Microfauna (conodonts, shark and fish teeth) and stable isotope geochemistry from the Middle Triassic (Upper Anisian-Lower Ladinian)

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All over the Germanic Basin, sediments known as Muschelkalk were deposited during the Middle Triassic. They are characterized by brachiopods and bivalves in rock-forming quantities as well as by a well-studied ceratite fauna, which allows a basin-wide correlation. The present study focuses on the Upper Anisian and Lower Ladinian (Upper Muschelkalk). The 90 m thick successions crop out near Stuttgart (SW Germany) and comprise bioclastic limestones as well as fine-grained, argillaceous limestones.

The data presented herein concentrated on the microfauna and stable isotope geochemistry in SW Germany. The microfauna consists of brachiopods, bivalves, fish and shark teeth, bones, scolicodontes, placoids, and conodonts. While conodonts are less abundant or even absent in fine-grained limestones, they are relatively high abundant in bioclastic limestones, and accumulations of conodonts were observed in ammonoids collected in the studied outcrops. Well preserved and big conodonts were found in stratigraphic older levels, whereas small-sized, poorly preserved and low-abundant specimens were collected from younger stratigraphic levels. This faunal change obviously occurs around the Cycloidesbank, a marker bed yielding masses of brachiopods *Coenothyris cycloides*. Therefore, a detailed bed-by-bed sampling, as well as carbon isotopes of micrites and oxygen isotopes of phosphate to reconstruct changing salinity and sea-water temperature were conducted below and above the Cycloidesbank. This aimed at a precise study of the faunal content and a reconstruction of environmental changes at this level, and helps to record migrations, immigrations or endemisms.

Bony and cartilaginous fishes from the Germanic Basin are mainly represented by isolated material such as teeth and scales. Partly preserved dentitions are also present but very scarce. All teeth and scales measure only a few millimeters in size leading to the assumption that the fishes were small with only a few dozens of centimeters in total length. The selachian fauna mainly consists of hybodont taxa, the extinct sister-clade to all extant sharks, skates and rays. Hybodontiformes were the most diversified cartilaginous fishes during the Palaeozoic and Early Mesozoic, dominating contemporaneous chondrichthyan faunas. The Muschelkalk shark assemblage presented herein is in fact very small concerning the specimens' size but diverse comprising very early representatives of a few hybodont groups, which were quite successful during the ensuing Mesozoic periods. Preliminary data of oxygen isotope values ($\delta^{18}O$) indicate low values between 15 and 19.5 ‰ $\delta^{18}O$ (V-SMOW) in the Germanic Basin, while, in comparison, values measured from time-equivalent Tethyan faunas are relatively high, and vary between 17.5 and 22.5 ‰ $\delta^{18}O$. Also, differences in the oxygen isotope values from coeval beds were measured between conodont apatite, fish and shark teeth, placoids, brachiopods, and scales. While values from conodonts, brachiopods (Lingula) and teeth crowns are highest, values from complete teeth, placoids and other scales, as well as from teeth without crowns are lowest. Therefore, diagenetic overprint can not be excluded especially for the lowest values, while the differences in oxygen isotope values between the Muschelkalk and the Tethyan faunas can be related to salinity and/or temperature.

To what extent the particular and changing environmental conditions of the Muschelkalk basin favored dwarfed fauna or were triggering the origin and/or radiation of specific vertebrate taxa still is ambiguous and need further comparative studies of faunal assemblages including geochemical analyses considering, i.e., changing salinities.

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Freshwater sharks (Chondrichthyes, Hybodontiformes) from the Late Jurassic Junggar Basin (Xinjiang, NW China)

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Hybodontiformes is an ancient group of cartilaginous fishes and sister to all living sharks, skates and rays, the Neoselachii. They formed an important component of Palaeozoic and Early Mesozoic fish faunas and occupied higher positions in trophic food webs. In the Triassic, they flourished and inhabitated a wide range of ecosystems from fully marine to fully freshwater environments. Most hybodont are reported from the Northern Hemisphere (Europe, North America), which, however, undoubtedly represents a collecting bias. Consequently, the knowledge of Mesozoic hybodont sharks from other parts of the world, especially

from Asia still is insufficient, although much progress in identifying fossil shark assemblages has been accomplished in the last two decades. In China, the known fossil record of hybodontiform sharks extends back into the Palaeozoic and a low-diversity assemblage was documented from the P/T-boundary in addition to few Mesozoic records.
Here, we document a small Late Jurassic hybodont shark assemblage from the Qigu Formation (Oxfordian) at Liuhuanggou in the southern Junggar Basin. It is of low diversity containing remains of three taxa based on isolated teeth. One of the species is assumed to be close to the hybodontid *Hybodus huangnidanensis* in tooth morphology. Although this taxon was previously described from Middle Jurassic estuarine deposits of South China, the available material is too fragmentary for an unambiguous determination. The other taxa represent two species of a previously unknown genus: *Jiaodontus montaltissimus* and *Jiaodontus vedenemus*. This genus is assigned to the Lonchidiidae and represents very small endemic species seemingly restricted to the Junggar Basin.
The teeth superficially resemble those of other lonchidiids such as *Parvodus* and *Vectiselachos*, but differ in several aspects including the morphology of cusp and cusplets and the ornamentation pattern. Both species assigned to *Jiaodontus* are very similar, however the asserted dental differences are interpreted as being related different resource adaptations for reducing intra-generic competition. Additionally, two different morphotypes of dermal denticles of hybodontiforms, possibly representing two species, are documented.
The bonebed from which the teeth were recovered most likely accumulated under freshwater conditions and the three shark taxa are considered to have been adapted to this regime. The oxygen isotope analysis of the tooth enameloid of H. sp. cf. *H. huangnidanensis* yielded low $\delta^{18}O_{PO4}$ values (9.7 ± 0.4‰, S.D., n = 5) indicating that at least this taxon was completely adapted to freshwater. This is in good accordance with the depositional setting and sedimentological results.

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First Mesozoic chimaeroid fish record (Holocephali, Chimaeriformes) from the Iberian Peninsula with comments on the Palaeoecology of *Ischyodus*

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Fossil cartilaginous fishes from the Mesozoic of the Iberian Peninsula have been only sporadically considered in the past. For instance, hybodontiform sharks were described from the Triassic of NE Spain, the Late Jurassic of Portugal and the Early Cretaceous of N and NE Spain. Neoselachian remains are known from the Late Jurassic of Portugal, the Late Jurassic and the Early Cretaceous of NE Spain and the Late Cretaceous of SE and N Spain. Fossil holocephalans, which represent the sister group of Elasmobranchii (Hybodontiformes + Neoselachii) and are the plesiomorphic group within Chondrichthyes, conversely, have not been reported from Portugal or Spain up to date. We present here the first Mesozoic holocephalan record from the Iberian Peninsula, which are assigned to *Ischyodus*.
The remains of *Ischyodus* were recovered from early Kimmeridgian (Late Jurassic) deposits in the Iberian Basin (Iberian Chain), which is located in NE Spain. It consists of a mandibular tooth plate, two incomplete and isolated symphyseal tritoral rods, and almost 20 frontal tenacular denticles. Based on the size and morphological features, the material represents different ontogenetic stages. The mandibular tooth plate is the smallest of a chimaeroid that has been described up to now. The unworn tritoral pads and unexposed symphyseal tritor as well as the little developed dentine layer, in which the tritors are embedded, support its embryonic origin. Additional isolated and fragmentary symphyseal tritoral rods, which are almost as large as the tooth plate, and isolated frontal tenacular spines of adults also occur in the fossiliferous strata. Unfortunately, it is not possible to assign these remains to any known species although close taxonomic connections to *Ischyodus egertoni*, which was a common species inhabiting the epicontinental seas covering wide areas of England and France during the Kimmeridgian are most likely.
In the Late Jurassic, extensive shallow epicontinental seas covered wide areas of Middle Europe and several important fish localities in England, France, and Germany