

4. Palaeontology

Lionel Cavin, Damien Becker, Christian Klug

*Swiss Geological Survey – swisstopo,
Schweizerisches Komitee für Stratigraphie,
Naturhistorisches Museum Bern,
Schweizerische Paläontologische Gesellschaft,
Kommission des Schweizerischen Paläontologischen Abhandlungen (KSPA)*

TALKS:

- 4.1 Aguirre-Fernández, G., Carrillo-Briceño, J. D., Sánchez, R., Jaramillo, C., Sánchez-Villagra, M. R.: Fossil whales and dolphins (Cetacea) from the Miocene of Venezuela and Colombia
- 4.2 Anquetin J.: A new diverse turtle fauna in the late Kimmeridgian of Switzerland
- 4.3 Bagherpour B., Bucher H., Brosse M., Baud A., Frisk Å., Guodun K.: Tectonic control on the deposition of Permian-Triassic boundary microbialites in the Nanpanjiang Basin (South China)
- 4.4 Carrillo J. D., Carlini A. A., Jaramillo C., Sánchez-Villagra M. R.: New fossil mammals from the northern neotropics (Urumaco, Venezuela, Castilletes, Colombia) and their significance for the new world diversity patterns and the Great American Biotic Interchange
- 4.5 Costeur L., Mennecart B., Rössner G.E., Azanza B.: Inner ear in early deer
- 4.6 Hiard F., Métais G., Goussard F.: On the “thumb” of anoplotheriins: a 3D comparative study of the hand of *Anoplotherium* and *Diplobune*.
- 4.7 Klug C., Hoffmann R.: The origin of the complexity of ammonoid sutures
- 4.8 Koppka, J.: The oysters (Ostreoidea, Bivalvia) of the Reuchenette Formation (Kimmeridgian, Upper Jurassic) in Northwestern Switzerland
- 4.9 Leuzinger L., Kocsis L., Billon-Bruyat J.-P., Spezzaferrri S.: Taxonomy and biogeochemistry of a new chondrichthyan fauna from the Swiss Jura (Kimmeridgian): an unusual isotopic signature for the hybodont shark *Asteracanthus*
- 4.10 Maridet O., Costeur L., Schwarz C., Furió M., van Glabbeek F. M., Hoek Ostende L. W.: Comparison of the bony labyrinths of some extant and fossil hedgehogs (Erinaceomorpha, Mammalia): evolutionary and paleoecological implications
- 4.11 Meier M., Bucher H., Ware D.: The diversity and phylogenetic bottleneck of ammonoids across the end-Permian mass extinction
- 4.12 Pérez-Asensio J.N., Samankassou E., Jiménez-Moreno G., Larrasoña J.C., Mata P., Civis J.: Late Miocene-early Pliocene benthic foraminiferal assemblages from the La Matilla core, lower Guadalquivir Basin (SW Spain)
- 4.13 Pirkenseer C., Rauber G.: The «Cyathula-Bank», a regional stratigraphic unit at the interface between two tectonic and sedimentological provinces.
- 4.14 Schaefer K., Billon-Bruyat J.-P.: The crocodylian *Steneosaurus* cf. *bouchardi* in the Kimmeridgian of Switzerland
- 4.15 Ware D., Bucher H., Schneebeili-Hermann E.: The Dienerian (Early Triassic) ammonoid diversity crisis: timing and environmental proxies from the northern Indian margin

POSTERS:

- P 4.1 Becker, D, Dini, M., Scherler, L.: Woolly rhinoceros from the Pleniglacial of Ajoie (Jura Canton, Switzerland): anatomical description and ecological implications
- P 4.2 Minwer-Barakat R., Marigó J., Costeur L. Engesser, B.: New primate material from the Middle Eocene Swiss Site Verrerie de Roches
- P 4.3 Marchegiano M., Gliozzi E., Buratti N., Ariztegui D., Cirilli S.: Environmental change in central Italy since the Late Pleistocene. The Lake Trasimeno ostracod record.
- P 4.4 Püntener C., Anquetin J., Billon-Bruyat J.-P.: A new species of the coastal marine turtle *Thalassemys* Rüttimeyer 1873 from the Kimmeridgian of the Swiss Jura Mountains
- P 4.5 Savary V., Mennecart B.: Testing the EBSD Method on Mammal Enamel

4.1

Fossil whales and dolphins (Cetacea) from the Miocene of Venezuela and Colombia

Gabriel Aguirre-Fernández¹, Jorge D. Carrillo-Briceño¹, Rodolfo Sánchez², Carlos Jaramillo², Marcelo R. Sánchez-Villagra¹

¹ Paläontologisches Institut und Museum, Universität Zürich, Karl-Schmid-Strasse 4, 8006 Zürich (gabriel.aguirre@otago.ac.nz)

² Center for Tropical Paleocology, Smithsonian Tropical Research Institute, Balboa, Ancón, Panama, 0843- 03092, Panama

There is an increasing interest on deep-time patterns of the latitudinal biodiversity gradient and their role in predicting the effects of future climate change (Mannion et al., 2014). Databases such as the Paleobiology Database (<http://paleobiodb.org/>) are widely used as tools to study past diversity and are constantly updated by a dedicated scientific community. But, as a general case, there is a latitudinal research effort bias towards Northern collections. The past diversity of fossil cetaceans (whales and dolphins) is globally biased by a greater collection and research effort in the Northern Hemisphere (Uhen, 2010). The past diversity of cetaceans in the Americas is strongly linked to collection effort in USA and NW Mexico (Figure 1). Contrastingly, a relationship between generic diversity and outcrop area (marine formations as a proxy) is less obvious (Figure 1).

Recent prospection in Colombian and Venezuelan Neogene localities have yielded six new specimens of cetaceans collected from three different formations: 1) two possible inioids from the Urumaco Formation (Late Miocene, Western Venezuela); 2) a possible squalodelphinid from the Querales Formation (Early to Middle Miocene, Western Venezuela); and 3) a small odontocete, an inioid, and a mysticete from the Castilletes Formation (Early Miocene, Northern Colombia). Previously reported cetaceans from Venezuela include some squalodelphinids (Cantaure and Castillo Formations, both Early Miocene), and an indeterminate mysticete (Punta Gavilan Fm, Early Pliocene). Ongoing preparation and study of the material presented here offers a unique opportunity to better understand the fauna from poorly-prospected northern Neotropical localities.

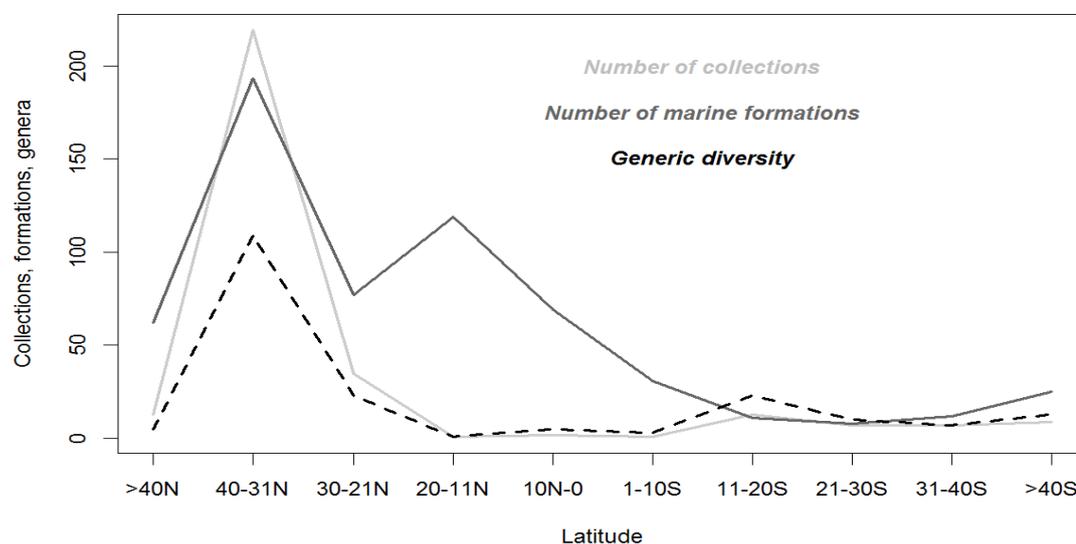


Figure 1. Latitudinal gradient of generic diversity of Neogene cetaceans in the Americas compared to number of collections and number of marine formations (as a proxy of outcrop area). Data taken from paleobiodb.org (see Uhen, 2014).

REFERENCES

- Mannion, P. D., Upchurch, P., Benson, R. B. J. & Goswami, A. 2014: The latitudinal biodiversity gradient through deep time. *Trends in Ecology & Evolution*, 29 (1), 42-50.
- Uhen, M. D. 2010: The Origin(s) of Whales. *Annual Review of Earth and Planetary Sciences*, 38 (1), 189–219.
- Uhen, M. D. Online systematics archive 9, Cetacea. [parameters: Cetacea; Eocene–Pliocene; North America, South America]. Retrieved on 12.05.2014 from www.paleobiodb.org.

4.2

A new diverse turtle fauna in the late Kimmeridgian of Switzerland

Anquetin Jérémy

Section d'archéologie et paléontologie, Office de la culture, République et Canton du Jura, Porrentruy, Switzerland
(j.anquetin@gmail.com)

During the Kimmeridgian and the Tithonian (Late Jurassic), Europe was the theater of the diversification of numerous coastal eucriptodiran turtles (Plesiochelyidae, Thalassemydidae, and Eurysternidae). Most turtle assemblages were discovered during the 19th century. The best localities and horizons include the Kimmeridge Clay of England, the Turtle Limestone of Solothurn, Switzerland, and the lithographic limestones of Bavaria, Germany. Despite the abundance of material, these faunas have been scarcely studied during the 20th century. Historically, Solothurn is the richest turtle locality for the Kimmeridgian (Bräm, 1965; Meyer and Thüning, 2009), with several hundreds shell remains and six valid species (Anquetin et al., 2014). The presence of six more or less closely related, relatively large coastal marine turtles in the same paleoenvironment is remarkable in terms of paleobiodiversity. For comparison, there are currently only eight species of marine turtles worldwide.

Here, we report an even more diverse turtle assemblage from late Kimmeridgian deposits in the vicinity of Porrentruy, Canton Jura, Switzerland. These turtles were discovered by the PAL A16 team during controlled excavations along the course of the A16 Transjurane motorway. The PAL A16 Kimmeridgian turtle collection includes about 80 sub-complete shells, five crania, four mandibles, and thousands of isolated remains. The description of this rich assemblage is still ongoing, but the presence of at least eight distinct taxa has already been recognized. Three of these are also present in the Solothurn assemblage: *Plesiochelys etalloni*, *Thalassemys moseri*, and *Tropidemys langii*. As in Solothurn, *Plesiochelys etalloni* is the most abundant species in Porrentruy. Interestingly, the second most abundant species is *Thalassemys moseri*, for which only two partial shells are known in Solothurn. *Tropidemys langii* is represented by several articulated shells, providing new insights into the anatomy of this characteristic plesiochelyid turtle (Püntener et al., 2014).

Remarkably, the rest of the Porrentruy assemblage differs from that of Solothurn. Thalassemydidae are represented by a new species of *Thalassemys* (see Poster by Christian Püntener). At least two species of Eurysternidae are present: *Solnhofia* aff. *parsonsi* and *Eurysternum* sp. *Solnhofia* aff. *parsonsi* is notably characterized by a short snout, whereas the Tithonian holotype of *Solnhofia parsonsi* is characterized by an elongated snout. Whether this is a distinct species or a morph of the same species will be further investigated. A skull from Solothurn initially referred to *Solnhofia parsonsi* may actually belong to this new form. The presence of numerous remains of *Eurysternum* sp. in Porrentruy is remarkable as eurysternids are rarely abundant in plesiochelyid-dominated assemblages. Plesiochelyidae are further represented by several additional taxa. A large, complete shell that exhibits several unusual features probably represents a new taxon. A few specimens, including a previously reported trampled shell (Billon-Bruyat et al., 2012), may be provisionally assigned to *Craspedochelys* sp. And finally, two additional taxa can be identified based on cranial material. One is a distinct, undetermined plesiochelyid that might correspond to one of the shell-based taxa. The other is identified as a new species of *Portlandemys*, a form previously only known in the Tithonian of the Isle of Portland, England.

The turtle localities around Porrentruy are slightly older (end of *Cymodoce* zone and *Eudoxus* zone) than the Turtle Limestone of Solothurn (*Autossiodorensis* zone). This short difference in age may explain some discrepancies between the two faunas, but other factors also probably played a part. The paleoenvironments must have been different, as apparent from the lithology and the presence of eurysternids. Some ammonites and sharks, as well as ostracods, also reveal the existence of a boreal signal in the Porrentruy fauna. Turtles may also reflect this influence, as suggested by the presence of *Portlandemys* sp.

The description of this rich new turtle assemblage in months and years to come, coupled with the long overdue taxonomic reassessment of Late Jurassic eucriptodires at the European scale, will provide a better understanding of the diversity and paleobiogeography of these coastal turtles, which represent the oldest documented radiation of these reptiles into marine environments. The first results suggest that European turtle faunas were more homogeneous than previously thought.

REFERENCES

- Anquetin, J., Püntener, C. & Billon-Bruyat, J.-P. 2014: A taxonomic review of the Late Jurassic eucriptodiran turtles from the Jura Mountains (Switzerland and France). *PeerJ*, 2, e369.
- Billon-Bruyat, J.-P., Marty, D., Bocat, L. & Paratte, G. 2012: Under the feet of sauropods: a trampled coastal marine turtle. Abstract, Fourth Symposium on Turtle Evolution 2012, University of Tübingen, Germany.
- Bräm, H. 1965: Die Schildkröten aus dem oberen Jura (Malm) der Gegend von Solothurn. *Schweizerische Paläontologische Abhandlungen*, 83, 1–190.

- Meyer, C. A. & Thüring, S. 2009: Late Jurassic marginal marine ecosystem of the Southern Jura Mountains. In: Billon-Bruyat, J.-P., Marty, D., Costeur, L., Meyer, C. A. & Thüring, B., eds. Abstracts and Field Guides, 5th International Symposium on Lithographic Limestone and Plattenkalk, Actes 2009 bis de la Société jurassienne d'émulation. Porrentruy, Switzerland, 130–141.
- Püntener, C., Billon-Bruyat, J.-P., Bocat, L., Berger, J.-P. & Joyce, W. G. 2014: Taxonomy and phylogeny of the turtle *Tropidemys langii* Rüttimeyer, 1873, based on new specimens from the Kimmeridgian of the Swiss Jura Mountains. *Journal of Vertebrate Paleontology*, 34, 353–374.

4.3

Tectonic control on the deposition of Permian-Triassic boundary microbialites in the Nanpanjiang Basin (South China)

Borhan Bagherpour¹, Hugo Bucher¹, Morgane Brosse¹, Aymon Baud², Åsa M. Frisk^{1,2} and Kuang Guodun⁴

¹ Paläontologisches Institut der Universität Zürich, Karl Schmid-Strasse 4, 8006 Zürich, Switzerland (borhan.bagherpour@pim.uzh.ch)

² Geological Museum, Lausanne University, Quartier UNIL-Dorigny, Bâtiment Anthropole, CH-1015 Lausanne, Switzerland

³ Palaeobiology, Department of Earth Sciences, Uppsala University, Villavägen 16, 753 36 Uppsala, Sweden

⁴ Guangxi Bureau of Geology and Mineral Resources, Jiangzheng Road 1, 530023 Nanning, China

In most shallow water successions from northwestern Guangxi and southern Guizhou, the Permian-Triassic boundary separates the Late Permian Heshan Fm. from the Early Triassic Luolou Fm. The Late Permian Heshan Formation consists of thick-bedded skeletal limestone with chert nodules and occasional ash layers. The abundant and diversified benthic fauna of the Heshan Fm. includes siliceous sponges, calcareous algae, corals, gastropods, foraminifera, bivalves, brachiopods, bryozoans, and crinoids. The last preserved bed of the Heshan Formation is often an ash layer. The base of the Early Triassic Luolou Formation shows the development of a microbialite unit, ranging from 3.5m to 9.5m in thickness.

Before the onset of microbial deposition, five successive events are recognized:

1. Deposition of an ash layer
2. Deposition of a high-energy grainstone with Late Permian reworked fauna (mainly foraminifera)
3. Deposition of a thin clotted microbialite bed on top of an erosional surface (wavy bedding plane underlined by iron oxide and with bioerosion cutting through 2)
4. Occasional deposition of a second, high-energy grainstone bed containing a Late Permian reworked fauna
5. Deposition of main microbialite episode

High resolution $\delta^{13}\text{C}_{\text{carb}}$ record across this succession shows that the main negative jump of ca. 1 per mil occurs between 1 and 2. No negative spikes comparable to those known from deeper water or expanded records are recovered. This indicates the presence of a substantial gap between 1 and 2. Moreover, the last preserved bed below this gap is usually an ash layer, which opens the possibility that any younger limestone layers of the Heshan Fm. may have been chemically and/or mechanically removed.

Macrostructure of the microbialite is mostly tabular in the lower half and dome shaped or columnar in the upper half. Shelly lenses yielding highly diversified benthic faunas may occasionally be trapped between the domes. This change of microbialite facies reflects a moderate drowning of the platform. Predominant mesostructures include layered stromatolite-type, fenestral, labyrinthic, spotted, and vesicular structures in the lower half of the microbialite unit and digitated structure in the upper half.

In all studied sections, the microbialite unit is directly capped by a greywacke whose thickness varies from a few cm up to 6 m. The base of this greywacke locally contains decimetric lenses of brecciated microbial limestone. Deposition of this greywacke and enclosed breccias indicates a sudden drowning of the platform. This tectonic phase is also responsible for the cessation of the deposition of the microbialites. The next overlying deeper water succession consists of laminated black shales and occasional thin-bedded micritic limestone yielding a conodont fauna of late Griesbachian age. This age constraint and the presence of a significant gap at the base suggest that deposition of the microbial unit took place in less than 1 Myr, a duration which was directly under synsedimentary tectonic control.

4.4

New fossil mammals from the northern neotropics (Urumaco, Venezuela; Castilletes, Colombia) and their significance for the new world diversity patterns and the Great American Biotic Interchange

Juan D. Carrillo¹, Alfredo A. Carlini², Carlos Jaramillo³ & Marcelo R. Sánchez-Villagra¹

¹ Paleontological Institute and Museum, University of Zurich, Karl Schmid-Strasse 4, CH-8006 Zurich (juan.carrillo@pim.uzh.ch)

² División de Paleontología de Vertebrados, Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, Paseo del Bosque s/n, B1900WFA La Plata, Argentina

³ Smithsonian Tropical Research Institute, 9100 Panama City PL, Washington DC, 20521-9100, USA

The Great American Biotic Interchange (GABI) refers to the faunal exchange between North and South America around the time of closure of the Central American Seaway, an event that modified the mammal fauna of both continents. Unfortunately, current hypotheses about diversity dynamics during this migration event have been mostly based on data from temperate sites. We present new data from the Urumaco sequence in Venezuela and from new sites at the Guajira Peninsula, northeastern Colombia, which together comprise a sequence of faunas expanding from the early Miocene to the early Pliocene. These faunas, due to their age and geographical location, serve to characterize the Neotropical mammal community before and after GABI's migrational intervals. Studies of several taxonomic groups involve different teams of researchers. In Urumaco the greatest diversity of mammals is in the xenarthrans, with at least 20 species representing Mylodontids, Megalonychids, Megatherines, Glyptodontids, Pamphatherids and Dasypodids. Different species provide insights into the re-ingression from North America, taxonomic affinities with megalonychids otherwise present in the Caribbean islands, and the record in these northern latitudes of 'basal' forms recorded in earlier deposits of higher latitudes of the continent. Among rodents, the revision of both new dental and postcranial remains and their variation revealed that several species must have existed, including *Phoberomys pattersoni*, *Eumegamys* sp., and *Neopiblema* sp. Among the 'meridiungulata', cranial remains of toxodonts suggest the presence of forms with plesiomorphic features unexpected for animals at this geological age. Astrapotheres include cranial remains from Castilletes representing the oldest record of Uruguaytheriinae in the tropics. The oldest procyonid carnivores from the northern neotropics are recorded based on dental remains, from Castilletes and Urumaco (San Gregorio Fm.), both of affinities with genera recorded so far from Argentina. We complement field data by compiling and analyzing the composition of late Neogene mammal assemblages in the Americas by computing the percentage of both native and migrational faunas across a latitudinal gradient. Migrations started in the late Miocene (~10 Ma), but most exchange occurred after the early Pliocene (~5 Ma). In tropical South America migrants are first recorded in the Pliocene, whereas in temperate South America there are some records of North American migrants during the late Miocene and Pliocene, but is not until the Pleistocene when migrants became common.



Figure 1. Artistic representation of *Phoberomys pattersoni*. A giant (XX kg) rodent recorded in Urumaco, late Miocene, Venezuela. Artwork by Jorge González. Taken from Sánchez-Villagra et al. (2010).

REFERENCES

- Sánchez-Villagra, M. R. Aguilera, O. A. Carlini, A. A (eds). 2010: Urumaco and Venezuelan Paleontology. The Fossil Record from the Northern Neotropics. Indiana University Press. Bloomington and Indianapolis. USA.
- Woodburne, M. O. 2010: The Great American Biotic Interchange: Dispersal, tectonics, climate, sea level and holding pens, *Journal of Mammalian Evolution*, 17, 245-264.

4.5

Inner ear in early deer

Loïc Costeur¹, Bastien Mennecart², Gertrud Rössner³ & Beatriz Azanza⁴

¹ *Naturhistorisches Museum Basel, CH-4001 Basel (loic.costeur@bs.ch)*

² *UMR 7207 CNRS-MNH-UPMC, 8 rue Buffon, 75005 Paris, France*

³ *Bavarian State Collections of Palaeontology and Geology, Richard-Wagner-Str. 10, 80333 Munich, Germany*

⁴ *University of Zaragoza, Ciencias de la Tierra,*

Deer (family Cervidae) are a diverse group of even-toed mammals with currently 5 tribes comprising about 50 species. Their evolutionary history spans the last 20 million years. Morphologically speaking, all deer are united by the presence of antlers (except in the Chinese water deer where they were secondarily lost). The identification of a fossil deer is thus made easier when antlers are preserved. So far, the earliest representatives of deer were found in the Early Miocene of Europe with *Procervulus*, *Acteocemas* or *Ligeromeryx* from MN3 localities (around 19 Myrs). These taxa show dichotomously forked antlers and a new specimen from Switzerland (Rössner et al. 2014) attributed to *Acteocemas* documents the first early cervoid with protoburr-and-pearls-bearing antlers of the dicrocerine lineage, close to muntjacs. Another shared character with muntjacs of all these early cervids are elongate, sabre-like upper canines.

A debate has arose in the last twenty years as to whether the Muntiacinae lineage was already established in the Middle Miocene with *Euprox* (about 15 Myrs old) as postulated by Azanza (1993). This hypothesis would push back the divergence time of the crown Cervidae in the Early to Middle Miocene while molecular data indicate an origin rather in the Late Miocene, several million years later (Miyamoto et al., 1990; Pitra et al., 2004, Gilbert et al. 2006). *Euprox* has muntjak-like antlers, but the latter authors regard them as basal, phylogenetically uninformative, and prefer to keep this taxon outside the Muntiacini clade. Azanza et al. (2013) question the sister relationship of Muntiacini with Cervini and rather postulate that muntiacines are the sister group to Cervini and Capreolini, with probable stem Muntiacinae in the Middle Miocene such as *Euprox*.

We add information to this discussion using characters of the inner ear which has been shown to yield significant phylogenetical information in other groups of mammals (i.e., in all placentals in Ekdale, 2013 or more specifically in primates, Gunz et al., 2012). Using high resolution x-ray computed tomography we scanned several Early to Middle Miocene “stem Cervidae” including *Procervulus*, *Heteroprox*, *Dicroceros* or indeterminate early deer (isolated petrosals) and compare the 3D-reconstructed shape of their inner ear to that of the five living clades. Fossil and extant deer all share a posterior limb of the lateral semi-circular canal entering the vestibule in or slightly above the ampulla of the posterior semi-circular canal, a different state than in most other ruminants. The canals in fossil species are long and largely extend above the common crus, a situation seen in the living tribe Cervini; the posterior canal is less expanded in the other tribes. The position and orientation of the cochlea close to the vestibule recalls the situation seen in. The massiveness of the cochlear basal turn in *Procervulus* or *Heteroprox* is a basal trait also present in other ruminant lineages. *Heteroprox* has a lateral canal entering the vestibule in the posterior ampulla somewhat anteromedially recalling the condition in *Odocoileus* (*Odocoileini*). The condition in the early deer from Chilleurs (MN3) is close to that in *Axis* (Cervini) or *Muntiacus* (Muntiacini), where both the lateral and posterior canals meet before the posterior ampulla, mimicking the basal condition of a secondary common crus seen in the earliest artiodactyls (e.g., *Diacodexis*, Orliac et al., 2012). The common area is nonetheless much smaller than a true secondary common crus and both canals are still recognizable despite their junction. The inner ear of *Procervulus* from Rauscheröd (MN4) shows very close canals, but not attached. *Dicroceros* has an angle of the posterior and anterior canals less than 90° close to *Muntiacus* condition but the entry of the lateral canal is closer to that of *Odocoileus* or *Heteroprox* than to that of *Muntiacus* or *Procervulus*.

To summarize, *Procervulus*, *Heteroprox* and *Dicroceros* have inner ears that look more like those of crown deer than like that of other extant ruminants or known fossil representatives of crown ruminants. The earliest crown Cervidae may thus be found earlier than usually accepted by molecular phylogenies (i.e., around 10.7 My), i.e., at least in the Middle Miocene

around 14-15 Myr such as already postulated by Azanza (1993) on the basis of antlers. The antlers without burr of *Procervulus* still leave this taxon in stem cervids. Its primitive-looking but deer-like inner ear confirms this position. The newly found antlers in the Early Miocene of Switzerland, testifying to a second stem lineage early in the Miocene, hint at a radiation in stem cervids.

REFERENCES

- Azanza, B. 1993: Sur la nature des appendices frontaux des cervidés (Artiodactyla, Mammalia) du Miocène inférieur et moyen. Remarques sur leur systématique et leur phylogénie. *Comptes Rendus de l'Académie des Sciences Paris II*, 316, 1163-1169.
- Azanza, B., Rössner, G.E. & Ortiz-Jaureguizar, E. 2013: The early Turolian (late Miocene) Cervidae (Artiodactyla, Mammalia) from the fossil site of Dorn-Dürkheim 1 (Germany) and implications on the origin of crown cervids. *Palaeodiversity and Palaeoenvironments*, 93, 217-258.
- Ekdale, E.G. 2013: Comparative Anatomy of the Bony Labyrinth (Inner Ear) of Placental Mammals. *PLoS ONE*, 8(6), e66624.
- Gilbert, C., Ropiquet, A. & Hassanin A. 2006: Mitochondrial and nuclear phylogenies of Cervidae (Mammalia, Ruminantia): Systematics, morphology, and biogeography. *Molecular Phylogenetics and Evolution* 40(1), 101-117.
- Gunz, P., Ramsier, M., Kuhrig, M., Hublin, J.-J. & Spoor F. 2012: The mammalian bony labyrinth reconsidered, introducing a comprehensive geometric morphometric approach. *Journal of Anatomy*, 220, 529-543.
- Miyamoto, M.M., Kraus, F. & Ryder, O.A. 1990: Phylogeny and evolution of antlered deer determined from mitochondrial DNA sequences. *Proceedings of the National Academy of Sciences USA*, 87, 6127-6131.
- Orliac, M., Benoit, J. & O'Leary, M.A. 2012: The inner ear of *Diacodexis*, the oldest artiodactyl mammal. *Journal of Anatomy*, 221(5), 417-426.
- Pitra, C., Fickel, J., Meijaard, E. & Groves, P.C. 2004: Evolution and Phylogeny of Old World deer. *Molecular Phylogenetics and Evolution*, 33, 880-895.
- Rössner, G.E., Azanza, B., Jost, J. & Costeur, L. 2014: New evidence of early cervids and phylogenetic implications. Annual Meeting of the Society of Vertebrate Paleontology.

4.6

On the “thumb” of anoplotheriins: a 3D comparative study of the hand of *Anoplotherium* and *Diplobune*.

Florent Hiard¹, Grégoire Métais² & Florent Guossard²

¹ Department of Geosciences – Earth Sciences, University of Fribourg, Chemin du Musée 6, CH-1700 Fribourg (florent.hiard@unifr.ch)

² UMR 7207 CR2P CNRS, Muséum d'Histoire Naturelle, 8 rue Buffon, CP38, 75231 Paris Cedex 05, France

Anoplotheriinae is an unusual clade of European artiodactyls that existed from the Middle Eocene to the earliest Oligocene characterised by a number of singular postcranial features (e.g. Sudre 1983, Hooker 2007). The notable presence of a well-developed digit II with an uncommon orientation in the fore- and hindlimbs is known at least for the taxa *Anoplotherium* and *Diplobune* but the functionality and utility of this toe have been discussed at least since the middle of the 19th century (Gervais 1848-1852).

We present here a new anatomical description and comparison of the carpals, the metacarpals bones and the phalanges of *Anoplotherium* and *Diplobune* and provide three-dimensional reconstruction of well-preserved specimens of the both taxa to model the mobility of the hand (Fig.1).

This study underlines several significant differences between both taxa, especially in the arrangement of the carpal bones. For instance, the lunate bone of *Diplobune* is more deeply inserted between the hamate and the capitate bones than in *Anoplotherium*, limiting the possibility of lateral movement in the wrist. A second difference is that the articular surface of the trapezoid bone with the scaphoid is more extended in *Diplobune* than in *Anoplotherium*, allowing a higher mobility of the digit II in the former.

The results of this study confirm the possibility of an arboreal lifestyle for *Diplobune*, as already supposed by Sudre (1983). The paleoecology of *Anoplotherium* remains unclear. Even if we accept that *A. commune*, which has a reduced digit II, was in fact the female of *A. latipes*, which presents a well-developed digit II, as proposed by Hooker (2007), it seems improbable that this structure is a sexually dimorphic adaptation for bipedal browsing as he also proposed, given that the teeth show the same type of morphology and wear. We suggest instead that digit II, with his claw-like hoof, was competitively used in male-to-male combats.

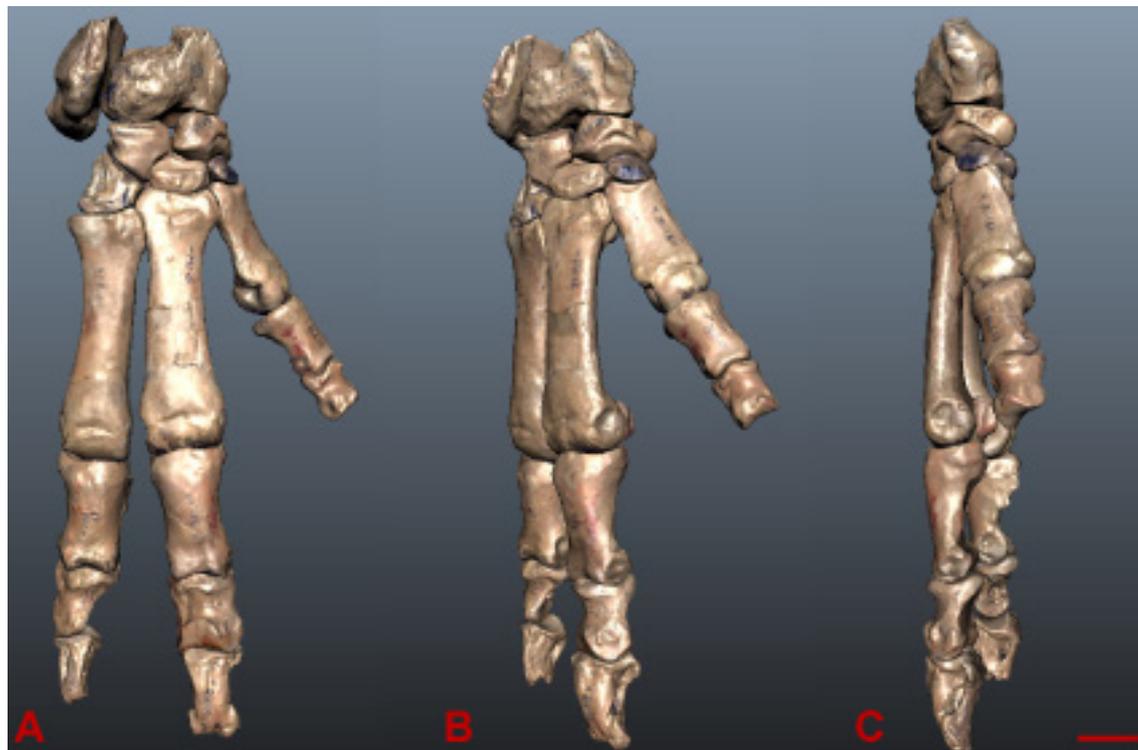


Figure 1. 3D reconstruction of MNHN-GY752 *Diplobune secundaria*. A, Dorsal view. B, Dorso-medial view. C, Medial view. Scale bar: 20 mm.

REFERENCES

- Gervais, P. 1848-1852: Zoologie et Paléontologie françaises (animaux vertébrés) ou Nouvelles Recherches sur les Animaux Vivants et Fossiles de la France, Tome II. Arthus Bertrand, Paris 46 pp.
- Hooker, J.J. 2007: Bipedal browsing adaptations of the unusual Late Eocene-earliest Oligocene tylopod *Anoplotherium* (Artiodactyla, Mammalia), *Zoological Journal of the Linnean Society*, 151, 609-659.
- Sudre J. 1983: Interprétation de la denture et description des éléments du squelette appendiculaire de l'espèce *Diplobune minor* (Filhol 1877): apports à la connaissance de l'anatomie des Anoplotheriinae Bonaparte 1850. In: Actes du Symposium Paléontologique G. Cuvier (Ed. By Buffetaut, E, Mazin, J.M. & Salmon, E.), Montbéliard, pp. 439-458.

4.7

The origin of the complexity of ammonoid sutures

Christian Klug¹ & René Hoffmann²

¹ Paläontologisches Institut und Museum, University of Zurich, Karl Schmid-Strasse 6, CH-8006 Zurich, Switzerland (chklug@pim.uzh.ch)

² Ruhr-Universität Bochum, Department of Earth Sciences, Institute of Geology, Mineralogy, and Geophysics, Bochum, Germany

Ranging from simple to complex, the folded septa of the phragmocone characterize the ammonoid clade and contribute much to their aesthetic appearance. However, many contradicting opinions and models on septum formation and as explanation for the evolution and function of sutural complexity and septal frilling have been published. The most important existing hypotheses are the Viscous Fingering Model, the Tie-Point Model and the application of the Reaction Diffusion Model to the morphogenesis of ammonoid septa.

We present a compound model including a revised chamber formation cycle. This model incorporates a series of older models and new thoughts and explanations. Notably, information from phylogenetic and developmental transformations have contributed much to our understanding of the morphogenesis of ammonoid septa. To begin with, it has to be understood that the ammonoid septum is derived from very simple, nearly hemispherical septa with central septal perforation of orthocerids. Lateral compression mechanically caused the formation of lateral lobes. In the course of the evolution of the Bacritida, the siphuncle shifted to a ventral position, leading to the formation of a ventral lobe.

Already with the Bacritida, the first forms with slightly curved shells evolved. These forms gave rise to such with shells, which comprise over one whorl, the first ammonoids. This increase in coiling in combination with the ventral siphuncle caused a dorsoventral imbalance that led to a dorsoventral asymmetry of the lateral lobe. With tighter coiling, the whorls began to touch and eventually overlap, thus introducing the dorsal or internal lobe. At a slightly later point in ammonoid evolution, a change in chamber pressure during septum formation is documented in inflexions of the septum. Ultimately, complexity is increased by a more and tighter coiling in combination with a reduction in embryonic shell size. Apparently, the septal mantle, which is responsible for mineralisation of the septum, kept the overall morphology of the preceding septum to a large extent and the increase in whorl section diameter than contributed to increasing complexity. Thus, many aspects of septum morphogenesis can be explained by simple mechanics rather than genetic heredity.

4.8

The oysters (*Ostreoidea*, *Bivalvia*) of the Reuchenette Formation (Kimmeridgian, Upper Jurassic) in Northwestern Switzerland

Jens Koppka¹

¹ Office de la culture, Section d'archéologie et paléontologie, Hôtel des Halles – CP 64, CH-2900, Porrentruy (jens.koppka@jura.ch)

During the construction of the Transjurane highway (A 16) in Northwestern Switzerland rich Late Jurassic invertebrate faunas have been discovered in the Reuchenette Formation by members of the “Section d'archéologie et paléontologie” (Paléontologie A 16). Bivalves are the most frequent finds among the invertebrates. Several oyster species have been found and collected in large quantities in the area north of Courtedoux (Canton Jura, Ajoie), especially in the Lower Kimmeridgian “Banné Marls” (*Cymodoce* Zone) and younger strata as the “Lower *Virgula* Marl” (Upper Kimmeridgian, *Eudoxus* Zone). The review of the oysters is the first part of a taxonomic revision of the high diverse Kimmeridgian bivalve associations found in the Reuchenette Formation. Most of these bivalves have been described in the 19th century in two monographies published by Contejean (1859) and Thurmann & Etallon (1861-1864), but most of the fauna remained literally untouched by subsequent authors for 150 years.

In the revision prepared by the author (Koppka 2014 (subm.)) eight oyster species characterizing the northern Helvetic shelf system are described, new classified and discussed in detail, including a documentation of their high intraspecific variability and palaeoecology. The species are: *Circunula* n. gen. *cotyledon* (Contejean, 1859) (Gryphaeidae, ?Pycnodontinae),

Nanogyra (*Nanogyra*) *nana* (J. Sowerby, 1822), *Nanogyra* (*Palaeogyra*) *reniformis* (Goldfuss, 1833), *Nanogyra* (*Palaeogyra*) *virgula* (Deshayes, 1831) (Gryphaeidae, Exogyrinae), *Helvetostrea* n. gen. *sequana* (Thurmann & Etallon, 1862) (Flemingostreidae, Crassostreinae), *Praeexogyra dubiensis* (Contejean, 1859), *Praeexogyra monsbeliardensis* (Contejean, 1859) (Flemingostreidae, Liostreinae), and *Actinostreon gregareum* (J. Sowerby, 1815) (Arctostreidae, Palaeolophinae). The genera *Circunula* and *Helvetostrea* are proposed as new. *Nanogyra* Beurlen, 1958 is divided into 2 subgenera, all species with developed chomata belonging to *Nanogyra* (*Palaeogyra*) Mirkamalov, 1963 the remaining to *Nanogyra* sensu stricto.

The early shell ontogeny in general and the generic characters of *Praeexogyra* are revisited. Larval shells respectively their moulds are shown for six species: *N. nana*, *N. reniformis*, *N. virgula* and for comparison also *N. cf. auricularis*, *Praeexogyra cf. sandalinoides* (de Loriol, 1901) and *Actinostreon marshii* (J. Sowerby, 1814). All of them share a “*Crassostrea*”-like prodissoconch morphology, suggesting a planktic-planktotrophic mode of development.

The observed species were adapted to different niches on a shallow marine carbonate platform. *Circunula* n. gen. *cotyledon* is a typical early settler of hardgrounds but occurs as well in subtidal soft-bottom environments attached to large shells. *Nanogyra* (*N.*) *nana* was found attached to apparently all kinds of biogenous hard and soft substrates including algal stems and thalli; it is regularly distributed in calm to moderate energetic shallow marine palaeoenvironments. *Nanogyra* (*P.*) *reniformis* frequently attached hidden on the interior of empty bivalve shells. *Nanogyra* (*P.*) *virgula* was a prolific secondary soft-bottom dweller of shallow marine marls and lime muds; the species is often found concentrated in widely distributed (par)autochthonous lumachelles (“*virgula* marls” of authors). *Praeexogyra dubiensis* and *P. monsbeliardensis* occur in marly, shallow marine palaeoenvironments. *Praeexogyra dubiensis* appears to have preferred attachment to small objects in a moderately energetic facies; in the study area it is also associated with algal meadows; *P. monsbeliardensis* was preferentially gregarious in a somewhat deeper and calmer palaeoenvironment. The strongly chambered and probably fast growing *Helvetostrea* n. gen. *sequana* was adapted to dynamic shallow marine, marly habitats; it is frequently found associated with corals and forming ostreoliths or small oyster buildups. *Actinostreon gregareum* usually lived gregariously but was also able to attach to algae on soft substrates (see Fig. 1); the species is known from calm marly to higher energetic coralline palaeoenvironments.

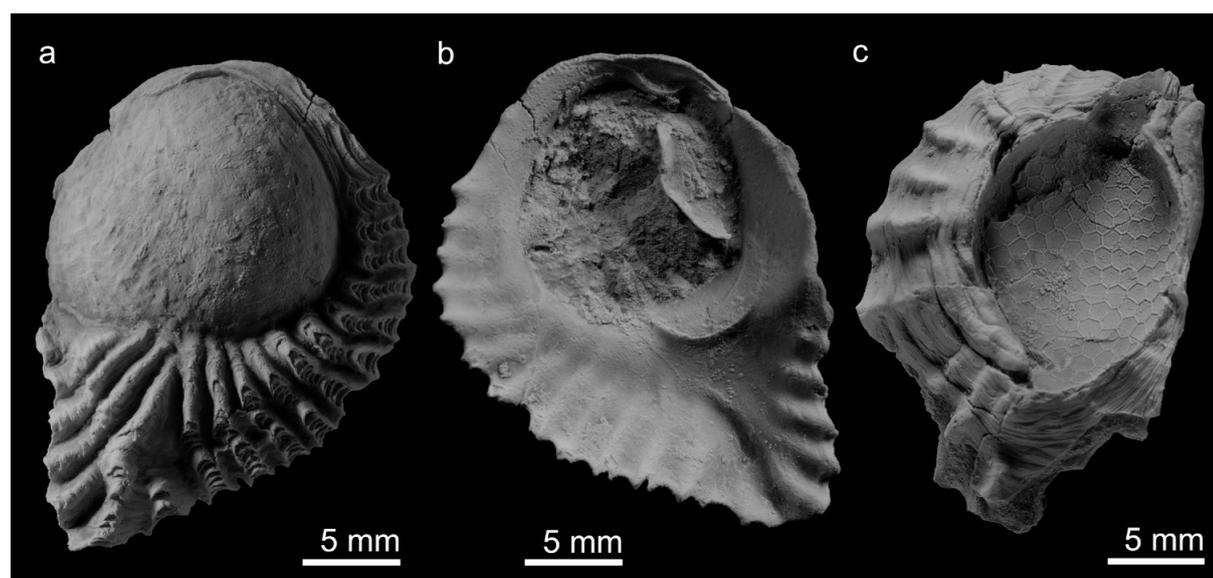


Figure 1. *Actinostreon gregareum* (J. Sowerby, 1815), Vâ Tche Tchâ close to Courtedoux, Banné Marls, Lower Kimmeridgian. a: right valve (CTD-VTT001-1173), exterior view, xenomorph after the calcareous algae *Goniolina geometrica*, b: same as a, interior view; c: left valve (CTD-VTT001-1602), exterior view, with imprint of bioimmured *Goniolina*.

REFERENCES

- Contejean, C.H. 1859: Étude de l'étage Kimmérien dans les environs de Montbéliard et dans le Jura, la France et l'Angleterre. Mémoires de la Société d'Émulation du Doubs, Year 1858, 352 pp.
- Koppka, J. 2014: Revision of the Bivalvia from the Upper Jurassic Reuchenette Formation, Northwest Switzerland – Ostreoidea. Zootaxa. (submitted)
- Thurmann, J. & Etallon, A. 1861-1864: Lethea Bruntrutana ou Études paléontologiques et stratigraphiques sur le Jura Bernois et en particulier les environs de Porrentruy. Denkschriften der Schweizerischen Naturforschenden Gesellschaft, 18, 1-146 (1861), 19, 147-354 (1862), 20, 355-500 (1864).

4.9

Taxonomy and biogeochemistry of a new chondrichthyan fauna from the Swiss Jura (Kimmeridgian): an unusual isotopic signature for the hybodont shark *Asteracanthus*

Léa Leuzinger^{1,2}, László Kocsis^{3,4}, Jean-Paul Billon-Bruyat², Silvia Spezzaferri¹

¹ Institut de Géologie, Université de Fribourg, Chemin du Musée 6, 1700 Fribourg

² Paléontologie A16, Office de la culture de la République du Canton du Jura, Hôtel des Halles, 2900 Porrentruy

³ Institut des Sciences de la Terre, Université de Lausanne, Quartier UNIL-Mouline, Bâtiment Géopolis, 1015 Lausanne

⁴ Geoscience Department, University of Brunei Darussalam

Remains of sharks, rays and chimaeras (class Chondrichthyes) are very common in Jurassic deposits. Especially chondrichthyan teeth are abundant due to their high resistance to mechanical and chemical alteration. Besides their taxonomic value, they are an ideal material for stable isotope analyses and are widely used as a palaeoenvironmental proxy. Since most chondrichthyans continuously grow and replace their teeth – in isotopic equilibrium with the surrounding water – the isotopic signal recorded in pristine teeth is directly related to the sea water isotopic composition at the time they formed. We report a new chondrichthyan association, in both taxonomic and biogeochemical perspectives. More than 2000 fossils were discovered in Kimmeridgian deposits of Ajoie (Canton Jura, Switzerland), during the building of the Transjurane highway (A16) in the framework of controlled excavations led by the Paléontologie A16, between 2000 and 2011.

The evolution history of sharks in the Late Jurassic is characterized by the expansion of modern forms, causing the decline of hybodonts, or “primitive” sharks, in the marine realms. With a strong dominance of rays and hybodonts (~50% and 40% of the material, respectively), our assemblage clearly differs from neighbouring late Jurassic associations from southern Germany or France, where hybodonts are scarce or absent. This suggests a relatively isolated environment still favourable to primitive sharks in the Ajoie region. It is also noteworthy that the modern shark *Corysodon* (*Neoselachii*) is reported for the first time in Switzerland.

Oxygen isotopic compositions of phosphate from apatite were measured in chondrichthyans (teeth), as well as in associated remains of turtles (osteoscutes) and of bony fish Pycnodontiformes (teeth) for comparisons. The isotopic values of Pycnodontiformes and *Asteracanthus* indicate distinct living environments, however both taxa are found in the same deposits. While the Pycnodontiformes' data are consistent with marine conditions, the results from the hybodont shark *Asteracanthus* indicate a brackish environment. Considering the absence of transport related marks on the analyzed teeth (e.g. damage from reworking), we suggest a marine lifestyle combined with excursions into estuaries or rivers for the hybodont shark *Asteracanthus*.

Our results are consistent with the presence of freshwater on the platform, as suggested by turtle and crocodylian biogeochemistry (Meyer et al. 2012), as well as inferred from the presence of sauropod dinosaur footprints and woods (Philippe et al. 2010). However, the location of the freshwater-influenced environment recorded in *Asteracanthus* remains questionable (on this platform?). This is the first biogeochemical evidence of freshwater influenced conditions for the large, durophagous shark *Asteracanthus*, classically considered as marine for more than 150 years (Agassiz 1837). Interestingly, the presence of *Asteracanthus* remains in Purbeck and Wealden of southern England (Woodward 1895) suggested a tolerance to brackish waters, without further evidence. Compared to previously published biogeochemical data and faunal composition of French and British Jurassic localities, our results represent so far a unique isotopic signature for *Asteracanthus*.

REFERENCES

- Agassiz, L. 1837. Recherches sur les poissons fossiles, Tome III. Neuchâtel: Imprimerie de Petipierre, 5, 383 pp. (Text), Plates A-S and 1-47 (Atlas).
- Leuzinger, L. 2013: Systematics and biogeochemistry of a new chondrichthyan fauna: implications for the palaeoecological reconstruction of a shallow-water platform (Late Jurassic, Swiss Jura). *Master's Thesis, University of Fribourg, Switzerland*, 134 pp.
- Meyer, C. A., Billon-Bruyat, J.-P., Lécuyer, C., & Bocat, L. 2012: Oxygen isotope compositions of Late Jurassic turtles in Europe: new data from Switzerland and Germany. Symposium on Turtle Evolution, University of Tübingen, Germany. Program and abstracts, p. 30.
- Philippe, M., Billon-Bruyat, J.-P., Garcia-Ramos, J. C., Bocat, L., Gomez, B., & Piñuela, L. 2010: New occurrences of the wood *Protocupressinoxylon purbeckensis* FRANCIS: implications for terrestrial biomes in southwestern Europe at the Jurassic/Cretaceous boundary. *Palaeontology*, 53(1), 201-214.
- Woodward, A. S. 1895: *Catalogue of fossil fishes in the British*, Part III. British Museum of Natural History, 544 pp.

4.10

Comparison of the bony labyrinths of some extant and fossil hedgehogs (Erinaceomorpha, Mammalia): evolutionary and paleoecological implications

Maridet Olivier¹, Costeur Loïc², Schwarz Cathrin³, Furió Marc⁴, van Glabbeek Flora M.⁵, Hoek Ostende Lars W.⁵

¹Jurassica Museum, route de Fontenais 21, CH-2900 Porrentruy (olivier.maridet@jurassica.ch)

²Geowissenschaften Abt., Naturhistorisches Museum Basel, Augustinergasse 2, CH-4001 Basel.

³Paläontologie Abt., Universität Wien, Althanstrasse 14, A-1090 Vienna.

⁴Institut Català de Paleontologia, Universitat Autònoma de Barcelona, c/ de les Columnes, s/n, SP-08193 Barcelona.

⁵Naturalis Biodiversity Center, Darwinweg 2, NL-2333 Leiden.

Family Erinaceidae comprises the spiny hedgehogs (Erinaceinae) and the hairy hedgehogs (Galericinae). Although the extant members of this family are well-known, their phylogenetic relationships and their position among the phylogeny of mammals, especially among Eulipotyphla, remain controversial (Meredith et al. 2011; Bininda-Emonds et al. 2007; He et al. 2012). Furthermore, the evolutionary history of Erinaceidae, especially the separation between the two extant subfamilies remains poorly understood. Extant spiny and hairy hedgehogs also differ in their ecological traits. The spiny hedgehogs are strictly ground-dwelling living in temperate or sub-desertic environments whereas hairy hedgehogs live in tropical forests and are slightly more agile, giving them the possibility to climb small obstacles.

Thanks to high-resolution computed tomography it is now possible to virtually study the inner morphology of skulls in a non-destructive way. The bony labyrinth is constituted of the organs of hearing and balance and is situated within the petrosal bone. It is a fine and complex network of canals known to bear meaningful systematic and phylogenetic information (Ni et al. 2012; Ekdale 2013). We reconstruct here for the first time the bony labyrinth of several extant and fossil hedgehogs.

A tentative cladistic analysis is performed based on the morphology of the bony labyrinth, in order to assess the potential contribution of these characteristics to our understanding of Erinaceidae evolutionary history. The phylogeny confirms that Soricidae constitute a primitive clade with regard to Erinaceidae, and that all fossil and extant taxa ascribed to the Erinaceinae form indeed a monophyletic and apomorphic clade. However, all taxa previously ascribed to Galericinae seem to constitute a polyphyletic clade.

The three semi-circular canals constitute the center of balance within the bony labyrinth. For instance, thinner canals indicate a more accurate sense of balance allowing a more agile mode of locomotion. This difference is obvious when comparing extant spiny and hairy hedgehogs, however several fossil forms of spiny hedgehogs display thin semi-circular canals (e.g. *Ampechinus*, Figure 1) thus indicating that the strict ground-dwelling locomotion is not characteristic of the Erinaceinae subfamily, but rather indicating a recent ecological evolution within this monophyletic clade.

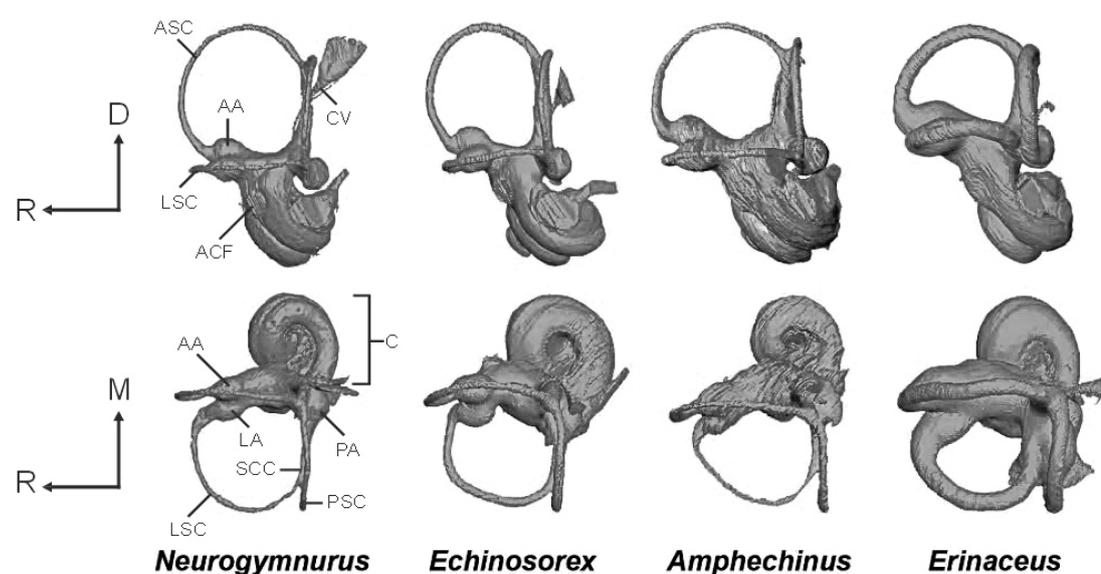


Figure 1. Reconstruction of the bony labyrinths for: *Neurogymnurus cayluxi* Filhol, 1877 (Galericinae, Early Oligocene, France); *Echinorex gymnura* Raffles, 1822 (Galericinae, Sumatra, extant); *Ampechinus edwardsi* (Filhol, 1879) (Erinaceinae, Early Miocene, France), *Erinaceus europaeus* Linnaeus, 1758 (Erinaceinae, Switzerland, extant). Orientations: R. Rostral, D. Dorsal, M. Medial. Abbreviations: C. Cochlea, ASC. Anterior Semicircular canal, LSC. Lateral semicircular canal, PSC. Posterior semicircular canal, AA. Anterior ampula, LA. Lateral ampula, PA. Posterior ampula, CV. Conduct of vestibule, SCC. Secondary crus commune, ACF. External aperture of the cochlear fossula.

This preliminary analysis emphasizes the potential of inner ear morphology to better understand the evolutionary history of Erinaceidae. Further analyses including more taxa and taking into account the morphology of the petrosal bone and the dentition will be necessary to fully understand the differentiation between the two extant subfamilies and the evolution of their ecology traits.

REFERENCES

- Meredith, R.W., et al. 2011: Impacts of the Cretaceous terrestrial revolution and KPg extinction on mammal diversification. *Science*, 334, 521-524.
- Bininda-Emonds, O.R.P., et al. 2007: The delayed rise of present-day mammals. *Nature*, 446, 507-511.
- He, K., et al. 2012: An Estimation of Erinaceidae Phylogeny: A combined analysis approach. *PLoS ONE*, 7(6), e39304.
- Ni, X., et al. 2012: Imaging the inner ear in fossil mammals: High-resolution CT scanning and 3-D virtual reconstructions. *Palaeontologia Electronica*, 15(2), 18A.
- Ekdale, E. 2013: Comparative anatomy of the bony labyrinth (inner ear) of placental mammals. *PLoS ONE*, 8(6), e66624.

4.11

The diversity and phylogenetic bottleneck of ammonoids across the end-Permian mass extinction

Maximiliano Meier¹, Hugo Bucher¹ & David Ware¹

¹ Paläontologisches Institut, University of Zürich, Karl-Schmid-Strasse 4, CH-8006 Zürich (maximiliano.meier@pim.uzh.ch)

Xenodiscids have long been recognized to survive the Permian-Triassic boundary mass extinction and to represent the long ranging stem group of the Early Triassic explosive radiation of ammonoids. Despite the general lack of adequate sections providing a complete, gap-free Permian-Triassic boundary ammonoid record (Tozer 1969), pioneers such as Griesbach and Diener already noticed similarities between late Permian and Early Triassic very evolute and morphologically simplified ammonoids. Kummel (1970) also argued that xenodiscids were Permian-Triassic boundary-crossers and stressed that these early Griesbachian evolute ammonoids represent an extremely plastic stock directly related to the late Permian forerunner *Xenodiscus*.

However, since the beginning of the 20th century, emphasis has been repeatedly put on the dissimilarities among xenodiscids with the pervasive aim of gaining higher biostratigraphic resolution. This resulted in taxonomic over-splitting and synonyms at the species, genus and family levels. Overlooked patterns of intraspecific variability also generated a significant bias in terms of diversity pattern at the base of the Early Triassic (Griesbachian).

The Griesbachian record from northeastern Greenland offers a rare and well preserved faunal succession. It includes, in stratigraphic order, the *Hypophiceras triviale*, *H. martini*, *Metophiceras subdemissum*, *Ophiceras commune* and *Wordieoceras decipiens* zones. Extensive and intensive bedrock-controlled sampling yielding numerous specimens per fossiliferous layers allows utilizing a biometric “population” approach of ontogenetic trajectories. Among the taxa from these zones, three xenodiscid genera are here of particular interest: *Metophiceras*, *Hypophiceras* and *Tompophiceras*. Their intraspecific variability is thoroughly investigated, leading to a revised taxonomy and new phylogenetic hypotheses. Together with new xenodiscid material from Oman and Spiti, this work aims at unravelling the phylogenetic link between xenodiscids and the basal Triassic iconic ophiceratids. Ophiceratids, the first typical Triassic clade, display many resemblances with some xenodiscids in terms of shell shape, but are considered to have a 6 lobed suture line instead of 5 lobed one as is the case of xenodiscids (Tozer 1969). Further studies of suture ontogeny should clarify the evolutionary relations during the ammonoid diversity and phylogenetic bottleneck around the Permian-Triassic boundary.

REFERENCES

- Kummel, B. 1970: Ammonoids from the Kathwai Member, Mianwali Formation, Salt Range, West Pakistan. In: Kummel, B., Teichert, C. (Eds.), *Stratigraphic Boundary Problems: Permian and Triassic of West Pakistan*. Department of Geology Special Publication, vol. 4. University Press of Kansas, pp. 177-192.
- Tozer, E.T., *Xenodiscacean Ammonoids and their bearing on the discrimination of the Permo-Triassic boundary*. *GEOLOGICAL MAGAZINE*, Vol. 106, No. 4, July-August, 1969, pp. 348-361.

4.12

Late Miocene-early Pliocene benthic foraminiferal assemblages from the La Matilla core, lower Guadalquivir Basin (SW Spain)

José N. Pérez-Asensio¹, Elias Samankassou¹, Gonzalo Jiménez-Moreno², Juan C. Larrasoña³, Pilar Mata³ & Jorge Civis³

¹ Section of Earth and Environmental Sciences, University of Geneva, Rue des Maraichers 13, CH-1205, Geneva, Switzerland
(Noel.PerezAsensio@unige.ch)

² Departamento de Estratigrafía y Paleontología, Universidad de Granada, Fuente Nueva s/n, 18002, Granada, Spain

³ Instituto Geológico y Minero de España, Calle Ríos Rosas 23, 28003, Madrid, Spain

Benthic foraminiferal assemblages have been studied in the lower part of the 276 m-long La Matilla core from the lower Guadalquivir Basin (SW Spain) that covers the late Miocene (Messinian) and early Pliocene (Zanclean). This part of the core encompasses marine sediments from the Messinian Arcillas de Gibraleón Formation, which consists mostly of greenish-bluish clays, and from the Zanclean Arenas de Huelva Formation including silts and sands. Forty samples were collected each 3 m along the interval from 257 to 150 m. Benthic foraminifera from the size fraction >125 µm were identified and counted until reaching at least 300 individuals. Furthermore, we calculated the relative abundance of species and several diversity indices, including number of taxa, Shannon index, evenness and species dominance. Benthic foraminiferal assemblages were established by means of Q-mode principal component analyses (PCA). In addition, benthic foraminifera were classified according to their microhabitat preferences. The planktonic/benthic ratio (P/B ratio), sand content and total number of benthic foraminifera per gram of dry sediment (N/g) were also calculated. Finally, Pearson correlation coefficients were used to quantify the relationships between all the metrics used in this study.

Five benthic foraminiferal assemblages have been identified in the studied interval. The distribution of these assemblages shows changes in paleobathymetry, productivity and oxygen content. In the lower part of the studied section, between 267 and 204 m, the dominance of the *Brizalina spathulata*, *Cibicidoides pachydermus* and *Uvigerina peregrina* s.l. assemblages indicates an outer shelf-slope setting. The upper part of the studied section, from 204 to 150 m, is characterized by the *Nonion fabum* and *Cassidulina laevigata* assemblages, which suggests an outer shelf environment. Therefore, a sea-level drop from the slope to the outer shelf is recorded during the late Miocene-early Pliocene. The slight increase in the sand content of the episodic sand inputs observed in the core is also consistent with the shallowing-upward trend. This sea-level lowering is also recorded in the Montemayor-1 core, located closer to the northwestern margin of the basin, and in the Atlantic side of the Rifian corridors (Pérez-Asensio et al. 2012; Jiménez-Moreno et al. 2013). Hence, this sea-level lowering has, at least, regional significance.

Concerning changes in productivity and oxygenation, the lowermost part of the studied interval, between 267 and 225 m, shows an alternation between the *Cibicidoides pachydermus* and *Uvigerina peregrina* s.l. assemblages, which can be interpreted as a moderately oxygenated mesotrophic environment with cyclic inputs of labile organic matter related to repeated upwelling events (Pérez-Asensio et al. 2012, 2014). This increased productivity during upwelling events is mirrored in higher abundances of shallow infaunal taxa, while less productivity is marked by more epifaunal-shallow infaunal taxa. Furthermore, these 2 assemblages show positive and negative correlations with the number of taxa and Shannon index, and dominance, respectively. Hence, these mesotrophic assemblages have a high diversity and low dominance suggesting low environmental stress. The uppermost part of the lower interval, from 225 to 204 m, is characterized by the *Brizalina spathulata* assemblage, which includes *Stainforthia complanata* as secondary species. This assemblage shows the highest abundance of deep infaunal taxa (up to 55%) along the studied interval and coincides with a period of low diversity and high dominance. Both species can thrive in environments with very low oxygen content and high organic carbon input. Hence, this assemblage inhabited the most eutrophic environment with the lowest oxygen content, which might be related to strong stratified water column conditions. Such particular eutrophic conditions have not been reported in more marginal areas of the basin (Pérez-Asensio et al. 2012). Finally, the upper part of the studied interval (204-150 m) exhibits an alternation between the *Nonion fabum* and *Cassidulina laevigata* assemblages. The presence of *Nonion fabum* assemblage with *Bulimina elongata* as associated taxa points to low oxygen eutrophic conditions with supply of continental degraded organic matter derived from river run-off (Pérez-Asensio et al. 2012). A lower diversity, higher dominance and more intermediate infaunal taxa are observed in the upper part of the studied interval indicating a gradual increase of the riverine discharge due to shallowing and/or increased humidity during the latest Miocene-lowest Pliocene. The mesotrophic *Cassidulina laevigata* assemblage and its secondary species *Spiroplectinella wrightii* are indicative of marine organic matter supply and moderate oxygenation, and mark freshwater-marine transitional conditions (Pérez-Asensio et al. 2012). This assemblage shows low abundance of intermediate infauna and high abundance of epifauna-shallow infauna pointing to less environmental stress compare to the *Nonion fabum* assemblage. Repeated riverine influence in the outer shelf could be controlled by low amplitude cyclic sea-level changes and/or enhanced rainfall during humid periods.

REFERENCES

- Jiménez-Moreno, G., Pérez-Asensio, J.N., Larrasoña, J.C., Aguirre, J., Civis, J., Rivas-Carballo, M.R., Valle-Hernández, M.F. & González-Delgado, J.A., 2013: Vegetation, sea-level and climate changes during the Messinian salinity crisis. *Geol. Soc. Am. Bull.*, 125, 432-444.
- Pérez-Asensio, J.N., Aguirre, J., Schmiedl, G. & Civis, J. 2012: Messinian paleoenvironmental evolution in the lower Guadalquivir Basin (SW Spain) based on benthic foraminifera. *Palaeogeogr. Palaeoclimatol. Palaeoecol.*, 326-328, 135-151.
- Pérez-Asensio, J.N., Aguirre, J., Schmiedl, G. & Civis, J. 2014: Messinian productivity changes in the northeastern Atlantic and their relationship to the closure of the Atlantic-Mediterranean gateway: implications for Neogene palaeoclimate and palaeoceanography. *J. Geol. Soc. London*, 171, 389-400.

4.13

The «Cyathula-Bank», a regional stratigraphic unit at the interface between two tectonic and sedimentological provinces

Claudius Pirkenseer¹, & Gaëtan Rauber¹

¹ Office Cantonal de la Culture, Paléontologie A16, Rue de la Chaumont 13, CH-2900 Porrentruy
(claudius.pirkenseer@jura.ch, gaetan.rauber@jura.ch)

During the last two decades the study of the Cenozoic deposits of the so-called “Jura-Molasse” re-intensified due to the construction of the highway A16, stimulating more complex interpretations of the palaeogeographic situation and lateral facies changes. Still, some lithological units like the “Cyathula-Bank/Mergel” remain poorly understood.

The “Cyathula-Bank” (after *Crassostrea cyathula*) in the area between Basel and Laufen has been interpreted as a marker bed subdividing the Late Rupelian Molasse alsacienne (equiv. to upper Cyrenenmergel, lower Niederroedern Formation in Fig. 1), possibly representing a short-term transgressive event within the final regressive phase of the Ru-3 sequence. The “Cyathula-Mergel” in the Delémont area has been interpreted as basin-marginal stratigraphic equivalent to the Cyrenenmergel of the southern Upper Rhine Graben. The preliminary analysis of cores drilled in the Delémont Basin however show the occurrence of a well-defined, densely packed *cyathula*-bearing (coquina) sandstone level at the base of a condensed, 5 to 20 m thick marine series equivalent to the much thicker Serie grise (mainly Meletta-Schichten and Cyrenenmergel) of the Upper Rhine Graben. The thickness of the oyster-bearing levels varies from beds > 5 m (DEL1), patches (Retzwiller) to scattered specimens (Dornachbrugg-1, DP-202, Allschwil-2) or absence (Laufen).

This stratigraphical disparity of occurrences of oysters either during the transgressive or regressive phase of the Serie grise requires a new definition of this lithological unit. A plausible solution represents the interpretation of the “Cyathula-Bank” as an estuarine / deltaic, laterally limited, repetitive regional facies related to fast palaeoenvironmental changes of the extensive prograding Molasse alsacienne-river system. The northward-directed development of the latter and the complex regional palaeogeography in the late Rupelian may explain the scattered occurrences through time and space. The arrival of fluvial sediments from the Molasse Basin to the southeast is not isochronous and clearly evidenced by changes in other faunal assemblages (autochthone vs. allochthone, marine vs. freshwater), heavy mineral associations (spectrum change) and sedimentological features (disconformity, increase in coarse clastic sediments, point bars).

The occurrence of oyster beds at the base of the marine series in the Delémont basin raises the question about the supposedly uniform timing of the initial transgression (Ru2 transgression) in the different subbasins at the southern end of the Upper Rhine Graben in the late Rupelian.

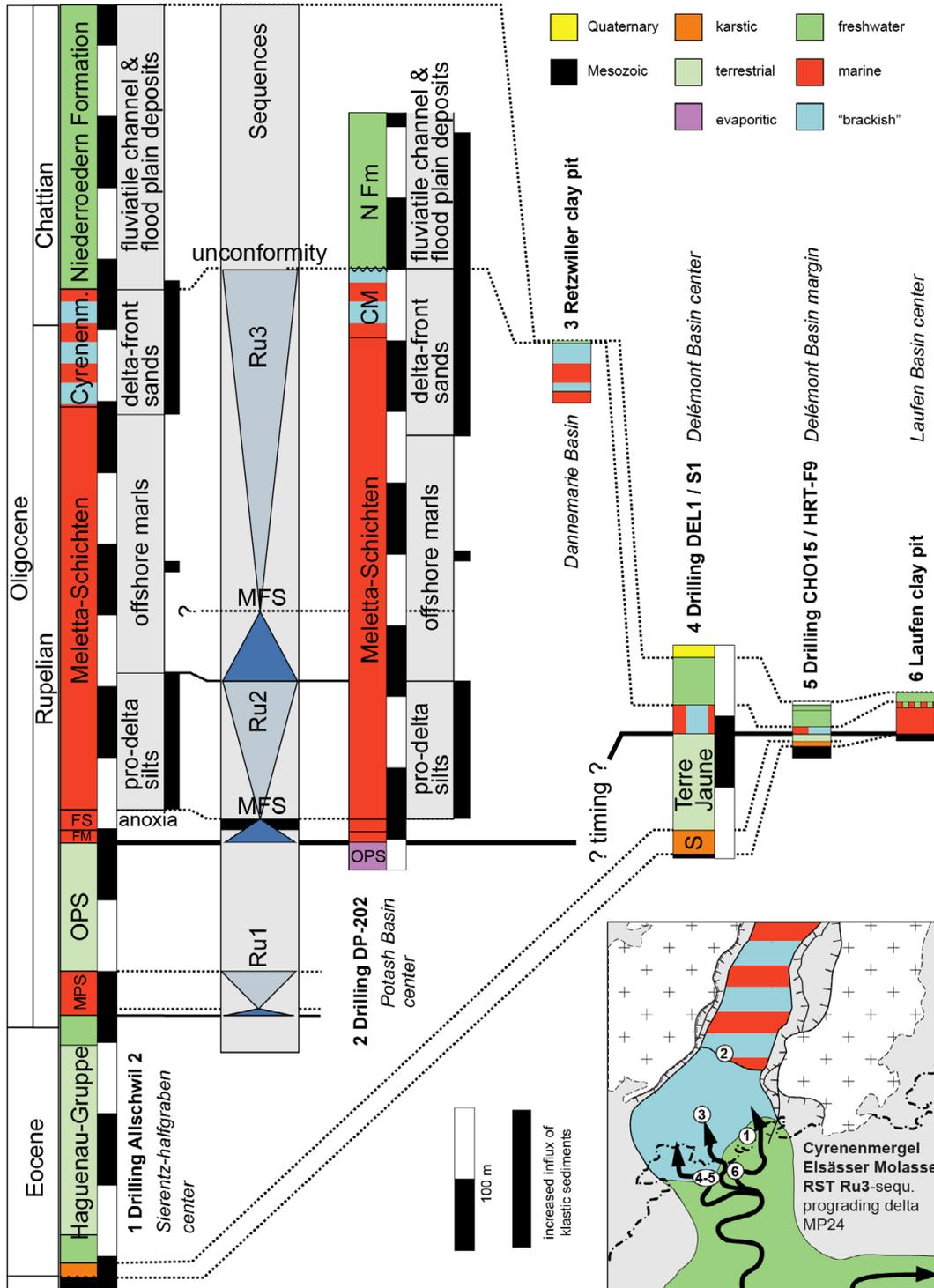


Figure 1. Sediment thickness and correlation between sections in different subbasins in the southernmost Upper Rhine Graben. The small inset indicates localities and the palaeogeography at the interface between the URG and the Molasse Basin during the latest Rupelian. Occurrences of *Crassostrea cyathula*: 1 isolated specimens in CM, 2 isolated specimens in CM, 3 small bioherms in CM, 4 bed of around 5 m at the transgressive surface, 5 bed 50 cm at the transgressive surface, 6 not recorded. (CM = Cyrenemergel, FS = Fischechiefer, FM = Foraminiferenmergel, S = Siderolithikum)

4.14

The crocodylian *Steneosaurus* cf. *bouchardi* in the Kimmeridgian of Switzerland

Schaefer Kévin, Billon-Bruyat Jean-Paul

Section d'archéologie et paléontologie, Office de la Culture, République et Canton du Jura, Hôtel des Halles, 2900 Porrentruy (kevin.schaefer@jura.ch)

Between 2000 and 2011, more than 500 isolated teeth and more than 170 isolated bones but also 3 skeletons of *Thalattosuchia* (Crocodylia, Mesosuchia), a suborder of Mesozoic marine crocodylians, have been discovered in the Canton Jura. Those remains have been found during controlled excavations along the future path of the A16 motorway (Transjurane). A preliminary study of the dentition - mainly based on isolated teeth - has shown that the crocodylian fauna consists of four genera, the teleosaurids *Steneosaurus* and *Machimosaurus* and the metriorhynchids *Metriorhynchus* and *Dakosaurus* (Schaefer 2012a, b). Most of the remains belong to *Steneosaurus*, a long-snouted form. It is represented in the Canton Jura by two species: *S. cf. jugleri*, a longirostrine species, and *S. cf. bouchardi*, a mesorostrine species.

Here, we report a nearly complete isolated mandible, with both *in situ* and associated teeth, and 34 isolated teeth referred to *Steneosaurus* cf. *bouchardi*. The mandible and most of the isolated teeth come from the upper Kimmeridgian *Eudoxus* ammonite zone, whereas some isolated teeth come from the upper Kimmeridgian *Acanthicum* and lower Kimmeridgian *Divisum* zones.

Comparisons with mandibles and a skeleton of *Steneosaurus* cf. *jugleri* allow to clarify dental and jaw differences between the two species of *Steneosaurus*. The teeth of *S. cf. bouchardi* are more massive with a “height/mesio-distal diameter” ratio lower or equal to 3, whereas in *S. cf. jugleri* the same ratio is greater or equal to 3, in addition the teeth are more gracile in shape. The mandible of *S. cf. bouchardi* is more massive, the alveoli are larger and circular in shape instead of being compressed. Moreover the “symphysis versus total mandible length” ratio is *ca.* 56.5%, instead of at least *ca.* 66.6% in *S. cf. jugleri*.

Steneosaurus bouchardi differs from other Late Jurassic *Steneosaurus* species in having a more massive skull (Vignaud 1995). It is known from two French specimens: a partial skull and mandible from the upper Kimmeridgian (*Autissiodorensis* zone) of the Boulonnais and a partial skull from the lower Kimmeridgian (*Baylei* zone) of Normandie (Sauvage 1874, Buffetaut & Makinsky 1984). The reported material with its massive mandible and dentition, is very close to *S. bouchardi*. However, a detailed comparison with the remains from France is precluded: the material from the Boulonnais is lost and the skull from Normandie belongs to a private collection.

Thus, the reported remains from the Canton Jura could be the only available material for *S. bouchardi*. It should also be noted that our team has recently discovered a skeleton (including the skull, mandible and many postcranial bones) related to *S. bouchardi*. Its description would confirm the identification at the species level.

REFERENCES

- Buffetaut, E., Makinsky, M. (1984): Un crâne de *Steneosaurus* (Crocodylia, Teleosauridae) dans le Kimméridgien de Villerville (Calvados). *Bulletin trimestriel de la Société Géologique de Normandie et des Amis du Muséum du Havre* 71, 19-24.
- Sauvage, H.-E. (1874): Mémoire sur les Dinosauriens et les Crocodyliens des terrains jurassiques de Boulogne-sur-Mer. *Mémoires de la Société Géologique de France* 10(2), 1-58.
- Schaefer, K. 2012a: Variabilité de la morphologie dentaire des crocodyliens marins (Thalattosuchia) du Kimméridgien d'Ajoie (Jura, Suisse). Unpublished master thesis, University of Fribourg, 111 pp.
- Schaefer, K. 2012b: Variability of the dental morphology in marine crocodylians (Thalattosuchia) from the Kimmeridgian of Ajoie (Jura, Switzerland). Abstract, 10th Swiss Geoscience Meeting 2012, Bern, p. 212-213.
- Vignaud P. (1995): Les Thalattosuchia, crocodiles marins du Mésozoïque: systématique phylogénétique, paléocologie, biochronologie et implications paléogéographiques. Unpublished doctoral thesis, University of Poitiers (France), 271 pp.

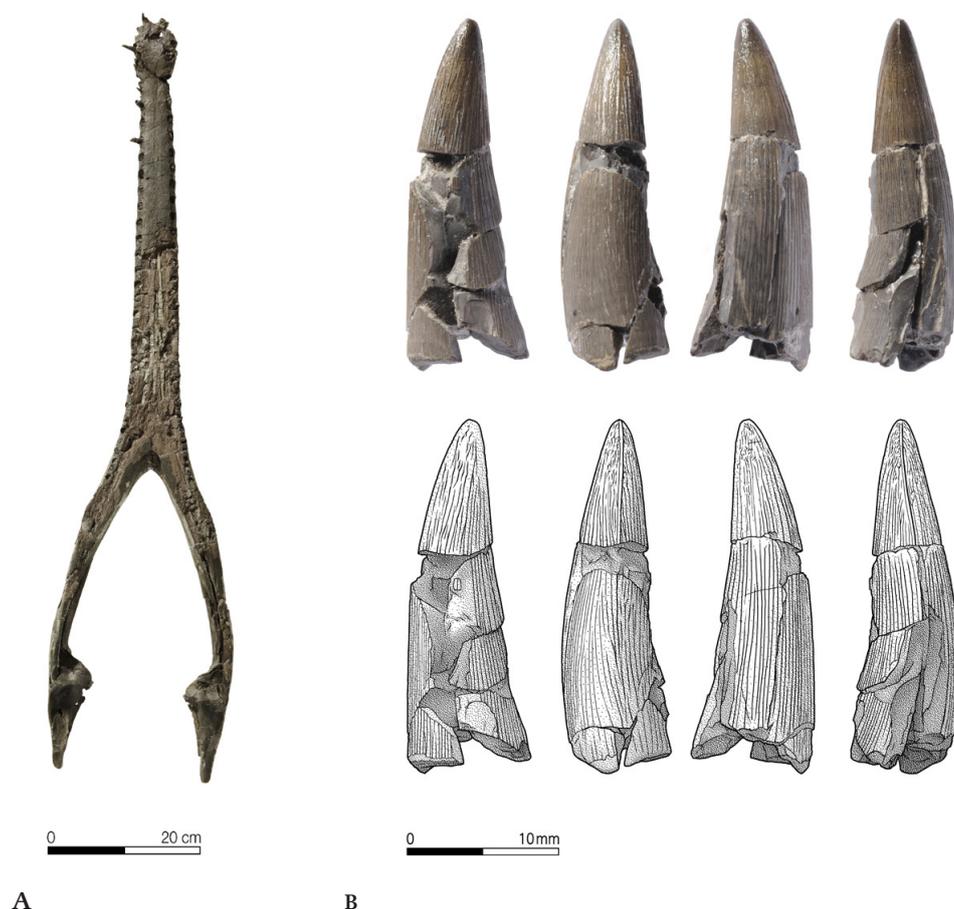


Figure 1. *Steneosaurus* cf. *bouchari* (late Kimmeridgian, Courtedoux, Swiss Jura). A: mandible TCH006-1439, in dorsal view. B: example of a tooth associated with the mandible in - from left to right - lingual, mesio-distal, labial and mesio-distal views (photographs and corresponding drawings).

4.15

The Dienerian (Early Triassic) ammonoid diversity crisis: timing and environmental proxies from the northern Indian margin

David Ware¹, Hugo Bucher¹ & Elke Schneebeili-Hermann¹

¹ Paläontologisches Institut und Museum der Universität Zürich, Karl Schmid-Strasse 4, CH-8006 Zürich, Switzerland
(david.ware@pim.uzh.ch; hugo.fr.bucher@pim.uzh.ch)

Following the recent revision of the taxonomy and biostratigraphy of Dienerian ammonoids from the Salt Range (Pakistan) and from Spiti (Northern India), a new high resolution biozonation based on the Unitary Association (UA) method is constructed for the Dienerian of the Northern Indian Margin (NIM). It includes 12 UA-zones and leads to subdivide the Dienerian into three parts (early, middle and late). This new scheme strongly contrasts with all previously established Dienerian biozonation. For example, Tozer (1994) divided the Dienerian stage of Canada it into two parts (early and late) and recognised only 4 sub-zones, grouped into two zones. Correlation of this new scheme outside the NIM is made difficult by the emergence of a latitudinal differentiation during the Dienerian, which indicates a substantial paleobiogeographic change from the cosmopolitan distribution of the preceding Griesbachian faunas.

The corresponding diversity analyses, coupled with results previously obtained for the early Smithian of the same margin, highlight the four following phases: (1) a first modest diversity high in the early Dienerian; (2) a protracted diversity low spanning the middle Dienerian; (3) a slow increase of diversity during the late Dienerian, and (4) a sustained diversificati-

on in the early Smithian. Turnover rates are very high during the whole interval, and the boundaries between early-middle and middle-late Dienerian are underlined by complete renewals of the faunas. The low diversity in the middle and early late Dienerian is associated with a global anoxic event and warmer temperatures than during early Dienerian and early Smithian times. Together with the end-Smithian extinction, middle and late Dienerian times witnessed the two most severe diversity demises of Early Triassic ammonoids. The middle Dienerian of the NIM (Salt Range) is also characterized by a spore spike similar to that previously documented at the end-Permian (Schneebeili-Hermann et al. 2014), thus emphasizing a marked and simultaneous deterioration of both terrestrial and marine environments. This pattern stands in strong contrast with the general view of a protracted or stepwise recovery following the end-Permian mass extinction.

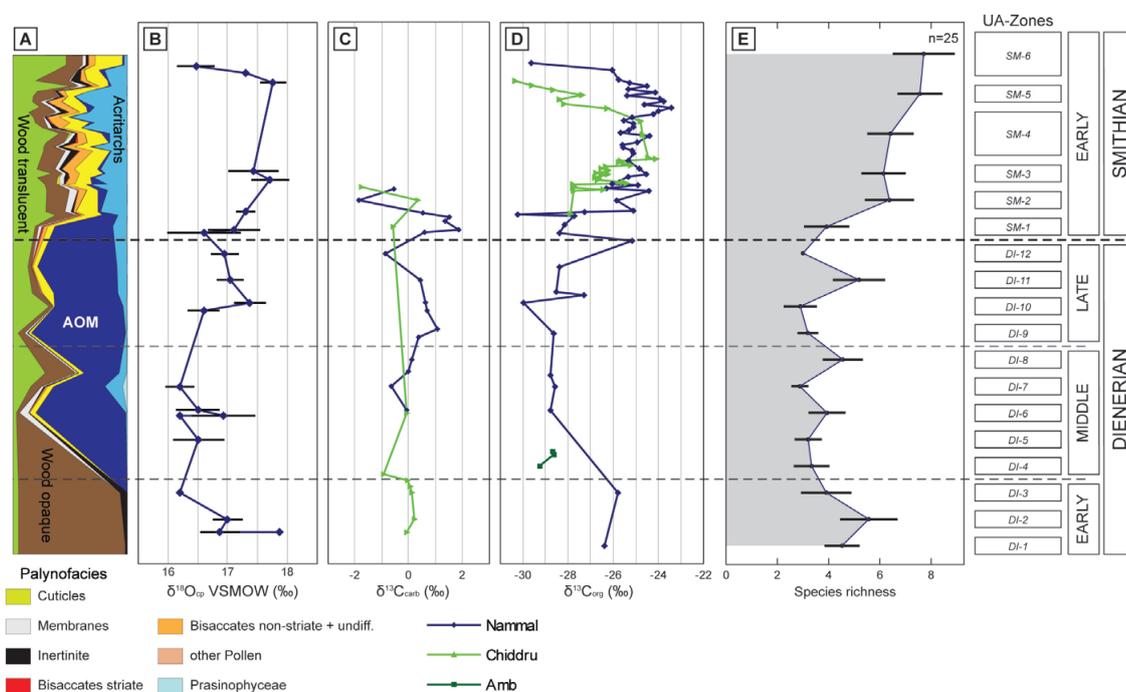


Figure 1. Comparison of the biodiversity signal with palaeoenvironmental proxies: [A] Palynofacies of the Nammal Nala section (modified after Hermann et al. 2011); AOM = Amorphous Organic Matter [B] Oxygen isotopes from Nammal Nala section (modified after Romano et al. 2013); [C] Carbonate carbon isotopes from Chiddu and Nammal (modified after Hermann et al., 2011) ; [D] Organic carbon isotopes from Chiddu and Nammal (modified after Hermann et al. 2011) and from Amb (modified after Schneebeili-Hermann et al. 2012); [E] Rarefied species richness curve and associated 95% confidence intervals for the Northern Indian Margin.

REFERENCES

- Hermann, E., Hochuli, P.A., Méhay, S., Bucher, H., Brühwiler, T., Ware, D., Hautmann, M., Roohi, G., ur-Rehman, K. & Yaseen, A. 2011: Organic matter and palaeoenvironmental signals during the Early Triassic biotic recovery: The Salt Range and Surghar Range records. *Sedimentary Geology* 234, 19-41.
- Romano, C., Goudemand, N., Vennemann, T.W., Ware, D., Schneebeili-Hermann, E., Hochuli, P.A., Brühwiler, T., Brinkmann, W. & Bucher, H. 2013: Climatic and biotic upheavals following the end-Permian mass extinction. *Nature geosciences* 6, 57-60.
- Schneebeili-Hermann, E., Kürschner, W.M., Hochuli, P.A., Bucher, H., Ware, D., Goudemand, N. & Roohi, G. 2012: Palynofacies analysis of the Permian–Triassic transition in the Amb section (Salt Range, Pakistan): Implications for the anoxia on the South Tethyan Margin. *Journal of Asian Earth Sciences* 60, 225-234.
- Schneebeili-Hermann, E., Kürschner, W.M., Bomfleur, B., Hochuli, P.A., Ware, D., Roohi, G. & Bucher, H. 2014: Vegetation history across the Permian-Triassic boundary in Pakistan (Amb section, Salt Range), *Gondwana Research*, <http://dx.doi.org/10.1016/j.gr.2013.11.007>.
- Tozer, E.T. 1994: Canadian Triassic Ammonoid Faunas. *Bulletin of the Geological Survey of Canada* 467, 1-663.

P 4.1

Woolly rhinoceros from the Pleniglacial of Ajoie (Jura Canton, Switzerland): anatomical description and ecological implications

Damien Becker^{1,2}, Méline Dini³, Laureline Scherler⁴

¹ Jurassica Museum, route de Fontenais 21, CH-2900 Porrentruy (damien.becker@jurassica.ch)

² Section d'archéologie et paléontologie, Office de la culture, République et Canton du Jura, Hôtel des Halles, CH-2900 Porrentruy

³ Département des Géosciences, Université de Fribourg, Chemin du Musée 6, CH-1700 Fribourg

⁴ Institut des Sciences de l'Evolution, Place Eugène Bataillon, Université de Montpellier 2, F-34095 Montpellier

The Ajoie region (N-W Switzerland) is dotted with numerous dolines, whose Quaternary fillings have regularly yielded megafauna remains dated from the Pleniglacial. The fossil specimens have been transported by biological (predators or scavengers) or physical (solifluction, withdrawing) processes resulting in sorting, abrasion, weathering and concentration of bones and teeth. The mammalian assemblages are dominated by grazing mega- and large herbivores. Previous studies showed that their preferred biotope was open, with low grassy vegetation and tall herbs, but there were also patches with bushes, dwarf shrubs, and scattered trees. There were both fairly damp ground with well-developed soils and drier, somewhat rocky surfaces. This natural environment of wooded tundra-steppe probably developed during relatively temperate interstadials that marked the Pleniglacial (Becker et al. 2009, 2013).

Based on comparative anatomy within late Quaternary Rhinocerotidae, the referred remains are attributed to the classical woolly rhinoceros *Coelodonta antiquitatis*. A detailed ecomorphological analysis underlines a grass-dominated mixed feeder in open habitats of a robust anatomical type. Also, a selective mortality of populations, dominated by breastfed juveniles and young adult and excluding old individuals, is observed on the base of dental wear analysis (Figure 1). Within the local periglacial context in North Alpine domain, woolly rhinoceros from the Pleniglacial of Ajoie seem to be in decline resulting from interspecific competition, low ecological tolerance, probably to the seasonality, and social behaviour rather solitary or in small groups. These results observed at regional scale could illustrate the mechanism of disappearance of woolly rhinoceros occurring in all Northern Eurasia during the terminal Late Glacial (Kuzmin 2010; Stuart & Lister 2012).

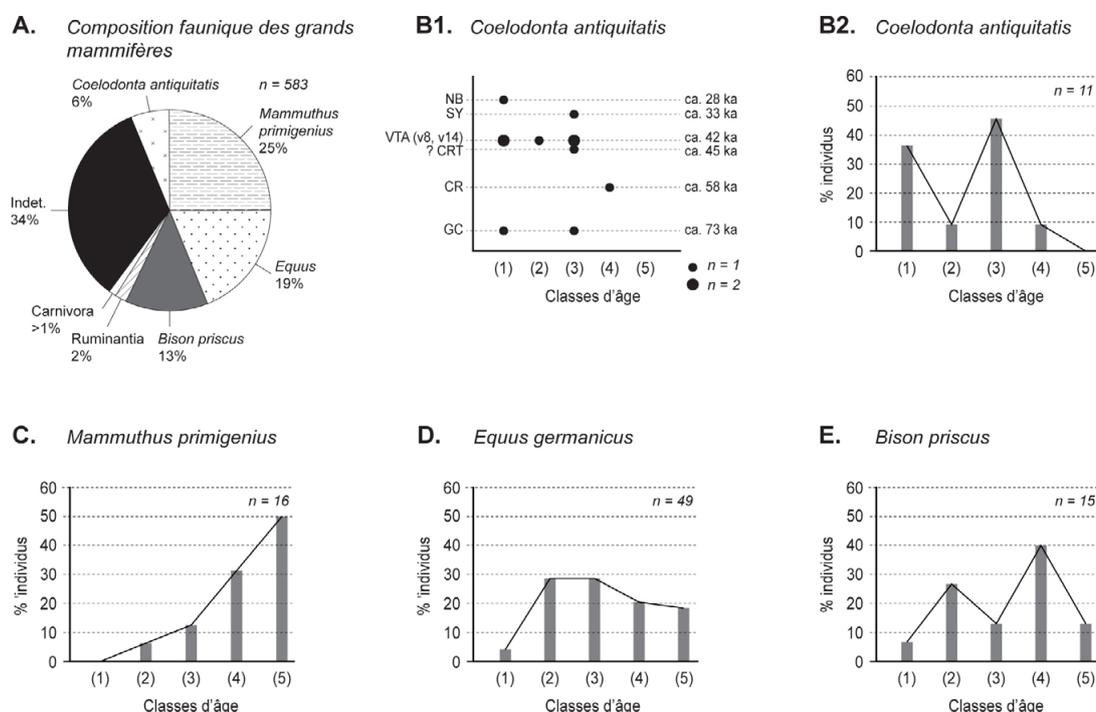


Figure 1. Faunal composition of large mammals recorded in the Ajoie (N-W Switzerland) during the Pleniglacial (A.). Mortality histogram of *Coelodonta antiquitatis* d'Ajoie (B1.) and age class vs remain number distribution per site (B2.). Mortality histogram of *Mammuthus primigenius* (C.), *Equus germanicus* (D.) and *Bison priscus* (E.) d'Ajoie (modified after Rothen et al. 2012 and Savoy et al. 2013).

REFERENCES

- Becker, D., Aubry, D. & Detrey, J. 2009: Les dolines du Pléistocène supérieur de la Combe de « Vâ Tche Tchâ » (Ajoie, Suisse): un piège à restes de mammifères et artefacts lithiques. *Quaternaire*, 20, 123-137.
- Becker, D., Oppliger, J., Thew, N., Scherler, L., Aubry, D. & Braillard, L. 2013: Climat et écologie en Ajoie durant la seconde partie du Pléniglaciaire moyen weichsélien : apport des remplissages des dolines de Courtedoux–Vâ Tche Tchâ (Jura, Suisse). *Annales Littéraires de l'Université de Franche-Comté*, 916, and *Cahier d'archéologie jurassienne*, 21, 13-24.
- Kuzmin, Y.V. 2010: Extinction of the woolly mammoth (*Mammuthus primigenius*) and woolly rhinoceros (*Coelodonta antiquitatis*) in Eurasia: review of chronological and environmental issues. *Boreas*, 39, 247-261.
- Rothen, J., Becker D. & Berger, J.-P. 2012: Morphométrie des dents jugales du mammoth laineux (*Mammuthus primigenius*) découvertes dans les remplissages pléistocènes de dolines d'Ajoie (Jura, Suisse). *Actes de la Société Jurassienne d'Emulation*, Porrentruy, 114, 17-36.
- Savoy, J., Scherler, L. & Becker, D. 2013: Variabilité morphologique et biométrique des dents d'*Equus germanicus* des dolines pléistocènes d'Ajoie (Jura, Suisse). *Actes de la Société jurassienne d'Emulation*, Porrentruy, 115, 17-36.
- Stuart, A.J. & Lister, A.M. 2012: Extinction chronology of the woolly *Coelodonta antiquitatis* in the context of late Quaternary megafaunal extinctions in northern Eurasia. *Quaternary Science Reviews*, 51, 1-17.

P 4.2

New primate material from the Middle Eocene Swiss Site Verrerie de Roches

Raef Minwer-Barakat¹, Judit Marigó², Loïc Costeur³ & Burkart Engesser³

¹ Institut Català de Paleontologia Miquel Crusafont, 08193 Cerdanyola del Vallès, Barcelona, Spain (raef.minwer@icp.cat)

² Duke University, Department of Evolutionary Anthropology, 27708 Durham, NC, USA

³ Naturhistorisches Museum Basel, CH-4001 Basel, Switzerland

Excavations carried out in the seventies yielded abundant mammal material of the Middle Eocene Swiss site Verrerie de Roches (Jura, MP16). While Stehlin (1916) and Becker et al. (2013) described about 10 primate teeth from old and new material, the present study adds more than 70 primate teeth to the previously published material.

Most specimens correspond to the genus *Necrolemur* already described from Verrerie de Roches (Stehlin 1916, Becker et al., 2013). A preliminary observation of the material has allowed us to observe that it is smaller than the species *Necrolemur antiquus* and shows a less accentuated enamel wrinkling and less developed conules in the upper molars. On the other hand, it is similar in size and morphology to a still undescribed species from Sant Jaume de Frontanyà-1, north-eastern Spain (Minwer-Barakat et al., 2014). A second microchoerine belonging to genus *Pseudoloris* has been identified at Verrerie de Roches. The presence of this genus there was not known before. The teeth of this primate, much less abundant than *Necrolemur* at this site, seem to be larger than those of *Pseudoloris parvulus*, and probably similar in size to other species such as *Pseudoloris pyrenaicus*, only found in Spain up to date in Sant Jaume de Frontanyà-3. The similarities between the primates from Verrerie de Roches and Sant Jaume de Frontanyà seem to support previous hypotheses considering that the Pyrenean Basins were connected to central Europe during the Middle Eocene. Further study is needed to give a determination at the specific level for the two primates identified at Verrerie de Roches, but the discovery of this rich material already represents a very notable advance in the knowledge of the Swiss Palaeogene primate faunas.

REFERENCES

- Becker, D., Rauber, G., Scherler, L. 2013: New small mammal fauna of late Middle Eocene age from a fissure filling at la Verrerie de Roches (Jura, NW Switzerland). *Revue de Paléobiologie*, 32(2), 433-446.
- Minwer-Barakat, R., Marigó, J. & Moyà-Solà, S. 2014: New material of *Necrolemur* (Microchoerinae, Omomyidae, Primates) from the Middle Eocene of the Pyrennes (Northeastern Spain). *American Journal of Physical Anthropology* 153, 111.
- Stehlin, H.G. 1916: Die Saugetiere des schweizerischen Eozäns, Critischer Catalog der materialien. *Caenopithecus–Necrolemur–Microchoerus–Nannopithec–Anchomomys–Periconodon–Amphichiromys–Hetero–Chiomys–Nachträge zu Adapis–Schlussbetrachtungen zu den Primaten*. Schweizerische Paläontologische Abhandlungen, 41, 1299-1552.

P 4.3

Environmental change in central Italy since the Late Pleistocene. The Lake Trasimeno ostracod record.

Marta Marchegiano¹, Elsa Gliozzi², Nicoletta Buratti³, Daniel Ariztegui¹ & Simonetta Cirilli³

¹ Earth & Environmental Sciences, University of Geneva, 13 rue de Maraichers, 1205 Geneva, Switzerland
(marta.marchegiano@unige.ch, daniel.ariztegui@unige.ch)

² Department of Science, University Roma Tre, Largo S. Leonardo Murialdo 1, 00146 Roma, Italy
(elsa.gliozzi@uniroma3.it)

³ Department of Geological Sciences, University of Perugia, Piazza Università 1, 06100 Perugia, Italy
(stradott@unipg.it, simocir@unipg.it)

Long terrestrial records such as lacustrine sediments are excellent archives of paleoenvironmental information. While the tectonic evolution of central Italy has been largely studied, there is a clear paucity of paleoenvironmental and paleoclimatic records covering the middle-late Pleistocene. Lake Trasimeno is located in Central Italy (Umbria Region). Previous studies have shown that this presently very shallow (6m maximum water depth) and large lake (surface ~120km²) was formed at the end of the early Pleistocene during a phase of general uplift in the area. As in most shallow water ecosystems, climate change plays a fundamental role in its evolution. Thus, Lake Trasimeno is an outstanding site to better understand the paleoenvironmental history of this area since the late Pleistocene.

A 175 m long sedimentary core was retrieved by the Geological Survey of the Umbria Region along the present southern shore of the lake (north of the Panicarola town). A multidisciplinary analysis of the lowermost 30 m is now in progress including physical properties, palynology, fossil remains, sedimentological and geochemical analyses. The sediments are relatively uniform comprising mostly green-gray clays with organic matter rich level, occasional sand intervals and evidence of oxidation layers probably caused by desiccation periods. TOC analyses reveal a low content of organic matter except for one level (from 29m to 29.52m) representing sapropel-like sediments. A preliminary age model based on two radiocarbon analysis and an estimation of sedimentation rate suggests that it is possible to bracket the age of the first 30 m of analyzed sediment core between around 140,000 and 21,000 yr.

Ostracod assemblages in lacustrine sediments provide an excellent tool for paleoenvironmental reconstructions. Despite that the Lake Trasimeno sediments are relatively uniform they contain ostracod remains showing distinctive changes. They are constantly present throughout the core except for the organic-rich level at the bottom and from 13 m to the uppermost part of the core that is sterile. The ostracod-rich interval is generally containing mature communities composed of adults and instars. On the whole, 16 species referable to 13 genera were collected (*Ilyocypris gibba*, *Candona neglecta*, *Candona angulata*, *Cypridopsis vidua*, *Heterocypris salina*, *Limnocythere* sp.2, *Limnocythere stationis*, *Darwinula stevensoni*, *Cyprideis torosa*, *Leptocythere* spp., *Fabaeformiscandona fabaeformis*, *Cyclocypris pigmea*, *Cyclocypris* sp. *Pseudocandona* juv., *Paralimnocythere* sp. and *Cypris subglobosa*.). Conspicuous changes in the abundance of these assemblages have been identified along the studied core alternating sections with very abundant ostracod remains with others with scant (or even null) individuals.

The recovering of species exclusives of certain intervals indicates substantial environmental variations. In particular, the section from 25.60 m to 23.50 m is characterized by a rich ostracod fauna and presence of halophilic species (*Cyprideis torosa* and *Leptocythere* spp) that suggests an increasing of TDS concentration

The presence of warm (*C. subglobosa*) and cool (*L. stationis*) indicators among ostracods matches very well the temperatures inferred from the marine isotopic curve. In particular, the warm species *C. subglobosa* inhabited the Trasimeno waters during the Eemian (5e) and the cool species *L. stationis* lived starting from the beginning of the first phase of the last glacial (isotopic stage 5a-4).

It appears also that the areal extension of the lake was climatically driven. In fact, during the warm and humid climatic phase of the isotopic stage 5, the Trasimeno Lake was wide and rather deep, whereas during the cool and arid stages 4-3 and 2 the lake level decreased drastically, reducing the extension of the lake. The delay observable between the maximum deepening of the lake and the maximum warm climatic phase is probably due to the feedback delay between the lacustrine system and the climate forcing.

P 4.4

A new species of the coastal marine turtle *Thalassemys* Rüttimeyer 1873 from the Kimmeridgian of the Swiss Jura Mountains

Christian Püntener, Jérémy Anquetin & Jean-Paul Billon-Bruyat

Section d'archéologie et paléontologie, Office de la culture, République et Canton du Jura, Hôtel des Halles, 2900 Porrentruy, Suisse
(christian.puntener@jura.ch)

The genus *Thalassemys* (Thalassemydidae) is represented by *T. hugii* from the Kimmeridgian of Solothurn, Switzerland (Rüttimeyer 1873; Bräm 1965) and *T. marina* from the Tithonian of Schnaitheim, Germany (Fraas 1903). The holotype of the type species *T. hugii* consists of a relatively flat and large shell (the largest turtle in Solothurn) with associated postcranial remains. Only a few other remains of *T. hugii* were found in the Solothurn Turtle Limestone, where plesiochelyid turtles are much more abundant (Anquetin et al. 2014).

Excavations in the Kimmeridgian of the Porrentruy area, Jura, Switzerland, brought to light a rich and diverse turtle fauna. As in Solothurn, this new fauna is dominated by the Plesiochelyidae (Anquetin et al. 2014; Püntener et al. 2014). Recently, an almost complete shell was found in Porrentruy, showing several anatomical similarities with *T. hugii*: a relatively flat and large carapace; a strong widening of the first neural; presence of linear striations perpendicular to sutures; presence of costo-peripheral fontanelles; and presence of central and notably lateral plastral fontanelles. While these features allow a confident attribution of this specimen to *Thalassemys*, other features differ strongly from *T. hugii*: a thickening of the nuchal; wider vertebral scales; a proportionally larger plastron; a different shape and orientation of the xiphiplastron; and a wider angle between the scapular and acromion processes.

The reported specimen is interpreted as belonging to a new species of *Thalassemys*. It reveals that the Thalassemydidae were more diverse than previously thought during the Kimmeridgian. In order to better understand the palaeobiogeographic distribution of these Late Jurassic turtles, comparisons will be extended with two yet undescribed specimens of *Thalassemys* from the Kimmeridgian of England.

REFERENCES

- Anquetin, J., Püntener, C. & Billon-Bruyat, J.-P. 2014: A taxonomic review of the Late Jurassic eucryptodiran turtles from the Jura Mountains (Switzerland and France). *PeerJ* 2, e369.
- Bräm, H. 1965: Die Schildkröten aus dem oberen Jura (Malm) der Gegend von Solothurn. *Schweizerische Paläontologische Abhandlungen* 83, 1-190.
- Fraas, E. 1903. *Thalassemys marina* E. Fraas aus dem oberen weissen Jura von Schnaitheim nebst Bemerkungen über die Stammesgeschichte der Schildkröten. *Jahreshefte des Vereins für vaterländische Naturkunde in Württemberg* 59, 72-104.
- Püntener, C., Billon-Bruyat, J.-P., Bocat, L., Berger, J.-P. & Joyce, W. G. 2014: Taxonomy and phylogeny of the turtle *Tropidemys langii* Rüttimeyer, 1873 based on new specimens from the Kimmeridgian of the Swiss Jura Mountains. *Journal of Vertebrate Paleontology* 34, 353-374.
- Rüttimeyer, L. 1873: Die fossilen Schildkröten von Solothurn und der übrigen Juraformation. *Neue Denkschrift der allgemeinen schweizerischen naturforschenden Gesellschaft* 25, 1-185.

P 4.5

Testing the EBSD Method on Mammal Enamel

Valentine Savary¹ & Bastien Mennecart²

¹ *Department of Geosciences – Earth Sciences, University of Fribourg, Chemin du Musée 6, CH-1700 Fribourg
(valentine.savary@unifr.ch)*

² *UMR 7207 (CNRS, MNHN, UPMC), Muséum National d'Histoire Naturelle, 8 rue Buffon, CP 38, F-75231 Paris, France*

The microstructure of enamel, the hard outer tissue of teeth, is known to reflect phylogenetic relationships and dietary preferences in mammals (Ungar 2010). The enamel of mammals is organised in five levels of complexity (Koenigswald & Clemens 1992). The most basal of these is the crystallite level, which is formed by hydroxyapatite crystals in varying orientations. Until now, the organisation of enamel at all levels was studied only through visualisations and morphological descriptions (Stefen 1997, Maas & Dumont 1999), but quantitative methods have not yet been applied.

Here we are presenting a new quantitative method that characterizes the preferential orientation of hydroxyapatite crystals in enamel at the crystallite level using Electron Backscatter Diffraction (EBSD). For this purpose, teeth of extant mammals are heated to 1000° C to remove organic matter and to increase the size of the hydroxyapatite crystals they contain. The samples are then mechanically and chemically polished to enable obtaining orientational measurements of the crystallites across the entire enamel layer using a scanning electron microscope. The primary data is then converted into a crystal orientation map using the EBSD method. This highlights regional differences in preferential crystal orientation within a defined enamel area. These maps can secondarily be converted into pole figures.

As a first step we are quantifying the crystallite orientation of a broad sample of mammals (e.g. wolf, dog, fox, cat, badger) to test for inter- and intraspecific variation. We hope this method will one day allow further characterizing the phylogenetic relationships and ecological preferences of fossil mammals.

REFERENCES

- Koenigswald, W. von, & Clemens, W. A. 1992: Levels of complexity in the microstructure of mammalian enamel and their application in studies of systematics, *Scanning Microscopy*, 6, 195-218.
- Maas, M. C., & Dumont, E. R. 1999: Built to last: The structure, function, and evolution of primate dental enamel, *Evolutionary Anthropology*, 8, 133-152.
- Stefen, C. 1997: Differentiations in Hunter-Schreger bands of carnivores. In: *Tooth Enamel Microstructure* (Ed. by Koenigswald, W. von & Sander, P. M.), A.A. Balkema, Rotterdam, p. 123–136.
- Ungar, P. S. 2010: *Mammal Teeth: Origin, Evolution and Diversity*. The John Hopkins University Press, Batimore, 312 pp.

