



# Permophiles

International Commission on Stratigraphy



*Brachiopods in a changing planet:  
from the past to the future*



Abstract Volume

Milano, 11-14 September 2018  
[www.8brachiopodcongress.com](http://www.8brachiopodcongress.com)



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**8<sup>th</sup> INTERNATIONAL BRACHIOPOD CONGRESS**  
**Brachiopods in a changing planet: from the past to the future**  
**Milano 11-14 September 2018**

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Renato Posenato, *Università di Ferrara, Italy*

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## CONGRESS MAIN PROGRAM

	am			LUNCH	pm			
	I	Coffee Break	II		III	Coffee break	IV	V
Sept 6-9 <sup>th</sup>	Pre-Congress excursion							
Monday Sept 10 <sup>th</sup>							Registration Ice Breaker Party	
Tuesday Sept 11 <sup>th</sup>	Opening Cerimony Plenary Lars Holmer		Scientific sessions S1		Scientific sessions S1		Scientific sessions S6	Poster Wine and Cheese
	Registration							
Wednesday Sept 12 <sup>th</sup>	Plenary Uwe Brand Scientific sessions S5		Scientific sessions S5		Scientific sessions S5-S4		Scientific sessions S4	Group photo Concert Gala dinner
Thursday Sept 13 <sup>th</sup>	Free day or Mid-Congress excursions							
Friday Sept 14 <sup>th</sup>	Plenary Elizabeth Harper Scientific sessions S3		Scientific sessions S3		Scientific sessions S3-S2		Scientific sessions S2	
Sept 15-18 <sup>th</sup>	Post-Congress excursions							

**Monday 10<sup>th</sup> September 2018**

- 16:30-19:00            **REGISTRATION**
- 17:30-19:30            **ICE BREAKER PARTY**

**Tuesday 11<sup>th</sup> September 2018**

- 08:30-08:50            **OPENING CERIMONY**  
**Institutional greetings**  
**Prof. E. Erba (Dipartimento di Scienze della Terra ‘A. Desio’ and Società Geologica Italiana)**  
**Prof. G. Carnevale (Società Paleontologica Italiana)**  
**Sig. G. Agostoni (Comunità Montana Valsassina, Valvarrone, Val d’Esino e Riviera)**
- 08:50-09:40            **PLENARY LECTURE**  
*Moderator: Posenato R.*  
Holmer L. E., Zhang Z., Zhang Z., Brock G. A., Popov L. E.  
**Brachiopod phylogeny in the Cambrian**
- 09:40-10:00            **COFFEE-BREAK**
- SESSION 1**            ***Systematics and evolution***  
*Convenors: Carlson S., Alvarez F. and Jin J.*
- 10:00-10:25            *Keynote lecture*  
Butler A. D., Eitel M., Wörheide G., Carlson S. J., Sperling E. A.  
**Phylogenomic analysis of Brachiopoda: revealing the evolutionary history of biomineralization with an integrated palaeontological and molecular approach**
- 10:25-10:40            Kuzmina T. V., Malakhov V. V., Temereva E.  
**Support of the “brachiopod fold hypothesis” in Recent rhynchonelliformeans: a new view on the evolution of brachiopod life cycles**
- 10:40-10:55            Madison A., Kuzmina T.  
**Fossil records of the evolution of brachiopod life cycles**
- 10:55-11:10            Zhang Z., Popov L. E., Holmer L. E., Chen F., Zhang Z.  
**Earliest ontogeny of Early Cambrian acrotretoid brachiopods — first evidence for metamorphosis and its implications**

- 11:10-11:25 Chen Y., Zhang Z., Zhang Z.  
**Geometric morphometric analysis reveals the ontogeny of Early Cambrian (Series 2) brachiopods *Eohadrotreta zhenbaensis* from Cigui, Hubei Province, South China**
- 11:25-11:40 Garbelli C.  
**Modelling the shape of brachiopod valves**
- 11:40-11:55 Liang Y., Zhang Z.  
**New data on shell structure in *Heliomedusa orientalis*: taxonomic and phylogenetic implications**
- 11:55-12:10 Chen F., Zhang Z., Betts M. J., Zhang Z., Liu F.  
**First report on Guanshan Biota (Cambrian Stage 4) at the stratotype area of Wulongqing Formation in Malong County, eastern Yunnan**
- 12:10-12:25 Skovsted C. B., Liu F., Topper T. P., Zhang Z., Shu D.  
**Are hyoliths brachiopods?**
- 12:25-12:40 Lavié F., Serra F., Feltes N.  
**Microbrachiopods from the Las Aguaditas and Las Chacritas Formations (Middle Ordovician), Precordillera terrane of western Argentina: a preliminary taxonomic analysis**
- 12:40-13:50 **LUNCH**
- 13:50-14:15 *Keynote lecture*  
Stigall A. L.  
**Brachiopods as key to evolutionary theory: from foundational systematics and phylogenetics to speciation and biogeography**
- 14:15-14:30 Jin J.  
**Morphological plasticity in the early diversification of the post-extinction Silurian pentameride fauna**
- 14:30-14:45 Zhou H., Huang B.  
**Population analysis of the Silurian brachiopod *Atrypoides foxi* Jones from Qujing, Yunnan Province**
- 14:45-15:00 Lü D., Ma X.  
**Small-sized brachiopods from the Upper Frasnian (Devonian) of central Hunan, China**
- 15:00-15:15 Qiao L.  
**Devonian brachiopod fauna from the Baoshan block in western Yunnan, China**
- 15:15-15:30 Wu H., Shi G. R., He W.  
**A quantitative taxonomic review of *Fusichonetes* and *Tethyochonetes* (Chonetidina, Brachiopoda)**
- 15:30-15:50 **COFFEE-BREAK**

- SESSION 6**      ***Modern brachiopods***  
*Convenors: Bitner M. A., Cusack M. and Lüter C.*
- 15:50-16:15      *Keynote lecture*  
Temereva E., Kuzmina T.  
**Organization of the lophophore in linguliform *Pelagodiscus atlanticus* (King) and the evolution of the lophophore in brachiopods**
- 16:15-16:30      Lüter C., Furchheim N.  
**Light sensation in adult brachiopods**
- 16:30-16:45      Simonet-Roda M., Milner Garcia S., Müller T., Griesshaber E., Jurikova H., A., Eisenhauer A., Harper D.A.T., Jansen U., Schmahl W. W.  
**The evolution of thecideide brachiopod shell microstructure from Triassic to modern times**
- 16:45-17:00      Simon E., Motchurova-Dekova N., Mottequin B.  
**Diving into the morphology and ontogeny of the micromorphic rhynchonellide genus *Tethyrhynchia* Logan, 1994 in an attempt to elucidate a conflict between morphological and molecular phylogenies**
- 17:00-17:15      López Carranza N., Carlson S. J.  
**Quantifying variability and understanding species delimitation: a case study integrating morphological and genetic datasets in terebratulide brachiopods**
- 17:15-17:30      Carlson S. J., López Carranza N., Butler A. D., Sperling E. A.  
**Extant Terebratellidina phylogeny and homology of the long loop**
- 17:30-17:45      Gaspard D.  
**Recent brachiopods of the French Insular Caribbean Region**
- 17:45-18:00      Pakhnevich A. V., Galkin S. V.  
**New data on brachiopods at the underwater Piip Volcano (Bering Sea)**
- 18:00-18.15      Bitner M. A.  
**Recent brachiopods from the Tonga Islands, SW Pacific: taxonomy and biogeography**
- 18:15-18.30      Williams U. M., Robinson J., Lee D., Lamare M.  
**Investigating the ecology and environmental tolerance to sedimentation of the brachiopod *Calloria inconspicua* in Otago Harbour, New Zealand**
- 18:30-20:30      **POSTER WINE AND CHEESE**

**Wednesday 12<sup>th</sup> September 2018**

- 8:45-9:35      **PLENARY LECTURE**  
*Moderator: Angiolini L.*  
Brand U.  
**Modern brachiopods: superheroes of archives**
- SESSION 5**      ***Biologic mineralization of natural functional materials and archives of geochemical proxies***  
*Convenors: Griesshaber E. and Eisenhauer A.*
- 09:35-10:00      *Keynote lecture*  
Ziegler A., Simonet-Roda M., Griesshaber E., Henkel D., Häusermann V., Eisenhauer A., Laudin J., Schmahl W. W.  
**Mechanisms of calcite fibre formation in *Magellania venosa***
- 10:00-10:15      Takayanagi H., Nishio T., Fujioka H., Yamamoto K., Endo K., Iryu Y.  
**A generalized monthly growth curve of modern brachiopod shells**
- 10:15-10:30      Robinson J. H.  
**Drill-hole repair in Cenozoic and Recent brachiopods**
- 10:30-10:45      Ye F., Angiolini L., Garbelli C., Shen S.  
**Evolution and fabric differentiation of Palaeozoic rhynchonelliformean brachiopod shells**
- 10:45-11:05      **COFFEE-BREAK**
- 11:05-11:20      Mages V., Casella L., Simonet-Roda M., Ye F., Crippa G., E. Griesshaber, Angiolini L., Schmahl W. W.  
**The intermediate stages of diagenetic overprint deduced from hydrothermally altered and fossil brachiopod shells**
- 11:20-11:35      Romanin M., Bitner M.A., Angiolini L., Gatta D. G., Brand U.  
**Cement-filled fossil brachiopod punctae and potential analytical bias in paleoenvironmental reconstructions**
- 11:35-12:00      *Keynote lecture*  
Rollion-Bard C., Milner Garcia S., Saulnier S., Burckel P., Vigier N., Angiolini L., Tomašových A., Henkel D., Jurikova H., Lécuyer C.  
**What can geochemical proxies tell about the biomineralization processes of brachiopods?**
- 12:00-12:15      Bajnai D., Fiebig J., Tomašových A., Milner Garcia S., Rollion-Bard C., Raddatz J., Löffler N., Primo-Ramos C., Angiolini L., Henkel D., Brand U.  
**Assessing kinetic fractionation in brachiopod calcite using clumped isotopes**
- 12:15-12:30      Smajgl D., Mandic M., Böhm F., Eisenhauer A.  
**New approach in stable isotope analysis of carbonates: isotope ratio infrared spectrometry**

- 12:30-12:45 Jurikova H., Liebetrau V., Gutjahr M., Krause S., Büsse S., Gorb S. N., Henkel D., Hiebenthal C., Schmidt M., Leipe T., Laudien J., Eisenhauer A.  
**Major and trace element composition and microstructure of cultured brachiopods – new proxies?**
- 12:45-13:00 Nishio T., Takayanagi H., Asami R., Shinjo R., Yamamoto K., Iryu Y.  
**Variations in trace element concentrations of modern brachiopod shells**
- 13:00-14:10 **LUNCH**
- 14:10-14:25 Müller T., Tomašových A., Mikuš T.  
**Variation of Mg/Ca in brachiopod shell: expression of growth rate rather than temperature seasonality**
- 14:25-14:40 Fuchs R., Lazar B., Angiolini L., Crippa G., Felletti F., Fruchter N., Eisenhauer A., Stein M.  
**Reconstructing  $^{87}\text{Sr}/^{86}\text{Sr}$  and  $\delta^{88/86}\text{Sr}$  in Pliocene-Pleistocene seawater by fossil brachiopods, bivalves, gastropods and foraminifera**
- 14:40-14:55 Wang W., Garbelli C., Shen S.  
**Permian strontium isotope stratigraphy based on brachiopod shells from South China**
- SESSION 4** *Mass extinctions and recovery*  
*Convenors: Shen S., Baliński A. and García Joral F.*
- 14:55-15:20 *Keynote lecture*  
Vörös A.  
**Mass extinctions and fatal extinctions in the history of brachiopods: review and post-Paleozoic cases**
- 15:20-15:35 Hughes Z. E., Belben R. A., Johnson K. G., Twitchett R. J., Hughes C.  
**Brachiomatic: utilising new museum collections digitisation protocols to examine brachiopod size across extinction boundaries cases**
- 15:35-15:50 Chen D., Rong J.  
**The linguliform and craniiform brachiopods from the latest Ordovician *Hirnantia* fauna of South China and Myanmar**
- 15:50-16:10 **COFFEE-BREAK**
- 16:10-16:25 Huang B., Jin J., Rong J.  
**Diversification patterns of brachiopods after the end Ordovician mass extinction and its palaeobiogeographic significance**
- 16:25-16:40 Mottequin B., Bartsch K., Simon E., Weyer D.  
**Evolution of the brachiopod assemblages at the Devonian–Carboniferous boundary (Hangenberg Crisis) in basinal facies from SE Thuringia (Germany)**



- 16:40-16:55 Jurikova H., Gutjahr M., Wallmann K., Flögel S., Liebetrau V., Posenato R., Angiolini L., Garbelli C., Brand U., Eisenhauer A.  
**Major marine carbon cycle perturbations during the Permian-Triassic mass extinction**
- 16:55-17:20 *Keynote lecture*  
Shen S., Ramezani J., Chen J., Cao C., Erwin D. H., Zhang H., Xiang L., Schoepfer S. D., Henderson C. M., Zheng Q., Bowring S. A., Wang Y., Li X., Wang X., Yuan D., Zhang Y., Mu L., Wang J., Wu Y.  
**A sudden end-Permian mass extinction in South China**
- 17:20-17:35 Wang F., Chen J., Dai X., Song H.  
**A new Induan (Early Triassic) brachiopod fauna from South China and implications for biotic recovery after the Permian-Triassic extinction**
- 17:35-17:50 MacFarlan D. A. B.  
**Early Jurassic terebratulide brachiopods from Zealandia**
- 17:50-18:05 Piazza V., Aberhan M.  
**Selectivity of temperature-related stresses towards brachiopods across the Early Toarcian (Early Jurassic) extinction event in Neo-Tethys**
- 18:05-19:00 **POSTERS**
- 19:00-20:00 **CONCERT**
- 20:00-23:00 **GALA DINNER**



**Friday, 14<sup>th</sup> September 2018**

- 08:30-09:20      **PLENARY LECTURE**  
*Moderator: Brand U.*  
Harper E. M.  
**Living brachiopods: hanging on or fit for a modern world?**
- SESSION 3**      ***Ecosystems in time and space***  
*Convenor: Harper D.A.T.*
- 09:20-09:45      *Keynote lecture*  
Zhang Z., Holmer L. E., Brock G. A., Topper T. P.  
**Paleoecological complexities during Cambrian explosion: evidence from brachiopods**
- 09:45-10:00      Topper T. P., Harper D. A. T.  
**Back to the beginning: the life and times of Cambrian brachiopods**
- 10:00-10:15      Liu F., Zhang Z., Chen Y., Chen F.  
**A diverse fossil assemblage from a new section through the Shipai Formation (Cambrian Series 2, Stage 4) in western Hubei Province, South China**
- 10:15-10:30      Pan B., Skovsted C. B., Li L., Li G.  
**The Cambrian Epoch 2 brachiopod fauna from the Xinji Formation, Shuiyu section of North China**
- 10:30-10:50      **COFFEE-BREAK**
- 10:50-11:15      *Keynote lecture*  
Harper D. A. T.  
**The rise of the rhynchonelliform brachiopods: the role of the great Ordovician biodiversification event**
- 11:15-11:30      Candela Y., Harper D. A. T., Mergl M.  
**Early Ordovician (late Tremadocian – early Floian) brachiopods from the Fezouata Shale, Anti-Atlas, SE Morocco**
- 11:30-11:45      Zhan R., Jin J., Rong J.  
***Foliomena* fauna: Macroevolution of deep water benthic communities with the environmental changes**
- 11:45-12:00      Cocks L. R. M., Torsvik T. H.  
**Useful and useless – brachiopods and palaeogeography**
- 12:00-12:15      Jansen U.  
**Evolution, stratigraphy and palaeobiogeography of late Pridolian–early Eifelian brachiopods from the Rhenish Massif (Germany)**
- 12:15-12:30      Guo W., Sun Y., Nie T.  
**Facies control on the Lower Emsian (Lower Devonian) brachiopod faunas in South China**

- 12:30-12:45 Balinski A., Halamski A. T., Racki G.  
**A diverse Early Frasnian brachiopod fauna from central Poland and its palaeoecological characteristics**
- 12:45-13:00 Halamski A. T.  
**Palaeobiogeography and evolutionary affinities of the Early Frasnian brachiopod fauna from central Poland**
- 13:00-14:00 **LUNCH**
- 14:00-14:15 Xu H., Zhang Y., Qiao F., Shen S.  
**A new Changhsingian (Late Permian) brachiopod fauna from the Xiala Formation at Coqen in the central Lhasa Block and its palaeogeographical implications**
- 14:15-14:40 *Keynote lecture*  
Twitchett R. J.  
**Brachiopods in post-Permian hothouse worlds**
- 14:40-14:55 Kiel S., Peckmann J.  
**The ecology of brachiopods in ancient methane-seep environments**
- 14:55-15:10 Dulai A., Özcan E., Less G.  
**Eocene brachiopods of the Thrace Basin (NW Turkey)**
- 15:10-15:25 García-Ramos D. A., Zuschin M.  
**Cyclicality of *Terebratula* pavements in a mixed carbonate-siliciclastic prograding wedge: Early Pliocene of SE Spain**
- 15:25-15:40 Buono G.  
**Brachiopods in Italy: a very long record and a new database**
- SESSION 2** *Taphonomy and Palaeoecology*  
*Convenors: Pérez-Huerta A. and Tomašových A.*
- 15:40-16:05 *Keynote lecture*  
Shiino Y.  
**Form and function of fossil brachiopods: insights into evolutionary morphology**
- 16:05-16:20 Tomašových A., Kidwell S. M., Müller T.  
**Time averaging of brachiopods in the southern California bight: implications for paleoecology, taphonomy, and conservation paleobiology**
- 16:20-16:35 **COFFEE-BREAK**
- 16:35-16:50 Cisterna G. A., Sterren A. F., Shi G.R.  
**Carboniferous-Permian glacial-deglacial events and their effects on the brachiopod faunas from Argentina and Australia**
- 16:50-17:05 Yuan Z., Sun Y., Shen B.  
**An *in situ* preserved late early Carboniferous brachiopod fauna in southern Guizhou, China**

- 17:05-17:20 Bahrammanesh M., Rezaee H., Mossadegh H.  
**Tournaisian (Mississippian) brachiopods from the Mobarak Formation, eastern Alborz (north Iran)**
- 17:20-17:35 Sun Y., Li T., Nie T., Shen B., Guo W.  
***Dzieduszyckia* in southern China: morphological variation and population dynamics**
- 17:35-17:50 Sproat C. D., Zhan R.  
**A late Katian (Late Ordovician) low diversity and high dominance brachiopod fauna from the Tarim Basin in Northwest China**
- 17:50-18:05 Chen J., Song H., Wang F.  
**Size evolution of brachiopods from the Late Permian through the Middle Triassic in South China**

## **POSTERS**

### **SESSION 1**

#### ***Systematics and evolution***

- 1 Bahrammanesh M., Zahabizadeh B., Alaeddini K.  
**Carboniferous brachiopods from NW Havar Lake (Damavand, N Iran)**
- 2 Berrocal-Casero M., Barroso-Barcenilla F., García Joral F.  
**Micronmentation and other external features as distinctive criteria for the Coniacian (Upper Cretaceous) terebratulides from Northern Spain**
- 3 Buono G.  
**Famous brachiopods, part 1: brachiopods in lapidary stones**
- 4 Buono G.  
**Famous brachiopods, part 3 – brachiopods in philately**
- 5 Legrand-Blain M.  
**Gigantoproductid and allied brachiopods from “L’ardoisiere” (Visean), northern Massif Central, France**
- 6 Leone M. F., Benedetto J. L.  
**Phylogenetic relationships of the Silurian Afro-South American Realm rhynchonellide brachiopods *Anabaia*, *Harringtonina* and *Clarkeia*: new insights from their ontogeny**
- 7 Mottequin B., Lefèvre U., Cisterna G. A.  
**A review of the brachiopod subfamily Septosyringothyridinae (Spiriferinida) from the Carboniferous of Laurussia and Gondwana**
- 8 Taddei Ruggiero E., Raia P.  
**The old, misnamed, misunderstood *Terebratula sinuosa***

### **SESSION 2**

#### ***Taphonomy and Palaeoecology***

- 9 Angiolini L., Banks V., Carniti A., Della Porta G., Stephenson M.  
**How mud mounds controlled brachiopod population growth and life-style in the Carboniferous: an example from the Viséan of Derbyshire, UK**
- 10 Baliński A., Skompski S., Szulczewski M., Zawadzka I.  
**The origin of the Middle–Late Devonian brachiopod shell concentration within intrashelf basinal carbonates in the Holy Cross Mountains (central Poland)**
- 11 Madison A., Kuzmina T.  
**The tube-like structures on the juvenile shells of strophomenids and billingsellids as evidence of their life cycles**
- 12 Pakhnevich A. V.  
**Preservation of brachiopod soft tissues outside the Lagerstätte conditions**

- 13 Pálffy J., Price G. D., Vörös A., Kovács Z., Johannson G. G.  
**Cold seep-related occurrence of the Early Jurassic rhynchonellid brachiopod *Anarhynchia* from the Canadian Cordillera**
- 14 Paredes R., Comas-Rengifo M. J., García Joral F., Duarte L. V., Goy A.  
**Disparity and diversity in Early Jurassic first colonizing brachiopods of the Lusitanian Basin (Portugal)**
- 15 Shiino Y., Tsuchida T.  
**A hydrodynamic approach to orthid brachiopod *Vinlandostrophia ponderosa*: reevaluation of zig-zag function**
- 16 Sklenář J.  
**Brachiopods of the Late Turonian hemipelagic strata of the Saxo-Bohemian Cretaceous Basin (central Europe)**
- 17 Stadtmauer D., Butts S.  
**Skeletal ultrastructure, ecology, and functional morphology of the Permian lyttoniid brachiopod *Pirgulia***
- 18 Viaretti M., Angiolini L., Heward A.  
**Lower to Middle Permian brachiopods from the Qarari Unit, Oman**
- 19 Zhang Y., Zhan R., Huang B.  
**Late Ordovician brachiopods from Xichuan, southwestern Henan, central China and their implications**
- 20 Zhang Z., Holmer L. E., Zhang Z., Chen F., Liang Y.  
**Brachiopods with soft parts from the Early Cambrian Wulongqing Formation (Series 2, Stage 4) of Yunnan, southern China**

**SESSION 3**      *Ecosystems in time and space*

- 21 Baeza-Carratalá J. F., Dulai A., Giannetti A., Soria J. M., Tent-Manclús J. E.  
**A new Late Tortonian brachiopod assemblage from the Mediterranean-Atlantic seaway (Guadix Basin, SE Spain)**
- 22 Vörös A., Escarguel G.  
**Brachiopod paleobiogeography in the western Tethys during the Early Jurassic taxonomic diversity maximum: identification of a new Pontic province**

**SESSION 4**      *Mass extinctions and recovery*

- 23 Baeza-Carratalá J. F., Dulai A., Sandoval J.  
**First brachiopod diversification in the Early Jurassic of the Subbetic platform (South-Iberian Paleomargin, Spain)**
- 24 Baeza-Carratalá J. F., García Joral F.  
**Adaptive response of brachiopod fauna to the environmental changes related to the Early Toarcian mass extinction event**

- 25 Serobyán V., Grigoryan A., Crônier C., Mottequin B., Taniel D.  
**The brachiopod record around the Devonian–Carboniferous boundary: insights from the sedimentary sequences of Armenia**
- 26 Vörös A., Dulai A., Fözy I.  
**Brachiopods and the Early Cretaceous Weissert event (Bakony Mountains, Hungary)**
- 27 Zhang Y., Wu H.  
**Early warning signals of marine benthic ecosystem prior to the Permian–Triassic boundary mass extinction event in South China**

**SESSION 5**      *Biologic mineralization of natural functional materials and archives of geochemical proxies*

- 28 Bruggmann S., Kläbe R., Frei R.  
**Chromium isotopes in brachiopods as a redox proxy**
- 29 Füger A., Kuessner M., Rollion-Bard C., Leis A., Dietzel M., Mavromatis V.  
**The effect of pH and precipitation rate on  $\delta^7\text{Li}_{\text{solid-fluid}}$  during the growth of calcite - an experimental approach**
- 30 Fujioka H., Takayanagi H., Yamamoto K., Iryu Y.  
**Quantitative study of geochemically diagenetic impact on fossil brachiopod shells from northeastern Japan**
- 31 Gaspard D.  
**Disorder introduced in the hierarchical architecture of selected fossil rhynchonelliform brachiopod shells**
- 32 Gaspers N., Magna T., Tomašových A., Henkel D., Jurikova H.  
**Lithium in brachiopods – proxy for seawater evolution?**
- 33 Isowa Y., Kito K., Endo K.  
**An immunological study of the shell matrix protein ICP-1 in brachiopods**
- 34 Jurikova H., Liebetrau V., Gutjahr M., Rollion-Bard C., Hu M. Y., Krause S., Henkel D., Hiebenthal C., Schmidt M., Laudien J., Eisenhauer A.  
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- 35 Kocsis L., Dulai A., Yunsi M., Cipriani A.  
**Geochemical study of *Megathiris detruncata*, a brachiopod species known since the Eocene in Europe**
- 36 Legett S. A., Rasbury E. T., Grossman E. L., Hemming N. G., Wright C. C.  
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- 37 Milner Garcia S. A., Rollion-Bard C., Burckel P., Müller T., Jurikova H., Tomašových A., Angiolini L., Henkel D.  
**Fossil brachiopod shell calcite: how well is the oxygen isotope composition and minor element ratios preserved within the shell microstructure?**

- 38 Romanin M., Crippa G., Ye F., Bitner M. A., Gaspard D., Häussermann V., Laudien J., Brand U.  
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- 39 Simonet-Roda M., X. Yin, Cross E., Harper E.M., Ziegler A., Schmahl W. W., Peck L., Griesshaber E.  
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- 40 Twitchett R. J., Paulus C., Hughes Z.E., Brownscombe W.  
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- 41 Ye F., Jurikova H., Angiolini L., Brand U., Crippa G., Henkel D., Laudien J., Hiebenthal C., Šmajgl D.  
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### *Modern brachiopods*

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- 43 Bitner M. A.  
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- 44 Buono G., Davidde B., Sacco Perasso C., Ricci S.  
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- 45 Endo K., Motchurova-Dekova N., Suzuki N., Maekawa Y., Takayanagi H., Hirose M.  
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- 46 Temereva E., Kuzmina T.  
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- 47 Posenato R.  
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eridine groups (the virgianids, stricklandiids, and clorindids), which in turn went through several pulses of radiations within their own clades in post-Rhuddanian times (notably the rise of pentamerids from virgianids) to become the dominant shallow marine shelly fauna, especially in tropical environments. From a small, subcircular, moderately biconvex, weakly ribbed shell of *Brevilamnulella*, the large, strongly ventribiconvex and variously ribbed virgianids evolved to dominate the inner- to mid-shelves by the late Rhuddanian, and the smooth virgianid *Borealis* gave rise to *Pentamerus* and pentameroid descendants that went through major diversifications from the mid Llandovery to Ludlow. During the Rhuddanian, both *Stricklandia* and *Clorinda* can be traced to the ancestral stock of *Brevilamnulella*, with the stricklandioids evolving towards a large, often flattened, strophic shell with distinct interareas and a relatively wide hingeline to adapt to relatively deep-water, soft muddy substrate in mid- to outer-shelf environment. The clorindioids retained a relatively small shell, but evolved towards a globular, tumid ventral umbo, to specialize in living in low-energy, deep water, on muddy substrates in the outer-shelf environment. The early Silurian diversification of pentamerides from *Brevilamnulella* was the result of rapid exploration and establishment in a wide range of ecological niches from shallow, high-energy settings to deep and quiet outer-shelf environments, left largely “empty” by the Late Ordovician mass extinction event.

## Major marine carbon cycle perturbations during the Permian-Triassic mass extinction

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The Permian-Triassic boundary-interval (PTB) witnessed the most severe environmental crisis in Earth's history, which dictated the course for evolution of life until today. Current lines of evidence on causation point towards massive flood-basalt magmatism from Siberian Traps, inducing a combination of global warming by ~6°C, substantial input of relatively light carbon to the atmosphere, sporadic to widespread anoxia or euxinia, and ocean acidification, however, the trigger mechanism and its feedbacks are yet to be fully understood. In order to reconstruct the potential changes in seawater chemistry during this time interval, we examined the boron isotope composition ( $\delta^{11}\text{B}$ ) of brachiopod shells. Although to-date hardly applied in Paleozoic settings, the  $\delta^{11}\text{B}$  of marine biogenic carbonates is considered to be one of the most reliable paleo-pH proxies (e.g., Gutjahr et al., 2017). Brachiopods present an advantageous and largely underutilised archive for Phanerozoic reconstructions considering their high abundance in the geological record and its origin dating back to the Early Cambrian.

Moreover, their low-magnesium calcite shell renders them more resilient to post-depositional diagenetic alteration of primary chemical signals. Using carefully chosen pre-screened (Brand et al., 2012) pristine specimens (class Rhynchonellata and Strophomenata), selected  $\delta^{11}\text{B}$  to pH relationships, and bulk seawater  $\delta^{11}\text{B}$  scenarios we present a high-resolution seawater pH record for the Tethys Ocean. This interval covers the negative carbon isotope excursion in excess of 4 ‰ and is associated with major climate and environmental changes that led to the mass extinction event. Our results show a significant decline in  $\delta^{11}\text{B}$  values succeeding the  $\delta^{13}\text{C}$  excursion, suggesting substantial and lasting suppression of seawater pH at the onset of the extinction event in the Late Permian related to carbon cycle perturbations. Combining our pH record with paired  $\delta^{13}\text{C}$  data and a quantitative modelling approach, we delineate unfolding carbon cycle dynamics that may have been responsible for initiating the catastrophic extinction. Using a new redox-resolving ocean model we determine the series of changes in the ocean chemistry that may have led to the gradual collapse of marine ecosystems terminating in the Early Triassic, which enables us to assemble the first congruent reconstruction of events throughout and post PTB mass extinction.

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## Major and trace element composition and microstructure of cultured brachiopods – New proxies?

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Reconstructing past seawater composition is fundamental for understanding the long-term geochemical processes and the functioning of Earth's systems. While brachiopods present

an advantageous archive for Phanerozoic paleo-reconstructions owing to their good preservation and abundance in the geological record, their proxy relationships have been hardly examined under controlled laboratory conditions. In contrast to other marine calcifiers only little is known regarding the mechanisms that control the incorporation of various key elements into brachiopod calcite. To evaluate the feasibility and robustness of multiple calcium-to-element ratios proxies we cultured *Magellania venosa*, *Terebratella dorsata* and *Pajaudina atlantica* under controlled experimental settings over a period of more than one year with closely monitored ambient conditions, carbonate system parameters and elemental composition of the culture seawater. The experimental setup used in this study includes control aquariums and treatments where the temperature, pH, and Mg/Ca composition of the seawater were manipulated. Using a solution-based ICP-MS mini-bulk approach as well as high spatial resolution electron microprobe maps we investigated the incorporation of several major and trace elements (Li, B, Na, Mg, Al, Ca, Mn, Fe, Zn, Sr, Cd, Ba, Nd, and U) into brachiopod calcite. To assess the effects of prolonged severe warming, acidification and chemical change of the seawater on the brachiopods and examine their potential links to the shell structure, we investigated the variations in shell density and punctae occurrence using micro-computed tomography (micro-CT). Combining the two approaches, we aim to provide new constraints for paleo-proxy applications. Emphasis will be also placed on the effect of extreme ambient condition on brachiopod survival and growth and their mechanisms to cope with such environmental changes – a key ability to withstand the increasing anthropogenic pressures.

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## Geochemical and physiological responses of brachiopods to ocean acidification – New insights from boron isotopes

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