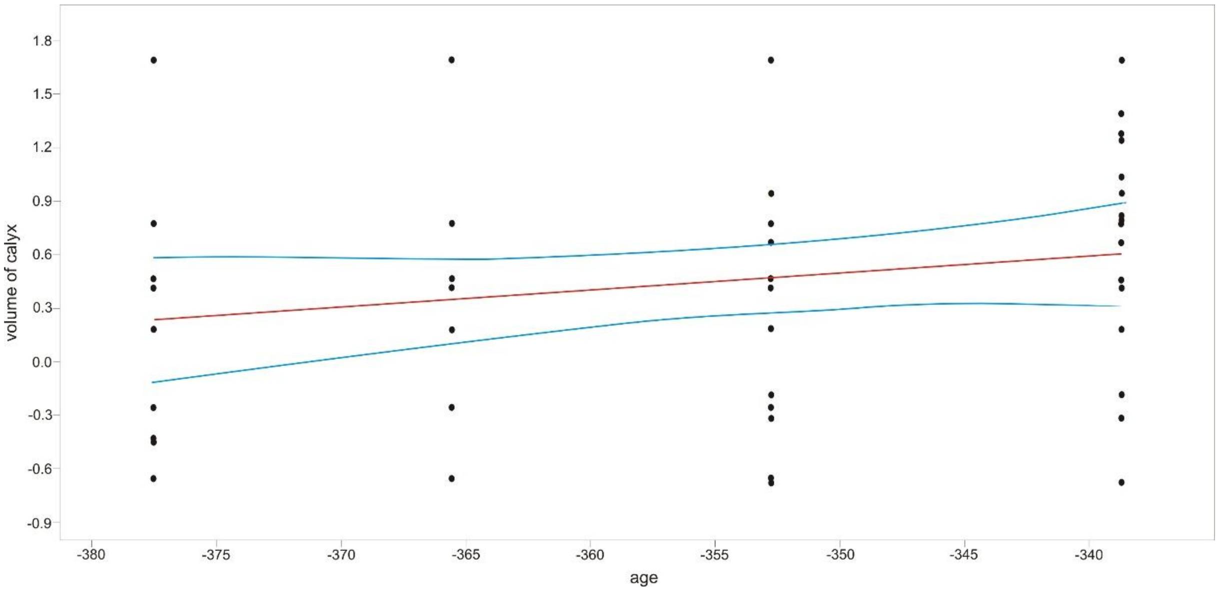
Slope *a*	0.02171	Std. error *a*	0.0053557
Intercept *b*	7.2158	Std. error *b*	1.8838
95% bootstrapped confidence intervals (N=1999)			
Slope *a*		(0.011369, 0.032023)	
Intercept *b*		(3.605, 10.812)	
Correlation			
r		0.27123	
***r*²**		0.07357	
t		4.0544	
***p* (uncorr.)**		7.12E-05	
permutation *p*		0.0001	



Supplementary Fig 25. RMA regression: Late Devonian-Early Carboniferous Log volume/age. [holotypes of type species of eucladids binned to 4 stages in which given genera occurred using a "range through approach")].

Supplementary Table 31. RMA regression statistics: Late Devonian-Early Carboniferous sizes and age. [holotypes of type species of eucladids binned to 4 stages in which given genera occurred using a "range through approach")]. Confidence intervals from 1999 bootstrapped replicates. Body volume transformed by Log_{10}.

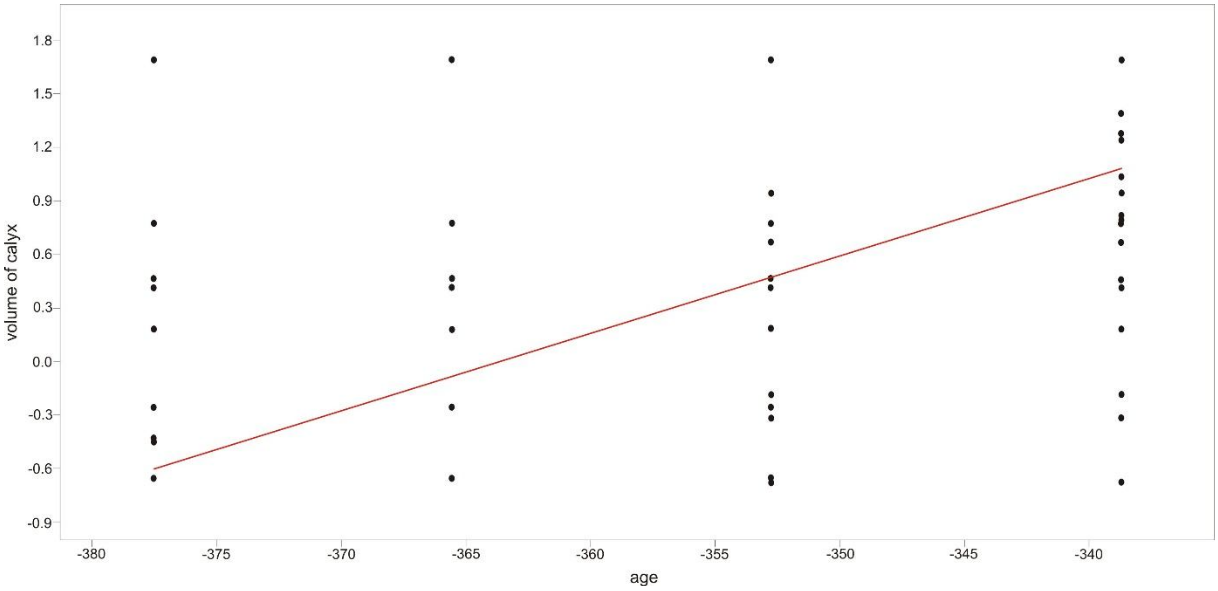
Slope *a*	0.08006	Std. error *a*	0.0053557
Intercept *b*	27.722	Std. error *b*	3.5516
95% bootstrapped confidence intervals (N=1999)			
Slope *a*		(0.066927, 0.092146)	
Intercept *b*		(23.262, 31.901)	
Correlation			
r		0.27123	
***r*²**		0.07357	
t		4.0544	
***p* (uncorr.)**		7.12E-05	
permutation *p*		0.0001	



Supplementary Fig 26. OLS regression: Late Devonian-Early Carboniferous Log volume/age. [holotypes of type species of flexibles binned to 4 stages in which given genera occurred using a "range through approach")].

Supplementary Table 32. OLS regression statistics: Late Devonian-Early Carboniferous sizes and age. [holotypes of type species of flexibles binned to 4 stages in which given genera occurred using a "range through approach")]. Confidence intervals from 1999 bootstrapped replicates. Body volume transformed by Log_{10}.

Slope *a*	0.0093414	Std. error *a*	0.0065986
Intercept *b*	3.7609	Std. error *b*	2.3445
95% bootstrapped confidence intervals (N=1999)			
Slope *a*		(-0.0029071, 0.023064)	
Intercept *b*		(-0.57234, 8.6067)	
Correlation			
r		0.2002	
***r*²**		0.040079	
t		1.4157	
***p* (uncorr.)**		0.16333	
permutation *p*		0.1704	



Supplementary Fig 27. RMA regression: Late Devonian-Early Carboniferous Log volume/age. [holotypes of type species of flexibles binned to 4 stages in which given genera occurred using a "range through approach")].

Supplementary Table 33. RMA regression statistics: Late Devonian-Early Carboniferous sizes and age. [holotypes of type species of flexibles binned to 4 stages in which given genera occurred using a "range through approach")]. Confidence intervals from 1999 bootstrapped replicates. Body volume transformed by Log_{10}.

Slope *a*	0.046661	Std. error *a*	0.0065986
Intercept *b*	17.01	Std. error *b*	5.5025
95% bootstrapped confidence intervals (N=1999)			
Slope *a*		(0.036963, 0.1434)	
Intercept *b*		(13.669, 51.303)	
Correlation			
r		0.2002	
r^2		0.040079	
t		1.4157	
***p* (uncorr.)**		0.16333	
permutation *p*		0.1658	

Supplementary Table 34. Database comprising estimated volumes of calyces of analyzed crinoid genera.

No.	Genus	Genus range	Type species	Type species age	Estimated volume
	Cl. Crinoidea				
	Subclass Camerata				
	Or. Diplobathrida				
1	*Cribanocrinus*	Tournaisian-Visean	*Rhodocrinus wortheni*	Tournaisian	2.7902
2	*Gilbertsocrinus*	Givetian-Visean	*Gilbertsocrinus calcaratus*	Tournaisian	7.4129
3	*Pterinocrinus*	Emsian-Frasnian	*Pterinocrinus quinquenodus*	Frasnian	0.2508
4	*Rhipidocrinus*	Eifelian-Famennian	*Rhodocrinites crenatus*	Givetian	9.0582
5	*Rhodocrinites*	Pragian-Serpukhovian	*Rhodocrinites verus*	Tournaisian	2.9821
	Or. Monobathrida				
6	*Aacocrinus*	Tournaisian-Bashkirian	*Aacocrinus nododorsatus*	Tournaisian	3.6024
7	*Abactinocrinus*	Famennian-Tournaisian	*Abactinocrinus rossei*	Tournaisian	3.2495
8	*Abatocrinus*	Tournaisian-Visean	*Actinocrinus turbinatus*	Tournaisian	5.8605
9	*Acrocrinus*	Visean-Serpukhovian	*Acrocrinus shumardi*	Visean	30.1075
10	*Actinocrinites*	Tournaisian-Artinskian	*Actinocrinites triacontadactylus*	Tournaisian	16.7059
11	*Agaricocrinus*	Tournaisian-Visean	*Agaricocrinus tuberosus*	Tournaisian-Visean	19.8313
12	*Agathocrinus*	Emsian-Famennian	*Agathocrinus globosus*	Frasnian-Famennian	0.9903
13	*Alloprosallocrinus*	Visean	*Alloprosallocrinus conicus*	Visean	5.2840
14	*Amphoracrinus*	Tournaisian-Visean	*Actinocrinus gilbertsoni*	Tournaisian	21.5273
15	*Amphoracrocrinus*	Visean-Serpukhovian	*Acrocrinus amphora*	Serpukhovian	1.9965
16	*Ancalocrinus*	Tournaisian	*Actinocrinus spinobrachiatus*	Tournaisian	4.7383
17	*Aorocrinus*	Givetian-Visean	*Dorycrinus immaturus*	Tournaisian	1.0500
18	*Arthroacantha*	Emsian-Frasnian	*Arthroacantha ithacensis*	Frasnian	1.5635
19	*Aryballocrinus*	Tournaisian-Visean	*Actinocrinus (Megistocrinus) whitei*	Tournaisian	32.1204
20	*Athabascacrinus*	Famennian-Tournaisian	*Athabascacrinus colemanensis*	Tournaisian	3.1745
21	*Azygocrinus*	Tournaisian	*Actinocrinus dodecadactylus*	Tournaisian	1.8027

22	*Batocrinus*	Visean	*Batocrinus icosidactylus*	Visean	11.9863
23	*Blairocrinus*	Tournaisian	*Blairocrinus trijugis*	Tournaisian	1.4003
24	*Brahmacrinus*	Tournaisian-Visean	*Brahmacrinus ponderosus*	Tournaisian	16.2723
25	*Cactocrinus*	Tournaisian	*Actinocrinus proboscidialis*	Tournaisian	10.2774
26	*Camptocrinus*	Visean-Artinskian	*Camptocrinus myelodactylus*	Visean	0.0244
27	*Cantharocrinus*	Emsian-Famennian	*Cantharocrinus minor*	Emsian	0.3124
28	*Cerasmocrinus*	Frasnian	*Cerasmocrinus springeri*	Frasnian	5.0667
29	*Chinacrinus*	Famennian	*Chinacrinus xinjiangensis*	Famennian	0.3548
30	*Coelocrinus*	Tournaisian	*Actinocrinus concavus*	Tournaisian	0.4236
31	*Ctenocrinus*	Wenlock-Frasnian	*Ctenocrinus typus*	Ludlovian	20.1838
32	*Cusacrinus*	Tournaisian	*Actinocrinus nodobrachiatus*	Tournaisian	4.2129
33	*Cytidocrinus*	Tournaisian	*Actinocrinus sculptus*	Tournaisian	154.1682
34	*Dialutocrinus*	Tournaisian	*Dialutocrinus milleri*	Tournaisian	7.7995
35	*Dichocrinus*	Tournaisian-Wordian	*Dichocrinus radiatus*	Tournaisian	3.3929
36	*Dilatocrinus*	Tournaisian	*Amphoracrinus multiramosus*	Tournaisian	8.5870
37	*Dizygocrinus*	Tournaisian-Visean	*Actinocrinus indianaensis*	Visean	2.8927
38	*Dorycrinus*	Tournaisian-Visean	*Dorycrinus mississippiensis*	Visean	26.7778
39	*Ectocrinus*	Tournaisian-Serpukhovian	*Actinocrinus olla*	Visean	38.7924
40	*Eretmocrinus*	Tournaisian-Moscovian	*Eretmocrinus magnificus*	Visean	12.0957
41	*Eumorphocrinus*	Tournaisian-Visean	*Eumorphocrinus erectus*	Visean	15.3659
42	*Eutrochocrinus*	Tournaisian-Visean	*Actinocrinus christyi*	Visean	23.7337
43	*Gennaeocrinus*	Givetian-Famennian	*Actinocrinus kentuckiensis*	Givetian	11.2246
44	*Glaphyrocrinus*	Tournaisian-Visean	*Glaphyrocrinus expansus*	Visean	29.6485
45	*Globocrinus*	Visean-Serpukhovian	*Batocrinus unionensis*	Visean	3.0979
46	*Hexacrinites*	Ludlovian-Tournaisian	*Platycrinus interscapularis*	Givetian	22.3290
47	*Hyrtanecrinus*	Visean-Serpukhovian	*Hyrtanecrinus diabolus*	Visean	0.2115
48	*Ilmocrinus*	Visean-Serpukhovian	*Ilmocrinus dissymmetricus*	Serpukhovian	24.3368
49	*Iotacrinus*	Tournaisian	*Iotacrinus dorsatus*	Tournaisian	4.4452
50	*Lenneocrinus*	Emsian-Frasnian	*Lenneocrinus cirratus*	Givetian	0.0586

51	*Macrocrinus*	Tournaisian-Visean	*Asterocrinus konincki*	Visean	1.4276
52	*Maligneocrinus*	Tournaisian	*Maligneocrinus medicinensis*	Tournaisian	25.4825
53	*Manillocrinus*	Tournaisian	*Cactocrinus? brownei*	Tournaisian	5.0393
54	*Megistocrinus*	Emsian-Tournaisian	*Actinocrinus evansii*	Tournaisian	76.2013
55	*Melocrinites*	Wenlock-Visean	*Melocrinites hieroglyphicus*	Frasnian	2.2533
56	*Nunnacrinus*	Tournaisian-Serpukhovian	*Nunnacrinus mamillatus*	Tournaisian-Visean	6.5237
57	*Oenochoacrinus*	Emsian-Tournaisian	*Oenochoacrinus princeps*	Emsian	0.8752
58	*Paradichocrinus*	Tournaisian-Visean	*Paradichocrinus polydactylus*	Tournaisian-Visean	19.2837
59	*Physetocrinus*	Famennian-Bashkirian	*Actinocrinus ventricosus*	Tournaisian-Visean	21.6388
60	*Pimlicocrinus*	Tournaisian-Bashkirian	*Amphoracrinus clitheroensis*	Visean	12.7790
61	*Platycrinites*	Eifelian-Guadalupian	*Platycrinites laevis*	Tournaisian	1.8067
62	*Plemnocrinus*	Tournaisian	*Plemnocrinus beebei*	Tournaisian	7.9039
63	*Pleurocrinus*	Tournaisian-Guadalupian	*Platycrinites mucronatus*	Tournaisian	6.2180
64	*Protacrocrinus*	Tournaisian	*Acrocrinus primitivus*	Tournaisian	0.0690
65	*Pterotocrinus*	Visean-Serpukhovian	*Asterocrinus capitalis*	Serpukhovian	1.8389
66	*Sampsonocrinus*	Tournaisian-Bashkirian	*Sampsonocrinus hemisphericus*	Tournaisian	7.7948
67	*Springeracrocrinus*	Tournaisian-Moscovian	*Acrocrinus intermedius*	Visean	0.0578
68	*Steganocrinus*	Tournaisian	*Actinocrinus pentagonaus*	Tournaisian	5.5500
69	*Stomiocrinus*	Tournaisian-Artinskian	*Stomiocrinus subglobosus*	Artinskian	0.2504
70	*Strimplecrinus*	Famennian-Serpukhovian	*Dichocrinus plicatus*	Tournaisian	0.3520
71	*Strotocrinus*	Tournaisian	*Actinocrinus perumbrosus*	Tournaisian	6.1115
72	*Sunwaptacrinus*	Tournaisian	*Sunwaptacrinus brazeauensis*	Tournaisian	8.3825
73	*Talarocrinus*	Visean-Serpukhovian	*Dichocrinus cornigerus*	Visean	0.8288
74	*Tarantocrinus*	Tournaisian	*Tarantocrinus typus*	Tournaisian	18.0363
75	*Teleiocrinus*	Tournaisian-Visean	*Actinocrinus umbrosus*	Tournaisian-Visean	34.0335
76	*Thinocrinus*	Tournaisian-Artinskian	*Thinocrinus westheadi*	Tournaisian	6.8823
77	*Trichotocrinus*	Frasnian	*Melocrinus harrisi*	Frasnian	0.1765
78	*Uperocrinus*	Famennian-Visean	*Actinocrinus pyriformis*	Tournaisian	16.0133
79	*Wacrinus*	Famennian	*Wacrinus caseyensis*	Famennian	6.9408

	Parvclass Disparida				
80	*Allagecrinus*	Famennian-Serpukhovian	*Allagecrinus austinii*	Tournaisian	0.0095
81	*Allocatillocrinus*	Visean-Artinskian	*Allagecrinus carpenteri*	Visean	0.0218
82	*Anamesocrinus*	Givetian-Famennian	*Anamesocrinus lutheri*	Givetian	0.0061
83	*Belemnocrinus*	Tournaisian-Visean	*Belemnocrinus typus*	Tournaisian	0.5886
84	*Calycanthocrinus*	Emsian-Famennian	*Calycanthocrinus decadactylus*	Emsian	1.0971
85	*Catillocrinus*	Tournaisian-Bashkirian	*Catillocrinus tennesseeae*	Tournaisian	2.7340
86	*Desmacriocrinus*	Famennian-Tournaisian	*Kallimorphocrinus weldenensis*	Tournaisian	0.0001
87	*Eucatillocrinus*	Visean	*Catillocrinus bradleyi*	Visean	3.8110
88	*Halysiocrinus*	Pragian-Visean	*Cheirocrinus dactylus*	Tournaisian	0.3728
89	*Haplocrinites*	Ludlovian-Tournaisian	*Haplocrinites sphaeroideus*	Eifelian	0.0139
90	*Jaekelicrinus*	Frasnian-Famennian	*Jaekelicrinus bashkiricus*	Eifelian	0.3449
91	*Kallimorphocrinus*	Visean-Wordian	*Kallimorphocrinus astrus typicus*	Baskhirian	0.0006
92	*Isoallagecrinus*	Visean-Wordian	*Allagecrinus bassleri*	Baskhirian	0.0365
93	*Playfordicrinus*	Famennian	*Playfordicrinus kellyensis*	Famennian	0.4082
94	*Storthingocrinus*	Eifelian-Famennian	*Platycrinus fritillus*	Eifelian	0.5185
95	*Thaminocrinus*	Visean	*Allagecrinus biplex*	Visean	0.0010
96	*Trophocrinus*	Tournaisian-Bashkirian	*Trophocrinus tumidus*	Tournaisian	0.0002
97	*Whiteocrinus*	Tournaisian	*Belemnocrinus florifer*	Tournaisian	0.0573
	Parvclass Cladida				
	Primitive cladids				
98	*Abrachiocrinus*	Visean-Artinskian	*Sycocrinites clausus*	Visean	0.0322
99	*Amphipsalidocrinus*	Givetian-Artinskian	*Amphipsalidocrinus scissurus*	Bashkirian	0.0001
100	*Aulodesocrinus*	Visean	*Aulodesocrinus parvus*	Visean	0.0033
101	*Barycrinus*	Tournaisian-Visean	*Cyathocrinus spurius*	Tournaisian-Visean	17.0077
102	*Belanskicrinus*	Frasnian	*Bactrocrinus westoni*	Frasnian	0.1116
103	*Carlopsocrinus*	Visean	*Carlopsocrinus bullatus*	Visean	0.0036
104	*Cestocrinus*	Visean	*Cestocrinus striatus*	Visean	1.6204

105	*Clistocrinus*	Givetian-Artinskian	*Clistocrinus pyriformis*	Bashkirian	0.0300
106	*Codiacrinus*	Lochkovian-Frasnian	*Codiacrinus granulatus*	Eifelian	2.2238
107	*Costalocrinus*	Pragian-Visean	*Poteriocrinus dilatatus*	Eifelian	4.0252
108	*Cradeocrinus*	Givetian-Tournaisian	*Cradeocrinus elongatus*	Frasnian	0.0221
109	*Cyathocrinites*	Wenlock-Wordian	*Cyathocrinites planus*	Tournaisian	3.5631
110	*Cydonocrinus*	Visean-Artinskian	*Cydonocrinus parvulus*	Visean	0.1289
111	*Dichostreblocrinus*	Tournaisian-Artinskian	*Dichostreblocrinus scrobiculus*	Bashkirian	1.2980
112	*Edapocrinus*	Visean	*Edapocrinus rugosus*	Visean	7.3358
113	*Fiannacrinus*	Tournaisian	*Poteriocrinus quinquangularis*	Tournaisian	0.0899
114	*Goniocrinus*	Eifelian-Visean	*Goniocrinus sculptilis*	Tournaisian	0.0206
115	*Iteacrinus*	Emsian-Frasnian	*Iteacrinus flagellum*	Frasnian	0.2122
116	*Lageniocrinus*	Visean-Artinskian	*Lageniocrinus seminulum*	Visean	0.1980
117	*Lampadosocrinus*	Tournaisian-Sakmarian	*Dichostreblocrinus minutus*	Tournaisian-Visean	0.0001
118	*Pagecrinus*	Emsian-Frasnian	*Pagecrinus gracilis*	Emsian	0.0254
119	*Parabotryocrinus*	Frasnian	*Parabotryocrinus tschudovensis*	Frasnian	0.2065
120	*Parisocrinus*	Eifelian-Visean	*Poteriocrinites perplexus*	Tournaisian	0.0677
121	*Pellecrinus*	Tournaisian-Visean	*Cyathocrinus hexadactylus*	Tournaisian	5.0724
122	*Quantoxocrinus*	Givetian-Famennian	*Quantoxocrinus ussheri*	Givetian	0.0673
123	*Saccosompsis*	Visean	*Cyathocrinus insperatus*	Visean	0.2180
124	*Sycocrinites*	Visean	*Sycocrinites anapeptamenus*	Visean	0.4528
125	*Zygiosocrinus*	Tournaisian	*Zygiosocrinus typicus*	Tournaisian	0.0124
126	*Zygotocrinus*	Tournaisian	*Zygotocrinus fragilis*	Tournaisian	0.1333
	Advanced cladids				
127	*Abrotocrinus*	Tournaisian-Visean	*Abrotocrinus cymosus*	Tournaisian	3.5378
128	*Acylocrinus*	Tournaisian-Visean	*Acylocrinus tumidus*	Tournaisian	0.3278
129	*Adiakritocrinus*	Tournaisian	*Adiakritocrinus oviatti*	Tournaisian	0.0200
130	*Adinocrinus*	Visean	*Zeacrinus nodosus*	Visean	18.1652
131	*Aenigmocrinus*	Visean	*Poteriocrinus anomalus*	Visean	0.0121
132	*Agassizocrinus*	Visean-Serpukhovian	*Agassizocrinus conicus*	Visean	3.4578

133	*Amabilicrinus*	Famennian-Tournaisian	*Amabilicrinus iranensis*	Tournaisian	0.4049
134	*Amadeusicrinus*	Famennian	*Pachylocrinus subpentagonalis*	Famennian	0.0642
135	*Ampelocrinus*	Visean-Serpukhovian	*Ampelocrinus bernhardinae*	Visean	0.3580
136	*Anartiocrinus*	Visean-Serpukhovian	*Anartiocrinus lyoni*	Visean	1.3722
137	*Anemetocrinus*	Visean	*Anemetocrinus biserialis*	Visean	0.9419
138	*Aphelecrinus*	Famennian-Serpukhovian	*Aphelecrinus elegans*	Visean	0.1717
139	*Apokryphocrinus*	Tournaisian	*Apokryphocrinus wellsvillensis*	Tournaisian	0.0391
140	*Armenocrinus*	Visean	*Armenocrinus watersi*	Visean	0.8972
141	*Ascetocrinus*	Tournaisian	*Scaphiocrinus rusticellus*	Tournaisian	0.1691
142	*Aulocrinus*	Visean	*Aulocrinus agassizi*	Visean	2.4130
143	*Blothrocrinus*	Famennian-Visean	*Poteriocrinus jesupi*	Tournaisian	4.8913
144	*Bollandocrinus*	Tournaisian-Visean	*Poteriocrinus conicus*	Tournaisian	4.5801
145	*Borucrinus*	Tournaisian-Visean	*Dinotocrinus eirensis*	Tournaisian	0.0375
146	*Bridgerocrinus*	Famennian-Tournaisian	*Bridgerocrinus fairyensis*	Tournaisian	0.0198
147	*Bronaughocrinus*	Visean-Serpukhovian	*Bronaughocrinus figuratus*	Visean	7.9765
148	*Bufalocrinus*	Famennian	*Catactocrinus? torus*	Famennian	0.0890
149	*Bursacrinus*	Tournaisian	*Bursacrinus wachsmuthi*	Tournaisian	2.0485
150	*Catactocrinus*	Frasnian-Famennian	*Catactocrinus leptodactylus*	Frasnian	0.0239
151	*Cercidocrinus*	Tournaisian	*Poteriocrinus bursaeformis*	Tournaisian	2.7024
152	*Charientocrinus*	Givetian-Frasnian	*Charientocrinus ithacensis*	Frasnian	0.1269
153	*Coeliocrinus*	Tournaisian	*Poteriocrinus dilatatus*	Tournaisian	0.1600
154	*Corematocrinus*	Frasnian	*Corematocrinus plumosus*	Frasnian	0.1971
155	*Corythocrinus*	Visean	*Corythocrinus romingeri*	Visean	0.8787
156	*Cosmetocrinus*	Famennian-Serpukhovian	*Cosmetocrinus gracilis*	Tournaisian	0.7731
157	*Cromyocrinus*	Visean-Moscovian	*Cromyocrinus simplex*	Osagean	4.2901
158	*Culmicrinus*	Tournaisian-Serpukhovian	*Poteriocrinus regularis*	Visean	0.1556
159	*Cupressocrinites*	Pragian-Famennian	*Cupressocrinites crassus*	Givetian	4.5436
160	*Cydrocrinus*	Tournaisian-Visean	*Poteriocrinus coxanus*	Tournaisian	6.0469
161	*Cymbiocrinus*	Visean-Bashkirian	*Cymbiocrinus romingeri*	Visean	0.2245

162	*Dasciocrinus*	Visean-Serpukhovian	*Cyathocrinus florialis*	Visean	0.4301
163	*Decadocrinus*	Givetian-Visean	*Poteriocrinus scalaris*	Tournaisian	0.5734
164	*Delocrinus*	Visean-Artinskian	*Poteriocrinus hemisphericus*	Visean	2.1887
165	*Derbiocrinus*	Visean	*Derbiocrinus diversus*	Visean	6.7166
166	*Derorhethocrinus*	Tournaisian	*Derorhethocrinus elongatus*	Tournaisian	0.0398
167	*Dinotocrinus*	Visean	*Dinotocrinus compactus*	Visean	0.2970
168	*Eratocrinus*	Tournaisian-Visean	*Zeacrinus elegans*	Tournaisian	2.0358
169	*Eupachycrinus*	Visean-Serpukhovian	*Graphiocrinus quatuordecimbrachialis*	Visean	3.7371
170	*Exaetocrinus*	Visean-Stephanian	*Stuartwellercrinus argentinei*	Moscovian	0.6607
171	*Exochocrinus*	Visean-Serpukhovian	*Eupachycrinus tumulosus*	Visean	6.6278
172	*Fifeocrinus*	Visean-Serpukhovian	*Pachylocrinus tielensis*	Visean	11.1499
173	*Forthocrinus*	Visean	*Forthocrinus lepidus*	Visean	1.7414
174	*Gaelicrinus*	Tournaisian	*Poteriocrinus rostratus*	Tournaisian	0.1379
175	*Gelasinocrinus*	Tournaisian	*Gelasinocrinus revimentus*	Tournaisian	0.2745
176	*Gilmocrinus*	Tournaisian-Visean	*Gilmocrinus iowensis*	Tournaisian	0.3311
177	*Glossocrinus*	Frasnian-Famennian	*Glossocrinus naplesensis*	Frasnian-Famennian	0.0124
178	*Goleocrinus*	Visean-Moscovian	*Goleocrinus masonensis*	Bashkirian	1.8029
179	*Graphiocrinus*	Tournaisian-Wordian	*Graphiocrinus encrinoides*	Tournaisian	0.0851
180	*Grabauicrinus*	Famennian	*"Decadocrinus" xinjiangensis*	Famennian	0.2740
181	*Hallocrinus*	Emsian-Frasnian	*Cyathocrinus ornatissimus*	Frasnian	1.5643
182	*Heliosocrinus*	Visean-Bashkirian	*Heliosocrinus aftonensis*	Visean	11.1285
183	*Histocrinus*	Tournaisian-Visean	*Poteriocrinus (Scytalocrinus) grandis*	Tournaisian	1.2695
184	*Holcocrinus*	Famennian-Visean	*Graphiocrinus longicirrifer*	Tournaisian	0.6874
185	*Hosieocrinus*	Visean	*Tribrachiocrinus caledonicus*	Visean	0.8135
186	*Hutkocrinus*	Tournaisian	*Hutkocrinus kermanensis*	Tournaisian	0.0712
187	*Hydreionocrinus*	Visean-Serpukhovian	*Hydreionocrinus woodianus*	Visean	1.5405
188	*Hylodecrinus*	Visean	*Hylodecrinus sculptus*	Visean	3.1345
189	*Hypselocrinus*	Famennian-Serpukhovian	*Poteriocrinus hoveyi*	Tournaisian	1.3753
190	*Idosocrinus*	Visean	*Idosocrinus bispinosus*	Visean	0.7622

191	*Julieticrinus*	Famennian	*Julieticrinus romeo*	Famennian	0.2814
192	*Lanecrinus*	Tournaisian-Moscovian	*Scaphiocrinus depressus*	Tournaisian-Visean	0.2129
193	*Lebetocrinus*	Tournaisian-Visean	*Lebetocrinus grandis*	Tournaisian	8.4611
194	*Lekocrinus*	Visean	*Scaphiocrinus divaricatus*	Visean	0.5341
195	*Linobrachiocrinus*	Frasnian	*Linocrinus kindlei*	Frasnian	0.3048
196	*Linocrinus*	Tournaisian-Serpukhovian	*Linocrinus wachsmuthi*	Visean	0.1463
197	*Liparocrinus*	Famennian	*Liparocrinus batheri*	Famennian	0.0533
198	*Logocrinus*	Givetian-Tournaisian	*Logocrinus geniculatus*	Givetian	0.2115
199	*Lophocrinus*	Visean	*Lophocrinus speciosus*	Visean	0.1947
200	*Lorocrinus*	Tournaisian	*Lorocrinus zanguensis*	Tournaisian	0.4891
201	*Maevecrinus*	Tournaisian	*Maevecrinus bothros*	Tournaisian	1.4956
202	*Mantikosocrinus*	Visean-Serpukhovian	*Mantikosocrinus castus*	Visean	0.8148
203	*Maragnicrinus*	Frasnian	*Maragnicrinus portlandicus*	Frasnian	4.2773
204	*Meniscocrinus*	Visean	*Meniscocrinus magnitubus*	Visean	5.0633
205	*Nactocrinus*	Tournaisian	*Nactocrinus nitidus*	Tournaisian	0.2112
206	*Nudalocrinus*	Tournaisian	*Culmicrinus jeffersonensis*	Tournaisian	3.1136
207	*Ophiurocrinus*	Tournaisian-Moscovian	*Poteriocrinus originarius*	Moscovian	1.7384
208	*Pachylocrinus*	Famennian-Serpukhovian	*Scaphiocrinus aequalis*	Tournaisian	0.4754
209	*Paracosmetocrinus*	Tournaisian	*Paracosmetocrinus straki*	Tournaisian	0.1389
210	*Parascytalocrinus*	Visean	*Scytalocrinus validus*	Visean	0.9562
211	*Parazeacrinites*	Visean	*Zeacrinus konincki*	Visean	4.1884
212	*Pedinocrinus*	Visean	*Pachylocrinus clavatus*	Visean	5.2105
213	*Pelecocrinus*	Tournaisian-Serpukhovian	*Pelecocrinus insignis*	Tournaisian	9.4083
214	*Pentaramicrinus*	Visean-Serpukhovian	*Cromyocrinus gracilis*	Visean	0.4077
215	*Pentececrinus*	Famennian	*Pentececrinus parvus*	Famennian	0.0001
216	*Phacelocrinus*	Tournaisian-Bashkirian	*Poteriocrinus wetherbyi*	Tournaisian-Visean	0.8328
217	*Phanocrinus*	Visean-Serpukhovian	*Zeacrinus formosus*	Visean	1.3767
218	*Plaxocrinus*	Visean-Sakmarian	*Hydreionocrinus crassidiscus*	Moscovian	1.1237
219	*Poteriocrinites*	Famennian-Visean	*Poteriocrinites crassus*	Tournaisian-Visean	5.2815

220	*Prininocrinus*	Frasnian-Tournaisian	*Prininocrinus robustus*	Frasnian	0.2180
221	*Proampelocrinus*	Tournaisian	*Proampelocrinus himalayaensis*	Tournaisian	0.0566
222	*Ramulocrinus*	Tournaisian-Serpukhovian	*Ramulocrinus nigelensis*	Tournaisian	0.0848
223	*Rhabdocrinus*	Visean-Serpukhovian	*Poteriocrinus scotocarbonarius*	Visean	9.6363
224	*Rhopocrinus*	Visean-Serpukhovian	*Rhopocrinus spinosus*	Visean	1.6404
225	*Sarocrinus*	Visean	*Sarocrinus nitidus*	Visean	0.3695
226	*Scotiacrinus*	Visean-Serpukhovian	*Pachylocrinus tyriensis*	Visean	7.6341
227	*Scytalocrinus*	Famennian-Stephanian	*Scaphiocrinus robustus*	Tournaisian	0.6598
228	*Snowycrinus*	Visean	*Snowycrinus stonehouseensis*	Visean	0.1172
229	*Sostronocrinus*	Famennian-Tournaisian	*Sostronocrinus superbus*	Tournaisian	0.1213
230	*Springericrinus*	Tournaisian-Visean	*Poteriocrinus magniventrus*	Tournaisian	21.0803
231	*Stinocrinus*	Visean	*Stinocrinus granulosus*	Visean	1.2767
232	*Tarassocrinus*	Famennian	*Tarassocrinus synchlydus*	Famennian	0.0401
233	*Tholocrinus*	Visean-Serpukhovian	*Hydreionocrinus spinosus*	Serpukhovian	0.7663
234	*Tyrieocrinus*	Visean-Serpukhovian	*Tyrieocrinus laxus*	Visean	2.5711
235	*Ulrichicrinus*	Visean-Moscovian	*Ulrichicrinus oklahoma*	Serpukhovian	13.6795
236	*Ureocrinus*	Visean-Serpukhovian	*Poteriocrinus bockschii*	Visean	0.9864
237	*Worthenocrinus*	Visean	*Worthenocrinus patenus*	Visean	1.4273
238	*Zeacrinites*	Visean-Serpukhovian	*Zeacrinites magnoliaeformis*	Visean	2.7498
	Superorder Flexibilia				
	Or. Taxocrinida				
239	*Enascocrinus*	Visean	*Talanterocrinus redesdalensis*	Visean	2.8879
240	*Eutaxocrinus*	Wenlock-Tournaisian	*Taxocrinus affinis*	Eifelian	0.2212
241	*Meristocrinus*	Wenlock-Tournaisian	*Taxocrinus (Gnorimocrinus) loveni*	Gotland	0.5539
242	*Onychocrinus*	Tournaisian-Serpukhovian	*Onychocrinus exsculptus*	Tournaisian	24.5446
243	*Parichthyocrinus*	Tournaisian-Visean	*Ichthyocrinus nobilis*	Tournaisian	0.4826
244	*Taxocrinus*	Eifelian-Serpukhovian	*Cyathocrinus macrodactylus*	Frasnian-Tournaisian	1.5132
	Or. Sagenocrinida				
245	*Aexitrophocrinus*	Visean-Stephanian	*Synerocrinus formosus*	Serpukhovian	6.6049

246	*Ainacrinus*	Tournaisian-Visean	*Synerocrinus? smithi*	Visean	0.2105
247	*Amphicrinus*	Visean-Moscovian	*Amphicrinus scoticus*	Visean	17.3476
248	*Ancoracrinus*	Tournaisian	*Ancoracrinus typus*	Tournaisian	1.5418
249	*Apodactylocrinus*	Frasnian	*Apodactylocrinus keithi*	Frasnian	0.3698
250	*Artichthyocrinus*	Visean-Wolffian	*Artichthyocrinus springeri*	Visean	2.8545
251	*Caldenocrinus*	Visean	*Caldenocrinus curtus*	Visean	6.2785
252	*Clidochirus*	Ashgillian-Visean	*Clidochirus pyrum*	Wenlock	5.9020
253	*Dactylocrinus*	Eifelian-Tournaisian	*Dimerocrinites oligoptilus*	Frasnian	2.9095
254	*Dieuryocrinus*	Visean	*Euryocrinus duplex*	Visean	10.7582
255	*Euryocrinus*	Givetian-Visean	*Euryocrinus concavus*	Tournaisian	5.9969
256	*Forbesiocrinus*	Famennian-Visean	*Forbesiocrinus nobilis*	Tournaisian	49.0625
257	*Gaulocrinus*	Visean	*Stemmatocrinus trautscholdi*	Visean	18.8166
258	*Mespilocrinus*	Tournaisian-Visean	*Mespilocrinus forbesianus*	Tournaisian	0.6513
259	*Metichthyocrinus*	Tournaisian-Visean	*Ichthyocrinus burlingtonensis*	Tournaisian	8.7677
260	*Nipterocrinus*	Tournaisian-Visean	*Nipterocrinus wachsmuthi*	Tournaisian	4.6547
261	*Synaptocrinus*	Givetian-Famennian	*Forbesiocrinus nuntius*	Givetian	0.3524
262	*Wachsmuthicrinus*	Frasnian-Visean	*Forbesiocrinus thiemei*	Tournaisian	2.5837

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