



Palaeodiversity and evolution in the Mesozoic world

Borja Holgado¹  · Maite Suñer² 

Received: 15 February 2018 / Accepted: 20 February 2018 / Published online: 6 March 2018
© Springer International Publishing AG, part of Springer Nature 2018

1 Introduction

Mesozoic research is one of the most exciting issues within Earth Science. It embraces a large variety of matters such as the different types of biodiversity that are essential components of past biota. For instance, many questions remain about mass extinctions that marked the beginning and end of the Mesozoic, which are essential for a full understanding of biosphere dynamics. It is also important to note that during the Mesozoic many of the main extant lineages, i.e., mammals, birds, lepidosaurs, teleosts, and/or angiosperms, among others, arise into a complete changing world (e.g., Springer et al. 2003; Friis et al. 2010; Near et al. 2012; Jones et al. 2013; O'Donovan et al. 2018). Palaeobiological aspects of the Mesozoic diverse and contrasted fauna show us how was the private life of numerous lineages of animals, that thanks to the fossil record it is easier to think that they inhabit our same world millions of years ago.

This special issue entitled *Mesozoic Palaeodiversity and Evolution of Journal of Iberian Geology* includes 11 significant contributions from the thematic workshop ‘Palaeodiversity and evolution in the Mesozoic world’ within the framework of the 1st International Meeting of Early-stage Researchers in Palaeontology (IMERP). This meeting was held in conjunction with the 14th Iberian meeting of young researchers in palaeontology—better known by its Spanish acronym EJIP (*Encuentro de Jóvenes Investigadores en Paleontología*)—at the municipality of Alpuente (Valencia,

Spain) in April 2016. More than 35 communications were presented to this Mesozoic workshop, two of them corresponding to guest lectures of senior researchers (see Dalla Vecchia 2016; Kirkland 2016). Submitted communications provide a comprehensive view of current research lines and topics addressed by future generations of palaeontologists. The abstracts of all communications presented during the 1st IMERP/XIV EJIP meeting are available in Manzaneres et al. (2016). Contributions cover a wide range of topics, zoological groups and depositional environments, most of them from the Iberian Peninsula, but also from other localities from Europe and South America (see map on Fig. 1).

2 Mesozoic palaeodiversity and evolution

The Mesozoic Era is a geological time interval that lasted almost 190 million years, since the beginning of the Indian (251.9 million years ago, Ma) till the end of the Maastrichtian (66.0 Ma) (Cohen et al. 2013; updated, see also <http://www.stratigraphy.org/ICSchart/ChronostratChart2017-02.pdf> for further details). It is conventionally known as the ‘Age of Reptiles’, a phrase introduced by the 19th century palaeontologist Gideon Mantell (Dean 1999), who viewed it as an era dominated by large saurians such as dinosaurs, ichthyosaurs, mosasaurs, plesiosaurs, and pterosaurs, among others. The Mesozoic is subdivided into three periods: the Triassic, Jurassic, and Cretaceous, which are further subdivided into a number of epochs and ages (Cohen et al. 2013; updated). The Mesozoic was a time of significant tectonic, climate and evolutionary activity (e.g., García-Navarro 2005; Wallmann 2008; Jolivet 2015). For instance, during the Mesozoic took place the gradual rifting of the supercontinent Pangaea into separate landmasses that would eventually move into their current positions (e.g., Yoshida and Hamano 2015). Below, a series of thematic papers linked to this exciting temporal framework of Earth history is presented (Fig. 1).

✉ Borja Holgado
borja.holgado@mn.ufrj.br

Maite Suñer
maite.sunyer@uv.es

¹ Laboratory of Systematics and Taphonomy of Fossil Vertebrates, Departamento de Geologia e Paleontologia, Museu Nacional/Universidade Federal do Rio de Janeiro, Quinta da Boa Vista, s/n, São Cristóvão, Rio de Janeiro, RJ 20940-040, Brazil

² Museo Paleontológico de Alpuente, Avda. San Blas, 17, Alpuente, 46178 Valencia, Spain



Fig. 1 Stratigraphical distribution (left; modified and updated from Cohen et al. 2013) and present-day map (right) showing the localities and basins where the contributions of this special issue are placed

2.1 The Triassic (252–201 Ma)

The Triassic period, initiated aftermath the most devastating mass extinction that occurred at the end-Permian (see e.g., Shen and Browning 2014, and references therein), experienced important diversification pulses into a sustained recovery phase (Tong et al. 2007). Importantly, the Triassic involves the heyday of gymnosperms (Anderson et al. 2007), the early diversification of non-avian dinosaurs (Benton 2004; Langer et al. 2010), as well as other archosauromorphs (Nesbitt 2011; Ezcurra 2016), among other groups. Four papers are linked to this important time interval; working on Early Triassic deposits, Mujal et al. (2018) document in this volume an exceptional xiphosurid evidence from the lowermost Buntsandstein of the Catalan Pyrenees. From this contribution, authors describe two interesting ichnotaxa (*Selenichnites* isp. and *Kouphichnium* isp.) that represent the earliest Triassic evidence of life after the end Permian mass extinction of the Catalan Pyrenees, and potentially from the Iberian Peninsula, providing new insights into the composition of the earliest Mesozoic ecosystems following the end-Permian mass extinction.

Continuing with the Triassic record of marine realms, Manzanares et al. (2018a) bring to the reader the first chondrichthyan evidence of several Middle-Late Triassic fossil sites of the Betic Domain (South Iberian Peninsula). Importantly, new evidence is compared with other Iberian coeval faunas. A rich fossil assemblage is described

nowadays. The letters (a–k) denote each publication geochronologically ordered from the earliest to the most recent, and marking each period by ICS' colours

including more than five taxa. Based on the small size of all teeth recovered, authors suggest that the very shallow epicontinental environments recorded in Middle-Upper Triassic rocks characteristics of the Betic Domain may was used as nursery areas of involved organisms.

The reader is subsequently taken to the Late Triassic from the histology of the temnospondyl *Metoposaurus krasiejowensis*. Teschner et al. (2018) report new information about the growth patterns of this temnospondyl amphibian based on new fossil material from a clay pit near Krasiejów, southwestern Poland. In this study, authors combine standard histological thin-sections and microCT analyses. Results reveal uniform growth series resulting in one morphotype and two different histotypes. But most importantly, evidences suggest that the analysed *Metoposaurus* remains come from two different populations separated by space and/or time and/or a possible sexual dimorphism, which provides a particular novelty to this work.

Finally, the publication by Karádi (2018) contributes to new biostratigraphic investigations of the pelagic dolomites from Hungary (Buda Hills area). This study is based on new data of Late Triassic (Norian) conodonts and aims to discern the cause (e.g. sedimentary and/or tectonic) and biases derived from taxonomic practices that driven a scarce representation of the Alaunian conodont record. Results provide new insights into the main characteristics of the Lacián/Alaunian faunal turnover and bring a feasible framework for more studies that are comprehensive on the Middle Norian biostratigraphy.

2.2 The Jurassic (201–145 Ma)

The Jurassic involves the dominance of land ecosystems by dinosaurs (Wang and Dodson 2014; Tennant et al. 2016), a series of major changes of palaeogeography with the break-up of Pangaea rifting into two landmasses: Laurasia in the northern hemisphere, and Gondwana in the southern hemisphere (see e.g., Chaboureau et al. 2014). The emergence of these new supercontinents produced more coastlines and shifted the continental climate from dry to humid, replacing many of the arid deserts of the Triassic by conifer rainforests. The start of the period was marked by the major Triassic–Jurassic extinction event (McElwain et al. 1999). Two other extinction events occurred during the period (even though neither is ranked as a major extinction event): the Toarcian turnover in the Early Jurassic (Little and Benton 1995), and the Tithonian event at the end of the Jurassic (Hallam 1986). Manzanares et al. (2018b) provide the unique contribution to the Jurassic. In this paper, new data on the enameloid microstructure of Archaeobatidae sharks are presented. Notably, this study highlights that the observed structural complexity on Archaeobatidae is comparable to that recently described in others fossil batoids. This new scenario suggests a general trend to “simplification” in batoid enameloid, as present in the majority of current batoids.

2.3 The Cretaceous (145–66 Ma)

The Cretaceous marks the starting point of current terrestrial ecosystems, especially from the early and ‘explosive’ diversification of angiosperms (see Friis et al. 2010, and references therein for further discussion) and subsequent diversity pulses of insects, mammals and birds of the so-called Cretaceous Terrestrial Revolution (Lloyd et al. 2008). The Cretaceous is also characterized by the last great extinction of marine realms (Friedman 2009), as well as by the disappearance of non-avian dinosaurs (Archibald and Fastovsky 2004). Up to six contributions from the Cretaceous, with relevant information to the Iberian vertebrate fossil records, are presented herein. For instance, Alonso et al. (2018) describe a new fossil site located near Estercuel (Teruel, Spain) from the Oliete sub-basin, in the Lower Cretaceous (Barremian) Blesa Formation that is interpreted as a coastal-transitional depositional environment (Canudo et al. 2012). Similar to other sites from this formation, this fossil site contains an important tetrapod diversity. Evidence comes from several isolated theropod teeth. From this, Alonso et al. (2018) suggest the presence of several taxa belonging to Spinosauridae and non-spinosaurid tetanurans, probably related to Carcharodontosauria. Likewise, Parrilla-Bel and Canudo (2018) provide also new data from the Blesa Formation. Fossil remains of crocodylomorphs are reported, which is highly relevant considering that there is poor evidence

of this group during mid-Cretaceous times (Tennant et al. 2016), and encourages further studies in this interesting area on Barremian marine vertebrates.

On the other hand, Bellardini et al. (2018) present new titanosaur remains [from the Upper Cretaceous (Coniacian–Santonian)] Plottier Formation. It increases the Coniacian sauropod record of the Neuquén Basin and provides new knowledge about the stratigraphical distribution of Patagonian sauropods. New vertebrate data are also supplied by Bandeira et al. (2018) via an interesting study that compares the known fossil diversity of Theropoda, Baurusuchidae, and Titanosauria from the Upper Cretaceous (Campanian–Santonian) Bauru Group (Brazil), which introduce a taphonomic class of each fossil considered. From this, Bandeira et al. (2018) demonstrate that different degrees of bone representativeness and preservation quality pattern exist on these groups. This work further reveals that baurusuchids lived close to or in the abundant flood plains, while theropods and titanosaurs did not live on such environments, which would explain the unequal observed preservation. Authors support the idea that the Baurusuchidae played an important role in the food chain of the Upper Cretaceous Bauru Group, and highlight the relevance of taphonomic studies linked to these records.

Two contributions are based on the uppermost Cretaceous fossil record. Firstly, de Celis et al. (2018) performed a series of multivariate data analysis (cluster and ordination methods) working on fossil material of Allodaposuchidae collected from the Lo Hueco fossil site from the Late Cretaceous (Campanian–Maastrichtian) Villalba de la Sierra Formation (Cuenca, Spain). Interestingly, results suggest morphological differences between extant crocodylians and Cretaceous allodaposuchids, providing a better understanding of allodaposuchid postcranial elements. Authors conclude that the observed morphotypes suggest the presence of two different allodaposuchids in this site. In the last paper in this special issue, Díaz-Martínez et al. (2018) document a new sauropod (probably titanosaur) trackway from the Mesozoic–Cenozoic transition. These new data come from the Yacoraite Formation (Argentina). The sauropod tracks observed by Díaz-Martínez et al. (2018) is moderate to poorly-preserved and does not allow an assignment to a concrete ichnotaxon. However, two different general shapes can be differentiated, which suggests the presence of at least two different feet morphology within the clade Titanosauria in the uppermost Cretaceous.

3 Future perspectives

The new evidence presented in this special issue of *Journal of Iberian Geology* brings a reasonable idea of the state-of-the-art of the current research lines carried out by new

generations not only of palaeontologists from the Iberian Peninsula, but also worldwide. This series of papers also provide valuable information about emerging interrelationships between young researchers by working on the Mesozoic fossil record. Many of the works have documented new evidence from new fossil-bearing sites, even several first data of a concrete group of organisms from well-defined formations. In some cases, authors have demonstrated a great mindfulness by obtaining important information at evolutionary scale from apparently no so well preserved material, or a small number of specimens, which suggests a promising future for Mesozoic works. It is also important to note that new technics and cutting-edge analytical methods have been used, and in some cases implemented by first time, to elucidate biological affinities of vertebrate fossil remains that give evidence of new trends on palaeontological research from new generations. Therefore, we hope the exposed trends and works inspire further works on Mesozoic research, and continuing provided new insights into the Iberian fossil record.

Acknowledgements We wish to thank Prof. José T. López-Gómez and Prof. Javier Martín-Chivelet, editors-in-chief of *Journal of Iberian Geology*, the opportunity to publish this special issue. We also acknowledge all referees for their efforts and constructive evaluation of each contribution to this issue. We would like to acknowledge all those participants who have collaborate in the organisation of the 1st IMERP/XIV EJP. Special thanks to the people of the municipalities of Alpuente and Titaguas (Valencia, Spain) which hosted the meeting. Also thanks to the Museo Paleontológico de Alpuente, Museu de Ciències Naturals de València, and Fundació Conjunt Paleontològic de Teruel—Dinópolis, among others. Last but not least, we also would like to thank our colleagues of the Organizing Committee of the 1st IMERP/XIV EJP, and all the fellows which made possible this special event with their participations, as well as to authors who have contributed to the publication of this volume.

References

- Alonso, A., Gasca, J. M., Navarro-Lorbés, P., Rubio, C., & Canudo, J. I. (2018). A new contribution to our knowledge of the large-bodied theropods from the Barremian of the Iberian Peninsula: the “Barranco del Hocino” site (Spain). In B. Holgado & M. Suñer (Eds.), *Mesozoic palaeodiversity and evolution. Journal of Iberian Geology*, 1–17. <https://doi.org/10.1007/s41513-018-0051-9> (this issue).
- Anderson, J. M., Anderson, H. M., & Cleal, C.J. (2007). Brief history of the gymnosperms: classification, biodiversity, phytogeography and ecology. Pretoria, Strelitzia 20, South African National Biodiversity Institute.
- Archibald, J. D., & Fastovsky, D. (2004). Dinosaur extinction. In D. B. Weishampel, P. Dodson, & H. Osmólska (Eds.), *The dinosaurs* (2nd ed., pp. 672–684). Berkeley: University of California Press.
- Bandeira, K. L. N., Brum, A. S., Pêgas, R. V., Cidade, G. M., Holgado, B., Cidade, A., et al. (2018). The Baurusuchidae vs Theropoda record in the Bauru Group (Upper Cretaceous, Brazil): a taphonomic perspective. In B. Holgado & M. Suñer (Eds.), *Mesozoic palaeodiversity and evolution. Journal of Iberian Geology*, 1–30. <https://doi.org/10.1007/s41513-018-0048-4> (this issue).
- Bellardini, F., Baiano, M. A., Barrios, F., Holgado, B., & Coria, R. A. (2018). New Titanosauria (Dinosauria: Sauropoda) remains from the Upper Cretaceous (Plottier Fm) of southern Neuquén Basin (Patagonia, Argentina). In B. Holgado & M. Suñer (Eds.), *Mesozoic palaeodiversity and evolution. Journal of Iberian Geology*, 1–10. <https://doi.org/10.1007/s41513-018-0047-5> (this issue).
- Benton, M. J. (2004). Origin and relationships of Dinosauria. In D. B. Weishampel, P. Dodson, & H. Osmólska (Eds.), *The dinosaurs* (2nd edn., pp. 7–19). Berkeley: University of California Press.
- Canudo, J. I., Gasca, J. M., Moreno-Azanza, M., & Aurell, M. (2012). New information about the stratigraphic position and age of the sauropod *Aragosaurus ischiaticus* from the Early Cretaceous of the Iberian Peninsula. *Geological Magazine*, 149(2), 252–263.
- Chaboureaud, A.-C., Sepulchre, P., Donnadiou, Y., & Franc, A. (2014). Tectonic-driven climate change and the diversification of angiosperms. *Proceedings of the National Academy of Sciences*, 111(13), 14066–14070.
- Cohen, K. M., Finney, S. C., Gibbard, P. L., & Fan, J.-X. (2013). The ICS international chronostratigraphic chart. *Episodes*, 36, 199–204.
- Dalla Vecchia, F. M. (2016). Triassic pterosaurs, the first active vertebrate flyers. In E. Manzanares, H. G. Ferrón, M. Suñer, B. Holgado, V. D. Crespo, S. Mansino, et al. (2016). *New perspectives on the Evolution of Phanerozoic Biotas and Ecosystems, Conference proceedings* (pp. 82–83). Alpuente, Valencia: Ayuntamiento de Alpuente.
- De Celis, A., Narváez, I., & Ortega, F. (2018). Pelvic and femoral anatomy of the Allodaposuchidae (Crocodyliformes, Eusuchia) from the Late Cretaceous of Lo Hueco (Cuenca, Spain). In B. Holgado & M. Suñer (Eds.), *Mesozoic palaeodiversity and evolution. Journal of Iberian Geology*, 1–14. <https://doi.org/10.1007/s41513-017-0044-0> (this issue).
- Dean, D. R. (1999). *Gideon Mantell and the Discovery of Dinosaurs* (p. 312). Cambridge: Cambridge University Press.
- Díaz-Martínez, I., de Valais, S., & Cónsole-Gonella, C. (2018). New sauropod tracks from the Yacoraita Formation (Maastrichtian-Danian), Valle del Tonco tracksite, Salta, northwestern Argentina. In B. Holgado & M. Suñer (Eds.), *Mesozoic palaeodiversity and evolution. Journal of Iberian Geology*, 1–15. <https://doi.org/10.1007/s41513-017-0035-1> (this issue).
- Ezcurra, M. D. (2016). The phylogenetic relationships of basal archosauriforms, with an emphasis on the systematics of proterosuchian archosauriforms. *PeerJ*, 4, e1778. <https://doi.org/10.7717/peerj.1778>.
- Friedman, M. (2009). Ecomorphological selectivity among marine teleost fishes during the end-Cretaceous extinction. *Proceedings of the National Academy of Sciences*, 106(13), 5218–5223. <https://doi.org/10.1073/pnas.0808468106>.
- Friis, E. M., Pedersen, K. R., & Crane, P. R. (2010). Diversity in obscurity: fossil flowers and the early history of angiosperms. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 365(1539), 369–382.
- García-Navarro, E. (2005). Mesozoic tectonic evolution of the southwest continental Iberian Margin. *Geodinamica Acta*, 18(2), 131–144.
- Hallam, A. (1986). The Pliensbachian and Tithonian extinction events. *Nature*, 319, 765–768. <https://doi.org/10.1038/319765a0>.
- Jolivet, M. (2015). Mesozoic tectonic and topographic evolution of Central Asia and Tibet: a preliminary synthesis. *Geological Society, London, Special Publications*, 427, 19–55.
- Jones, M. E., Anderson, C. L., Hipsley, C. A., Müller, J., Evans, S. E., & Schoch, R. R. (2013). Integration of molecules and new fossils supports a Triassic origin for Lepidosauria (lizards, snakes,

- and tuatara). *BMC Evolutionary Biology*, 13, 208. <https://doi.org/10.1186/1471-2148-13-208>.
- Karádi, V. (2018). Middle Norian conodonts from the Buda Hills, Hungary: an exceptional record from the western Tethys. In B. Holgado & M. Suñer (Eds.), *Mesozoic palaeodiversity and evolution. Journal of Iberian Geology*, 1–20. <https://doi.org/10.1007/s41513-017-0009-3> (this issue).
- Kirkland, J. I. (2016). Utah's outstanding dinosaur heritage. In E. Manzanares, H. G. Ferrón, M. Suñer, B. Holgado, V. D. Crespo, S. Mansino, et al. (2016). *New perspectives on the Evolution of Phanerozoic Biotas and Ecosystems, Conference proceedings* (pp. 79–81). Alpuente, Valencia: Ayuntamiento de Alpuente.
- Langer, M. C., Ezcurra, M. D., Bittencourt, J. S., & Novas, F. E. (2010). The origin and early evolution of dinosaurs. *Biological Reviews*, 85(1), 65–66.
- Little, C. T. S., & Benton, M. J. (1995). Early Jurassic mass extinction: a global long-term event. *Geology*, 23, 495–498.
- Lloyd, G. T., Davis, K. E., Pisani, D., Tarver, J. E., Ruta, M., Sakamoto, M., et al. (2008). Dinosaurs and the Cretaceous terrestrial revolution. *Proceedings of the Royal Society B*, 275, 2483–2490.
- Manzanares, E., Ferrón, H. G., Suñer, M., Holgado, B., Crespo, V. D., Mansino, S., et al. (2016). *New perspectives on the Evolution of Phanerozoic Biotas and Ecosystems* (p. 204). Alpuente: Ayuntamiento de Alpuente. (Conference proceedings).
- Manzanares, E., Pla, C., Ferrón, H. G., & Botella, H. (2018a). Middle-Late Triassic chondrichthyan remains from the Betic Range (Spain). In B. Holgado & M. Suñer (Eds.), *Mesozoic palaeodiversity and evolution. Journal of Iberian Geology*, 1–10. <https://doi.org/10.1007/s41513-017-0027-1> (this issue).
- Manzanares, E., Botella, H., & Delsate, D. (2018b). On the enameloid microstructure of Archaeobatoidea (Neoselachii, Chondrichthyes). In B. Holgado & M. Suñer (Eds.), *Mesozoic palaeodiversity and evolution. Journal of Iberian Geology*, 1–8. <https://doi.org/10.1007/s41513-018-0049-3> (this issue).
- McElwain, J. C., Beerling, D. J., & Woodward, F. I. (1999). Fossil plants and global warming at the Triassic–Jurassic boundary. *Science*, 285(5432), 1386–1390. <https://doi.org/10.1126/science.285.5432.1386>.
- Mujal, E., Belaústegui, Z., Fortuny, J., Bolet, A., Oms, O., & López, J. A. (2018). Ichnological evidence of a horseshoe crab hot-spot in the Early Triassic Buntsandstein continental deposits from the Catalan Pyrenees (NE Iberian Peninsula). In B. Holgado & M. Suñer (Eds.), *Mesozoic palaeodiversity and evolution. Journal of Iberian Geology*, 1–15. <https://doi.org/10.1007/s41513-017-0026-2> (this issue).
- Near, T. J., Eytan, R. I., Dornburg, A., Kuhn, K. L., Moore, J. A., Davis, M. P., et al. (2012). Resolution of ray-finned fish phylogeny and timing of diversification. *Proceedings of the National Academy of Sciences*, 109(34), 13698–13703. <https://doi.org/10.1073/pnas.1206625109>.
- Nesbitt, S. J. (2011). The early evolution of Archosaurs: relationships and the origin of major clades. *Bulletin of American Museum of Natural History*, 352, 1–292.
- O'Donovan, C., Meade, A., & Venditti, C. (2018). Dinosaurs reveal the geographical signature of an evolutionary radiation. *Nature Ecology & Evolution* (advance online publication). <https://doi.org/10.1038/s41559-017-0454-6>.
- Parrilla-Bel, J., & Canudo, J. I. (2018). New longirostrine crocodylomorph remains from the Blesa Formation (Barremian) in Teruel (Spain). In B. Holgado & M. Suñer (Eds.), *Mesozoic palaeodiversity and evolution. Journal of Iberian Geology*, 1–12. <https://doi.org/10.1007/s41513-017-0043-1> (this issue).
- Shen, S.-Z., & Browing, S. A. (2014). The end-Permian mass extinction: a still unexplained catastrophe. *National Science Review*, 1(4), 492–495.
- Springer, M. S., Murphy, W. J., Eizirik, E., & O'Brien, S. J. (2003). Placental mammal diversification and the Cretaceous-tertiary boundary. *Proceedings of the National Academy of Sciences*, 100(3), 1056–1061. <https://doi.org/10.1073/pnas.0334222100>.
- Tennant, J. P., Mannion, P. D., & Upchurch, P. (2016). Environmental drivers of crocodyliform extinction across the Jurassic/Cretaceous transition. *Proceedings of the Royal Society B*, 283, 20152840. <https://doi.org/10.1098/rspb.2015.2840>.
- Teschner, E. M., Sander, P. M., & Konietzko-Meier, D. (2018). Variability of growth pattern observed in *Metoposaurus krasiejowensis* humeri and its biological meaning. In B. Holgado & M. Suñer (Eds.), *Mesozoic palaeodiversity and evolution. Journal of Iberian Geology*, 1–13. <https://doi.org/10.1007/s41513-017-0038-y> (this issue).
- Tong, J., Zhang, S., Zuo, J., & Xiong, X. (2007). Events during Early Triassic recovery from the end-Permian extinction. *Global and Planetary Change*, 55(1–3), 66–80.
- Wallmann, K. (2008). Mesozoic climate: Liverworts and all. *Nature Geoscience*, 1, 14–15.
- Wang, S. C., & Dodson, P. (2014). Estimating the diversity of dinosaurs. *Proceedings of the National Academy of Sciences*, 103(37), 13601–13605. <https://doi.org/10.1073/pnas.0606028103>.
- Yoshida, M., & Hamano, Y. (2015). Pangea breakup and northward drift of the Indian subcontinent reproduced by a numerical model of mantle convection. *Scientific Reports*, 5, 8407. <https://doi.org/10.1038/srep08407>.