Triassic-Jurassic biodiversity, ecosystems, and climate in the Junggar Basin, Xinjiang, Northwest China

T. Martin • G. Sun • V. Mosbrugger

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The Junggar Basin, one of the largest continental basins in Central Asia, represents a landlocked sedimentary environment that has been cut off from marine influence since the late Palaeozoic (Hendrix et al. 1992). The basin contains a largely fossiliferous sedimentary succession from the Permian to the Late Cretaceous (Dong 1992). Throughout the Mesozoic, the Junggar Basin maintained a mid-latitude position, making it particularly interesting for palaeoecologic and palaeoclimatic studies (e.g., Eberth et al. 2001). The focus of this issue is on the Late Triassic and Jurassic fluvio-lacustrine strata in the southern Junggar Basin that have yielded a wealth of continental biota in the last decade (e.g., Maisch et al. 2003), but other areas of the basin are also considered. The nine articles of the Special Issue report on the palaeontological and sedimentological research that has been conducted by the “Sino-German Joint Group of Palaeontology and Geosciences” funded

between 2005 and 2009 by the Sino-German Center for Research Promotion (Beijing). The topics addressed are basin development, sedimentology, reconstruction of the Jurassic forest, palaeoclimate, and the palaeobiogeographic and palaeoecologic implications of aquatic and terrestrial organisms such as hybodontid sharks, turtles, crocodiles, squamates, mammals, and plants. In its multidisciplinary approach, the Special Issue provides the first comprehensive overview of the evolution of the Late Triassic to the Late Jurassic ecosystems in the Junggar Basin with an emphasis on its southern part.

Bian et al. provide an overview on the geological evolution of the Junggar Basin from the Early Permian onward when the sea regressed to the southeast and the basin became landlocked. The Lower to Middle Triassic is characterised by alluvial fan and delta systems that are overlain by lacustrine deposits of the Upper Triassic. In the Lower and Middle Jurassic, coal-bearing braid delta systems developed while the Upper Jurassic was widely eroded except for a depocentre along the southern part of the Junggar Basin between the cities Manas and Urumqi. The Cretaceous is characterised by continuous and homogeneous lacustrine conditions with the depocentre located in the basin centre. During the Paleogene, braid delta systems developed, whereas with the early Neogene, sedimentation was restricted to the southern part of the basin, when the north Tianshan experienced a rapid uplift and northward over-thrust.

Ashraf et al. present a review and new data on the Triassic and Jurassic palaeoclimate development in the Junggar Basin. New lithological data mainly derive from the southern part of the basin and cover a period from the Late Triassic (Norian) to the latest Jurassic (Tithonian). Based on new palynological data, the authors convincingly demonstrate that the base of the Middle Jurassic does not coincide with the lithostratigraphical formation boundaries.

T. Martin (✉)
Steinmann-Institut für Geologie, Mineralogie und Paläontologie,
Universität Bonn,
Nussallee 8,
53115 Bonn, Germany
e-mail: tmartin@uni-bonn.de

G. Sun
Paleontological Institute of Shenyang Normal University,
Shenyang 110034, China

G. Sun
Key-Lab for Evolution of Past Life and Environment in NE Asia,
Ministry of Education, China (Jilin University),
Changchun 130026, China

V. Mosbrugger
Senckenberg Forschungsinstitut und Naturmuseum,
Senckenberganlage 25,
60325 Frankfurt am Main, Germany

During the Triassic and Early Jurassic, the climate was generally humid. The first basin-wide seasonal dry conditions occurred in the Middle Jurassic, and since the Late Jurassic, a seasonally dry climate has been permanently established in the Junggar Basin.

Sun et al. give a report on the Upper Triassic Huangshanjie and Haojiagou Formations, the Lower Jurassic Badaowan and Shangonghe Formations, and the Middle Jurassic Xishanyao and Toutunhe Formations that represent fluvial to fluvial swamp as well as lacustrine facies. The Late Triassic flora represents the “North China Flora” (*Daeniopsis-Bernoullia* Flora), and the Early to Middle Jurassic Flora belongs to the “Siberian Flora” (Continental Floristic Province). The palaeoclimatic development indicates a warming and moistening from the Late Triassic to the Early Jurassic. The warm-temperate climate of the early Middle Jurassic was favourable for the formation of coal, and these strata represent the largest coal, oil, and natural gas reservoir of the Junggar Basin.

Hinz et al. present a high resolution three-dimensional reconstruction of a fossil forest. The studied petrified forest is located in the Late Jurassic upper Shishugou Formation near Jiangjunmiao, in northeastern Junggar Basin. The high resolution digital computer model is based on tree stumps in growth positions and published data on megaplant fossils as well as seeds and spores. Sixty-five tree stumps with diameters between 0.2 and 2.9 m were mapped by the authors. The forest consisted mainly of araucarians and grew in a moist climate probably near the banks of a braided river. Although the density of the forest was only 22 trees/ha, according to the reconstruction it had a widely closed canopy. The understory of the forest consisted of *Angiopteris*, *Osmunda*, and *Coniopteris* as indicated by megaplant remains and spores.

Klug et al. report on a Late Jurassic (Oxfordian) freshwater shark assemblage from the Qigu Formation at the Liuhuanguo locality 40 km southwest of Urumqi. The assemblage shows a low diversity of only three taxa with two species of a new genus assigned to the Lonchidiidae. A third taxon probably represents a new species of the genus *Hybodus*. The shark species are endemic to the Junggar Basin. The low enameloid $\delta^{18}\text{O}_{\text{PO}_4}$ values in the teeth of the new *Hybodus*-species indicate an exclusive freshwater habitat which is in accordance with the other palaeoecological indicators of the Qigu Formation.

Rabi et al. give a review of the Mesozoic turtles of the Junggar Basin. The Jurassic taxa include the purportedly basal turtle *Sichuanchelys* as well as at least six basal eucryptodiran taxa, currently united in the probably paraphyletic “Xinjiangchelyidae”. Early Cretaceous taxa include only a single xinjiangchelyid and a potential pantrionychian, but are otherwise dominated by more derived eucryptodires (“Sinemydidae”/“Macrobaenidae”). The authors point out

that Asian turtle assemblages were rather homogenous during the Jurassic, but diverged in the Early Cretaceous. The Early Cretaceous Junggar turtle assemblage differs from those of most other Asian localities, which, according to the authors, is probably due to dry conditions in this isolated inland basin with ephemeral lake habitats that were favourable for basal eucryptodires.

Richter et al. report on Squamata and possible choristoderan remains from the Late Jurassic (Oxfordian) Qigu Formation of the Liuhuanguo locality. Screen washing yielded two lizard jaw fragments and two lizard osteoderm fragments jaw fragments that can be assigned to the Paramacellodidae as well as a few tentative choristoderan jaw and tooth fragments. These new findings represent the first record of Mesozoic lizards and probable choristoderes from the Junggar Basin and Northwest China and expands the palaeobiodiversity known from the Qigu Formation.

Wings et al. provide an overview of Mesozoic crocodyliforms from the Junggar Basin and describe new crocodyliform teeth from the Late Jurassic (Oxfordian) Qigu Formation of the Liuhuanguo locality. There are at least five crocodyliform taxa known from the Jurassic and Cretaceous of the Junggar Basin. *Sunosuchus junggarensis* and *Nominosuchus matutinus* derive from the Late Jurassic Shishugou Formation, and *Sunosuchus* is also known from the contemporaneous Qigu Formation. From the Early Cretaceous Tugulu Group, two crocodyliforms have been reported, of which *Edentosuchus tienshanensis* is represented by cranial material and represents the geologically youngest protosuchid. Screen washing at the Liuhuanguo locality has yielded a large number of isolated crocodyliform teeth, that were attributed to a shartegosuchid, to juvenile specimens of *Sunosuchus*, and to an unidentified mesoeucrocodylian. This mixture of basal and derived crocodyliforms is similar to that of the upper Shishugou Formation and differs from contemporary European and North American assemblages.

Martin et al. finally report on the Late Jurassic mammal assemblage from the Late Jurassic (Oxfordian) Qigu Formation at the Liuhuanguo site. Five mammalian taxa are represented by teeth and jaw fragments, comprising a new eleutherodontid haramiyid, the docodonts *Dsungarodon* and *Tegotherium*, an undetermined amphilestid triconodont, and a new species of the stem zatherian *Nanolestes* that was formerly known only from the Late Jurassic of Portugal. This represents the most diverse Late Jurassic mammal assemblage of Asia. The known Late Jurassic mammalian assemblages of Asia are similar to the Middle Jurassic assemblages from Asia and elsewhere in the world. The faunal turnover, leading to the mammalian communities char-

acteristic of the Early Cretaceous, probably occurred in Asia sometime after the Oxfordian, possibly during the Kimmeridgian.

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