Supplementary Text

1. List of genera that are not included in analyses.

2. Serial sections of *Meishanorhynchia*.

3. Characters applied in phylogenetic analyses.

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1. List of genera that are not included in analyses

Ancorhynchia, *Aparimarhynchia*, *Bicamella*, *Camarophorinella*, *Coledium*, *Dierisma*, *Dimerella*, *Excavatorhynchia*, *Gerassimovia*, *Glyptorhynchia*, *Halorellina*, *Hybostenoscisma*, *Laevorhynchia*, *Lambdarina*, *Maorirhynchia*, *Maxillirhynchia*, *Multicorhynchia*, *Murihikurhynchia*, *Neofascicosta*, *Neopsilocamara*, *Ortarhynchia*, *Plekonella*, *Pseudowellerella*, *Qilianoconcha*, *Sacothyropsis*, *Septaliphorioidea*, *Septocyclothyris*, *Terebratuloidea*, *Wairakiella*, *Wairakirhynchia*, and *Wellerellina*

2. Serial sections of *Meishanorhynchia*

Meishanorhynchia is monotypic and only the type species *Meishanorhynchia changxingensis* is included. The sectioned specimens of *Meishanorhynchia changxingensis* were collected from the Yinkeng Formation at its type locality in Meishan, south China. The specimens are usually deformed and often have thin and fragile shells.

Supplementary Figure S1. *Meishanorhynchia changxingensis*. A, The dorsal valve sectioned. B–E, Serial sections of this specimen. The numbers indicate distances from the first section.

The specimen displayed here is an incomplete dorsal valve (Supplementary Fig. S1). The posterior part of this valve was broken, so the median septum and hinge plates are not revealed. However, the crura are well preserved. The first section (Supplementary Fig. S1B) shows the initial part of crura which are coarse, strong, and distinct in serial sections, being comparable with the last section of Chen et al. (2002, fig. 4). Anteriorly, the crura become more and more slender. Distally, the crura are laterally compressed and nearly parallel to each other. Besides, the crura are almost straight, implying that *Meishanorhynchia* has spinuliform crura.

Chen, Z. Q., G. R. Shi, and K. Kaiho. 2002. A new genus of rhynchonellid brachiopod from the lower Triassic of South China and implications for timing the recovery of Brachiopoda after the end Permian mass extinction. Palaeontology 45:149–164.

3. Characters applied in phylogenetic analyses

1. Outline. (0)subcircular; (1)elongately oval; (2)elongately subquadrate; (3)elongately subtriangular; (4)transversely subtriangular; (5)transversely subpentagonal; (6)transversely oval like *Halorella*

2. Ventral valve convexity. (0)gently convex; (1)moderately convex; (2)strongly convex

3. Dorsal valve convexity. (0)gently convex; (1)moderately convex; (2)strongly convex

4. Anterior commissure of adults. (0)rectimarginate; (1)uniplicate; (2)unisulcate

5. Planareas. (0)not prominent; (1)prominent

6. Ventral sulcus. (0)absent or very weak; (1)moderate; (2)deep; (3)very deep and forming long tongue

7. Position of ventral sulcus. (0)restricted to anterior margin of the valve; (1)commencing from about medial length of the valve; (2)commencing from posterior part of the valve

8. Dorsal fold. (0)absent or very low; (1)moderate; (2)high

9. Dorsal sulcus. (0)absent; (1)shallow; (2)deep

10. Distribution of dorsal sulcus. (0)restricted to anterior part of the valve; (1)commencing from posterior part of the valve, and continue to anterior part; (2)restricted to posterior part of the valve

11. Radial ornament. (0)absent; (1)present

12. Bifurcation or intercalation of radial ornament. (0)ribs simple; (1)bifurcation and intercalation present

13. Distribution of radial ornament. (0)near anterior margin; (1)on anterior half of the valve; (2)beginning near beak; (3)beginning at beak; (4)only in sulcus and on fold

14. Type of radial ornament. (0)coarse plicae (number of ribs < 10); (1)fine plicae (10 ≤ number of ribs < 20); (2)costellae (number of ribs ≥ 20); (3)antidichotomous ribbing

15. Type of radial ornament. (0)rounded; (1)sharp and angular

16. Microornament. (0)absent; (1)capillae

17. Ventral umbo. (0)low; (1)moderate; (2)high

18. Beak curvature. (0)straight; (1)slightly curved; (2)strongly curved

19. Beak ridges. (0)rounded; (1)angular

20. Position of pedicle opening. (0)permesothyrid; (1)mesothyrid; (2)submesothyrid; (3)hypothyrid; (4)no pedicle opening

21. Size of foramen. (0)small; (1)large

22. Foramen margin. (0)absent; (1)present (auriculate)

23. Deltidial plates. (0)absent; (1)disjunct; (2)conjunct; (3)double deltidial plates

24. Stolidium (thin, marginal extension of one or both valves that forms a frill protruding at an angle to the main commissural plane of the shell, e.g., *Stenoscisma*). (0)absent; (1)present

25. Pedicle collar. (0)absent; (1)present

26. Teeth or sockets. (0)not crenulated; (1)crenulated

27. Dental plates. (0)absent; (1)present

28. Dental plates. (0)rudimentary and slender; (1)strong

29. Dental plates orientation. (0)subparallel; (1)convergent ventrally; (2)divergent ventrally; (4)O-shaped like *Meishanorhynchia*

30. Dental plates length. (0)short, and disappeared very quickly in serial sections; (1)long, may continue to hinge zone

31. Lateral umbonal chambers. (0)filled by callus; (1)narrow; (2)large

32. Spondylium. (0)absent; (1)present

33. Ventral median septum. (0)absent; (1)present

34. Marginal spines (e.g., *Uncinulus*). (0)absent; (1)present

35. Pouch structure (a pair of ovoid posterolateral hinge pouches that, in cross section, give impression of bifurcate dental plates, e.g., *Saccorhynchia*). (0)absent; (1)present

36. Cardinal process. (0)absent; (1)present

37. Inner hinge plates. (0)absent; (1)present

38. Crural plates. (0)absent or rudiment; (1)distinct

39. Outer hinge plates. (0)narrow or absent; (1)wide and distinct

40. Septalium. (0)absent; (1)complete; (2)incomplete (an incomplete septalium is generally very short and disappears rapidly forward; see Shi and Grant 1993, fig. 13E)

41. Complete septalium. (0)short, only developed in apical region; (1)long, may continue to hinge zone

42. Complete septalium. (0)shallow; (1)deep; (2)very deep, maybe sessile

43. Camarophorium. (0)absent; (1)present

44. Intercamarophorial plate. (0)absent; (1)present

45. Dorsal median septum. (0)absent; (1)present

46. Length of dorsal median septum. (0)short, only developed in apical region; (1)long, may continue to 1/3 length of shell

47. Height of dorsal median septum height. (0)low, and the height decreased rapidly; (1)high

48. Support plate (an oblique septa arising from dorsal valve floor, e.g., *Crurirhynchia*). (0)absent; (1)present

49. Crural curvature in lateral view. (0)nearly straight; (1)moderately curved; (2)abruptly curved toward ventral valve

50. Point of origination of crus. (0)dorsal side of hinge plate with evident dorsal extension; (1)inner edge of outer hinge plates, with no evident dorsal extension; (2)support plate; (3)fused “septalium” (e.g., *Carapezzia*); (4)socket ridges (the crural bases are merged with socket ridges, e.g., *Halorella*)

51. Initial lamellae of crus in cross section. (0)“()” like, slightly extended; (1)nearly equilateral; (2)concave dorsally; (3)flat like *Halorella*; (4)bladelike and not concave medianly

52. Shape of distal end of crus in cross section. (0)slightly flared vertically; (1)strongly flared vertically; (2)*Halorella*-like; (3)flared with blades dorsally divergent; (4)concave dorsally; (5)concave dorsally but with two blades of different length, nearly calciform; (6)with two divergent blades like *Pseudohalorella*

53. Length of crura. (0)short (usually < 1/2 of shell length); (1)long (>1/2 of shell length)

54. Crural distance in cross section. (0)very narrow (the two crura are closely located in serial section, e.g. *Carapezzia*); (1)wide

55. Spicules of crura (crura connected by spicules). (0)absent; (1)present

56. Shell thickness. (0)not thickened; (1)slightly thickened; (2)strongly thickened

57. Punctation. (0)not punctate; (1)endopunctate

Shi, X.Y., and R. E. Grant. 1993. Jurassic rhynchonellids: Internal structures and taxonomic revisions. Smithsonian Contributions to Paleobiology 73:1–190, pl. 1–18.

4. Distributions and values of parameters for tip-dated analysis

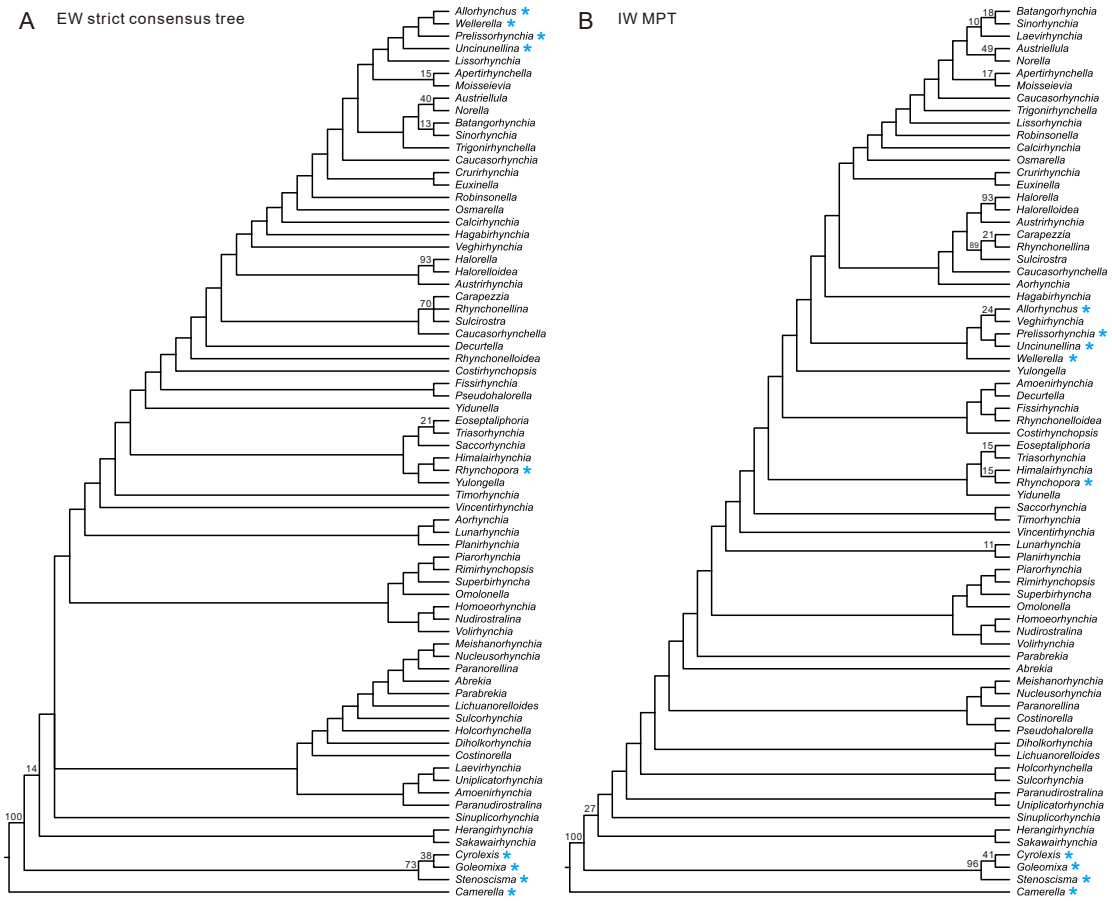
Parameter	**Value**
Origin time	Uniform (0, 500)
Diversification rate	Exponential (mean 0.1)
Sampling proportion	Uniform (0, 1)
Turnover rate	Uniform (0, 1)
Clock rate	Exponential (mean 1)
Clock standard deviation	Exponential (mean 1)
Gamma shape	Uniform (0, 10)

5. Other consensus trees generated by phylogenetic analyses

Fifty percentage majority-rule consensus (MRC) trees generated by tip-dated analyses (Supplementary Fig. S2):

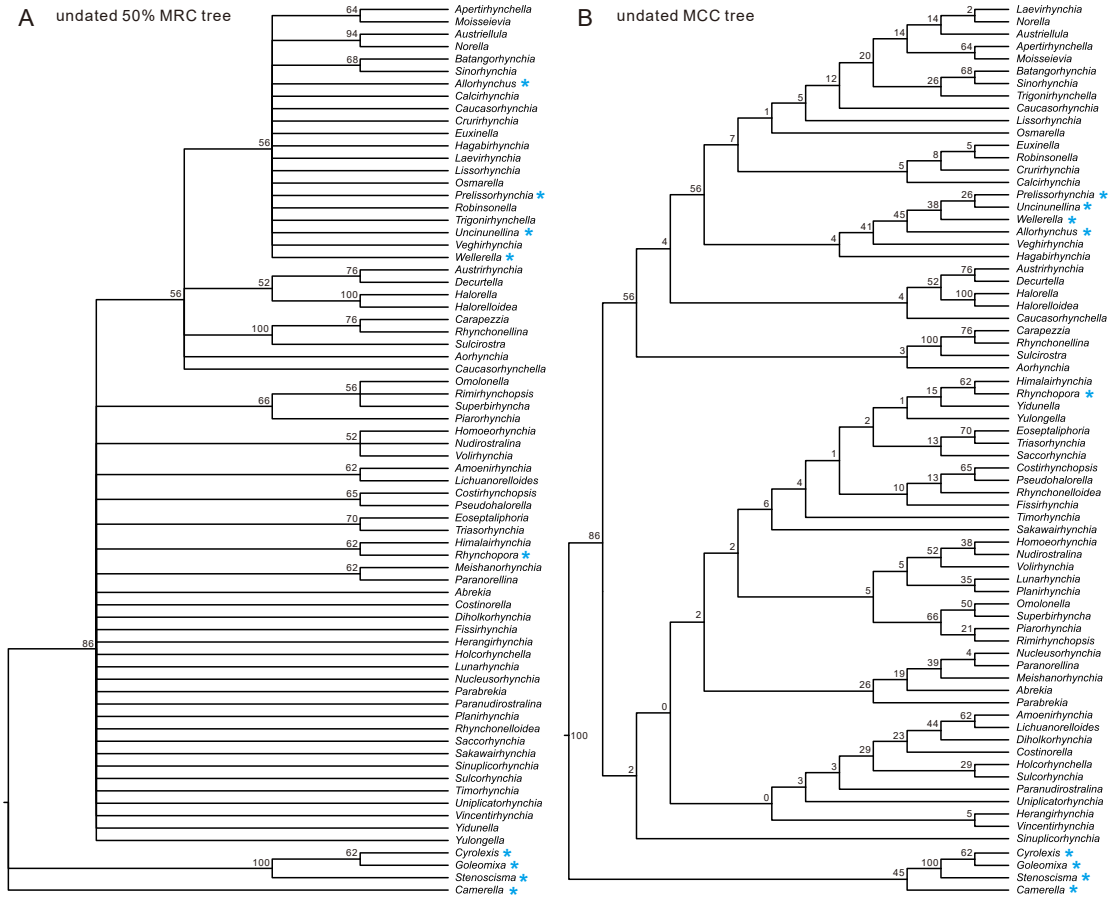
Supplementary Figure S2. Fifty percentage majority-rule consensus (MRC) trees generated by species-dated analysis (A) and genus-dated analysis (B). The posterior probability of each clade is presented as a node label (in percentage). Paleozoic genera are marked by asterisks.

Equal-weighting parsimony (EW) generated two most parsimonious trees (MPTs) with a tree length (TL) of 459, a consistency index (CI) of 0.218, and a retention index (RI) of 0.551. The strict consensus tree of the two MPTs is shown in Supplementary Figure S3A. Implied-weighting parsimony (IW) (k = 12.63) generated only one tree (TL: 468; CI: 0.214; RI: 0.539) and is shown in Supplementary Figure S3B.



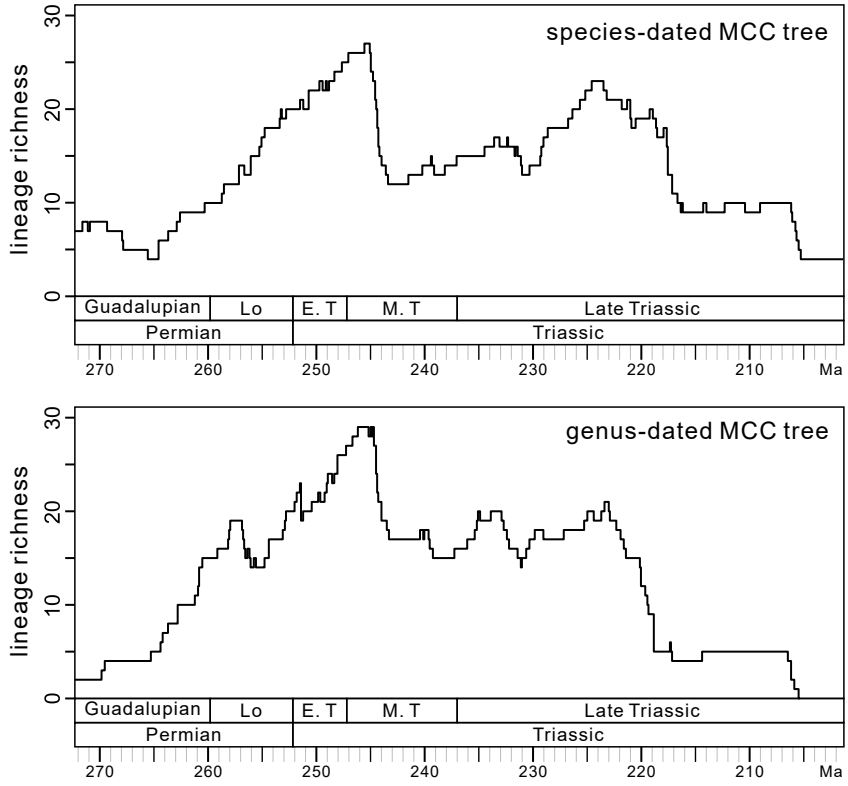
Supplementary Figure S3. Strict consensus tree of the most parsimonious trees (MPTs) generated by equal-weighting parsimony (EW) (A), and an MPT recovered by implied-weighting parsimony (IW) (B). Bootstrap values and symmetric resampling support values are labeled in the two trees, respectively. Only values >10 are shown. Paleozoic genera are marked by asterisks.

Supplementary Figure S4 displays the 50% MRC tree and MCC tree generated by undated Bayesian (UB) analysis.

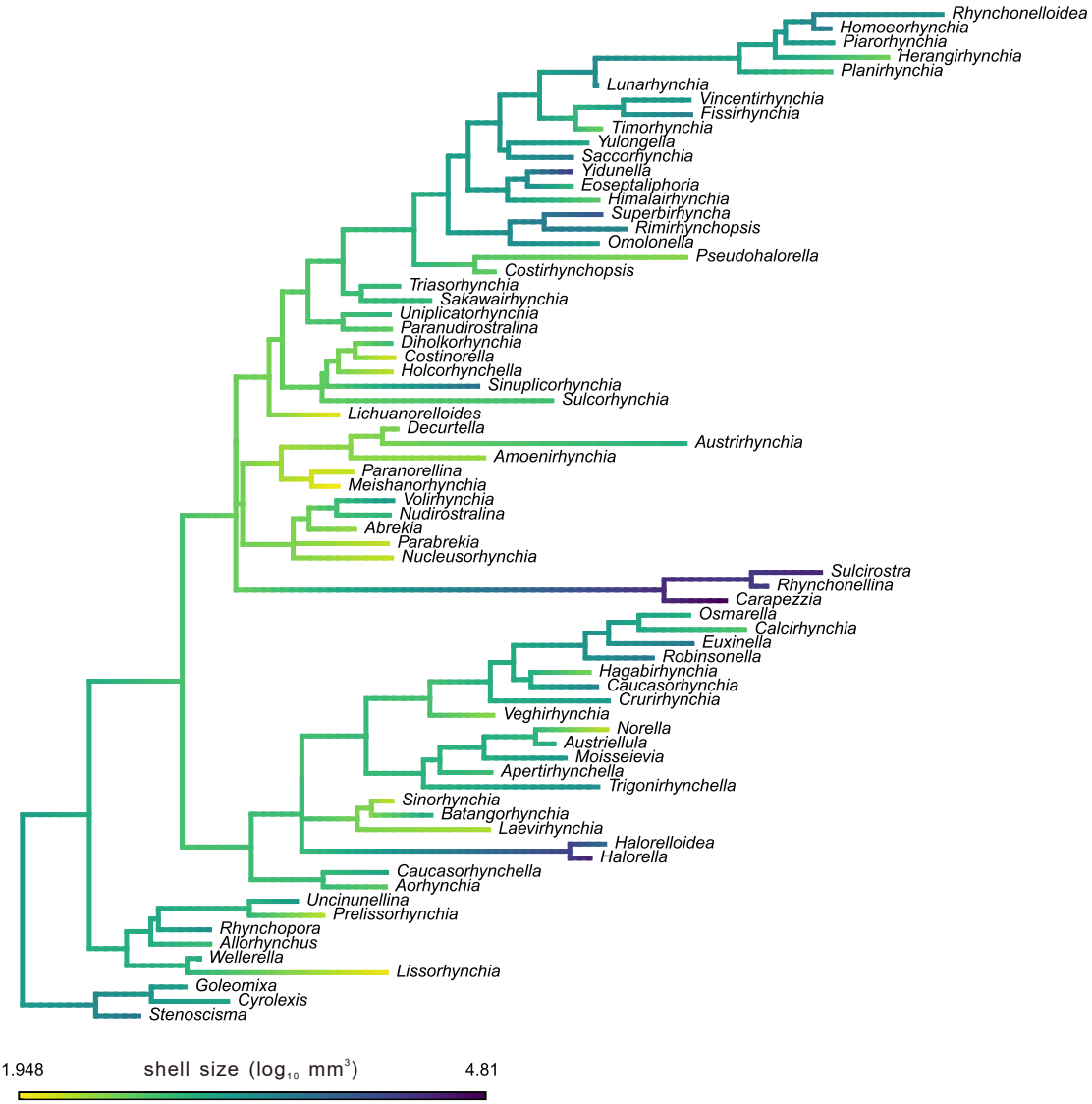


Supplementary Figure S4. Fifty percentage MRC tree (A) and maximum clade credibility (MCC) tree (B) generated by undated Bayesian (UB) analysis. The posterior probability of each clade is presented as a node label (in percentage). Paleozoic genera are marked by asterisks.

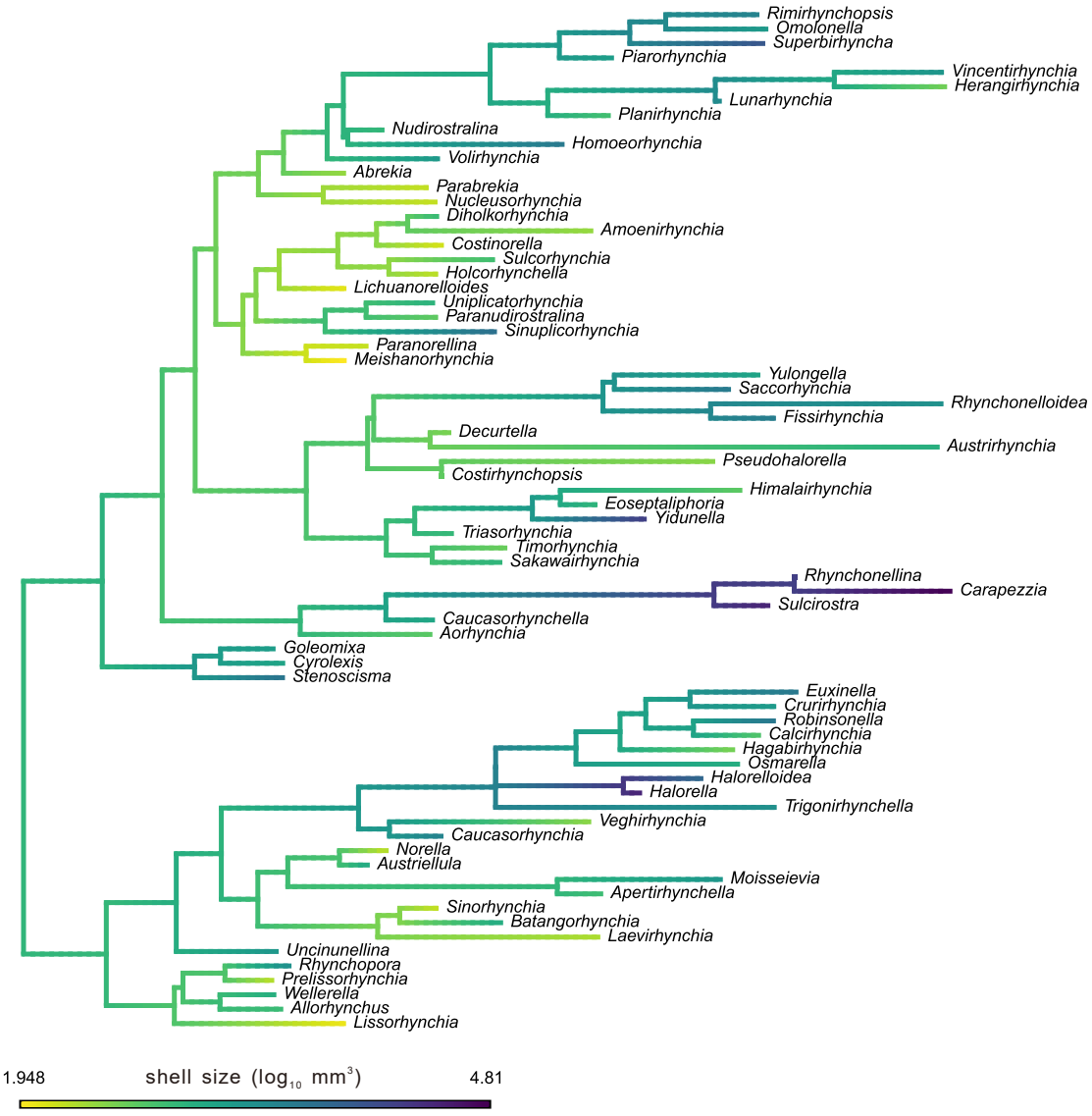
6. Supplementary Figures S5–10



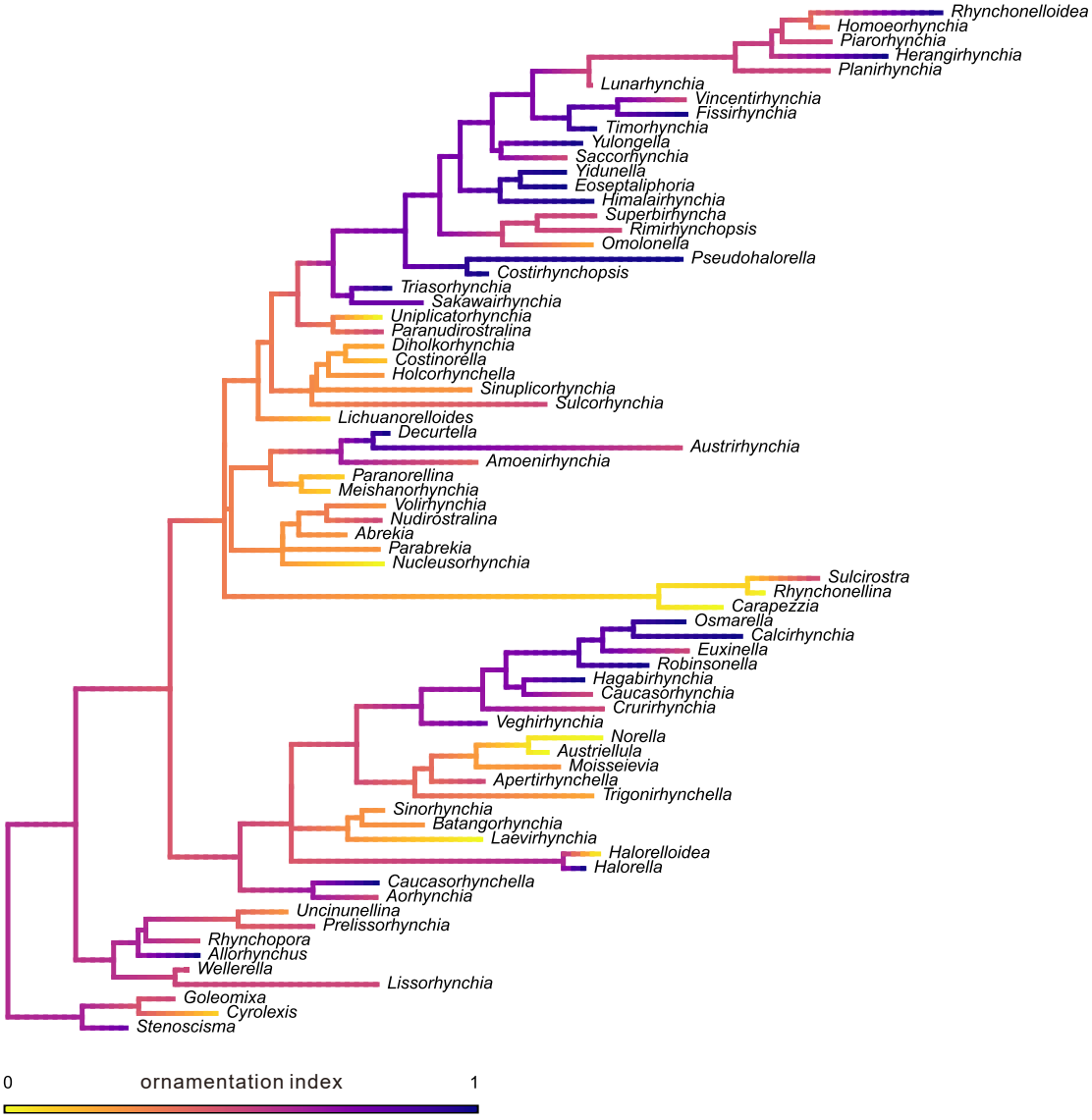
Supplementary Figure S5. Lineage diversity variations calculated from non-recalibrated MCC trees based on the species-dated method (A) and genus-dated method (B). Lo, Lopingian; E. T, Early Triassic; M. T, Middle Triassic.



Supplementary Figure S6. Ancestral state reconstruction of shell size, plotted on species-dated MCC tree. Darker color means larger size.

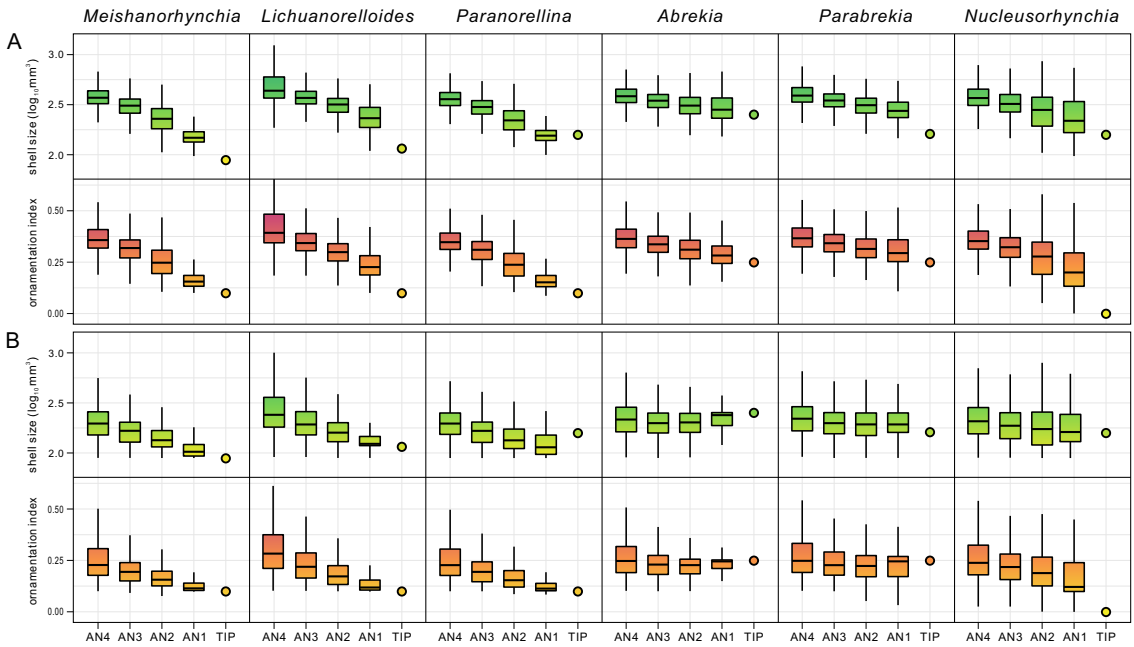


Supplementary Figure S7. Ancestral state reconstruction of shell size, plotted on genus-dated MCC tree. Darker color means larger size.



Supplementary Figure S8. Ancestral state reconstruction of ornamentation index (OI), plotted on species-dated MCC tree. Darker color means higher OI and more pronounced ornamentation.

Supplementary Figure S9. Ancestral state reconstruction of OI, plotted on genus-dated MCC tree. Darker color means higher OI and more pronounced ornamentation.



Supplementary Figure S10. Estimates of character states of the small-sized taxa (tips) and their respective ancestral nodes (AN1–AN4) based on 1000 trees randomly selected from the posterior samples. A, Results calculated from non-recalibrated species-dated trees. B, Results calculated from *cal3*-recalibrated species-dated trees. Outliers are omitted.