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26

4th International Symposium on Lithographic Limestone and Plattenkalk

Eichstätt/Solnhofen, Germany

September 12th-18th, 2005

- Abstracts and Field Trip Guides -

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Organised by

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Jura-Museum, Eichstätt

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Bürgermeister-Müller-Museum, Solnhofen

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– Abstracts and Field Trip Guides –

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Cover illustration: *Mesolimulus walchi* Desmarest; horse-shoe crab with its trail; Lower Tithonian, Solnhofen (BSPG AS I 944).

Umschlagbild: *Mesolimulus walchi* Desmarest; Pfeilschwanzkrebs mit Fährte; Lower Tithonian, Solnhofen (BSPG AS I 944).

The Contribution of Late Jurassic Fishes from Germany to Understand the Evolutionary History of Teleosts

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Jurassic fishes are known from localities in England, France, and Germany (many localities in the Solnhofen limestone) for over two centuries. Recently, important new discoveries in German localities such as Schamhaupten, Nusplingen, Ettling, and Daiting have enriched previous knowledge of the fish fauna, and several fishes are currently under study.

Studies of the fish fauna have followed their own "evolutionary" history.

(1) *Descriptive period; alpha taxonomy*. This long period has remained active up to now, when new discoveries are still made. It includes the last 40 years, beginning with O. Nybelin's revisions concerning ichthyodectiforms, *Anaethalion*, *Ascalabos*, *Leptolepides*, and *Tharsis*, and my own studies (e.g., *Ascalabothrissops*, *Eichstaettia*, *Elopsomolos*, *Daitingichthys*, *Orthogonikleithrus*, *Tischlingerichthys*). During most of this period, many of the basal teleosts (e.g., *Ascalabos*, *Leptolepides*, *Tharsis*) were erroneously interpreted as "leptolepids". Recently, approximately 11 new taxa have been described, including a new family. In this context, the taxonomy of fishes from Schamhaupten remains problematic because these fishes show morphological differences in comparison to late Late Jurassic species from the Solnhofen limestone.

(2) *Modern systematic approach*. Only in the last 10 years, the phylogenetic position and relationships of teleosts from the Late Jurassic have been investigated. These studies have produced significant results such as: I. A better understanding of the role of basal teleosts. II. New schemes of character transformations. III. Change of previous interpretations of oldest records of modern clades, e.g., anaethalionids from Schamhaupten are the oldest members of the Elopomorpha, whereas members of *Orthogonikleithrus* are the oldest members of the "Salmoniformes". Previously, it was accepted that modern teleostean lineages have arisen in the Cretaceous. IV. A new understanding of early teleostean radiation.

In the present contribution, new discoveries are presented and discussed in light of their importance to understand the evolution of Teleostei.

Geochemical Position of the Franconian Plattenkalk

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Fourteen Franconian plattenkalk occurrences from three distinct stratigraphical levels are described with regard to geochemistry, and compared to two well-known French sites (i.e. Cerin, Montdardier). All the plattenkalks are classified in a new system.

The geochemical characterization of platy limestones is difficult. This is due primarily to the fact that platy limestones are generally pure. Excellent correlation lines are usually displayed in two-element-diagrams of the "clastic elements" (Si, Al, K, Fe), especially if marls (or similar beds) are intercalated and analyzed.

The gradients of those correlation lines contain the geochemical information. The elements mentioned above allow six two-element-combinations. As a result, six different parameters are available. In less pure limestone sequences, the analysis of Ti and Rb also provides suitable results. Alltogether, 15 parameters can in theory be obtained. However, of the occurrences considered, only Montdardier and Maxberg fulfill these conditions.

The K/Si and K/Al ratios, respectively, are maximal at Montdardier, while they are minimal at Cerin and Maxberg. This is due to the mineralogy of noncarbonate residues: relatively high potassium values are caused by the dominance of illite, and lack of potassium is due to the presence of kaolinite. This, in turn, provides an insight into the climatic conditions during formation.

The Al/Si ratios are maximal at Cerin and minimal at Montdardier. The values from Franconia range between these extremes. Because the residue mineralogy in Franconia is more or less stable (except Maxberg), this effect is probably caused by transport conditions (fluvial input of clay minerals – high Al – versus aeolian input of silty quartz (high Si)). In this context, the significant decrease of noncarbonate contents from west to east in Franconia is remarkable.

Other element ratios cannot be discussed within the framework of this abstract.

The Schamhaupten locality exhibits a heavily silicified plattenkalk. Only its K/Al ratio is comparable to other occur-

rences. Moreover, geochemical analyses of the Schamhaupten plattenkalk demonstrates that Ba and P have been enriched during silification. The Zandt locality provides indicators for slight evaporation in the form of partial dolomitization of some of the "fäulen", and gypsum in the clay fraction of the insoluble residues.

Based on the simple but significant parameters 1) carbonate contents and 2) bed thicknesses of both limestones and marls ("flinze" and "fäulen") a new classification system can be established. Although especially the Franconian plattenkalks seem to be very similar, application of this system places each occurrence in a specific position.

Revision of the Age Relationships of Maxberg/Solnhofen

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The deposits commonly known as the "Solnhofen Plattenkalk" in fact consist of two stratigraphically independent units, of which the lower unit is relatively widespread in the area north of Eichstätt and southwest of Solnhofen. Historically, a system of old quarrymen terms has been applied to subdivide this lower unit in a very detailed, narrow-scale local stratigraphy. Later, Fesefeldt (1962) has optimized this system and documented its existence in numerous quarries. However, four quarries located southeastern of Solnhofen do not fit into this system. The best known (and best exposed) of these quarries is Maxberg. It has been hypothesized that the Maxberg group represents a higher stratigraphic unit. This hypothesis is supported by the following facts:

a) Differences in the bedding types. Eichstätt is the type locality of the bedding type "E" (Bausch et al. 1994). Maxberg, however, is a modified A/B-rhythmite, which resembles bedding type "C".

b) Geochemistry. The matrix of the Maxberg lithographic limestone differs significantly from all other Eichstätt quarries that have been studied in detail. This is due in part to

c) Noncarbonate residue mineralogy. Kaolinite does not occur in the Eichstätt beds, whereas noticeable amounts of kaolinite have been detected at Maxberg. This major discrepancy can perhaps best be explained by palaeoclimatic differences.

d) Sedimentological features. Recrystallization flakes (Münch 1955) occur in the Maxberg beds, but are absent in the Eichstätt strata.

e) Analogies 50 km to the east. On the sheets Schamhaupten and Riedenburg (west of Kelheim), a clear stratigraphic succession of Eichstätt-like plattenkalks occurs, which is overlain by "Runzelkalke". The geochemical, mineralogical, and sedimentological features of the "Runzelkalke" correspond to those recorded for the Maxberg quarry. The ammonite *Gravesia gigas* has been found in a horizon of the "Runzelkalke".

f) Significant geochemical differences in trace elements of the noncarbonate residues.

A Review of *Ctenochasma*: Taxonomy and Ontogeny

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The pterodactyloid pterosaur *Ctenochasma* is an important component of the vertebrate fauna of the Solnhofen Limestone. The genus was erected for a mandibular fragment with abundant slender teeth from the Purbeck of Deister bei Hannover, which was interpreted as a fish and named *C. roemeri*. A second species, *C. gracile*, was erected for a fragmentary upper jaw with similar dentition from the Solnhofen Limestone, but the specimen was not reinterpreted as a pterosaur until much later. Over the years, three more specimens were referred to *C. gracile*. They showed that *C. gracile* was a small pterosaur with elongate jaws bearing many long slender teeth forming a sieve for filtering small food items. A third species, *C. porocristata*, was erected for a large incomplete skull with a premaxillary crest because all previously known specimens of *Ctenochasma* lacked crests. Subsequently, I suggested that small specimens assigned to *Pterodactylus elegans* represented juveniles of *Ctenochasma* with short jaws and less than the adult complement of teeth. Recently, it was shown that specimens assigned to *P. elegans* and *C. gracile* fall on a single line when tooth number is plotted against skull length, and *P. elegans*, *C. gracile*, and *C. porocristata* were synonymized under the name *Ctenochasma elegans*. Thus *Ctenochasma* now contains three species:

1. *Ctenochasma roemeri*, based on a partial mandible, which had about 54 moderately slender teeth per side in its jaws.

2. *Ctenochasma elegans*, represented by more than a dozen specimens, which had up to 102 slender (more slender than *C. roemeri*) teeth per side.

3. An unnamed large species, represented by an incomplete skull from the Tithonian of France, which had about 103 slender teeth per side. This specimen is quite similar to *C. elegans* in tooth size and count, but is considerably larger.

The sample of *Ctenochasma elegans* consists of 13 specimens with skull lengths ranging from 33 mm up to 200 mm, and so provides an excellent growth series for examination of ontogeny. The skull, neck, antebrachium, and metacarpus exhibit positive allometry. In the skull, there is marked positive allometric growth of the rostrum and dentaries. The increase in tooth number is correlated with the growth of the rostrum and dentaries.

Comparison of the Tetrapod Assemblages from the Late Jurassic Plattenkalk Deposits of Western Europe

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The Late Jurassic Plattenkalk deposits of western Europe, generated in coastal marine environments of shallow carbonate platforms, are famous for their tetrapods. This work presents a comparison of these tetrapod assemblages (based both on bones and ichnites), despite several biases can affect the similarities (*e.g.* different collecting histories, depositional environments). Assemblages from six localities are compared: Porrentruy (Kimmeridgian, Switzerland), Solothurn (Kimmeridgian, Switzerland), Cerin (Kimmeridgian–Tithonian, France), Solnhofen (Tithonian, Germany), Crayssac (Tithonian, France) and Canjuers (Tithonian, France), that of Porrentruy resulting from excavations in progress in the Swiss Jura mountains (along the future course of the Transjurane highway).

The qualitative comparison shows five major similarities: (1) a predominance of reptiles in all the sites, birds occurring only in Solnhofen, an absence of amphibians and mammals; (2) a majority of continental and coastal marine families, a rarity or absence of pelagic forms; (3) a predominance of autochthones and parautochthones (4) a majority of carnivores and omnivores, herbivores being sauropod dinosaurs only revealed by ichnites (at Porrentruy and Solothurn); (5) an absence of large-sized terrestrial tetrapods, except some sauropods. According to these palaeoecological resemblances, it is proposed that the assemblages result mainly from an accumulation of balanced insular communities.

A cluster analysis (Raup-Crick, Jaccard and Dice similarity indices, UPGMA method) grouped assemblages according to their families. The resulting dendrograms indicate two major clusters: (1) the assemblages of Cerin, Solnhofen and Canjuers, whose branching topology varies depending on the similarity index; (2) the Swiss assemblages (Porrentruy and Solothurn). A single assemblage falls outside, Crayssac, the identification of its families being difficult because the majority of taxa are revealed by ichnites. According to the similarity measures, these communities appear related but not as similar as previously thought. Moreover, it would be interesting to test if the Swiss group could be interpreted in terms of biogeography or environment.

The Lower Cretaceous Crato Formation´s Ichthyofauna (Araripe Basin, Northeastern Brazil)

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The Crato Formation of the Araripe Basin is one of the richest fossil localities in the Lower Cretaceous of Brazil. Attributed as a typical continental freshwater environment, this stratigraphic unit has yielded hundreds of fossils of plants, invertebrates, fishes, and tetrapods.

Fossil fishes are very common in this formation where the ichthyofauna is dominated by the gonorynchiform genus *Dastilbe crandalli* (= *Dastilbe elongatus*) followed, in terms of number of specimens, by the ichthyodectiform *Cladocyclus gardineri.* Other taxa described from this Formation include

the semionotiform cf. *Araripelepidotes* sp., the coelacanth *Axelrodichthys* sp., and the amiiform *Calamopleurus* cf. *cylindricus*. Except for *Dastilbe crandalli,* all these taxa are relatively common in the slightly younger Santana Formation of the same basin.

In the present study I will show, for the first time, some new taxa such as an amiiform, a semionotiform, and a teleost *incertae sedis,* as well as two taxa previously known from other stratigaphical units such as the aspidorhynchiform *Vinctifer longirostris,* and the possible Ostariophysi *Santanichthys* cf. *diasii,* with a discussion on their paleoecological implications.

The Paleoecology of *Archaeopteryx* – A Re-Evaluation

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The paleoecology of *Archaeopteryx* is re-evaluated in light of the Jehol paleoecosystem. Both the Solnhofen and Jehol deposits result from episodic geologic events and contain fossil records of birds with remarkable feather preservation as well as similar faunal and floral elements.

The Upper Jurassic Solnhofen Plattenkalks represent shallow, saline lagoons and backwater reef basins. This biota also had terrestrial forms, including the oldest known bird, *Archaeopteryx*, apparently blown into the area by storms. The primitive birds were obviously preserved a distance from their natural habitat. The closest landmass to the north supported shrubs, conifers, and gymnosperms interspersed with open areas. This subtropical habitat was ideal for the skeletal adaptations seen in *Archaeopteryx* in which its climbing ability far outweighed its rudimentary flight attributes.

The Early Cretaceous lakes of Jehol were modified by episodic deposition of volcanoclastic sediments. The area surrounding these lakes had been forested by conifers and gymnosperms. Volcanoes acted as killing agents in a variety of ways and mass assemblages of fossil birds and dinosaurs were preserved close to their natural habitats. Within this assemblage were small, feathered forms such as *Microraptor*, with anatomy refined for life in trees and wings on the hindlegs for gliding.

Comparison and contrast of anatomy and functional morphology of *Archaeopteryx* and *Microraptor* reveals the sequence of acquisitions needed to evolve flight. Although Solnhofen was a sparsely forested habitat of shrubs and trees, it was adequate for the arboreal origin of flight. Additionally, anatomical evidence shows that *Archaeopteryx* was a rudimentary flier incapable of cursorial takeoff thereby taking advantage of the elevation found by climbing trees. *Microraptor*, having even more arboreal features, supports the assumption that gliding preceded flying.

Vertebrate-fossil Rich Plattenkalk of Pietraroia (Southern Appennines, Italy). A Sedimentological and Taphonomical Approach

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Pietraroia plattenkalks are richly fossiliferous, fine-grained cherty limestones, from the Matese Mountains – southern Apennines, Italy, and are well known for the exceptional state of preservation of the fossils.

Based on detailed taphonomical analyses, fossil assemblage recognised in the Pietraroia plattenkalk represents a taphocoenosis and an obruption deposit in the sense that most (if not all) of the animals were transported to an accumulation site from other places. A likely scenario could be described as a depressed area in which gravitative currents account for the mobilisation and transport of animals (both alive and dead individuals) from above with subsequent deposition well below the original place where they lived and/or died.

First considered as shallow lagoon deposits or as intraplatform small basin-fill, the Pietraroia plattenkalk sequences, on the basis of sedimentological analyses and geometrical reconstructions, are here interpreted as abandon-deposits of a submarine channel ("Pietraroia Channel") documenting a major transgressive event. Transgression was associated with the development of suboxic to anoxic conditions at the sea-floor which favoured the preservation of fossils as well as the deposition of coprolite-rich and bituminous layers found

within the plattenkalk sequences.

A peculiar paleogeographic and paleotopographic setting, strongly controlled by local tectonics, saw the contiguity of wide emerged areas with a relatively deep-water channelised area where fossiliferous plattenkalk sequences were deposited.

A new Theropod Dinosaur from the Upper Jurassic Limestones of Schamhaupten (Bavaria, Germany)

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Excavations directed by the Jura-Museum Eichstätt during the late 1990s resulted in the discovery of an exquisitely preserved theropod dinosaur from the Kimmeridgian limestones of Schamhaupten. Preserving nearly the whole skeleton – from the snout to the last third of the tail – and portions of integument, the new carnivorous dinosaur is undoubtedly the most completely known theropod in all Europe.

Evidence from the surface of its bones (intense pitting) and the existence of open centroneural sutures in its tail vertebrae suggest that the fossil corresponds to a very young individual. The fossil exhibits a relatively large skull with circular orbits and serrations in almost every tooth, forelimbs that are approximately half the length of the robust hindlimbs, and a very long tail.

Schamhaupten has produced fossil species known also from the slightly younger Solnhofen limestones but a number of morphological differences distinguish the new theropod from the celebrated *Compsognathus longipes*, the only known non-avian theropod from the Solnhofen limestones. Several characters support the assignation of the new fossil to Coelurosauria and other features place it phylogenetically closer to *Compsognathus* and other compsognathids.

Remains of soft tissues are preserved surrounding several portions of the skeleton, although they are best observed along the tail. Unlike other non-avian coelurosaurs with traces of integument (e.g., *Sinosauropteryx*, *Caudipteryx*, *Microraptor*), neither feathers nor feather-like structures are preserved in the new fossil. This evidence suggests that the evolution of feathers in theropod dinosaurs may have been more complex than previously envisioned.

The Upper Kimmeridgian Nusplingen Plattenkalk (W Swabian Alb, SW Germany)

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The Nusplingen Plattenkalk (also known as 'Nusplingen Lithographic Limestone') is less well-known than the famous Solnhofen Lithographic Limestone but in some layers it is much richer in fossils. Its age is late Kimmeridgian, and therefore is about 500 000 years older than the lower Tithonian Solnhofen Lithographic Limestone. The site of Nusplingen is located in the SW part of the Swabian Alb (S Germany) only few kilometres north of the Upper Danube Valley. The lamination results from small turbidites and probably seasonal accumulation of lime mud and plankton within a more or less anoxic environment. The laminates were deposited in a deep lagoon surrounded by sponge/microbial reef mounds, which were partly uplifted over the sea level as small islands. New excavations done by the Natural History Museum of Stuttgart provided new data about sedimentology, palaeoecology, taphonomy, and biostratinomy. Since 1993, more than 8000 specimens of 320 taxa have been recorded, among which many new species and exceptionally preserved findings are. The most spectacular fossils from the Nusplingen Plattenkalk are: plants like *Cycadopteris*, *Brachyphyllum*, *Araucarites*, *Podozamites*, and others; many species of moderately preserved radiolarians; sponges like the non-rigid Rhax-bearing *Codites*; ammonites and nautilids still showing in-situ their complete jaw apparatus and even their stomach-contents; belemnites very often bitten; teuthoids with ink sacks and beaks; marine worms in organic preservation; insects like dragonflies and beetles; the first Jurassic centipede, an isopod; many genera and species of crustaceans such as *Antrimpos*, *Dusa*, *Coleia*, *Cycleryon*, *Eryma*

etc.; bitten echinoids; brittle stars; crinoids like *Pterocoma* and *Saccocoma*; among vertebrates many selachians, holocephalans, crossopterygians and actinopterygian fishes; marine crocodiles like *Geosaurus* and *Dakosaurus*; pterosaurs with *Pterodactylus, Gallodactylus*, and *Rhamphorhynchus*. The ichnofauna is surprisingly diverse but mostly restricted to special layers. In contrast, coprolites are generally frequent. They tell interesting stories about sea life in and around the Nusplingen lagoon. The most typical and spectacular fossil of the Nusplingen Plattenkalk is the angel shark *Squatina acanthoderma*, usually completely preserved with its skin. In the bituminous layers of the upper part of the section the fossil preservation is very impressive. In the land plants coming from these layers even finest anatomical structures such as stomata are preserved. Also in the dragonflies finest wing structures are still visible. In the bituminous layers the formerly chitineous upper jaws of the ammonites are still preserved in organic matter. Under special circumstances of preservation and preparation the facets of the eyes within the lobster *Coleia*, the horseshoe crab *Mesolimulus* and the marine isopod are discernable. Within the former resin vessels of araucariacean cone scales amber was identified. In 2004 an almost complete skeleton of the marine crocodile *Geosaurus* with remains of the skin and stomach content was found. All this underlines the great importance of the Nusplingen fossil site for palaeontology. Therefore the excavations will be continued in the following years.

Coleoid Cephalopods from the Lithographic Limestones of Hâqel (Lebanon) – A Comparison with Solnhofen (Germany)

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The Lithographic Limestones of Nusplingen (Late Kimmeridgian, Upper Jurassic) and Solnhofen (Lower Tithonian, Upper Jurassic) as well as the Lithographic Limestones of Hâqel (Cenomanian, Upper Cretaceous) and Sâhel Aalma (Santonian, Upper Cretaceous) contain the best-preserved coleoids so far discovered. Because of its extraordinary soft-part preservation, each of these Konservat-Lagerstätten gives an indispensable insight into the morphological organisation and the evolutionary level of these ancestral coleoids. However, comparable Konservat-Lagerstätten, stratigraphically located between Solnhofen and Hâqel (a range of 50 million years), are missing, and interpretations regarding evolutionary transformations are therefore problematic.

While coleoid morphology and diversity of the German faunas are well investigated, knowledge about Lebanese coleoids is still comparatively scarce (Fraas 1878; Woodward 1883, 1896; Naef 1922; Engeser & Reitner 1986).

However, more than 40 newly investigated specimens from Hâqel (housed in the Museo Civico di Storia Naturale Milan) provided additional morphological and taxonomical information.

Among known taxa like *Dorateuthis*, *Glyphiteuthis* (=*Libanoteuthis*) and *Palaeoctopus* the collection yields an undoubted specimen of *Trachyteuthis* cf. *hastiformis.* The stratigraphic range of *Trachyteuthis* can, therefore, be extended from the Middle Jurassic into the lower Upper Cretaceous. In addition, a previously undescribed species was discovered, here informally-referred to *Rachiteuthis donovani* (Fuchs, submitted). Excellent soft-part preservation confirms previous theories that each of these specimens belongs exclusively to the eight-armed Vampyropoda.

Morphological comparisons between Jurassic and Cenomanian taxa show that especially gladius characteristics such as conus, lateral fields, median field and median keel exhibit in part significant transformations. The Hâqel fauna includes a mixture of almost unmodified (*Trachyteuthis*), slightly modified (*Dorateuthis, Glyphiteuthis, Rachiteuthis*) as well as strongly modified taxa (*Palaeoctopus*). There are no evidences for the presence of Decabrachia in Hâqel (as well as Sâhel Aalma).

The goal of the present work is to present the coleoids from Hâqel and to demonstrate the different evolutionary pathways that have occurred in the Vampyropoda during the Cretaceous.

References

Engeser, T. & Reitner, J. (1986): Coleoidenreste aus der Oberkreide des Libanon im Staatlichen Museum für Naturkunde in Stuttgart. – Stuttgarter Beiträge zur Naturkunde., Ser. B, **124:** 1-17.

Fuchs, D. (submitted): Diversity, Taxonomy and Morphology of coleoid Cephalopods from the Upper Cretaceous (Cenomanian) of Hâqel (Lebanon). – Paleontologia Lombarda.

Fraas, O. (1878): Geologisches aus dem Libanon. – Jahreshefte des Vereins vaterländischer Naturkunde Württemberg, **34:** 257-391.

Naef, A. (1922): Die fossilen Tintenfische – Eine paläozoologische Monographie. Jena (Fischer), 322 pp.

Woodward, H. (1883): On a new genus of fossil „calamary" from the Cretaceous formation of Sahel Alma, near Beirut, Lebanon, Syria. – Geological Magazine, N.S., **10:** 1-5.

Woodward, H. (1896): On a Fossil Octopus (*Calais Newboldi*, J. de C. Sby. MS.) from the Cretaceous of the Lebanon. – Quaternary Journal of the Geological Society of London, **52:** 229-234.

Sedimentology and Palaeoecology of Laminated Limestones from the Kimmeridgian of the Northern Franconian Alb (Southern Germany)

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At Wattendorf, situated northeast of Bamberg near the northern tip of the Franconian Alb, typical plattenkalk facies occurs as centimetre- to decimetre-thick intercalations between bedded limestones. These limestones form a wedge-like sedimentary package between underlying dolomitized microbialite-sponge reefs and the overlying so-called Wattendorf Limestone. The find of the ammonite *Aulacostephanus eudoxus* in the plattenkalk facies indicates a late Middle Kimmeridgian age, while the overlying Wattendorf Limestone is mainly Late Kimmeridgian in age. Thus, this occurrence is the oldest plattenkalk known so far from southern Germany.

In Summer of 2004, a 13 cm thick plattenkalk unit has been systematically excavated layer by layer across an area of 80 m^2. This corresponds to a rock volume of roughly 10.5 m^3. All fossils were recorded according to their stratigraphic position within the unit. This procedure resulted in a quantitative data set comprising approximately 3,500 objects. The microfacies of the plattenkalk is composed of alternations of finely laminated microbial layers (bindstones) and graded packstones. The latter exhibit a sharp base and clearly have been introduced into the depositional area from neighbouring shallows by density currents. In the bedded micritic limestones above and below the investigated package intercalations of such graded beds (commonly bio-rudstones) are common and may reach a thickness of up to 25 cm.

The fossil content of the plattenkalk facies is comparatively high. The most abundant fossil group are the brachiopods (50%) although they are represented only by two species, followed by bivalves (17%), cephalopods (6%), crustaceans (6%), echinoderms (5%) and a number of still rarer groups (fishes, gastropods, reptiles, algae, polychaetes, soft sponges and plants). Other fossil remains include coprolites (very abundant), "regurgitates", isolated fish scales, and aptychi). Considering that a number of groups have so far been surveyed only cursorily , the diversity (60 taxa) is quite high. The percentage of benthic elements of the total fauna is surprisingly high (>80%). The palaeoecological and taphonomic analysis of the benthic shelly macrofauna shows, however, that nearly all elements are allochthonous and were introduced into the plattenkalk facies from shallow water areas. Predominantly anoxic conditions are indicated by the undisturbed sediment, the lack of scavengers, and the preservation of soft parts. The only autochthonous element appears to be the bivalve *Aulacomyella,* which occurs as a rare faunal element throughout the plattenkalk facies but is common in a single horizon near the base. It is interpreted here as able to tolerate dysoxic conditions.

The depositional environment of the plattenkalk facies is envisaged as small, stagnant basins between shallows of former microbialite-sponge reefs. The lack of sponge remains within the plattenkalk facies and coral debris-bearing rudstones above the plattenkalk facies suggest that the microbialite sponge reefs probably were dead at the time and formed shallow water, hard substrate areas which were colonised by a pedunculate, byssally attached, cemented, and mobile fauna. This fauna was episodically swept from the platform by storms and, together with nektic elements (e.g., cephalopds, fishes, part of the crustaceans) accumulated in the dysoxic to anoxic basins.

Recent and Fossil Chelonian Kingdoms

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On the occasion of the First International Symposium on Lithographic Limestones (1991), the Aldabra lagoon (Indian Ocean, Seychelles) was presented as the closest environment found in the Recent that can be compared with the Upper Kimmeridgian Cerin lagoon (Southern Jura Mountain, France). The latter is characterized by true lithographic limestones and considered as one of the most famous Upper Jurassic lagerstätten. The main similarities between Aldabra and Cerin are:

tropical climate, proximity to emerged land, corallian substratum, protected lagoonal environment, very shallow water, frequent emersions, pure calcareous mud deposition, microbial mat proliferation, marine fauna mixing, and burrow zonation (Gaillard et al. 1994).

Aldabra Island is one of the last environments in the Recent dominated by Reptiles. Indeed, an interesting particularity of the isolated atoll of Aldabra is the occurrence of a natural population of more than 150,000 giant tortoises (*Aldabrachelys gigantea*). Occasionally, they tread on mudflats bordering the lagoon and form trackways. Similar fossil trackways occur in Cerin limestones (Bernier et al. 1982).

The interpretation of new trackways increases the interest of Chelonian faunas from Cerin. These trackways are 1.50 to 1.70 m wide and exhibit opposite footprints and web imprints. They are attributed to giant marine turtles, which swam with a simultaneous movement of their forelimbs, like the modern ones (Gaillard et al. 2003). Other abundant trackways are rather similar and could indicate the habitual presence of marine turtles. They swam in very shallow waters close to the land which was perhaps a nesting area. Aldabra is also a well-known nesting site for the green turtle (*Chelonia mydas*). Estimations based on trackway and pit counts suggest that about 700 turtles nest at Aldabra during a year (Gibson 1979).

All these observations strengthen the relatively high similarity between Cerin and Aldabra. These fossil and recent environments seem to be very favourable for Chelonians, both terrestrial tortoises and marine turtles, which abound and reach large sizes.

References

Bernier, P., Barale, G., Bourseau, J. P., Buffeteaut, E., Demathieu, G., Gaillard, C., & Gall, J. C. (1982): Trace nouvelle de locomotion de Chélonien et figures d'émersion associées dans les calcaires lithographiques de Cerin (Kimméridgien supérieur, Ain, France). – Geobios, **15:** 447-467.

Gaillard, C., Bernier, P. & Gruet, Y. (1994): Le lagon d'Aldabra (Seychelles, Océan Indien), un modèle pour le paléoenvironnement de Cerin (Kimméridgien sup., Jura méridional, France). – Geobios, Mém. sp.,**16:** 331-348.

Gaillard, C., Bernier, P., Barale, G., Bourseau, J. P., De Lapparent De Broin, F., Buffetaut, E., Ezquerra, R., Gall, J. C., Renous, S. & Wenz, S. (2003): An Upper Jurassic giant turtle revealed by its trackways. – Lethaia, **36:** 315-322.

Gibson, T. S. H. (1979): Green turtle (*Chelonia mydas* (L.)) nesting activity at Aldabra Atoll. – Philosphical Transactions of the Royal Society of London, B, **286:** 255-263.

Brachyurans from the Upper Jurassic (Tithonian) of Pfalzpaint and Breitenhill (Bavaria, South Germany)

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The Pfalzpaint quarry is located 10 kilometres east of Eichstätt and the fossils are well-known especially for their nicely preserved jellyfishes and numerous remains of horseshoes crabs, often with their trail behind. The ammonites of Pfalzpaint, *Neochetoceras bous*, *Silicisphinctes irregularis,* and *Taramelliceras rebouletianum*, suggest a latest Kimmeridgian age. The following decapod crustaceans were from Pfalzpaint: *Eryma modestiforme*, *Pseudastacus pustulosus*, *Mecochirus brevimanus*, *Magila desmarestii*, and *Pithonoton* sp.

The Öchselberg quarry near the village of Breitenhill is located 25 kilometres east of Eichstätt. The therein exposed lithographic limestones belong to the more biodetritic Öchselberg Member of the Painten Formation, the age of which is around the Kimmeridgian/Tithonian boundary. Decapods are said to be quite common, and recently the penaeid species *Bylgia ruedeli* was described from this locality.

Even though the three studied specimens, discovered in the Pfalzpaint and Breitenhill quarries, are poorly preserved they were ascribed or compared with *Pithonoton*, a genus already known from the Upper Jurassic of Germany. One specimen was assigned to *P. marginatum* for the some common morphological characters, one specimen was compared with *P. serratum* and the third specimen is poorly preserved and it was assigned in dubitative form to *Pithonoton* for the absence of the main morphological characters of the carapace useful for its systematic ascription.

Even though *Pithonoton marginatum* and *P. serratum* were already known from the Upper Jurassic of Germany, it was their second report from the lithographic limestones of the Pfalzpaint and Breitenhill quarries.

The Upper Jurassic Solnhofen Decapod Crustacean Fauna: Review of the Types from Old Descriptions

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Since many species of the decapod crustacean fauna from Solnhofen and Eichstätt were described by few or poorly preserved specimens, a review of the original sample, today housed in various museum's collections, was necessary in order to establish their true systematic validity.

The review of the penaeids documented the systematic validity of these species: *Aeger tipularius*, *A. elegans*, *A. spinipes*, *Acanthochirana cordata*, *A. longipes*, *A. angulata*, *Antrimpos speciosus*, *Rauna angusta*, *Bylgia spinosa*, *Drobna deformis*, *Dusa monocera*, *D. denticulata*, *Koelga curvirostris*. Among the species belonging to the same genera resulted these synonymies: *Aeger insignis* = *A. elegans*, *Aeger armatus*, and *A. bronni* = *A. tipularius* . Moreover, *Bylgia hexadon* is the type species of *Bylginella* nov. gen. mscr. and *Bylgia haeberleini* must be also included in this new genus; *Penaeus intermedius*, is the type species of *Eystaettia* nov. gen. mscr.; *Penaeus meyeri* is the type species of *Franconipenaeus* nov. gen. mscr.; *Penaeus latipes* is the type species of *Oppelicaris* nov. gen. mscr.

The review of the carideans documented the systematic validity of these species: *Blaculla nikoides*, *B. sieboldi*, *Hefriga serrata*, *H. frischmanni*, *Udora brevispina*, *Udorella agassizi*. Among the species belonging to the same genera resulted these synonymies: *Blaculla brevipes* = *B. nikoides*, *Rauna multipes* and *Hefriga subserrata* = *H. serrata*, *Udora rarispina* = *U. brevispina*. Moreover, *Dusa bronni* is the type-species of *Ctenodusa* nov. gen. mscr.

The review of the astacideans documented the systematic validity of these species: *Eryma modestiforme*, *E. veltheimi*, *Palaeastacus fuciformis*, *Pustulina minuta*, *Pseudastacus pustulosus*, *Stenochirus angustus*, *S. meyeri*, *Glyphea pseudoscyllarus*, *G. tenuis*, *Squamosoglyphea squamosa*, *Mecochirus longimanatus*. Among the species belonging to same genera resulted these synonymies: *Eryma leptodactylinum* = *E. modestiforme*, *Eryma verrucosum* = *P. minuta*, *Mecochirus bajeri* = *M. longimanatus*. Moreover, *Pseudastacus muensteri* is the female of *P. pustulosus*, and *Mecochirus brevimanus* is the female of *M. longimanatus*.

The review of the palinurids documented the systematic validity of these species: *Cycleryon propinquus*, *C. orbiculatus*, *C. elongatus*, *Eryon arctiformis*, *Knebelia bilobata*, *Palaeopentacheles roettenbacheri*, *Palinurina longipes*, *P. tenera*, *Cancrinos claviger*. Among the species belonging to the same genera resulted these synonymies: *Cycleryon armatus* = *C. orbiculatus*, *Knebelia schuberti* = *C. propinquus*; *Cancrinos latipes* = *C. claviger*, *Palinurina pygmea* = *P. longipes*. Moreover, *Cycleryon spinimanus* is the female of *C. propinquus*, *Eryon oppeli* is ascribed to *Rosenfeldia*, and *Cycleryon subrotundus* is probably a juvenile stage of *C. orbiculatus*.

The review of the thalassinids documented the systematic validity of these species: *Etallonia longimana*, *Magila latimana*, *Orhomalus deformis*. Among the species belonging to the same genera resulted these synonymies: *Magila robusta* = *M. desmarestii*.

Upper Cretaceous (Cenomanian-Turonian and Turonian-Coniacian) open Marine *Plattenkalk*-Deposits in NE Mexico

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Thin-bedded and millimetrically laminated platy marl quarried near Vallecillo, Nuevo León, NE Mexico, contains abundant marine vertebrates with an excellent state of preservation, for instance of fins and soft tissues. Planktic foraminifers, inoceramids and ammonoids are abundant throughout a 7.7 m thick section of these *plattenkalks*. They provide a precise and detailed biostratigraphic zonation from the latest Cenomanian to early Turonian. The abundance of fossil fishes allows the application of statistics and taphonomic investigations of the Vallecillo assemblage. Anoxic conditions near the sea bottom extend into the Lower Turonian and are related to the Cenomanian-Turonian Oceanic Anoxic Event 2 (OAE2). Vallecillo

thus provides a complete biostratigraphic record for marine invertebrates and vertebrates for the Cenomanian-Turonian boundary and Lower Turonian substage.

Another outcrop area with Upper Cretaceous *plattenkalks* in N Coahuila, Mexico is also under study by us, the limestone quarry El Rosario, 150km WNW of Muzquiz, and several other quarries in the vicinity. The alternating evenly layered platy limestone and fissile marly limestone, which is of late Turonian to early Coniacian age, yield an extraordinary rich fossil assemblage. The T/C transition is biostratigraphically complete, and is well documented by most ammonite, inoceramid and planktic foraminiferal marker species. The vertebrate fossils are well-preserved and in cases yield anatomical details of the soft tissues, which were replaced by fluorapatite at a very early stage of diagenetic mineralization, preceding or accompanying microbial decay. Our preliminary data suggest that the soft tissue preservation is a result of hyper-saturated solutions of phosphatic salts near the sea floor, in combination with anoxic conditions and rapid burial in a soft, micritic lime mud suspension.

Both the El Rosario and Vallecillo *plattenkalks* were deposited in an open marine shelf environment under stagnant low oxygen conditions. They represent *Konservat-Lagerstätten* that formed at the southern opening of the Western Interior Seaway into to the western Tethys, several hundreds of kilometres from the North American coastline, in water depths of at least 50m.

Fossil Assemblages from the Upper Cretaceous Carbon Rich Sediments of Kras, Slovenia

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Cretaceous and Paleogene beds of Kras were deposited in the northwestern part of the Adriatic-Dinaric carbonate platform. The dark platy and laminated limestones with chert occur at several apparently lithological horizons within different formations ranging from the Cenomanian to the Upper Santonian and Lower Campanian. These beds are rich in fossil content.

1. Komen limestone (Cenomanian) is a typical shallow water marine sediment formed within intertidal and lagoonal environment with low water energy. Fossils: plants (Conifera), fishes (Pycnodontidae, *Belonostomus*, *Chirocentrites*, Ichthyodectidae, Teleostei), reptile (*Carsosaurus*), crabs, bioturbations.

2. Komen pelagic limestone (Cenomanian–Turonian) is a result of the Cenomanian–Turonian eustatic sea level rise. It has been often discussed as evidence for the second oceanic anoxic event (OAE2). Fossils: fishes (*Enchodus*, *Ptychodus*), ammonites.

3. and 4. Komen limestone (Coniacian; Santonian). The third level and the fourth level are represented by alternating beds of biomicritic limestone, laminated limestone, flat pebble conglomerate and stromatolite. Fossils: plants (*Phlebopteris*, Conifera), fishes (*Coelodus*).

5. Tomaj limestone (Upper Santonian–Lower Campanian). Lithology and fossils point to a deeper depositional environment and good connection with the open sea. It is also related to the sea level rise during the Santonian–Campanian pelagic episode on the Adriatic-Dinaric carbonate platform. Fossils: plants (*Equisetites*, *Araucarites*?, *Brachyphyllum*, *Pagiophyllum*, Conifera, *Magnoliaephyllum*, *Eucalyptus*, *Sassafras*), jelly-fish, Echinodermata (Saccocomidae, Echinoidea), brachiopoda, bivalvia (*Exogyra*, *Ceratostreon*), ammonites, (Placenticeratidae), fishes ("Rhinobatidae", Pycnodontidae, *Chirocentrites*, Ichtyodectidae, Euteleostei, *Enchodus*, *Rhynchodercetis*, *Hoplopteryx*, Acanthopterygii, Teleostei), turtles, bird or dinosaur feather.

Selected references

Cavin, L., Jurkovšek, B. & Kolar-Jurkovšek, T. (2000): Stratigraphic succession of the Upper Cretaceous fish assemblages of Kras (Slovenia). – Geologija, **43/2:** 165-195.

Dobruskina, I.A., Jurkovšek, B. & Kolar-Jurkovšek, T. (1999): Upper Cretaceous flora of Slovenia. – Annales, **17:** 243-268.

Jurkovšek, B., Toman, M., Ogorelec, B., Šribar, L., Drobne, K., Poljak, M. & Šribar, Lj. (1996): Geological map of the southern part of the Trieste-Komen plateau. Cretaceous and Paleogene carbonate rocks. – IGGG, 143 pp.

Summesberger, H., Jurkovšek, B. & Kolar-Jurkovšek, T. (1996): Aptychi associated with ammonites from the Lipica-Formation (Upper Cretaceous, Slovenia). – Annalen des Naturhistorischen Museums Wien, **97A:** 1-19.

Complete Ammonoid Jaw Apparatuses from the Solnhofen Plattenkalks: Implications for Aptychi Function and Microphage Feeding of Ammonoids

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New findings of complete ammonitic jaw apparatuses are described from the Lower Tithonian Solnhofen plattenkalks. These finds consist of the large calcareous lower jaws (*Laevaptychus* and *Lamellaptychus*) and the non-calcified, small upper jaws, some of which are attached to the ammonite shells. The unequal development of the antagonistic mandibles and the significant reduction of the upper jaw to the internal lamellae only – without formation of a rostrum – confirm the postulate that the jaw apparatuses of aptychophore ammonites had lost their biting function. The aptychus itself was transformed into an operculum, while the relict of the upper jaw was functionally reduced to the attachment of the dorsal part of the upper mandibular muscle. Within the muscle system of the cephalopod buccal apparatus, only the bifurcated upper mandibular muscle was able to bring the aptychus in an upright position by contraction, owing to its deep insertion near the oesophagus. The fossil preservation of presumed muscular tissue sometimes observed inside the *Granulaptychus* of *Subplanites* from Solnhofen confirms that the required significant masses of musculature were present here.

The prerequisite for an operculum was the change from a predatory to a microphage, particularly planktotrophic behavior. A microphage nutrition is also evident from the fossil record of well-preserved stomach and crop contents, with remains of *Saccocoma* and young ammonites, in various ammonites of the Solnhofen plattenkalks.

On the other hand, the transformation of the mandibles into an operculum must have also influenced the morphology of the so-called cephalopodium. In all Modern cephalopods, the primary anlage of the tentacles occurs circularly around the mouth. Supposing that ten arms represent the plesiomorphic feature of Cephalopods, we presume that the aptychophore ammonites had fewer arms, because during closure of the body chamber by bringing the aptychus from the horizontal position into the vertical by contraction of the upper mandibular muscle system, the ventrally positioned tentacles would have been exposed in front of the aptychus, rather than protected behind it. Therefore, we suppose that – at least the aptychophore – ammonites reduced their ventral tentacles and had therefore eight or six arms only. An alternative, but less probable, explanation would be that the anlage of the arms in ammonites was – uniquely among the cephalopods – only dorsolateral, like a horseshoe.

Coleoid Beaks from the Nusplingen Lithographic Limestone (Late Kimmeridgian, SW Germany)

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Over twenty specimens of coleoid beaks were recovered from the Nusplingen Lithographic Limestone (Late Jurassic, Late Kimmeridgian, Beckeri Zone, Ulmense Subzone; SW Germany).

Based on their morphology, four forms of lower beaks and three forms of upper beaks can be distinguished among the finds. Two gladii of *Trachyteuthis hastiformis* are associated with a complete beak and hence enable taxonomic assignment of two beak forms. In one of the two specimens, the beaks are still articulated. A third specimen shows another form of upper and lower beak on one slab, which is interpreted with reservation as the beak elements of *Plesioteuthis prisca*. The largest type of upper beak probably belongs to *Leptotheuthis gigas* because of its scarcity and size. The remaining two forms are of uncertain taxonomic affiliation. The lower beak of *Trachyteuthis* resembles that of Recent *Octopus* and thus emphasizes a phylogenetic relation to the Octopoda, whereas the lower beak of Recent *Vampyroteuthis infernalis* has a diffe-

rent morphology. Nevertheless, the phylogenetic relationship between the Jurassic coleoids still remains somewhat cryptic. These originally chitinous organs are preserved in the Fossillagerstätte of Nusplingen probably because the bituminous sediments still contain a significant part of the original content of organic matter. Otherwise, these delicate structures would hardly be discernible without the colour contrast against the carbonate matrix.

Occurrence and Diversity of Palaeospinacid Sharks (Neoselachii, Synechodontiformes) from the Upper Jurassic Lithographic Limestones of South Germany

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Synechodontiform sharks are the basal group of Galeomorphii without extant representatives. They were small, bottom-dwelling sharks inhabiting shallow marine habitats. Eight genera, ranging from the Late Triassic to Eocene, have been described from the Northern and Southern Hemisphere. The majority of synechodontiform taxa are only known from isolated material such as teeth, fin spines, and placoid scales. Articulated material, especially jaws, vertebrae or complete skeletons are, conversely, extremely rare. Articulated specimens occur only in the Upper Jurassic lithographic limestones of southern Germany (Nusplingen, Solnhofen, Eichstätt), and in Lower Jurassic deposits of Lyme Regis (England).

The taxonomy of most clades within Synechodontiformes, especially of the Palaeospinacidae, is controversially discussed. The scarcity of skeletal specimens and the resemblance of isolated teeth are the main reasons for this dispute.

Up to now, only a single species of *Paraorthacodus*, the holotype of *P. jurensis*, has been described from the lithographic limestones of southern Germany. It is represented by the anterior, partially disarticulated section of the vertebral column and the branchial skeleton with gill arches, jaws and parts of the dentition. In addition to this specimen, only one up to now undescribed palaeospinacid – a new species of *Synechodus* – occurs in Nusplingen.

Although numerous sharks are known from the famous lithographic limestones of Solnhofen and Eichstätt, no species of *Paraorthacodus* has been reported from there so far. A revision of the Late Jurassic selachians from the Solnhofen area yielded the first evidence of this genus. The two completely preserved specimens, a juvenile and an adult one, are characterized *inter alia* by a single, spine-less dorsal fin. The adult individual is a female based on the absence of clasper organs.

The other palaeospinacid, *Synechodus*, is represented by two specimens in the Solnhofen area. One of them belongs to the same species that also occurs in Nusplingen, whereas the other one represents a different species based on skeletal characters.

The find of completely articulated specimens of *Paraorthacodus* and *Synechodus* provides new insights into the systematics of Palaeospinacidae, their diversity and occurrence in the Upper Jurassic reef environments of southern Germany.

New Data on Sedimentology of Upper Jurassic Carbonate Rocks from the Southern Franconian Alb.

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Upper Jurassic (Malm delta - zeta 1) massive limestones (algal-sponge-reefs, sponge-reefs, reef-complexes, reefs, algal-sponge-bioherms, biolithites, Massenkalk, bioherms, Stillwasser-Mudmounds) were analyzed some years ago in the Southern Swabian Alb within the frame of a multidisciplinary DFG-study. It could be shown that the largest part (70 %) of the massive limestones consists of a peloid-lithoclast-ooid sand facies rich in completely micritized ooids. This corresponds to a shallow water carbonate sand facies as deposited recently in parts of the great Bahama Bank and in Florida (e.g. Joulters Key oolite).

Analyses carried out in the last five years in the Southern Franconian Alb (Dollnstein, Burgstein, Konstein, Eichstätt) showed that the data can be overtaken without any problems.

True biogenic constructions only occur within and at the margins of this carbonate-sand-facies which is interpreted as platform sands. The spatial distribution of the buildups (sponge-algal-mudmounds, algal-sponge-boundstones, brachiopod-algal-sponge mounds) in relation to the sand facies was probably controlled by hydrodynamic conditions.

This facies model allows to describe classical carbonate facies as the Treuchtlingen limestone, the "Dollnstein Reef" and the "Dohlenfels-Reef" more in the light of modern carbonate sedimentation as particle facies deposited in shallow water environments lithified during early diagenesis by shallow marine phreatic cements. Furthermore vertical patterns of repeated variations on the type of cementation (marine phreatic, granular) probably indicate a shallow subtidal to intertidal environment. Consequently real sponge-reef occurring locally were formed in a shallow marine environment and not in a deeper environment below wave base as interpreted before.

Characteristics of Solnhofen Monument Stones

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The extremely fine-grained Solnhofen limestone is commonly used for epitaphs, grave plates, and very precise sculptures. Furthermore the use of Solnhofen limestone as plates for roof covers is well-known giving a marked contribution to the characteristic pictures of historical houses in Southern Franconia.

The technical use is based on the unique petrophysical parameters of Solnhofen limestone which are caused by a special facial and diagenetic history of the rock. Porosity, permeability, pore-radii, and inner surface are triggered by the homogenous micro-nanostructure of the limestone which was caused by the sedimentation of micritic particles probably under suspension-like conditions into an extremely calm (low-energy) environment. Special geochemical conditions hindered early recrystallisation and thus resulted in the preservation of early sedimentary characteristics.

These parameters result e.g. in an extreme low permeability which on the other hand is the prerequisite for the use of the Solnhofen limestone as lithographic limestone. The limited water uptake together with the homogenous microtexture hinders deep penetration of surface weathering. On the other hand there seems to be no possibility for the conservation of weathered-damaged sculptures made of Solnhofen limestone because of the extremely limited permeability which just allows material transport in a diffusion scale.

Fortunately, these characteristics are predominantly responsible for the good preservation of famous fossils found in the Solnhofen limestone.

Late Jurassic Carpetsharks (Neoselachii, Orectolobiformes) from South Germany

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Carpetsharks of the order Orectolobiformes are plesiomorphic galeoid neoselachians with a fossil record consisting mainly of isolated teeth and ranging back to the Early Jurassic some 190 million years ago. Articulated skeletons are only known from the Kimmeridgian and Tithonian (Late Jurassic) lithographic limestones of southern Germany and France, and the Santonian (Late Cretaceous) of Lebanon. The Jurassic was indisputable an important period in the evolution and radiation of modern neoselachian sharks and rays. Only few modern lineages of neoselachians were present in the Early Jurassic although the fossil record of neoselachian sharks can be traced back into the Triassic with confidence. However, the absence of modern neoselachians lineages before the Jurassic suggests that there was probably no modern neoselachian radiation event prior to the Early Jurassic.

The lithographic limestones of southern Germany (Nusplingen, Solnhofen area), which are late Kimmeridgian and early Tithonian in age, and their lateral equivalents in France of early Kimmeridgian age, are amongst the most famous fossil fish localities world-wide, because they produced well-

preserved skeletons of vertebrates. Nevertheless, carpetsharks are rather rare in the Jurassic lithographic plattenkalks of the Solnhofen area but absent in Nusplingen. The only known orectolobiform from the Solnhofen area so far is *Phorcynis catulina*, which was originally described from Cerin (France). All other European Jurassic orectolobiforms are only known from their fossilised teeth. Here, we present a re-examination of *Phorcynis*. Its systematic position is explored using cladistic principles and the taxon is consequently assigned to a new family. In addition, a new carpetshark is presented. The single specimen is, unfortunately, not completely preserved but it displays the important characters allowing its assignment to the Orectolobidae. The dental morphology of the new taxon differs, however, significantly from that of modern orectolobids. Both genera are the only Late Jurassic orectolobiforms known from articulated skeletal material.

Sedimentology and Taphonomy of Dinosaur Track-bearing Plattenkalke (Kimmeridgian, Canton Jura, Switzerland)

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Since 2002 the "Palaeontology A16" systematically excavates dinosaur tracks in early Late Kimmeridgian platy limestones (Plattenkalke) along the "Transjurane" highway.

The tabular and thinly-bedded platy limestones have a stromatolitic appearance in the field, which, however, is difficult to recognize in polished slabs or thin sections. Bedding planes yield a diverse tetrapod ichnocoenose exhibiting different size-classes of both sauropod and theropod dinosaur tracks. They also display desiccation cracks and wave and current ripples. The layer-by-layer excavation clearly identifies overtracks, true tracks (elite tracks) and undertracks, whereas dinoturbated layers generally consist of true tracks as well as over- and undertracks stemming from adjacent levels.

Several sauropod tracks have been artificially consolidated and cut into serial sections. Together with the sedimentological and ichnological data gained from bedding planes, the cross sections allow conclusions about the genesis and the taphonomical history of a given dinosaur track and the substrate consistency at the time of the track formation respectively.

Sedimentological and ichnological analysis of the platy limestones combined with track taphonomy and palaeoecological information allow a subdivision into several different units. These units correspond to different palaeoenvironments ranging from shallow lagoon to beach and to supratidal flat (algal marsh). In similar recent environments of the Bahamas and the Sabkha El Melah (Tunisia), a wide range of track morphologies has been observed, which are basically due to differences in water content of the sediment, the presence of microbial-algal mats that bind and stabilize the sediment, and early-diagenetic carbonate cementation, even if exceptional behaviour of the trackmaker is present or weathering affects the track morphology. To conclude, the understanding of track taphonomy helps to characterize the palaeoenvironment and is indispensable for ichnotaxonomical classification.

The Fish Fauna of the Messel Pit: Rule or Exception?

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The fish fauna of the world-famous middle Eocene fossil site Messel Pit (8 km NE of Darmstadt, Hessen, S Germany) presently consists of eight nominal genera and species. According to morphological details, however, most Messel fish species clearly exceed the degree of variation known from closely related extant or fossil forms and the Messel fish fauna may represent the onset of an ancient speciation. Messel fishes are furthermore distinguished by a set of other peculiarities. These bear valuable information for the reconstruction of the palaeoecological framework, and some of them may furthermore represent general traits of various fossil fish associations, which are not restricted to the Messel ichthyofauna. Messel fishes seem to be "survival artists" showing direct evidence for the recovery from a large variety of negative events. There is, e.g., a predominance of specimens which are preserved with evacuated digestive tracts. And in the few records showing prey

item remains, these are either indicating rare forage species, or others which cannot be expected according to the general morphology of the respective predators. Not rarely, there are healed fin ray breakages and scales which are characteristic for recovery from ectoparasite infestations or avitaminoses. The most puzzling feature, however, is the high degree of scale regeneration. This is obvious from all Messel fish species, except the unique record of the eel *Anguilla ignota* and the gars. In some of them, the relative number of regenerated scales is more than twice as much as in closely related extant forms. Generally, scale regeneration is rather common in various extant fish species and almost exclusively results from superficial injuries. Scale loss may be due to a rough habitat, predator attacks, injuries by lepidophageous species, rival combats and territorial behaviour. In certain species, scales get frequently lost during spawning. However, most of these possibilities can be discarded for the Messel fish species. The fishes may have lost scales during their immigration into the lake (e.g., via small inlets or during high water periods). This, however contrasts the fact that the ancient Messel lake is a maar and probably was an isolated structure for extended periods of time.

New Data about the Age and Palaeoenvironment of the "Pesciara di Bolca" Fossil-Lagerstätte

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The "Pesciara di Bolca" (Verona Province, Northern Italy) is one of the most famous fossil-lagerstätten, known since the mid XVI century for its spectacularly preserved fish faunas. The latter were extensively studied during past years (e.g. Sorbini 1972), but little or no attention at all was spent on the invertebrate microfauna (especially foraminiferans) and to the facies analysis.

The larger foraminiferans present in the Pesciara succession were up to now neglected because they show signs of transport and, therefore, they were considered as reworked. A careful analysis of the field and microfacies features allowed us to conclude that the foraminiferans are certainly mostly transported, but with no signs of a real reworking. Moreover, the *Alveolina* assemblages from all the collected samples belong to the same biozone (*Alveolina dainellii* Zone, SBZ 11 or Middle Cuisian) except for some extraclasts in the lower portion of the succession, where silicified alveolinids indicate the underlying SBZ 10 (*Alveolina oblonga* Zone, Early Cuisian).

Previously, the age of the Pesciara was given as Early-Middle Eocene, relying on a single-sample attribution to the nannoplankton zone NP 14 (*Discoaster sublodoensis* Zone; Medizza 1975). Now, the *Alveolina* assemblages recognized over the whole succession allow a more stable dating.

The facies analysis allowed us to distinguish between strictly autochthonous micritic limestones and allochthonous biocalcarenites-biocalcirudites. The former represent the fish-bearing levels, probably settled within an oxygen-depleted paleoenvironment accounting for the exceptional preservation of fossils. The latter, containing the larger foraminiferans, were probably the result of storm-induced transport from nearby very shallow sea bottom.

The presence of emerged lands close to the Pesciara "basin" is testified by several continental fossils of both plants and animals (especially insects). The recent discovery of amber within the Pesciara limestones reinforces this interpretation (Trevisani et al. 2005, in press).

References

Medizza, F. (1975): Il nannoplancton calcareo della Pesciara di Bolca (Monti Lessini). – Studi e ricerche sui giacimenti terziari di Bolca, **2:** 433-444.

Sorbini, L. (1972): I fossili di Bolca. – Museo Civico di Storia Naturale di Verona; 133 pp.

Trevisani. E., Papazzoni, C.A., Ragazzi, E. & Roghi, G. (2005, in press): Early Eocene amber from the "Pesciara di Bolca" (Lessini Mountains, Northern Italy). – Palaeogeography, Palaeoclimatology, Palaeoecology.

New Colobodontid (Actinopterygians) from the Carnian (Late Triassic) of Northern Italy

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The importance of the Lagerstaetten is universally recognized. The find of a large number of fossils of different organisms, often exceptionally preserved, in just one site, whose stratigraphic position is clear and whose accurate paleoenvironmental reconstruction is possible, considerably widens our knowledge of the past fauna and flora. Unfortunately, this ideal condition is rather rare, and most times we deal with isolate remains coming from units with uncertain stratigraphic position.

This is the case of the colobodontid fragments recently found in the Raibl Group of several Carnian localities (Friuli, Northern Italy). Because of the particular morphology of the territory and the nature of the outcrops along very steep creeks, systematic excavations are particularly difficult: fossils are often found in the debris. Also very difficult is to define to which among the three units of the Raibl group (Predil Limestone, Rio del Lago Formation and Rio Conzen Limestone), the fossils effectively belong. The weakly marly calcareous matrix apparently point to the Rio del Lago Formation. In any case, despite their scarcity and the uncertain stratigraphic position, the Friuli fossil remains at issue turn out to be very interesting: being the only certain record of colobodontids from the Carnian, the distribution of this family is consequently widened. Actually, the presence of these basal actinopterygians has often been reported from Carnian formations in different parts of the world, but they all are sporadic finds, like isolated teeth and scales. Furthermore, their attribution to Colobodontidae is rather arbitrary, being elements with very low taxonomic value. The Friuli remains, although fragmentary, show large parts of the body scale covering joined to skull elements which are diagnostic for the family, making the determination decidedly more reliable. We must keep in mind that comparison has been made possible by the numerous well preserved specimens from the Monte San Giorgio area (Middle Triassic, TI, Switzerland).

These new colobodontids from Friuli add new, important data on the Triassic ichthyofaunas, and they prove that even sporadic findings can be of great value in almost unexploited sites.

Ammonite Biostratigraphy as a Tool for Dating Upper Jurassic Lithographic Limestones from South Germany – First Results and Open Questions

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Jurassic ammonites are known to be good indicators for age determinations and they are used as guide fossils, but their stratigraphic value within lithographic limestones (including Plattenkalk and similar laminated limestones) was often neglected in the past because of their often poor preservation due to compaction and distortion. Differences in the specific faunal composition of the outcrops were previously thought to have primarily ecological reasons. Comparisons with independently obtained stratigraphical successions of ammonite faunas from other areas or lithologies, however, showed that these differences are mostly caused by different ages. Only very few sites of laminated limestones in South Germany have not proliferated ammonites and are thus not directly biostratigraphically dateable.

In Franconia, according to their ammonite faunas included, lithographic limestones in general become younger from the East to the West and from the North to the South. The oldest, just recently recovered intercalation of laminated limestones occurs far in the North at Wattendorf (N Franconia). It belongs to the Kimmeridgian Pseudomutabilis Zone as indicated by the presence of *Aulacostephanus eudoxus*. Another locality in the Southeast of Bavaria, Ebenwies near Regensburg, has not proliferated yet ammonites, but the laminates there are overlain by micritic limestones of the Subeumela Subzone of the Beckeri Zone. Other occurrences in that area higher in the section are dated still within the Beckeri Zone (Brunn: Beckeri Zone, Subeumela Subzone). At the boundary between the late Kimmeridgian Setatum Subzone and the Ulmense Subzone a major tectonic event with a shallowing trend is recognizable throughout South Germany, with disconformities in Swabia or a thin laminated limestone interval followed by a stratigraphic gap in W Franconia.

In SW Swabia, the Plattenkalk at the unique Fossil Lagerstaette Nusplingen yields abundant ammonites of the

middle part of the Ulmense Subzone, indicated by the index *Lithacoceras ulmense* and accompanying species. Slightly younger ammonite faunas come from Painten, Schamhaupten, and Breitenhill in Franconia, all sections situated around the Kimmeridgian/Tithonian boundary. The same ammonite assemblage as in Schamhaupten occurs in the quarry district of Pfalzpaint, famous for its abundance of jellyfishes. Since the Ki/Ti boundary has not yet been defined by international plenary ratification, it is impossible to locate it precisely within the Upper Jurassic succession of southern Germany. In SE Franconia laminated limestones of early Tithonian age occur at Hienheim, proven by the occurrence of *Gravesia gigas*, a very important species for longer-distance correlations. The 'classical' Tithonian lithographic limestones – those in the vicinity of Eichstätt and those of Solnhofen and Langenaltheim – have been formerly assigned to the same member and thus they were assumed to be exactly coeval. However, their ammonite faunas are strikingly distinct, thus indicating a difference in age. According to the ammonite fauna included the "Oberer Schiefer" of Solnhofen with the Tithonian index *Hybonoticeras hybonotum* is significantly younger than the "Oberer Schiefer" in the vicinity of Eichstätt. This has important consequences for palaeogeographic reconstructions and correlations in the area. Laminated limestones also occur higher in the section, like in the Mörnsheim Formation of Mörnsheim and Daiting and in the Usseltal Formation. The youngest ammonite-bearing laminated limestones, which are equivalent to the upper Lower Tithonian Neuburg Formation, occur in a small area NW of Neuburg.

The Lobster Genus *Squamosoglyphea* Beurlen, 1930 (Crustacea, Decapoda, Glypheidae) in the Upper Jurassic Lithographic Limestones of Southern Germany

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In this communication we report on some remains of the glypheid lobster *Squamosoglyphea* which is extremely rare but excellently preserved within the lithographic limestones.

Besides the type species *Squamosoglyphea squamosa*, we described two new species, *S. rogeri* and *S. redenbacheri*. These three species differ for the different ornamentation of the dorsal surface of carapace, for the presence or absence of carinae in the antennal region of carapace, for the presence or absence of a row of spines along the lower margin of propodus of pereiopod I, and for the presence or absence of carinae on the dorsal surface of the propodus of pereiopod I. Even though these species are very likely, these taxa inhabited different endobenthic environments in the far surroundings of the laminated deposits.

In the Jurassic, the diversity of glypheids was high, but most taxa are only known from few randomly recorded specimens, as in the case of *Squamosoglyphea*. Interestingly, both specimens of *S. squamosa* come from the upper Kimmeridgian lithographic limestones in the surroundings of Kelheim, whereas the specimens of *S. rogeri* and *S. redenbacheri* come from the lower Tithonian of the quarry district of Eichstätt. Although the ages of these limestones differ significantly, the morphologies of these taxa exclude that they represent members of an evolutionary line. Another possibility is the occurrence of sexual dimorphism in glypheids. Dimorphism in fossil *Squamosoglyphea* has been suggested as far as by Ėtallon for a specimen of *S. udressieri* from the Oxfordian figured by himself as the female and another one figured by Eudes-Deslongchamps as the male.

A probable reason for the presence of three species of this rare genus could be that they have lived in different environments. Similar palaeoecological distribution patterns are recognizable in other late Jurassic glypheids. For instance the giant *Glyphea saemanni*, originally described from the lithographic limestones of Cerin (France) was recently also recorded from the upper Kimmeridgian of Brunn in eastern Bavaria where it is associated with *Spongeliomorpha* burrows. The gracile, poorly sculptured *Glyphea tenuis* Oppel, 1860, is rather common in the lithographic limestones of Zandt and Eichstätt, but yet unknown from Solnhofen. In contrast, *Glyphea pseudoscyllarus* (Schlotheim, 1822), occurs in the classical Tithonian lithographic limestone quarries of Solnhofen and Langenaltheim, but it is also known from the upper Kimmeridgian site of Nusplingen and it occurs very rarely in the lower Tithonian of Zandt and Eichstätt.

Development of a Jurassic Basin in Terms of Palaeohydrodynamic Reconstruction (Miechów Trough, Poland)

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The area of research, Miechów Trough, is located between the SW margin of the Holy Cross Mountains and the Carpathian overthrust. Jurassic deposits are well known not only from outcrops but also from borehole data. The oldest Jurassic deposits are Bathonian in age and they formed as clastic sediments with good hydraulic properties. Very low permeability of overlaying compressed marly limestones (Callovian) and overlaying marls and marly limestones (Lower and Middle Oxfordian) causes their role as a seal horizon. Upper Oxfordian lithology is bipartite. The lower Upper Oxfordian is characterised by massive limestones, reef limestones and marly limestones. The uppermost Upper Oxfordian is very similar to the Lower and Middle Oxfordian, i.e. being composed of marly sediments again function as a seal horizon. The Kimmeridgian, mainly characterised by organodetritic deposits with thin marl interbeddings, is quite permeable.

During Jurassic time the study area subsided unequally. The strongest subsidence took place along the SW margin of the Holy Cross Mountains as well as along the through axis (till SE part of the study area). Compaction of marly sediments effected subsidence in the area of research. It increased the pressure on pore fluids, driving it toward margins and upward. Usually when sediments with low permeability compact very rapid, pore fluid pressure is higher then hydrostatic pressure. Such pressures are known as overpressure. Numerical simulations performed in Basin2 help me to indicate areas with this specific overpressure. Moreover, overpressures did not always result in rapid compaction of sediment with low permeability, what can be observed in the NW part of the study area. There is probably an other reason, maybe temperature. The highest overpressure values were indicated in Olesnica, Radlów and Szczurowa area (SE part of study area) and are in direct proportion to the subsidence rate. Marls and marly limestones are compacted with the highest rate. During compaction, these sediments lost 70 % fluids on the average. Compaction wasn't a dominant factor in that basin. More important factors seem to be topographic relief, eustasy, arrangements of supply and drainage zones and temperature in the SE part of the area. It is quite probable that diagenesis could effect ground water flow. Bathonian waters stay in hydraulic connection with older waters. Only in few places they are refreshed by water supply from younger and more permeable deposits. Flow changed through time not only because of compaction and load of overlaying deposits but also because of basin uplift and subsidence. Another important aquifer is connected to lower Upper Oxfordian deposits. It is possible to recognise reef zones by their different flow pattern. It was a streamline flow that emphasised reefs and mud mound zones. The basin was very diversified in that time. In NW part of the area eustasy resulted both in local tectonic and sediment loading controlling the carbonate deposition. The analysis indicates an enormous role of waters that were squeezed out of overlaying marly sediments (uppermost Upper Oxfordian). They were flowing with accordance to the highest porosity and permeability zones upward or toward basin margins. Pressure in Kimmeridgian deposits in the NW part of the area seemed to affect groundwater flow toward SE. At the end of the Kimmeridgian the area was uplifted. Sea water regressed, exposing most of the area and atmospheric water refreshed by infiltration older, sedimentary waters.

Bolca (Eocene, Verona) Fossils under a New Light

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For the first time after some 500 years of fossil fish-collecting at Bolca, the excavations now follow a scientific methodology. Based on bed-by-bed collections of all significant fossils along the southern slope of Monte Postale, new hypotheses on the depositional basin environment can be advanced. Furthermore, a number of new taxa, especially invertebrates, have been discovered that were not recorded during the foregoing, commercial excavations.

We were unable to date to find any evidence in support of the commonly offered hypothesis that fishes were killed by a catastrophic event (mass mortality). Rather, attritional mortality in this life-rich environment seems to be sufficient

to account for the large number of specimens yielded from the various fossiliferous levels at Bolca.

Moreover, the limestones that contain the fishes do not display any traces of volcanic products, and hence the involvement of volcanism, which was often hypothesized to have caused the death of marine organisms, can also be excluded. Vulcanoclastic rocks envelop the Pesciara and Monte Postale blocks; they belong to a sedimentary belt that collapsed during subsequent volcanic activity.

Although a detailed taphonomic study is still missing, we suggest that the excellent preservation of many fishes may be related to a very high sedimentation rate on a fairly soft bottom.

The life environment, at least that related to the levels under excavation at Monte Postale, can perhaps best be characterized as a shallow-water inner shelf with abundant bottom vegetation (similar to the modern *Posidonia oceanica* meadows). This environment is probably positioned close to a land mass that was rich in vegetation because plant remains are abundant in several layers, and may be due to sudden flooding events. Traces of an Eocene reef have not yet been found in the entire Prealps. As a result, the traditional restoration of Bolca as a tropical back-reef lagoon must be rejected.

Finally, we regard the fossil assemblages from Pesciara and Monte Postale (this excavation) as originating from neighbouring environments, possibly with some variability in the relationships with continental environments and/or depth of the bottom. The famous palms and crocodilians come from a continental rock at the Purga di Bolca.

The Middle Triassic Vertebrate Levels in the Western Tethys: are Fossil Fishes Useful for Biostratigraphy?

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The Besano-Monte S. Giorgio (MSG) paleontological district is located in a mountainous area encompassed by the South-Eastern branches of the Lugano (Ceresio) Lake.

Since the second half of the 19th century, this area is known for its exceptionally well-preserved and diverse vertebrate fauna of middle Triassic age. To emphasize the value of these fossils the Swiss side of MSG was included in the UNESCO World Heritage List in 2003; it represents first the nineth addition worldwide of a paleontological site to this list.

The research, which in this area has continuously been carried out since the 1850's, has focused in particular on the Besano Formation (=Grenzbitumenzone), and has yielded several thousands of reptiles, fish and invertebrates fossils. Recently, also some previously understudied fossiliferous levels within the Kalkschieferzone at the top of the Meride Limestone have been investigated by the UNIMI team on both the Italian and Swiss side. It appeared that certain layers of the Kalkschieferzone beds yield the best preserved fossils of the whole MSG, including numerous tiny fishes and nice crustacean and insects, the latter of which were recorded for the first time for this area. The aim of these new investigations is to evaluate the faunal differences (either among the various sites/levels or very detailed within a single site/level), as well as to complete the collection from the stratigraphic succession. The total time span exposed is about 15 MY. Since the depositional environment is relatively homogeneous, it is possible to reconstruct the evolution of fishes and reptiles throughout the entire succession. This makes the MSG the reachest (richest?) and most important fossiliferous district on Earth for the marine Middle Triassic

During the last three years, we also explored several localities outside the MSG area in order to investigate new vertebrate sites discovered in nearby basins, though under somewhat different life and preservation conditions. New fossil fish assemblages come from the Formazione di Cunardo toward the West, and from the Formazione di Buchenstein in the Grigna Mountains (LC). These sites are coeval to the upper part of the F.di Besano and lower Calcare di Meride. Many genera and species of fishes are in common in these localities; however, several new and very interesting taxa have also been discovered.

Ultraviolet Light Investigations of Fossils from the Upper Jurassic Plattenkalks of Southern Franconia

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Most skeletal remains of fossils as well as slightly mineralised soft parts from the Upper Jurassic plattenkalks of the Southern Franconian Alb are fluorescent under ultraviolet radiation. Many morphological details of skeletal remains and soft parts can be more precisely investigated in ultraviolet light than in visible light. Very often delicate skeletal elements and remains of soft tissues are not discernable in visible light. Sometimes essential details of the preserved soft parts can only be demonstrated by long-wave ultraviolet-light photography. For investigation and photographic documentation an established filtering technique is crucial. The application of different filters allows a selective visualization of peculiar fine structures.

In the last years, many fossils from the Upper Jurassic Solnhofen lithographic limestone and other Upper Jurassic plattenkalks from the Southern Franconian Alb have been investigated. These studies have enriched our knowledge of hard parts and soft tissues, especially in lepidosaurians, pterosaurs, and *Archaeopteryx*. Recently, UV-investigations of important new discoveries of fishes, turtles, pterosaurs and a dinosaur from classical "Solnhofen" fossil-lagerstätten like Eichstätt, Solnhofen and Daiting and the localities of Ettling and Schamhaupten, respectively, have produced significant results.

Selected examples

PLANTS: A few specimens of the pteridosperm *Cycadopteris* from Schamhaupten are fluorescent under ultraviolet light.

FISHES: From the locality of Ettling several new fishes, which are currently under study, show well-preserved pigmentation patterns.

LEPIDOSAURIANS: In some rhynchocephalians (*Pleurosaurus, Homoeosaurus*, *Kallimodon, Sapheosaurus*) and lizards (*Eichstaettisaurus, Ardeosaurus*) exquisitely preserved squamation was observed, fracture planes (autotomy septae) in the caudal vertebrae became clearly visible and in a few specimens caudal autotomy represented by regenerated tails was proved.

PTEROSAURS: Soft-tissue crests, occipital cones, a heel and sole pad with subcircular scales, fibres in the webbing of both feet as well as keratinous claw sheaths were described in *Pterodactylus*. Specimens of *Rhamphorhynchus* with phosphatized soft tissues exhibited wing membranes (brachiopatagia) to a hitherto unknown detail including the internal anatomy with support fibres, a blood vessel system and a fascia layer as well as structural details of foot and hand and integumental structures. A fully articulated and excellently preserved *Anurognathus* shows phosphatized details of the brachiopatagium and remains of muscles along both humeri and the hind limbs.

DINOSAURS: A new theropod dinosaur from Schamhaupten exhibits remains of soft parts surrounding several portions of the skeleton. Exquisitely preserved soft tissues are visible along the tail.

ARCHAEOPTERYX: In the Eichstätt and the Berlin example of *Archaeopteryx* many morphological details of the skeleton could be more precisely resolved in ultraviolet light than in visible light. The feather impressions of the Berlin specimen have usually been described as relief impressions, but under UV-light it was clear that some regions of the flight feathers are preserved as a thin filmy substance. Light and dark areas in the isolated feather of *Archaeopteryx* are possible relicts of what was originally colour patterning. UV-investigations and a new preparation under regular control by ultraviolet light of the shoulder girdle of the Munich specimen, *Archaeopteryx bavarica*, provided positive evidence that the bone which hitherto had been identified as a part of the sternal plate is in fact the medial part of the left coracoid.

Schamhaupten, an Outstanding Fossil-Lagerstätte in a Silicified Plattenkalk (Kimmeridgian-Tithonian Boundary, Southern Franconian Alb, Bavaria)

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Between 1989 and 1998 excavations were carried out near Schamhaupten (eastern part of the district of Eichstätt, Bavaria), in a silicified plattenkalk for which the ammonite fauna suggests an age at the Kimmeridgian-Tithonian boundary. Geologically the excavation site is situated at the southeastern margin of the Schamhaupten basin which developed during the Kimmeridgian and is surrounded by massive dolomite.

In terms of facies two main alternating rock types can be distinguished: bindstones and detrital carbonates (ranging from rudstones to mudstones) which are often normally graded and show mostly a stronger silification. Bioturbation is completely lacking in the bindstones, but can rarely be observed in the detrital beds.

The biota display a great diversity. About 200 taxa can be distinguished so far. They comprise protista (coccolithophorids, foraminifers, radiolaria), plants (mainly conifers and the pteridosperm *Cycadopteris*), sponges, brachiopods, bryozoans, gastropods, bivalves, ammonites (largest number of individuals of all macrofossils, around 30 species), coleoids, crustaceans (more than 50 taxa), one insect, echinoderms, fish (more than 30 taxa), and reptiles (among them several turtles, remains of crocodiles and an ichthyosaur, the sphenodont *Leptosaurus*, the pterosaur *Rhamphorhynchus*, and a complete specimen of a small new theropod).

Most pelagic forms (coccolithophorids, radiolaria, cephalopods, planktonic crinoid *Saccocoma*, fish, and marine reptiles) were autochthonous. The abundant coprolites, regurgitates, and traces of predation testify to a rich life in the surface waters, in contrast to the hostile bottom zone. The benthic fauna has been washed into the basin from the rims.

The abundance of pelagic organisms points to a water exchange and good connection with the Tethys. From the thickness of the test walls of the foraminifers "*Tubiphytes*" *morronensis* a water depth between 40 and 50 m at the site of their growth can be deduced. That means that the floor of the basin must have been at least 60 m deep.

A striking taphonomic feature is the high percentage of articulated fossils which is due to the lack of scavengers in the hostile environment and a quick sealing of the carcasses by bacterial veils. Articulated fossils are restricted to the bindstones. In the detrital layers only shells and other skeletal elements occur.

The diagenesis of fossils was different. In the bindstones these were normally completely flattened by compaction, in the stronger silicified detrital beds they have been preserved three-dimensionally. Also in bindstones an early silification could occasionally lead to an excellent concretionary preservation, as some turtles show.

Due to the hot, semiarid climate a salinity – density stratification developed in the basin of Schamhaupten leading to a hypersaline, dysaerobic bottom zone which was hostile to benthic life. Only bacterial mats could thrive there forming bindstones by trapping sedimentary particles. They played an important role in the conservation of articulated fossils. The rims of the basin which now appear as massive dolomite consisted of an arenitic substratum of organic origin, probably bound by microbial mats and partly colonized by sponges. Storm events reworked it and triggered turbulent density currents which brought the detrital carbonates into the basin. Nearby, probably to the south, an island emerged from which the terrestrial forms were washed-in or blown-in, respectively.

Diagenesis of Thin Bedded Carbonate Rocks in the Cambro-Ordovician Sequences of the North China Carbonate Platform

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The Northern China carbonate platform consists of shallow water carbonates that reach a thickness of 2000 m. In the study area, the Western Hills near Beijing, Cambrian carbonates show a typical shallowing upward cycle. The sea level changes and the cyclicity are described by Meng et al. (1997). The base of the section consists of thick bedded conglomerates and sand- to siltstones. The middle part continues with oolitic grainstones and tempestites, merging into tidal flat mudstones in the upper part. The mudstones contain thin bedded limestones. The matrix is very fine grained and contains few components; mostly fossils and fossil fragments. The thickness of the limestone beds is controlled by two factors: a) sequence cycles can be subdivided in one megacycle and several subcycles up two the third order (Meng et al., 1997). b) the diagenetic development of the limestones indicates repeated phases of cementation. Generally, the cycles are structured by different non carbonate contents. These changes in the non-carbonate fraction control the development of stylolites which form the boundary between single layers (beds). Within the small meter-scale cycles the thickness of one subcycle is just a few millimetres. The non-carbonate content is investigated by XRD analyses and shows a high variety of minerals. Other diagenetic factors are different kinds of cements, like granular blocky and locally silicious cements. The carbonate rocks are penetrated by several generations of tectonic fractures, which allow, together with the relative timing of diagenetic parameters (cements) for the dating of the stylolites. Moreover the carbonates contain different types of dolomite, which are in the lower part related to the matrix and in the upper part to fractures and stylolites. Almost all components are recrystallized or replaced by silicate.

References

Meng, X.-H., Ge, M. & Tucker, E.M. (1997): Sequence stratigraphy, sea level changes and depositional systems in the Cambro-Ordovician of the North China carbonate platform. – Sedimentary Geology, **114**: 189-222.

The Ninth Specimen of *Archaeopteryx* from Solnhofen

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From the historically oldest quarry near Solnhofen an isolated skeleton of the right wing, the ninth specimen of *Archaeopteryx*, is described and figured. The bones are partly disarticulated, and three-dimensionally preserved on a slab of Solnhofen lithographic limestone (Lower Tithonian, Malm zeta 2b). Distinct imprints of the shafts of proximal primary remiges extend fan-like from the second finger. With regard to its size the wing was part of an individual larger than the Berlin specimen, and almost equal to the Maxberg specimen of *Archaeopteryx*. Compared to the total wing span of the Berlin specimen (51 cm) the span of the feathered wing of the new specimen can be estimated at 57 cm. Based on its osteological characters and the intramembral ratios the specimen can be assigned to the taxon *Archaeopteryx lithographica* H. v. Meyer, 1861, but is distinct from the smaller species *Archaeopteryx bavarica* Wellnhofer, 1993, the Munich specimen. The articular surfaces of the humerus, ulna, and radius, as well as the phylogenetically significant semilunate carpal are preserved in excellent condition. Only the claw of the first digit is missing, the unguals of the second and third digits are still imbedded in matrix with their tips. "Unfinished" surfaces of the periost in form of fine striations with small foramina suggest that this Urvogel individual was probably not yet fully grown. Possibly, this could place the animal in a growth series comprising the Eichstätt specimen, as the smallest individual, followed by the Berlin, Maxberg, Haarlem, and London specimens, up to the Solnhofen specimen as the largest individual of *Archaeopteryx lithographica* as suggested by several authors previously. Alt-

hough the segments of the wing are no longer in their natural position, the bones do not show any marks or other indications of damage that could have been caused by a predator. This suggests that this single wing separated from a carcass floating in the Solnhofen "lagoon" due to successive decay and stepwise disintegration of the urvogel body.

The Ammonites from Schamhaupten (Southern Franconian Alb, Bavaria) – An Interesting Faunal Association at the Boundary Upper Kimmeridgian/Lower Tithonian

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Ammonites from the region of Schamhaupten have been first mentioned by Bausch (1963). Already at that time it was assumed (Zeiss in Bausch 1963: 20), that besides Upper Kimmeridgian species of the Setatum Subzone also younger ones occur. In a smaller study Zeiss (2001) supposed that at the excavation site of the Jura-Museum there are ammonites belonging to the uppermost horizon of the Ulmense Subzone of the Beckeri Zone, i.e. to the uppermost Kimmeridgian.

Now, when the whole material is available for study new aspects result. By the discovery of a *Hybonoticeras* of the *pseudohybonotum* group, which is in some details rather similar to the *hybonotum* group, it can be shown that bed E 8 belongs already to the Lower Tithonian. Also specimens of *L.* aff. *riedense* (bed E 5) and L. aff. *fructicans* point to this age. The Lower Tithonian ammonites include also numerous specimens of *Subplanites*, a single *Physodoceras* aff. *hoplisum* (bed E4), and many oppellids, which for the most part must be assigned to *Neochetoceras* n. sp., aff. *subnudatum*. Forms similar to *N. subnudatum* exist already in the next older *rebouletianum* horizon of the uppermost Kimmeridgian. This horizon has yielded also *N. rebouletianum, Glochiceras lens, Gl.* cf. *solenoides, Gl. planulatum, Taramelliceras* aff. *hemipleura,* some late representatives of *Lithacoceras* und *Silicisphinctes* (*ulmense/russi* group), *Sutneria* cf. *rebholzi,* and a new species of *Sutneria*, which, surprisingly, is decorated with the same sculpture as *S. platynota.* Furthermore several specimens related to *Torquatisphinctes isolatus* have been found which occur, however, also in younger strata.

The ammonite fauna of the beds E 4-8 at Schamhaupten has more or less the same age as the fauna of Ried near Dollnstein. This locality was assumed by Schneid (1914) to be younger than the other localities of his Beckeri Zone. The find of a „*Waagenia hybonota*" (= *H. hybonotum*) mentioned by him fits well this assumption. We assign this fauna to the lowermost Lower Tithonian (lower Riedense Zone). The beds below bed Si 4 at Schamhaupten are regarded as the uppermost Upper Kimmeridgian (*rebouletianum* horizon of the Ulmense Subzone), while the beds Si 3 to E 3 delivered only lithacoceratid perisphinctids which need more detailed study.

Also the fauna of Großmehring near Ingolstadt (Haberl et al. 1999) is approximately of the same age as the fauna discussed here. The specimen mentioned by Bausch (1963) as *P.* aff. *ardescicus* could be revised and identified as *Silicisphinctes russi*. Thus the middle part of the Ulmense Subzone, the *hoelderi* horizon, could be proved in the region of Schamhaupten, too.