The 2nd

Wiman meeting

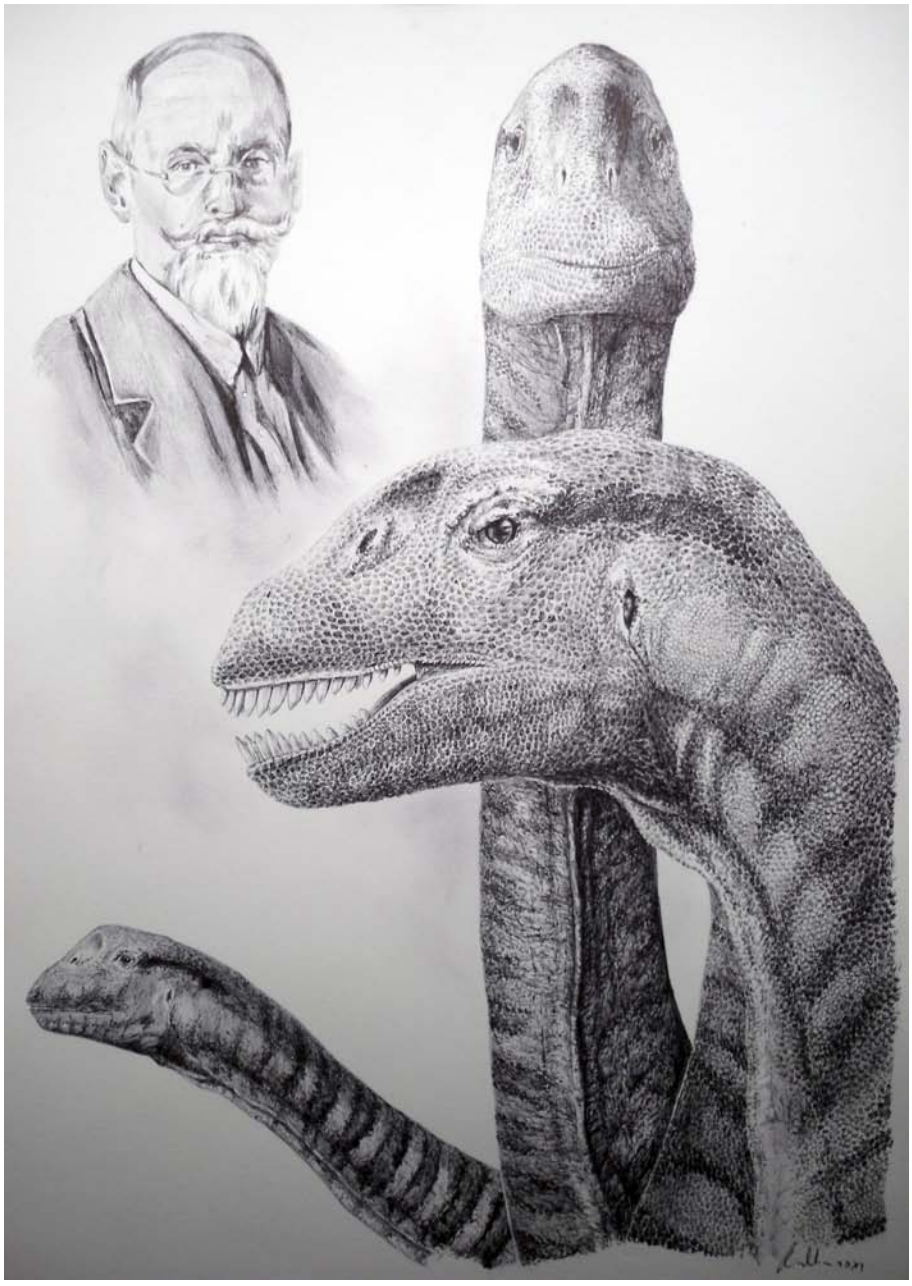
Carl Wiman's Legacy: 100 years of Swedish Palaeontology

UPPSALA UNIVERSITET

Uppsala 17–18 November 2011

Abstracts

Edited by Benjamin P. Kear and Michael Streng



Carl Wiman and *Euhelopus zdanskyi*. Art work by Vladimir Rimbala 2011.

WIMAN MEETING SCHEDULE 17-18 NOVEMBER 2011

THURSDAY 17 NOVEMBER

09:00	**Introduction**	
09:15	**Frängsmyr (Key note)**	A brief history of Carl Wiman
09:45	**Ebbestad**	Palaeontology at the Museum of Evolution – past, present and future
10:05	**COFFEE**	
10:40	**Peel**	Geological setting of the lower Cambrian Sirius Passet Lagerstätte, North Greenland
11:00	**McLoughlin**	The Talbragar Fossil Fish Bed of eastern Australia – a world-class Late Jurassic Lagerstätte
11:20	**Mellbin**	A dipnoan pterygoid from Bergisch Gladbach, Germany
11:40	**Bercovici**	Dinosaur Extinction: No demise prior to the Chicxulub asteroid impact
12:00	**LUNCH**	
13:30	**Vajda**	Dinosaur footprints associated with the latest Triassic vegetation turnover in Skåne, Sweden
13:50	**Agić**	Mesoproterozoic acritarchs from Shanxi, Northern China – eukaryotic biota in 1.4 Ga oceans
14:10	**Kear**	From sea to sand: palaeobiogeographical implications of Mesozoic-Cenozoic marine reptile assemblages from Saudi Arabia
14:30	**Ahlberg**	A very primitive tetrapod from the earliest Famennian of South Timan, Russia
14:50	**POSTER SESSION**	
16:00	**Butler**	Recent palaeobiological and stratigraphical advances from the Cambrian of Estonia
16:20	**Dupret**	Intracranial anatomy of *Romundina stellina* (Vertebrata, Placodermi, Acanthothoraci) revealed by phase contrast synchrotron imaging
16:40	**Kröger**	The pelmatozoan-receptaculite frame reefs of the Vasalemma Formation, north Estonia (late Keila –late Oandu Regional Stage, Ordovician)
18:00	**CONFERENCE DINNER**	

FRIDAY 18 NOVEMBER

09:00	**Bengtson**	Ediacaran stem-group ctenophores
09:20	**Högström**	New trace fossil finds, acritarchs and trilobites from latest Ediacaran–Cambrian deposits of the Digermul peninsula, Finnmark, Northern Norway
09:40	**Žigaitė**	Geochemistry of fossilised dental remains – a key to palaeobiology and palaeoenvironment
10:00	**Willman**	Geotourism in the central Baltic – what have we learned?
10:20	**COFFEE**	
10:50	**Sallstedt**	Phosphatization of microbial mat communities from the Palaeoproterozoic Vindhyan Supergroup, India
11:10	**Streng**	Palaeontology and stratigraphy of the middle Cambrian Stephen Formation, western Canadian Rocky Mountains
11:30	**Larsson**	Early Cambrian *Askepasma* from South Australia – having a crack at brachs
11:50	**Henderiks**	Size of marine phytoplankton: Why does it matter?
12:10	**Blom**	Affinities of *Lophosteus* and the origin of the osteichthyan body plan
	Final remarks	

WIMAN MEETING 17-18 NOVEMBER 2011

POSTERS FOR SESSION 17 NOVEMBER

Arvestål	A new species of *Cyrtograptus* (Graptoloidea) from the Llandovery of Västergötland (Sweden)
Bremer	CT-scan of *Parasaurolophus tubicen* from the Sternberg collection (Uppsala)
Chen	Three-dimensional histology of tooth cushions of *Lophosteus* from the Late Silurian of Estonia
Einarsson	A mid-Campanian marine extinction event – evidence from Kristianstad Basin, southern Sweden
Grahn	The primitive antiarch *Yunnanolepis* from China: a microtomographic study
Høyberget	Biostratigraphy of the Early Cambrian Evjevik Member, Ringstrand Formation, Mjösa Area, Norway
Hurum	The Upper Jurassic – Lower Cretaceous of Svalbard – a paleontological bonanza
Jerve	Evidence of endochondral ossification in spine material from the Upper Devonian, Scat Craig locality, Scotland
Karlsson	The San Juan Basin Collection at the Evolutionsmuseet (Uppsala University): a paleontological and historical resource
Lagebro	Branchiopod assemblages of the Upper Devonian Strud locality, Belgium
Lindahl	Redescription of *Agrionemys honanensis* and its position in the evolution of tortoises.
Lundgren	Phylogenetic patterns in the heterostracan families Cyathaspidae, Ariaspidae and Ctenaspidae
Mehlqvist	Evidence for plant-animal interactions in the early terrestrial ecosystems from the upper Silurian of Baltica (Gotland, Sweden)
Niedźwiedzki	Large footrpints of theropod dinosaurs from the Upper Triassic of Poland
Pleijel	Fish-remains in sediments from Gotland
Poropat	The significance of Carl Wiman's sauropod dinosaurs
Qu	What is a pore-canal system?
Wang	Peduncular attached secondary tiering acrotretoid brachiopods from the Chengjiang fauna: implications for the ecological expansion of brachiopods during the Cambrian explosion
Weidner	The lower Middle Cambrian agnostid *Pentagnostus praecurrens* from Sweden

Mesoproterozoic acritarchs from Shanxi, Northern China – eukaryotic biota in 1.4 Ga oceans

HEDA AGIĆ[1], MAŁGORZATA MOCZYDŁOWSKA-VIDAL[1] and LEIMING YIN[2]

Organic-walled microfossils (acritarchs and cyanobacteria) have been recovered from Mesoproterozoic (~1.3 Ga) sediments of the Beidajian Formation in Shanxi Province, China. This 'Shanxi biota' is composed of mostly sphaeromorphic and acantomorphic acritarchs that probably have eukaryotic affinity, thus potentially making them among the oldest ornamented eukaryotes in the fossil record. Past interpretations of these fossils, together with others from coeval Chinese localities, vary from dinoflagellates to fungi; however, their affinities are still uncertain. An alternative interpretation as zygotic cysts of green algae is proposed here. Although fragmentary, the two best-known taxa, *Dictyosphaera delicata* and *Shuiyousphaeridium macroreticulatum*, are defined solely by the presence of a multilayered vesicle wall reticulated by polygonal platelets and indentations. We have supplemented this basic diagnostic trait with a morphometric approach using cell wall measurements to reconstruct the complete cyct outline from broken pieces. This approach permits assessment of taxonomic diversity within the assemblage, and provides a more detailed glimpse of planktonic community composition in the Mesoproterozoic oceans.

[1]*Department of Earth Sciences, Palaeobiology Programme, Uppsala University, Villavägen 16, 75236 Uppsala, Sweden; heda.agic@geo.uu.se*
[2]*Nanjing Institute of Geology and Paleontology, Academia Sinica, 39 East Beijing Road, Nanjing 210008, China*

A very primitive tetrapod from the earliest Famennian of South Timan, Russia

PER E. AHLBERG[1], PAVEL BEZNOSOV[2], ERVINS LUKŠEVIČS[3] and JENNIFER A. CLACK[4]

Three field seasons collecting in the Sosnogorsk Formation, a basal Famennian lacustrine or lagoonal deposit from a tropical coastal setting in present-day South Timan, Russia, has yielded an extensive collection of stem tetrapod bones. All of the specimens are attributable to a single previously unknown species, on the basis of a shared distinctive ornament and close morphological match between duplicate elements. The material also includes an articulated snout and several articulated skull tables, enabling us to present a provisional but fairly well constrained skull reconstruction. We tentatively identify it as a tetrapod *sensu stricto*, i.e. a taxon with limbs rather than paired fins, because the cleithrum + partial scapulocoracoid shows a characteristic tetrapod morphology, similar to *Ichthyostega* and quite different from *Panderichthys* or *Tiktaalik*. However, the remains also show a number of primitive characteristics, which suggest that it is the least crownward of known basal tetrapods:the snout does not have the 'spade-like'shape otherwise typical of early tetrapods; the vomeral morphology is intermediate between the elpistostegid and tetrapod conditions; the pterygoids are separated by the parasphenoid, the braincase has a well-developed crista parotica attached to the skull roof; the postorbital separates the squamosal from the supratemporal (as in *Tiktaalik*); and the cleithrum carries dermal ornament. The Sosnogorsk Formation tetrapod will thus provide important new data about character polarization among stem-group

tetrapods. Notably, its otoccipital braincase differs from those of *Ichthyostega* and *Acanthostega*, themselves very different from each other, but represents a pattern that could be antecedent to both.

[1]*Department of Organismal Biology, Subdepartment of Evolution and Development, Uppsala University, Norbyvägen 18A, 75236 Uppsala, Sweden; per.ahlberg@ebc.uu.se*
[2]*Institute of Geology, Komi Scientific Centre, UB of RAS, 167982 Syktyvkar, Russia*
[3]*Department of Geology, University of Latvia, Riga LV-1586, Latvia*
[4]*University Museum of Zoology Cambridge, Cambridge CB2 3EJ, UK*

A new species of *Cyrtograptus* (Graptoloidea) from the Llandovery of Västergötland (Sweden)

EMMA H. M. ARVESTÅL[1] and MICHAEL STRENG[1]

A new species of the genus *Cyrtograptus* from the late Llandovery of southern Sweden (Västergötland) is presented. The new species has been found near the top of Kinnekulle (Högkullen) in the *Retiolites* Shales, which are part of the *lapworthi* zone (late Telychian). Although it resembles the coeval *C. lapworthi* in appearance, a detailed comparison of the type material of *C. lapworthi* revealed distinct differences: the new species is more openly coiled in the proximal part; has a larger Two Thecae Repeat Distance (2TRD)' and most significantly, bears a second order cladium. Second order cladia are unknown from *C. lapworthi*. The new species is also compared with other species of *Cyrtograptus* that are characterized by second order cladia, such as the cotemporaneous *C. laqueus* and the slightly younger *C. insectus* (*insectus* zone; latest Telychian). However, *C. laqueus* differs from the new species in having a lower number of thecae separating the cladia, and also by the appearance of its proximal part, which forms a loop by crossing its own main stipe. *C. insectus* differs by having wider spaced cladia and a stronger coiled proximal part. Furthermore, the need of a redefinition of *C. lapworthi* is highlighted, due to the large morphological variations within this species.

[1]*Department of Earth Sciences, Palaeobiology Programme, Uppsala University, Villavägen 16, 75236 Uppsala, Sweden; emmaarvestal@gmail.com*

Ediacaran stem-group ctenophores

STEFAN BENGTSON[1], FENG TANG[2], YUE WANG[3], XUN-LIAN WANG[4] and CHONG-YU YIN[2]

The Ediacaran fossil *Eoandromeda octobrachiata* had a high conical body with eight arms in helicospiral arrangement along the flanks. The arms carried transverse bands here regarded as homologues of ctenophore ctenes (comb plates). *Eoandromeda* is interpreted as an early stem-group ctenophore, on the basis of these ctenes comb rows, and octoradial symmetry; however, it lacks ctenophore crown-group synapomorphies such as tentacles, statoliths, polar fields, and biradial symmetry. *Eoandromeda* probably had a pelagic mode of life. The early appearance of octoradial ctenophores in the fossil record is consistent with the Planulozoa hypothesis (Ctenophora as the sister group of Cnidaria + Bilateria) of metazoan phylogeny.

[1]*Department of Palaeozoology and Nordic Center for Earth Evolution, Swedish Museum of Natural History, Box 50007, 10405, Stockholm, Sweden; stefan.bengtson@nrm.se*
[2]*Feng Tang, Institute of Geology and Key Laboratory of Stratigraphy and Paleontology, Chinese Academy of Geological Sciences, Beijing, 100037, China*
[3]*Yue Wang, School of Resources and Environment, Guizhou University, Guiyang, 550003, China*
[4]*Xun-lian Wang, School of Earth Sciences and Resources, China University of Geosciences, Beijing, 100083, China*

Dinosaur Extinction: No demise prior to the Chicxulub asteroid impact

ANTOINE BERCOVICI[1], TYLER R. LYSON[2, 3], VIVI VAJDA[1], STEPHEN G. B. CHESTER[4], ERIC J. SARGIS[4, 5], DEAN A. PEARSON[6] and WALTER G. JOYCE[7]

On-going debate about the extinction of non-avian dinosaurs was first ignited by the publication of the Cretaceous–Palaeogene (K–Pg) asteroid impact theory, which has subsequently seen 30 years of dispute over the position of the stratigraphically youngest *in situ* dinosaur. A discrete zone devoid of dinosaur fossils has been reported from the last three metres of Upper Cretaceous in the Western Interior of the United States, and popularly termed the 'three meter gap',. Here we report on the discovery of the stratigraphically youngest *in situ* dinosaur specimen: a ceratopsian brow horn found in a poorly rooted, silty, mudstone floodplain deposit located no more than 13 centimetres below the palynologically defined K–Pg boundary. This famous transitional layer was identified using three criteria: 1) a decrease in Cretaceous pollen and spores without subsequent recovery; 2) the existence of a 'fern spike'; and 3) correlation with a nearby stratigraphic section where primary extraterrestrial impact markers are present (e.g., iridium anomaly, spherules and shocked quartz). The *in situ* ceratopsian brow horn demonstrates that the 'three meter gap' does not exist, and moreover that it is inconsistent with the hypothesis that non-avian dinosaurs were extinct prior to the K–Pg boundary asteroid impact event.

[1]*Department of Earth and Ecosystem Sciences, Lund University, Sölvegatan 12, 22362 Lund, Sweden;* aberco@free.fr
[2]*Department of Geology and Geophysics, Yale University, New Haven, CT 06511, USA*
[3]*Marmarth Research Foundation, Marmarth, ND 58643, USA*
[4]*Department of Anthropology, Yale University, New Haven, CT 06520, USA*
[5]*Division of Vertebrate Paleontology, Yale Peabody Museum of Natural History, New Haven, CT 06520, USA*
[6]*Pioneer Trails Regional Museum, Bowman, ND 58623, USA*
[7]*Department of Geosciences, University of Tübingen, 72074 Tübingen, Germany*

Affinities of *Lophosteus* and the origin of the osteichthyan body plan

HENNING BLOM[1], ANNA JERVE[1], QINGMING QU[1], DONGLEI CHEN[1], TIIU MÄRSS[2], VINCENT DUPRET[1], SOPHIE SANCHEZ[1,3] and PER E. AHLBERG[1].

Although the monophyly of gnathostomes is commonly accepted, relationships within this clade remain controversial. Chondrichthyans (cartilaginous fishes) and osteichthyans (bony

fishes and tetrapods) are well-supported lineages, and fossil representatives of most of their respective crown groups are known from as early as the Silurian and Devonian; however, their relationships with extinct Palaeozoic jawed vertebrates such as acanthodians and placoderms are unclear. Resolution of this issue, which is essential for reconstructing the origins of jawed vertebrates, would be possible if derived stem group osteichthyans and chondrichthyans could be identified to link the crown radiations and permit reassembly of character complexes. Here we report on new character data for the Late Silurian potential osteichthyan, *Lophosteus superbus*, which has long been known from isolated bone fragments, scales and teeth. Our fossil material is derived from Saaremaa Island, Estonia, and comprises disarticulated elements representing practically the whole animal. Significantly, the skull roof morphology and histology of scales and spines show features intermediate between some placoderms and osteichthyans. These findings could alter earlier conceptions of basal gnathostome phylogeny and consequently help to provide a more detailed understanding of the acquisition of the osteichthyan body plan.

[1]*Department of Organismal Biology, Subdepartment of Evolution and Development, Uppsala University, Norbyvägen 18A, 75236 Uppsala, Sweden; henning.blom@ebc.uu.se*
[2]*Institute of Geology at Tallinn University of Technology, Ehitajate Road 5, 19086 Tallinn, Estonia*
[3]*European Synchrotron Radiation Facility 6 rue Jules Horowitz, bp 22038043 Grenoble cedex, France*

CT-scan of *Parasaurolophus tubicen* from the Sternberg Collection (Uppsala University)

OSKAR BREMER[1], BENJAMIN P. KEAR[1] and MARTIN KUNDRAT[2]

In 1922, Carl Wiman, head of the then Palaeontological Institute at Uppsala University, received a series of crates containing dinosaur remains from the Upper Cretaceous (upper Campanian–Maastrichtian) Kirtland Formation of New Mexico, U.S.A. The specimens had been collected in 1921 by the famous American fossil hunter, Charles H. Sternberg, during a commissioned 5 month field expedition to the in the San Juan Basin. Arguably, one of the most significant specimens recovered was the partial skull of the spectacular crested hadrosaur *Parasaurolophus tubicen*. The holotype (PMU 24925) comprises the massive crest and neurocranium, together with parts of the pareital, frontal, prefrontals, postorbitals, squamosals and exoccipitals. The right quadrate is also preserved in articulation with the quadratojugal and pterygoid; the right jugal, maxilla, pterygoid, ectopterygoid and the anterior section of the lacrimal make up the facial region of the skull. Wiman was the first to propose that the crest of *Parasaurolophus* functioned as a vocalization structure. This study aims to investigate the functional morphology of the crest in this hadrosaur, in conjunction with endocranial anatomy, using CT-scanning and 3D modelling of the intracranial chambers. Comparisons with other specimens of *Parasaurolophus* will permit reconstruction of sensory capabilities in this 'classic' dinosaur taxon.

[1]*Department of Earth Sciences, Palaeobiology Programme, Uppsala University, Villavägen 16, 75236 Uppsala, Sweden; bremer.oskar@gmail.com*
[2]*Department of Organismal Biology, Subdepartment of Evolution and Development, Uppsala University, Norbyvägen 18A, 75236 Uppsala, Sweden*

Recent palaeobiological and stratigraphical advances from the Cambrian of Estonia

AODHÁN BUTLER[1], LARS HOLMER[1], HEIKKI BAUERT[2], MICHAEL STRENG[1] and HEDA AGIĆ[1]

The unique Cambrian sediments of Estonia represent an important and understudied component of the Baltic system. Here we present an overview of recent field studies conducted by Uppsala University in association with colleagues from the Baltic Geotourism project. These have produced a number of discoveries with potential significance for Cambrian palaeontology and stratigraphy in Estonia, including new stem lophotrochozoans with apparently bizarre shell structure. Current efforts to describe and systematically appraise this material are outlined, and in particular, whether the unusual shell types are the result of taphonomic alteration or de novo morphological evolution. We propose that our specimens have affinities with the inarticulate stem-brachiopod *Mickwitzia* based upon gross features and the presence of an umbo. Possible new records of *Estoniadiscus discinoides*, a rare enigmatic organism with postulated relationships to eldonioids or other stem-group lophophorates are also described from the Kakumägi type section of the Lower Cambrian Kakumägi Member, Tiskre Formation. The discovery of *Rhabdinopora* sp. graptolites, which have until now demarcated the Cambrian-Ordovician boundary, *in-situ at* approximately three metres below the demarcating Pakri cape section of the Kallavere Formation is also significant. Our findings highlight the need for both a stratigraphical and palaeobiological reappraisal of these important sequences, and their correlative implications for the Swedish and broader Baltoscandian regions.

[1]*Department of Earth Sciences, Palaeobiology Programme, Uppsala University, Villavägen 16, 75236 Uppsala, Sweden; aodhan.butler@geo.uu.se*
[2]*NGO Geoguide Baltoscandia, Estonia*

Three-dimensional histology of tooth cushions of *Lophosteus* from the Upper Silurian of Estonia

DONGLEI CHEN[1], HENNING BLOM[1], PER E. AHLBERG[1] and SOPHIE SANCHEZ[1]

Lophosteus superbus from the Late Silurian of Estonia is one of the oldest and most plesiomorphic osteichthyans described to date. Unfortunately at present it is known only from fragmented dermal microremains. The affinities of *Lophosteus* are therefore controversial with the taxon placed as either basal to both actinopterygians and sarcopterygians, or ambiguously linked to either placoderms or acanthodians. To confound matters further, the character states diagnosing actinopterygians and sarcopterygians have recently been brought into question, and even monophyly of the traditional placoderm and acanthodian clades has been challenged. As a possible stem osteichthyan, *Lophosteus* could thus be central to our understanding of early gnathostome evolution and the origin of the osteichthyan body plan. Often the best-preserved, although incompletely documented, elements of *Lophosteus* are tooth cushions. These tooth-bearing arched ossicles could arguably be homologous with the parasymphysial tooth whorls in chondrichthyans, acanthodians, and sarcopterygians, or even the parasymphysial tooth plates in tetrapodomorphs. High-resolution synchrotron scans of

isolated tooth cushions from the Upper Silurian of Estonia has permitted a detailed reconstruction of their three-dimensional architecture. The absence of an enamel layer and the presence of large hollows (bigger than normal osteocytes) in the deepest lamellar layer confirmed assignment of the specimens to *Lophosteus*. The external surface displays irregularly distributed denticles and there are large parallel vessels running horizontally on the basal bone that feed the denticle rows internally. The odontodes have two distinct generations (with successive odontodes accreted between those of the preceding buried generation) and are organised in a similar manner to those found on *Lophosteus* scales. This new histological data on vascularization provides insight into early gnathostome tooth patterning and could contribute to future phylogenetic assessments.

[1]*Department of Organismal Biology, Subdepartment of Evolution and Development, Uppsala University, Norbyvägen 18A, 75236 Uppsala, Sweden; donglei.chen@ebc.uu.se*

Intracranial anatomy of *Romundina stellina* (Vertebrata, Placodermi, Acanthothoraci) revealed by phase contrast synchrotron imaging

VINCENT DUPRET[1], SOPHIE SANCHEZ[1, 2], DANIEL GOUJET[3], PAUL TAFFOREAU[2] AND PER E.AHLBERG[1]

Acanthothoracid placoderms are considered amongst the most basal of primitive gnathostomes. However, their endocranial morphology is poorly understood, and only one genus (*Brindabellaspis*) has been described in detail. Here we present a synchrotron-generated 3D reconstruction of a nearly complete skull of *Romundina stellina*, a taxon established in 1975 by the Norwegian-born Swedish palaeontologist Tor Ørvig based on remains from the Lochkovian (Lower Devonian) of Prince of Wales Island, Canadian Arctic Archipelago. The specimen was imaged with propagation phase contrast microtomography on the ID19 beamline of the ESRF, using a 7.45 µm isotropic voxel size. Most structural features of the fossil are very well preserved, allowing missing elements to be virtually rebuilt by symmetry. This permitted reconnection of the external foramina and blood vessel/nerve canals, and alignment of the central/internal structures. Expanding on Ørvig's original interpretations, our virtual models show the vasculature of the skull bones, and indicate establishment of successive dermal over perichondral bone layers. The perichondral bone wrapping the endocranial cavity, in between the trigeminal and vagus nerve (and the inner ears), shows a "lace" pattern, which is otherwise unknown in vertebrates (presumably because of the lack of data). The significance of this trait is unclear but it is not an artifact of taphonomy or scanning.

[1]*Department of Organismal Biology, Subdepartment of Evolution and Development, Uppsala University, Norbyvägen 18A, 75236 Uppsala, Sweden; vincent.dupret@ebc.uu.se*
[2]*European Synchrotron Radiation Facility, 6 Rue Jules Horowitz, 38043 Grenoble Cedex, France*
[3]*Museum National d'Histoire Naturelle, Département Histoire de la Terre, Paléontologie, 8 rue Buffon, 75005 Paris, France*

Palaeontology at the Museum of Evolution – past, present and future

JAN OVE R. EBBESTAD[1] and VIVIANNE BERG-MADSEN[1]

On January the 1st 1999, the natural history collections at Uppsala University were amalgamated into the new Museum of Evolution. These accumulated zoological, botanical, mineralogical and palaeontological archives number about five million artifacts. The former museum buildings of zoology and palaeontology still house original collections and exhibits, while most of the staff and the botanical specimens have been relocated to a new facility. The palaeontological collections alone include about 250,000 fossils, with ~15,000 invertebrate and some 6,000 vertebrate types. The bulk of this material was accumulated through the singular efforts of the founder of palaeontological research in Uppsala, Carl Wiman. After being founded as a research institute in 1921, the museum moved to its current premises in 1932 and eventually came to house many significant specimens from North and South America, Europe, and most famously, China. Historically important collections were also transferred from *Kungl. Vetenskaps-Societeten i Uppsala*, including the private repositories of Bromell, Wahlenberg, Dalman, Marklin and Cleve. More recently, important invertebrate research materials recovered by Warburg, Thorslund, Bohlin, Jaanusson, Reyment and others have been acquired. The revival of vertebrate palaeontology in Uppsala during the last few years has been another great asset to the museum. In the present information society our challenge is to increase the availability and accessibility of our fossil resources. This will be achieved through a major reorganisation of the storage facilities, together with a standardised database system that will be released in digital format.

[1]*Museum of Evolution, Palaeontology, Uppsala University, Norbyvägen 16, 75236 Uppsala, Sweden; jan-ove.ebbestad@em.uu.se*

A mid-Campanian marine extinction event – possible evidence from the Kristianstad Basin of southern Sweden

ELISABETH EINARSSON[1] and BENJAMIN P. KEAR[2]

Potential traces of a mid-Campanian (83–73 Ma) marine extinction event have been documented as sequential faunal turnover in shallow coastal calcareous sands and calcarenite strata at the Åsen locality in the Kristianstad Basin of southern Sweden. The depositional succession at Åsen is conformably divided into the latest-early Campanian *Belemnellocamax mammillatus* belemnite Zone (a lateral equivalent of the northern European *Belemnitella mucronata senior*/*Gonioteuthis quadrata gracilis* Zone), and an overlying earliest-late Campanian *Belemnellocamax balsvikensis* Zone. The stratigraphically older *B. mammillatus* Zone assemblages comprise storm-accumulated remains (associated with coquina beds and oyster banks) that include selachians, chimaeroids, bony fish (pachycormiforms, pycnodontids, and teleosts), dyrosaurid crocodilians, elasmosaurid and polycotylid plesiosaurs, mosasaurs (mosasaurines, halisaurines, tylosaurines, and plioplatecarpines), and cheloniid sea turtles. Coeval invertebrates comprise abundant belemnites, bivalves,

brachiopods, and echinoderms. This rich biodiversity abruptly declines up-sequence through the oyster bed layer and into the *B. balsvikensis* Zone; this is characterised by a sandier facies, which is exceptionally poor in reptile remains and manifests only small teleosts and sharks. Benthic molluscs and brachiopods also decline in abundance while worm tracks and decapod crustaceans (crabs) make a first appearance. Although, this observed change clearly corresponds to an environmental shift, it also correlates with a recognised trans-Atlantic mid-Campanian extinction event that affected warm-temperate to sub-tropical palaeolatitudinal belt assemblages in North America, and might have been part of a broader global phenomenon.

[1]*Department of Earth and Ecosystem Sciences, Division of Geology, Lund University, Sölvegatan 12, 22362 Lund, Sweden; elisabeth.einarsson@geol.lu.se*
[2]*Department of Earth Sciences, Palaeobiology Programme, Uppsala University, Villavägen 16, 75236 Uppsala, Sweden*

A brief history of Carl Wiman

TORE FRÄNGSMYR[1]

In the middle of the 19th century, research in the discipline of chemistry was divided into two distinct fields− chemistry and the combined areas of mineralogy, and to a lesser extent, geology. In 1858 the SGU (Swedish Geological Survey) was establish in order to map the Swedish landscape and undertake polar exploration, which subsequently became very popular through several famous expeditions. Then a young student at Uppsala University, Carl Wiman (1867-1944) had already become specialized in paleontology by the 1890s, and participated in a number of field-based projects both inside and outside of Sweden. In 1911, he received a personal chair in palaeontology and developed a highly successful research programme. Following the establishment of the Chinese Geological Survey by Wiman's colleague Johan Gunnar Andersson, Chinese fossil material started to be shipped to Uppsala in large quantities. Wiman was asked to lead the scientific descriptions, and his two disciples, Otto Zdansky and Birger Bohlin, made other important discoveries during the 1920s; one of these was the identification of isolated teeth later dubbed Peking Man (*Sinanthropus pekinensis*). The recognition of Peking Man catapulted palaeontological research at Uppsala into the global spotlight, because the specimens were at that time regarded as evidence for the oldest human. Wiman also founded apalaeontolgical institute and later museum (or temple as it was called) of palaeontology, now the Museum of Evolution. For many years Wiman's personal Chair in Palaeontology was the only one in Sweden; it became permanent in the 1920s after he personally approached the then Prime Minister Hjalmar Branting. This presentation provides a brief history of Carl Wiman's career based on his handwritten diaries and unpublished notes.

[1]*Department of History of Science and Ideas, History of Science, Uppsala University, Box 629, 75126 Uppsala, Sweden; Tore.Frangsmyr@idehist.uu.se*

The primitive antiarch *Yunnanolepis* from China: a microtomographic study

JESSICA GRAHN[1], HENNING BLOM[1] and PER E. AHLBERG[1]

Placoderms first appeared during the Silurian, after which they diversified and spread rapidly to dominate the Devonian seas. One of the stratigraphically earliest placoderms is *Yunnanolepis*, a primitive antiarch from the Early Devonian of China and Vietnam. To date, little specific research has been devoted to yunnanolepids, and previous assessments have utilised conventional descriptive methods. In contrast, this study constructed exceptionally detailed 3D-models based on a synchrotron X-ray microtomographic scan series of *Yunnanolepis* material from the Muséum National d'Histoire Naturelle, Paris. Our novel data set revealed a well-preserved anterior ventrolateral plate (AVL) with the opening for the pectoral fin, and other hitherto unknown structures such as the transverse crista, postbranchial lamina, and external ornamentation. The first 3D image of the mysterious ’Chang's apparatus’ was also generated. ‘Chang's apparatus’ in known only in Yunnanolepididae, and its function remains unknown. Disarticulated tooth plates and scales of other gnathostomes were also found with the specimen, and include very small AVL plates of young antiarchs. These lack ornamentation and their postbranchial laminae are weakly developed compared to osteologically more mature individuals.

[1]Department of Organismal Biology, Subdepartment of Evolution and Development, Uppsala University, Norbyvägen 18A, 75236 Uppsala, Sweden; jessica.grahn.5434@student.uu.se

---

Size of marine phytoplankton: Why does it matter?

JORIJNTJE HENDERIKS[1]

Marine phytoplankton, such as diatoms and coccolithophores, constitute the base of the marine food chain and are a fundamental component in biogeochemical cycles. The overall ecological success of marine phytoplankton, but also its taxonomic diversity and size distribution, determines the efficiency by which fixed carbon is transferred to higher trophic levels and into the deep ocean- and sedimentary carbon reservoirs. In recent years, several hypotheses have been invoked to explain distinct macroevolutionary decreases in the cell size of phytoplankton during the Cenozoic. Global, long-term cooling has been cast a major role in driving these cell size decreases. Despite overall correspondence between long-term trends, however, it's becoming more and more clear that not all phytoplankton dance to the same tune. The latter is particularly evident when looking at different coccolithophore lineages. Here, I will review the state-of-the-art and highlight some open avenues that are worth exploring.

[1]Department of Earth Sciences, Palaeobiology Programme, Uppsala University, Villavägen 16, 75236 Uppsala, Sweden; jorijntje.henderiks@geo.uu.se

---

New trace fossil finds, acritarchs and trilobites from latest Ediacaran–Cambrian deposits of the Digermul peninsula, Finnmark, Northern Norway

ANETTE E.S. HÖGSTRÖM[1], JAN OVE R. EBBESTAD[2], TEODORO PALACIOS[3] and SÖREN JENSEN[3]

The inaccessible Digermul peninsula of Northern Norway preserves a 1,500 metre thick, predominantly siliclastic sequence that spans the Ediacaran to Early Ordovician. The Ediacaran-Cambrian transition component contains a rich suite of trace fossils, and at the Digermul section, includes the only known Scandinavian locality where Ediacara-type fossils have been found – these are probably referable to the disc-shaped form *Aspidella*. Fieldwork conducted during 2011 resulted in the discovery of the Cambrian index fossil *Treptichnus pedum* from the upper part of the Manndraperelva Member, suggesting that this part of the unit might not be of Ediacaran age as previously thought. Another unusual trace fossil consisting of vertically oriented probes connected to a horizontal burrow was found approximately 100 metres below the *Treptichnus pedum* occurrence in the middle part of the Manndraperelva Member, and is the stratigraphically oldest complex trace fossil yet documented from Scandinavia. The late Ediacaran to Cambrian Digermul succession was also sampled for organic-walled microfossils, which werepreviously only recorded from trilobite-bearing levels in the Doulbasgaissa Formation. This new acritarch assemblage incorporates *Skiagia ciliosa*, *Heliosphaeridium dissmilare* and *H. obscurum*, taxa that advocate assignment to the *Heliosphaeridium-Skiagia* Zone, and contradict younger age estimates for the upper part of the Doulbasgaissa Formation Well preserved specimens of *Kjerulfia lata*, together with a new species of *Elliptocephala*, provide other novel occurrences for the Baltoscandian region.

[1]*Tromsø University Museum, Natural Sciences, N-9037 Tromsø, Norway; anette.hogstrom@uit.no*
[2]*Museum of Evolution, Palaeontology, Uppsala University, Norbyvägen 16, 75236 Uppsala, Sweden*
[3]*Area de Paleontología, Universidad de Extremadura, E-06006 Badajoz, Spain*

Biostratigraphy of the Early Cambrian Evjevik Member, Ringstrand Formation, Mjösa Area, Norway

MAGNE HØYBERGET[1], JAN OVE R. EBBESTAD[2], BJØRN FUNKE[3] and HANS ARNE NAKREM[4]

The Evjevik Member of the Ringstrand Formation is restricted to the Lower Allochthon in the Mjøsa area, Norway. The unit comprises a lower bioclastic limestone (25–30 centimetres), followed by a fissile mudstone (70 centimetres) and a bioclastic limestone capping (20 centimetres). While the lithology and accompanying fossil fauna of the Evjevik Member is well known, a detailed biostratigraphical appraisal has never been undertaken. Our subsequent assessments have identified a distinctive lower bioclastic limestone assemblage containing abundant examples of the brachiopod *Magnicanalis rotundata*, together with *Ellipsocephalus linnarssoni*, *Ellipsocephalus gripi*, and rare occurrences of both *Holmia kjerulfi* and *Kjerulfia lata*; the helcionelloid molluscs *Scenella antiqua, Capitoconus* and *Mackinnonia* are also present. The fissile mudstone horizon contains the stratigraphically youngest occurrence of *Holmia kjerulfi* from Scandinavia associated with *M. rotundata*, inarticulate brachiopods and hyolithids. The capping limestone bed is a coquina of *E. linnarssoni* and other ellipsocephalids. Rare occurrences of the eodiscid trilobite *Calodiscus lobatus* and the brachiopod *M. rotundata* are also evident with rare specimens of the helcionelloid ?*Capitoconus.* The Evjevik Member is traditionally correlated with the upper part of the

Gislöv Formation in Gislövshammar, southern Sweden, and represents the lower part of the *Ornamentaspis*? *linnarssoni* Assemblage Zone. The present study revises the zonal trilobites and molluscs, permitting broader comparisons within Scandinavia as well as other Early Cambrian provinces including Newfoundland and England.

[1]*Rennesveien 14, 4513 Mandal, Norway; a-rostr@online.no*
[2]*Museum of Evolution, Palaeontology, Uppsala University, Uppsala, Sweden. Norbyvägen 16, 75236 Uppsala, Sweden*
[3]*Gjelleråsveien 10, 1481 Hagan, Norway*
[4]*Natural History Museum, Oslo, Norway*

The Upper Jurassic to Lower Cretaceous of Svalbard – a palaeontological bonanza

JØRN H. HURUM[1], HANS A. NAKREM[1], ØYVIND HAMMER[1], ESPEN M. KNUTSEN[1], KRZYSZTOF HRYNIEWICZ[1], JULIE ROUSSEAU[1], MAGNE HØYBERGET[4], PATRICK DRUCKENMILLER[3] and CRISPIN T. S. LITTLE[2]

A series of palaeontological expeditions to the Svalbard archipelago in 2004-2011 have revealed abundant marine reptile remains in the Upper Jurassic to Lower Cretaceous Slottsmøya Member – a 70–100 metre-thick dark grey to black shale unit of the Agardhfjellet Formation. To date, approximately 40 individual skeletal occurrences have been mapped, of which only 10 have been excavated. These specimens are fully to partially articulated, although the quality of bone preservation is variable because of damage by permafrost. Cranial and postcranial specimens representing seven ophthalmosaurid ichthyosaurs have been documented. The most abundant marine reptile fossils belong to long-necked plesiosauromorphs; elements derived from two large short-necked pliosauromorphs have also been recovered. Accompanying invertebrates include at least 15 species of small to medium sized bivalves, rarer brachiopods, gastropods, ammonites, serpulids, and probable vestimentiferans. There are also five new echinoderm species that have yet to be formally described. Hydrocarbon seep carbonates in the uppermost Slottsmøya Member display negative $\delta^{13}C$ stable isotope values (down to ca. -43‰ VPDB) consistent with methane-derived authigenesis. The Slottsmøya Member assemblage is significant because it is one of the few known occurrences from northern high palaeolatitudes.

[1]*Natural History Museum, Oslo, Norway, j.h.hurum@nhm.uio.no*
[2]*University of Leeds, United Kingdom*
[3]*University of Alaska Museum of the North, Fairbanks, Alaska, U.S.A.*
[4]*Rennesveien 14, 4513 Mandal, Norway*

Evidence of endochondral ossification in fish fin spines from the Upper Devonian, Scat Craig locality of Scotland

ANNA JERVE[1]

The Upper Devonian (upper Frasnian) Scat Craig locality near Elgin in Scotland has long been known for its unique vertebrate fossils. Among these are the articulated remains of several fish taxa (*Holoptychius*, *Bothriolepis*, *Cosmacanthus*) and an early tetrapod (*Elginerpeton pancheni*). Isolated bones are also common, and although typically incomplete, are often excellently preserved making them useful for histological analyses. Of particular interest are spine-like elements that have been previously attributed to 'acanthodians' or rhizodonts. These distinctive structures show evidence of endochondral ossification, which can be observed macroscopically, and the presence of bony trabeculae identified through synchrotron scan data. Endochondral ossification is a defining feature of osteichthyans and has not been observed in the fin spines of chondrichthyans, 'acanthodians', sarcopterygians, actinopterygians, or other early gnathostomes such as placoderms. Fin spines are normally dermal bones that develop intramembranously rather than from a cartilaginous precursor (vis-à-vis endochondral bone). The Scat Craig specimens are therefore morphologically unusual and highly significant for investigating the growth and evolutionary development of fin spines in early vertebrates. Furthermore, their distinctive construction sets them apart from typical osteichthyans and 'acanthodians', revealing new information about skeletal mineralization in bony fish as a group.

[1]*Department of Organismal Biology, Subdepartment of Evolution and Development, Uppsala University, Norbyvägen 18A, 75236 Uppsala, Sweden; ajerve@gmail.com*

The Sternberg Collection at the Museum of Evolution (Uppsala University): a palaeontological and historical resource

HENRIK KARLSSON[1] and BENJAMIN P. KEAR[1]

The Sternberg Collection at the Museum of Evolution, Uppsala University constitutes the single largest repository of Kirtland Formation vertebrate fossils outside of the U.S.A., and is the core off the most extensive collection of original dinosaur remains in Scandinavia. Its specimens derive from various localities in the San Juan Basin of northwestern New Mexico, and include mainly Late Cretaceous (late Campanian–Maastrichtian) dinosaurs, turtles, crocodiles and fish (teleosts, lepisosteids and mylobatid rays) together with a few middle Paleocene reptiles and mammals. The famous North American dinosaur hunter, Charles H. Sternberg, excavated and shipped the material to Sweden during the summer and autumn of 1921, under a commission from the then director of the Palaeontological Institute and subsequently first Professor of Palaeontology at Uppsala University, Carl Wiman. Unusually for the time, Sternberg and his two Navajo indian assistants made a thorough survey for both display-quality skeletons and much smaller fragmentary remains (including plants); thus the Sternberg Collection comprises an actual assemblage cross-section. Wiman established two new taxa (and wrote four papers) on the basis of his material: the hadrosaurid dinosaur *Parasaurolophus tubicen*, and goniopholid crocodylian *Denazinosuchus kirtlandicus*. Later workers have also identified other dinosaurs including hadrosaurs (*Kritosaurus* sp.), sauropods (*Alamosaurus sanjuanensis*), and theropods (*Bistahieversor seeleyi*, *Saurornitholestes robustus*). This study provides the first comprehensive catalogue of the Museum of Evolution Sternberg Collection and assesses its palaeoecological utility.

[1]*Department of Earth Sciences, Palaeobiology Programme, Uppsala University, Villavägen 16, 75236 Uppsala, Sweden; heka9491@student.uu.se*

Wiman's forgotten plesiosaurs: the earliest recorded sauropterygian fossils from the High Arctic

BENJAMIN P. KEAR[1] and ERIN E. MAXWELL[2]

The first detailed reports of sauropterygian remains from the Arctic island of Spitsbergen (Svalbard Archipelago) were published as short notes in 1914 and 1916 by the prolific Swedish palaeontologist Carl Wiman. Since then, his original specimens have languished in obscurity despite recent discoveries renewing interest in the Scandinavian, Russian, and Canadian polar regions as highly significant sources of Mesozoic marine reptile fossils. A reassessment of Wiman's Spitsbergen collection housed in the Museum of Evolution at Uppsala University (Sweden) has identified a pistosaurid vertebral centrum from Upper Triassic (Carnian) sediments in the Tschermakfjellet Formation, and plesiosaurian elements including a previously undocumented partial skeleton probably derived from the restricted Upper Jurassic (Tithonian) bone bed horizon of the Slottsmøya Member, Agardhfjellet Formation. Although fragmentary, Wiman's sauropterygian fossils are historically important and represent some of only a handful of occurrences thus far described from the Mesozoic boreal high-latitude region of Europe.

[1]*Department of Earth Sciences, Palaeobiology Programme, Uppsala University, Villavägen 16, 75236 Uppsala, Sweden; benjamin.kear@geo.uu.se*
[2]*Museum für Naturkunde, Invalidenstraße 43, 10115 Berlin, Germany*

From sea to sand: palaeobiogeographical implications of Mesozoic-Cenozoic marine reptile assemblages from Saudi Arabia

BENJAMIN P. KEAR[1] and THOMAS H. RICH[2]

The record of marine reptile fossils from Saudi Arabia is sparsely documented compared to elsewhere in the Middle East. However, recent systematic surveys have uncovered tantalizing evidence of diverse assemblages from both Mesozoic (Triassic, Cretaceous) and Cenozoic (Palaeogene) strata. The stratigraphically oldest specimens come from the Middle-Upper Triassic (Anisian-Carnian) Jilh Formation, a paralic-shallow marine (tidal flat) deposit that outcrops along the eastern margin of the cratonic Arabian Shield. The Jilh Formation is rich in fragmentary vertebrate remains including ichthyosaurs (mixosaurids), a tanystropheid prolacertiform, and sauropterygians: cyamodontoid placodonts (*Psephosauriscus*) and nothosaurs (*Nothosaurus*, *Simosaurus*). Compositionally, this fauna closely resembles others previously reported from the Middle East and North Africa and is consistent with derivation from the 'Sephardic Realm' – a widespread Muschelkalk facies that characterised the northern Gondwanan shelf throughout the Middle–Late Triassic. Late Cretaceous

(Campanian–Maastrichtian) marine reptile fossils from northern Saudi Arabia also show close palaeobiogeographical affinities with Middle Eastern and North African taxa. Mosasaurs (*Prognathodon*, indeterminate plioplatecarpines), small aquatic varanoids (*Pachyvaranus*), bothremydid turtles, elasmosaurid plesiosaurs and dyrosaurid crocodyliforms have all been recovered from paralic (supratidal) sediments of the Adaffa Formation in the Midyan region on the Gulf of Aqaba, and from marine shelf carbonates of the Jalamid Formation close to the Jordanian border. These units reflect a low-latitude, warm water belt that dominated the Mediterranean Tethys during the Late Cretaceous-Palaeogene. Well-preserved dyrosaurid (*Rhabdognathus*, *Hyposaurus*, *Phosphatosaurus*) and indeterminate bothremydid material found in the Upper Paleocene Umm Himar Formation near Makkah also demonstrate the persistence of distinctive Mediterranean Tethyan elements in the Arabian region well into the earliest Cenozoic.

[1]*Department of Earth Sciences, Palaeobiology Programme, Uppsala University, Villavägen 16, 75236 Uppsala, Sweden; benjamin.kear@geo.uu.se*
[2]*Department of Palaeontology, Museum Victoria, Melbourne, Victoria, Australia 3000*

The pelmatozoan-receptaculite frame reefs of the Vasalemma Formation, north Estonia (late Keila –late Oandu Regional Stage, Ordovician)

BJÖRN KRÖGER[1] and MARE ISAKAR[2]

Bahamitic carbonates of the Vasalemma Formation where deposited in a narrow E-W striking area of north-west Estonia during the early Katian (Ordovician). The Vasalemma Formation consists of a pelmatozoan-grainstone with locally developed reefs of >20 metres diameter and up to 8 metres thick. The rombiferan *Hemicosmites* represents the main reef frame builder in lower stratigraphic intervals, while *Calathium*-like receptaculites and stromatolites dominate the upper parts. A bed-by-bed correlation within the Vasalemma quarry has allowed for detailed stratigraphic integration of the bahamites and reefs with the surrounding Kahula and Hirmuse formations. The bahamites appear low in the Saue Member and have their maximum northward expansion in the Lehtmehtsa Member of the Kahula Formation (late Keila Stage). The reefs are unconformably overlain by the Rägavere Formation (Rakvere Stage), thus their development in the Vasalemma Formation was contemporaneous with formation of the Kullsberg mud mounds in Sweden. The Vasalemma Formation reef system grew during two successive depositional cycles (interpreted as increasingly shallow water depths), and terminated at the top of the Hirmuse Formation with the appearance of giant tabulates on the reef-flanks. Erosion and reworking of the top surfaces seems to have been minimal, and locally developed coated conglomerates with rounded reef-core clasts indicate a termination of the reef growth during a top Oandu sea-level lowstand.

[1]*Museum of Evolution, Palaeontology, Uppsala University, Norbyvägen 16, 75236 Uppsala, Sweden; bjoekroe@gmx.de*
[2]*Museum of Geology of the University of Tartu, 46, Vanemuise Street,51014 Tartu, Estonia*

Branchiopod assemblages of the Upper Devonian Strud

locality, Belgium

LINDA LAGEBRO[1], NICOLAS RABET[2], OLIVIER BÉTHOUX[3], SYLVAIN CHARBONNIER[4], MARCO VECOLI [5], PIERRE GUERIAU[4], SÉBASTIEN OLIVE[6] and GAËL CLEMENT[4]

Since its initial discovery in 2005, the Upper Devonian locality of Strud, Namur Province, Belgium, has yielded substantial collections of vertebrate, invertebrate and plant fossils. The site is best known for its flora and vertebrate fauna, but also produces exceptionally preserved arthropod remains. These primarily comprise branchiopod and malacostracan crustaceans. Eurypterid specimens have also been found, together with assumed encysted branchiopod eggs. Here we discuss the branchiopod material, composed of Notostraca, Anostraca, and particularly Spinicaudata. The fossils occur within silty sandstone and evaporitic dolomite layers, which can be environmentally interpreted as representing a fluvial-estuarine setting. The resting eggs indicate that the area suffered episodic desiccation, a phenomenon typical in the life cycle of modern branchiopods.

[1]Department of Earth Sciences, Palaeobiology Programme, Uppsala University, Villavägen 16, 75236 Uppsala, Sweden; Linda.lagebro@geo.uu.se
[2] UMR BOREA, 61 rue Buffon, MNHN-Université Pierre et Marie Curie (Paris 6), 75005 Paris, France
[3]40 rue d'Aveillans, La Motte d'Aveillans, 38770, France
[4]UMR-CNRS 7207 "CR2P", Département Histoire de la Terre, Muséum national d'Histoire naturelle, 57 Rue Cuvier, 75005 Paris, France
[5]Université de Lille 1, Sciences de la Terre, UMR 8157 du CNRS «Géosystèmes», Equipe de Paléontologie et Paléogéographie du Paléozoïque (LP3), F-59655 Villeneuve d'Ascq cedex, France
[6]Department of Paleontology, Royal Belgian Institute of Natural Sciences, Rue Vautier, 291000 Brussels, Belgium

---

Early Cambrian *Askepasma* from South Australia – having a crack at brachs

CECILIA M. LARSSON[1] and TIMOTHY P. TOPPER[2]

Previously, the majority of paterinate brachiopods recovered from the Lower Cambrian limestone deposits of South Australia were assigned to the genus *Askepasma*; however, their higher-level taxonomic assignment remains open, mainly because of poor preservation. Recent assessment of both new and existing specimens representing several sections through the Ajax, Wilkawillina and Wirrapowie limestones of the Arrowie Basin (Flinders Ranges, South Australia), has offered an opportunity to revise the morphology and organophosphatic shell structure of *Askepasma*. This data prompts a redescription of the type species *Askepasma toddense*, and the recognition of a new taxon, *Askepasma* n. sp. The FAD of *Askepasma* n. sp. pre-dates the Lower Cambrian trilobite zone successions of South Australian; hence, it is the oldest reported brachiopod from the region. Sectioned specimens of *Askepasma* and the coeval tommotiid *Paterimitra* show remarkably similar shell microstructures. This and other morphological traits support the hypothesised close relationship between paterinate brachiopods and tommotiids, and furthermore, advocate a proximal stem group position of *Askepasma* within Brachiopoda.

[1]*Department of Earth Sciences, Palaeobiology Programme, Uppsala University, Villavägen 16, 75236 Uppsala, Sweden; cecilia.larsson@geo.uu.se*
[2]*Geologisk Museum, Statens Naturhistoriske Museum, Øster Voldgade 5-7, DK-1350 København K, Denmark*

A revision of *Testudo honanensis* (Testudinidae) and the biogeographical history of Palearctic tortoises

JENNY LINDAHL[1] and BENJAMIN P. KEAR[1]

In 1930, Carl Wiman named a series of tortoise species based on fossils recovered from the Late Miocene (Baodean: Tortonian-Messinian equivalent) 'red-beds' of Shaanxi in northern China. The most complete of these specimens, an articulated skeleton including skull and carapace/plastron, was dubbed *Testudo honanensis* and has been considered a potential sister taxon of the currently extant Russian or Steppe tortoise *Testudo horsfeldii*; a species occasionally distinguished as a separate genus, *Agrionemys*, although recent molecular analyses advocate nesting within *Testudo* spp. A phylogenetic reassessment of Wiman's original holotype using a combined morphological/DNA sequence data set suggests that *T. honanensis* is distinct from *T.* (*Agrionemys*) *horsfeldii*, but forms part of the Palearctic testudonan clade (*Testudo* + '*Eurotestudo*'). This primarily Mediterranean radiation is thought to have migrated out of Africa into Asia Minor and Europe (via Anatolia) with the spread of dry savannah grasslands around 10 Ma. A Late Miocene occurrence of testudonan tortoises in Eastern Asia is consistent with the distribution of coeval *Hipparion* Fauna mammals, and supports interpretations of the modern *Testudo* spp. as vicariant remnants of what was once a much more widely geographically dispersed Eurasian lineage.

[1]*Department of Earth Sciences, Palaeobiology Programme, Uppsala University, Villavägen 16, 75236 Uppsala, Sweden; jenny.lindahl@gmail.com*

Phylogenetic patterns in the heterostracan families Cyathaspidae, Ariaspidae and Ctenaspidae

METTE LUNDGREN[1] and HENNING BLOM[1]

The order Heterostraci includes early armoured vertebrates that are defined by a pair of common external branchial openings on either side of the head. The position of these openings and their arrangement in relation to the plates of the dermal armour has been shown to vary in different species of the Cyathaspidae, Ariaspidae and Ctenaspidae (previously grouped in the family Cyathaspididae). In order to explore evolutionary patterns in the branchial region of heterostracans, a phylogenetic analysis comprising 55 skeletal characters and 37 species-level taxa belonging to the Cyathaspidae, Ariaspidae and Ctenaspidae was carried out; this is the first cladistic appraisal of these heterostracan families. The resulting trees place *Asketaspis interstincta* in a basal position with all other taxa forming a discrete monophyletic clade. This infers aprogressional shift of the branchial opening and rearrangement of the adjacent dermal plates in *Alainaspis*, *Allocryptaspis*, and culminating in Ctenaspidae where the branchial opening is relocated to the posterolatertal corner of the dorsal shield and coincides with the loss of the superficial layer of the dermal armour.

[1]*Department of Organismal Biology, Subdepartment of Evolution and Development, Uppsala University, Norbyvägen 18A, 75236 Uppsala, Sweden; mette_j@ yahoo.com*

The Talbragar Fossil Fish Bed of eastern Australia – a world-class Late Jurassic Lagerstätte

STEPHEN MCLOUGHLIN[1]

The Talbragar Fossil Fish bed, exposed 30 kilometres northwest of Gulgong in central New South Wales, Australia, consists of a restricted 1.5 metre thick package of several, nearly flat-lying, fine-grained beds exposed over a strike length of at least 200 metres. Recent excavations at the site have yielded diverse new plant fossils including fertile structures that improve the prospect of whole-plant reconstructions. Araucariacean conifers, together with pentoxylalean and corystospermalean seed-ferns dominate the flora. Only a single insect fossil had been described from the deposit in the past 100 years but recent studies have revealed over 400 new specimens – the entomofauna being dominated by Hemiptera. Heteropterans, coleopterans, odonatans, orthopterans, mecopterans, neuropterans, plecopterans, and a dipteran have also been identified. Insect-plant interactions are evidenced by leaf-margin and hole-feeding damage to broad-leafed plants. The fish fauna is dominated by the primitive teleost *Cavenderichthys talbragarensis*. Other fish include the palaeoniscid, *Coccolepis australis*, members of the "holostean" family Archaeomenidae, Macrosemiiformes, an amiiform caturidid and a hybodontiform shark. Isolated burrows occur in the upper few centimetres of the fish bed. Fish coprolites, gastropods and bivalves are also present, attesting to a shallow lacustrine palaeoenvironment. Originally assigned an Early Jurassic age, recent S.H.R.I.M.P analyses of zircons from the deposit have yielded a revised date of 151.55 ± 4.27 Ma (Oxfordian–Tithonian) – roughly coeval with the famous Solnhofen Limestone of Germany. The yellow-brown colour of the fossiliferous beds is post-depositional. Many of the fossils are coated with diagenetic kaolinite and opaline quartz. The presence of euhedral zircon crystals and strong silicification suggest that a succession of ash falls from felsic volcanic eruptions filled the Talbragar lake and caused both the mass fish kills and fine preservation of the plant and insect remains.

[1]*Department of Palaeobotany, Swedish Museum of Natural History, P.O. Box 50007, 10405, Stockholm, Sweden; steve.mcloughlin@nrm.se*

Evidence for plant-animal interactions in early terrestrial ecosystems from the Upper Silurian of Baltica (Gotland, Sweden)

KRISTINA MEHLQVIST[1], JONAS HAGSTRÖM[2] and VIVI VAJDA[1]

This study presents the first report of definitive Silurian land plants from Baltica, and one of the earliest examples of plant-animal interactions in an early terrestrial ecosystem. Primitive land plant remains in the form of elongate sporangia with *in situ* cryptospores, spore masses,

and a possible axis, were identified in the Burgsvik beds of Gotland, Sweden. These plant fossils potentially represent liverworts that would have thrived in a moist coastal environment. Spores associated with the sporangia have been referred to *Dyadospora murusdensa* and *Laevolancis divellomedia*, the latter being a common local constituent of the dispersed Silurian microflora. Other naked spore masses (also attributable to *L. divellomedia*) consisting of cryptospore monads shrouded in amorphous organic material most probably represent coprolites of terrestrial arthropods; their comparatively poor preservation perhaps resulting from passage through the digestive system. Palynological analysis of drillcore material from Skåne (Bjärsjölagård and Klinta), Sweden, shows that the Burgsvik beds correlate to the *libycus-poecilimorphus* spore Zone, which is of late Ludlow age. Correlation with marine zonation schemes is presently being undertaken.

[1]*Department of Earth and Ecosystem Sciences, Division of Geology, Lund University, Sölvegatan 12, 22362 Lund, Sweden; kristina.mehlqvist@geol.lu.se*
[2]*Department of Palaeozoology, The Swedish Museum of Natural History, Box 50007, 10405 Stockholm, Sweden*

A dipnoan pterygoid from Bergisch Gladbach, Germany

BARBRO B. MELLBIN[1]

The Upper Devonian Bergisch Gladbach locality in western Germany has yielded numerous fossil lungfish, including *Rhinodipterus*, *Griphognathus*, and *Dipterus*. Lungfishes are very important to our understanding of Devonian vertebrate evolution, yet critical phases of their early history remain poorly understood. The isolated dipnoan pterygoid described here was initially as attributed to a dipnorhynchid because it shared several specific characteristics, including dentine plating, with *Dipnorynchus*. However, closer inspection suggests an alternative referral to a new taxon based on a unique combination of traits: no clearly defined teeth (similar to *Dipnorhynchus*), and the presence of three distinct oval elevations along its lateral edge and two along its medial edge. The anterior medial, and lateral elevations are sub-equal in size, whereas the posterior one is significantly larger, rounded, and placed slightly posterior to the centre of the specimen. The left and right pterygoids appear to have been in contact and enclosed the long, narrow parasphenoid; this differs from *Dipnorhynchus* in which the palate is fully fused. The unusual morphology and size of the Bergisch Gladbach pterygoid is completely unlike that of other coeval lungfishes, and might therefore provide important phylogenetic and ecological information.

[1]*Department of Organismal Biology, Subdepartment of Evolution and Development, Uppsala University, Norbyvägen 18A, 75236 Uppsala, Sweden; barbro.mellbin@ebc.uu.se*

Footprints of large theropod dinosaurs from the Upper Triassic of Poland

GRZEGORZ NIEDŹWIEDZKI[1,2]

A set of large theropod dinosaur footprints has been recorded from Upper Triassic deposits at Lipie Śląskie-Lisowice in SW Poland. These ichnofossils comprise natural casts (tracks and undertracks) and natural moulds (true prints) grouped into two morphotypes: '*Eubrontes*-

Kayenatpus', and '*Megalosauripus-Hispanosauropus*'. Sediment infills of the deepest footprints, which were formed in mixture of soft mud and sand, lack fine anatomical details but reveal the locomotory kinematics of the track-maker through the structure of external track fills and sinking traces. Current body-fossil records suggest that the origin and initial diversification of large theropod dinosaurs (early Tetanuran theropods) was rapid, occupying an interval of about 5–10 million years during the Middle Jurassic. However, numerous earlier reports of large tridactyl dinosaur tracks from around the world imply that the emergence of tetanurans was a more protracted affair, extending through much of the Late Triassic and on into the Early Jurassic. This study finds no convincing evidence of large theropod dinosaur tracks prior to the late Carnian. The origin of tetanuran theropods was therefore probably not the correlate or consequence of any single event or process, be it global change, competitive replacement, or opportunism in the wake of mass extinction. Rather, a series of cladogenetic events over an interval of at least 20 million years, and possibly as much as 30 million years, is considered a more viable scenario.

[1]*Department of Organismal Biology, Subdepartment of Evolution and Development, Uppsala University, Norbyvägen 18A, 75236 Uppsala, Sweden; grzegorz.niedzwiedzki@ebc.uu.se*
[2]*Department of Paleobiology and Evolution, Warsaw University, PL-02-097 Warsaw, Poland; gniedzwiedzki@biol.uw.edu.pl*

Geological setting of the lower Cambrian Sirius Passet Lagerstätte, North Greenland.

JOHN S. PEEL[1] and JON R. INESON[2]

The Sirius Passet Lagerstätte of North Greenland is preserved in mudstones of the Buen Formation (lower Cambrian). These were deposited in a slope environment, seawards of the eroded scarp of a pre-existing carbonate platform represented by the Portfjeld Formation (Neoproterozoic-lowermost Cambrian). The juxtaposition of fossiliferous mudstones with the margin of the carbonate platform is reminiscent of the depositional setting of the world famous Burgess Shale Lagerstätte (middle Cambrian) of western Canada. Proximity to a platform margin has served to protect both these unique Lagerstätten from obliteration by tectonic deformation and metamorphism. While Burgess Shale localities can be traced for a substantial distance along the Cathedral Escarpment, the Sirius Passet fossiliferous deposits occur only as a thin, one kilometre long sliver within the tectonized terrane of north-western Peary Land.

[1]*Department of Earth Sciences, Palaeobiology Programme, Uppsala University, Villavägen 16, 75236 Uppsala, Sweden; john.peel@pal.uu.se*
[2]*Geological Survey of Denmark and Greenland, Øster Voldgade 10, DK-1350 Copenhagen K, Denmark*

Fish-remains in Ludlow sediments from Gotland

CARL PLEIJEL[1,2]

Acetic acid processing of Silurian (Ludlow) sediments from the Lau and Kräklingbo areas of Gotland have yielded isolated and usually broken fish remains including jaws and scales of

acanthodians, scales of Thelodontia and Heterostraci, and elements referable to *Andreolepis*, which is potentially the oldest actinopterygian. Other unidentifiable bone fragments and possible plant remains also occur in the samples. Only one Silurian taxon, *Archaegonaspis*, has ever been reported from articulated specimens on Gotland. Nevertheless, the stratigraphically long-ranging sequences (Llandovery–Wenlock) and diverse palaeoenvironments of the Gotland strata highlight their importance in future exploration for early fish fossils.

[1]*Åsa 11, 64024 Sköldinge, Sweden; carl.pleijel@folkbildning.net*
[2]*Department of Palaeozoology, Swedish Museum of Natural History, P.O. Box 50007, 10405, Stockholm, Sweden*

The significance of Carl Wiman's sauropod dinosaurs

STEPHEN F. POROPAT[1,2] and BENJAMIN P. KEAR[1]

Of the Mesozoic vertebrate fossils received and published on by Carl Wiman during his diverse career as Sweden's first Professor of Palaeontology, his sauropod dinosaurs arguably remain some of the most significant to modern researchers. In particular, *Euhelopus* [*Helopus*] *zdanskyi* described by Wiman in 1929 from the Lower Cretaceous Qingshan Formation of China is one of the best-known taxa, being represented by a partial skull and associated presacral axial skeketon, referred dorsal vertebral series, complete hind limb, and partial forelimb. Paradoxically, the anatomy, phylogenetic relationships, and stratigraphical disposition of *Euhelopus* have until recently been highly controversial. Indeed, on-going work is now focused upon the biomechanical aspects of the skull and ultimately will undertake a complete CT-based reconstruction of the head and neck to investigate ecomorphological adaptation amongst titanosauriforms. Wiman's other important sauropod discoveries include several isolated vertebrae also from the Qingshan Formation: (1) a caudal interpreted as the first Asian diplodocid; and (2) a cervical and dorsal, both of which are under study but might represent other titanosauriform taxa. Another collection of sauropod postcranial elements (an ilium, cervical vertebra, and three sacral vertebrae) sent by the famous American dinosaur collector Charles H. Sternberg in 1921, might represent components of the holotype of *Alamosaurus sanjuanensis*, a Late Cretaceous (Maastrichtian) titanosaurid from the Kirtland Formation of New Mexico. Despite having been in the scientific spotlight for more than 80 years, Carl Wiman's specimens are still critical to the broader understanding of Cretaceous sauropod evolution.

[1]*Palaeobiology Programme, Department of Earth Sciences, Uppsala University, Villavägen 16, 75236 Uppsala, Sweden; stephen.poropat@geo.uu.se*
[2]*Australian Age of Dinosaurs Museum of Natural History, The Jump-up, Winton, Queensland 4735, Australia*

What is a pore-canal system?

QINGMING QU[1], PER AHLBERG[1] and HENNING BLOM[1]

The pore-canal system is part of the defining ‘comsine’ structure of early sarcopterygians. It lies in the upper dentinous region of the dermal skeleton and has abundant external openings connected by horizontal ‘Maschenkanäle' to a deeper canal system in the thickened spongia layer – the ‘Unter-Maschenkanäle'. A similar horizontal canal system is also present in early actinopterygians but is not generally considered homologous. We generated 3D reconstructions of scale canals in three early osteichthyans: *Lophosteus*, *Andreolepis*, and *Psarolepis*, the latter being a basal sarcopterygian. Well-developed horizontal canal-systems were found in all of the sampled taxa, although their morphology was more regular in *Psarolepis*. In addition, *Psarolepis* possesses a less regular canal system at slightly deeper levels within the bony tissues, which might correspond to the ‘Unter-Maschenkanäle' of crown sarcopterygians (e.g. *Porolepis*). Conversely, the dentinal canals in *Psarolepis* appear to arise from both the lower canal system and horizontal ‘Maschenkanäle'. This feature represents a potential link between actinopterygians and sarcopterygians, thus rendering the horizontal canal system (probably part of the vascularization of the scale) potentially homologous across early osteichthyans.

[1]*Department of Organismal Biology, Subdepartment of Evolution and Development, Uppsala University, Norbyvägen 18A, 75236 Uppsala, Sweden; quqingming@hotmail.com*

Phosphatization of microbial mat communities from the Palaeoproterozoic Vindhyan Supergroup, India

THERESE SALLSTEDT[1,2]

Phosphatic stromatolites from the 1.6 Ga Vindhyan Supergroup of central India contain abundant microbial fabrics dominated by mat-constructing filamentous microorganisms and coccoidal species. The Vindhyan Supergroup represents one of few voluminous Palaeo-Mesoproterozoic phosphorite deposits known globally, and is thus a unique locality in which to study phosphatization processes, palaeoecology and taphonomy of ancient microbial mat associations. Morphological data derived from petrographic analyses and Synchrotron X- ray Tomographic Microscopy (SrXTM) infers that variations in seasonal/diurnal solar input, or recurring depositional changes affected the growth position of motile filamentous bacteria in the Vindhyan phosphorites. The microbial fabrics were characterised by alternating prostrate and erect phosphatized filaments, similar to cyclic cyanobacterial fabrics found in active hydrothermal environments today. Morphological differences observed between layers in laminated mat sections could correspond to varying community structures, and at least two distinct epibenthic filamentous communities appear to have played a framework-building role in Vindhyan stromatolite morphogenesis. Variations in microbial growth patterns, such as the construction of tufts, might have also influenced the formation of individual laminae.

[1]*Department of Palaeozoology, Swedish Museum of Natural History10405 Stockholm, Sweden; therese.sallstedt@nrm.se*
[2]*Nordic Center for Earth Evolution and Institute of Biology, University of Southern Denmark, DK-5230 Odense, Denmark*

Palaeontology and stratigraphy of the middle Cambrian Stephen Formation, western Canadian Rocky Mountains

MICHAEL STRENG[1], ROBERT R. GAINES[2] and JEAN-BERNARD CARON[3]

The middle Cambrian Stephen Formation of the western Canadian Rocky Mountains is best known for incorporating the famous Burgess Shale deposits with their exceptionally preserved fossils. However, the depositional setting of this rock unit is equally remarkable, being characterised by a spectacular submarine cliff, the Cathedral Escarpment, that divided the local palaeoenvironment into contrasting deep, basinal and shallower water habitats; these are expressed geologically as different regional facies within the formation. Previous palaeontological assessments of the Stephen Formation have mainly focused on the popular macrofossil fauna. Here we present an alternative perspective – the first systematic study of the microfossil assemblage, which has been extracted from successive limestone horizons occurring throughout the sequence. Five sections from the basinal and shallow water facies of the Stephen Formation were measured, and over 130 horizons sampled at sites in the Yoho and Kootenay national parks. Formic acid preparation of this material has revealed a variable fauna of predominantly phosphatic-shelled brachiopods (primarily *Acrothyra* and *Paterina*, but also lingulids and zhanatellids) and trilobites (dominated by ptychoparids and *Pagetia*; other taxa including agnostids are rare). Locally recrystallized echinoderm ossicles, which can be referred to ctenocystoids and edrioasteroids, and a variety of siliceous sponge spicules are also evident. Molluscs, such as helcionellids, stenothecoids, and hyoliths form an insignificant component of the associations. Bradoriids and protoconodonts are rare, and restricted to particular horizons. Determining the stratigraphical distribution of individual taxa will permit detailed correlations between different sections and horizons, and ultimately, a comprehensive understanding of the biostratigraphy and regional variability within this iconic fossil deposit.

[1]Department of Earth Sciences, Palaeobiology Programme, Uppsala University, Villavägen 16, 75236 Uppsala, Sweden; michael.streng@geo.uu.se
[2]Pomona College, Geology Department, 185 E. Sixth Street, Claremont, California 91711, USA
[3]Department of Natural History-Palaeobiology, Royal Ontario Museum, 100 Queen's Park, Toronto, Ontario M5S 2C6, Canada

---

Dinosaur footprints associated with the latest Triassic vegetation turnover in Skåne, Sweden

VIVI VAJDA[1] and MIKAEL CALNER[1]

Triassic–Jurassic sediments are extensively distributed in offshore areas of the Baltic Shelf, although onshore outcrops are restricted to Skåne in southern Sweden. Here, regional sedimentation took place in fluvial-estuarine and marginal marine depositional systems, which have been stratigraphically subdivided using palynomorphs. The Skåne exposures span the Triassic-Jurassic boundary, and are distributed mainly through the north-western and central areas of the province, where they extend along the eastern margin of the Vomb Trough and rest upon lower Palaeozoic shales. Of most note are the fluvial and deltaic deposits of the Höganäs Formation (Rhaetian–Hettangian), which are best known for preserving dinosaur tracks. Host mudrock matrix associated with four of these dinosaur footprints were sampled

for palynological analysis. The results indicate age correlation with a latest Triassic (latest Rhaetian) 'disaster zone' typified by high abundance of pteridophyte spores including *Deltoidospora* spp., *Gleicheniidites* spp., *Striatella seebergensis*, and the enigmatic *Riccisporites tuberculatus*. These pollen types occur widely in northern hemisphere successions spanning the Triassic-Jurassic boundary.

[1]*Department of Earth and Ecosystem Sciences, Lund University, Sölvegatan 12, 22362 Lund, Sweden; vivi.vajda@geol.lu.se*

Peduncular attached, secondary tiering acrotretoid brachiopods from the Chengjiang fauna: implications for ecological expansion of brachiopods during the Cambrian explosion

HAIZHOU WANG[1, 2], ZHIFEI ZHANG[2, 3], LARS E. HOLMER[1], SHIXUE HU[4] and XIANGREN WANG[2]

Preservation of *in situ* secondary tierers is very rare in the lower Palaeozoic fossil record; and there are even fewer examples from the early Cambrian. Here we report on a new medium−high secondary tiering (+5 to +10 cm tier) lingulate acrotretoid brachiopod from the lower Cambrian Chengjiang fauna (Series 2, Stage 3) of Yunnan, southern China. Articulated examples of the shells were found attached to fronds of the algae-like fossil *Malongitubus kuangshanensis*. This appears to have been a direct shell-frond contact and there is no evidence of a pedicle, which is otherwise indicative of Chengjiang lingulates. The attachment mode of the new acrotretoid was thus probably similar to that of secondary tiering paterinates from the middle Cambrian Burgess Shale, which occur in contact association with the spicules of erect sponges. The Chengjiang acrotretoid is significant because it provides the first glimpse into the palaeoecology of these enigmatic micromorphic brachiopods that were especially diverse in the lower Palaeozoic. Definitive evidence of an acrotretoid/*Malongitubus* association also demonstrates that high tiering levels were well established by the early Cambrian.

[1]*Department of Earth Sciences, Palaeobiology Programme, Uppsala University, Villavägen 16, 75236 Uppsala, Sweden; haizhou.wang@geo.uu.se*
[2]*Early Life Institute, State Key Laboratory of Continental Dynamics, Northwest University, Xi'an, China*
[3]*LPS, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing, China*
[4]*Yunnan Geological Survey and Yunnan Institute of Geological Science, Kunming, China*

The lower-Middle Cambrian agnostid *Pentagnostus praecurrens* from Sweden

THOMAS WEIDNER[1] and JAN OVE R. EBBESTAD[2]

The agnostid, *Pentagnostus praecurrens*, is the Scandinavian index species for the lower-Middle Cambrian *Acadoparadoxides pinus–Pentagnostus praecurrens* Zone

(*Baltoparadoxides oelandicus* Superzone). This biostratigraphical unit is otherwise characterised by several paradoxidid genera and species, together with a low diversity fauna of polymerid and agnostid trilobites. Whereas '*Paradoxides*' assemblages are widely distributed elsewhere in the Acadobaltic provinces of Baltica and Avalonia, Bohemia, Spain, Morocco, and Russia, *P. praecurrens* is only confidently identified from Sweden (Öland, Östergötland, Närke, Jämtland, and here for the first time from Ångermanland) and coeval deposits in Russia, Australia, and Canada. The species does not range into the younger *Triplagnostus gibbus* Zone in Sweden. The original descriptions of *P. praecurrens* was based on detached cephala and pygidia from Öland, which were poorly preserved and both proportionally/morphologically different. This study presents new material (including numerous complete specimens) from Jämtland that facilitates a comprehensive revision of the species. Our sample also exhibits considerable morphological variation, especially relative to examples from outside of Sweden, and thus might help to improve global correlations of lower-Middle Cambrian strata.

[1]*Ravnholtvej 23, Råtup, DK 7130 Juelsminde, Denmark; we@paradis.dk*
[2]*Museum of Evolution, Palaeontology, Uppsala University, Norbyvägen 16, 75236 Uppsala, Sweden*

Geotourism in the central Baltic – what have we learned?

SEBASTIAN WILLMAN[1] and HEIKKI BAUERT[2]

Like the rest of the world, the Scandinavian and Baltic countries are rapidly developing their eco-nature oriented tourism, although this work is still in its infancy. An intensive public outreach programme, supported by a collaborative EU-Interreg IVa Swedish-Estonian initiative, is therefore aiming to aggressively promote common, cross-border geological heritage through thematic print, video and online media. A primary outcome of the project was the identification and development of key aspects for future improvement: (1) conservation of globally outstanding geological features including the world famous 'rauks' on Gotland (Sweden) and Kaali meteorite craters on Saaremaa (Estonia). How can we advertise and protect these sites for future generations without over exploitation? (2) Education at local, national, and international levels to disseminate knowledge about dynamic Earth processes and increase environmental awareness. How can we foster greater public interest in earth sciences? (3) Use geotourism to stimulate economic activity and enhanced value for local communities/governments. Can the establishment of geoparks facilitate sustainable development through financial returns, or should we go down a different route?

[1]*Department of Earth Sciences, Palaeobiology Programme, Uppsala University, Villavägen 16, 75236 Uppsala, Sweden, sebastian.willman@geo.uu.se;* [2] *NGO Geoguide Baltoscandia, Jahimehe tee 24, Tallinn 11911, Estonia.*

Geochemistry of fossilised dental remains – a key to palaeobiology and palaeoenvironment

ŽIVILĖ ŽIGAITĖ[1], ALBERTO PÉREZ-HUERTA[2], TERESA JEFFRIES[3], BENJAMIN P. KEAR[4] and HENNING BLOM[1]

We assessed Palaeozoic (Silurian-Devonian) and Mesozoic (Cretaceous) vertebrate teeth and dental dermoskeletal microremains for their isotopic and elemental compositions. Abundances of rare earth elements (REE) were measured using laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS). Pre-evaluation of the fossil preservation level was also evaluated by semi-quantitative spot geochemistry analyses of finely polished thin sections via energy dispersive X-ray spectroscopy (EDS). Electron Backscatter Diffractometry (EBSD) provided crystallinity of fossil biominerals. Silicification of bioapatite and elevated heavy element concentrations were found to correspond to fossil tissue structure and colour alteration. Stable oxygen isotope measurements ($\delta^{18}O$) of bulk biomineral also generally yielded lower heavy oxygen values in diagenetically modified specimens. Clear distinction in REE concentrations between dentine and enamel suggests that the latter is more geochemically resistant to diagenetic overprint. $\delta^{18}O$ ratios similarly appear to be species-dependent, which might infer either susceptibility to loss of primary isotopic signal, or specific palaeobiological isotope assimilation in biominerals.

[1]*Department of Organismal Biology, Subdepartment of Evolution and Development, Uppsala University, Norbyvägen 18A, 75236 Uppsala, Sweden; zivile.zigaite@ebc.uu.se*
[2]*Department of Geological Sciences, University of Alabama, USA*
[3]*Mineralogy Department, Natural History Museum London, UK*
[4]*Department of Earth Sciences, Palaeobiology Programme, Uppsala University, Villavägen 16, 75236 Uppsala, Sweden*