PROGRAMME & ABSTRACTS

International Conodont Symposium 2006

Leicester

Compiled and edited by Mark Purnell, Philip Donoghue, Richard Aldridge and John Repetski

Pander Society

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Financial support from sponsors subsidised the participation in ICOS2006 of ~20 people, including students, who may otherwise have been unable to attend.

International
Conodont
2006
Symposium
Leicester
ICOS

Organised by
Mark Purnell

Scientific committee
Professor Richard J. Aldridge, University of Leicester
Dr Howard A. Armstrong, University of Durham
Dr Pierre Bultynck
Dr Patrick Cossey, University of Staffordshire
Dr Philip C. J. Donoghue, University of Bristol
Dr C. Giles Miller, Natural History Museum, London
Dr Mike J. Orchard, Geological Survey of Canada
Dr Mark A. Purnell, University of Leicester (Chair; Co-ordinator)
Dr John Repetski, U.S. Geological Survey, Reston
Professor George Sevastopulo, Trinity College, Dublin
Professor M. Paul Smith, University of Birmingham

Volunteer helpers
David Baines
David Jones
Dr Gary Mullins

Welcome to Leicester…

… and to ICOS2006, the first International Conodont Symposium. On the following pages you will find the programme and schedule of events, together with information that will help you to get around while in Leicester. The meeting will take place on two sites, and while this has certain advantages it does make the logistics a little more complicated. Please read the information below so that you know where to be, when, and how to get there.

Scientific sessions (both talks and posters), will take place on the Main Campus of the University, in the Bennett Building, Lecture Theatre 2 and the adjacent foyer area. Tea, coffee and buffet lunches will also be provided here. Accommodation, evening meals, and the Sunday Ice Breaker are in Beaumont Hall, situated in landscaped grounds 3.5 km south east of the Main Campus. The reception on Monday evening will be in the City's New Walk Museum, a short walk North of the Campus. The conference banquet will be at Coombe Abbey, not far from Leicester

Getting around during the meeting

Private vehicles should be parked in the free places at Beaumont Hall; no parking is provided on or near the Main Campus. On Monday, Tuesday, Thursday and Friday buses will be provided to transport participants to the Main Campus in the morning and then back to Beaumont Hall at the end of the day. The times of these buses are shown on the programme. **There will be only one departure in each direction each day**. If you miss the bus you can catch a scheduled bus service from outside Beaumont Hall (route 80; approximately hourly; get off at Mayors Walk, University Entrance Gate 2) or, probably better, from London Road, opposite the end of Stoughton Drive South (routes 29, 30, 30A, 31; more frequent; get off near north end of University Road and walk to University Entrance Gate 2). These buses will also take you back to Beaumont Hall (get off after the Race Course, and walk up Stoughton Drive South). Alternatively, 'phone numbers for local taxi companies are listed in your copy of "Guest Information and Maps" (in your registration pack). If you need to ask for directions, the following pronunciation guide may help:
Leicester – pronounced Lester (or, to be authentic, Lest'o, the o pronounced as in rock);
Beaumont Hall - Beaumont pronounced Bo-mont (to rhyme with toe-mont);
Stoughton Drive South - Stoughton pronounced Sto-tun (to rhyme with toe-tun);
Loughborough (if you need to get to East Midlands Airport) pronounced luff-buhruh (uh as in huh).

Bank and cash machine (ATM)

The nearest bank and cash machines are on campus, a few hundred metres south of the Bennett Building. A branch of HSBC is located at the south side of the Charles Wilson Building, with a cash machine on the south wall. A National Westminster cash machine is located in the corner of the Percy Gee Students Union building opposite. Will your card allow you to extract sterling from these machines? There's only one way to find out…

Accommodation

Almost all participants are staying in Beaumont Hall University Residence. Keys will be issued from the registration desk in Beaumont Hall when you arrive.
Check out times: You will need to clear your room before 9:30 in the morning on your day of departure.

Arrangements for meals

If you have notified us of special dietary requirements, please make these known to the serving staff when they serve dinner. Buffet lunches will include both vegetarian and non-vegetarian items. Please note that **dinner in Beaumont Hall is not self-service**; you should be seated in the Dining Hall prior to the times indicated below.

Times and locations of meals are as follows:
Sunday, July 16th, dinner, Beaumont Hall, dining hall, served at 19:00; booked in advance, ticket required (in registration pack).
Monday, July 17th, breakfast, Beaumont Hall, dining hall, from 07:00; included with accommodation.
Monday, July 17th, buffet lunch, Bennett Building, Lower Foyer.
Monday, July 17th, Dinner, Beaumont Hall, dining hall, served at 19:30; booked in advance, ticket required.
Tuesday, July 18th, breakfast, Beaumont Hall, dining hall, from 07:00; included with accommodation.
Tuesday, July 18th, buffet lunch, Bennett Building, Lower Foyer.
Tuesday, July 18th, dinner, Beaumont Hall, dining hall, served at 19:30; booked in advance, ticket required.
Wednesday, July 19th, breakfast, Beaumont Hall, dining hall, from 07:00; included with accommodation.
Wednesday, July 19th, lunch will be provided for those booked on excursions; if you are staying in Leicester you will have to fend for yourself.
Wednesday, July 19th, dinner, Beaumont Hall, dining hall, served at 19:30; booked in advance, ticket required.
Thursday, July 20th, breakfast, Beaumont Hall, dining hall, from 07:00; included with accommodation.
Thursday, July 20th, buffet lunch, Bennett Building, Lower Foyer.
Thursday, July 20th, Mediaeval Banquet, Coombe Abbey, from 19:20; booked in advance, ticket required.
Friday, July 21st, breakfast, Beaumont Hall, dining hall, from 07:00; included with accommodation.
Friday, July 21st, buffet lunch, Bennett Building, Lower Foyer.
Friday, July 21st, dinner, Beaumont Hall, dining hall, served at 18:30; booked in advance, ticket required.

Bar

The Beaumont Hall bar will be open at the following times (subject to demand; if the bar is empty, it will close):
Sunday, July 16th, from 18:00 till 24:00 (Ice Breaker tokens for those who booked them)
Monday, July 17th, from 18:30 till 24:00
Tuesday, July 18th, from 18:30 till 24:00
Wednesday, July 19th, from 18:30 till 24:00
Thursday, July 20th, from 18:00 till 19:00
Friday, July 21st, from 18:00 till 24:00

The bar will be closed during dinner, but bottles of wine or other drinks can be purchased from serving staff.

Arrangements for the Wednesday Excursions

Outline itineraries for the Wednesday excursions are as follows:

Carboniferous of North Staffordshire
Leaders: Mark Purnell and Patrick Cossey
08:30 Depart Beaumont Hall
10:00 Arrive Brown End Quarry, Waterhouses (nr Leek)
12:00 Travel from Waterhouses to Cauldon Low (<5 miles) for lunch

12:00 – 13:30 buffet lunch in the Yew Tree Inn
13:30 - 13:45 walk to Railway Cutting
13:45 – 14:45, time at cutting
14:45 - 15:00 walk back to coach
15:00 travel Cauldon Low to Dovedale (6 miles)
17:00 depart Dovedale
18:30 Arrive Oadby

Natural History Museum, London
Leader: Giles Miller
08:30 Depart Beaumont Hall
11:00+ arrive at NHM
11:30 Tour of Micropalaeo division in two groups, including imaging suite.
12:30 Lunch in galleries with tickets for Dino Jaws or in Micropalaeo while looking at collections (for those that pre-booked)
15:30 Depart for Leicester
18.30 Arrive at Beaumont Hall

For Speakers

The computers in the lecture theatre run Powerpoint 2003; the operating system is Windows XP. Please give the CD or USB data stick containing your presentation (labelled with your name, talk title and talk slot) to one of the projection assistants at the beginning of the meeting (or the day before you speak, at the latest). They will load the files onto the hard drive of the computer to be used in your session. Please remember that the time you have been allocated for your presentation includes time for questions and discussion. As there are no parallel sessions, your talk should be *accessible to the whole audience*, not just those with specialist knowledge in your area. Please bear this in mind when presenting your talk.

Poster Presentations

If you have brought a poster, please attach it with Velcro to one of the poster boards in the Lower Foyer of the Bennett Building, outside the Lecture Theatre. Please note that there are enough boards for each submitted poster to be displayed at A0 size, portrait orientation (i.e. 841 mm wide). If you have not prepared your poster to fit this space (and have not made arrangements in advance) there may not room to display your poster. Within these constraints, poster space is available on a first-come-first-served basis.

Symposia

The following thematic symposia will form the core of the scientific session for ICOS2006.

Pander's legacy, 150 years on
2006 marks the Sesquicentennial of Pander's monograph in which conodonts were described for the first time. This symposium will consider Pander and his scientific contribution, including his work on conodonts, other fossil vertebrates, and developmental biology. Keynote speakers in this symposium will be:
Professor R. J. Aldridge (Leicester), Professor Simon Knell (Museum Studies, Leicester), Professor Anthony Graham (Developmental Biology, King's College, London) and Professor Peter Forey (Palaeontology, Natural History Museum).

Conodont phylogenies - alternative approaches, implications, and applications
Hypotheses of conodont phylogeny underpin many areas of conodont research, including taxonomy, biostratigraphic zonation, evolutionary palaeobiology, and analysis of the quality of the fossil record. This session will explore alternative approaches to reconstructing conodont phylogeny, their assumptions, implications and applications.
Keynote speaker: Dr Philip Donoghue (University of Bristol).

Conodonts, Palaeobiogeography and Palaeoceanography
This session will cover all aspects of global influences on conodont distribution and the uses of conodonts in the investigation of palaeocontinental configurations, eustatic sea-level changes, climate models and the ocean/atmosphere system. Topics will include conodont biogeography, conodont geochemistry and the relationship between conodont distribution and sequence stratigraphy. Investigations of major patterns of extinction, radiation and faunal turnover will also be relevant.
Keynote speaker: Professor Chris Barnes (Victoria University, BC).

Triassic Conodonts: Taxonomy and Time Scales
Convened by Mike Orchard. Conodonts play a primary role in Triassic biochronology and yet the taxonomic framework in which they are applied remains largely based on form taxonomic concepts. This symposium explores both the variability of taxonomic approaches currently in use in the study of Triassic conodonts, including their Permian forebears, and their application in biostratigraphy and time scales. Co-sponsored by IGCP 467, "Triassic Time and trans-Panthalassan correlations"
Keynote speaker: Mike Orchard (Geological Survey of Canada).

'Coniform' conodont apparatuses and architecture - whence and whither?
The last two decades have seen a major leap forwards in the interpretation of more derived conodonts, with the elucidation of apparatus architectures using natural assemblages and the use of these architectural models as templates for apparatus reconstruction in taxa unrepresented by natural assemblages. In contrast, primitive conodonts with apparatuses composed of coniform elements are poorly represented by natural assemblages and it is clear that the record is replete with partial reconstructions, and limitations created by the unknown extent of morphologically similar elements within the apparatuses of individual conodonts. Even simple questions regarding the apparatuses of these taxa have uncertain answers. How many elements were there in conodonts with apparatuses of this type? How similar was the architecture to that of primitive prioniodontid conodonts? How much variation in architecture is there within primitive conodonts? Can consistent architectural models be developed with the available assemblage data? If so, can these be used to guide apparatus reconstruction in taxa represented only by collections of isolated elements? If the phylogeny of primitive conodonts, and other aspects of their palaeobiology, are to be investigated in a secure, reproducible and testable manner, then better constrained apparatus models are essential.
Keynote speaker: Professor Paul Smith (Birmingham University).

Devonian Conodont Biostratigraphy
Convened by Pierre Bultynck. The Devonian standard conodont zonation, mostly based on successions in deeper-water deposits, is widely used among conodont workers. However, some zones are not always easily accepted. This symposium will focus on the following topics: Constraints on the Devonian standard conodont zonation; Alternative zonations in deeper-water facies; Alternative zonations/faunas in shallower-water facies
Graphic correlation.
Keynote speaker: Dr Sophie Gouwy.

If you need assistance during the meeting, please ask one of the local team (identified by their coloured name badges).

Finally, enjoy the meeting!

Programme

Sunday, July 16

14:00	Registration, Beaumont Hall
19:00	Dinner
20:00	Ice Breaker, Beaumont Hall Bar

Monday, July 17

7:00	Breakfast
8:30	Bus departs Beaumont Hall (from Stoughton Drive South)
9:00 - 9:20	Introductory and welcoming speeches
9:20 - 12:50	**SYMPOSIUM: PANDER'S LEGACY, 150 YEARS ON**
9:20 - 10:00	PANDER’S ENIGMA: THE FIRST CENTURY OF CONODONT STUDIES (Keynote)
	Simon Knell
10:00 - 10:40	THE CRANIAL NEURAL CREST – MASTER OR SLAVE (Keynote)
	Anthony Graham
10:40 - 11:10	Tea/Coffee and posters
11:10 - 11:50	PANDER’S SILURIAN JAWLESS FISHES – THEN AND NOW (Keynote)
	Peter L. Forey
11:50 - 12:30	PANDER AND THE PHYLOGENETIC POSITION OF THE CONODONTS – THEN AND NOW (Keynote)
	Richard J. Aldridge
12:30 - 12:50	PANDERS’S CONODONTS: RE-EVALUATION OF SPECIES FROM THE TYPE AREA
	Tatiana Tolmacheva
12:50 - 14:00	Lunch
14:00 - 16:05	**SYMPOSIUM: 'CONIFORM' CONODONT APPARATUSES AND ARCHITECTURE - WHENCE AND WHITHER?**
14:00 - 14:45	'CONIFORM' CONODONT APPARATUSES AND ARCHITECTURE - WHENCE AND WHITHER? (Keynote)
	Paul Smith
14:45 - 15:05	ARCHITECTURE, GROWTH AND FUNCTION OF THE *PANDERODUS* APPARATUS
	Ivan J. Sansom, ***Howard A. Armstrong***
15:05 - 15:25	BIOLOGICAL INTERPRETATION OF THE STRUCTURE OF PANDERODONTIDAE ELEMENTS
	Hubert Szaniawski
15:25 - 15:45	DEVELOPMENTAL DISPARITY AND ECOSPACE OCCUPATION IN THE STEM GNATHOSTOME *PANDERODUS* (ETHINGTON:CONODONTA)
	Howard A. Armstrong, *Ivan J. Sansom*
15:45 - 16:05	THE APPARATUS STRUCTURE OF THE CONIFORM CONODONT *PSEUDOONEOTODUS*: EVIDENCE FROM A COMPLETE ARTICULATED APPARATUS WITH SOFT PARTS?
	Mark A. Purnell, *Peter H. von Bitter*
16:05 - 17:00	Posters & walk to New Walk Museum
17:00 - 19:00	Reception, sponsored by *Hitachi High-Technologies*, at New Walk Museum
19:00	Bus back to Beaumont Hall (from behind New Walk Museum)
19:30	Dinner

Names in **bold** are speakers

Tuesday, July 18 (SEM workshops will run in parallel throughout the day, SEM lab, Geology Dept)

7:00	Breakfast
8:30	Bus departs Beaumont Hall (from Stoughton Drive South)
9:00 - 15:00	**SYMPOSIUM: DEVONIAN CONODONT BIOSTRATIGRAPHY**
9:00 - 9:20	CONSTRAINTS ON THE DEVONIAN STANDARD CONODONT ZONATION ***Pierre Bultynck***
9:20 - 9:50	GRAPHIC CORRELATION AS A REMEDY FOR BIOZONE'S DEFICIENCIES – APPLICATION TO FRASNIAN SUCCESSIONS FROM THE EASTERN ANTI-ATLAS (MOROCCO) (Keynote) ***Sofie Gouwy****, Pierre Bultynck*
9:50 - 10:00	Discussion
10:00 - 10:20	LATE LUDLOW AND PRÍDOLÍ GUIDE CONODONTS IN THE POZÁRY SECTION (CZECH REPUBLIC) AND THEIR CORRELATION *Peter Carls, Ladislav Slavík,* ***José I. Valenzuela-Ríos***
10:20 - 10:40	LOCHKOVIAN GUIDE CONODONTS IN THE POZÁRY SECTION (CZECH REPUBLIC) *Peter Carls, Ladislav Slavík,* ***José I. Valenzuela-Ríos***
10:40 - 11:10	Tea/Coffee and posters
11:10 - 11:30	CORRELATIONS OF SILURIAN – DEVONIAN SUCCESSIONS IN THE BALKAN TERRAIN, WESTERN BULGARIA ***Iliana Boncheva****, Valeri Sachanski*
11:30 - 11:50	A COMBINED CONODONT ZONATION FOR THE GIVETIAN (MIDDLE DEVONIAN) OF THE RADOM-LUBLIN AREA, SE POLAND ***Katarzyna Narkiewicz****, Pierre Bultynck*
11:50 - 12:10	LOWER DEVONIAN CONODONTS FROM OBEJO-VALSEQUILLO-PUEBLA DE LA REINA DOMAIN (OSSA-MORENA ZONE, SPAIN) ***José I. Valenzuela-Ríos****, Jau-Chyn Liao*
12:10 - 12:30	GIVETIAN AND EARLY FRASNIAN CONODONT BIOSTRATIGRAPHY FROM COMPTE (SPANISH CENTRAL PYRENEES), RECOGNITION OF THE STANDARD ZONATION ***Jau-Chyn Liao****, José I. Valenzuela-Ríos*
12:30 - 12:50	NEW MIDDLE GIVETIAN TO LOWER FRASNIAN CONODONT FAUNAS FROM THE TAFILALT (ANTI-ATLAS, SOUTHERN MOROCCO) *Zhor Sarah Aboussalam,* ***R. Thomas Becker***
12:50 - 14:00	Lunch
14:00 - 14:20	MULTIELEMENT RECONSTRUCTIONS OF *ANCYRODELLA* AND *MESOTAXIS* FROM THE VOROTA FORMATION (GIVETIAN-FRASNIAN, DEVONIAN) OF THE KOZHYM RIVER SECTION, SUB POLAR URALS, RUSSIA ***C. Giles Miller****, Alexandra B. (Yudina) Pannell*
14:20 - 14:40	UPPER DEVONIAN CONODONTS FROM BOLIVIA ***D. Jeffey Over****, Sarah de la Rue, Peter E. Isaacson*
14:40 - 15:00	A FAMENNIAN-TOURNAISIAN (LATE DEVONIAN-EARLY CARBONIFEROUS) REGIONAL CONODONT ZONATION IN SARDINIA (ITALY) ***Carlo Corradini***
15:00 - 18:15	**SYMPOSIUM: CONODONTS, PALAEOBIOGEOGRAPHY AND PALAEOCEANOGRAPHY**
15:00 - 15:45	INTERPRETING PAST OCEANOGRAPHIC, CLIMATIC AND TECTONIC CHANGES FROM CONODONT DATA (Keynote) ***Chris R. Barnes****, Shunxin Zhang, Julie A. Trotter, Leanne J. Pyle*
15:45 - 16:15	Tea/Coffee and posters
16:15 - 16:35	TWO CASE STUDIES ON EARLY PALAEOZOIC CLIMATE RECONSTRUCTIONS BASED ON δ^{18}O DATA FROM CONODONT APATITE: AN EARLY TO MID-ORDOVICIAN GREENHOUSE AND A LATE SILURIAN ICEHOUSE ***Oliver Lehnert****, Michael Joachimski, Werner Buggisch, Svend Stouge, Jiri Fryda, Lennart Jeppsson*
16:35 - 16:55	SEA-LEVEL CONTROL ON THE CONCENTRATION OF ORDOVICIAN CONODONTS FROM DEEP-WATER SILICICLASTIC SETTINGS ***Stephen A. Leslie****, Daniel Goldman, John E. Repetski, Jorg Maletz*
16:55 - 17:15	CONODONT BIOSTRATIGRAPHY AND BIOGEOGRAPHY OF ORDOVICIAN CHERTS FROM NEW SOUTH WALES, AUSTRALIA ***Ian G. Percival***
17:15 - 17:35	MIDDLE AND LATE ORDOVICIAN CONODONTS FROM THE LANGKAWI ISLANDS, PENINSULAR MALAYSIA ***Sachiko Agematsu****, Katsuo Sashida, Amnan B. Ibrahim*
17:35 - 17:55	CONODONT FAUNAS AND STABLE ISOTOPE CHEMOSTRATIGRAPHY ACROSS THE HOMERIAN (LATE WENLOCK; SILURIAN) MULDE SECUNDO-SECUNDO EVENT IN WEST TEXAS AND SOUTHERN OKLAHOMA, USA ***James E. Barrick****, Mark A. Kleffner, Haraldur R. Karlsson, Michael Kohl*
17:55 - 18:15	LATE DEVONIAN CONODONT ECOLOGY AND PALAEOBIOGEOGRAPHY: AN EXAMPLE FROM THE POMERANIAN BASIN, NW POLAND ***Hanna Matyja***
18:15	Bus back to Beaumont Hall (from Mayors Walk)
19:30	Dinner
20:30	**SDS Business meeting, Wedgewood Room, Beaumont Hall**

Wednesday, July 19

7:00	Excursions to NHM and North Staffordshire. Coaches depart 8:30 (from Stoughton Drive South), return at 18:30 (approx)
19:30	Dinner

Thursday, July 20

7:00	Breakfast
8:30	Bus departs Beaumont Hall (from Stoughton Drive South)
9:00 - 13:45	**SYMPOSIUM: TRIASSIC CONODONTS: TAXONOMY AND TIME SCALES** Sponsored by IGCP 467 - Triassic Time and trans-Panthalassan correlations
9:00 - 9:45	CONODONT DIVERSITY AND EVOLUTION THROUGH THE LATEST PERMIAN AND EARLY TRIASSIC UPHEAVALS (Keynote) ***Michael J. Orchard***
9:45 - 10:05	CONODONT ZONATION OF THE TRIASSIC BASEMENT OF THE ADRIATIC-DINARIC CARBONATE PLATFORM IN MT. SVILAJA (EXTERNAL DINARIDES, CROATIA) ***Tea Kolar-Jurkovšek****, Bogdan Jurkovšek, Marco Balini*
10:05 - 10:25	CONODONT APPARATUSES FROM THE *MESOGONDOLELLA-JINOGONDOLELLA* TRANSITION, CISURALIAN-GUADALUPIAN (PERMIAN) OF WEST TEXAS ***Lance L. Lambert****, Bruce R. Wardlaw*
10:25 - 10:45	PERMIAN–TRIASSIC BOUNDARY ENVIRONMENTAL AND BIOTIC CHANGES: THE BULLA PARASTRATOTYPE, ITALY *Enzo Farabegoli,* ***M. Cristina Perri****, Renato Posenato*
10:45 - 11:15	Tea/Coffee and posters
11:15 - 11:35	TAXONOMIC APPROACHES FOR LATE PERMIAN & EARLY TRIASSIC GONDOLELLID TAXA ***Charles M. Henderson***
11:35 - 11:55	AFTER THE PERMIAN EXTINCTION: THE LAST RISE OF THE CONODONTS ***Pablo Plasencia Camps****, Ana Márquez-Aliaga*
11:55 - 12:15	EARLY TRIASSIC (DIENERIAN) CONODONTS FROM NORTHERN THAILAND AND THEIR BEARING ON THE EVOLUTION OF MULTIELEMENT APPARATUSES ***Norman M. Savage****, Michael J. Orchard, Apsorn Sardsud, Petra Lutat*
12:15 - 12:35	TETHYAN LOWER TRIASSIC INTEGRATED HIGH-RESOLUTION AMMONOID-CONODONT CORRELATION AND RADIATION EVENTS ***Leopold Krystyn****, Michael J. Orchard*
12:35 - 12:55	A NEW EARLY SPATHIAN (EARLY TRIASSIC) CONODONT SUCCESSION FROM NORTH AMERICA ***Nicolas Goudemand****, Michael J. Orchard, Guobiao Li, Thomas Galfetti, Hugo Bucher*
12:55 - 13:15	SEPHARDIELLINAE, A NEW GONDONELLIDAE SUBFAMILY FROM THE MIDDLE TRIASSIC ***Pablo Plasencia Camps****, Francis Hirsch, Ana Márquez-Aliaga*
13:15 - 14:15	Lunch
14:15 - 16:00	**SYMPOSIUM: CONODONT PHYLOGENIES - ALTERNATIVE APPROACHES, IMPLICATIONS, AND APPLICATIONS**
14:15 - 15:00	THE INTERRELATIONSHIPS OF ‘COMPLEX’ CONODONTS (Keynote) ***Philip C. J. Donoghue****, Mark A. Purnell, Richard J. Aldridge, Shunxin Zhang*
15:00 - 15:20	*OULODUS* – HOMOLOGY, CLADISTIC ANALYSIS AND EVOLUTIONARY RELATIONSHIPS ***Linda M. Wickstrom***
15:20 - 15:40	THE APPARATUS ARCHITECTURE OF *ERISMODUS QUADRIDACTYLUS* (STAUFFER) AND ITS IMPLICATIONS FOR THE EVOLUTIONARY RELATIONSHIPS OF THE PRIONIODINIDA ***Rosie Dhanda****, John E. Repetski, M. Paul Smith, P.C.J. Donoghue*
15:40 - 16:00	NEW CONDONT DATA ACROSS THE P/T BOUNDARY IN SOUTH CHINA ***Xulong Lai****, Haishui Jiang, Genming Luo, Yadong Sun*
16:00 - 16:30	Tea/Coffee and posters
16:30 - 16:50	ORDOVICIAN CONODONTS IN PELAGIC TROPHIC WEBS: ASPECTS OF BEHAVIOUR AND PREDATION STRATEGIES ***Tatiana Tolmacheva***
16:50 - 17:10	MICROWEAR ON CONODONTS AND FISH TEETH AS A PALAEOECOLOGICAL TOOL ***Mark Purnell***
17:10 - 17:30	PRESERVATION OF CONODONTS TRAVELING THROUGH THE ALIMENTARY CANAL OF MODERN FISH *James J. Helms,* ***D. Jeffrey Over***
17:30 - 17:50	Bus back to Beaumont Hall (from Mayors Walk)
18:40	Coaches depart Beaumont Hall (from Stoughton Drive South) for Coombe Abbey
19:20	**Banquet** (return to Beaumont Hall around midnight)

Friday, July 21

7:00	Breakfast
8:30	Bus departs Beaumont Hall (from Stoughton Drive South)
9:00 - 9:20	ENVIRONMENTAL CONTROLS ON THE COMPOSITION AND DISTRIBUTION OF EXCEPTIONALLY-PRESERVED CONODONTS AND OTHER VERTEBRATES IN THE ERAMOSA LAGERSTÄTTE, BRUCE PENINSULA, ONTARIO, CANADA ***Peter H. von Bitter***, *Mark A. Purnell, Christopher A. Stott*
9:20 - 9:40	ELEMENTAL VARIATION WITHIN CONODONT TEETH: IMPLICATIONS FOR FUNCTION ***Erik C. Katvala***, *Charles M. Henderson*
9:40 - 10:00	THE MUSCULAR SYSTEM OF EUCONODONTS *Alla P. Kasatkina*, ***Galina I. Buryi***
10:00 - 10:20	DEVONIAN-CARBONIFEROUS CONODONT FAUNA FROM OCEANIC RADIOLARITES IN NORTHERN THAILAND ***Carine Randon***
10:20 - 10:40	A MULTIDISCIPLINARY APPROACH TO UNTANGLE THE HANGENBERG MASS EXTINCTION EVENT AT THE DEVONIAN/CARBONIFEROUS BOUNDARY ***Sandra I. Kaiser***, *Thomas Steuber, R.Thomas Becker*
10:40 - 11:00	MAKING SENSE OF CONODONT MORPHOLOGY: A NEW MORPHOMETRIC APPROACH ***David Jones***, *Mark A. Purnell*
11:00 - 11:30	Tea/Coffee and posters
11:30 - 12:00	**PANDER SOCIETY BUSINESS MEETING**
12:00 - 13:00	Lunch
13:00 - 14:00	Palaeobiology Workshop, session 1 (Sylvester Bradley Room), or posters
14:00 - 15:00	Palaeobiology Workshop, session 2 (Sylvester Bradley Room), or posters
15:00	Bus back to Beaumont Hall (from Mayors Walk)
15:30	Iapetus Excursion departs from Beaumont Hall car park

NEW MIDDLE GIVETIAN TO LOWER FRASNIAN CONODONT FAUNAS FROM THE TAFILALT (ANTI-ATLAS, SOUTHERN MOROCCO)

Zhor Sarah Aboussalam and R. Thomas Becker
Institute of Geology & Palaeontology, Westfälische Wilhelms-University, Münster, Germany

Givetian and Frasnian conodont faunas from the Tafilalt have been described in papers by P. Bultynck and co-authors but previous studies concentrated on a limited number of sections. Aboussalam (2003) investigated platform and basinal sections around the latest Middle Givetian Taghanic Event, revised the zonation, and described new and rare forms. Field work continued the sampling with a focus on latest Givetian to basal Frasnian beds. Faunas include new taxa, first regional or youngest records, and contribute to the refinement of the zonation. Some rare species enable correlation into neritic facies.

The upper part of the *ansatus* Zone surprisingly yielded youngest *Bipennatus*, normally a genus of more shallow facies, accompanied by an unusual *Tortodus* with a bifurcate posterior end. The *semialternans* Zone cannot be recognized in the western Tafilalt Platform. The *hermanni* and *cristatus ectypus* Zone are always condensed but have diverse faunas, including a new *Schmidtognathus* with an incipient side-lobe. The *disparilis* Zone is frequently found in the "Lower Marker Bed". The revised *dengleri* Zone can be subdivided into two subzones, based on the successive entry of *Po. dengleri* morphotypes/subspecies with subtriangular or rounded, leaf-shaped platform. A polygnathid radiation (*webbi*, *collieri*, *angustidiscus*, various new forms) characterizes the upper subzone and "Upper Marker Bed". The overlying Petteroceras Beds fall in the *norrisi* Zone but the zonal marker and *Mesotaxis falsiovalis* are rare. Instead, the first *Po. pseudoxylus* and some new polygnathids are found. The basalmost Frasnian *rotundiloba pristina* Zone is only preserved at Bine Jebilet, where it yields *Po. brevilaminus incompletus*, a second new *Tortodus*, and advanced subspecies of *Po. cristatus*. The styliolinites of the Frasne Event are difficult to date but the section at Mdoura-East provided ancyrodellids of the *rotundiloba soluta* Zone. This requires a revision of the correlation of the basal Frasnian hypoxic phase.

Presentation format: Talk *Day and time:* Tuesday, 12:30

MIDDLE AND LATE ORDOVICIAN CONODONTS FROM THE LANGKAWI ISLANDS, PENINSULAR MALAYSIA

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Twenty-three species representing 16 genera of Middle and Late Ordovician conodonts have been discovered from the Langkawi Islands, northwestern peninsular Malaysia. Four conodont biostratigraphic zones are established; the *Drepanoistodus costatus* range zone, the *Panderodus nogamii* interval zone, the *Baltoniodus* sp. cf. *B. variabilis* range zone, and the *Hamarodus europaeus* range zone, in ascending order. Faunas from these zones include zonal index species of neither the North Atlantic nor North American Midcontinent faunal schemes. However, occurrences of several species with relatively short stratigraphic ranges suggest that these zones can be correlated with faunas from Australia and South China. The *D. costatus* and *P. nogamii* zones correspond to the Tabita Formation in New South Wales and the Goldwyer Formation in the Canning Basin, Australia, respectively. The *B.* sp. cf. *B. variabilis* and *H. europaeus* zones are correlated with the *B. variabilis* and the *H. europaeus* zones in the biostratigraphic succession of South China, respectively. Faunas from the *D. costatus* and *P. nogamii* zones consist of cosmopolitan species and endemic species of the Australian or Gondwanan Province, for example *Aurilobodus leptosomatus*, *Triangulodus larapintinensis*, and *P. nogamii*. On the other hand, most of the species occurring in the *B.* sp. cf. *B. variabilis* and *H. europaeus* zones are common in the North Atlantic areas, the North American deeper-water areas, Australia, and South China. High frequencies of *Scabbardella altipes*, *H. europaeus*, *Dapsilodus mutatus,* and *Protopanderodus liripipus* in the fauna from the *H. europaeus* zone suggest that the fauna has an affinity with the *Hamarodus europaeus- Dapsilodus mutatus- Scabbardella altipes* Biofacies, which is widely known from the Baltic, British, and Mediterranean areas and South China.

Presentation format: Talk *Day and time:* Tuesday, 17:15

PERMIAN-TRIASSIC MIXED CONODONT FAUNA FROM THE NABEYAMA LIMESTONE IN THE ASHIO TERRANE, CENTRAL JAPAN

Sachiko Agematsu and Katsuo Sashida
University of Tsukuba, Ibaraki, Japan

A mixed conodont fauna, consisting of Early Permian to Late Triassic species, has been recovered from the Nabeyama Limestone, distributed in the Kuzuu area, Ashio Terrane, central Japan. The Nabeyama Limestone is generally interpreted as shallow-marine carbonates, deposited on a seamount during Middle Permian in the Panthalassa Ocean. The upper part of the Nabeyama Limestone is brecciated and characterized by poorly sorted and rounded limestone clasts, whose diameter attains approximately 3 metres, and a block of laminated limestone, whose thickness and length range from 10 cm to 1.5 m and from 30 cm to 2 m, respectively. Strikes and dips of the laminated limestone are randomly oriented. The laminated limestone is composed of silt- to granule-sized limestone clasts with variable sorting and roundness. The conodont fauna is represented by Early to Late Permian and Early to Late Triassic species such as *Diplognathus* sp. cf. *D. nodosus*, *Anchignathodus* sp. cf. *A. minutus, Neospathodus* sp. cf. *N. symmetricus, Neogondolella bulgarica*, *Neogondolella excelsa*, *Gladigondolella tethydis*, *Neogondolella polygnathiformis*, *Epigondolella quadrata*, *Epigondolella postera*, and *Misikella posthernsteini*. The Nabeyama Limestone is considered to be the host rock of these Middle Permian conodonts. The Early and Late Permian and Early to Late Triassic conodonts are thought to have been washed out from a missing succession, which has most likely existed under and over the Nabeyama Limestone, and re-accumulated in the laminated limestone. On the basis of ages of the mixed conodont fauna and Middle Jurassic Bajocian to Bathonian radiolarian-bearing siliceous shale that discomformably overlies the Nabeyama Limestone, the Lower and Upper Permian and Lower to Upper Triassic limestone successions have been completely lost during Rhaetian (latest Triassic) to Aalenian (Middle Jurassic).

Presentation format: Poster

PANDER AND THE PHYLOGENETIC POSITION OF THE CONODONTS – THEN AND NOW

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Christian Pander was the first to document conodont elements, in his *Monographie der Fossilen Fische des Silurischen Systems der Russisch-Baltischen Gouvernements*, 1856. As well as describing specimens from a wide range of Palaeozoic strata, Pander also addressed the possible affinities of the elements, and, recognising that their composition was the same as that of the remains of associated fishes, interpreted them as the teeth of an otherwise unknown fish group. He particularly made comparisons with the cyclostomes and squalids, noting, however, that conodonts had histological characteristics that were unique. He expressed no hope of finding any other solid parts from the same animals and concluded that their classification would stay precarious and arbitrary.

Over the next 125 years, the nature of conodonts remained enigmatic, but a breakthrough came in 1982, with the chance discovery by Euan Clarkson of a Carboniferous conodont with preserved soft tissues. This specimen allowed conodont anatomy to be investigated and interpreted for the first time. Although Clarkson initially considered the specimen to be a lamprey, the possibility of affinities with chaetognaths was also addressed, and the conodonts were provisionally retained in their own phylum. Further discoveries from Scotland and from the Ordovician of South Africa, however, revealed more about the anatomy of conodonts and provided characters for cladisitc anlayses. On present evidence the most parsimonious phylogenetic position for the conodonts is within the vertebrates, as primitive stem-group gnathostomes more derived than the hagfishes and lampreys.

Debate still continues about the precise phylogenetic position and function of conodonts, but is now much more tightly constrained. The current hypotheses demonstrate that, on the limited evidence available to him, Pander was remarkably prescient. The conodonts do, indeed, appear to be ‘fishes’ and their elements do appear to have functioned as teeth, albeit in the absence of jaws.

Presentation format: Keynote talk *Day and time:* Monday, 11:50

DEVELOPMENTAL DISPARITY AND ECOSPACE OCCUPATION IN THE STEM GNATHOSTOME *PANDERODUS* (ETHINGTON: CONODONTA)

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Histological and biometric analyses indicate that *Panderodus* had a form of growth apparently unique within euconodonts. During the first phase a proto-element grew that was morphologically identical to the mature element. A second phase resulted in the eruption of the proto-element by the addition of lamellae around the base of the element. Element growth continued whilst functioning, only ceasing at maturity or death, and was therefore indeterminate; the enamel organ remained functional until this point.

The appearance of *Panderodus* in the epipelagic zone, with this key developmental innovation, coincided with environmental changes during the Darriwilian (Ordovician, ~468 Ma) transgression. Such a coincidence is predicted by the hypothesis that developmental and consequent morphological innovations depend on new ecological opportunities at a particular point in time for survival and persistence.

Presentation format: Talk *Day and time:* Monday, 15:25

INTERPRETING PAST OCEANOGRAPHIC, CLIMATIC AND TECTONIC CHANGES FROM CONODONT DATA

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Ancient oceanographic, climatic and tectonic changes can be deduced by utilizing comprehensive global conodont data and preserved isotope/geochemical signatures (e.g. Sr, Nd, O, Mg/Ca). Early Palaeozoic examples are discussed when the climate, oceanography and palaeogeography were significantly different from today. Although many specific conditions/systems need additional quantification and modelling, prevailing oceanographic and related conditions in that interval included: 1. Significantly lower oxygen levels in the coupled ocean-atmosphere system, probably about 50 percent present atmospheric level (PAL). 2. Greenhouse climate state with high carbon dioxide levels of 14-18x PAL, reduced by half during the Caradocian-latest Llandovery glacial phases and mass extinction. 3. Sluggish surface and deep ocean circulation and periodic widespread anoxia, produced by the overall greenhouse state; circulation was driven more by mid-latitude evaporation and subduction of higher salinity waters than by the high-latitude thermohaline circulation pattern of today that characterized the Ashgillian. 4. Periods of extreme eustatic highstand, the largest in the Phanerozoic, occurred during the Caradocian. Epeiric seas existed for long periods and high salinities produced localised evaporites in lower latitudes. 5. Periods of increased volcanicity, notably vast outpourings of ash. The most extensive bentonites in the Phanerozoic occur in Laurentia, Baltica, and the Argentine Precordillera terrane and may have been an important factor in surface ocean fertilization. 6. A mantle superplume that probably developed in the late Middle Ordovician would have increased temperature and modified deep ocean circulation and nutrient flux, probably contributing to enhanced volcanism. 7. Palaeoceanographic conditions/changes were probably directly responsible for ecologic partitioning of conodont communities and fostering new trophic structures. In particular, such conditions may have controlled the emergence of the Palaeozoic Evolutionary Fauna, replacing the Cambrian Evolutionary Fauna during the Early Ordovician, with a threefold increase in diversity, representing one of the most profound Phanerozoic biotic changes and reflected in conodont evolutionary development.

Presentation format: Keynote talk *Day and time:* Tuesday, 15:00

CONODONT FAUNAS AND STABLE ISOTOPE CHEMOSTRATIGRAPHY ACROSS THE HOMERIAN (LATE WENLOCK; SILURIAN) MULDE SECUNDO-SECUNDO EVENT IN WEST TEXAS AND SOUTHERN OKLAHOMA, USA

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The Mulde Event marks a level of major extinctions among graptolites, an abrupt shift in composition of conodont faunas, and a positive $\delta^{13}C$ excursion. At the same time, a sea-level event effected major facies shifts on the carbonate platform in Gotland. Although the Mulde Event is a global oceanic event, most of the details of the Mulde Event are known from Baltica (Gotland) and adjacent areas. The Wenlock carbonate ramp along the southwestern margin of Laurentia lay thousands of kilometers from Baltica and in a different position relative to global oceanic circulation, making it an ideal location to evaluate the global effects of the Mulde Event in carbonate facies.

The Wink Formation (west Texas) and Clarita Formation (southern Oklahoma) comprise carbonate mudstones to wackestones deposited in a distal carbonate ramp setting on southwestern Laurentia during the Wenlock. Each section studied preserves slightly different details of the Mulde Event, generalized here. Conodont faunas at all levels are dominated by species of *Dapsilodus*. The pre-Mulde fauna is characterized by common *D. praecipuus* and *Panderodus unicostatus*, with *Kockelella ortus, Pseudooneotodus lingulicornis, P. “recurvatus,”* and *D. sparsus*. In most sections, a discontinuity surface terminates the pre-Mulde fauna. The fauna immediately above it includes common *P. equicostatus, Belodella silurica*, and *Decoriconus fragilis*. *Ozarkodina bohemica longa* and *K. absidata* appear less than a meter higher. A $\delta^{13}C$ excursion crosses the discontinuity surface, forming a gentle curve going from a pre-Mulde low of +1 to a peak near +2.5 above the discontinuity surface, before falling below +2. The presence of the Mulde Event as an abrupt shift in conodont faunas, a positive $\delta^{13}C$ excursion, and a depositional break is confirmed for southwestern Laurentia, but many details of the Mulde Event described from Baltica and other areas have not been recognized.

Presentation format: Talk *Day and time:* Tuesday, 17:35

LOWER-MIDDLE DEVONIAN CONODONT BIOSTRATIGRAPHY OF THE RABAT-TIFLET AREA (NORTHWESTERN MOROCCAN MESETA)

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The Rabat-Tiflet area constitutes the most northern part of the Central Moroccan Meseta and extends from west to east for some 50 kilometres. The Lower-Middle Devonian succession consists mainly of carbonate rocks and shales with development of biostromal or reef structures in the lower part of the Givetian.

Conodont faunas are generally sparse (10-20 specimens/kg), although conodont elements can be extremely abundant at some levels, e.g. *Belodella* in the Lower Devonian (several thousands/kg). The presence of zonal index species is rare and the specimens are few in number. Consequently many “standard” conodont zones cannot be directly recognized and the positioning of the base of zones has to be considered as approximate.

In the Lower Devonian the *sulcatus*, *pireneae*, *dehiscens* and *inversus* (upper part with *Polygnathus laticostatus*) zones have been identified by the index species. This is also the case for the Eifelian *partitus* and *ensensis* (= lower part of former *ensensis* Zone) zones. The lower part of the Givetian shows the succession of the defining species of the *hemiansatus*, *timorensis* and *rhenanus*/*varcus* zones. The two last mentioned zones correspond to the former Lower *varcus* Zone.

Presentation format: Poster

RECONSTRUCTION OF THE APPARATUS OF *BELODELLA* (CONODONTA) FROM THE LOWER AND MIDDLE DEVONIAN OF THE RABAT-OUED AKRECH AREA (NORTHWESTERN MESETA, MOROCCO)

El Mostafa Benfrika
Université Hassan II- Mohammedia, Casablanca, Morocco

Among Silurian and Devonian conodonts from the Northwestern Meseta of Morocco, specimens of species of *Belodella*, such as *Belodella devonica* are very common, especially in Lower Devonian strata. This paper concerns only the systematics of the genus *Belodella*. 25 limestone samples were examined; and more than 1084 elements of *Belodella* were studied.

In order to propose a reconstruction of the *Belodella* apparatus from the Lower and Middle Devonian of this region (southeast of Rabat), we addressed several aspects, including:

- morphological study of all elements observed;
- statistical study and construction of graphs showing the variation of the various elements by samples;
- Jaccard coefficient study.

Thus, we recognized that the *Belodella* apparatus consists of at least 12 pairs of elements, which can be grouped into 5 principal kinds. The apparatus shows a transition series of very curved to straight elements. The M element is adenticulate. The other elements (Sa, Sb, Sc and Sd) bear numerous fine denticles on their posterior margins. These S elements are distinguished by their cross sections, which constitute a transition series, from triangular, subtriangular to lenticular cross section.

In addition, comparison of the various kinds of cross sections by calculation of the Jaccard coefficient, always gave results higher than 0.5. This result seems to confirm that the various forms observed belong to the same apparatus. From Sa to Sc elements, the cross sections become narrower and the elements become higher. Each kind of cross section is represented by 3 elements (very curved, weakly curved and straight).

Presentation format: Poster

THE CLASSICAL CONODONT WORK BY BRANSON & MEHL (1933) REVISITED: REDISCOVERY OF THEIR OZORA, MISSOURI KEY LOCALITY AND THE MORPHOLOGY OF THE ZONE INDEX *AMORPHOGNATHUS ORDOVICICUS*

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Upper Ordovician conodonts remained largely unknown until the late 1920s when Branson and Mehl initiated their classic investigations of Palaeozoic conodont faunas from Missouri. Their investigations were based exclusively on shale and sandstone samples that were disintegrated using washing and boiling techniques. The conodonts from the Maquoketa-Thebes formations (Branson and Mehl, 1933) represent the first diverse Upper Ordovician conodont fauna described. Several of their new species are now known to be widespread geographically and important biostratigraphically. Specimens were adequately described and illustrated in the original publication. However, aspects of their morphology and multielement taxonomy have remained unclear, and their bulk collections appear to be lost. Repeated attempts since the 1950s by several conodont workers to obtain topotype specimens from their most important Maquoketa-Thebes locality, a small quarry near Ozora, were unsuccessful until 2003 when we located the inconspicuous quarry. Branson and Mehl's specimens came from the basalmost 2-3 cm of the Maquoketa Shale, which rests in sharp contact on the underlying Thebes Formation. This basal interval appears to be a condensation deposit containing redeposited sand from the underlying Thebes and is the initial deposit of the Maquoketa transgression. Our collection of several hundred, mostly broken, elements contains at least 14 multielement species belonging to 13 genera. It contains topotypes of most of Branson and Mehl's 10 new single element species (including *Amorphognathus ordovicicus*, *Belodina diminutiva*, *B. ornata*, *Dapsilodus? mutatus*, *Protopanderodus insculptus*, and *Plectodina mirus*). Of significance is the recovery of several M elements of the important index species *Amorphognathus ordovicicus* which were previously unknown from Ozora. All these elements have a single cusp and agree with most recent suggestions of the appearance of this diagnostic element. In our Ozora collections there are eight multielement species not recorded by Branson and Mehl, including *Icriodella superba*, *Phragmodus undatus*, *Plectodina florida* and *P. tenuis*.

Presentation format: Poster

VARISCAN THERMAL CONDITIONS OF THE NORTH-EASTERN PONGA UNIT (CANTABRIAN ZONE, NW SPAIN)

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In the eastern part of the Cantabrian Zone, the north-eastern sector of the Ponga unit overthrusts the Picos de Europa unit to the south. The Variscan structure is formed by a south-directed imbricate system, whose thrusts converge towards a basal one. The thrusts gave rise to a multiple repetition of the Carboniferous succession, mainly consisting of Carboniferous limestones and shales. The structure was modified by the Alpine deformation that produced faults and the reactivation of some thrusts. Samples for conodonts from more than one hundred localities were collected in the study area to obtain Conodont Colour Alteration Index (CAI) data. In addition, several samples were collected to obtain the Kübler Index (KI) of illite. 70% of the samples yielded conodonts and all CAI values (CAI 1-2, and exceptionally CAI 2-3) indicate diacaizonal conditions. The KI values are diagenetic and they agree with CAI data. These conditions agree with the tectonothermal model proposed for the Picos de Europa unit. A late Carboniferous to early Permian metamorphism reached anchizonal conditions near the southernmost boundary of the Picos de Europa unit. The CAI values decrease northwards through the Picos de Europa and Ponga units. The lack of apparent discontinuities in the CAI values indicates small displacements along the Alpine faults. CAI dispersion is low, except for one locality. Many conodonts are bleached and have a sugary texture with dull and corroded surfaces. The textural characters of the conodonts and the local anomaly could be the result of hydrothermal processes forming mineralizations and dolomitizations, taking advantage of the dense fracturing in the area. Hydrothermal fluids would have migrated through late Variscan fractures during Permian extensional episodes.

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Presentation format: Poster

CORRELATIONS OF SILURIAN – DEVONIAN SUCCESSIONS IN THE BALKAN TERRAIN, WESTERN BULGARIA

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The position of the Balkan Terrain during Early Palaeozoic time is related to Peri-Gondwana since its accretion to Laurussia in late Palaeozoic time. The Balkan Terrain in Bulgaria incorporates Neoproterozoic and Palaeozoic sequences. Within the Balkan Terrain, two distinct areas of specific stratigraphical and sedimentological development can be recognised: the Western Balkanides and the Kraishte Region. There are signifincant differences between Silurian and Devonian sediments and facies in the Balkan Terrain but in both the Western Balkanides and the Kraiste Region, there was continuous deposition.

In the Western Balkanides, a coeval section of Silurian and Lower Devonian age is represented by deep marine graptolitic shales accumulated in basinal environments. Following a continuous transition from the Ordovician, the Silurian represents a pelagic pelitic succession of lydites, black graptolitic shales and laminated shales-siltstones, dated using graptolites. The succession of graptolite zones demonstrates a complete Silurian section and transitional sedimentation across the Silurian-Devonian boundary. The Devonian represents a succession of shales and siltstones with scarce tentaculites, graptolites and chitinozoans (Lower and Middle Devonian)

The oldest Palaeozoic sedimentary rocks in the Kraishte Region are Silurian black shales. The age, based on graptolites, is Wenlock to Ludlow. From the Late Ludlow carbonate sedimentation is developed in the Western and Central Kraishte, and this continues into the Givetian. Common features of the Lower Devonian sedimentation are the non-rhythmic distribution of limestones and argillites, the dominant presence of argillites, and the subordinated position of limestones. Recognition of a total of nine conodont zones through the Lochkovian, Pragian and Emsian/Eifelian shows a complete Lower Devonian succession. Tentaculites, crinoids, orthoceras, and bryozoans have also been found. Both areas were accumulating siliciclastic sediments during the Middle Devonian. The development of flysch sedimentation in a progressively subsiding basin occurred from late Devonian to probably Visean. Age determination is based on macroflora and on conodonts.

Presentation format: Talk *Day and time:* Tuesday, 11:10

PERMO-CARBONIFEROUS CARBONATE PLATFORM SEDIMENTATION IN IRAN (ASADABAD SECTION, SE ISFAHAN, RAMSHEH AREA)

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During the Palaeozoic, Iran was situated on the northern margin of Gondwana. The main Palaeozoic sequences occur in the eastern and central part of the country. An area in Central Iran (Ramsheh, SE Isfahan) contains the Asadabad section, one of the most complete sequences across Lower Carboniferous - Upper Carboniferous boundary interval, providing detailed information about the environment during the Carboniferous and into the Permian. Concerning the Upper Carboniferous conodont fauna, Pennsylvanian associations are relatively well represented in the section and reflect a shallow, subtidal shelf environment (the Early Carboniferous of the area was characterised by similar environments). The carbonates display features of reef deposition and are very rich in corals, brachiopods, bivalves and foraminifers, especially in the upper part of the sequence. High energetic and near shore sediments, such as oolitic and oncolitic sediments or oncolitic sandy limestones, are present at the base of Permian. Terrestrial to near shore beds of lowermost Permian age have also been traced in the area. *Streptognathodus expansus* Igo & Koike was recoverd from just below the base of Permian, and based on an assignment to the *elongatus* zone, the eroded surface in the area is determined to span the Stephanian to late-Middle Permian interval. Permian conodonts *Clarkina altudaensis* Kozur and *Clarkina changxingensis* Wang & Wang, ranging from the Guadalupian to the Lopingian stage (Middle to Late Permian) provide evidence of a formerly widespread marine sedimentary wedge during the Carboniferous *and* Permian, with a carbonate platform extending over much of Central Iran. In Pakistan and Afghanistan, however, the onset of carbonate platform deposition was late Frasnian-Tournaisian and terminated in late Permian, in contrast to the other Terrains situated west of the Arabian platform, where flysch sediments were being deposited at that time. Carboniferous goniatites and conodonts are reported from Ramsheh area, Iran for the first time, the latter allowing recognition of nine conodont zones.

Presentation format: Poster

CONSTRAINTS ON THE DEVONIAN STANDARD CONODONT ZONATION

Pierre Bultynck
Royal Belgian Institute of Natural Sciences

In the 1994 edition of the IUGS International Stratigraphic Guide, “standard zone “ is mentioned as a term with limited or no acceptance. In Devonian biostratigraphy standard zones and zonations are used by ammonoid workers (e.g. Becker & House 2000) and conodont workers (e.g. Ziegler & Sandberg 1990, Upper Devonian). From these papers it is clear that a standard zonation implies that it can be applied worldwide because of the pelagic habitat of the index-species. However, there is no unanimity about the methods to establish standard zonations and the palaeogeographic dispersal potential of the index-species.

Here, I question whether the Frasnian Standard Conodont Zonation based on a phylogenetic succession of species of the pelagic genera *Mesotaxis*, *Palmatolepis* and *Siphonodella* is the best tool for worldwide correlation. My opinion is supported by current Frasnian conodont zonations which are partly or completely different from one another.

An international reference scale should be conceived as a synthesis of well established and documented conodont successions from key areas representing a variety of facies. This implies that the zones should have a high correlation potential. The base of the zones should be defined in reference sections, the lowest occurrence of the index-species should be documented by figured specimens and their taxonomy should not be a matter of opinion. From a pragmatic point of view it is necessary that data from different facies have been analysed. Graphic correlation is likely the most objective, unbiased method to construct such an international Devonian conodont reference scale. Much graphic correlation work based on sections in different parts of the world has been realized and is being developed for the Middle Devonian. A disadvantage may be the nameless numerical scale of the Standard Composite, hampering easy communication during direct discussions and frightening the uninitiated.

Presentation format: Talk *Day and time:* Tuesday, 9:00

ROUNDED PHOSPHATIC STRUCTURES (H ELEMENTS) OF EUCONODONTS

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We present a morphological analysis of the rounded structures in the head part of euconodont imprints from the Carboniferous deposits of Granton (Scotland), and the Ordovician Soom Shale (South Africa), and of the rounded phosphatic structures present as isolated remains in Upper Silurian and Upper Devonian deposits of Germany and Lower Triassic deposits of Primorsk. Terr. (Russia). The close similarlity of these structures, in terms of morphology and ontogenetic stage, testifies that all of them belong to euconodonts. The rounded head structures of euconodonts, or H elements (Buryi and Kasatkina, 2001), appear to be analogous to the skeletal attaching plates of Chaetognatha. They were arranged in pairs in the anterior part of head in front of the tooth apparatus, symmetrically disposed with respect to the sagittal plane of the euconodont. Their surface was completely coated with a soft connective-muscular tissue, like a cap. The H skeletal elements are part of the mouth assemblage of euconodont animals, along with the pharynx, P, M, and S elements of the tooth apparatus, and muscles (connective-muscular tissue). The presence of skeletal attaching plates (H elements) in euconodonts is responsible for the unique structure of the head part and of the whole animal (the euconodont mouth is arranged along the sagittal axis between the H elements). This supports recognition of these animals as a separate type, Euconodontophylea (Kasatkina and Buryi 1997).

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Presentation format: Poster

LATE LUDLOW AND PRÍDOLÍ GUIDE CONODONTS IN THE POZÁRY SECTION (CZECH REPUBLIC) AND THEIR CORRELATION

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The Pozáry section SW of Prague comprises the Prídolí GSSP and type section (40 m). Entries and ranges of its late Ludlow and Prídolí conodonts enable correlations relevant for a revision of the conodont biozonation. (Taxa in open nomenclature are ready for publication). Records begin 9 m below the GSSP with *Pedavis latialatus* and *Parazieglerodina plodowskii* with incipient alternation of denticle sizes in ramiforms. Within the *latialatus* Zone, "*Ozarkodina*" *snajdri* s.s. enters; after a transition "*Oz.*" *crispa* follows (just above *P. latialatus*) 3 m below the GSSP. In the first Prídolí bed *Zieglerodina*? sp. Z correlates with the base of the Estonian Äigu Fm., where it had been considered to mark the *eosteinhornensis* Zone. 14.5 m above the GSSP *Delotaxis elegans detorta* and *Zieglerodina*? sp. I enter below the *eosteinhornensis* Zone s.s.; their association in a Nordic glacial erratic indicates similarly old age. In the Elbersreuth Orthoceratid Limestone *D. e. detorta* enters also before the *eosteinhornensis* Zone. At 16.9 m the index species, genus W *eosteinhornensis* s. s., enters; it ends 4.7 m below the S/D boundary. At Elbersreuth, at its entry there is *Amydrotaxis*? cf. *praecox*, a species which in Baltic sections occurs only in the youngest beds; reports of the index *eosteinhornensis* do not apply. Baltic conodont successions end before or at the beginning of the *eosteinhornensis* Zone. About 13 m below the Devonian, *Zieglerodina* sp. K (= *Ozarkodina* "*remscheidensis* (Ziegler 1960) *sensu* nov." of Jeppsson (1989)) enters and fades toward the S/D boundary. In the Pozáry and Elbersreuth sections, accessory species of *Ozarkodina* s. s. occur. The first conodont suggesting Devonian age is *Icriodus hesperius*, 0.5 m above last *D. e. detorta* and 1.8 m below Devonian *Warburgella*.

This work has been partially supported by the AvH Foundation and represents a contribution to the IGCP 499 (Devonian land-sea interactions: evolution of Ecosystems and climate).

Presentation format: Talk *Day and time:* Tuesday, 10:00

LOCHKOVIAN GUIDE CONODONTS IN THE POZÁRY SECTION (CZECH REPUBLIC)

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In the Pozáry section SW of Prague, about 80 m of Lochkovian limestones were sampled for early and middle Lochkovian conodonts. The Silurian-Devonian boundary is inferred 0.5 m above *Delotaxis elegans detorta*, because *Icriodus hesperius* enters as the first possibly Devonian conodont and is used as reference datum, about 1.8 m below *Warburgella rugulosa*. 1.25 m above, *Zieglerodina remscheidensis* s.s. enters; here the *Icr. woschmidti* group radiates toward *Icr. transiens* and *Icr. angustoides*. *Icr. woschmidti* s.s. appears at 10.7 m as a side branch and *Del. cristagalli* suggests correlation with the type stratum of *Icr. woschmidti*.

At about 9 m, Pa elements resembling "*Ozarkodina*" *optima* begin, but ramiform elements differ in having only few intercalated small denticles. At 23-24 m, there are primitive *Lanea*, *Wurmiella* aff. *wurmi*, and *Pedavis breviramus*. *Ped. breviramus* overlaps with sporadic *Ancyrodelloides* aff. *asymmetricus* at 27-28 m and then fades. From 35 m to 41 m *Anc. carlsi* is frequent; it ends beside "*Ozarkodina*" *boucoti* and first embryonal bulbs of Dacryoconarida. *Anc. carlsi* occurs just below the *Acastella tiro* Zone in the Celtiberian type stratum of *Icr. transiens*, *Icr. bidentatus* and *Icr. Rectangularis,* through the *postwoschmidti* Zone, whereas the Podolian namegiving index conodont begins in the early radiation during the *Acastella heberti* Zone. At 56 m, *Anc. transitans enters*; at 63 m its transition to *Anc. trigonicus* begins; near 66 m *Anc. trigonicus* and *Anc. kutscheri* join with the youngest morph of *Pelekysgnathus elongatus*, indicating late *Acastella tiro* Zone. Near 70 m, *Anc. transitans* still indicates Middle Lochkovian. Hardly 10 m thickness remains for the Late Lochkovian.

This work has been partially supported by the Alexander von Humboldt Foundation and represents a contribution to the IGCP 499 (Devonian land-sea interactions: evolution of Ecosystems and climate).

Presentation format: Talk *Day and time:* Tuesday, 10:20

A FAMENNIAN-TOURNAISIAN (LATE DEVONIAN-EARLY CARBONIFEROUS) REGIONAL CONODONT ZONATION IN SARDINIA (ITALY)

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The calcareous sediments of Late Devonian – Early Carboniferous age of south-eastern Sardinia are mainly represented by grey massive limestones known as “Calcari a Clymeniae” (= “Clymeniae Limestone”) because of the occurrence of ammonoids in some levels. The unit is not yet formally defined. Ammonoids, apart from crinoid stems, are the only abundant macrofossils; they seem to be concentrated at specific levels. Very rare brachiopods and fish teeth have been reported from the heavy fraction obtained in acid-leaching. The microfacies is always represented by “poorly fossiliferous micrite”.

More than 130 conodont taxa (species, subspecies and morphotypes) belonging to 14 genera (*Alternognathus*, *Ancyrognathus*, *Bispathodus*, *Branmehla*, *Icriodus*, *Mehlina*, *Palmatolepis*, *Pelekysgnathus*, *Protognathodus*, *Polygnathus*, *Protognathodus*, *Pseudopolygnathus*, *Scaphignathus* and *Siphonodella*) have been discriminated from several sections and localities. Seventeen famennian conodont zones in continuous sequence from Lower *crepida* to Lower *praesulcata* have been recognised, as well as two Tournaisian (Lower and Upper *duplicata*). Up to date, no evidence of the Upper *praesulcata* and of the *sulcata* zones have been found. The zonation scheme proposed is broadly similar to the standard zonation schemes used in the Upper Devonian and Lower Carboniferous, though a few variations are needed to better accomodate the species occurrences in Sardinia: the *velifer* Zone and the *styriacus* Zone have been reintroduced, even if with slightly different meanings than previously used in old zonations; the Lower *praesulcata* Zone has been expanded to include the Middle *praesulcata* interval. Even if the D/C boundary beds are not exposed, the occurrence in the Monte Taccu North Sections of *Si. sulcata* together with several taxa whose range is restricted to the Devonian suggests that the base of the Carboniferous could be redefined.

Presentation format: Talk *Day and time:* Tuesday, 14:40

PALAEOECOLOGY OF THE *CHAETETES*-BAND: A MARINE BIOSTROME IN THE CARBONIFEROUS, BASAL NAMURIAN (BASAL SERPUKHOVIAN) GREAT LIMESTONE OF NORTHERN ENGLAND

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The *Chaetetes*-Band commonly occurs near the base of the basal Serpukhovian Great Limestone in Northern England, and classically comprises compact bands of the sclerosponge *Chaetetes depressus* and the colonial coral *Diphyphyllum lateseptatum.* Samples have been collected from six disused quarries in the Alston area, and the macrofossils and conodonts identified from each facies within the band. The facies include ‘planar’ and bioclastic beds, and *Chaetetes* and coral bands, together with various transitions. By identifying the fossils sampled from each facies, at each locality, we should gain a fuller understanding of the environmental setting and community structure of each fossil assemblage.

Interpreting the palaeoecology of each of the Carboniferous shelf-dwelling organisms has largely relied on Bob Wilson (ex BGS) for the macrofaunas, and the classical literature (various authors pre 1987) for the conodonts. Work so far on the amalgamated assemblages (palaeocommunities) suggests the following:

For the planar-bedded and bioclastic facies, the macrofauna indicates environments characterised by epifaunal, sessile, benthonic suspension feeders that preferred firm substrates and clearer waters, off or nearshore on the marine shelf. Dominant were crinoids, which apparently preferred higher energy, current-affected waters. The conodonts were dominated by probably pelagic *Lochriea* and *Gnathodus* with apparently nektobenthic *Synclydognathus*. The latter, with *Lochriea*, may have tolerated higher energy waters.

Chaetetes encrusted bioherms and apparently preferred low energy, clearer waters on the shelf. The dominant conodont in this facies was *Gnathodus*, which may also have preferred a quieter environment, but the associated, environmentally controlled *Cavusgnathus* and ‘*Apatognathus*’ tolerated greater turbulence.

The coral-band facies was dominated by *Diphyphyllum*, other corals and *Chaetetes*, which appears to suggest a biohermal setting in clear, low-energy waters. The dominant conodont *Kladognathus* was probably pelagic, but the common presence of *Gnathodus* and *Vogelgnathus* apparently supports a quieter environment.

Much potential remains in this work, which continues in progress.

Presentation format: Poster

THE APPARATUS ARCHITECTURE OF *ERISMODUS QUADRIDACTYLUS* (STAUFFER) AND ITS IMPLICATIONS FOR THE EVOLUTIONARY RELATIONSHIPS OF THE PRIONIODINIDA

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Taxonomically, prioniodinid conodonts (*sensu* Sweet 1988) are not well resolved within the phylogeny of the Conodonta. Sweet (1988) and Dzik (1991) each erected classifications that acknowledge (albeit implicitly), the Prioniodontida as a plesiomorphic paraphyletic group with respect to the Prioniodinida and Ozarkodinida, but their schemes differ in the inter-relationships of prioniodinids. These differences are partly a result of two assumptions: firstly, that the fossil record is complete and, secondly, that P elements alone are the most diagnostic of a species and hence sufficient for phylogenetic reconstruction. Sweet's analysis is supported to a degree by preliminary cladistic analysis (Sweet and Donoghue 2001), but there remains a need to better resolve the classifications.

The apparatus compositions of basal prioniodinid conodonts are poorly understood because there are only a small number of natural assemblages available for study. Consequently, the involvement of this group of conodonts in phylogenetic analysis has offered limited paths for resolution. A recently interpreted assemblage of the prioniodinid *Erismodus quadridactylus* (Stauffer) from the Upper Ordovician of North Dakota, USA, has been utilised to define the apparatus architecture and to refine the species concept of the Prioniodinida. Studies of the assemblage and comparisons with collections of discrete elements reveal that element morphotypes traditionally considered to be positioned within the S array are actually M elements, and others that have been interpreted as P elements are found in the S array of the assemblage. These observations have been used as a basis for refining concepts of element homology among other prioniodinid conodonts and their close relatives, on which a cladistic analysis, in turn, has been based.

Presentation format: Talk *Day and time:* Thursday, 15:20

THE INTERRELATIONSHIPS OF ‘COMPLEX’ CONODONTS

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Little attention has been paid to the suprageneric classification for conodonts and existing schemes have been formulated without attention to homology, diagnosis and definition. The development of a multielement taxonomy and a positional concept of homology, not morphology, of elements within the apparatus provide the ideal foundation for the application of cladistics to conodonts. In an attempt to unravel the evolutionary relationships among ‘complex’ conodonts (Prioniodontids and derivative lineages) we compiled a datamatrix based upon 95 characters and 61 representative taxa. The dataset was analysed using parsimony and the resulting hypotheses were assessed using measures of support including bootstrap, Bremer Support, double-decay, by comparison to expected levels of homoplasy given the size of the dataset, and in comparison to random datasets. The dataset was analysed in three hierarchical tranches, representing three levels of certainty concerning multielement reconstructions and positional homologies. There is much agreement between the results derived from the three partitions, but some inconsistency, particularly in the precise composition of the three main evolutionary grades traditionally recognised (Prioniodontida, Prioniodinina, Ozarkodinina). This is considered to result from a) the progressive inclusion of data that are increasingly uncertain, and b) the inclusion of increasingly distantly related taxa, introducing spurious hypotheses of homology. We tested for these effects by partitioning the dataset into the three main evolutionary grades and in each instance resolution was seen to increase substantially, especially among prioniodinins.

The results of this analysis indicate that cladistics provides a means of reconciling large and complex datasets of morphological characters, corroborating many established hypotheses of evolutionary relationships and classification, and challenging others. It highlights how poorly understood are our concepts of homology within the conodont skeleton, but also provides novel insights into comparative anatomy that will underpin a new understanding of homology and further developments in unraveling evolutionary relationships among conodonts.

Presentation format: Keynote talk *Day and time:* Thursday, 14:15

PERMIAN–TRIASSIC BOUNDARY ENVIRONMENTAL AND BIOTIC CHANGES: THE BULLA PARASTRATOTYPE, ITALY

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Sedimentary and biotic evolution through 190 metres of marine/lagoonal facies in the Bellerophon and Werfen formations are compared with Meishan D, Salt Range and Abadeh (Iran) sequences. 1). The upper Bellerophon Fm. (*changxingensis–deflecta* Zone) displaying tectonically-driven sedimentary and biotic variation with $\delta^{13}C$ decreasing (uppermost 30 metres), correlates with decreasing organic productivity from ca. 1 metres below the PTB in Chinese sequences and 20 metres below at Abadeh. 2). The Bulla Member (uppermost Bellerophon Formation), a ca. 1 metres transgressive–regressive cycle (Early *praeparvus* Zone) represents maximum flooding. Its base (Unconformity 1) correlates with regressive Meishan D Bed 24e—with disappearance of foraminifers and algae in eastern Tethys. 3). The main extinction phase (ca. 25cm; correlating partly with regressive Bed 26 Meishan D) includes the uppermost regressive Bulla Mbr, Unconformity 2, and possibly the basal Tesero Member transgressive bed. The main biodiversity decrease coincides with appearance of distinctive oolites near the basal transgressive tract of the Tesero Member, a ca. 220 cm cycle, followed by extension of microbialitic layers alternating with biostromes of algae, brachiopods and byssate bivalves. Hindeodid biodiversity increased with species developing *Isarcicella* characteristics in the Late *praeparvus* Zone, correlated with Bed 27a–b Meishan D. The PTB (entry *Hindeodus parvus*) at Bulla is 1.3 metres into the Werfen Formation in a microbialitic layer correlating with Bed 27c Meishan D. 4). Three biozones are discriminated by entry of *Isarcicella lobata*, *I. staeschei* (equivalent Bed 28 Meishan D) and *I. isarcica* in the schizohaline upper part of the succeeding sandy bioturbated microbialitic interval. The main western Tethys extinction phase reflects a swift acid- to alkaline-bath transition (cf. Deev Jahi model).

Presentation format: Talk *Day and time:* Thursday, 10:25

PANDER’S SILURIAN JAWLESS FISHES – THEN AND NOW

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The jawless fishes described by Pander in 1856 from the Silurian of Saaremaa were represented as tiny fragmentary pieces of armour, scales and teeth. At the time of their discovery these were the earliest fishes known and they are beautifully illustrated. In the context of contemporaneous classification these were very difficult to identify, not least because most of the groups represented had not been recognised. Some he named in open nomenclature (spines and teeth). Others he referred to Agassiz’s ganoids; an ill-construed group, the members of which are linked mainly by the shiny surface of the scales and armour. All of Pander’s types are lost but it is testament to his descriptive powers and attention to histological detail that, through his superb illustrations, many can be recognised today as valid taxa, or as synonyms. Some of Pander’s taxa of heterostracans, osteostracans and anaspids survive. Significantly, he brought together a few taxa in a subgroup of ganoids that he named Coelolepiden. Today these are known as thelodonts but the recognition of these fishes as a distinct assemblage is Pander’s contribution to higher taxonomy of jawless fishes. Unfortunately thelodonts remain as enigmatic now as in Pander’s day. There is no consensus on whether they are a monophyletic group, how they relate to other fishes, or on any internal phylogeny.

Presentation format: Keynote talk *Day and time:* Monday, 11:10

EAST GONDWANA SHARKS FOUND IN THE DEVONIAN OF NEW YORK

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The chondrichthyan fauna from the Middle-Late Devonian Aztec Siltstone of southern Victoria Land, Antarctica, consists of two tooth-based species, *Portalodus bradshawae* and *Aztecodus harmsenae* (Long and Young 1995), a partly articulated shark *Antarctilamna prisca* Young, 1982, and a problematic form, *Mcmurdodus featherensis* White, 1968. The recent re-examinations of collections from western New York housed in the Buffalo Museum of Science and new discoveries made in eastern New York indicate that at least *Antarctilamna* and *Portalodus* were cosmopolitan sharks whose distribution extended to the Laurussian seas.

It was already suggested earlier that *Antarctilamna* and *Wellerodus* Turner, 1997, a shark commonly found in the late Givetian – early Frasnian Conodont Bed in western New York, probably represent the same genus, but such unification has never been formalized. The feature repeatedly shown as distinguishing the teeth of *Antarctilamna prisca* from those of *Wellerodus* is the number of intermediate cusplets between two large main cusps: there are usually three minute cusplets in the former, and only one, but relatively robust, in the latter. However, there occur at least two teeth from the Conodont Bed of the Morse Creek valley (Athol Springs, Erie Co.; BMS E18308) whose crowns do have three intermediate cusplets. These teeth resemble the most those of the holotype of *A. prisca*.

In addition to the teeth of *Antarctilamna*, the Middle Devonian of western New York yielded fin spines probably belonging to this genus. They are known under the name of *Ctenacanthus wrighti* Newberry, 1884.

The first three teeth of *Portalodus bradshawae* from eastern New York were found in the Hamilton Group of Cairo (Greene Co.) and preliminarily studied by JGM and MG. Later, additional teeth (associated with a fin-spine?) were collected from the same locality by RC. The teeth are almost identical morphologically to those from Antarctica, but much better preserved.

Presentation format: Poster

DYNAMICS OF THE MORPHOLOGICAL DIVERSIFICATION OF THE CONODONT GENUS *PALMATOLEPIS* DURING THE UPPER DEVONIAN

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The Frasnian/Famennian (F/F) extinction event strongly reduced the taxonomic diversity of the conodonts. Among them, *Palmatolepis* was reduced to a single species which survived this crisis. This species is supposed to be the ancestor of all Famennian *Palmatolepis*. In order to understand the dynamics of this diversification, we have preformed morphometric analyses of the outline of *Palmatolepis* P_1 elements ranging from the Late Frasnian (*rhenana* Zone) to the Late Famennian (*praesulcata* Zone). A composite record has been considered with data from two sections in France (Coumiac Upper Quarry and Puech de la Suque, Montagne Noire) and two sections in Germany (Effenberg and Schaumburg, Rhenish Slate Mountains). On the basis of the diversity patterns, Late Frasnian *Palmatolepis* are morphologically homogeneous. Just after the Frasnian/Famennian boundary, *Palmatolepis* elements are morphologically close to those of the Late Frasnian, supporting the hypothesis of a Late Frasnian ancestor at the root of the Famennian diversification. The morphological diversification of the genus *Palmatolepis* is initiated as early as the *triangularis* Zone. Yet, the diversification towards new morphotypes starts during the *crepida* Zone and culminates during the *rhomboidea* Zone. Diversity then decreases, and the variability of the last representatives of the *Palmatolepis* genus is low. However, the late Famennian *Palmatolepis* are morphologically very different from the Late Frasnian *Palmatolepis*. The Famennian diversification seems to have been a transitional phase between two morphologically homogeneous faunas.

Presentation format: Poster

A NEW EARLY SPATHIAN (EARLY TRIASSIC) CONODONT SUCCESSION FROM NORTH AMERICA

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New collections of Early Triassic conodonts from the Darwin section, Inyo Mountains, California, include an array of *Neospathodus* and *Neogondolella* related species, many of which are new. The conodonts displayed at Darwin represent what seems to be an almost complete Early Spathian succession. This succession greatly helps understanding the phylogenetic history of many of the known Spathian *Neospathodus* species (or classically regarded as *Neospathodus* species). These well-constrained conodont collections from ammonoid-bearing strata provide also invaluable information on the Early Spathian conodont radiation following the end-Smithian “crisis”.

Preliminary results concerning the occurrence and range of *Neospathodus*, *Icriospathodus*, *Novispathodus*, *Triassospathodus*, and *Spathicuspus* species are presented. 24 *Neospathodus* related species or subspecies are recognized in this section, 10 of which are new.

Novispathodus abruptus seems to be the rootstock for most of these Spathian conodont species. Its most probable ancestor is *Ns. pingdingshanensis* Zhao, whose small segminate elements were also retrieved from Early Triassic rocks from Chaohu, Anhui Province, South China (Zhao Laishi, personal communication, 2006). Several “trends” or “lineages” arise from *Nv. abruptus*, which lead respectively to *Icriospathodus crassatus* and probably to *Ic.collinsoni*, on one side, and to *Ns. brevissimus* on another. New transitional forms towards these known Spathian species are represented here respectively by *Ic*.? aff. *crassatus*, *Ns*. ex gr. *brevissimus* subsp. A, B, C. It is still uncertain whether *Ns*. *curtatus* and consequently *Ns*. *triangularis* originated from *Ns*. *brevissimus* or also from *Nv*. *abruptus* (see also Orchard, 1995). It seems that *Nv*. *abruptus* also lead to *Tr*. *symmetricus* and consecutively to *Tr*.? *brochus*. The relationship with *Tr*. *homeri* is unclear.

Presentation format: Talk

Day and time: Thursday, 12:35

GRAPHIC CORRELATION AS A REMEDY FOR BIOZONE'S DEFICIENCIES – APPLICATION TO FRASNIAN SUCCESSIONS FROM THE EASTERN ANTI-ATLAS (MOROCCO)

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One of the main purposes of biostratigraphy is correlating sections and this is quiet easy when the sections are rich in well-preserved fossils. It becomes more difficult when fossils are not abundant, when the different sections do not have many fossil taxa in common, or when the zone defining taxa are not present due to environmental causes. A situation like this occurs when trying to correlate sections from different facies environments. In this case correlation of sections based on classical zonations may be quiet challenging. The Frasnian successions from the Eastern Anti-Atlas provide such an example. The Frasnian of the Tafilalt belongs to the hemipelagic and pelagic facies, moreover in the N Tafilalt the Frasnian deposits can be strongly condensed, with evidence of non-sedimentation and submarine erosion. In some parts of the Ma'der, transitional facies between pelagic and neritic facies can be observed. Ten sections, spread over the different facies environments, were correlated based on conodonts. In some of them, like Bou Tchrafine (NW Tafilalt) most of the conodont zones can be easily located. In others, like El Atrous (SW Tafilalt), which shows a more neritic facies, some biozone markers are not present. To correlate them, the graphic correlation method was used. This method avoids the problem of biozone correlation by basing its correlations on first and last occurrences of all taxa present, and not only on biozone markers. Therefore the correlation obtained is more detailed than that obtained by classical biozone correlation. The result of the graphic correlation is a database of events for the region and can be used for detailed interregional correlations.

Presentation format: Keynote talk   *Day and time:* Tuesday, 9:20

THE CRANIAL NEURAL CREST – MASTER OR SLAVE

Anthony Graham
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The chick embryo has proven to be an extremely useful model system for studying developmental processes. Indeed, it was analyses of chick embryos that led Pander to propose the theory of germ layers. In this paper I will give an overview of the other contributions to developmental biology that have arisen from studies of the chick embryo. I will then move onto to a discussion of my own work on the neural crest. The cranial crest has long been believed to have a special role in the development of the vertebrate head. Firstly, a wealth of studies suggested that the cranial neural crest played a key role in organising the morphogenesis of the head, and that crest cells from different axial levels endowed each of the pharyngeal arches with distinct patterning information. Secondly, the cranial crest forms skeletal derivatives, and this potential was thought to be restricted to this population. More recently, however, several studies have suggested that the cranial crest may not be so influential in terms of patterning or so exceptional in the derivatives that it can generate. It is now clear that it is the pharyngeal endoderm that plays the key role in directing the development of the pharyngeal arches. Furthermore, it is now apparent that trunk neural crest cells also possess skeletogenic potential, and thus the cranial neural crest is not unique in possessing this potential. Finally, it is now clear that neural crest cells exist in ascidian species. Thus vertebrates are not defined by their possession of neural crest cells *per se*, but rather, I would argue, by their possession of ectomesenchymal neural crest. I will present a model for the emergence of ectomesenchymal neural crest.

Presentation format: Keynote talk *Day and time:* Monday, 10:00

PRESERVATION OF CONODONTS TRAVELING THROUGH THE ALIMENTARY CANAL OF MODERN FISH

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The fossil record shows a bias in conodont preservation where more P_1 elements are recovered than M, S, and P_2 elements. One of the possibilities for this bias, at least in the post-Silurian, is predation by fish. Pristine Devonian conodonts were photographed, arranged singularly or in a fifteen-element apparatus following the models of Purnell's reconstructions of multi-element apparatuses, and fed to aquarium fish to determine the preservation following predation. The fish were fed in a controlled environment where the faeces could be retrieved and the conodont elements examined; furthermore one fish was dissected to determine if conodonts were lodged within the gut.

Two fifteen-element apparatuses were fed to a 13 cm long oscar, a cichlid with pharyngeal teeth; three fifteen-element apparatuses were fed to a 5 cm long pacus, a piranhid; two fifteen-element apparatuses were fed to a 5 cm long betta. In addition, isolated elements were fed to all of the fish. From the apparatuses, thirteen of fourteen P_1 elements were recovered; one of fourteen P_2 elements was recovered; and thirteen of 63 M and S elements were recovered. The results indicate separation, breakage, and reordering of the conodont elements. P_1 elements were commonly preserved whole while S and P_2 elements were preferentially broken. In the dissected fish, in which fourteen of fifteen S elements were lost, no conodonts were found inside the stomach or intestines.

Presentation format: Talk

Day and time: Thursday, 17:10

TAXONOMIC APPROACHES FOR LATE PERMIAN AND EARLY TRIASSIC GONDOLELLID TAXA

Charles M. Henderson

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Late Permian and Early Triassic gondolellid species are largely discriminated by changes in the carinal denticles of the P_1 element. At the Middle-Late Permian boundary changes in the denticle spacing between *Jinogondolella granti* and the descendant *Clarkina postbitteri* suggests a paedomorphic evolutionary process. *Clarkina* is defined by the lack of serration, high, anterior, blade-like denticles, and a major change in P_1 platform outline. However, the validity of this generic assignment is called into question by the multielement apparatuses of Triassic Gondolelloidea developed by Orchard (2005). Orchard placed *Clarkina* into synonomy with *Neogondolella* and indicated that key characters of this multielement diagnosis included a bipennate S_3 element with a bifid anterior process and changes in the S_0 element. The lateral processes of S_0 elements project from the cusp in Late Permian and Early Triassic species whereas in the Middle Anisian, forms appear in which the processes project from a denticle anterior of the cusp. The latter form does not occur in all specimens of species until the Late Ladinian. Orchard interpreted this trend as gradual evolution and rejected this character for further taxonomic differentiation. However, it could be argued that the controlling genetic code for this character appears suddenly, either in only part of a *Neogondolella* population or within a different ancestral taxon like *Neospathodus*. This provides a clear criterion to differentiate *Clarkina* and *Neogondolella*; the former taxon includes all Late Permian species and some Early Triassic species. Furthermore, this lineage may become extinct in the Induan as suggested by differences in ontogenetic development; the smallest specimens of *Clarkina* have a significant platform whereas in *Neogondolella* comparable specimens are “naked” or bear a narrow rib. The latter character is typical of *Neospathodus*, which appears in the Induan and includes an S_0 element with lateral processes branching anterior of the cusp.

Presentation format: Talk *Day and time:* Thursday, 11:15

MAKING SENSE OF CONODONT MORPHOLOGY: A NEW MORPHOMETRIC APPROACH

David Jones and Mark Purnell
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A rigorous understanding of conodont element morphology is fundamental to virtually every aspect of conodont research, including biostratigraphy, palaeobiology, evolution and cladistics. Yet the complexity of element morphology presents a challenge for qualitative analysis when trying to constrain patterns of morphological variation within the conodont skeleton. Attempts have been made previously to address the shortcomings of traditional approaches by utilising morphometrics, but the potential of quantitative analysis that is suggested by such studies has yet to be fully realised. Here, we outline a suite of new, standardised morphometric protocols, suitable for examining conodonts, with wide cross-taxon applicability and present an example of its utility in analysing variation within the morphologically plastic species *Ozarkodina excavata*. Using this protocol, we have identified morphological discontinuities within samples assigned to *O. excavata*, and have determined which morphological characters delineate them. Analysis of the discontinuities in their spatiotemporal context reveals significant differences between populations of *O. excavata*, suggesting that multiple species are currently accommodated within this taxon. We hope that the methods and results presented here will catalyse more comprehensive morphometric analyses of conodonts using these protocols, thereby refining the existing qualitative framework around which our understanding of conodont morphology is based.

Presentation format: Talk *Day and time:* Friday, 10:40

A MULTIDISCIPLINARY APPROACH TO UNTANGLE THE HANGENBERG MASS EXTINCTION EVENT AT THE DEVONIAN/CARBONIFEROUS BOUNDARY

Sandra I. Kaiser[1], Thomas Steuber[2], and R.Thomas Becker[3]

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In order to untangle the factors controlling the mass extinction event at the Devonian/Carboniferous boundary, sections from different palaeogeographical settings were studied in order to obtain a global record of environmental changes. The studied regions (Germany, France, Austria, Italy, Morocco) differ considerably in terms of lithofacies, displaying different depositional environments. This required a multidisciplinary approach, based on conodont and ammonoid stratigraphy, sedimentology, $\partial^{13}C_{carb}$, $\partial^{13}C_{org}$, $\partial^{18}O_{phosph}$ analysis.

The sampling resulted in a high-resolution conodont stratigraphy between the Upper *postera* and *sandbergi* Zone. For the first time positive carbon isotope excursions were found in micrites and in the organic matter (Kaiser et al. 2006), and coincide with the main extinction phase during the deposition of the Hangenberg Black Shale. These excursions indicate enhanced organic carbon burial during a period of warm seawater temperatures. Oxygen isotopes of conodont apatite indicate an episode of low-latitude warming, persisting during the globally widespread deposition of black shales in the Middle *praesulcata* Zone. In Morocco, the Hangenberg Black Shale equivalents correspond with a major sea-level rise. High rates of organic matter burial and drawdown of atmospheric CO_2 as evidenced by the positive carbon isotope excursion, contributed to global cooling. This is indicated by a short-lived glacial pulse in Gondwana, and a major eustatic drop in sea-level, as reflected in the Rhenish Hangenberg Sandstone and its equivalents in Morocco. The high frequency of sea-level changes recorded in Morocco is obviously related to glacially-induced eustatic oscillations at the D/C boundary, which is consistent with palynologic evidence of cool and humid conditions enabling the buildup of continental glaciers in high latitudes.

Oceanographic and climate changes reported here are remarkably similar to those of other Phanerozoic extinction events. The new data support the hypothesis that oceanic anoxia and increased C_{org} burial can trigger mass extinctions, glaciations and eustatic sea-level changes.

Presentation format: Talk *Day and time:* Friday, 10:20

MIDDLE TRIASSIC (MUSCHELKALK) CONODONT FAUNAS IN SW GERMANY – FIRST RESULTS OF A NEW PROJECT

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All over the German Basin, sediments known as Muschelkalk were deposited during the Middle Triassic. They are characterized by brachiopods and bivalves in rock-forming quantities as well as by a well-studied endemic ceratite fauna, which allows a high-resolution, basin-wide correlation. The conodont fauna in SW Germany has not been studied bed-by-bed (Rafek 1976). Previous biostratigraphic studies (Kozur 1974a,b) were restricted to random samples and do not provide conodont range charts. Therefore, a high-resolution conodont zonation and a correlation with the ceratite zonation have not been achieved. Also, the stratigraphic position of the Anisian/Ladinian boundary in SW Germany is still a matter of discussion, with the boundary being placed at different stratigraphic positions. The conodont fauna is endemic, so correlation with the GSSP for the base of the Ladinian in the Southern Alps (Brack et al. 2005) is difficult.

This paper presents a new project focusing on index conodonts and their ranges, in the context of regional biofacies evolution, with the aim of producing a precise correlation of the Muschelkalk Beds.

The study focuses on the Upper Anisian and Lower Ladinian (Upper Muschelkalk). The 90 m thick successions crop out near Stuttgart, and comprise "basinal" sediments (50 m water depth), and sediments displaying the transition to the coast. Bioclastic limestones as well as fine-grained, argillaceous limestones were sampled. A detailed bed-by-bed sampling was conducted below and above the Cycloidesbank, a marker bed yielding masses of the brachiopod *Coenothyris cycloides*. This will help to explain the sudden faunal change and strong decrease of the faunal content at this level. The microfauna consists of brachiopods, bivalves, fish teeth, scolecodonts, and well preserved but small conodonts. While conodonts are less abundant in the fine-grained limestones, the bioclastic limestones contain more specimens, and accumulations of conodonts were observed in ammonoids collected in the studied outcrops.

Presentation format: Poster

THE DEVONIAN/CARBONIFEROUS BOUNDARY STRATOTYPE SECTION (LA SERRE E´, MONTAGNE NOIRE) REVISITED

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The La Serre section trench E´ south of Cabrières (Montagne Noire) has been selected as the Devonian/Carboniferous Global Boundary Stratotype Section and Point (GSSP). However, this section cannot be regarded as an ideal GSSP. The boundary was fixed between Beds 88/89 within an oolitic sequence, thus conodonts and other fossil groups are reworked. Also, the stratotype lacks ammonoids and palynomorphs just at the boundary, and the high variability of siphonodellids and transitional morphotypes makes precise determinations difficult. However, this section is the only one that was thought to show the evolutionary lineage from *Siphonodella praesulcata* to *Siphonodella sulcata* when the boundary was decided.

The succession was re-sampled in detail. Based on the new conodont records presented herein, a new D/C boundary position and a revised zonation is proposed. The bases of the Upper *praesulcata*, *sulcata* and *duplicata* Zones were fixed at older stratigrapical levels than previously proposed (Flajs & Feist 1988). The base of the *sulcata* Zone corresponds to the base of Bed 85 due to the first occurrence of *S. sulcata*. Therefore, the D/C boundary is placed between Beds 84 and 85, which is the basal part of a regressive interval (basal Upper Calcoolite Unit).

Conodont specimens from Bed 85 were previously determined and tentatively assigned to *S. sulcata* (Ziegler & Sandberg 1996), which is in accordance with our new results. However, if the first occurrence of *S. sulcata* is in Bed 85, then “…the whole sequence containing the supposed *S. praesulcata-S. sulcata* lineage is an artefact created by reworked sediments derived from different source areas…” (Ziegler & Sandberg 1996, p. 178-179). Thus, the GSSP position needs either to be re-located at La Serre, or a new stratotype section needs to be searched for.

Presentation format: Poster

THE MUSCULAR SYSTEM OF EUCONODONTS

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The muscular system of euconodonts has been studied in detail on the basis of pictures of its imprints from the Carboniferous Shrimp Bed of Granton, Scotland, from theOrdovician Soom Shale, South Africa, and from the Silurian Waukesha biota, North America. Superficial body structures have been first recognized for euconodonts - external annulation (*Panderodus* imprint) and its traces (second and third imprints from Granton) - which make conodont look like many invertebrates, such as annelids, priapulids, and pentastomides, rather than primitive chordates. In other soft tissue imprints of conodonts, a deep frontal break, reaching their central part, uncovers inner transverse structures of body - muscular fibers. As in invertebrates, they have different form and orientation (obliquely-oriented and parallel). Their medial apices could be directed towards both head - apically (first, second, fourth, fifth, seventh, and *Promissum pulchrum* imprints) and tail - terminally (second and sixth imprints). Parallel position of muscular fibers is observed in the third, fourth and fifth imprints. Discontinuity of the transverse structures appears to occur in euconodonts, and this suggests that the transverse obliquely-oriented structures, visible on euconodont imprints, are not chordate myomeres. Differences in the direction of medial apices of obliquely-oriented muscular fibers depend on the physical state (direction of movement) of an animal. The longitudinal median structure can not be considered as a notochord, but is rather a gut extending from the anterior pharynx to the posterior anus. In spite of their visual similarity, strict study of euconodonts preserving soft tissues indicated that they can not be classified as chordates, or chaetognaths. Their muscular system differs from that of all known groups of animals and shows unique features - inner transverse structures are muscular fibers, which externally look like annulation. This supports our earlier conclusion that euconodonts are an independent type - Euconodontophylea Kasatkina & Buryi, 1997.

The work was made under financial support of RFBR grant 06-04-96051.

Presentation format: Talk *Day and time:* Friday, 9:40

ELEMENTAL VARIATION WITHIN CONODONT TEETH: IMPLICATIONS FOR FUNCTION

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Many studies now support the interpretation that the conodont animal was an active, marine vertebrate with oral phosphatic structures, large eyes, and fins for swimming. Studies of mineral composition, histology, and morphology in conodont elements provide important information on biological function and taxonomic affinity. This study utilizes advances in modern instrumentation to map precisely variations in elemental abundance across the conodont element for the purpose of identifying function and assisting palaeobiologic interpretations.

Electron microprobe analysis of well-preserved P_1 elements of *Mesogondolella idahoensis lamberti* from the Middle Permian of West Texas reveals important patterns in element distributions. The crown of the conodont element is more mineralized than the basal plate and shows no evidence of calcium or phosphate deficiency in areas of rapid lateral growth that might have been interpreted as white matter. Additionally, the basal plate has higher concentrations of fluorine, iron, potassium, magnesium, strontium, and yttrium, which indicate a different mineral structure and composition. Sodium concentrations are high on oral surfaces in the crown between the parapets and low elsewhere, while sulphur concentrations display the opposite pattern. These patterns are independent of the crown-basal plate boundary and indicate chemical differentiation between the oral and aboral surfaces in the conodont element. This differentiation supports oral exposure of conodont elements during life, approximates the position at which the conodont element was embedded in tissue, and indicates functional use as a tooth as opposed to a support structure for soft tissue. These variations in chemical composition support previously interpreted histologic properties of the crown and the basal plate that indicate similarity to enamel and dentine respectively. Accordingly, conodont elements should henceforth be called conodont teeth.

Presentation format: Talk *Day and time:* Friday, 9:20

PANDER'S ENIGMA: THE FIRST CENTURY OF CONODONT STUDIES

Simon Knell
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In claiming the Conodonta as the earliest vertebrates, Pander gave nineteenth-century palaeontology an insoluble headache. Throughout that century, Pander's views were alternately supported and refuted, and although rarely straying from the worm-fish axis, these created a mythology of contention. In 1879, Hinde gave fairly conclusive proof of the fish, only to have this overturned by his former teacher, Zittel who claimed superior knowledge and technologies (rather than superior arguments) and painted Pander as a primitive. The new century saw conodont studies develop in the US on the back of an oil-induced explosion of interest in microfossils. The new utilitarians, led by the outspoken Ulrich, and his protégé Bassler, claimed – on little evidence – that each species of conodont represented a species of fish. By this means the fossils became uncomplicated stratigraphic tools that were soon used to understand the relative age of 'unfossiliferous' strata and, most importantly, contribute to the black shales debate then raging. Branson and Mehl took this utilitarianism to new levels, permitting it to shape interpretations, methods and nomenclature. Contemporaries, however, fell into disagreement in these areas. By then the American fish was swimming, uncontested, in German waters. It provided a starting point for Schmidt's functional interpretation of newly discovered assemblages. In the US, Scott simultaneously used poorer, but similar, material to make an emphatic claim for the worm. By the late 1940s, it was difficult deny the truth of assemblages or the utility of these fossils but these two truths sat uncomfortably together. In some respects, the conodont represented the state of US palaeontology in 1950. For some, like G.A. Cooper, true palaeontology had been swallowed up by commercial utility. Help, however, was at hand, as, in the 1950s, a new generation of worker began to establish a more holistic science using new methods.

Presentation format: Keynote talk *Day and time:* Monday, 9:20

PANDER'S TOOTH: WRITING A HISTORY OF CONODONT STUDIES

Simon Knell
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This poster explains the ideas behind this 150 year history of conodont research due to be published in 2007. It addresses the successive generations of people who have studied these fossils, rather than being a book about the fossils themselves. It sets out to accurately record and interpret that history of study. Some of this can be found in the 10,000 or so papers on the subject, but to give a real sense of a research community it is essential that the voices and memories of workers shape the volume. The book is both chronological and thematic. It focuses particularly on new developments as they arose, illustrating them with particular geological periods, workers and examples. It does not aim to bring everything up to date, or in any sense to fulfil a role as a palaeontology text. The book has got to be accessible to an audience beyond conodont workers and historians of science, but it is not aimed at a mass market; all the same, it does not represent a simple act of documentation. The poster will show current chapters, themes and workers. An outline of chapters is: 1. Pander to WW1; 2. American stratigraphy WW1 to c.1952; 3. Apparatus and biology WW1 to c.1940; 4. Structure and assemblages 1940-c1952; 5. Evolution and stratigraphy c 1952- c.1976; 6. Language esp. parataxa 1950s; 7. Shaping multi-element taxonomy, symmetry etc 1960s to early 1970s; 8. Ecology mainly 1970s; 9. Event stratigraphy c.1980 to mid 1990s; 9. CAI; 10. Animal, including microstructure 1964-1982; 11. Scottish animals and aftermath up to 1988; 12. Shaping the animal c.1990-2006; 13. Analysis of research community and progress. This is a book about YOU, so please look at the poster and come and have a chat.

Presentation format: Poster

CONODONT ZONATION OF THE TRIASSIC BASEMENT OF THE ADRIATIC-DINARIC CARBONATE PLATFORM IN MT. SVILAJA (EXTERNAL DINARIDES, CROATIA)

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The study area is situated in the geotectonic unit of the External Dinarides which is composed predominantly of carbonate deposits. The unit extends in NW-SE direction from Slovenia in the north through Croatia, Bosnia and Herzegovina to Montenegro and Albania in the south. It consists from 6000 to 8000 metres of prevalent carbonate rocks with three distinguished megasequences, 1) Middle Permian – Upper Ladinian, 2) Upper Norian – Upper Cretaceous, and 3) Paleocene – Middle Eocene.

The first sequence (Middle Permian – Middle Triassic), to which the investigated section belongs, is characterized by carbonate and mixed siliciclastic-carbonate deposits of an epeiric platform along the northern Gondwana margin. The Middle and Upper Permian consists of carbonates, mostly dolostones. The Lower Triassic is characterized by mixed clastic-carbonate deposits. The Middle Triassic is mainly represented by shallow water limestones with numerous occurrences of volcanic and volcanoclastic rocks, predominantly in the Upper Anisian and Ladinian part. The pyroclastic rocks can be interpreted as a result of rift tectonics and accompanying basalt magmatism. The Triassic sequence is transgressivelly overlain by uppermost Triassic or Early Jurassic sediments which belong to the new Late Mesozoic megasequence of the External Dinarides. The biostratigraphical data allow subdivision of the Triassic sequence into six conodont biozones: *obliqua* (Smithian), *constricta* (Anisian), *trammeri* (Ladinian), *hungaricus* (Ladinian), *mungoensis* (Ladinian) and *murchianus* (Upper Ladinian-Lower Carnian) Zones. More detailed fieldwork was focused to the Middle Triassic part of the section. Much attention was paid in collecting megafauna in order to intercalibrate conodont biochronology with ammonoid data.

Presentation format: Talk *Day and time:* Thursday, 9:45

TETHYAN LOWER TRIASSIC INTEGRATED HIGH-RESOLUTION AMMONOID-CONODONT CORRELATION AND RADIATION EVENTS

Leopold Krystyn[1] and Michael J. Orchard[2]

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[2] Geological Survey of Canada, Vancouver, B.C., Canada

Based on recent and new sampling in Spiti (Indian Himalaya) a refined and more detailed conodont zonation of the Induan and lower Olenekian stages is presented. Spiti has one of the richest and most diverse Lower Triassic conodont records in the world and a high-resolution calibration to the Low Palaeolatitude (LPL) ammonoid time scale. Though the P-T boundary interval is not represented due to a depositional break, a rapid transgression leads to immediate onset of offshore conditions and to the occurrence of pelagic faunas. Spiti is therefore one of the rare places in the Tethys with a *Neogondolella*-dominated conodont biofacies in the Griesbachian, and more than 10 neogondolellinid species document a worldwide peak in diversity as well as an alternate biozonation for this interval. The base of the Dienerian is marked by a drastic change in facies from well oxygenated to disoxic and in part anoxic conditions paralleled by a sharp drop in *Neogondolella* diversity and later complete loss of species. Replacement rate by the newly appearing genus *Neospathodus* is surprisingly low, as is the apparent evolutionary diversification. The Dienerian-Smithian boundary interval shows a return to well oxygenated sea bottom conditions and to very rich conodont faunas. Within five successive, biostratigraphically useful steps, 3 new genera (*Borinella*, *Eurygnathodus*, *Discretella*) and about 10 new species (6 of them neospathodids) appear during a short time interval of less than 1 myr. This explosive radiation allows a very fine-tuned conodont zonation of the Induan – Olenekian boundary.

Presentation format: Talk *Day and time:* Thursday, 12:15

NEW CONDONT DATA ACROSS THE P/T BOUNDARY IN SOUTH CHINA

Xulong Lai, Haishui Jiang, Genming Luo, and Yadong Sun
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Large conodont samples have been collected from the uppermost Permian and lowermost Triassic at the Meishan section - the Global Stratotype Section and Point (GSSP) for the Permian - Triassic Boundary. The same work is also engaged at Shangsi section and Chaotian section in Sichuan Province. To date, several tens of thousands of conodont elements have been obtained from these sections. These new materials are used to revise the ranges of some important conodont species in interval. For the first time, good numbers of *Neogondolella* specimens have been found from the basal Triassic at Meishan section, enabling us to establish parallel hindeodid and gondolellid zonations through the same section over this interval. A new species of *Isarcicella* is recognized below the *Isarcicella staeschei* zone at both Meishan and Shangsi sections.

Based on both generic and species level investigation of the individual size of the Pa elements of Neogondolella collected from Meishan and Shangsi sections, an obvious size variation of Neogondolella is recognized. Size variation in *Neogondolella* occurs simultaneously with important events including a negative shift of $\delta^{13}C$, change in the ratio of the abundance of cyanobacterial biomarkers versus that of other general bacterial biomarkers and the shallowing of sea level. Similar size variation of genus *Hindeodus* can be also recognized around the Permian-Triassic boundary.

All the new condont data bring insight into conodont zonation and evolution during the Permian – Triassic transitional period.

Presentation format: Talk *Day and time:* Thursday, 15:40

CONODONT APPARATUSES FROM THE *MESOGONDOLELLA-JINOGONDOLELLA* TRANSITION, CISURALIAN-GUADALUPIAN (PERMIAN) OF WEST TEXAS

Lance L. Lambert[1] and Bruce R. Wardlaw[2]
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[2] U.S. Geological Survey, Reston, VA, USA

Orchard (2005) demonstrated that Triassic gondolellid ramiforms are useful at lower taxonomic levels. Here we compare our large collections from the Cisuralian-Guadalupian (Lower-Middle Permian) boundary interval to Orchard's apparatus template. The boundary interval contains three long-ranging species established on Pa element morphology:
Mesogondolella idahoensis (*sensu* Mei and Henderson, 2002), distinguished by Pa elements with a terminal, very high, elongate cusp;
Mesogondolella lamberti (*sensu* Mei and Henderson, 2002), distinguished by Pa elements with a moderate, conical cusp and a posterior brim;
Jinogondolella nankingensis (*sensu* Lambert and Wardlaw, 1996), distinguished by Pa elements with a conical cusp and lateral margin serrations.

All three species have similar apparatuses composed of at least 15 elements (we prefer treating the interpreted detached distal processes as individual elements, in part because one type occurs with Pennsylvanian taxa). In comparison with Orchard's reconstructions, these apparatuses most closely match that of *Neogondolella*. In contrast, all three apparatuses feature dimorphic Pb elements that occur in roughly equivalent numbers. They may represent individual conodont animals as an asymmetric pair or two complete pairs, or may represent different individuals as sexual dimorphism. The Sd element is a simple blade that resembles the detached posterior process of Orchard's S_0 element, but it vastly outnumbers the Sa elements in our *Mesogondolella* collections. The *Mesogondolella* apparatuses feature non-bifurcating Sc elements, whereas the *Jinogondolella* apparatus features an Sc element with an additional process that bifurcates at the cusp. The ramiform elements of each species are consistent within that species, but are distinct between species in subtle expression of denticulation pattern, curvature, and process length. We have *M. idahoensis* and *M. lamberti* in stratigraphic succession, which along with the distinct apparatuses support treating them as separate species. The distinguishing apparatus characters of *J. nankingensis* support it and its descendants as belonging to a different genus-level clade.

Presentation format: Talk *Day and time:* Thursday, 10:05

TWO CASE STUDIES ON EARLY PALAEOZOIC CLIMATE RECONSTRUCTIONS BASED ON $\delta^{18}O$ DATA FROM CONODONT APATITE: AN EARLY TO MID-ORDOVICIAN GREENHOUSE AND A LATE SILURIAN ICEHOUSE

Oliver Lehnert[1], Michael Joachimski[2], Werner Buggisch[3], Svend Stouge[4], Jiri Frýda[5], and Lennart Jeppsson[6]

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(1) Oxygen isotope data from sections on Baltica (Öland, Sweden), Cuyania (Argentine Precordillera) and South China (Chenjiahe, Hubei Province) provide insight into climate change during the Early and Mid Ordovician. The investigated interval spans more than 15 myr from the post CRE *Paroistodus proteus* Zone (uppermost Tremadocian, Latorp) through Darriwilian *Eoplacognathus suecicus* Zone. Data indicate stable conditions for the uppermost Tremadocian through Lower Darriwilian in the tropics and subtropics. There is no evidence for any strong cooling or warming event and recorded sea-level fluctuations apparently were not related to dramatic shifts in climate. Small variations in $\delta^{18}O$ values (mostly between17 and 18 ‰ with slight variations of mainly 0.5 ‰ between two datapoints) may provide evidence for minor changes within the stable climatic conditions that prevailed overall.

(2) Since 1990 it has been obvious that Silurian environments were unstable, evidenced by mass extinctions, the stable isotope record, sea-level changes and rapid switches between warm and cold climates. Changes in $\delta^{18}O$ coincide with positive $\delta^{13}C$ excursions indicating major changes in the global carbon cycle. Late Silurian glacial sediments are unknown, but oxygen isotopic changes in conodont apatite can be used as a proxy to argue for ice build-up in high latitudes during the late Ludlow Lau Event. The values from Gotland (Sweden) and the Prague Basin show an increase in $\delta^{18}O$ by more than 2 ‰ translating into cooling of surface waters of about 8° C assuming no major changes in salinity. However, such a cooling of low to mid latitude surface waters seems unrealistic. Consequently, we interpret the +2 ‰ increase in $\delta^{18}O$ as the combined signal of the build-up of a polar ice cap and climatic cooling, affecting the entire ocean.

Presentation format: Talk *Day and time:* Tuesday, 16:15

SEA-LEVEL CONTROL ON THE CONCENTRATION OF ORDOVICIAN CONODONTS FROM DEEP-WATER SILICICLASTIC SETTINGS

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Conodonts from deep-water siliciclastic bedding plane surfaces are well known, but finding conodonts on these surfaces is a ‘needle in a haystack’ problem. Sequence stratigraphic models suggest that when sea level is high, siliciclastic material may be choked in newly created accommodation space, resulting in less sediment being transported to the deep water environment. This, in turn, results in a greater amount of biogenic material deposited relative to siliciclastic detritus. This model explains high concentrations of conodonts on certain bedding surfaces in Lower (Floian) and Upper Ordovician (Sandbian and Katian) deposits at Trail Creek, Idaho and Black Knob Ridge, Oklahoma, USA, respectively.

The Floian portion of the Phi Kappa Formation, exposed along Trail Creek Road in central Idaho, preserves a graptolite fauna from the *Didymograptus bifidus – Isograptus victoriae* zones. This section contains a low diversity, high abundance conodont fauna dominated by *Periodon flabellum*, *Oepikodus*, *O. communis* and uncommon elements of *Protopanderodus*, *Paroistodus proteus*? and *Drepanodus arcuatus*?. The Sandbian portion, exposed at Little Fall Creek in central Idaho, and the Athens Shale from Pratt Ferry, Alabama, USA contain *Hustedograptus teretiusculus* and *Nemagraptus gracilis* zone faunas, respectively. They also preserve a low diversity, high abundance conodont fauna dominated by *Periodon aculeatus*?, *Pygodus anserinus*, and *Drepanodus*?. The Katian deposits at Black Knob Ridge preserve a *Climacograptus bicornis – Diplacathograptus caudatus* graptolite zone fauna. This section also preserves a low diversity, high abundance conodont fauna dominated by *Periodon grandis, Scabbardella, Amorphognathus tvaerensis,* lower abundances of *Icriodella superba*?, *Drepanoistodus suberectus, Protopanderodus liripipus,* and *Oistodus*. *Amorphognathus superbus*? occurs near the base of the *Diplacanthograptus caudatus* Zone. At each locality, intervals interpreted as sea-level highstands contain biostratigraphically significant conodonts that are part of the deepwater community. This approach to find conodonts in deep water settings should improve the resolution between conodont and graptolite zonations.

Presentation format: Talk   *Day and time:* Tuesday, 16:35

GIVETIAN AND EARLY FRASNIAN CONODONT BIOSTRATIGRAPHY FROM COMPTE (SPANISH CENTRAL PYRENEES), RECOGNITION OF THE STANDARD ZONATION

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The section at Compte belongs to what traditionally has been considered as the Compte Subfacies area, within the Southern facies area of Mey (1967). This is an almost continuous section, spanning the Givetian to Famennian interval, but only the Givetian and the early Frasnian are considered herein. This report complements and up-dates a previous one presented during ECOS VIII.

Beds below the Lower *varcus* Zone are tectonically disturbed and, thus, the Lower Givetian is not well exposed at Compte. The subdivision of the Lower *varcus* Zone into *timorensis* and *rhenanus* subzones is recognizable at Compte in bed 9. Lack of *Polygnathus ansatus* hinders recognition of the boundary between the Lower and Middle *varcus* Zone, which will be close to bed 18b with the entry of *Icriodus difficilis*. *Polygnathus linguiformis mucronatus* is an important markerr within the Zone in bed 41a. The Upper *varcus* subzone starts at bed 45c with the entry of *Pol. latifossatus* and "*Ozarkodina*" *semialternans*. The Middle/Upper Givetian boundary (= base of the *hermanni* Zone) is traced at bed 46a with the entry of *Schmidtognathus hermanni*. The entry of *Pol. cristatus* (*epticus* type) 190 cm above base of bed 46a indicates the upper *hermanni* Zone. The entry of *Klaperinna disparilis* in bed 47 indicates the *disparilis* Zone. Within this zone the entry of *Mesotaxis falsiovalis* (bed 51) is an important marker. Bed 58, with *Skelethognathus norrisi,* could be the uppermost Givetian bed because the entry of *Ancyrodella pristina* in bed 59 indicates a Frasnian age. Above this follows a sequence of *Ancyrodella* with the successive entries of *A. soluta* (bed 60b), *A. rotundiloba* (bed 61), *A. triangulata* and *A. alata* (bed 64).

This work has been partially supported by the Spanish DGICYT Research Grant BTE200301609, the Alexander von Humboldt Foundation and represents a contribution to the IGCP 499 (Devonian land-sea interactions: evolution of Ecosystems and climate).

Presentation format: Talk *Day and time:* Tuesday, 12:10

DISCRIMINATION OF FRASNIAN (LATE DEVONIAN) *PALMATOLEPIS* SPECIES USING MULTIVARIATE ANALYSIS OF PLATFORM ELEMENTS

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Species of *Palmatolepis* are a primary means for recognizing and correlating the subdivisions of the Late Devonian. Attempts to further refine the Frasnian conodont zonation utilizing shorter ranged species have led to increasingly finer subdivision of morphologic features of the platform (P_1) elements, especially platform outline and lobe development. However, subtle differences and variation in shapes of the P_1 elements make reliable discrimination of these species problematic and precise identification of Frasnian zones difficult.

This study employs discriminate function analyses for the differentiation of key Frasnian *Palmatolepis* species (*P. bogartensis, P. boogaardi, P. gigas, P. hassi, P. muelleri, P. rhenana,* and *P. winchelli*) based on 94 specimens previously analyzed by Klapper & Foster (1986,1993), who used the method of equal arc segmentation. Using scanned images on the ArcGIS Desktop, primary landmarks were placed at the central node, ventral tip and dorsal tip. Primary reference points were placed half the distance from central node to ventral tip and half the distance from the central node to dorsal tip, and then half-way between these points. Landmark points were positioned along the conodont perimeter at right angles from each primary reference point. A program of functions executed by Matlab software calculated interlandmark distances based on the Cartesian coordinates. Discriminate function analysis of the standardized measurements shows statistically significant differences between the species examined. The analysis yields clearly defined morphological characters and establishes shape-diagnostic criteria for ease in identification.

Presentation format: Poster

LATE DEVONIAN CONODONT ECOLOGY AND PALAEOBIOGEOGRAPHY: AN EXAMPLE FROM THE POMERANIAN BASIN, NW POLAND

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Segregation of conodont species into relatively discrete biofacies can be demonstrated and compared with the Late Devonian conodont biofacies models of Sandberg and his co-authors. It is clear that some genera characterized near-shore environments, whereas others occurred in relatively off-shore areas. As more data on conodont distribution have become available, it is apparent that some species of the same genus occupied different ecological niches. Therefore, the distribution of conodont taxa has been examined at the specific level. An off-shore group of species, represented here by palmatolepids, with some polygnathids and icriodids, preferred rather stable environmental conditions. Narrow, weakly ornamented or smooth polygnathids, most icriodids, and “bizzare” species prospered in nearshore environments characterized by more varied conditions, with considerable fluctuation in temperature, salinity and water energy.

There is a direct correspondence between sea-level changes and conodont biofacies turnovers. The dispersal of the Late Devonian conodont faunas and the observed shifting of conodont biofacies through time is in good agreement with the Early and Middle Devonian offlap-onlap model of Klapper and Johnson. The Late Devonian eustatic transgressions and regressions, as well as relative changes of sea-level on a regional scale, were the primary controls on biofacies development and on the restricted distribution of certain conodont taxa. Endemic, often “bizzare” faunas developed mainly in a shallow part of the Pomeranian Basin during the early stage of transgressions, whereas cosmopolitan conodont species prevailed in the whole area during transgressional maxima. The Late Devonian conodont fauna was somewhat less cosmopolitan than has commonly been assumed.

The repeated turnovers of conodont biofacies, connected with sea-level changes, also provide support for the hypothesis that the majority of Late Devonian conodonts were nektobenhic.

Presentation format: Talk *Day and time:* Tuesday, 17:55

MULTIELEMENT RECONSTRUCTIONS OF *ANCYRODELLA* AND *MESOTAXIS* FROM THE VOROTA FORMATION (GIVETIAN-FRASNIAN, DEVONIAN) OF THE KOZHYM RIVER SECTION, SUB POLAR URALS, RUSSIA

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The conodont genera *Polygnathus*, *Ancyrodella*, *Prioniodina*, *Icriodus* and *Mesotaxis* have been recovered and published from the Devonian of the Sub-Polar Urals, Russia, in the context of P_1 element taxonomy. *Mesotaxis* and *Palmatolepis* are considered to have similar P_1 elements and more multielemental reconstructions are needed to clear up some of the taxonomic problems associated with their phylogenetic relationship (Donoghue 2001). Three samples from the Givetian-Frasnian Vorota Formation of the Kozhym River Section provide well-preserved conodont elements suitable for this kind of study. The platform elements of *Polygnathus*, *Ancyrodella* and *Mesotaxis* show a range of sizes as well as ontogenetic series presence indicating that little or no sorting of element types has taken place. These genera co-occur with icriodids and prioniodinids in varying proportions in each of the samples. A reconstruction is presented for *Mesotaxis falsiovalis* Sandberg et al., 1990 with elements in the S_{1-4} positions assigned with doubt. These S elements are either extremely underrepresented in the collections or it is more likely that they are very similar to polygnathid S elements. Previous reconstructions of *Mesotaxis* by Klapper and Philip (1972) and Dzik (2002, 2004) show variable types of S_{1-4} elements and also differ from our reconstruction. Reconstructions of *Ancyrodella* are also presented here and compared with previous reconstructions of Klapper and Philip (1971, 1972), Kralik (1994), Schulke (1997) and Dzik (2002, 2004). Bedding plane assemblages of prioniodinids described by Purnell (1993) show a similar relative proportion of elements to the discrete collections from the Urals. The Urals material therefore shows potential for future reconstructions of prioniodinid apparatuses from discrete elements.

Presentation format: Talk

Day and time: Tuesday, 14:00

A COMBINED CONODONT ZONATION FOR THE GIVETIAN (MIDDLE DEVONIAN) OF THE RADOM-LUBLIN AREA, SE POLAND

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The application of some of the zones of the most commonly used Givetian conodont zonation poses problems in the Radom-Lublin area. This is true e.g. when considering the zonal definitions and their applicability to rock successions representing shallow-water environments. The Radom-Lublin area formed a margin of an epicontinental marine basin at the southern edge of the Old Red Continent. Former sedimentological and facies studies demonstrated that during the Middle Devonian three predominantly shallow-marine subregions can be distinguished. The conodont data were obtained from 8 boreholes. Conodonts belong mostly to the genera *Icriodus* and *Polygnathus*. In total 37 species/subspecies have been recognised. The different environments as indicated by sedimentological data can also be recognised by conodont biofacies analyses and the palaeoecology of particular species. Four conodont biofacies have been distinguished: polygnathid, polygnathid-icriodid, icriodid-polygnathid and icriodid. The middle Givetian is dominated by polygnathid-icriodid and icriodid-polygnathid biofacies. An impoverished polygnathid biofacies appears sporadically and in the upper part a shallowing trend is demonstrated by an icriodid biofacies. The upper Givetian faunas belong to the icriodid-polygnathid and icriodid biofacies. In the uppermost Givetian an icriodid biofacies occurs in addition to polygnathid and polygnathid-icriodid ones. The latter biofacies are dominated by narrow-platform *Polygnathus* taxa, considered to occupy a rather vast area within the shelf system.

The biostratigraphic analysis has been carried out using the index taxa of the compiled zonation of Clausen, Weddige and Ziegler (1993) or of alternative zonations. A critical comparative biostratigraphical analysis of the total ranges of all taxa finally enabled recognition of six biostratigraphic units in the Givetian, from the base: *rhenanus*/*varcus* Zone, *ansatus* Zone, *hermanni* Zone, *subterminus* Fauna, *norrisi* Zone and *insita* Fauna (= lowest *falsiovalis* Zone). The present study indicates that in a case of Givetian shallower-water/more nearshore facies it is possible to use a fairly accurate alternative conodont zonation.

Presentation format: Talk *Day and time:* Tuesday, 11:30

XRD PROPERTIES OF CONODONT APATITE

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In order to test the affinity of conodont apatite properties to those of the recent vertebrates, conodont apatite was examined by means of XRD whole pattern fitting technique. The enamel/enameloid tissues of recent vertebrates are built up of two discrete crystallite series, a specific feature that survives fossilization and diagenetic alteration of this tissue type. Conodonts (at least 20 mg conodont material) were picked out of originally ca 20–40 kg rock material; only euconodonts (CAI=1) were analysed. Identified species are:
KONO01: *O. roopaensis*, *O. siluricus* and *Panderodus* sp. (Silurian, *O. snajdri* Biozone, carbonate rock matrix) – a=9.374(7)Å; c= 6.889(3)
KONO02: *A. flugeli*, *O. polinclinata estonica*, *Pterospathodos eopennatus* ssp. no 1 (*sensu* Männik 1998), *A. irregularis, A.* cf. *kuehni*, *D. staurognathoides, Walliserodus* sp., *P. unicostatus, P. recurvatus, P. greenlandensis, Oulodus* sp. and *Apsidognathus* sp. (Silurian, *P. eopennatus* ssp. no 1 Biozone, clay rock matrix) – a=9.377(6); c=6.892(0)
KONO03: *C. proavus, C. caseyi*, *C. intermedius, C. angulatus, C. lindstromi* and *E. altus*. (Lower Ordovician, *C. angulatus* Biozone, quartz sand matrix) – a=9.370(6); c=6.888(5).

It appeared that conodont apatite was highly crystalline. It is concluded that conodont elements exhibit no taxon specific features, i.e. no interspecific differences of conodont apatite. It is concluded that the nature of surrounding rock matrix does not affect the chemical composition and positioning of ions in the conodont apatite lattice. The diagenetic alteration of conodont apatitic matter is more similar to enamel/enameloid than other types of phosphatic tissues. Calculation of crystallite dimensions and strain of conodont matter indicates that the most elementary crystallites had dimensions >3000Å. It is assumed that this dimension series corresponds to larger crystallite component in vertebrate enamel/enameloid, while the smaller one was missing in original conodont architecture.

Presentation format: Poster

THE UPPER TRIASSIC CONODONT FAUNA OF PIZZO MONDELLO SECTION (SICANI MOUNTAINS, SICILY)

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Recently, studies of Late Triassic conodonts have increased mostly because of attempts to define Late Triassic GSSPs. Unfortunately, some genera and many species have been poorly defined mostly because of low occurrances of conodonts.

At present, the Pizzo Mondello section cropping out in the Sicani Mountains (western Sicily, Italy) is one of the best sections recording the whole Upper Triassic in a pelagic setting and it has been recently proposed as the GSSP candidate for the Norian stage.

The main events are as follows, from the bottom to the top of the section:

1. the first 36 metres (samples MP0-MP11) are characterized by *Paragondolella polygnathiformis*, *P. carpathica*, *P. nodosa* which dissapear at PM12 (meter 38,75);
2. *Metapolygnathus zoae* occurs up to MP20 (meter 67);
3. from 38.75 metres (MP12), along with the previous *Metapolygnathus zoae*, *M. communisti*, *M. oertlii*, *M. pseudodiebeli*, *M. pseudoechinatus*, *M. primitius* and *Neocavitella cavitata* occur;
4. the FO of *Metapolygnathus communisti* B occurs at meter 64, sample MP19 C;
5. genus *Epigondolella* occurs at PM23, 76 metres above the base of section, with *Epigondolella quadrata*, *E. permica* and *E. triangularis uniformis* as first representatives;
6. starting from PM31 (100 metres), no more *Metapolygnathus* spp. are present;
7. *Epigondolella orchardi* occurs at sample PM34, 109.72 metres;
8. An assemblage characterized by *Epigondolella orchardi*, *E. quadrata*, *E. abneptis*, *E. spatulata*, *E. triangularis uniformis*, *E. triangularis triangularis*, *E. spiculata*, *E. serrulata* and *E. tozeri* occurs up to sample PM70, 268 metres;
9. *Epigondolella bidentata* is present from sample PM71 (272 metres);
10. At sample PM74, at 293,60 metres, *Norigondolella steinbergensis* occurs;
11. *Parvigondolella andrusovi* occurs from sample PM104, at 361.20 metres, along with *Parvigondolella lata*, *Epigondolella bidentata*, *E. zapfei*, *E. slovakensis* and *Norigondolella steinbergensis* until sample PM122 (415.80 metres), just below a fault zone.

Presentation format: Poster

OLENEKIAN TO ANISIAN CONODONTS FROM NAKHLAK AND AGHDARBAND AREAS (CENTRAL AND NE IRAN)

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The Triassic successions exposed in the Nakhlak and Aghdarband areas are of great interest for understanding the collision of the Iran plate with Laurasia, i.e., for the reconstruction of the late history of Palaeotethys Ocean in Northern Iran.

The two areas have been investigated during three field trips in 2003-2005, with the purpose to improve dating and correlations with conodonts and ammonoids. In both the areas, for the first time, detailed bed-by-bed sampling was carried out.

The most fossiliferous unit in the Nakhlak area is the Alam Formation, where Olenekian, Aegean and Bithynian sediments are dated by their rich conodont and ammonoid faunas. Conodonts are especially important for the identification of the Olenekian-Anisian boundary, marked by the first occurrence of *Chiosella timorensis*.

In the Aghdarband area the Olenekian to Anisian succession is represented by the Sefid Kuh and Nazarkardeh Formations. The Sefid Kuh Fm. is characterized by Olenekian faunas, dominated by *Neospathodus triangularis*, accompanied by *N. homeri* and *N.* cf. *gondolelloides* at the top of the unit. The Nazarkardeh Formation contains in the lowermost part Aegean conodont faunas with *Neogondolella regale*, while the middle-upper part of the formation is characterized by rich ammonoid faunas of the *Nicomedites osmani* and *Aghdarbandites ismidicus* Zone along with conodonts of the *bulgarica* group.

Presentation format: Poster

CONODONT DIVERSITY AND EVOLUTION THROUGH THE LATEST PERMIAN AND EARLY TRIASSIC UPHEAVALS

Michael J. Orchard
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Study of latest Permian-Early Triassic multielement conodonts identifies eight steps in their evolutionary history: 1) gradual decline of families/ genera through the Changhsingian; 2) biofacies change and extinction of Tethyan endemics close to Permian-Triassic Boundary (PTB); 3) faunal turnover in late Griesbachian; 4) radiation in gondolellids and apparatus diversification during Dienerian; 5) explosive radiation in early-middle Smithian; 6) major extinction in late Smithian; 7) major radiation early in Spathian; 8) gradual turnover and decline in late Spathian through early Anisian. Conodontophorids were reduced from five families at the beginning of the Changhsingian to three by the PTB, and to two late in the Griesbachian. A single multielement gondolellid apparatus at the PTB sourced at least twelve by the Olenekian. Given absolute age constraints, the conodont recovery in the aftermath of the PTB was extraordinary. Conodont evolution during the Dienerian remains obscure but was very significant in multielement terms. In spite of Induan extinctions, generic diversity generally increased from the PTB up to the middle Smithian, the acme of Triassic conodonts. The largest extinction was in the late Smithian, after which generic and apparatus diversity quickly returned to high levels marking a significant Spathian recovery. Gradual decline characterized the late Spathian through early Anisian. A composited summary of the temporal distribution and proposed relationships amongst all of the known Lower Triassic conodonts provide an improved foundation for biostratigraphic and biochronologic studies. Extinction and radiation trends correlate well with sea-level changes and sequence boundaries: faunal turnovers correspond to lowstands in the late Griesbachian, late Smithian, and late Spathian, and radiations correspond to transgressions in the early Griesbachian, early Smithian, and early Spathian. The trends also correlate with perturbations in the carbon cycle, with Lower Triassic $\delta^{13}C$ minima corresponding to extinction and faunal turnover, and positive values generally occurring during radiations.

Presentation format: Keynote talk   *Day and time:* Thursday, 9:00

UPPER DEVONIAN CONODONTS FROM BOLIVIA

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A 17 m thick interval of drill core - Mobile Boliviana/Occidental Boliviana Pando X-1 - in northern Bolivia, Department of Pando, that penetrated approximately 700 m of Devonian strata, has yielded 75 conodonts. These were recovered from bedding surfaces of organic-rich shales within interbedded sandstones and shales of the Tomachi Formation in the Madre de Dios Basin. Conodonts from the 1579 m to 1583 m interval include *Polygnathus foliatus* Bryant *sensu* Ziegler et al. 2000, *Polygnathus* sp., and *Ozarkodina semialternans*?, suggestive of the Frasnian. The higher 1564 m to 1566 m interval yielded *Branmehla bohlenana* and *Cryptotaxis sp.*, a fauna similar to that described from the Upper Amazon Basin of Brazil, and indicative of the middle-upper Famennian. This places conodonts south of 60 degrees South latitude in the Upper Devonian and constrains biostratigraphic correlations based on palynomorphs as well as a magnetic susceptibility curve that was also measured from the core. The conodonts commonly occur with actinopterygian fish scales and have a conodont colour alteration index of 1.

Presentation format: Talk *Day and time:* Tuesday, 14:20

CONODONT BIOSTRATIGRAPHY AND BIOGEOGRAPHY OF ORDOVICIAN CHERTS FROM NEW SOUTH WALES, AUSTRALIA

Ian G. Percival
Geological Survey of New South Wales, Australia

Ordovician cherts occur in two terranes in the Lachlan Orogen of central and southern New South Wales: (1) Adaminaby Superterrane with craton-derived quartz sandstone-dominated turbidites, and (2) Narooma Terrane with oceanic cherts and argillites. These successions are often discontinuous or fault-bounded, with age control provided solely by conodonts preserved in cherts. Preparation of bedding-plane parallel thin sections of cherts allows identification of microfractured elements that would be destroyed by dissolution of the matrix using hydrofluoric acid. A preliminary biostratigraphic zonation recognises two zones in the Early Ordovician and a further two in the Darriwilian (late Middle Ordovician):

1. *Paracordylodus gracilis* assemblage zone, of late Lancefieldian to early Bendigonian age;
2. *Oepikodus evae* assemblage zone, of late Bendigonian to late Chewtonian age;
3. *Paroistodus horridus-Spinodus spinatus* asemblage zone, of early to mid Darriwilian age;
4. *Pygodus serra* assemblage zone, of late Darriwilian age.

This zonation assists in field mapping by indicating younging directions in thin chert beds separated by intervals of poorly exposed siltstones and sandstones, and allows correlation of isolated fault-bounded outcrops. Examples of the utility of the technique include (1) dating of pillow basalts of the Mount Dijou Volcanics by recognition of Early Ordovician conodonts (*Oepikodus evae* assemblage zone) in interstitial cherts, and (2) reinterpretation of the Narooma sequence as a disrupted synclinorium, rather than an anticlinorium.

Conodont faunas preserved in cherts are representative of the Open-Sea Realm, and, in the case of those from terranes of the Lachlan Orogen, inhabited the Tropical Domain. Comparison with Early Ordovician conodonts documented from cherts in Kazakhstan (Temperate to Cold Domain) suggests that many species are cosmopolitan, and extend into the Shallow-Sea Realm. Provincialism in the Open-Sea Realm is much less pronounced than is evident in shallow water faunas, and is likely to be masked by temperature variations of large-scale oceanic gyres.

Presentation format: Talk *Day and time:* Tuesday, 16:55

AFTER THE PERMIAN EXTINCTION: THE LAST RISE OF THE CONODONTS

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Conodonts were partially affected by the Upper Permian mass extinction, the biggest of the “Big Five Extinction Events”. Even though, three families (Ellisonidae, Spathognathodontidae, Gondonellidae) survivied the Permian-Triassic boundary. In the Lower Triassic conodonts show a quick recovery, but their variability was hardly affected and two families disappeared (Ellisonidae, Spathognathodontidae) during this stage. The Middle Triassic could be considered as a period of general environmental stabilization and taxa radiation; the Gondonellidae, the only survivor family, diversified greatly. During early Upper Triassic an important reduction in conodont taxa is seen, followed by a slight recovery in the Norian. During the Rhaetian, diversity was quickly reduced and conodont extinction took place just before the end Triassic, maybe related to another of the “Big Five Extinction Events”, the Triassic-Jurassic extinction event.

In this work, a worldwide conodont database including more than 150 species was used to calculate the origination, extinction and growth rates. We propose two causes of extinction, first the internal biological evolution of a Palaeozoic group and second the external geological events, both in conjunction drove the final conodont extinction at the end of the Triassic.

Presentation format: Talk *Day and time:* Thursday, 11:35

SEPHARDIELLINAE, A NEW GONDONELLIDAE SUBFAMILY FROM THE MIDDLE TRIASSIC

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In the course of the Middle Triassic, two generic conodont lineages, *Pseudofurnishius* and *Sephardiella*, evolved within the Sephardic Realm. Located at the western edge of Tethys, this realm lasted during the Middle Triassic until the Early Carnian Salinity Crisis and extended from Iberia and N. Africa, to Arabia and Apulia. The Sephardic realm reached its maximum extension in the Ladinian, during which interval some taxa spread worldwide. The genera *Pseudofurnishius* and *Sephardiella* form the new subfamily of Sephardiellinae based on very particular differential criteria. These include the structure of the basal cavity in element P1, variable morphologies at the level of the element P2, S3 element devoid of a diplodellid bifid anterior process.

The oldest taxon of the new subfamily is the Late Anisian *Pseudofurnishius shagami*, followed during the Ladinian by *P. sosioensis*, *P. huddlei* and finally *P. murcianus*. Derived from earliest forms of *Pseudofurnishius*, the Sephardiella lineage includes *S. truempyi*, *S. mungoensis*, *S. japonica*, ending with *S. diebeli* in Early Carnian. *Pseudofurnishius* appears to have been confined to slightly hypersaline waters of the Sephardic realm and of its Tethyan vicinity, during the Early Carnian. *Sephardiella* is a normal marine taxon that spread worldwide. The apparent derivation of *Mosherella* from *Pseudofurnishius* is not sufficiently substantiated.

Sephardiellinae became extinct during the Early Carnian.

Presentation format: Talk *Day and time:* Thursday, 12:55

MICROWEAR ON CONODONTS AND FISH TEETH AS A PALAEOECOLOGICAL TOOL

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Microscopic scratches and chips on the functional surfaces of conodont elements, combined with recurrent patterns of denticle abrasion and breakage provide strong direct evidence that elements functioned as teeth. Analysis of such microwear patterns on vertebrate teeth is now widely used to reveal details of the trophic ecology of extinct mammals, and can provide evidence of subtle shifts in diet tracking environmental change. Could analysis of wear in conodont teeth extend the applicability of these powerful methods beyond terrestrial mammals and into the marine Palaeozoic?

Application of microwear analysis to conodonts, however, raises a number of problems. These include differences in the size of mammal and conodont teeth, differences in the media within which they function, differences in the way teeth interact, occlude and are constrained during feeding, and differences in the source of abrasive particles that generate wear.

In order to address some of these problems a Leicester-based research team has undertaken the first analyses of dental microwear in fishes. Controlled feeding experiments have revealed that fish teeth develop microwear patterns which differ significantly according to mode of feeding (benthic feeding versus feeding within the water column) and substrate type. Further work on wild-caught and fossil fish has corroborated these results and provided the first direct evidence of shifts in habitat and feeding correlated with microevolutionary morphological change over geological timescales.

These results clearly demonstrate that microwear analysis has great potential for revealing details of the ecology and diet of aquatic vertebrates, including conodonts. The discovery that fish feeding within the plankton exhibit different tooth wear patterns to those feeding on benthos may allow the mode of life of particular conodont species to be determined with greater certainty than has been possible. This has obvious implications for the use of conodonts in palaeoecological and geochemical applications.

Presentation format: Talk *Day and time:* Thursday, 16:50

THE APPARATUS STRUCTURE OF THE CONIFORM CONODONT *PSEUDOONEOTODUS*: EVIDENCE FROM A COMPLETE ARTICULATED APPARATUS WITH SOFT PARTS?

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Hypotheses of element homology underpin almost all aspects of modern conodont palaeontology, and these hypotheses ultimately rest on our understanding of conodonts as skeletal apparatuses. Uncertainty regarding homology generates difficulties in application of element notation, in assessments of ecology and post-mortem bias, in determining stratigraphic ranges of species (rather than form taxa), in analysis of evolutionary relationships, and in palaeobiological research. Unfortunately, the conodont fossil record consists almost entirely of disarticulated remains, and for the vast majority of taxa the skeletal apparatus must be reconstructed using indirect methods. The confidence that can be placed in these reconstructions varies, but even the best are nothing more than hypotheses, the ultimate test of which is the discovery of the constituent elements as an articulated skeleton.

The problems of uncertain element homologies and their knock-on effects are particularly acute for conodonts which bore apparatuses composed of coniform elements. Very few articulated skeletons are known, and hypotheses of homology between coniform taxa and with better known ‘complex’ conodonts are consequently poorly constrained. The long ranging conodont genus *Pseudooneotodus* (Ordovician (?Tremadocian/Darriwilian) - Devonian (Emsian)) exemplifies many of these problems, but we report here a new articulated skeleton of *Pseudooneotodus* that may help to resolve matters.

The specimen comes from the Silurian Eramosa Lagerstätte, now known to contain the worlds most diverse fauna of articulated conodont skeletons. Like other conodont apparatuses recovered from this Lagerstätte, the *Pseudooneotodus* assemblage preserves remnants of soft-tissue anatomy. The apparatus confirms that elements were bilaterally opposed, but it contains fewer element types occupying fewer positions than current hypotheses predict, and provides no evidence for the anterior-posterior spatial and morphological differentiation that characterises most other conodont apparatuses. Whether the preserved elements are homologous with the P, S or M elements of other taxa is open to debate.

Presentation format: Talk *Day and time:* Monday, 15:45

DEVONIAN-CARBONIFEROUS CONODONT FAUNA FROM OCEANIC RADIOLARITES IN NORTHERN THAILAND

Carine Randon
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In northern Thailand, radiolarites (radiolarian cherts) are very common and their study represents an important tool to understand the regional and South-East Asian geology. They were deposited from Devonian to Triassic times. These continuous, siliceous and biogenic sediments bear witness to an oceanic realm that must have been opened between the Shan-Thai and the Indochina continental terranes and whose size must have been rather large and deep to avoid significant detritic and/or carbonaceous sedimentation (at least several hundred of kilometres as the present Red Sea, and several thousands of kilometres during Carboniferous and Permian). Some of these deep and distal oceanic series have yielded conodonts. This study focuses on the Upper Devonian and Lower Carboniferous conodonts from the Chiang Dao area (Chiang Mai province). Conodont faunas from these distal oceanic series are interesting for several reasons:

- They represent the first record of Upper Devonian –Lower Carboniferous conodonts from this region.
- They allow correlation of the radiolarian zonation established in northern Thailand with the standard conodont zonation.
- They provide a rare record of a deep oceanic conodont fauna.

The fauna ranges from Frasnian to Viséan. Conodonts are characterized mainly by species of the genus *Palmatolepis* (e.g. *P. eureka*, *P. regularis*, *P. glabra prima*, *P. minuta*) in the Devonian. In the Carboniferous, conodonts of the genera *Polygnathus*, *Hindeodus*, *Scaliognathus*, *Gnathodus* and *Lochriea* are represented. The conodont biozonation is correlated with the radiolarian zonation established by Wonganan (2005) in the Lower Carboniferous. The conodont assemblage found in oceanic deposits is similar to that of the external platform. However, conodont elements are smaller than those usually found in limestones. The different possible causes of this feature (taphonomic or biologic) are reviewed.

Presentation format: Talk *Day and time:* Friday, 10:00

CARBONIFEROUS “SILICEOUS EVENT”: THE CONODONT CONTRIBUTION

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During the Upper Devonian-Lower Carboniferous, biogenic siliceous sediments were deposited in different regions, and particularly in Europe. These siliceous sediments are well known as “lydites” or “lydian rocks” and correspond to a deposit of bedded cherts within limestone series. This “siliceous event” is considered to be Carboniferous in age and has often been interpreted as a deepening and/or a change in oceanic circulation. However, many questions remain regarding the time of deposition of these bedded cherts and their origin.

To answer these questions, a multidisciplinary approach was conducted, integrating analysis of conodont faunas, lithologic and microfacies analyses and inorganic geochemistry, based on outcrops in France (Pyrenees) and Spain (Cantabrian Mountains).

This study addresses the timing of deposition: do these deposits represent a widespread, global, isochronous event, or do they appear diachronously on different platforms according to local palaeogeographic conditions? Conodonts are a tool to answer this question. Conodont successions in four sections are presented. The biostratigraphic study of conodont faunas provides temporal constraint on the bedded cherts. It shows that deposition of bedded cherts occurred during the Late Tournaisian and during Viséan in different basins.

Presentation format: Poster

NEW CONODONT CAI-BASED THERMAL MATURITY MAPS FOR ORDOVICIAN AND DEVONIAN ROCKS OF THE CENTRAL APPALACHIAN AND MICHIGAN BASINS, USA

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New thermal maturation maps have been constructed for Ordovician and Devonian rocks of New York, Pennsylvania, West Virginia, Ohio, Kentucky, and Michigan, U.S.A., using conodont colour alteration index (CAI) values derived mainly from drill cuttings in several hundred wells. Ordovician and Devonian carbonate intervals were chosen because they are known to contain conodonts and they are within or near oil and gas reservoir zones and probable hydrocarbon source beds in the central Appalachian and Michigan basins. The addition of these new subsurface data have resulted in palaeothermal isograd patterns that complement, refine, and extend westward the primarily outcrop-based CAI maps constructed for the Appalachian basin by A.G. Harris and colleagues in 1978. For example, the new maps show thermal patterns that are aligned with, and probably causally related to, structural/geophysical features such as the Rome trough and selected basement-fault systems. Also, the CAI isograds indicate differing levels of compatibility with known hydrocarbon accumulations, suggesting that accumulations originating from local migration may be distinguished from those originating from longer-distance migration.

As in other palaeothermal investigations in both the Appalachian and the Michigan basins, the CAI isograds, as well as the %Ro isograds, indicate that a significantly greater thickness of overburden than is present today once existed over the region. Even so, some of the higher isograds likely resulted from some additional heating. Possible sources of this additional heating vary region to region but include crustal thinning and emplacement of mantle-derived rocks along reactivated extensional structures in post-Palaeozoic time, migration of geothermal fluids of elevated temperatures, and insulation of Lower Palaeozoic rocks by Devonian black shale and Pennsylvanian coal. These CAI data and maps will aid in the development of burial history/thermal history, hydrocarbon generation, and fluid flow models for this region.

Presentation format: Poster

IDIOGNATHODUS MORPHOTYPES ACROSS THE DESMOINESIAN-MISSOURIAN BOUNDARY IN MIDCONTINENT NORTH AMERICA: SIGNIFICANCE FOR PLACEMENT AND CORRELATION OF THE MIDDLE-UPPER PENNSYLVANIAN BOUNDARY

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The Moscovian-Kasimovian (Middle-Upper Pennsylvanian) boundary will likely be placed at the FAD of a species of *Idiognathodus*. In Midcontinent North America, abundant *Idiognathodus* occur in cyclothems that span the regional Desmoinesian-Missourian boundary, which may lie near the formalized Middle-Upper Pennsylvanian boundary. Midcontinent *Idiognathodus* collections comprise several morphotypes apparently distinct from coeval Eurasian taxa, but incomplete description of faunas from both regions hinders comparison and correlation.

The Lost Branch cyclothem is the highest Midcontinent cyclothem with a typical Desmoinesian fauna. *Idiognathodus expansus* and *Idiognathodus* n. sp. A occur with *Swadelina* and *Neognathodus*. The highest Desmoinesian level, the Checkerboard-South Mound minor cycle contains a range of *Idiognathodus* morphotypes, similar to, but distinct from *Idiognathodus* n. sp. A. These forms possess relatively long carinas and expanded adcarinal ridges, especially in small specimens, and vary from elements with broad triangular shapes with short outer lobes to ones with slender sagittate shapes and longer outer lobes. The basal Missourian Exline cyclothem includes morphotypes like those from the Checkerboard, but the carina is reduced and the upper platform is often more nodose than ridged. Broad strongly noded platforms occur, sagittate forms are better developed, and platforms with a complete inner eccentric groove appear. In the overlying Hertha (Mound City) cyclothem, *Idiognathodus* morphotypes from older cycles appear more distinctive, and new morphotypes with a central row of nodes or a broad shallow medial trough appear.

Presentation format: Poster

ARCHITECTURE, GROWTH AND FUNCTION OF THE *PANDERODUS* APPARATUS

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A functional model for the *Panderodus* apparatus has been developed which infers bilateral occlusion for the paired elements of the rostral domain (qt, qg and r) and a dorso-ventral motion for the symmetrical element (ae element). The function of the petromyzontid laminae presents a functional anologue for the rostral domain, as it incorporates occlusion of the bilateral components and a dorso-ventrally located median element; however, it lacks the rostral-caudal differentiation found in Panderodus.

The falciform pf element was located within the caudal domain in the same location as the P_2 element in the more derived ozarkodinid apparatus. The pf element increased in size, scaling with positive allometry and a growth rate that scales at 0.67, commensurate with a surface area to volume geometric relationship. This relationship implies that the pf elements were located within a circular pharyngeal cavity. The length of the element was constrained by the diameter of the pharynx. Both pharynx diameter and element length increased with the increasing food requirements of the growing animal.

Despite the morphology and growth of the pf and P_2 elements being markedly different in Panderodus and the derived ozarkodinids, respectively, we suggest locational homology and a similar function, for slicing the prey.

Presentation format: Talk *Day and time:* Monday, 14:45

EVOLUTIONARY MORPHOLOGIES AND SPECIATION EVENTS FROM SPANISH *GNATHODUS* Pa ELEMENTS

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Gnathodus species are characterized by highly variable Pa elements, usually used for biostratigraphic studies given their cosmopolitan distribution. Several new species of *Gnathodus* have been described in recent years, particularly from the Eurasian province. Among them, *G. joseramoni* Sanz-López et al., 2004, is a species probably derived from *G. semiglaber* through the growth in the length of the inner parapet. *G. joseramoni* probably gave rise to *G. kiensis* Pazukhin, 1992, through the distal outward deflection of the inner parapet. *G. kiensis* appeared in the range of *G. bilineatus* and persisted in the early Serpukhovian.

A new species (Sanz-López et al., submitted) is recognized from middle-late Serpukhovian to early Bashkirian beds of Northern Spain. It was described previously by Ji and Ziegler (1993) as "*G. bilineatus* subsp. A" from China. The Pa element has a relatively short inner parapet that is aligned obliquely with respect to the carina, in a similar way to that present in *G. kiensis*. However, other characters are considered typical of *G. bilineatus*. A small number of elements that occur just below and also with the new species are considered *G. b. bilineatus*, but showing a trend towards the new species.

G. joseramoni as *G. kiensis*, and "*G. bilineatus* subsp. A", include several morphotypes that are found in successive stratigraphical sequences. They show morphological trends that could correspond to hypothesized anagenetic lineages. However, the inner parapet morphology, considered an important diagnostic character, is developed in two different probable speciation events: first developed from a short parapet species (from *G. joseramoni* to *G. kiensis*) and later, from a long parapet species (from *G. b. bilineatus* to "*G. bilineatus* subsp. A").

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Presentation format: Poster

EARLY TRIASSIC (DIENERIAN) CONODONTS FROM NORTHERN THAILAND AND THEIR BEARING ON THE EVOLUTION OF MULTIELEMENT APPARATUSES

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Twenty conodont faunas from about a 1 metre thick interval of an unnamed Early Triassic unit west of Phrao, northern Thailand, are composed of several thousand well-preserved elements that appear to represent the full apparatuses of several species of the *Neospathodus dieneri* Sweet 1970 group. This group was amongst the first species from *Neogondolella* ancestors in the early Induan and as such represents the major rootstock for many Olenekian conodonts. The conodonts also serve as the primary tools in zonation of the Lower Triassic and a better understanding of their evolution promises to improve available biochronology.

The conodont faunas include two morphotypes of *N. dieneri*, plus fewer specimens of the new species *Neospathodus chii*, *N. concavus*, and ?*N. chaohuensis*, all recently described from Induan-Olenekian boundary beds at Chaohu, China (Zhao et al., in press). The faunas also contain rare specimens of *Neogondolella carinata* and *Hindeodus parvus*, species that have been regarded as casualties of the end-Griesbachian extinction. The faunas are regarded as Dienerian (late Induan) in age, dating from a time when multielement apparatuses of the ‘neospathodan’ gondolellids were going through rapid change.

By the Smithian (early Olenekian), at least nine different apparatuses have been recognized amongst taxa sourced in *Neospathodus* sensu stricto (Orchard, 2005) but the pathways along which these developed from a single gondolellid apparatus, presumably within the Dienerian, are unknown. The Thailand material contributes important data to our understanding of the evolving apparatuses of the Early Triassic. The horizons have yielded abundant specimens but at this stage of the work it is difficult to confidently differentiate all apparatuses. We discuss some of the key conodont elements, present possible multielement reconstructions, and speculate how they fit into the explosive radiation of conodonts in the Early Triassic.

Presentation format: oral *Day and time:* Thursday, 11:55

‘CONIFORM’ CONODONT APPARATUSES AND ARCHITECTURE - WHENCE AND WHITHER?

Paul Smith
University of Birmingham, UK

After thirty years of reconstructing the apparatus architecture of ‘complex’ conodonts [Ozarkodinida + Prioniodontida + Prioniodinida] it is becoming clear that a relatively small number of apparatus topologies are present within these groups. Within architectural reconstructions that are well-constrained by natural assemblage data, the number of elements is reasonably consistent, leading to suggestions that 15 elements is a synapomorphy for the Conodonta, with only a small number of more derived taxa (e.g. *Promissum*) exceeding this number. Similarly there is remarkably little variation from the ‘standard’ ozarkodinid architecture that was first elucidated as long ago as 1976. However, whilst knowledge of derived conodonts has matured to the point where detailed functional analysis can now be undertaken, the lack of understanding relating to non-prioniodontid primitive conodonts with coniform elements is profound, mainly due to the paucity of natural assemblages. Nevertheless, it is clear that some coniform taxa have a radically different architecture to more derived groups. *Panderodus*, *Besselodus* and *Cordylodus* all have well-constrained architectures in which element pairs oppose across the midline in linear arrays, rather than an ozarkodinid-style architecture. P, S and M homologues can be recognised within this architecture, but it is not currently possible to recognise the homologues of any individual S elements other than the S_0. A few natural assemblages suggest that other architectures are present within primitive conodonts, but progress is hampered by the lack of material. In the absence of more natural assemblage data, the only way forwards will be to improve the understanding of individual element homologies and of apparatus reconstructions of isolated elements. In the Ordovician, in particular, there is a suspicion that there are abundant partial, rather than full, apparatus reconstructions in the literature that cloud the true apparatus composition of coniform taxa and thus hinder the recognition of element homologies.

Presentation format: Keynote talk *Day and time:* Monday, 14:00

PRIDOLIAN TO PRAGIAN CONODONTS OF THE SEEWARTE SECTION (WOLAYER AREA, CARNIC ALPS, AUSTRIA)

Thomas J. Suttner
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The Pridolian to Pragian succession of Mount Seewarte includes the Megaerella Formation (slope sediments; 5-7m exposed), the Rauchkofel Formation (neritic facies; 120m) and the Hohe Warte Formation (platform sediments; at least 200m). Recent investigations provide new conodont data aiming to improve stratigraphic ranging of observed formations assumed by Vai 1973 and other authors.

Abundant conodonts were obtained from the Megaerella Formation indicating a late Pridolian age. The lower part of the Rauchkofel Formation yield a diverse fauna referring to the *delta* Zone (e.g. *Ancyrodelloides kutscheri*, *Ancyrodelloides limbacarinatus*, *Ancyrodelloides transitans*, *Flajsella schulzei*, *Flajsella stygia*, *Lanea omoalpha*, *Lanea eoeleanorae* and *Lanea telleri*). Above the last occurrence of the typical *delta* fauna M2 elements of *Pedavis* sp. were discovered within a short interval. This is succeeded by an eye-catching mega-conglomerate, the matrix of which yields elements of *Latericriodus steinachensis*, possibly tracing the base of the Pragian. Because of the shallow marine settings and platform development within the Hohe Warte Formation, difficulties were encountered in using standard conodont zonation for Pragian strata. Though the recovered conodont assemblages lack Pa elements of *Eognathodus*, the record of *Latericriodus steinachensis*, *Pelekysgnathus* sp. and *Caudicriodus* aff. *celtibericus* corresponds to and supports the alternative zonation by Slavik 2004 for the Pragian stage. Additional sparsely distributed Spathognathodontids (*Ozarkodina remscheidensis repetitor, Pandorinellina ebzeryi*, *Pandorinellina miae*, *Pandorinellina optima optima* and *Pandorinellina steinhornensis steinhornensis*) and few coniform taxa (*Coelocerodontus reduncus, Neopanderodus aequabilis* and *Neopanderodus leptostriatus*) were identified.

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Presentation format: Poster

BIOLOGICAL INTERPRETATION OF THE STRUCTURE OF PANDERODONTIDAE ELEMENTS

Hubert Szaniawski
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Morphology and internal structure of the elements of Panderodontidae differ from other conodonts (Barnes et al., 1973). Their most characteristic feature is a long, narrow furrow. It runs along the whole length of the inner surface and is very deep. Only at the base it broadens into a wider groove. On both sides of the furrow, and parallel to it, there is a series of very fine and sharp ridges. Adult specimens of some species have also short grooves on their basal part. Lateral faces of the elements are covered with fine striation. The furrow is nearly constant in all elements and must have had an important biological function. Apparatuses of the genus are composed of exclusively coniform, arched and usually strongly elongated elements. They have a very deep basal cavity in which basal body is often preserved. Comparative studies of the elements and fangs of venomous lizards and snakes, as well as teeth of venomous fishes, show that the furrow could be useful in a venom delivery system. Many of the venomous fangs of reptiles have a deep longitudinal groove and also sharp ridges or costae parallel to it. The costae serve for enlargement of the surface of the victim’s wound for better infiltration of venom. Often the fangs also have additional short grooves at the base, which probably are useful to drain off the venom, blood and saliva. Some of the fangs have also striation on their entire surface.

Another characteristic feature of elements of Panderodontidae are longitudinal channels in their basal body. The channels are well traceable in a series of cross sections. They are surrounded by thin walls and are independent of lamination. The channels most probably functioned as vascular canals.

Presentation format: Talk *Day and time:* Monday, 15:05

PANDERS’S CONODONTS: RE-EVALUATION OF SPECIES FROM THE TYPE AREA

Tatiana Tolmacheva
Russian Geological Institute, St. Petersburg, Russia

In his pioneer monograph, Ch. Pander described and figured 26 species of nine conodont genera that he collected in the Lower Ordovician glauconitic sandstones in the vicinity of St. Petersburg. Eight of his genera are widely in use, despite the absence of the type material. The main paradox of Pander’s conodonts is that the overwhelming majority of his formal species have never been recognised in collections from the corresponding stratigraphic level in countries neighbouring the St.Petersburg region. This is mainly due to the exotic taxonomic composition of conodont assemblages in the type area, which are different from those of Estonia and Sweden. However, identification of some Pander’s species in the collections from the type area is also problematic. The situation is complicated by the fact that the majority of outcrops mentioned by Pander no longer exist, with almost all of them now grassed over. Part of Pander’s original collection was found a few years ago in the museum of the Mining Institute in St. Petersburg , and this has helped to solve some of the problems of Pander’s conodonts. It has become clear that Pander selected conodonts by size and completeness during the picking and he seems to have illustrated the largest, sometimes gerontic, elements in the assemblage. Revision of *Acodus erectus* Pander, 1856, the most enigmatic of Pander’s conodonts, has shown that it is probably based on a broken specimen, which is nevertheless clearly identifiable as a part of the same natural assemblage as *Acodus crassus* Pander, 1856, also described by Pander according to form taxonomy. *Tripodus* Bradshaw, 1969, with the type species *T. laevis*, has an identical kind of apparatus and may be considered as a junior synonym of *Acodus* Pander.

Presentation format: Talk *Day and time:* Monday, 12:30

ORDOVICIAN CONODONTS IN PELAGIC TROPHIC WEBS: ASPECTS OF BEHAVIOUR AND PREDATION STRATEGIES

Tatiana Tolmacheva
Russian Geological Institute, St. Petersburg, Russia

Numerous faecal pellets collected from the Lower Ordovician radiolarian cherts of the Burubaital Formation in Central Kazakhstan demonstrate the existence of complicated trophic interactions of organisms in ancient ecosystems. The majority of the faecal pellets are composed of fragmented carapaces of pelagic arthropods; a lower number contain conodont elements. The size of the faecal pellets, and the number and taxonomic composition of contained conodont elements vary significantly, but almost all of them contain the remains of a single individual animal. Rare faecal pellets are composed of more than a hundred conodont elements of one species that are from animals of the same ontogenetic stage. It is considered that the majority of faecal pellets were produced by conodonts that were trophically linked to mesoplanktonic pelagic arthropods. It is most likely that the spectrum of feeding of conodonts was wide and that the conodont animal could feed on smaller representatives of other species as well as on juveniles. The strategy of predation was the consumption of one prey animal at one time. The unknown larger predator had the opposite predation strategy, consuming up to 10 or more conodont animals at once. The large pellets clearly demonstrate that at least some species of conodonts occurred in cohorts of individuals of the same age.

Presentation format: Talk *Day and time:* Thursday, 16:30

LOWER DEVONIAN CONODONTS FROM OBEJO-VALSEQUILLO-PUEBLA DE LA REINA DOMAIN (OSSA-MORENA ZONE, SPAIN)

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The Obejo-Valsequillo-Puebla de la Reina Domain (OVPD) is bounded by the Pedroches syncline to the north and the Badajoz-Córdoba shear Zone to the south and belongs to the Ossa-Morena Zone (Spain). The lower Devonian rocks of OVPD are characterized by a thick development of shallow water carbonates with minor siliciclastics. A multidisciplinary study (brachiopods, corals, stromatoporids, conodonts, microfacies) is ongoing; the goal of the current report is to present the conodont sequence obtained from four sections in the southeastern part of this domain (near Valsequillo).

The lowest record belongs to *Icriodus lotzei* that is a common middle-upper Lochkovian taxon in the classic Celtiberia region, where an icriodid zonation was developed. Above follows *Icr. fallax*, which is aligned with the upper Lochkovian. *Icr. angustoides angustoides* spans the Lochkovian/Pragian boundary, while *Icr. angs. castilianus* indicates a Pragian age. Specimens related to *Icr. curvicauda-Icr. celtibericus* indicate a position close to the Pragian-Emsian boundary in the traditional German sense. Specimens close to *Icr. bilatericrescens* clearly indicate Emsian. The uppermost beds in one of the sections yielded *Icriodus* of the *corniger* group, indicating upper Emsian and, perhaps, lower Eifelian.

In brief, a good icriodid sequence from four sections in the OVPD permits identification of Lochkovian, Pragian, Emsian and, possibly, earliest Eifelian Stages and allows precise correlations with other shallow-water sequences in southwestern Europe, such as Celtiberia and the Massif Armoricain, as well as North Africa.

This work has been supported by the Spanish DGICYT Research Grant BTE200302065 and represents a contribution to the IGCP 499 (Devonian land-sea interactions: evolution of Ecosystems and climate).

Presentation format: Talk *Day and time:* Tuesday, 11:50

CONODONTS OF THE MIDDLE/UPPER ORDOVICIAN BOUNDARY BEDS IN ESTONIA

Viive Viira
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The base of the global Upper Ordovician Series is defined by appearance of graptolite *Nemagraptus gracilis* 1.4 m below the phosphorite bed in the locality Fågelsång, Sweden. The Fågelsång Phosphorite coincides with the boundary between the *Pygodus anserinus* and the *Amorphognathus tvaerensis* zones, and thus the base of Upper Ordovician is defined in the upper part of the *P. anserinus* Zone.

In Estonia the conodonts of the Middle/Upper Ordovician boundary beds have been studied in 15 borehole sections and in the Kohtla outcrop. The conodont succession begins with *P. anserinus* and *Baltoniodus variabilis* and is followed by the interval with *B. variabilis*. At first, *A. tvaerensis* occurs rarely, but becomes more numerous higher in the stratigraphic succession. In the lowermost part of its range *A. tvaerensis* is accompanied by *Eoplacognathus elongatus* and in the upper part by *B. gerdae* and *B. alobatus*. The morphology of *A. tvaerensis* elements changes throughout the range. *A. tvaerensis* from the middle-upper part of the range in Estonia is similar to *A. tvaerensis* from the Tvären area, Sweden. The first specimens of *A. tvaerensis* in Estonian sections resemble early forms of this species from the Mojcza section in Poland, formerly identified as *A. inaequalis*. The similarity of Polish *A. tvaerensis* and Welsh *A. inaequalis* is of current interest in Estonia because *A. inaequalis* has been identified in two core sections.

Stratigraphically, *P. anserinus* occurs in the upper part of the Uhaku Stage. *A. tvaerensis* appears in the lower part of the Kukruse Stage or on the lower boundary of this stage, above the interval with *B. variabilis*. The base of the Upper Ordovician in Estonia coincides therefore with the lower boundary of the Kukruse Stage (appearance of *A. tvaerensis*) or some level below the last occurrences of *P. anserinus* in the upper part of the Uhaku Stage.

Presentation format: Poster

ENVIRONMENTAL CONTROLS ON THE COMPOSITION AND DISTRIBUTION OF EXCEPTIONALLY-PRESERVED CONODONTS AND OTHER VERTEBRATES IN THE ERAMOSA LAGERSTÄTTE, BRUCE PENINSULA, ONTARIO, CANADA

Peter H. von Bitter[1], Mark A. Purnell[2], and Christopher A. Stott[3]

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The composition of exceptionally-preserved conodont and other jawless vertebrate faunas occurring in the Eramosa Member of the Guelph Formation (Silurian/Wenlock) varies on the southern Bruce Peninsula across a geographically limited outcrop belt. Just north of Park Head, the most southerly locality, the vertebrate fauna consists of fluorescent corvaspid and tolypelepid heterostracan fish, associated with eurypterids, ostracodes and polychaetes. 3.4 km to the north, at Hepworth, abundant and well-preserved articulated skeletons of the conodont *Ozarkodina excavata* dominate; associated, but rare, articulated conodont skeletons include *Ozarkodina confluens, Ctenognathodus* cf. *murchisoni, Panderodus* and *Pseudooneotodus* species, and a new taxon. These conodonts occur with a sparse, low-diversity, shelly marine fauna of brachiopods and cephalopods, associated with rare eurypterids, graptolites and algae. Approximately 3 km west of Hepworth, faunal composition is reversed. Articulated skeletons of the conodont *Ctenognathodus* cf. *murchisoni* dominate, associated with rare articulated skeletons of *Panderodus* and the new taxon (above). *Ozarkodina* species, non-conodont vertebrates and marine invertebrates are either absent, or are exceedingly rare.

The Park Head vertebrate biota, lacking associated stenohaline biotic elements such as conodonts, brachiopods and cephalopods, but containing eurypterids, polychaetes and ostracodes, groups tolerant of a range of salinities, likely inhabited near-shore, brackish-water, hyposaline environments. The abundance of *Ctenognathodus* cf. *murchisoni*, the apparent absence of *Ozarkodina* species, and the apparent absence of more normal-marine invertebrates west of Hepworth, suggests that this biota lived under shallow-water, lagoonal conditions. The dominance of *Ozarkodina excavata* and the presence of a more normal-marine macrofauna at Hepworth indicates that the biota lived under more open-marine conditions. Assuming contemporaneity of environments, we postulate the existence of an environmental gradient in the shallow-water, epeiric seas of the southern Bruce Peninsula; marginal-marine conditions in the south graded into lagoonal, marine environments to the northwest, and into more open-marine conditions to the north and the north-east.

Presentation format: Talk *Day and time:* Friday, 9:00

OULODUS – HOMOLOGY, CLADISTIC ANALYSIS AND EVOLUTIONARY RELATIONSHIPS

Linda M. Wickstrom
Geological Survey of Sweden, Uppsala, Sweden

Oulodus has by many been considered as a problematic prioniodinid conodont. The composition of its apparatus is poorly known and there are many different hypotheses regarding the intrageneric relationships, origin and diversification of the genus. However, none of these evolutionary hypotheses has been independently tested in a single phylogenetic analysis. The cladistic analysis presented is a first attempt to resolve the evolutionary relationships of *Oulodus*. The analysis includes all taxa of *Oulodus* following the present understanding of the genus and those taxa that previously have been included in the genus. Species previsouly considered closely related have also been included in the analysis in order to test monophyly of *Oulodus*.

The backbone for any phylogenetic study is homology. Positional homologies within the apparatus and element homologies, i.e. homologies among separate elements, are therefore crucial in order to understand conodont evolution. *Oulodus* is unknown from natural assemblages. Thus, in order to constrain positional homologies, species known from bedding plane assemblages have been used as role models. Following these models and studies of published and unpublished collections, published data of *Oulodus* apparatuses have been reconsidered.

The cladistic analysis is based on morphological data originating from all 15 element positions. Stratigraphic data has not been used during cladogram reconstruction. A total of 129 characters and 43 taxa have been included in the primary analysis, producing 165 equally most parsimonious trees. A posteriori reweighting reduced the number of trees to 1.

Presentation format: Talk

Day and time: Thursday, 15:00

FINDING OF IMPRINTS OF EUCONODONT SOFT TISSUES IN THE LOWER CARBONIFEROUS SHALE OF THE NORTHERN URALS

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The first imprints of the soft body of euconodonts to be found in Russia come from a cherty carbonaceous shale in the Kozhim River section of the Northern Urals (Lower Tournaisian, *sulcata* zone) (Zhuravlev, 1997). They represent a complex of specimens revealing from the outer side of the animal. They have different sizes, orientation, and preservation. The best preserved imprint, about 9 mm long, is described. Its body consists of head and body parts. On of this imprint there are the head with H elements and the body part of another animal. The trunk of the specimen has a worm-like, laterally compressed form and contains irregular parallel transverse segment-like structures. The head has the H elements and the set of S elements, which are directed obliquely to the body axis. Parts of three S elements with hindeodellan denticulation and strongly inclined denticles can be recognized. The H elements of this imprint are very similar to the H elements of the euconodont animal of Granton, Scotland (Buryi, Kasatkina, 2004). A particular feature of the muscular system of these imprints is the presence of transverse segment-like structures (annulation) that makes them different from primitive chordats (Kasatkina, Buryi, 2006, in press).

The work was made under the financial support of RFBR grant 06-04-96051.

Presentation format: Poster

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