Supplementary Materials for

**Towards an understanding of cosmopolitanism in deep time: a case study of ammonoids from the middle Permian to the Middle Triassic**

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5. **Supplementary methods**

**source code**

* 1. **resampling method to calculate BC.**

TL.matrix<-read.table("data.txt")

n.rows<-nrow(TL.matrix)

n.cols<-ncol(TL.matrix)

n<-n.rows

TL.rs<-rep(NA,5000)

a<-rep(NA,n.cols)

for(i in 1:5000){

 sr<-sample(n.rows, size=n, replace=T)

 bootsur<-TL.matrix[sr,]

 for(j in 1:n.cols){

 if(sum(bootsur[,j])>0){a[j]=1}

 else{a[j]=0}}

 o<-sum(bootsur)

 BC <- (o-n)/(sum(a)\*n-n)

 TL.rs[i]<-BC

 }

TL.mean<-mean(TL.rs,na.rm=TRUE)

TL.sd<-sd(TL.rs,na.rm=TRUE)

TL.low<-quantile(TL.rs,0.025,na.rm=TRUE)

TL.up<-quantile(TL.rs,0.975,na.rm=TRUE)

c(TL.mean,TL.sd,TL.low,TL.up)

hist(TL.rs)

1. **Supplementary figures**



Figure S1. Middle Permian to Middle Triassic numerical age.



Figure S2. Early Triassic numerical age.



Figure S3. Estimated BC with different replications of the Wordian ammonoid. The vertical bars indicate 95% confidence interval.



Figure S4. A, Estimated mean biogeographic connectedness with 95% confidence interval (sample size = 90% genera); B, Estimated mean biogeographic connectedness with 95% confidence interval, calculated by even resample size, eight locations, with 5000 runs; C, Estimated mean biogeographic connectedness with 95% confidence interval, calculated by jackknife method on locations with 5000 runs. Ro., Roadian; Wo., Wordian; Cap., Capitanian; Wu., Wuchiapingian; Ch., Changhsingian; Gr., Griesbachian; Di., Dienerian; e. S., early Smithian; m. S., middle Smithian; l. S., late Smithian; Sp., Spathian; e. A., early Anisian; m. A., middle Anisian; l. A., late Anisian; La., Ladinian; E., Early; M., Middle; L., Late.

1. **Supplementary tables**

Table S1. middle Permian-Middle Triassic ammonoid geographic occurrences. (separated as the supplementary excel file).

Table S2. middle Permian-Middle Triassic ammonoid genera-location matrixes. (separated as the supplementary excel file).

Table S3. Abbreviations of locations in Figure 3.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Ab | Albania | Gc | Greece | Ma | Malaysia | SC | South China | Tu | Turkey |
| AC | Arctic Canada | Ge | Germany | Md | Madagascar | Si | Siberia | Tm | Timor |
| Af | Afghanistan | Gr | Greenland | Me | Mexico | Sn | Spain | Tn | Tunisia |
| Al | Alaska | Hi | Himalayas | Mo | Mongolia | SP | South\_Primorye | Ur | Volga-Ural |
| Ap | Alps | Hu | Hungary | NC | North China | SR | Salt\_Range | Ve | Verkhoyansk |
| BC | British Columbia | Ik | Irak | Ol | Olenek | Tb | Tibet | Vi | NE\_Vietnam |
| Ca | Caucasus | Ir | Iran | Om | Oman | Te | Texas | WA | Western Australia |
| Ch | Chios | Is | Israel | PA | Pamirs-Afghanistan | Th | Thailand | WU | Western USA |
| CI | Central Iran | It | Italy | Qh | Qinghai | TI | Transcaucasia-North Iran | Yu | Yugoslavia |
| Cr | Crimea | JP | Japan | Ru | Rumania | 　 | 　 |
| FE | Far East, Russian | Ki | Kirovsk | Sb | Spitsbergen |  |  |

1. **Supplementary references.**

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